NEXUS BETWEEN ECONOMIC GROWTH AND RAILWAYS IN PAKISTAN: COINTEGRATION ESTIMATION WITH MULTIPLE STRUCTURAL BREAK TEST AND CAUSALITY ANALYSIS

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ABSTRACT: *Railways have been the oldest mode of the mass transit. Its role in transportation of human beings and physical goods is well documented. This paper shall focus on the long term relationship between economic growth and railways growth in Pakistan. The data of railways and economic growth is borrowed from World Development Indicators (WDI). We are taking 33 years (1980-2012) of data. Since the expected length of data is beyond 30 years, we used long run analysis techniques such as cointegration. An additional feature of this paper is the use of structural breaks in the long run analysis. Structural break is a characteristic of the long run time series. Statistical tests have been used to point out the structural breaks. The application of Fully Modified Ordinary Least Squares estimation technique has also enabled us to quantify the contribution of Railways in growth. Causality is also investigated by using Granger Causality test. The results shall allow the policy makers in transport sector to formulate policies for Pakistan Railways with confidence.*

Key Words: GDP, Railways Goods Transported, Time Series, Cointegration, Structural breaks, FMOLS, Granger Causality.

1. INTRODUCTION

Transport system contributes to economic growth by low production cost through timely delivery of raw materials, integrating markets, increasing economies of scale, creating economic opportunities and communication links. It also increases the competitive advantage in production which further promotes trade. It also inspires tourism and foreign investment. It creates employment like currently 6% of employed labor force is engaged in this sector[1]. It also contributes to the government revenues by duties and taxes on production and on imports the parts and vehicles. Therefore, railways is one indicator for quality of infrastructure of an economy.

Table 1: Quality of Infrastructure

	Road	Rail	Air
Pakistan	72	55	81
India	90	23	71
China	53	27	79
Bangladesh	100	71	117
Indonesia	84	56	69
Malaysia	21	20	29
Thailand	36	57	28

Source: Global Competitiveness Report, 2010.

The table show a glimpse of some parameters for quality of infrastructure. The above table show the rankings of 133 countries. The ranks showed that Malaysia and India have better rankings in railway infrastructure. China is also in the list. These countries are enjoying all of the benefits railways to their long and short. Pakistan is on the other hand lacking behind. In 2005-10, railways expense was only PKR 45.5 billion. By proper management, this infrastructure needs to be fully utilized to increase efficiency. So, railways is better where there are better economic growth rates.

We are focusing on Pakistan economic growth in reference to railways. There has been a long history of losses for Pakistan railways. The pace towards larger revenues is very low. Some initiatives have taken to reduce the fares up to 33% to attract the passengers again toward this means of transportation. Due to this decision, total passenger revenue target for the current fiscal year is PKR 14 billion.

1.1 Objectives

This paper aims at analyzing the railways-growth nexus for the Pakistan. Specific testable proposition is as follows:

P_A: There exists a causal long run relationship between railways services and economic growth of Pakistan.

2. LITERATURE REVIEW

Initial research on railway-growth nexus can be attributed to [1] that tried to explained how railroads initiate economic growth. In US, through railroads, it was easy to utilize the economies of specialization which was essential for per capita income and its growth rate in the 19th century. US demand had shifted in the past towards the efficiently production of goods and services. This had increased the demand of technology in railways as well.Large inputs of railway technology were required for profitable industries which increased the railroad investment with a sudden burst of speed.

[9] considered the influence of railways on the US economy in three phases; railroad as an idea, construction enterprise and producer of transport services. Contrary to this, Britain railways were not creating new towns and industries but its coal industry gained most from this cheaper transport service. Hence, the 1st phase which was railroad as an idea was insignificant for the British economy because commercial relationships were already served by existing communication services[2]. It was also suggested that in its first two decades, railways decreased the freight cost which further reduced the cost of the economy.

[1] Economic Survey of Pakistan 2009-10.

