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**PERSISTENCE IN RAILWAY OUTPUT
OF BANGLADESH – AN
ECONOMETRIC ANALYSIS**

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Abstract

The declining share of output of Bangladesh Railway (BR) to real GDP is a major public policy concern and needs to be addressed. Policy effectiveness depends on the data generating process. The paper investigates into the time series properties of different measures of railway's output. Traditional unit root tests fail to distinguish series with low from those with high degree of non-stationarity, and thus cannot determine the magnitude of the random walk component. Using Cochrane's (1988) methodology, the magnitude of random walk component for various rail output is estimated. The degree of persistence for the series is also estimated using a non-parametric approach following Cochrane. Results show that the decline in passenger output is more persistent than the decline in freight output. It appears that there has been a long term shift in demand for BR's services to other competing modes of transport. Based on the findings, we recommend a set of policies for the BR to arrest further decline in its share in national output. A comprehensive recovery plan would help its recovery.

JEL Classification: L9, L91, L92

Key words: Degree of non-stationarity, Persistence, Random walk

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PERSISTENCE IN RAILWAY OUTPUT OF BANGLADESH – AN ECONOMETRIC ANALYSIS

I. Introduction

Transportation sector in general and Bangladesh Railway (BR) in particular, has always played a vital role in the economic growth and development of Bangladesh by hauling both goods and passengers. However, BR has been facing formidable challenges from alternative modes of transport during the past decades. BR is losing its share, both in absolute and relative terms, to a fast growing road sector. This loss of share can largely be attributed to a well planned and well developed road network that began expanding since the eighties.

The road transportation is mostly privately managed and is more efficiently operated¹ relative to BR. The latter has been a publicly funded and managed organization. Railway is known to have competitive advantage in bulk goods and long haul due to cost effectiveness and safety issues. However, BR has failed to meet the standards due to institutional shortcomings and physical bottlenecks. Today BR is in frail health with obvious symptoms of further decline in its performance. An in-depth academic investigation to identify some weaknesses of can help formulate appropriate policy measures for improvement of the sector.

Besides providing transportation services, railway is also a major employer of civilian labor force. The current level of employment in this sector exceeds 40,000 employees. BR should be capable of providing optimal services and help economic growth by ensuring a smooth flow of goods, e.g., food, raw material, industrial and agricultural inputs, exports etc. With its net operating income in the red, the problems seem to demand a higher degree of attention, as the

¹ Bangladesh Road Transport Corporation (BRTC), the public sector road operator has a fleet of 867 Buses and Trucks. Of this 739 are in running condition and 159 are trucks. The Truck Division was established in 1971 to carry government foods, relief, fertilizers in the aftermath of liberation. BRTC Trucks carry about 20% of govt. food and can be hired for private use.

sector continues to claim a larger share on the limited resources. The Railway receives a sizeable subsidy from the public exchequer, despite the well-documented evidence that subsidy promotes inefficiency. The onus must be on the railway to play a socially desirable role. From policy considerations, it is important that the sector runs efficiently, remains economically viable, and makes significant contribution to growth of the economy. From that perspective, research on the performance of this sector, is long overdue.

The contribution of the Railway sector to GDP can be measured by the share of railway output to GDP. A secularly declining output share in GDP might be a signal that the sector is not performing well. Such ratio provides important insight into the long term trend and variability of the sector's economic contribution. The output of a service sector like railway is a derived demand. Instability in railway output can hamper the smooth flow of passenger and goods and services. Too much fluctuations or a secular decline in the share of railway output can adversely affect the macro aggregates. Hence, both the level and the variability of the output of BR have important implications for the overall economy. An examination of the underlying secular trend in the flow of railway traffic can provide important clues to better understand the shape, amplitude and duration of its output.

The success of any stabilization program depends on whether shocks to a time series are temporary or permanent. It can be examined by decomposing the changes in a time series into temporary and permanent components. (Cuddington and Urzua, 1989; Deaton, 1992). Stabilization policies are effective if shocks are short-lived, whereas a structural adjustment to a new equilibrium is necessary if shocks are long-lived (Cashin and McDermott, 2000). Despite the overwhelming importance of the railway sector in the context of Bangladesh economy, the academic interest has been inadequate at best, with the exception of Islam (1981).

