Banking outreach, infrastructure development and regional growth

Empirical evidence from Indian states

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Abstract

Purpose – The purpose of this paper is to examine the dynamics between banking penetration, infrastructure development and regional growth within a multivariate framework in 23 Indian states over the period 2000-2012.

Design/methodology/approach – The study employs the multivariate panel data framework to analyze the dynamics between banking penetration, infrastructure development and regional growth within the vector error correction model (VECM) framework.

Findings – The findings confirm the long-run equilibrium relationship between banking penetration, infrastructure and income for the panel. Long-run income elasticity of infrastructure, estimated using Panel dynamic ordinary least square, is positive, statistically significant and has a value of 0.1531. Further, results show bidirectional causality between income and aggregate infrastructure and unidirectional causality running from banking penetration to income and aggregate infrastructure in the long run. However, there is unidirectional causality running from income to banking penetration and aggregate infrastructure and from banking penetration to aggregate infrastructure in the short run.

Research limitations/implications – The study mainly concentrates on the 2000-2012 period and includes transportation (roadways and railways), energy (including electricity) and telecommunication as indicators for infrastructure, as the data for these sectors are easily available at the state level. Second, this study employs the panel data technique as it has a shorter data count.

Practical implications – In order to minimize the existing regional disparity in a developing India, national infrastructure policies should be aimed toward improving the overall access to as well as the quality of infrastructure (existing as well as newly planned). Further, widening the banking outreach at the bottom level may further help the economy as well as the infrastructure sector in mobilizing long-term finances for productive investments, in order to have a balanced, more inclusive and faster growth in the long run.

Originality/value – The study employs panel unit root, cointegration and Granger causality tests within the panel VECM framework to explore the dynamics among the system variables. Further, the study creates a composite index of infrastructure with principle component analysis.

Keywords India, Infrastructure, Banking outreach, Panel vector error correction method, Regional growth

Paper type Research paper

1. Introduction

Limited and below-par domestic infrastructure in developing countries is often cited as an important impediment for stimulating productivity and growth, be it the economic, industrial or service sector. Therefore, there is a great amount of economic literature, post Aschauer (1989), exploring the contribution of infrastructure to growth. There is extensive literature (e.g. Aschauer, 1989; Munnell, 1990; Munnell and Cook, 1990; Easterly and Rebelo, 1993; World Bank, 1994; Röller and Waverman, 2001; Mitra *et al.*, 2002, 2012, 2016; Calderon and Servén, 2003; Calderon *et al.*, 2004; Canning and Pedroni, 2004; Hulten *et al.*, 2006; Lall, 2007; Sahoo and Dash, 2009, 2012; Dash and Sahoo, 2010; Sharma and Sehgal, 2010; Pradhan and Bagchi, 2013; Vidyarthi and Sharma, 2014; Calderon *et al.*, 2015; Mohmand *et al.*, 2016) supporting the fact that improvement in infrastructure fosters firm efficiency and competitiveness in national and international markets, improves regional connectivity, lowers trade cost, improves market access, sustains development and accelerates social development. However, studies by Evans and Karras (1994) and Holtz-Eakin (1994) challenged

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these findings on a methodological basis and showed an insignificant, negative or minimal impact of public infrastructure. Against the inconsistency of empirical findings on the impact of infrastructure growth, the current study reinvestigates the relationship between banking penetration, infrastructure development and regional growth in India during 2000-2012 within a panel data framework.

Since the economic reforms initiated in the early 1990s, India has experienced a remarkable uninterrupted average growth of 6.4 percent per annum and since 2014 has become the third largest economy in the world after USA and China (based on purchasing power parity). This growth has resulted in an unprecedented increase in infrastructure across the nation over the years, and the demand-supply mismatch is still growing. The major constraints from the supply side are lack of strong political will, red tapism, land acquisitions, corruption, political and regulatory risk, access to financing and macroeconomic instability; these constraints have affected the overall growth in recent times, even after a gradual opening of the infrastructure sector to the private sector's strategic public-private partnership, viable gap funding provisioning, up to 100 percent FDI in greenfield projects, tax incentives, the Ujwal Discom Assurance Yojana, proactive governance and timely implementation (Pragati), flexibility in refinancing infra projects (5/25 scheme), CRR/SLR exemptions to banks with respect to infrastructure bonds, liberalization of external commercial borrowing policy and transmission of rate cuts by the Reserve Bank of India to further accelerate infrastructure investments across the country.

