Estimating Infrastructural Investment Needs for India

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Abstract

This paper attempts to systemically project the demand and fund requirements of the Indian infrastructure sector up to 2013. In the infrastructure sector transportation (rail, port, air and road), electricity and telecommunication sectors are covered in this study. Our analysis is performed in three stages. In the first stage, long run linkage between infrastructure variables and income are established by applying cointegration method. Subsequently, infrastructure demand functions are estimated by using Dynamic OLS (DOLS) technique. In the second stage, by using the estimated infrastructure elasticity to income of variables and IMF's projected income data, we project the sector-wise demand and funding requirement. In the final stage, we put forward some suggestions for reforms in infrastructure financing, so the projected demand in the country would be achieved. The results of the analysis indicates that in important sectors like electricity and port, the government(the Planning Commission) has seriously underestimated the future demand, while in air transport sector, the demand seems to be overestimated. Only in telecommunication sector, the projections of this study are at par with their projections. Overall, we find that the government has at least 7% underestimated the infrastructure needs. Based on these results, we propose for initiation of a set of reforms in existing financing pattern of infrastructure in the country.

JEL classification: C53, H54
Keywords: Infrastructure projection, DOLS, India

1. Introduction

Indian economy has been growing at more than 8% (on average) for the last five years before the global crisis. To stimulate the growth momentum further and achieve the ambitious the double digit growth in the coming decade, the government has undertaken some necessary policy initiatives. Accompanying this growth will be an increase in demand for infrastructure services, for both consumption as well as for production

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purposes. It has been very well documented and widely debated that a failure to respond (by increasing infrastructure availability) to its demand will cause serious impediments for achieving the country's economic growth objective. To meet the future demand of infrastructure services, it is pertinent to estimate the extent of these demands would arise in coming years.

Towards this directions, the present study attempts to estimate the extent of demand for infrastructure services that will arise for achieving the growth objectives that envisaged in the 11th Five Year Plan document. Hence, this study is an attempt to provide a framework and also estimate what infrastructure levels will be required in the future, either as consumption goods or as input into production function. This study does not try to deal with the issue of socially optimal measure of need for infrastructure services or infrastructure investment. In the later stage, the paper also compares with the estimates made by the Planning Commission of India.

There are numerous reasons necessitating for more rigorous exercise to empirically forecast the infrastructure investment needs in India at present. First, the strong international and national evidence that shows the strong linkage between infrastructure and growth, productivity, equity and poverty in India (for instance, see Aschauer, 1989, Zegeye, 2000, Hulten and Schwab, 1997, Fedderke and Bogetić, 2005, Mitra et al., 2002, Ghosh and De, 2004 and Hulten et al., 2006). Second, recent debate suggests that one of the biggest obstacles that the Indian industry is facing in their expansion path is the infrastructure deficit. The World Bank's recent Enterprise Surveys also confirms that the infrastructure condition in the country is extremely inadequate and domestic enterprises are paying its price heavily by losing competitiveness in the world market. Third, the Planning Commissions of India (hereafter PCI)[1] projections of the infrastructure demand for the11th Five Year Plan (2007-08 to 2011-12) is highly susceptible, because of the way

[1] Note: For simplicity Working Group/Steering Committee/Task Force Reports on the infrastructure sector are called Planning Commission' reports in this research. However, the recommendations contained in the Working Group/Steering Committee/Task Force Reports are those of respective Ministries/Departments and not those of Planning Commission. The Planning Commission used these report in the 11th Five Year Plan document but doesn't own them.

the income elasticity of infrastructure variables estimation has been done or assumed. [2] Finally, recent trends suggest that the government has been putting some serious efforts to enhance the infrastructure services by liberalizing the related policies[3], investing directly in the sector (the ongoing economic crisis has also provided this opportunity, incidentally through enhancing public capital expenditure as part of fiscal stimulus) and encouraging higher private sector participation.

Against this background, this study is set to estimate the required level of infrastructure demand till 2013. This is performed at sectoral level. For the analysis, the present study heavily relay on the IMF's forecast of GDP for the Indian economy. The working groups' reports of the 11th plan (2007-08 to 2011-12) on the different infrastructure sectors are also utilized in the forecasting procedure mainly for the pricing purpose. The approach of this study is somewhat similar with those of Fay (2001) and Fay and Yepes (2003), and Bogetić and Fedderke (2006). However, we depart from the above mentioned studies is in terms of use of data. These studies have used panel data for forecasting, while in this study we utilized time series data, which makes our analysis perhaps more reliable.

The present study broadly focuses on three key infrastructure sectors, namely, transportation (rail, port, air and road), electricity and telecommunications. However, the study is unable to cover water and sanitation sectors in the analysis due to lack of availability of the time series data for this sector. This study contributes to relevant literature in two ways. First, to the best of our knowledge none of the previous studies at least in India has systematically forecasted the future demand and fund requirement of the infrastructure sector. The findings of this study would enormously help policymakers in making appropriate policy to deal with the sectors' demand-supply gap and optimally utilize the limited resources available. Second, the study not only projects the demand

[2] The working groups on the different infrastructure sector have projected the sector-wise demand and funding requirements. But in the reports, the estimation of income elasticity of the sectors has not been shown and in some instances it is merely assumed. And many sectors' the assumed income elasticity seems to be over or under estimated. On the basis these elasticity, projections have been made in the reports, hence it is seemed to be questionable.

[3] Under the recent the stimulus packages, many steps have been taken to ensure more flows of fund go to infrastructure construction which includes the permission given to Indian Infrastructure Finance Corporation Limited (IIFCL) to borrow Rs. 3000 million from market by issuing tax free bonds.

and fund requirement for the future but also suggest the possible ways of sources of financing this projected demand.

The rest of the study is organized as follows: Section 2 presents empirical methodology and data related issues. The model and estimation results are discussed in Section 3. Section 4 brings the sector–wise demand and funding projections. Section 5 contains suggestions for reforming the infrastructure financing. The last section brings the concluding remarks.