The objective of this paper is to conduct an empirical investigation into the time series properties of railway's output measured as a ratio of GDP by closely following Cuddington (1992), Cuddington and Urzua (1989) and Reinhart and Wickam, (1994). Their methodology found widespread application in the movement of commodity prices. Despite its simplicity, the approach did not proliferate to other research topics, including the transportation sector. This paper is an attempt to fill in a gap in knowledge and is a significant contribution to the literature in terms of an application of a methodology to understand the operation and performance of BR. The paper also offers a set of policy suggestions for the short, the medium, and the long term. The policies should help the railway arrest its declining share and improve its performance.

The paper is organized as follows. The data source and measurement issues are presented in Section II. Section III outlines the econometric methodology including derivation of the measures of persistence in the series. Section IV offers policy perspective for the railway. Section V provides a summary and draws conclusion arising out of the paper.

II. Data Source and Measurement Issues

A burgeoning literature emerged with the application of advanced time series methodology to the Prebisch-Singer hypothesis in the eighties. The research was mainly applied to the measurement of persistence in commodity prices. However, for a public utility sector such as railway in a developing country such as Bangladesh, rates are regulated by the public authorities. As such any analysis of the price series makes little sense, and output is the better indicator of the performance of the sector.

Measurement of the output of the railway sector is shrouded with difficulties. Railway produces two different kinds of output, viz. freight hauling and passengers carried. Transportation of goods and passengers can obviously be carried out in term of tons hauled or

number of passengers transported. The problem with this approach is that it does not capture the essence of the service the sector provides. More meaningful measures can be obtained if the output is measured in terms of ton miles and passenger miles carried. Even this approach does not allow for easy aggregation. However, the most common methodology to resolve this problem is to take a weighted average of the two products, measured in ton miles, the weights being proportional to the revenue earned by each activity. Following this principle, we used the gross total output for the railway. It may be noted that the transportation sector has undergone major changes over the last three decades both in terms of structure as well as in quality and composition. As such to get an actual picture on what is really happening to the railway sector, it is necessary to look at the measure of the output from more than one perspective. Accordingly, the railway's output will be measured under different measures. To measure output of the railway sector, we used the data provided in the official source published as available in the "Information Book" published by the Bangladesh Railway. Supplementary data was taken from the Statistical Yearbook of Bangladesh.

III. Methodology and Empirical Results

a. Descriptive statistics

The following different measures of rail output are considered in the statistical analysis.

RFN = Ratio of freight hauled (tons) to real GDP

RPN = Ratio of passengers carried (number) to real GDP

RFK = Ratio of freight hauled (tons-kilometers) to real GDP

RPK = Ratio of passengers carried (passenger-kilometers) to real GDP

RQN = Weighted sum of number of passengers carried and freight tons carried as ratio of GDP

RQK = Weighted sum of freight output (tons-kilometers) and passenger output (passenger-kilometers) as ratio of real GDP. All variables are in the logarithmic forms.

RPN (Number of passengers), RFN (Freight in tons) and RQN (weighted average of RPN and RFN) are plotted in Figure 1 for years 1973 to 2003. Both RFN and RQN exhibit upward trends in the seventies and downward trend since early 1980s. The RPN series shows a downward trend since the beginning of the period, although the series exhibited some constancy from late 1970s to early 1980s. Although all the three series show some variability during the period initially, the variability seems to have diminished since mid 1980s. RFK (Freight in ton-kilometers), RPK (passengers-kilometers) and RQK (weighted sum of freight ton-kilometers and passenger-kilometers), as percentages of real GDP are plotted in Figure 2. Up to the early 1980s, RFK has been flat. After an initial dip in the early seventies, RFK declined sharply in the early eighties staying low until the beginning of 1990s followed by a sharp rise. Since then it has been showing a declining trend. The RPK series showed a slight increasing trend until mid eighties. Since then it has been declining. The RQK series shows slightly downward trend until about 1987 and then shows a sharp decline with some fluctuations.