Even the banking sector has gone through phenomenal changes in terms of banking penetration, participation of private and foreign sector banks, core banking system and reality of anytime anywhere banking with the help of automatic teller machines, gradual improvement in its asset quality and efficiency, and introduction of internet banking, mobile banking and social banking. Further, it needs to be noted clearly that the banking sector remains the primary source of debt funding for the infrastructure sector, as the corporate debt markets and pension fund are still in nascent stages. Banking sector lending toward infrastructure has continuously gone up to more than one-third of the gross industrial credit (INR9,648.11 billion as on March 18, 2016) with a cumulative annual growth rate of more than 25 percent, i.e. higher than overall credit growth (about 15 percent) during the last 15 years. The bank-deposit-based (typically having a maturity of less than three years) financing of infrastructure project loans with a tenure of 10-15 years is posing a serious asset liability mismatch, as the bank's exposure to the infrastructure is still significant and growing. However, the recent economic slowdown, inflated project cost, overestimated demand-supply positions, poor project appraisal system and aggressive bidding system resulted in all-time high stressed assets in the sector. This has adversely affected the infrastructure companies as well as the banking sector profitability because of excessive provisioning for bad debts.

India's total surfaced road network has reached 29.88 lakh kilometers (comprising 79,116 kilometers of national highways and 167,219 kilometers of state highways), the country's rail network has reached 65,436 kilometers (including 23,541 kilometers of electrified network), total electricity generation capacity has increased to 264,169 megawatts (including 40,726 megawatts of non-utilities) and telecommunications subscriber base has expanded to 89.80 crores, including 3.02 crore subscribers of wireline networks at the end of 2012 (source: Planning Commission[1], Government of India). However, national and state highways constitute only about 2 and 4 percent of the total road network, respectively, but carry almost 40 and 25-30 percent, respectively, of the total road traffic.

However, India's infrastructure performance with respect to other developing countries like China, Malaysia or the Russian Federation is still poor in almost all indicators (whether quality or quantity based), as per the recent Global Competitiveness Report (GCR 2012-2013) released by the World Economic Forum. India's ranking is 84th out of 144 countries in terms of overall infrastructure, with a score of 3.60[2]. However, India ranked 87th, 27th, 86th and

110th out of 144 countries in terms of quality of overall infrastructure and railroad, road and electricity supply, respectively. India's ranking further slipped to 116th and 118th out of 144 in case of mobile telephone and fixed/wireline telephone infrastructure, respectively, based on subscriptions per 100 people.

Further, the GCR also reports that lack of adequate infrastructure is the factor most detrimental to growth of business in India. Even the World Bank investment climate surveys (2014) and Planning Commission (2011) have expressed similar views about the limited and poor quality of infrastructure, particularly electricity and transportation (road and rail), which acts as a major constraint to growth. To overcome the pan-India infrastructure deficiencies, the Government of India has gradually increased the infrastructure investment to 9.14 (projected), 7.22 and 5.02 percent of GDP during the 12th, 11th and 10th five-year plans, respectively. In absolute terms, these investments correspond approximately to 51.46, 27.29 and 13.15 lakh crores (at constant 2011-2012 prices), respectively. Further, moving to the regional level, access to infrastructure (road, rail, electricity or telecommunications), banking services or social infrastructure is highly asymmetric, thus creating serious regional disparity. The regional asymmetry poses serious concern to the proposed double-digit growth in the near future. Some interesting facts are listed below:

(1) Of the entire road network in the six states of Haryana, Gujarat, Punjab, Maharashtra, Tamil Nadu and Rajasthan, more than 80 percent in each state are quality paved roads; on the other hand, Assam (19 percent) and Odisha (24 percent) have the minimum paved road concentration compared with the national average of 63 percent.

