ISSN No. 2349-7165

Rail-Route to Economic Growth: An Empirical Assessment of the Indian Railways

Prerna Panda
Ph.D. Research Scholar,
School of Economics, University of Hyderabad,
Email : prernapanda@gmail.com,

ABSTRACT

It is a general supposition that infrastructure investment has a positive impact on economic growth and also economic growth further requires investments in infrastructure. Public investment in railways generates largest spillovers compared to other sectors. The aim of this paper is to empirically investigate the impact of rail-route to economic growth from 1980-2015. The paper attempts to look at the relationship between economic growth, railway supply, railway demand, consumption and investment for the Indian economy, in a VECM framework. The empirical estimates convey that a long-run causality exists from railway demand, railway supply to economic growth, consumption and investment in the economy over the period studied. With few more results, the paper suggests to curb the modal shift from railways to other modes, discussing several benefits of railways as a mode of transportation.

Key Words: Rail-route, causality, modal shift, agglomeration

1. Introduction

Infrastructure is the product of prudent public investment. Infrastructure development is also the channel of opening opportunities. Development of infrastructure is recognised as an essential factor to sustain economic growth of a country. The International Monetary Fund in the World Economic Outlook (2014) has noted that increases in public infrastructure investment, if efficiently implemented, affects the economy in two ways. In the short-run it boosts aggregate demand and crowds in private investment due to the complementary nature of infrastructure services. In the long-run, a supply side effect also kicks in as the infrastructure built feeds into the productive capacity of the economy. India, being a fast growing economy requires world-class infrastructure to promote global competitive efficiency. India's infrastructure is indisputably a growth sector and is given recognition of national priority. This gap needs to be bridged to sustain the trajectory of growth.

Infrastructure investments on transportation networks have multi-dimensional effects, to boost growth in an economy. The direct effects are reduced transportation costs and enhanced accessibility. Apart from these primary effects, transport networks strengthen markets by linking them, distances being easily connected creates greater competition, with higher productivity effects, there's increase in incomes, inducing higher work and leisure travels and hence paving the road to agglomerative spillovers. These give a strong conceptual reasoning towards investing transport capital.

Railways are univocally considered the life-line of any economy. As Rostow remarked, "... the introduction of the railways has been historically the most powerful single initiator of take-offs". The British companies in 1850s spread out the first railway lines in India. The establishment of Indian railways led to the integration of markets and consequently raising incomes. With its introduction, there was displacement for road mode of transport, both in carrying people and goods. This was mostly for long distance travels. But the scenario changed with industrial development. There was increase in traffic along with motorisation. This led a modal split towards roads. This makes the base of our present paper.

2. State of Indian Railways

The transport sector in India is shifting towards roadways than railways. Though traffic has increased over the years both in terms of freight and passengers, but has got diverted towards roadways. There are financial inadequacies lumping so keeping aside modernisation, even capacity addition is limited even with the rise in traffic demand. The finances of Indian railways have been stressed over the past 15 years. The Rakesh Mohan Committee Report (2014) stated a key observation that 'until the 1990s, public investments in railways were at least as much as those in roads. However in the past 15 years, investments in roads have increased to 1 per cent of GDP but for railways it is just 0.4 per cent of the GDP as per the national accounts data.' The share of railways in total plan outlay is only 5.5 per cent whereas it is 11 per cent for other transport sectors (Economic Survey 2014-15). This has led to modal shift in passenger and especially in freight traffic to road sector. The modal share in freight traffic stands at 36 per cent for railways. This is estimated decline to 25 per cent by 2020 (McKinsey Report 2010).

The persistent rise of load on railway services along with lower speeds stem out of lack of inadequate capacity addition. Both passengers and goods train share the same track network in India. With passenger trains utilizing around 65 percent of the network capacity, the above situation imposes constraints on the running of heavy freight trains and high speed passenger trains as passenger traffic is generally accorded priority (Economic Survey 2014-15).

This scenario depicts a 'route to nowhere' by the Economic Survey (2014-15). The Indian Railways are underinvested resulting in low capacity and consequent over use

3. Literature Review

There has been a plethora of academic research over the nexus of public investment and growth. Gramlich (1994) refer it as a "speculative bubble". The importance of public capital as an input in the production of total output is impeccably recognised by Macroeconomists. Research in this field was steered by three series of seminal works of Aschauer (1989a, 1989b, 1989c). He blamed the cut of funds of infrastructure investment for decline in U.S productivity at that time. For India, Hulten, Bennathan and Srinivasan (2006) stated that infrastructure is a major contributor to productivity growth and to a reduction in cost of production with significant positive spillover externalities. Tripathy, Srikanth & Aravalath (2016) and Sahoo & Dash (2010) estimate that there exists a unidirectional causality from both physical and social infrastructure to output growth in India.