Measures to test for normality are reported in Table 1. Based on skewness and kurtosis values, we reject the null hypothesis of normal distribution for all the series under study. Therefore, non-parametric tests are suitable for determining the persistence of these series.

b. Unit Root Tests

The widely used unit root tests such as the Augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) tests are employed to detect the presence of non-stationarity. ADF assumes the errors to be iid, but PP test is more general and uses a non-parametric correction to deal with any serial correlation in the error term and is robust to the underlying distribution. We employed

both a constant and a constant with deterministic drift. The results of unit root statistics are reported in Table 2. RFK (ratio of freight output in tons-kilometers to GDP) is found to be non-stationary in levels with or without a trend, but stationary in the first difference under all tests so that the series RFK is I(1). RFN (ratio of freight output in tons to GDP) is found to be non-stationary in levels under all three tests, but stationary in the first difference under all tests, so that RFN is I(1). Both ratio of passenger outputs, in numbers and number-kilometers are found to be I(1). The ratio railway output (weighted average of number of passengers and freight in tons) is found to be I(1). RQK (ratio of total output as weighted average of passengers-kilometers and freight ton-kilometers) is found to be stationary in the model with trend.

c. Trend-stationary vs. difference-stationary process:

A time series can be modeled in two different ways. First we model output as a trend-stationary process represented by equation (1):

$$Y_t = bt + \sum_{j=0}^{\alpha} a_j \varepsilon_{t-j} \quad (1)$$

Equation (1) is trend-stationary if fluctuations in y_t are temporary such that $\sum a_j \varepsilon_{t-j}$ is a stationary stochastic process in which case a_j must approach zero for large j . For trend-stationary series, one unit shock has no impact on the long term forecast of output. If a series is characterized by temporary or transitory fluctuations, the series reverts to its trend, and shocks leave minimal impact. Equation (1) with a deterministic trend is called mean-reverting.

Second, a random walk model with a drift is represented below:

$$y_t = \mu + y_{t-1} + \varepsilon_{t-j} \quad (2)$$

In this model a fall in output by one unit will cause a continued fall in the forecast of output by one unit in the indefinite future (Cochrane, 1988). In general, a non-stationary series has a higher degree of permanent component and a shock causes the series to deviate permanently from the

original path. These series also have a higher degree of persistence so that the effect of a shock does not dissipate quickly.

The difference between a trend-stationary, as in equation (1) and a random walk model as in equation (2) is extreme (Cochrane, 1988). In addition to the differences noted above, there is the possibility of intermediate cases, where one-unit shock may change the long run forecast by a number between zero and one or greater than one. If the change in the long run forecast is between zero and one, “a series returns toward a trend in the far future, but does not get all the way there” (Cochrane, 1988, p. 894). If the change in the forecast is greater than one, the series will move further away from the original trend.

d. Measurement of persistence

Cochrane (1988) developed a non-parametric method² by which a series whose fluctuations are partly temporary and partly permanent can be modeled as a combination of a random walk and a stationary series. The random walk represents the permanent part of the change while the stationary series represents the temporary part of the change. The size of a random walk component can be measured from the variance of differences over various time intervals as given by the following variance-ratio in equation (3):

$$V_k = [1/(k+1)][(\text{var}(X_t - X_{t-k})) / (\text{var}(x_t - x_{t-1}))] \quad (3)$$

Cochrane’s variance-ratio methodology is based on the following intuition. If the log of a variable X_t is a pure random walk, then the variance of its k -differences will increase over time as k increases. On the other hand, if X_t is a trend-stationary model, represented by equation (1), the variance of k differences will approach a constant, which is twice that of the unconditional

² The parametric measure of persistence was developed by Campbell and Mankiw, (1987b), which measures persistence from the autoregressive and moving average coefficients of a univariate ARIMA structure. The two measures are equal for random walk and stationary series (Campbell and Mankiw, 1989).

variance. If X_t is random walk, the plot of $[(1/k)\text{var}(X_t - X_{t-1})]$ as a function of k approaches a constant. If X_t is trend-stationary, the plot approaches zero (Cochrane, 1988). The plots of V_k s are presented in Figures 3 and 4 and V_k s are reported in Table 3.

As shown in Table 3, the variance of the random walk component of RPN series is about one-fifth of variance of year to year changes after 20 years. For RFN, the random walk component accounts for only 9 percent of the total variance after 20 years. This implies that the size of the unit root or permanent component is higher for passenger output (number of passengers) series than that of freight output series (in tons). For RFK series, the variance ratio is only 0.09 while the variance ratio for RPK series is much high (0.42) after 20 years. These results strongly suggest a higher degree of random-walk component or permanent component in the passenger output (number-km) than in the freight output (tons-km). This may be due to the fact that the demand for passenger rail transportation may have permanently declined because of availability, convenience and flexibility of alternative modes of transportation. As for weighted measures of total output, the permanent component of RQK is slightly higher than that of RQN.