(2) Road density in Jammu and Kashmir, Uttar Pradesh and Jharkhand is still less than one-third of the national average of 765 kilometers of road network per thousand square kilometers of territorial area.

(3) Network penetration of railways in terms of rail density (kilometers of rail route network per thousand square kilometers of territorial area) is the least in Jammu and Kashmir, followed by Himachal Pradesh, Uttarakhand and Chhattisgarh; it is maximum in Delhi, followed by West Bengal, Punjab, Bihar and Haryana.

(4) Electricity consumption per capita is the least in Bihar, as low as 145 KWh (just 16 percent of the national average of 914 KWh) in 2012-2013 compared with Goa (2,045 KWh), Gujarat (1,796 KWh) and Punjab (1,761 KWh). Even electricity transmission and distribution losses are still very high in Jammu and Kashmir (46.72 percent), Bihar (42 percent) and Odisha (39.84 percent) compared with the national average of nearly 22 percent of gross generation, showing poor technical management. The four states of Odisha, Uttar Pradesh, Jharkhand and Bihar constitute almost 80 percent of the still un-electrified villages in the country (33,060 villages) as on 2012-2013.

(5) The overall condition of telecommunication infrastructure based on tele-density (subscriber base per 100 people) has shown remarkable growth, particularly because of better connectivity, mobility, cheap tariffs and easy availability of cellular connections in recent years, particularly in urban areas. The overall telecommunication penetration remains poor in Assam (46.61) and Bihar – Jharkhand (48.90), followed by Madhya Pradesh – Chhattisgarh (53.81), Jammu and Kashmir (54.82) and Uttar Pradesh – Uttaranchal (60.93), compared with the national average of 78.66. However, there is a wide gap between urban tele-density (169.17) and rural tele-density (39.28) at national as well as state level. Thus, the infrastructure availability across states still remains very uneven, posing a serious threat to a balanced national growth.

The objective of the study is to empirically examine the impact of banking penetration and aggregate infrastructure on regional growth for the 23 Indian states, namely Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal, during 2000-2012 and to derive the policy implication from the empirical findings. This paper differs from earlier studies focusing on India in three important ways. First, this paper focuses particularly on India, and (to the best of our knowledge) no such study exists that examines the relationship between banking penetration, aggregate infrastructure and regional growth within a panel framework comprising 23 states, which treats the recently created states of Chhattisgarh, Jharkhand and Uttarakhand separately from Madhya Pradesh, Bihar and Uttar Pradesh, respectively. A multivariate framework has been employed for analysis in order to avoid the omitted variable biases associated with the bivariate analysis with fairly longer data sets ($23 \times 13 = 299$ data points). Second, this study employs panel unit root, cointegration and causality techniques, which yield additional power by combining the cross-section and time-series data while allowing for heterogeneity across cross-sections. Further, this study extends its scope by examining the short-run and long-run causality prevailing among the variables within the vector error correction model (VECM) framework for robust analysis. Third, this study prefers to employ physical measures of infrastructure (energy, transport or telecommunications) instead of gross public expenditure/infrastructure investments or single infrastructure indicator as the sole proxy for overall infrastructure, because of the geographical nature of the regions, governance structure and poor outcomes of infrastructure investment. Acknowledging the multidimensional nature of infrastructure capitals, this study computes the synthetic index of infrastructure using principle component analysis (hereafter PCA) to minimize the multicollinearity problem arising from the inclusion of too many variables individually in the estimation and to obtain the cumulative impact of overall infrastructure (comprising of energy, transport and telecommunications) on growth. Finally, the findings of this paper may supplement the formulation of appropriate regional infrastructure policies for further accelerating the growth momentum in India.

The rest of this paper is organized as follows. Section 2 presents the methodology and data employed in the study. Section 3 presents and discusses the empirical findings. Section 4 offers concluding remarks with policy implications from the results.