In the nineteenth century, railway was considered one the most essential technological breakthroughs. It did lead to an upward shift in the production possibility frontiers of many economies' worldwide. Yet, there has either been extensive research on infrastructure in general or transport infrastructure in particular, where railway is a consolidated part. There is very little literature that study railway exclusively.

Dave and Hornbeck (2016) in studying U.S. data from 1870 to 1890 estimate that as railroads expanded, agricultural land values also increased substantially during the same period of time. A removal of all railroads in 1890 was found to decrease the total value of U.S. agricultural land by 60 per cent. Using panel data of 29 provinces of China from 1986 to 2011, Jiang, He, Zhang, Qin and Shao (2017) adopt a national Structural equation model and a region-specific Structural Equation Model. Then on estimation of relationship between transportation investment and regional economic growth, they find that both transportation investments in the current region and in the surrounding regions have statistically significant impacts on economic growth. There are differences in national level and provincial level. These differences can be associated with phases of economic development, transportation investment policy and spillovers. Transport infrastructure is a crucial factor towards economic growth. This was concluded by Hong, Chu and Wang (2011) with a panel data model making use of a sample of 31 Chinese provinces from 1998 to 2007. They also state that uneven distribution of transport infrastructure is a dominant reason for economic disparities across Chinese regions. Railroads were the cause of Midwestern urbanisation and might account for more than half of the increased urbanisation in the American Midwest during the 1850s (Atack, Haines 2009). A study by Affuso, Masson and Newbery (2003) suggests that railways have substantially lower returns when compared to roads.

To analyse India's future of transport performance, Ramanathan and Parikh (1999) use cointegration approach and scenario analysis. The model projects that the passenger traffic in India is likely to grow more than 8 per cent and freight traffic at more than 5 per cent per year during 1990-2021. The scenario analysis shows that if modal split is promoted towards public transport modes (rail and public road transport), around 45 per cent reduction in energy requirements and carbon dioxide emissions in expected. Donaldson (2010) collected archival data from colonial India to evaluate the impact of India's railroads. He estimated that railroads reduced trade costs, inter-regional gaps in prices; trade volumes rose, real agricultural income increased, real income volatility reduced and local price shocks due to local productivity shocks became unresponsive. Pradhan and Bagchi (2013) infer that stressing on transport infrastructure development along with gross capital formation in India will augment growth substantially. They make use of road and rail data to study the effect of transportation from 1970-2010 in a Vector Error Correction Model (VECM) framework.

The motivation behind this paper is stressing the role of railways in particular. Testing the nexus of railways in the causal relationship with Economic Growth is what makes this paper different. There have been studies who have studied railways as a part of Transport infrastructure and not isolating it, despite it being the major reason for transition in the growth trajectory of the Indian Economy. Therefore, the paper examines if there's an empirically justified rail-route to economic growth. When the contribution of railways to GDP is merely 1 per cent, in this conjecture, can data ascertain the linkage between the two?

4. Data and Econometric Modelling

The study in this paper aims to explore the relationship between supply of railways, economic growth, consumption, investment and railway demand. There lie significant intricacies in the relationship among the few selected variables.

The selected variables in the study are Consumption is measured by taking data on Final Consumption Expenditure (FCE), Investment by Gross Fixed Capital Formation (GFCF), Railway demand includes two variables Passenger-kilometres (PKM) and Tonne-kilometres (TKM) and Railway supply is measured by Rail Lines route-kilometres (RL). Along with Gross Domestic Product (GDP) which is proxy for economic growth, there are six variables in the study. All the data collected pertain to India. The annual data spanning from 1980 to 2015 is sourced from the World Development Indicators reported by the World Bank. To account for endogeneity of the variables included in the model, we decide to test for Vector Error Correction Model (VECM).

The following section tries to empirically examine the linkages between RL, PKM, TKM, GDP, GFCF and FCE. Here, we try to check for the impact of Railways on Economic Growth. Railways' effect is being examined in two ways- supply and demand. RL is taken to capture the interface between railway investment and economic growth. Railway demand is dependent on economic development, urbanisation, agriculture development, work and leisure travels, industrialisation, and agriculture development and so on. This leads to a rise in freight and passenger traffic in railways. So the model has incorporated the behaviour of railways performance through PKM and TKM. The rationale for incorporating FCE is that it guides investment in an economy and so also GDP. FCE is also facilitated by railways.