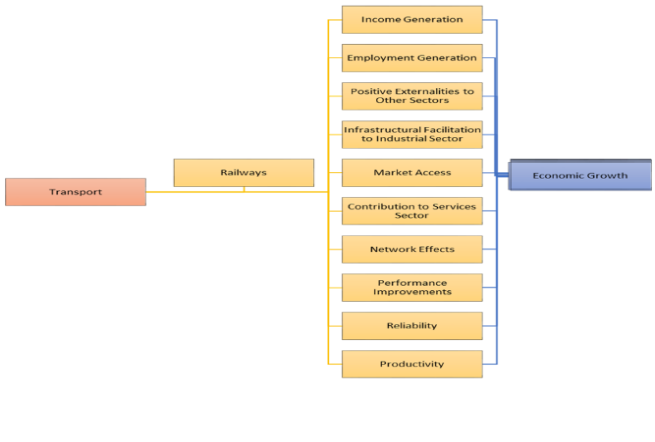
[2]The Coming of the Railway and United Kingdom Economic Growth, *The Journal of Economic History*, Vol. 24, No. 3 (Sep., 1964), pp. 315-336

[2] assessed the role of investment for infrastructure in economic growth in South Africa. By using bound test approach, the output was determined by the economic infrastructure i.e. public infrastructure, locomotives, railway goods stock, un-paved and paved roads, electricity generation and goods and passenger vehicles. Time series was from 1875 to 2001 and to check the long run and short run effects, Johansen and VECM techniques have been used. To reduce the chances of non-stationarity, variables were used in log form. They found a positive impact of infrastructural investment, property rights and electricity on output.

[3] described 'aviation/air transportation' in association with economic growth in the case of Czech Republic. To measure aviation, they used passengers carried by air transport. To measure economic growth, GDP in constant local currency unit were used. The time period was from 1970 to 2012. In the case of the Czech Republic, the data had two breaks during 1989 and 1990 and attributed to oil shocks after effects and raised the fares of flight. For statistical analysis, unit root tests (ADF and PP), Johansen test, Granger Causality test and VECM were used. They also used other sophisticated tools like Fully Modified OLS, Dynamic OLS and Conical Cointegration Regression (CCR) which had pioneered in the case of aviation. They concluded that aviation had positive impact on economic growth. Similar results regarding aviation-led growth are found in [4], [5], [6], [7] and [8]. Railways, despite being a conventional mode of transportation, has lacked attention of researchers. Accordingly, this research tries to fill this gap for case of Pakistan Railways.

3. CONCEPTUAL FRAMEWORK

Railways affect development patterns and it can enhance or block the economic growth of individual nations. Moreover, investment in railways induce the producers and consumers to optimal division of production. It also pulls geographical comparative advantage and increase economies of scale and scope. Railway's contribution to economic development is shown by the following figure:



Source: Authors' formulation

Figure 1: Conceptual Framework

4. DATA AND METHODOLOGICAL ISSUES

4.1 Data

Borrowing from [2], this model analyzes the performance of railway on economic growth. A goods transported is used as the proxy of railway's performance. Economic growth is represented by GNI growth rate. The data of goods transported and GNI growth rate is taken from World Development Indicators (WDI). For the case of Pakistan, time series data is available from 1980 to 2012. The time span allows to use 33 observations. E-Views 8 is used for all estimations. Economic growth is proxied by GNI (YNG) while railways is proxied by 'goods transported' (GT).

4.2Stationarity Tests

The stationarity tests, Augmented Dickey Fuller (ADF) and Phillip Peron (PP) are used. It is assumed that YNG and GT are in the logarithmic form with intercept. It is tabulated in Table 2.

Table 2: Stationarity Tests

	Stationarity	Variables	t-Statistic	p-value
ADF	At Level	YNG	-1.7778	0.383
		GT	-0.6090	0.855
	At First Difference	ΔYNG	-10.0004	0.000
		ΔGT	-4.0272	0.004
PP	At Level	YNG	-2.5953	0.104
		GT	-0.4398	0.890
	At First Difference	ΔYNG	-10.4263	0.000
		ΔGT	-4.0272	0.004

Source: Authors' estimates

Johansen cointegration test is applied on these variables and it is expressed as the following equations.

$$\Delta GT_t = \alpha_1 + \sum_i \alpha_{11} \Delta GT_{t-i} + \sum_i \alpha_{12} \Delta YNG_{t-i} + \beta_1 Z_{t-1} + e_{1t}$$

$$\Delta YNG_t = \alpha_1 + \sum_i \alpha_{21} \Delta GT_{t-i} + \sum_i \alpha_{22} \Delta YNG_{t-i} + \beta_2 Z_{t-1} + e_{2t}$$

Here ΔGT_{t-i} and ΔYNG_{t-i} are the lagged differences; e_{1t} and e_{2t} are the serially uncorrelated error terms and Z_{t-1} is the error correction term.