2. Methodology and data

Following related literature[3], this study analyzes the impact of banking penetration and aggregate infrastructure on regional growth within a multivariate panel framework for 23 Indian states during 2000-2012 with an econometric model in log-linear form:

$$Y_{it} = \alpha_i + \beta_{1t}\text{BP}_{it} + \beta_{2i}\text{Infrastructure}_{it} + \varepsilon_{it}$$

where $i = 1, 2, 3, \ldots, 23$ refers to each state in the panel; $t = 2000, 2001, \ldots, 2012$ denotes the year; α_i, β_1 and β_2 indicate the constant term, long-run income elasticity of banking penetration and infrastructure, respectively; and ε_{it} refers to independently and normally distributed random variables for all i and t with zero means and finite heterogenous variances (σ_i^2). Y, BP and Infrastructure denote natural logarithmic transformation of income per capita, banking penetration and aggregate infrastructure index created using PCA. Long-run and causal relationship between banking penetration, aggregate infrastructure and regional growth for 23 Indian states has been examined with the help of panel unit root test, panel cointegration test and panel causality test.

Analysis begins with exploring the order of integration of variables with the help of Levin *et al.* (2002), Im *et al.* (2003) and Pesaran (2007) CADF panel unit-root tests (hereafter referred to as Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS) and Pesaran test, respectively) as a perquisite for cointegration analysis. In the second stage, Kao's and Pedroni's panel cointegration tests are applied to examine the possible long-run equilibrium relationship among variables in consideration, followed by an estimation of the cointegrating equation using the panel dynamic ordinary least square (DOLS[4]). Panel DOLS estimator (Mark and Sul, 2003) corrects the standard ordinary least square for bias due to serial correlation and endogeneity. Finally, the VECM (Engle and Granger, 1987) is used to explore the direction of causality among variables in the short run and the long run:

$$\Delta Y_{it} = \alpha_{1i} + \sum_{i=1}^{p} \theta_{11ip} \Delta Y_{it-p} + \sum_{i=1}^{p} \theta_{12ip} \Delta \mathrm{BP}_{it-p} + \sum_{i=1}^{p} \theta_{13ip} \Delta \mathrm{Infra}_{it-p} + \varphi_{1i} \mathrm{ECT}_{t-1} + \mu_{1it} \quad (1)$$

$$\Delta \mathrm{BP}_{it} = \alpha_{2i} + \sum_{i=1}^{p} \theta_{21ip} \Delta Y_{it-p} + \sum_{i=1}^{p} \theta_{22ip} \Delta \mathrm{BP}_{it-p} + \sum_{i=1}^{p} \theta_{23ip} \Delta \mathrm{Infra}_{it-p} + \varphi_{2i} \mathrm{ECT}_{t-1} + \mu_{2it} \quad (2)$$

$$\Delta \mathrm{Infra}_{it} = \alpha_{3i} + \sum_{i=1}^{p} \theta_{31ip} \Delta Y_{it-p} + \sum_{i=1}^{p} \theta_{32ip} \Delta \mathrm{BP}_{it-p} + \sum_{i=1}^{p} \theta_{33ip} \Delta \mathrm{Infra}_{it-p} + \varphi_{3i} \mathrm{ECT}_{t-1} + \mu_{3it} \quad (3)$$

where Δ, p and ECT denote the first-difference operator, the lag length and the lagged error correction term (ECT) derived from long-run cointegrating relationship. The statistical significance of the first-differenced variables provides the evidence for the direction of causality in the short run. However, long-run causality is explained by the significance of the t-statistic coefficients of ECT (φ_{1i}, φ_{2i} and φ_{3i}).

2.1 Data

This study mainly focuses on three infrastructure sectors: energy, including electricity; transport, comprising railways and roadways; and telecommunications. Annual data of geographic branch penetration (number of banking branches per thousand square kilometers of territorial area), electricity consumption (kilowatts per capita), oil consumption (liters per capita), rail density (kilometer of rail route length per thousand square kilometers of territorial area), road density (kilometer of road network per thousand square kilometer territorial area) and tele-density (wireline and wireless phones subscriber base per 100 people) have been taken as sectoral indicators for banking penetration, electricity, energy, railways, roadways and telecommunications infrastructure, respectively. Regional growth is measured using per-capita state domestic product at 2004-2005 constant base price. The analysis is based on almost 299 observations consisting of a 13-year data set of 23 Indian states.