The relationship is studied through the following equations:

$$\Delta GDP_t = \alpha_1 + \sum_{i=1}^{p} \beta_{11,i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \delta_{12,i} \Delta GFCF_{t-i} + \sum_{i=1}^{p} \lambda_{13,i} \Delta FCE_{t-i} + \sum_{i=1}^{p} \mu_{14,i} \Delta PKM_{t-i} + \sum_{i=1}^{p} \eta_{15,i} \Delta TKM_{t-i} + \sum_{i=1}^{p} \Theta_{16,i} \Delta RL_{t-i} + \phi_1 EC_{t-1} + \zeta_t \quad (1)$$

$$\Delta GFCF_t = \alpha_2 + \sum_{i=1}^{p} \beta_{21,i} \Delta GFCF_{t-i} + \sum_{i=1}^{p} \delta_{22,i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \lambda_{23,i} \Delta FCE_{t-i} + \sum_{i=1}^{p} \mu_{24,i} \Delta PKM_{t-i} + \sum_{i=1}^{p} \eta_{25,i} \Delta TKM_{t-i} + \sum_{i=1}^{p} \Theta_{26,i} \Delta RL_{t-i} + \phi_2 EC_{t-1} + \zeta_t \quad (2)$$

$$\Delta FCE_t = \alpha_3 + \sum_{i=1}^{p} \beta_{31,i} \Delta FCE_{t-i} + \sum_{i=1}^{p} \delta_{32,i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \lambda_{33,i} \Delta GFCF_{t-i} + \sum_{i=1}^{p} \mu_{34,i} \Delta PKM_{t-i} + \sum_{i=1}^{p} \eta_{35,i} \Delta TKM_{t-i} + \sum_{i=1}^{p} \Theta_{36,i} \Delta RL_{t-i} + \phi_3 EC_{t-1} + \zeta_t \quad (3)$$

$$\Delta PKM_t = \alpha_4 + \sum_{i=1}^{p} \beta_{41,i} \Delta PKM_{t-i} + \sum_{i=1}^{p} \delta_{42,i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \lambda_{43,i} \Delta GFCF_{t-i} + \sum_{i=1}^{p} \mu_{44,i} \Delta FCE_{t-i} + \sum_{i=1}^{p} \eta_{45,i} \Delta TKM_{t-i} + \sum_{i=1}^{p} \Theta_{46,i} \Delta RL_{t-i} + \phi_4 EC_{t-1} + \zeta_t \quad (4)$$

$$\Delta TKM_t = \alpha_5 + \sum_{i=1}^{p} \beta_{51,i} \Delta TKM_{t-i} + \sum_{i=1}^{p} \delta_{52,i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \lambda_{53,i} \Delta GFCF_{t-i} + \sum_{i=1}^{p} \mu_{54,i} \Delta FCE_{t-i} + \sum_{i=1}^{p} \eta_{55,i} \Delta PKM_{t-i} + \sum_{i=1}^{p} \Theta_{56,i} \Delta RL_{t-i} + \phi_5 EC_{t-1} + \zeta_t \quad (5)$$

$$\Delta RL_t = \alpha_6 + \sum_{i=1}^{p} \beta_{61,i} \Delta RL_{t-i} + \sum_{i=1}^{p} \delta_{62,i} \Delta GDP_{t-i} + \sum_{i=1}^{p} \lambda_{63,i} \Delta GFCF_{t-i} + \sum_{i=1}^{p} \mu_{64,i} \Delta FCE_{t-i} + \sum_{i=1}^{p} \eta_{65,i} \Delta PKM_{t-i} + \sum_{i=1}^{p} \Theta_{66,i} \Delta TKM_{t-i} + \phi_6 EC_{t-1} + \zeta_t \quad (6)$$

Table 1 displays the summary statistics for all the variables included in the model.

Table 1

Summary Statistics

	GDP	*GFCF*	*FCE*	*PKM*	*TKM*	*RL*
Mean	4.41E+13	1.24E+13	3.05E+13	499008.3	349365.9	62937.12
Median	3.41E+13	8.02E+12	2.45E+13	391890.5	282881.0	62742.00
Maximum	1.14E+14	3.52E+13	7.37E+13	1147190	681696.0	66030.00
Minimum	1.34E+13	2.69E+12	1.11E+13	208550.0	158474.0	61230.00
Std. Dev	2.90E+13	1.04E+13	1.83E+13	289981.9	162871.2	1182.431
Skewness	0.936621	0.974840	0.961086	0.989896	0.844024	0.945783
Kurtosis	2.712253	2.504864	2.751675	2.672903	2.324875	3.678702
Jarque-Bera	5.387752	6.069619	5.634620	6.039851	4.957953	6.057985
Probability	0.067618	0.048084	0.059766	0.048805	0.083829	0.048364
Sum	1.59E+15	4.47E+14	1.10E+15	17964299	12577174	2265736
Sum Square Dev	2.94E+28	3.75E+27	1.17E+28	2.94E+12	9.28E+11	48935013

Note: The total number of observations is 35

 ISSN No. 2349-7165

We proceed with the unit root test (Tables 2 and 3) making use of Dickey-Fuller (DF), Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests. The comparisons are drawn from the significance table as jotted by Dickey-Fuller (1979).