4.3Structural Breaks& Cointegration

By using Bai-Perron test, one structural breakat2008 is found.Structural dummyis used to incorporate the structural breaks. In Table 3, Johansen cointegration with structural breaks are tabulated.

Table 3: Johansen Cointegration with Structural Breaks

No. of cointegrating vectors	Eigen value	Trace statistic	5%critical value
None*	0.5876	47.3693	42.9153
At most 1*	0.3385	21.6826	25.8721
At most 2	0.2842	9.6980	12.5180

Source: Authors' estimates
Trace test indicate 1 cointegrating equation at the 0.05 level.

Presence of 1 cointegrating equation shows long run relationship between GT and YNG in Pakistan.

4.4 Vector Error Correction Model (VECM)

The model is a first order VECM as shown in the previous equations. According to SI and AI criteria, lag length was '3'. ECM is estimated for analyzing the short and long-run causality. Table 4 shows the causality test. For this purpose, both tests have been performed:

(1) long-run causality: which shows the significance of the Error Correction Term (ECT) by t-test

(2) short-run adjustment to re-establish long-run equilibrium: which shows the joint significance of the sum of lagged terms of each explanatory variable and the ECT by joint F test.

The coefficient of the ECT is significant in YNG equation, which shows that if there is a deviation in the ECT, both variables will cooperate in a dynamic fashion to restore long-run equilibrium. In other words, GT will make short-run adjustment to re-establish long-run equilibrium.

Table 4: Error Correction Model

	ECT	Joint SR/LR	
Variables		**ΔYNG&ECT**	**ΔGT&ECT**
	t-statistic	F-statistic	
ΔYNG	-2.6864[b]	-	2.8409[a]
ΔGT	1.1535	0.8218	-

Source: Authors' estimates.
[a] and [b] show significance at 1% and 5% level, respectively.

4.5Diagnostic Tests

Table 5: Diagnostic Tests

Tests	F-statistics	p-value
Heteroskedasticity	0.3267	0.806
Serial Correlation	1.3181	0.305
Normality	-	0.069
Ramsey RESET	1.4161	0.251

Source: Authors' estimates.

Residual Normality test shows that the residuals are normally distributed. Heteroskedasticity test shows that there is no ARCH effect. In the LM test, the probability of χ^2 shows that the model has serial correlation. Ramsey Test shows that parameters are stable and regression line is linear. In the end, coefficient diagnostic test has also applied. On the whole, the diagnostic tests reveal a suitable model with no serious statistical issues.

4.6Estimation of Cointegrating Equation

Cointegrating equation can also estimate by using recently developed methodologies like fully modified ordinary least squares (FMOLS) of [10] and dynamic ordinary least squares (DOLS) technique of [11]. These methodologies show the robustness of results and produce reliable estimates in small sample sizes.

4.6.1Fully Modified OLS

FMOLS is appropriate where the series are cointegrated at first difference I(1). It is used to illuminate serial correlation and the endogeneity in the regressors which occur in cointegration.

$$\mathbf{x_t = \acute{\Gamma}_{2'1} D_{1t} + \acute{\Gamma}_{2'1} D_{1t} + \hat{e}_t}$$

Or directly from the difference regressions:

$$\mathbf{\Delta x_t = \acute{\Gamma}_{2'1} \Delta D_{1t} + \acute{\Gamma}_{2'1} \Delta D_{1t} + \hat{u}_t}$$

Let $\grave{\Omega}$ and $\hat{A}$ are the long-run covariance matrices computed through residuals $\hat{u}_t = (\hat{u}_{1t}, \hat{u}_{2t})$. Then we define the modified data:

$$\mathbf{y_t^* = y_t - \acute{\omega}_{12} \grave{\Omega}_{22}^{-1} \hat{u}_2}$$

An estimated bias correction term:

$$\mathbf{\lambda_{12}^* = \lambda_{12} - \acute{\omega}_{12} \grave{\Omega}_{22}^{-1} \hat{A}_{22}}$$

FMOLS estimator is:

$$\boldsymbol{\theta} = \begin{pmatrix} \boldsymbol{\beta} \\ \boldsymbol{\gamma_1} \end{pmatrix} = \left(\sum_{t=1} \boldsymbol{T\, Z_t Z_t'} \right) \left(\sum_{t=1} \boldsymbol{T\, Z_t y_t^*} - \boldsymbol{T} \begin{pmatrix} \boldsymbol{\lambda_{12}^{*\prime}} \\ \mathbf{0} \end{pmatrix} \right)$$