These data sets have been extracted from the RBI's *Handbook of Statistics of Indian Economy 2014*, and State of India database of the Centre for Monitoring Indian Economy. Further, a composite index of infrastructure as a representative of the aggregate infrastructure indicator has been created using PCA. Our composite index is represented by the first two principle components (having eigenvalue larger than 1), which explain almost 80 percent of the total variation among them. The eigenvalues and variance of respective principle components along with corresponding factor loadings are given in Tables AII and AIII, respectively.

3. Empirical results

The results of LLC, IPS and Pesaran (2007) CADF unit-root tests for the level- and first-differenced series of all of the variables used in the study are presented in Table I. Results indicate that all series are non-stationary at level and integrated to order 1, i.e. $I(1)$. As the variables are integrated at first difference, we can proceed further to perform Kao's and Pedroni's panel cointegration tests.

Kao's and Pedroni's cointegration tests are presented in Table II. The results show that all test statistics for both tests are statistically significant at 5 percent or a stricter 1 percent significance level. Thus, the null hypothesis of no cointegration can be rejected through both tests indicating that the system variables have a long-run equilibrium relationship. Therefore, there is evidence of a long-run equilibrium relationship between banking penetration, infrastructure and regional growth for the panel. Hence, the study proceeds to reveal the cointegrating relationship using Panel DOLS.

Table III shows that the Panel DOLS results suggest that all the coefficients are positive and statistically significant at 10 percent or a stricter 1 percent significance level. Because this study uses variables after logarithmic transformation, these coefficients can be considered as

Table I. Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS) and Pesaran (2007) CADF unit root test results, 2000-2012

	Levin, Lin and Chu (LLC) test		Im, Pesaran and Shin (IPS) test		Pesaran's CADF test		
Variables ↓	Level	First difference	Level	First difference	Level	First difference	Order of integration
Banking	5.28708	−7.0333*	10.7636	−1.4401***	2.119	−5.789*	$I(1)$
Infrastructure	5.42841	−2.9204*	−0.6904	−3.5111*	3.889	−6.678*	$I(1)$
Y_{pc}	1.93391	−7.24218	6.80849	−6.2370*	−2.256	−2.659**	$I(1)$

Notes: *,**,***Statistically significant at 1, 5 and 10 percent levels, respectively
Source: Author's estimation

Table II. Kao's and Pedroni's panel cointegration test results, 2000-2012

Test ↓			Statistics ↓
Kao test		ADF stat	−1.8397**
Pedroni test	Within dimension	Panel v-stat	3.5057*
		Panel ρ-stat	−3.7536*
		Panel PP-stat	−15.0386*
		Panel ADF-stat	−17.1184*
	Between dimension	Group ρ-stat	−0.708776
		Group PP-stat	−12.8787*
		Group ADF-stat	−14.0755*

Notes: Model infrastructure: the cointegration among per-capita state domestic product, banking penetration and aggregate infrastructure index. *,**Statistically significant at 1 and 5 percent levels, respectively
Source: Author's estimation

Table III. Selected results of panel DOLS

Independent variables ↓	Statistics ↓
Banking	0.5800*
Infrastructure	0.1531***

Notes: *,***Statistically significant at 1 and 10 percent levels, respectively
Source: Author's estimates

income elasticity estimates. Thus, a 1 percent increase in aggregate infrastructure stocks and banking penetration increases the SGDP per capita by 0.1531 and 0.5800 percent, respectively. Because all variables under consideration are integrated to order 1 and cointegrated in the long run, it suggests that there is a causal relationship between banking penetration, infrastructure and SGDP per capita in at least one direction without specifying the direction of causality. Therefore, the study proceeds to employ the Panel VECM to investigate the causal relationship among the variables of the panel.