2. Data, Empirical Methodology and the Demand Functions

2.1. The Data

This study utilizes annual data of GDP per capita and normalized data of infrastructure sectors namely, electricity, transportation (air, road and port) and telecommunication (see Table 2.A. of Appendix for details of indicators and their sources). The data sources for infrastructure variables are World Development Indicators (WDI) (2009) provided by the World Bank and Infrastructure (2008) publication of Center for Monitoring Indian Economy (CMIE). The time horizon of the study starts since 1980, however, end period for the different infrastructure variables varies. The GDP per-capita data is utilized from 1980 to 2013 and its source is World Economic Outlook (WEO) database, 2008 (September). This database provides IMF's projections of macroeconomics variables of several countries. Details of variables, time period and their sources are discussed in Table 2.A of Appendix.

2.2. The Empirical Methodology

Following Fay (2001) and Fay and Yepes (2003), and Bogetić and Fedderke (2006) this study conducts three stages to project the infrastructure demand for future. In the first stage, the study utilizes time series data and estimate separate demand functions for each infrastructure sector namely telecommunication, electricity, air transport, road, rail and port. This process yields the income elasticity of each of the infrastructure variables. In the second stage, using the estimated income elasticity of infrastructure variables and on the basis of projected GDP by the IMF for India, the study projects each sector demand

up to 2013. In the final stage, the study uses price of each unit of infrastructure variables and attempt to project the investment requirements. Since it is not possible here to forecast the demand of all components of a sector, thus our working hypothesis in this study is a leading indicator from each sector represents that sector. Then the projected demand is compared with the PCI's projection for each indicator. Finally, using the working groups' reports of the 11th plan, funding projections for each sector is performed and also estimates the gaps in PCI's projections from that of projections based on this paper.

2.3. Estimating the Demand Functions

The first task of this part of research is to estimate the income elasticity of infrastructure variables. Previous mentioned studies have used panel data for the same purpose, but this study prefers to utilize time series data of India instead. [4] This is because our approach would have direct policy relevance in India.

For the similar purpose, some recent country-specific studies used the Dynamic OLS (DOLS) methodology developed by Stock and Watson (1993). This methodology found to generate more robust estimators for small samples, and corrects the bias, simultaneity and serial correlation problems. For instance, Masih and Masih (1996b) for China, Al-Azzam and Hawdon (1999) for Jordan, Akmal and Stern (2001) for Australia and Irffi et al. (2008) for Brazil have utilized this technique and their estimates performed quite well. Since, the variables and estimations in this study are also expected to encounter similar problems, i.e. small samples, biasness, simultaneity, stationary and serial correlation. it is, therefore, appropriate to employ DOLS methodology to estimate the elasticity.

The Dynamic OLS (DOLS)

One important method of extracting the long run coefficients of cointegration series is DOLS. The DOLS procedure developed by Saikonnen (1991) and Stock and Watson

[4]Bogetić and Fedderke (2006) used 52 country data to project the infrastructure demand for South Africa. Since there is a possibility of a wide difference in income elasticity for each infrastructure variable between the countries, hence, this research believes using cross-country results for a country specific forecasting is not justified. Therefore, this study adopts a different approach, and utilizes Time-Series data approach.

(1993), has advantage over other popular procedures that endogeneity of any of the regressors has no asymptotic effect on the robustness of the estimates. Further, statistical inference on the parameters of the cointegrating vector is facilitated by the fact that t-statistics of the estimated coefficient have asymptotically equivalent to the maximum likelihood estimator of Johansen(1988) and has been shown well in finite sample (Stock and Watson,1993). Given the limited data availability of the infrastructure variables, this approach seems to be most appropriate technique for our analysis. The DOLS procedure incorporates the lags and leads of the first difference of the I(1) variables. Thus, estimation of the long run relation between Y and X is carried out by estimating the following regression:

$$Y = \lambda^d X + \sum a_i \Delta X_{t+j} \quad \text{.....(1)}$$

where λ^d denotes the vector of long run coefficient of X using the dynamic procedure. The inclusion of ΔX_{t+j} terms take care of the possibilities of endogeneity of X, i.e., feedback from Y to future values of X.

In estimating the long-run parameters of the demand function, the DOLS procedure that basically involves regressing any 1(1) variables on other I(1) variables, any I(0) variables and leads and lags of the first differences of any I(1) variables are adopted. Generally, VECM type of tests is also conducted with DOLS to estimate the short run relationship between the series. However, in this study, as the short run function estimation is not of much of our interest, the estimation is limited to DOLS and does not move further to conduct any short run analysis.

3. The Model and Empirical Results

3.1. The Model

We begin our analysis by adopting the demand function estimation process of Fay (2001) and Fay and Yepes (2003), and Bogetić and Fedderke (2006) and use the sectoral shares i.e. manufacturing, agriculture and services sectors, in the model apart from per-capita income. [5] Therefore ideally our model should be as follows:

$$\frac{I}{P} = f(Y; \frac{q_i}{w}; Y_{AG}; Y_{IND}; Y_{SERV} A) \quad \text{.....(2)}$$

[5] The derivation of this model can be seen in Fay (2001) and Fay and Yepes (2003), and Bogetić and Fedderke (2006)

where I , Y and A are infrastructure variable, income of the country and technology respectively. $Y_{AG}, Y_{IND}\ and Y_{SERV}$ represent share of agriculture, industry and service sector of country, respectively. P is the price level and $\frac{q_i}{w}$ is the real price of infrastructure variables. But we could not follow equation 2 because of three reasons. First, a serious multicollinearity problem is identified between these variables (for correlation between variables, see Table 1.A. of Appendix). Second, projection is available only for GDP but it is not for GDP compositions, i.e. share in agriculture and in manufacturing. Third, the data of price of infrastructure variables and technology level are not available. Therefore, variables of sectoral shares are dropped from the model and only per-capita income and infrastructure variables are included in the model.