The persistence measure in equation-3 can be written as a function of autocorrelation coefficients as follows:

$$V_k = 1 + 2[\sum(1-j/(k+1)\rho_j] \quad (4)$$

where, ρ_j is the j^{th} autocorrelation of Δx_t .

Using the estimated value of the population autocorrelations (Campbell and Mankiw, 1989), the persistence estimator is:

$$W_k = 1 + 2[\sum(1-j/(k+1)r_j] \quad (5)$$

Where r_j is the estimate of unknown population autocorrelation coefficient, ρ_j , in equation (4). W_k is a consistent estimator of V_k as long as k increases with sample size.

The sample ACF's are the most important ingredients in computing Cochrane's non-parametric measures of persistence which are reported for each measure of output, reported in Table-4. The ACF of the change in passenger output (RPN) oscillates between negative and mostly positive without showing any discernible pattern. The autocorrelation at lag 1 is 0.34, which decreases substantially at subsequent lags to 0.05 and 0.02 at lags 2 and 3 respectively, turning to negative at lags 4 and 5. The ACF then increases until lag 8, and then gradually declines until lag 21 and increases thereafter. This erratic behavior of ACFs is also reflected in the measure of persistence reported in Table-5. The persistence increases from 1.40 at lag 4 to 1.87 at lag 12 and then falls to 0.04 at lag 20.

Compared to RPN, the autocorrelation of RFN is much smaller which starts with negative at lags 1 and 2. Initially, ACF increases until lag 6 and then decreases and like RPN, the ACF series oscillates between positive and negative. The persistence declines after window size 8. RFN, RQN also fluctuates between positive and negative numbers. The persistence also declines substantially between lags 4 and 8, and then slightly increases before declining.

The growth in passenger output in kilometers (RPK) has positive autocorrelation initially, followed by negative after lag 4. The persistence increases until lag 16 and then substantially decreases at lag 20, implying permanent and long lasting effect of a shock. Increased popularity of alternative modes of transport perhaps explains the long-lived effects of a shock suggesting some structural adjustment to a new equilibrium.

The growth of freight output in ton-kilometers starts with negative autocorrelation, and then becomes positive, fluctuating between positive and negative numbers. The persistence

declines substantially from 0.78 at lag 4 to 0.36 at lags 8 and then to 0.05 at lag 12. Since RQK is stationary, the shock is short-lived, as evident from measures of persistence, which declines from a 0.58 to -0.05 between lags 4 and 8.

The W_{kS} are reported in Table-5. The results on persistence are close to those obtained directly from the variance ratios. As expected, all the series exhibit higher degree of persistence at lower lags, and then decline at higher lags with the exception of RPN and RPK. The W_k values for RPN and RPK start well above unity. Instead of decreasing, W_{kS} increase for both series, as k increases, implying that they deviate further away from the trend. Both series fall below unity only at lag 20. At lag 20, W_k for RPN, is 0.04, and RFN is 0.13. This implies that permanent shocks account for 4% of the variance of passenger output measured by number of passengers and 13% of the variance of freight output measured in tons.

A comparison between W_{kS} for passenger output measured in passenger-kilometers with those of freight output measured in ton-kilometers shows that the former displays a higher degree of non-stationarity as evidenced by higher w_{kS} (0.51 at lag 20). Thus passenger output in passenger-kilometers is not only more persistent than passengers output measured by number of passengers, but also more persistent than freight outputs measured both in tons and in ton-kilometers. The higher degree of non-stationarity of passenger output may be attributed to growing demand for alternative modes of transport. In a traditional sense, supply shocks to price series originating from technology related factors are considered permanent in nature. However, demand changes can be considered permanent, particularly in the transportation industry.

IV. Policy Implications

BR has the potential to provide cost-effective and an array of efficient services. BR must increase its operational efficiency and establish itself as a viable organization to avoid financial

and operational collapse. Inter modal competition is the most serious among the challenges. It is important to evaluate the operation of BR vis-à-vis the recent policy measures taken by the Government. Recently some areas of operation of BR have been privatized³.