Table IV reports the VECM results for the panel. The optimal lag-length selection is based on the Schwarz information criterion. The long-run causality is confirmed by the statistical significance of the ECT in Equations (1)-(3). The causality results have been summarized as follows:

(1) The coefficients of ECT_{t-1} are negative and statistically significant in all equations except when banking penetration acts as a dependent variable. This implies that there is bidirectional causality between regional growth and aggregate infrastructure and unidirectional causality running from banking penetration to regional growth and aggregate infrastructure in the long run. Bidirectional causality between income and aggregate infrastructure suggests that:

- As economy sizes grow, the demand for infrastructure services also increases, and once the infrastructure reaches the threshold value its role as the stimulus for growth becomes much more visible.
- Any supply-side constraint in meeting the demand for these infrastructure services for productive production/consumption may have an adverse impact on the economy. Thus, infrastructure policies should focus on improving the overall efficiency (by working toward reduction of transmission and distribution losses, renewable energy development, using energy efficient equipment, sustainable traffic management, better public transport, etc.) and toward further expansion of new infrastructure over time and across the sectors. Further, uneven infrastructure availability at the regional level needs to be addressed on an urgent basis through the creation of new infrastructure for sustainable, more inclusive and faster growth across the nation.

(2) The presence of the long-run unidirectional causality running from banking penetration to aggregate infrastructure implies that the banking sector acts as a major lender for all capital-intensive infrastructure (electricity, energy, rail, road and telecommunications) development in a country like India (that still does not have developed corporate debt markets and where the response to infrastructure projects from equity markets is poor). Thus, a better banking outreach leading to capital mobilization has a significant and unidirectional impact on infrastructure development.

(3) However, there is unidirectional causality from regional growth to banking penetration and bidirectional causality from banking penetration to aggregate infrastructure in the short run. The short-run unidirectional causality running from

Table IV. Selected results of Granger causality tests based on panel VECM

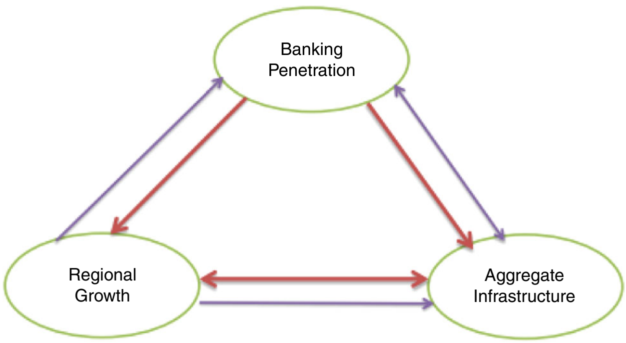
Model	Dependent variables↓	ΔY	ΔBanking	ΔInfrastructure	ECT
Electricity	ΔY	–	4.292665	0.497898	−0.015636*
	ΔBanking	18.4163*	–	13.5494*	0.00000292
	ΔInfrastructure	1.4955*	8.1451**	–	−0.089657*

Note: *,**Statistically significant at 1 and 5 percent levels, respectively
Source: Author’s estimation

SGDP per capita to banking penetration suggests the economy's expansionary effect on banking penetration. The banking sector acts as a primary mover for stimulating surplus investment or borrowing or routing normal financial transactions smoothly among the financial stakeholders. Further, recent demonetization, increased emphasis on cashless society, and financial inclusion thrust at the bottom of the pyramid by the government to connect unbanked people to the formal banking sector on a priority basis may not be implemented without adequate infrastructure (particularly telecommunications, energy along with electricity, railways as well as roadways) provisioning (Figure 1).