It is a noted fact that infrastructure stocks tend to change reasonably slow over time and have a long life span. Therefore, lagged values of the dependant and explanatory variables are included in the regression in order to increase explanatory power. Nevertheless, this study is not interested to establish a causal relationship between infrastructure endowments and income of the country. Instead, we conduct this regression to project the infrastructure demand. To this end, it is to obtain the robust parameters that gives best fit and also has higher explanatory power. Keeping this in mind, the final model to be estimated is as follows:

$$lI_{i,t} = f(lypc_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where $l\ and\ ypc_t$ denote for log and per-capita income respectively. As it is discussed that lags and leads values are added in the model with appropriate year dummy (if required) to control the model.

3.2. Results of Unit Root and Cointegration Tests

It is well established in the literature that most of the time series data contains unit roots and the estimated parameters based on these time series data are spurious. Hence, before estimating the demand functions, the unit root of the series are examined by applying Augmented Dickey and Fuller (ADF) tests. The results are reported in Table 1, which apparently suggest that all variables contain unit root and integrated of order one, I (1). Having established that all variables are I (1), the study now proceeds to conduct the

cointegration analysis, and employs Johansen and Juselius (1990) multivariate cointegration analysis. For this purpose, pair-wise cointegration tests are conducted between the infrastructure variables and per-capita income.

Table 1: Test for unit root applying Augmented Dickey-Fuller (ADF) Test

Variables	Test statistics (levels)	Optimal Lags (AIC)	Test statistics (1st difference)	Optimal Lags (AIC)
ltel	12.495	0	-3.8857*t	6
lelectpc	0.2144	3	-4.8313*	2
lport	-0.4474	0	-5.0706*	0
lair	0.8929	0	-3.2716*	0
lrail	-0.1865	0	-4.5035*	1
lypc	-0.5273	1	-3.7347*	0

Notes: 1. * denotes that the null hypothesis that the variable concerned is non-stationary can be rejected at 5% significance level. 2. Asymptotic cutoff values for 5% significance level are -3.41 when the trend term is included and -2.86 when the trend tern is not included (see Davidson and Mackinnon, 1993) 3. t denotes for with trend.

Table 2: Results of Johansen cointegration test (Max-Eigen value and Trace Statistics)

H_0	r = 0		R ≤ 1	
Models	λ_{trace}	$\lambda_{\max}$	λ_{trace}	$\lambda_{\max}$
Models1(with *ltel*)	17.346*	14.471*	2.8760+	2.8761+
Models 2(with *lelectpc*)	18.412*	18.397*	0.0151	0.0151
Models3(with *lport*)	21.455*	17.095*	4.3598*	4.3598*
Models 4(with *lair*)	13.634*	11.627*	2.0066	2.0066
Models 5(with *lrail*)	11.828*	11.142*	0.6865	0.6865

Notes: 1. * and + denotes significant at 5% and 10% critical level respectively .2. Significant determined by MacKinnon-Haug-Michelis (1999) p-values

The results of cointegration suggest that all pairs follow cointegration process (see Table 2). We do not test integration of road variable as it has a small sample size.

3.3. Results of Long-run Elasticities Estimation: Applying Stock-Watson DOLS

After establishing that cointegartion is present, the long run elasticities of these models are estimated using the DOLS technique. In this process, appropriate year dummies (as decided by the Chow breakpoint test) and leads and lags of first difference of the infrastructure and per-capita income variables are also included in the empirical models. Our estimation yields fairly good estimate of the models. The Durbin-Watson (DW)

statistics for all models indicates existence of autocorrelation. However, the DW statistic is not appropriate our case as a test for serial correlation, because the models include lagged dependent variables. Therefore, Breusch-Godfrey (BG) serial correlation LM test is applied, which suggests that in all models (except in the Rail-transport) serial correlation do not exist. The heteroskedastic bias in standard deviation is corrected using Newey-West's estimator. This will provide consistent estimate even in the presence of both heteroskedasticity and autocorrelation of unknown form.

The estimated models of infrastructure predications are as follows[6]:

(A)The Telecommunication Demand Function:

$$ltel = -3.11 + 2.43lypc + 1.88\Delta ltel - 0.22dummy00 \quad \text{.....(4)}$$
$$(-6.14) \quad (4.77) \qquad (2.06) \qquad (5.37)$$

$R^2 = 0.97, S.E. = 0.049, DW = 1.18$, Breusch-Godfrey Serial Correlation LM Test (P-value): 0.1693

Notes: (i) dummy 00, is dummy for year 2000. (ii) Sample period is 1980 to 2007. (iii) t-values are in bracket.

(B)The Electricity Demand Function:

$$lelectpc = 6.72 + 1.45lypc + 2.01\Delta lelctpc + 1.66\Delta lelectc(-1) + 0.08dummy91 \quad \text{.....(5)}$$
$$(41.54) \quad (11.16) \quad (2.62) \qquad (2.17) \qquad (4.45)$$

$R^2 = 0.96, S.E. = 0.021, DW = 0.96$, Breusch-Godfrey Serial Correlation LM Test (P-value): 0.2211

Notes: (i) dummy 91, is dummy for year 1991. (ii) Sample period is 1980 to 2006. (iii) t-values are in bracket.

(C)The Port Infrastructure Demand Function:

$$lport = 1.01 + 1.08lypc + 0.63\Delta lport + 0.35\Delta lport(-1) + \Delta 0.75\Delta lypc(+1) - 0.23\Delta lport(+1) \quad \text{..(6)}$$
$$(67.26) \quad (69.99) \quad (5.31) \qquad (3.00) \qquad (2.75) \qquad (-2.29)$$

$R^2 = 0.97, S.E. = 0.006, DW = 0.922$, Breusch-Godfrey Serial Correlation LM Test (P-value): 0.0976

Notes: (i) Sample period is 1980 to 2006. (ii) t-values are in bracket.

(D)The Air-transport Infrastructure Demand Function:

[6] Only statistically significant variables are reported in the models.

$$lair = 3.12 + 1.14lypc + \Delta 3.69\Delta lypc(+1) - 0.12dummy91 \text{.....(7)}$$
$$(19.42)\ (5.33)\qquad (2.85)\qquad (-3.92)$$

$R^2 = 0.85, S.E. = 0.037, DW = 1.65$, Breusch-Godfrey Serial Correlation LM Test (P-value): 0.2650

Notes: (i) dummy 91, is dummy for year 1991. (ii) Sample period is 1980 to 2006. (iii) t-values are in bracket.