Table 2

Unit Root Test at Level

With Trend and Intercept			
Variables	*ADF*	*DF*	*PP*
GDP	4.040010 (9)	-1.599033	7.313479
GFCF	-0.125182 (9)	-0.689923	-0.237628
FCE	3.485171 (9)	-1.579066	2.493478
PKM	0.157053 (9)	-1.637368	0.153356
TKM	-1.0277079 (9)	-1.148458	-0.594762
RL	-0.687061 (9)	-1.217221	-0.646815

Note: Above values are of t-statistics. Number in parenthesis () are lag length based on the optimum lag selection criterion. The critical values for unit root tests at 1 per cent, 5 per cent and 10 per cent levels are -4.243644, -3.544284 and -3.204699 (with trend and intercept) respectively.
* denotes significance at the 10 per cent level
** denotes significance at the 5 per cent level
*** denotes significance at the 1 per cent level

Table 3

Unit Root Test at First Difference

With Trend and Intercept			
Variables	*DF*	*ADF*	*PP*
FDGDP	-3.465391* (8)	-3.505330**	-3.341357*
FDGFCF	-4.255390*** (8)	-4.363541***	-4.194032**
FDFCE	-3.323406* (8)	-3.261900**	-3.257866*
FPKM	-5.097714*** (8)	-4.872748***	-5.111158***
FDTKM	-3.928604** (8)	-3.840479***	-3.920488**
FDRL	-3.784792 *** (8)	-6.997534***	-6.753090***

Note: Above values are of t-statistics. Number in parenthesis () are lag length based on the optimum lag selection criterion. The critical values for unit root tests at 1 per cent, 5 per cent and 10 per cent levels are -4.252879, -3.548490 and -3.207094 (with trend and intercept) respectively.
* denotes significance at the 10 per cent level
** denotes significance at the 5 per cent level
*** denotes significance at the 1 per cent level

To know the kind of model to be applied in detecting the railways and economic growth relationship, we make use of the Cointegration Test. Johansen multivariate cointegration technique, proposed by Johansen (1988) and Johansen and Juselius (1990), was applied to do the Cointegration Test. Trace statistics and maximum eigen value statistics are the two likelihood ratio test as provided by this technique are used for drawing results of cointegrating relationship. We employ the standard Grangers Causality test first. This test crucially depends upon the stationarity condition of the time series variables involved. Therefore, in their first differences and thus the stationary variables are checked for Grangers Causality. This has been reported in Table 4.

Table 4

Granger Causality Test

Null Hypothesis	*F-Statistic*
FDGFCF ⇏ FDGDP	3.17*
FDGDP ⇏ FDGFCF	10.43***
FDFCE ⇏ FDGDP	2.51
FDGDP ⇏ FDFCE	6.07**
FDPKM ⇏ FDGDP	1.39
FDGDP⇏ FDPKM	9.96***
FDTKM ⇏ FDGDP	2.0E-05
FDGDP⇏ FDTKM	4.70**
FDRL⇏ FDGDP	0.79
FDGDP ⇏ FDRL	3.73*
FDFCE ⇏ FDGFCF	5.03**
FDGFCF⇏ FDFCE	0.02
FDPKM⇏ FDGFCF	5.17**
FDGFCF ⇏ FDPKM	3.21*
FDTKM ⇏ FDGFCF	5.87**

Null Hypothesis	*F-Statistic*
FDGFCF ⇏ FDTKM	3.84*
FDRL ⇏ FDGFCF	0.36
FDGFCF⇏ FDRL	0.56
FDPKM ⇏ FDFCE	0.12
FDFCE ⇏ FDPKM	8.67***
FDTKM ⇏ FDFCE	1.77
FDFCE ⇏ FDTKM	2.56
FDRL ⇏FDFCE	0.27
FDFCE ⇏FDRL	1.94
FDTKM ⇏FDPKM	4.00*
FDPKM⇏FDTKM	1.05
FDRL ⇏FDPKM	0.49
FDPKM ⇏ FDRL	0.17
FDRL ⇏ FDTKM	0.005
FDTKM ⇏ FDRL	0.03

Note: The notation ⇏ stands for does not Granger Cause

Above Pair-wise Granger Causality Test is done in lag 1.
The total number of observation is 34.
* denotes significance at the 10 per cent level
** denotes significance at the 5 per cent level
*** denotes significance at the 1 per cent level

Granger causality test is put to use without considering the possibility of cointegrating relationship among the six variables. We search for cointegrating relationship among the variables first by ascertaining the lag length. It is taken to be 1 in the model based on Schwarz Information Criterion (SC) and Hannan Quinn Criterion (HQ). We consider 1 based on the number of observations, not to lose much degree of freedom. Then we report the results in Table 5 of the Johansen's Cointegration Test. There are 34 observations after adjustment