4. Conclusion

The study examines the impact of banking penetration and infrastructure on regional growth in the 23 Indian states within a multivariate panel framework for the period 2000-2012. Our analysis reveals the presence of a long-term equilibrium relationship among the variables under consideration, suggesting that banking penetration and infrastructure are positively correlated to regional growth in the long run. The income elasticity of infrastructure is 0.1531, suggesting that 1 percent increase in infrastructure stocks increases the SGDP per capita by 0.1531 percent. Further, results confirm bidirectional causality between income and aggregate infrastructure and unidirectional causality running from banking penetration to income and aggregate infrastructure in the long run. However, there is unidirectional causality from income to banking penetration and aggregate infrastructure and from banking penetration to aggregate infrastructure in the short run. In the light of these results, the study emphasizes the creation of a nationwide adequate infrastructure intended to improve the overall quality and access in order to reduce the regional disparity currently existing in the country. These can be achieved either through enhancing the direct public spending or through promoting public-private partnerships in case of viable infrastructure projects. After the level of infrastructure reaches the threshold level, its impact on the economy becomes more visible in the long run. Second, policies intended to further improve the robustness and efficiency of the Indian banking system are warranted in the near future because they will help in mobilizing the required capital for the productive sectors of the economy, particularly capital-intensive infrastructure, as there is an absence of structured corporate debt market and because there is a poor response to infrastructure sector companies in equity markets.



Notes: [red line] and [purple line] represent long run and short run causality respectively

Figure 1. Long-run and short-run causality representation among variables

Notes

1. Planning Commission has been transformed into Niti Aayog with effect from January 1, 2015.
2. The possible score ranges from 1 (worst) to 7 (best).
3. Munnell (1990), Mitra *et al.* (2002, 2012), Calderon and Servén (2003), Canning and Pedroni (2004), Sharma and Sehgal (2010).
4. Kao and Chiang (2000) show that OLS and FMOLS are biased and they are both outperformed by the DOLS estimator. The DOLS method allows for consistent and efficient estimators of the long-run relationship. It also deals with the endogeneity of regressors and accounts for integration and cointegration properties of data.

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Appendix

States/UTs	National highways (KM)	State highways (KM)	Surfaced road length (KM)	Total length of roads (KM)	Total route length (KM)	Total route kilometers electrified (KM)	Eletricity consumption per capita (kw)	T and D losses as %	Gross installed capacity (MW)
Andhra Pradesh	5,022	10,700	172,272	256,448	5,322	2,759	1,134.9	16	13,792.00
Assam	2,940	3,134	53,525	284,232	2,459	na	240.28	26.69	512.5
Delhi	80		22,025	30,711	183	139	1,613.25	*22.11*	1,812.00
Gujarat	3,828	18,506	146,575	163,149	5,257	785	1,796.29	18.4	22,402.20
Haryana	1,633	2,416	38,679	42,638	1,630	416	1,722.3	23.72	5,916.60
Himachal Pradesh	1,506	1,504	35,529	50,449	296	15	1,379.78	12.39	2,729.60
Jammu and Kashmir	1,695	–	21,980	36,353	256	106	1,043.36	46.72	1,094.50
Karnataka	4,642	20,749	198,777	303,128	3,228	338	1,129.09	19.09	12,126.00
Kerala	1,457	4,341	123,869	215,438	1,050	694	630.07	16.77	2,605.30
Odisha	4,416	3,607	60,846	254,709	2,507	1,473	1,209.21	39.84	5,329.20
Punjab	1,557	1,477	83,717	93,871	2,215	615	1,761.08	16.84	5,772.80
Rajasthan	7,180	10,465	202,584	248,604	5,872	656	981.85	23	9,964.40
Tamil Nadu	4,943	10,764	188,087	230,200	4,027	1,708	1,226.26	20	15,484.20
West Bengal	2,681	3,952	131,904	315,404	4,037	2,241	593.86	21.09	7,572.00
Tripura	400	689	14,548	29,248	151	na	296.05	22.36	169.4
Bihar	4,168	4,483	65,356	138,517	3,656	1,390	145.42	42	544
Jharkhand	2,374	1,960	18,836	26,277	2,113	1,591	846.8	32.58	2,240.10
Madhya Pradesh	5,116	10,934	127,948	201,261	4,955	2,155	752.74	31	6,324.80
Chhattisgarh	2,289	5,240	57,493	75,742	1,196	861	1,495.41	26.27	4,723.90
Goa	269	279	7,827	11,082	69	na	2,044.9	15.92	78.1
Maharashtra	4,498	38,765	335,389	396,685	5,725	2,331	1,239.33	17.56	24,006.70
Uttar Pradesh	7,818	7,703	310,398	403,102	345	52	449.98	28.83	9,121.10
Uttarakhand	2,042	3,788	29,247	52,628	8,832	3,205	1,297.26	19	1,842.00
India	79,116	169,227	2,515,388	3,965,394	65,436	23,541	914.41	21.78	223,343.60

(*continued*)

Table AI. State-level infrastructure indicators for the period 2012-2013

Table AI.