(E)The Rail-transport Infrastructure Demand Function:

$$lrail = 4.28 + 0.95lypc + 0.55\Delta lrail - 0.36\Delta lrail(+1) + 0.03dummy94 \text{.....(8)}$$
$$(67.88)\ (16.71)\quad (2.94)\qquad (-1.95)\qquad (2.55)$$

$R^2 = 0.94, S.E. = 0.016, DW = 0.65$, Breusch-Godfrey Serial Correlation LM Test (P-value): 0.0315

Notes: (i) dummy 94, is dummy for year 1991. (ii) Sample period is 1980 to 2006. (iii) t-values are in bracket.

(F) The Road transport Infrastructure Demand Function:

$$lroad = 1.97 + 1.27lypc - 4.15\Delta lypc \text{.....(9)}$$
$$(6.82)\ (5.70)\quad (-2.20)$$

$R^2 = 0.94, S.E. = 0.016, DW = 2.22$, Breusch - Godfrey Serial Correlation LM Test (P - value) : 0.1125

Notes: (i) Sample period is 1980to 2002. (ii) t-values are in bracket.

4. Sector–Wise Demand and Funding Projections

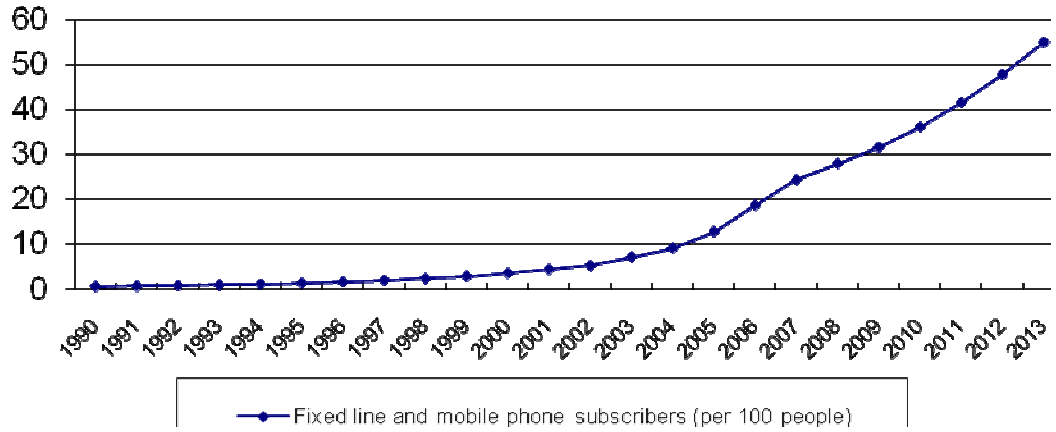
Based on the estimated elasticities and projected GDP data for India, we now turn to estimate the infrastructure needs. To project the funding requirement of the sectors, unavailability of price of infrastructure services compels us to perform the measurement alternatively. Therefore, it is performed by using the PCI's projections for the 11th Plan, by comparing the projection of demand of this study to their projections. The sector-wise demand and funding requirements are discussed below:

4.1. Telecommunication:

For the telecommunication sector, the estimated income elasticity is found to be 2.43. This is relatively very large if one compares it with other countries or regions. For instance, Bogetić and Fedderke (2006) estimated 1.19 for a group 52 countries. Not surprisingly, a dramatic growth in the recent years and a low base of availability of

telecommunication in the country, perhaps make this elasticity large in India. On the basis of above estimation and projected GDP (by IMF), fixed and mobile subscribers are estimated to be increased to 47.76 (total 598.77 million connection)[7] and 54.93 (total 697.72 million connection) as per 100 hundred people in 2012 and 2013, respectively (see Figure1). For this sector, our projections match with PCI's projection for the year 2012, which has projected 600 million total tele-connections in this sector.

Figure-1
Fixed line and mobile phone subscribers (per 100 people)



Note: Projection period start from 2008.

Source: Authors' estimate.

In the funding requirements, the PCI projects only for the public sector which is estimated to be Rs.12163.031million for the 11th Plan. The projections based on this study for the public sector is Rs. 2935.3552 and Rs.3188.296 million, respectively, for 2012 and 2013. The public sector constitutes 26% of market in the sector. Overall, fund requirement is expected to be Rs. 34617.86 million for the11th Plan. For years 2012 and 2013, expected funding requirements for the private sector are estimated to be around Rs.8354.4725 and Rs.9074.381 million, respectively.

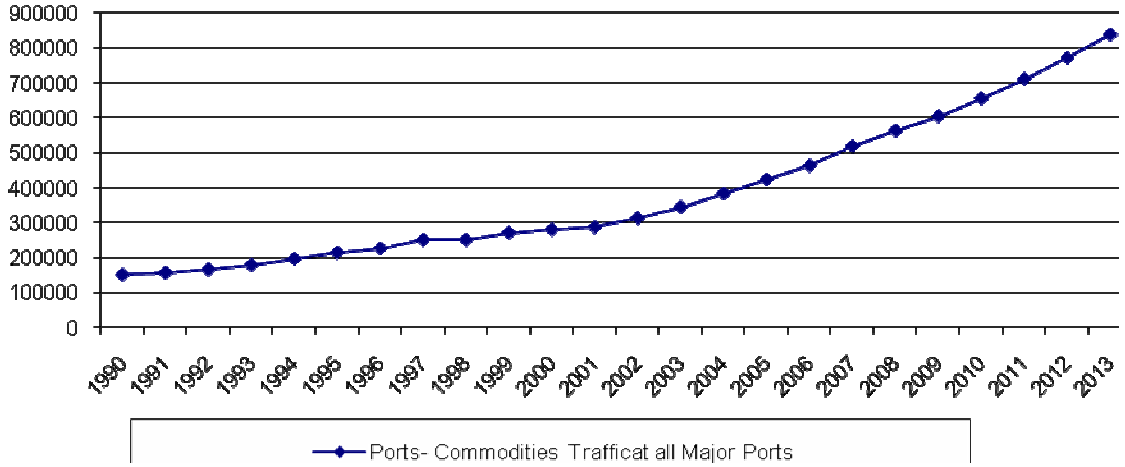
4.2. Port:

The demand estimation for port sector suggests that income elasticity to be 1.08. On the basis of this, the study projects the demand for the period of 2008-2013. This projection

[7] The PCI has estimated 600 million total connections at the end of 11th plan, which is almost same to our estimate.

does not match with the planning commission projection for 11th Five Year Plan as they have projected 9.8% growth in the sector.. A comparison suggests that the PCI has underestimated the major port capacity requirement at least by 10% (see, the Working Group Report on Port, page no.91). Therefore, Rs.1853.3 million which has been projected for fund requirement of the public sector during the 11th Plan should not be adequate to finance the demand of port infrastructure for this period. Our projection suggests that the fund requirement for the public sector in the same duration would be around Rs. 2040 million. The private investment requirements have been projected to Rs. 3686.80 million by the Working Group. Calculations of this study suggest that it should be around Rs. 4055.4 million. In 2012 and 2013, funding requirement would be Rs.1543 and Rs.1674.80 million, respectively, covering both private as well as public sector. Further, In India, the non major ports contribute around 30% of total tariff load. It means total Rs 2011.482 million would be additionally required for the funding of non major ports during the 11th plan.

Figure -2
Commodities Traffic at all Major Ports



Notes: Projection period start from 2008.

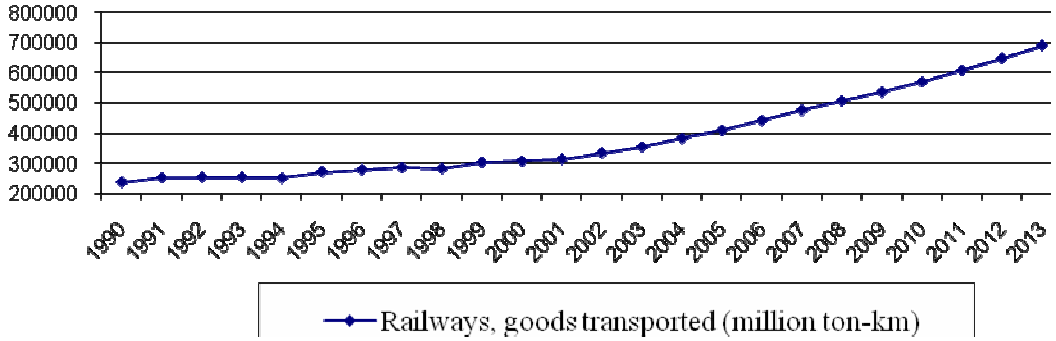
Source: Authors' estimate.

4.3. Railways:

In railways sector, the estimated demand function shows the elasticity of income of 0.95. On the basis of this, demand of the sector for the period 2007-2013 is projected. For the 11th plan, our analysis suggests that the sector has to grow at an average of 6.8%. This projection comes very near to the Working Group's projections which have estimated

6.3% growth. In terms of funding, the country would be required to invest Rs.27092 million during the 11th plan, which is marginally higher than the projections of the Working Group. For 2012 and 2013, the demand growth is projected to be 6.6% and funding requirements for 2012 and 2013 are Rs 6511.77 and 6943.35 million, respectively.

Figure-3
Railways, goods transported (million ton-km)



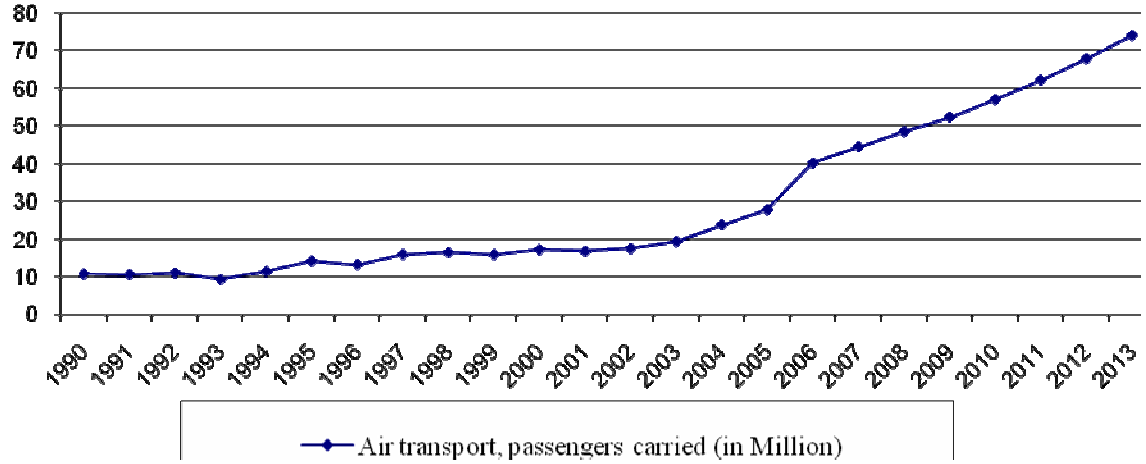
Note: Projection period start from 2007.

Source: Authors' estimate.

4.4. Air-transport:

The estimation of Air transport demand function suggests that the elasticity with respect of income of this sector is 1.14, while the PCI consider it around 2. This indicates that the PCI has substantially overestimated the demand and outlay requirements of this sector. On the basis of estimated elasticity, this study suggests a cumulative growth of 58% during the 11th Plan. The PCI's projections are around 19% annual growths, and cumulative they assumed it 200 to 300% in the Plan period. In the funding requirements, our analysis suggests that the sector would be required to invest Rs. 10675.74 million in the 11th plan, while the planning commission has projected Rs. 5210.70 million. Furthermore, this study projects the funding requirements for 2012 and 2013, Rs. 1080.20 and Rs. 1199 million, respectively.