Table 5

Cointegration Test

Null Hypothesis	*Alternative Hypothesis*	*Tests of Cointegration*	*0.05 Critical Values*
λ Trace Test	*λ Trace Test*	*λ Trace Value*	*5%*
r = 0	r > 0	156.55	95.75366
	r > 1	106.1207	69.81889
r ≤ 2	r > 2	67.82565	47.85613
r ≤ 3	r > 3	33.20634	29.79707
r ≤ 4	r > 4	10.60347	15.49471
λ Max Test	*λ Max Test*	*λ Max Value*	*5%*
r = 0	r = 1	50.43104	40.07757
r = 1	r = 2	38.29504	33.87687
r = 2	r = 3	34.61931	27.58434
r = 3	r = 4	22.60287	21.13162
r = 4	r = 5	7.435211	14.26460

Table 5 shows the trace and max-eigen value statistics along with the p-values for determining the number of cointegrating vectors (r) using Johansen's maximum likelihood approach. In trace and max-eigen value statistics, the null hypotheses at several levels of cointegrating vectors are tested. Interpreting the test results, both trace and max-eigen values reject the null hypotheses till r = 3, which shows that there are four cointegrating relationship among the variables.

Vector Autoregression Model can no longer be applied, as it assumes no Cointegration should exist among the variables. So by using VECM we can show types of causality from the two sources possible. Long-run causality can be ascertained from the error correction term and short-run causality from the lagged explanatory variables. The VECM results are stated in Table 6.

Table 6

Results of Vector Error Correction Model

Dependent Variable	? GDP	? GFCF	? FCE	? PKM	? TKM	? RL	ECT_1	ECT_2	ECT_3	ECT_4
? GDP	-	**-0.670****	0.72	-1933206	-16972161	2.57E+08	1.035***	-0.35	**-1.99*****	3276557122
? GFCF	-0.137	-	0.654*	**-19393075***	-9310802	7.50E+08*	0.98***	**-0.77*****	**-1.665*****	29035120***
? FCE	0.009	**-0.248***	-	-1760925	-1508495	8.27E+08**	0.49***	-0.135	**-0.67****	-3935183
? PKM	7.25E-09	**-1.06E-08****	**-1.58E-08***	-	0.284	40.919***	8.60E-10	4.79E-09	1.88E-08**	**-1.55*****
? TKM	3.67E-09	1.71E-09	-9.16E-09	0.35	-	6.77	2.28E-09	-9.18E-10	2.14E-09	-0.376
? RL	1.88E-10**	6.59E-12	**-4.97E-10*****	0.0047	**-0.009***	-	-8.96E-11	2.33E-11	2.30E-10	-0.005

Notes: Above values are coefficients of VECM
* denotes significance at the 1 per cent level
** denotes significance at the 5 per cent level
*** denotes significance at the 10 per cent level

Due to the presence of four cointegrating vectors as found from the Cointegration Test, there are four cointegrating equations, and hence four corresponding Error Correction Terms (ECT). The condition for establishing long-run causality is that at least one of the ECTs must be at the same time negative and significant in terms of p-value. On that basis, we draw the results from VECM. Finally in Table 7 we jot down how much is the VECM model robust. To do so, we make use of several diagnostic checks of Serial Correlation, White's Heteroskedasticity and test of Normality.

Table 7

Diagnostic Test of VECM Residual

Diagnostic Test	*d.f*	*Test Statistic*	*p-value*
White's Heteroskedasticity	420	427.5282	0.3893
Serial Correlation LM Tests	36	27.99678	0.8273
Jarque Bera	12	11.09100	0.5211

Table 8

VEC Granger Causality/Block Exogeneity Wald Test

Dependent Variable	Independent Variable						
	ΔGDP	ΔGFCF	ΔFCE	ΔPKM	ΔTKM	ΔRL	ECT
ΔGDP		**4.23**** (0.0396)	0.93 (0.3356)	0.85 (0.3574)	0.49 (0.4860)	0.11 (0.7429)	6.890 (0.2290)
ΔGFCF	0.62 (0.4321)	-	**3.02*** (0.0820)	**3.42*** (0.0643)	0.59 (0.4440)	**3.66*** (0.0557)	**10.45*** (0.0634)
ΔFCE	0.004 (0.9475)	**3.59*** (0.0578)		0.043 (0.8349)	0.02 (0.8777)	**6.864***** (0.0088)	**10.15*** (0.0710)
ΔPKM	**2.91*** (0.0882)	**7.13***** (0.0076)	**2.99*** (0.0838)	-	0.92 (0.3362)	**18.41***** (0.0000)	**31.26***** (0.0000)
ΔTKM	0.76 (0.3827)	0.19 (0.6620)	1.020 (0.3124)	1.98 (0.1591)	-	0.514 (0.4733)	2.53 (0.7726)
ΔRL	**6.66***** (0.0099)	**0.009** (0.9226)	**10.002***** (0.0016)	1.183 (0.2766)	**3.335*** (0.0678)	-	**22.51***** (0.0004)