Where $Z_t = (X_t', D_t')'$. Long-run covariance matrix estimator's $\grave{\Omega}$ and $\hat{A}$ are the key to estimate FMOLS. Moreover, the scalar estimator:

$$\mathbf{\acute{\omega}_{1.2} = \acute{\omega}_{11} - \acute{\omega}_{12} \grave{\Omega}_{22}^{-1} \acute{\omega}_{21}}$$

It is the estimated long-run variance of υ_{1t} conditional on υ_{2t}. We may also use a correction of degree of freedom to $\acute{\omega}_{1.2}$.

4.6.2 Dynamic OLS

It is used to construct asymptotically efficient estimator which removes the response in the cointegration. It is used to augment the cointegrating regression with leads and lags, then the estimated cointegrating equation error term become orthogonal to the stochastic regressor innovations:

$$y_t = X'_t\beta + D'_{1t}\gamma_1 + \Sigma^{r}_{j=-q} \Delta X'_{t+j}\delta + \upsilon_{1t}$$

It is assumed that addition of q lags and r leads to the differenced regressors soaks up all the long-run correlation between υ_{1t} and υ_{2t}. Estimates of least squares $\theta = (\beta', \gamma')'$ have same asymptotic distribution as FMOLS.

Asymptotic variance matrix can be estimated from the simple OLS coefficient covariance, but by exchanging the estimator for the residual variance of υ_{1t} with the estimator of the long-run variance of the residuals. Conversely, you may estimate a robust HAC estimator for the coefficient covariance matrix.In recent empirical literature, it is customary to check robustness of the slope using these techniques [3,4,5,6,7,8]Estimates of these techniques are summarized in Table 6

.Table 6: Long Run Slopes using FMOLS and DOLS

	Slope	S.E.	Remarks
FMOLS	0.3332[a]	0.1295	+ve and significant relationship
DOLS	0.2825	0.1732	+ve but insignificant relationship

Source: Authors' estimates.
[a] shows significance at 1% level.

In Table 6, the relationship has remained positive, but statistical significance is absent in case DOLS. It can be inferred that relationship between YNG and GT has moderate robustness with respect to choice of estimation technique.

3.7 Causality Analysis

Table 7: Granger Causality Results

Direction	F-statistic	p-value	Remarks
GT → YNG	0.1122	0.988	Weak Uni-causalityfrom YNG to GT
YNG → GT	2.7422	0.054	

Source: Authors' estimates

Table 7 shows that goods transported has tendency to increase the GNI growth but having further linkages. Whereas, the causality does not run in opposite direction. It means that increase in goods transported by railways in Pakistan enhance the economic opportunities which further leads to growth.

5. CONCLUSION

This paper has estimated that goods transported have a positive and significant impact on the economic growth of Pakistan. The positive relationship can be attributed to direct and indirect effects of goods transported. Direct effects include transportation of goods and indirect effects include backward and forward linkages which also leads to growth. Moreover, effective railway system accelerates commerce and trade, reduces transportation cost and promotes national integration. It also reduces the burden of travelers.

Pakistan Railways was the primary mode of transportation till the seventies. However, due to scarce resources, the performance of Pakistan Railways declined and its share of inland traffic reduced from 41% to 10% for passenger and

73% to 4% for freight traffic[3]. This decreased share is attributed to the recession in the country as well as law and order situation created by the criminals. Remarkable shares have also not been given due to financial constraint. Performance of railways has also declined because of its over-aged infrastructure. The finances required for maintenance could not be borne by the Railways. Moreover, the increase in the salary and pension also led to decrease the revenue earnings at the cost of maintenance requirements. The subsidy which is given to decrease the fares, increases the expenditures in greater proportion as compared to increase the revenue.

Therefore, railways need some policy attention to enhance economic growth. Incentives by the government can increase its macroeconomic contribution. An autonomous monitoring group should be set up to ensure low prices and better performance. An improved law and order situation would be beneficial to attract more travelers and hence more revenue would be generated. This revenue can be used for maintenance and expansion of track infrastructure. Disguised unemployment should also be eradicated to decrease its expenditures. However, Finance Division has committed to bear the expense of salary and pension along with its increments in future till the crisis is over. Restricted privatization should be encouraged to improve administration. Last but not least, the government should increase the allocation of PSDP for the development interventions in Pakistan Railways.

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