Figure-4
Air transport, passengers carried



Note: Projection period start from 2007.

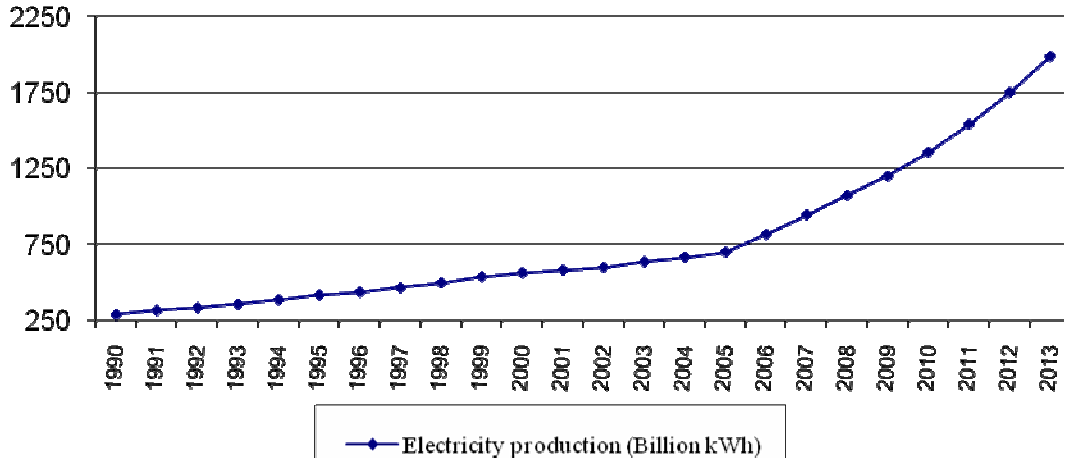
Source: Authors' estimate.

4.5. Electricity:

With the estimated elasticity of 1.45, the electricity sector needs to grow at an average of 12% annually for the period 2007-13 Compared to this, the PCI has considered 1% elasticity in the sector and their projections suggests for a growth of 9.5% for the same period, thus, it indicates that official figures are substantially underestimated the demand of the sector in the coming years.

In the outlay for 11th Plan, this study projects Rs. 3,43,84 million funding requirements, while the PCI's projection is Rs. 3,07,00 million for the same duration. For the 2012 and 2013, the sector would be required to fund Rs. 8971.21 and Rs 10047.76 million, respectively.

Figure-5
Electricity Production



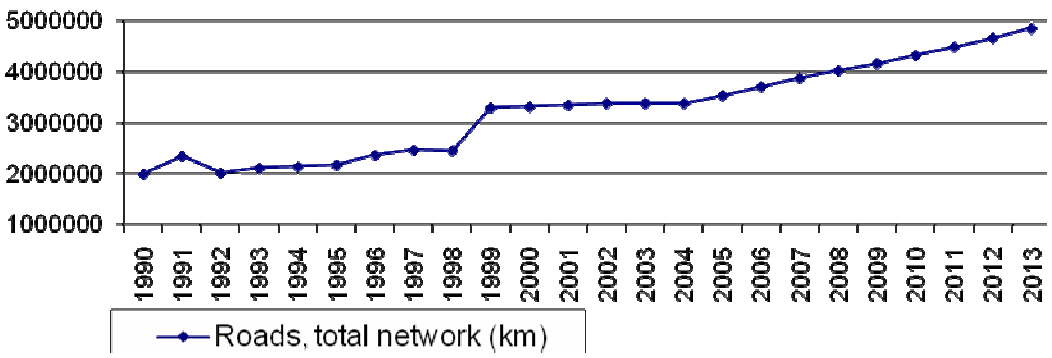
Note: Projection period start from 2007.

Source: Authors' estimate.

4.6. Roads:

For the roads sector, as the data was not available after 2003, the future needs have been estimated from 2004 onwards. The results of the road demand function estimation, which performs poorly, suggest that the income elasticity is 1.27**.** This is very large in comparison with other countries (see, Fay and Yeaps, 2003). The PCI has not reported the estimate the road demand function, so the elasticity of the sector is not available for the comparison purpose. In this situation, we are not able to project investment requirements for this sector by using their report, as we have done for other sectors. We adopt, therefore, different approach for this sector and utilized international pricing of road construction from Fay and Yeaps. (2003). The projection of PCI for this sector is Rs 12175.80 million , while our estimate suggest for Rs 14444.70 million.

Figure-6
Per capita-total road network (km)



Note: projection period start from 2004, source: Authors' estimate.

Overall our estimate for 11th plan (2007-2011) and for 2012 and 2013 are presented in Table 3. The last two columns of the table compare our estimates with those of the PCI. The government expects Rs 12175.8 million investment requirement during the 11th Plan, while our projections indicate that it should be at least 7.34% higher than those and around Rs 94115.2 million.

Table 3
Projections of Infrastructure Investment Needs for India (in Rs Million)

Sector	Projections of this study for the11th plan	Projections of this study for 2012	Projections of this study for 2013	Planning Commission Projection for 11th plan	projections of this study for the11th plan (comparable with the PCI)	Gap in Projections (in %)^
Electricity	34384	8971.21	10047.80	3,07,00	34384	-12
Telecommunication	46777.90	11289.80	12262.70	12163.03@	12162.24@	0
Railways	27092	6511.77	6943.36	25100	27092	-7.94
Port*	6095	1543	1674	1853@	2040@	-10.07
Air Transport	3992.38	1080.22	1199.04	5210.72	3992.38	30.51
Road	14444.70	3229.20	3366	12175.80	14444.70	-18.64
Total	139469.70	34294.90	37288.60	87202.80	94115.20	-7.34

@only for public sector, * only for major ports, ^ negative gap indicates the extent of underestimation by the PCI

5. Financing the Projected Investment

In India, traditionally the public sector has been the main provider of basic infrastructure facilities. However, given the growing needs of infrastructure facilities and limitations in publicly financing, it is likely that the public sector will be unable to generate the needed levels of investments requirements. Under the existing practice and regulation in the infrastructure sector, the private sector is facing several hurdles in actively participating in the development projects. However, recently, at least in some areas, important reforms initiatives have been undertaken. For instance, in information and communication technology (ICT) sector, regulations for private firms entry has been made easy, which has attracted a large number of firms (and private investment) in the sector.