Note: Above values are chi-square statistics. Number in parenthesis () are values of probability.
Number in parenthesis () of ECT are t- statistics
* denotes significance at the 1 per cent level
** denotes significance at the 5 per cent level
*** denotes significance at the 10 per cent level

In an effort to further determine the causality among the six variables more distinctively a Granger causality/Block Exogeneity Wald tests based upon VECM is performed as well. Here, unlike Granger's causality test, we take the time series variables at levels, despite the fact of the existence of unit root. Moreover, in VECM where all the variables were endogenous, here we consider the exogeneity of variables and then check for short-run and long run causality. The results of which are enumerated in Table 8 above. In the next section we discuss the outcome of these rigorous econometric tests.

5. Empirical Results

The present analysis of empirically examining the rail-route to economic growth started with test of stationarity. All the variables are found to stationary at their first order. When all the variables are stationary and hence integrated of order one, we make use of the Granger Causality Test. We see bidirectional causality between the first difference of Gross Domestic Product & Gross Fixed Capital Formation (FDGDP ↔ FDGFCF), Passenger-kilometres & Gross Fixed Capital Formation (FDPKM↔ FDGFCF) and Tonne-kilometres & Gross Fixed Capital Formation (FDTKM↔ FDGFCF). A unidirectional causality exits from GDP to FCE (FDGDP ≥ FDFCE) and then from FCE to GFCF (FDFCE ≥ FDGFCF) also from FCE to PKM (FDFCE ≥ FDPKM), all the variables are at their first differences.

With Johansen's Maximum Likelihood Test, we check for long-run equilibrium among the six variables considered in the study. The results of λ_{trace} and λ_{max} show that out of the six variables, there are cointegrating relationships among four. So, with long-run association, there's also a causality attached. Therefore, to know the direction of causality, VECM was applied. Interpreting the results from Table 7, we find that in the long-run, PKM, TKM and RL have substantial influence on GDP, GFCF and FCE. The relationship between PKM and GFCF (PKM ↔ GFCF) is bidirectional. GFCF has a unidirectional causal impact on GDP and FCE (GFCF ≥ GDP and GFCF ≥ FCE). FCE further has a unidirectional impact on PKM, TKM and RL (FCE ≥ PKM, FCE ≥ TKM and FCE ≥ RL). Also a long-run causality also runs from all the variables to PKM.

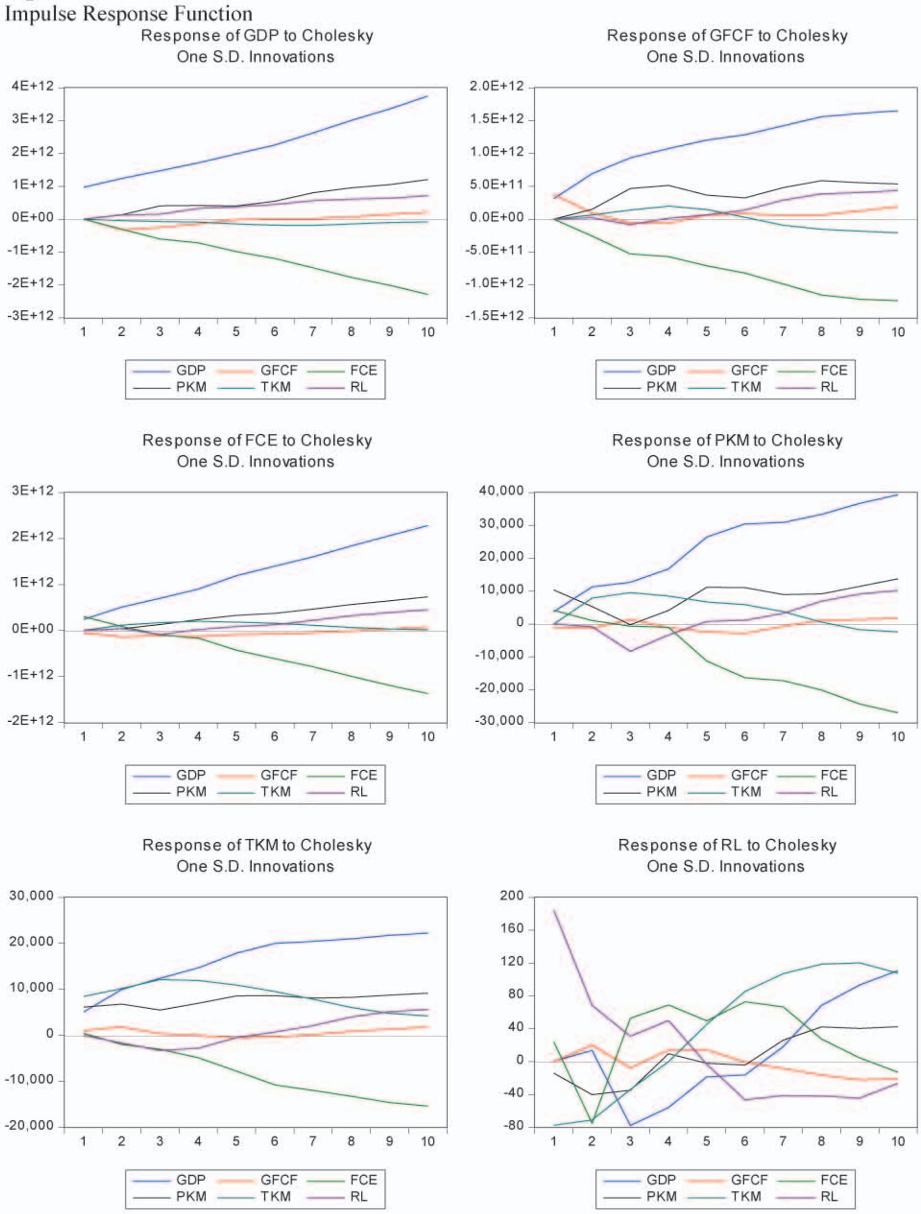
To give a graphical picture and further verify the results we show below the Generalised Impulse Response Functions. The impact or response of other variables when one standard deviation shock is given to one endogenous variable is traced in the graph below in Figure 1. These figures confirm the existence of causality as found in the VECM model.