States/UTs	Peak demand (MW)	Peak demand met (MW)	Peak deficit	% age villages electrified	Un-electrified villages	Overall tele-density (subscriber base per 100 people)	Urban tele-density (subscriber base per 100 people)	Rural tele-density (subscriber base per 100 people)
Andhra Pradesh	14,582	11,630	−20.24	100	0	80.87	189.26	39.21
Assam	1,197.00	1,148.00	−4.09	96.1	968	46.61	148.54	28.35
Delhi	5,942.00	5,642.00	−5.05	100	0	238.59		
Gujarat	11,999.00	11,960.00	−0.33	99.8	35	91.13	145.50	53.89
Haryana	7,432.00	6,725.00	−9.51	100	0	89.42	153.96	55.92
Himachal Pradesh	2,116.00	1,672.00	−21	99.9	15	120.68	469.57	76.76
Jammu and Kashmir	2,422.00	1,817.00	−25	98.2	113	54.82	119.52	30.84
Karnataka	10,124.00	8,761.00	−13.46	99.95	13	97.22	185.62	44.08
Kerala	3,578.00	3,262.00	−8.83	100	0	106.61	237.08	61.94
Odisha	3,968.00	3,694.00	−6.91	78.9	10,029	65.84	216.24	35.11
Punjab	11,520.00	8,751.00	−24.04	100	0	113.13	180.53	64.90
Rajasthan	8,940.00	8,515.00	−4.75	97.5	975	72.96	165.30	43.86
Tamil Nadu	12,736.00	11,053.00	−13.21	100	0	116.61	164.40	56.20
West Bengal	7,322.00	7,249.00	−1	99.7	104	61.52	178.63	42.05
Tripura	229	228	−0.44	92.9	61	65.72	153.90	37.38
Bihar	2,295.00	1,784.00	−22.27	94.2	2,058	48.90	196.24	25.58
Jharkhand	1,263.00	1,172.00	−7.21	89.2	3,164			
Madhya Pradesh	10,077.00	9,462.00	−6.1	97.6	1,254	53.81	130.38	25.90
Chhattisgarh	3,271.00	3,134.00	−4.19	97.1	563			
Goa	524	475	−9.35	100	0	77.19	124.23	52.03
Maharashtra	17,934.00	16,765.00	−6.52	99.9	36			
Uttar Pradesh	13,940.00	12,048.00	−13.57	88.9	10,856	60.93	161.32	31.98
Uttarakhand	1,759.00	1,674.00	−4.83	98.9	168			
India	160,259.00	14,3562	−10.42	94.39	33,060	78.66	169.17	39.26

Notes: For tele-density data, four states, namely Jharkhand, Chhattisgarh, Goa and Uttarakhand, are included under Bihar, Madhya Pradesh, Maharashtra and Uttar Pradesh circle, respectively
Source: Planning Commission, Government of India

Principal components	Eigenvalues	Percentage of variance	Cumulative variance
1	2.66771	0.5335	0.5335
2	1.3376	0.2675	0.8011

Note: Eigenvalues and variance explained using principal components

Table AII. Selected results from PCA

	Factor loadings	
Infrastructure variables ↓	Factor 1	Factor 2
Electricity power consumption (per capita)	0.4586	0.5062
Energy usage (kg of oil equivalent per capita)	0.4100	0.5417
Rail density (area)	0.4457	−0.5166
Road density (area)	0.4918	−0.4270
Tele-density (subscription per 100 people)	0.4256	−0.0328

Table AIII. Factor loadings of original values

About the author

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