With major improvement, the road sector has emerged as a viable alternative mode of transport. Modern larger capacity trucks are competing with BR. Roads offer faster, reliable, and often door-to-door service and even at a lower cost. BR must improve its quality of service to address customer needs of a growing economy and also improve its service profile. Institutional shortcomings, physical bottlenecks hinder efficiency. The BR can harness its advantage in long haul and bulky freight, concentrating on inter-city passenger and freight. The demand for quality is enormous. With an inefficient and costly domestic airline, quality passenger service can divert air passengers, adding to BR's economic health. BR must provide market driven services in a responsible manner addressing safety and comfort issues at reasonable prices and add capacity on growth corridors to secure its competitive advantage.

BR has embarked upon a comprehensive Railway Recovery Program supported by the Asian Development Bank (ADB) to increase efficiency and reduce cost. The reform program includes creation of a new corporate entity. Understandably, this is meeting strong internal resistance. The draft Railway Act, for renewed commitment to structural change is under review by the ADB and may help reinstate the suspended technical assistance and loan agreements. Given the strong competition and need for high capital investment, perhaps increased private participation in BR may be fruitful.

As short term goals, BR must increase its efficiency and reduce non-commercial services, adjust tariff to market levels, and go for profitable services. Steps may include installation of a

³ BR has both a meter and a broad gauge track. After 1998, trains can cross the Jamuna Bridge linking the east to the west. BR

traffic-costing system with greater focus on freight traffic combined with aggressive outsourcing and private partnerships in areas where feasible. BR should address the safety concerns of its users. Today more than half of the country's railroad network is falling in a state of dilapidation, leading to over 500 accidents a year. Improving the railroad will gain passenger's trust.

In the mid-term also partnership with private sector must be explored. Changes seen by staff as beneficial to all parties will meet less resistance. Targeting new profitable routes and closing unprofitable service must continue. For increased efficiency opportunities for incentive for the staff must be established. These may include but not limited to services areas such as terminals, train operations, freight forwarding, ticketing etc.

The long term plan should include conceding more railway operations to private sector that is in line with the long term growth potential of the economy. Fair and effective strategy for reducing excess personnel by implementing effective outplacement and staff redundancy payment structure schemes. Disposing off the non-core assets might allow that management to attend to its core business needed to perform efficiently.

V. Summary and Conclusions

The paper investigates time series properties of different measures of railway output. Unit root tests results indicate that all output series are non-stationary, except the gross weighted output. All the non-stationary series are found to be difference stationary. Based on measures of skewness and kurtosis the selected output series appear to follow non-normal distribution and therefore, are suitable for non-parametric tests.

Traditional unit root tests do not distinguish series low degree of non-stationarity from the high degree ones, and thus may fail to determine the magnitude of the random walk

component (Cochrane, 1988). Shock persists over a longer time, if the magnitude of the random walk component is high. Higher values of persistence indicate higher permanent component in the series. Following Cochrane persistence for various railway output series are computed employing both the estimated autocorrelation coefficients and the variance ratios. Using window sizes for different years, we examine dissipation of shock after selected number of years. All series exhibit a high degree of persistence at lower lags.

Both ACF and variance ratio tests indicate that passenger output, under both measures show higher degree of persistence relative to both measures of freight output. This may be explained by a long term shift in demand from railway to other modes of transport. The rising popularity of road transport may have permanently altered the landscape of transport sector in Bangladesh. Many developed and developing economies are experiencing similar phenomenon in their rail sector. However, the paper argues given the current of state of BR, there are still rooms for improving its efficiency.

Table 1: Descriptive Statistics for Railway Earnings (1973-2003)

	Mean	Standard Deviation	Skewness*	Kurtosis*	χ^2 * statistic
RFN	221.62	123.03	0.39 (0.31)	1.69 (.004)	8.13 (.02)
RPN	256.73	162.57	0.19 (0.61)	1.35 (.00)	22.07 (.00)
RFK	138.5	89.71	0.71 (.08)	1.74 (.008)	8.63 (.01)
RPK	164.76	66.38	-0.21 (.58)	1.49 (.00)	13.78 (.00)
RQN	260.85	158.07	0.37 (0.34)	1.75 (.01)	6.84 (.03)
RQK	165.47	61.38	-0.13 (.73)	1.60 (.001)	9.61 (.01)