Figure 1

Impulse Response Function

Figure 1

Impulse Response Function



To further show the fit of the VECM, we conduct serial correlation test, White's Heteroskedasticity test and test of normality. From Table 8, we see that there is no serial correlation, no Heteroskedasticity and also the residual is normally distributed. So our VECM passes all the diagnostic tests.

On conducting a Block Exogeneity Wald Test we find that the results of it are in almost conformity with the VECM. It further shows that causality runs from all other five variables to Railway Lines. The relation between RL and GFCF is bidirectional (RL ↔ GFCF). A unidirectional causality runs from RL to PKM (RL ≥ PKM), RL to GFCF (RL ≥ GFCF) and then from GFCF to PKM (GFCF ≥ PKM). Again, TKM unidirectionally cause RL (TKM ≥ RL). The results of which are stated in Table 9.

6. Discussion and Conclusion

Railway like transport is an economic activity, it creates and induces economic activity and it also facilitates economic activity. "…Railways have been a most powerful agent in the progress of commerce, in improving the conditions of the working classes, and in developing the agricultural and mineral resources of the country (United Kingdom)" Baxter (1866). Railways, as an efficient mode of transportation, reduce variety of costs, increase the extent of markets, improve competitiveness and hence generate networked agglomeration economies. Railways are a key factor in production and distribution, transferring inputs and finished goods between and within locations, connecting businesses, businesses and their input sources, and businesses and markets. It increases the size of the market and facilitates division of labor and specialization. It also enhances opportunities for trade by reducing trade costs. Producers and consumers take decisions regarding location, markets, products, prices, costs, etc those depend on availability, capacity and costs of transport. In fact, higher economic growth leading to higher incomes creates further leisure travels. Railway ensures it through its track laid connectivity.

Indian Railways are the fourth largest railway network in the world, functioning under a single management. But there are severe capacity bottlenecks that exist. The current demand and also growth needs have been over-looked. Railways, despite being the most reliable and energy efficient mode are suffering from severe capacity deficiency due to lack of public investment, leading to a modal imbalance. With lack of capacity addition, the share of railways in the GDP has declined to stand at around 1 per cent in recent years (Economic Survey 2014-15). Due to this, despite the unhidden benefits of railways in any economy, it is difficult to robustly show the empirical evidence of rail-route to economic growth. The model any how gives consistent results on employing three tests such as Granger Causality, VECM and Block Exogeneity Wald Test. We find a long-run causality existing from railway demand (PKM and TKM), railway supply (RL) to economic growth (GDP), Investment (GFCF) and Consumption (FCE). There is bidirectional causality between PKM and GFCF. RL has a bidirectional relation with FCE. Bidirectional causality also exists between FCE and GFCF and hence GFCF unidirectionally causes GDP. The power of the model lies in PKM and TKM strongly influencing GFCF and FCE which in turn influence GDP and hence economic growth.