By observing the gigantic investment requirements in the coming years (as this study has projected), there is a desperate need to reform the existing financing modes and find new avenues for better fund flows in the sector. Some of the policy reforms are discussed below, which can be implemented may facilitate in achieving the projected fund requirements. Although these reforms are not new, this study only reiterates the importance of these policies in covering the huge infrastructure deficit in India.

5.1.Encourage the use of Derivatives: Derivatives markets are important for infrastructure projects financing because of the risk transformation roles they perform. In India, these markets are largely underdeveloped mainly due to a range of regulatory hurdles. Currently credit derivatives are not permitted in the Indian markets, while the banks are not allowed to trade in equity and commodity derivatives. Further, the market for interest rates derivatives is very small because there are tough restrictions on the participation of banks in the exchange traded derivatives. The introduction of credit derivatives can largely benefit infrastructure financing because credit derivatives facilitate efficient risk distribution which is very desirable in financing of infrastructure projects. Further, foreign investors' participation in credit derivatives would help in distributing the risks even more widely. In the wake of global financial crisis, there could have been large apprehensions in developing derivate markets. But, following the lessons that are learnt from the crisis, it would be feasible to make derivates risk free.

5.2. Liberalize Investment Guidelines for Debt Instruments: As per the existing regulations, qualifying investment approval is very stringent. The investee company should have a dividend payment record to qualify and this criterion could be difficult for most of the firms. To increase the flow of funds through this route, there is a desperate need to re-look at this regulation. Relaxing this regulation will not only widen the spectrum of infrastructure firms but this can also boost in the insurers' investment portfolio. In this direction, government should also consider all equity investments in listed infrastructure companies as approved investments and insurance companies should be allowed to take advantage of the mutual funds with schemes targeted at infrastructure investment. This would help insurance companies in making higher return and maintaining liquidity.

5.3. IPO by Infrastructure Companies: In the country, there are many profitable public sector enterprises that are operating in infrastructure sector. Their stocks are highly demanded in the market. To generate fund for infrastructure development, limited portion of these firms' stocks can be supplied in the market by way of IPOs (Initial Public Offers) or FPOs (Follow-on Public Offers). The raised fund would go solely to the infrastructure investment. This option is especially attractive for the power sector and the 11th Plan Working Group has estimated an amount of Rs. 10,00 -15,00 million, which can be raised over the Plan period in the power sector through this way. This estimate seems to be easily achievable given the size of public sector firms operating in the sector.

5.4. Develop Bond Market in the Country: In the Indian financial system, the debt market has a marginal role. Its size and liquidity both are too small and mainly dominated by Government securities.[8] To finance the infrastructure projects through active bond market is a popular way in many countries. In India too, it can be strengthen by initiating measure like screen based trading and rating of Bonds.

[8] The Debt Markets in India are dominated by government securities, which account for 70 - 75% of the outstanding value of issued securities and 90-95% of the trading volumes in the Indian Debt Markets.

5.5. Allow Non-Banking Financial Companies (NBFCs) to Access Infrastructure Fund: Despite some recent initiatives, still the existing regulations for NBFCs to generate fund abroad to invest in domestic infrastructure projects is very cumbersome in India. They are accompanied by too many inexplicable caveats. By seeing the importance NBFCs in the financing process, a rational approach is required for this area. The central bank (RBI) may develop a rating system to keep out less serious firms out of this process. Also, it can be ensured that deployment of generated fund should take place in a limited time frame.

5.6. Funding from Multilateral Agencies: This has been a vital source of infrastructure projects funding in India. Comparatively lengthy and time consuming appraisal of the projects and emphasis on environment and social issues with added costs of audits and certifications issues remains concerns in the process. Further, inadequate returns due to poor financial health of the authorized infrastructure firms (mainly public sectors units; announcements of free power by state, lack of comprehensive payment security mechanism etc.) are creating obstacles in advancement of financing by agencies like World Bank, ADB to the sector in a large way. Therefore, these issues should be addressed as soon as possible.

5.7. External Commercial Borrowings (ECBs) for Investment in Infrastructure Sector: Financing through this method falls under the Automatic Route and it does not require the government approval. However, there are some limits in regards to the amount and duration of ECBs raised through the automatic route. The main problem with this way of funding is that the tenure of ECB borrowings is usually short and costly, which is not appropriate for infrastructure projects especially for power projects. Therefore, new possibilities should be explored to raise fund thorough this way with at competitive rates and also for a longer tenure.

***5.8. Encourage Public Private Participations (PPPs)*:** This method of infrastructure building is becoming popular at least in some sectors in India. The government is actively promoting PPPs in the important infrastructure sectors of transport (including railways),

power and urban infrastructure. Nevertheless, a lot more should be done in this area for better participation of private players in the process. There is an urgent need for the governments to develop a policy on unsolicited proposals from the private sector. PPPs can succeed only if they are structured and planned in detail and are managed by expert teams. Governments also need to use technical and financial advisors wherever needed, to match the advantages of the private sector, particularly in large-scale programs. Also, the central assistance and guarantee is required in capacity-building. For the long term success of PPPs, proper allocation of risks, responsibilities, costs, and risks between the public and private sectors is desirable.

6. Summary and Conclusion

This paper attempts to systemically estimate the demand and fund requirement of the Indian infrastructure sector up to 2013. In the infrastructure sector, transportation (Rail, Port, Air and Roads), electricity and telecommunication sector are considered for this study. The study is performed in three stages. In the first stage, long run linkage between infrastructure variables and income are established by applying cointegration technique and then long infrastructure demand function are estimated by using the Stock and Watson's Dynamic OLS(DOLS) technique. In the next stage, the estimated income elasticity of infrastructure variables and IMF's projected income data are used to forecast the sector-wise demand. At final stage, the study has put forward some suggestions for reforms in infrastructure financing, so the projected demand for the country would be achieved. The results of the analysis indicates that in important sectors like electricity and port, the government has underestimated the future demand, while in air transport sector, the demand has overestimated. In telecommunication sector, the projections of this study are at par with their projections. Overall findings suggest for huge investment requirements in the sectors, which at least 7% higher than the expectation of the government.