***P- values are provided in parentheses.**

Table 2: Results of Unit Root Tests¹

	ADF		PP	
	Level	First Difference	Level	First Difference
	<u>With Trends</u>			
RFN	0.89	-6.60***	-0.90	-6.84***
RPN	-1.69	-3.57**	-2.13	-3.53**
RFK	-1.72	-6.54***	-1.64	-6.55***
RPK	-3.07	-5.02***	-3.07	-5.01***
RQN	-2.78	-4.13***	-3.17*	-5.39***
RQK	-4.44***	-5.83***	-5.10***	-7.55***

¹t-values are in parentheses

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

Mackinnon Critical values: 1% -4.02, 5% -3.43, 10% -3.14

Regression Equation : $\Delta X_t = \alpha_1 + \alpha_2 t + \alpha_3 X_{t-1} + \sum \alpha_{2i} \Delta X_{t-1} + e_t$

Table 3: Variance Ratio of Various Railway Output (V_k)

Variable		K(years)							
		1	2	3	4	8	12	18	20
RFN	σ_k^2	0.03	0.02	0.02	0.01	0.01	0.00	0.01	0.00
	σ_k^2/σ_1^2	1.00	0.74	0.62	0.56	0.39	0.18	0.24	0.09
RPN	σ_k^2	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
	σ_k^2/σ_1^2	1.00	1.25	1.30	1.37	1.04	0.94	0.34	0.22
RFK	σ_k^2	0.10	0.08	0.07	0.07	0.08	0.07	0.03	0.01
	σ_k^2/σ_1^2	1.00	0.85	0.69	0.71	0.82	0.66	0.27	0.09
RPK	σ_k^2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
	σ_k^2/σ_1^2	1.00	1.11	1.10	1.18	1.10	1.10	0.69	0.42
RQN	σ_k^2	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00
	σ_k^2/σ_1^2	1.00	1.03	0.75	0.72	0.26	0.36	0.09	0.15
RQK	σ_k^2	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00
	σ_k^2/σ_1^2	1.00	0.97	0.76	0.67	0.29	0.31	0.18	0.17

Table 4: Autocorrelations of change in log of real output of railway

j	RPN	RFN	RQN	RPK	RFK	RQK
1	0.348	-0.068	0.081	0.084	-0.133	-0.034
2	0.057	-0.03	-0.216	0.048	-0.169	-0.223
3	0.015	0.076	0.226	0.121	0.164	-0.016
4	-0.298	-0.169	-0.248	-0.174	0.164	-0.219
5	-0.24	0.057	-0.391	0.057	-0.263	-0.012
6	0.051	0.223	0.005	-0.043	-0.013	-0.012
7	0.261	0.011	0.111	0.277	0.115	0.323
8	0.223	-0.084	0.076	0.193	-0.126	0.089
9	0.05	0.035	0.238	0.044	-0.267	-0.189
10	-0.13	-0.021	0.076	0.025	0.103	0.097
11	-0.282	-0.391	-0.16	-0.127	0.085	-0.066
12	-0.28	0.052	-0.012	-0.148	-0.017	-0.006
13	-0.353	0.132	-0.174	-0.301	0.066	-0.098
14	-0.103	-0.129	-0.243	-0.092	-0.046	-0.042
15	0.012	0.199	0.068	0.073	0.046	0.093
16	-0.054	-0.14	0.056	-0.131	-0.019	-0.06
17	0.029	-0.245	0.007	0.091	0.018	0.075
18	0.013	0.048	0.028	-0.021	-0.06	0.038
19	-0.054	-0.006	0.002	-0.177	0.017	-0.04
20	-0.01	-0.036	-0.059	-0.115	-0.187	-0.081
21	-0.03	0.066	-0.147	-0.174	0.022	-0.15
22	0.018	-0.038	-0.035	-0.026	-0.013	-0.008
23	0.045	-0.005	0.078	0.063	0.005	0.067
24	0.02	-0.1	0.002	-0.035	0.004	-0.01
25	0.051	0.091	0.018	0	0.007	0.012
26	0.061	-0.028	0.068	0.044	0.005	0.044
27	0.037	0.04	0.02	-0.03	0.015	-0.007
28	0.032	0.034	0.007	-0.025	0.006	-0.014

Table 5: Measures of persistence¹

<u>Window size (k)</u>	<u>LRFN</u>	<u>LRPN</u>	<u>LRFK</u>	<u>LRPK</u>	<u>LRQN</u>	<u>LRQK</u>
4	0.85	1.40	0.78	1.22	0.95	0.58
8	0.86	1.74	0.36	1.76	0.11	-0.05
12	0.72	1.87	0.05	2.17	0.21	-0.04
16	0.59	1.22	-0.01	1.89	-0.09	-0.14
20	0.13	0.04	0.20	0.51	1.13	0.76

¹Window size refers to time lags.