Though, the benefits of railways are in wide purview, reaping them will need policy initiatives. Apart from the direct contribution to economic growth, most benefits welfare effects or advantages that goes to economic growth indirectly is through spillovers. Due to data unavailability, spillovers of railways have not been covered in this paper. This along with some comparisons can be the basis of the further study.

7. References

Affuso, L., Masson, J. & Newbery, D. (2003). Comparing Investments in New Transport Infrastructure: Roads versus Railways? Fiscal Studies, 24, 275-315.

Aschauer, D.A (1989a). Is public expenditure productive? Journal of Monetary Economics, 23, 177-200.

Aschauer, D.A (1989b). Public Investment and Productivity Growth in the Group of Seven. Federal Reserve Bank of Chicago, 1-25.

Aschauer, D.A (1989c). Does public capital crowd out private capital? Journal of Monetary Economics, 24, 171-188.

Atack, J., Bateman, F., Haines, M. & Margo, R.A. (2009). Did Railroads Induce or Follow Economic Growth? Urbanisation and Population Growth in the American Midwest, 1850-60, National Bureau of Economic Research, Working Paper 14640, Cambridge, MA.

Chaudhury, P.D. (2005). Modal Split between rail and road modes of transport in India, Vikalpa, 30, 17-33.

Donaldson, D. (2010). Railroads of the Raj: Estimating the Impact of Transportation Infrastructure. London School Economics, Asia Research Centre Working Paper 41, London.

Donaldson, D. & Hornbeck, R (2013), Railroads and American Economic Growth: A "market access" Approach. National Bureau of Economic Research.

Dickey, D. and Fuller, W. (1979): Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association 74 (366), 427–431.

Gramlich, E.M. (1994). Infrastructure investment: A review essay. Journal of Economic Literature, 32, 1176-1196.

Granger, C.W.J. (1988): Some Recent Developments in the Concept of Causality. Journal of Econometrics 39, 199-21.

Hong, J., Chu, Z. & Wang, Q. (2011). Transport infrastructure and regional economic growth: Evidence from China. Transportation, 38, 737-752.

Hulten, C.R., Bennathan, E. and Srinivasan, S. (2006) Infrastructure, Externalities, and Economic Development. A study of the Indian Manufacturing Industry. World Bank Economic Review, 20 (2), 291-308.

Infrastructure Investment and Regional Economic Development: A Structural Equation Modelling empirical analysis from 1986-2011. Transport Policy, 54, 43-52.

International Monetary Fund (2014). From Stabilization to Sustainable Growth. Washington., D.C.

International Monetary Fund (2015). Making Public Investment more effective. Washington., D.C.

Jiang, X., He, X., Zhang, L.,Qin, H & Shao, F (2017). Multimodal Transportation.

Johansen, S. (1988): Statistical Analysis of Cointegration Vectors. Journal of Economic Dynamics and Control 12 (2-3), 231-254.

Johansen, S. and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration-with Applications to the Demand for Money. Oxford Bulletin of Economics and Statistics 52, 169-210.

Kulshreshtha, M., Nag B., & Kulshreshtha, M. (2001). A Multivariate Cointegrating Vector Auto Regression model of freight transport demand: Evidence from Indian railways. Transport Research Part A, 35, 29-45.

Lakshmanan, T.R (2011), The broader economic consequences of transport infrastructure investmenrs. Journal of Transport Geography, 19, 1-12.

Maddala, G.S. (1992). Introduction to econometrics. New Jersey: Prentice Hall.

Phillips, P. and Perron, P. (1988). Testing for a Unit Root in Time Series Regression. Biometrica 75, 335-346.

Pradhan, R., & Bagchi (2013). Effect of transportation infrastructure on economic growth in India: The VECM Approach. Research in Transportation Economics, 38, 139-148.

Mohan, R. (2014). India Transport Report: Moving India to 2032. Rouledge, Vol(1).

Ramanathan, R. (2001). The long-run behaviour of transport performance in India: A Cointegration Approach. Transport Research Part A, 35, 309-320.

Ramanathan, R., & Parikh, J.K. (1999). Transport sector in India: An analysis in the context of sustainable development. Transport Policy, 6, 35-45.

Sahoo, P and Dash, R.K..2010. Economic Growth in India: the role of physical and social infrastructure. Journal of Economic Policy Reform,13 (4), 373-385.

Sinha, S., & Sarma, V(2016). Indian Railways: On the fast track to growth. McKinsey & Company.

Tripathy, N., Srikanth, M., and Aravalath, L.M..(2016). Infrastructure Investment and Economic Growth: Evidence from India. Journal of International Business and Economy, 17(1), 91-111.

Vikerman, R., (2008). Transit Investment & economic development. Research in Transport Economics, 23, 107-115.

Owen, W. (1959).Transportation and Economic Develpoment. The American Economic Review, 49,179-187.