As part of the Mid-Term Appraisal of the Eleventh Plan, the Planning Commission has undertaken the revision of the infrastructure investment needs. It highlighted the extent of investments in infrastructure in the Eleventh Plan period. Earlier the Approach paper

estimated the infrastructure need of over US$ 500 billions and the revised estimates was also almost similar. But for the Twelfth Plan, the Planning Commission estimates an investment need of little over US$ 1 trillion, twice as much as in the Eleventh Plan. This is estimated to be nearly 9.95% of GDP compared to 7.55% in the Eleventh Plan. Although, it has been pointed in the Appraisal that the 'successful infrastructure strategy depends critically on the implementation', in our view this would also depend equally on the robustness of the framework used for estimation of infrastructure needs.

The recent publication of 'Investment in Infrastructure during the Eleventh Five Year Plan' by the Secretariat of Infrastructure (within the Planning Commission), highlights the methodology that was used in revising the Eleventh Plan targets and also estimating the Twelfth Plan targets (Government of India, 2010). The estimates were provided for at sub-sectoral level and also at Centre, State and private sector level. One significant addition in these estimates is that it adds investments on gas pipelines, which was not considered in the Approach Paper, to the oil pipelines. But it is disappointing to note that most of the estimates are done at adhoc basis. In other words, the growth rate in the latest period has been used for the projection period. For both Central and State sector, constant growth of 10% is assumed. But for the private sector, in the electricity sector it has assumed 10% growth and in railways, telecom and storage sectors, the report indicate using 'log-linear' model based on past five years of observations! For the oil & gas pipelines, roads and ports, it assumes 15% growth per annum. The report also assumes a GDP growth of 9% for the Twelfth Plan while for the rest two years of Eleventh Plan as 8% and 9%.

Based on our study, ideally the assessment of investment (or expenditure) needs of any sector should be based on the sectoral elasticities (or multipliers) with respect to income and these elasticities could be used for generating realistic projections for the future period. Other way of estimating is through a dynamic macroeconomic framework that considers GDP (or the relevant sectoral) growth also an endogenous variable.

To finance the projected investment needs, government encouraged private sector participation through Public-Private Partnerships (PPP). But the extent of projects under PPP, except in airports, appears to be negligible. Even the extent of FDI investments in infrastructure is also not substantial. This calls for more concerted efforts to boost investments in this sector. There is a need for structural reforms in the domestic financial markets that helps in mobilizing long term finances for infrastructure and in achieving double-digit growth. On the foreign investments front also, although many of the infrastructure sectors have been allowed for upto 100% through automatic route, there appears to be many more bottlenecks that hinder the actual FDI flows. This is evident from the World Bank's Doing Business Survey-2010 that ranks India in 133 (out of 183 countries). This is very low compared to other emerging market economies (BRICS), which compete for the FDI, such as Brazil (129), Russia (120), China (89) and South Africa (34). Even within South Asia, India ranks least.

Keeping in mind of the projected huge requirements of the sectors in the near future, there is an urgent need for some reforms initiatives that could help in improving the macroeconomic outlook and, hence, achieving the projected investments. For instance, encourage the use of derivatives, liberalizing investment guidelines for debt instruments, IPO by Infrastructure companies, develop bond market in the country, allow NBFCs to access infrastructure fund, funding from multilateral agencies, encourage ECB for investment in infrastructure sector and boost PPPs modes of financing.

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APPENDIX

Table: 1.A.
Cross- correlation between variables

	Y_{SERV}	Y_{AGR}	Y_{MAN}	*lypc*	*lelectpc*	*lair*	*lrail*	*ltel*	*lport*
Y_{SERV}	1	-0.98	-0.65	0.97	0.95	0.79	-0.97	0.97	0.97
Y_{AGR}	-0.98	1.00	0.54	-0.97	-0.91	-0.85	0.95	-0.98	-0.97
Y_{MAN}	-0.65	0.54	1.00	-0.55	-0.52	-0.37	0.54	-0.57	-0.52
lypc	0.97	-0.97	-0.55	1.00	0.98	0.77	-0.99	0.98	0.99

lelectpc	0.95	-0.91	-0.52	0.98	1.00	0.70	-0.99	0.93	0.97
lair	0.79	-0.85	-0.37	0.77	0.70	1.00	-0.73	0.79	0.80
lrail	-0.97	0.95	0.54	-0.99	-0.99	-0.73	1.00	-0.96	-0.99
ltel	0.97	-0.98	-0.57	0.98	0.93	0.79	-0.96	1.00	0.98
lport	0.97	-0.97	-0.52	0.99	0.97	0.80	-0.99	0.98	1.00

Table-2.A.

Data and its Sources

Serial No.	Variables	Sector	Indicator	Time Period	Data sources
1	Y_{AGR}	Agriculture	%Share of Agriculture GDP	1980-2007	WDI
2	*air*	Air ((transportation)	Per-capita Air transport, passengers carried	1980-2006	WDI
3	*electpc*	Electricity	Per-capita Electricity production (kWh)	1980-2006	WDI
4	*ypc*	Income	Per-capita GDP	1980-2013	WEO
5	Y_{MAN}	Manufacturing	%Share of Manufacturing in GDP	1980-2007	WDI
6	*port*	Port (transportation)	Per-capita Ports-commodity traffic at all major ports	1980-2007	CMIE
6	*rail*	Railways (transportation)	Railways, goods transported (million ton-km)	1980-2005	WDI
7	*road*	Road (transportation)	Per-capita Roads, total network (km)	1980-2002	CMIE
8	Y_{SERV}	Services	%Share of Services in GDP	1980-2007	WDI
9	*tel*	Telecommunication	Fixed line and mobile phone subscribers (per 100 people)	1980-2007	WDI