Figure 1: Ratio of Rail Output to real GDP (1973-2003)

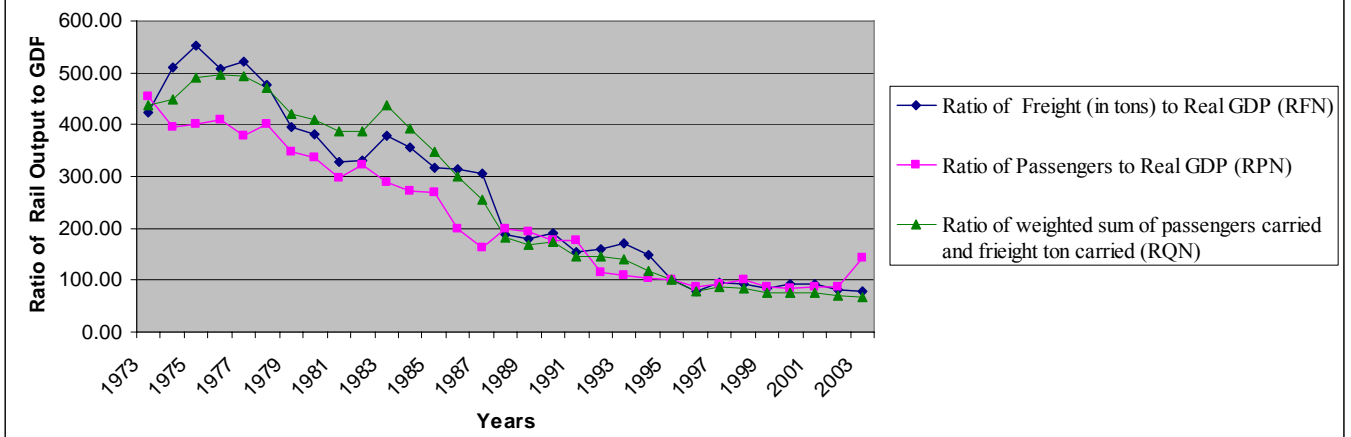
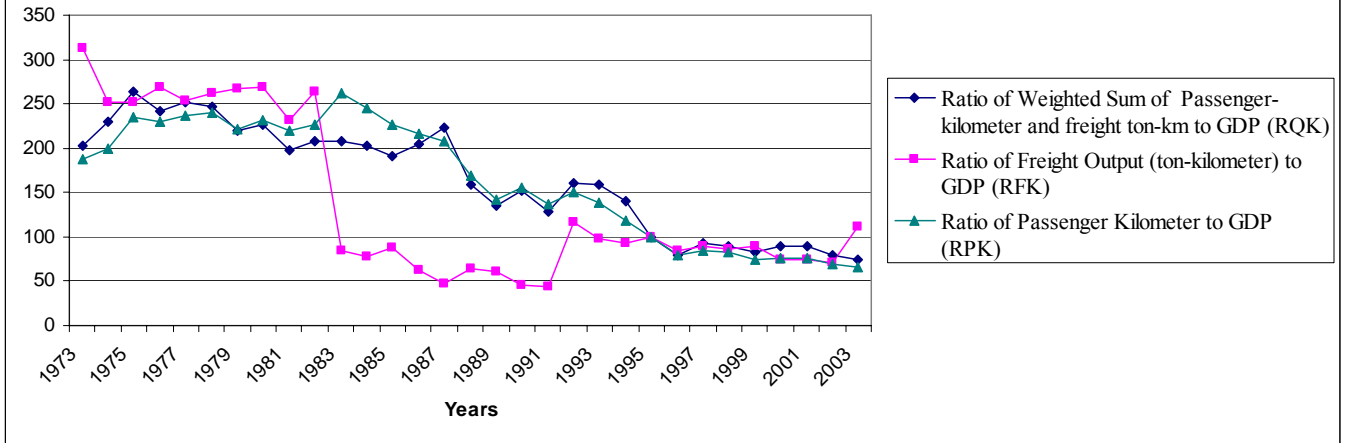
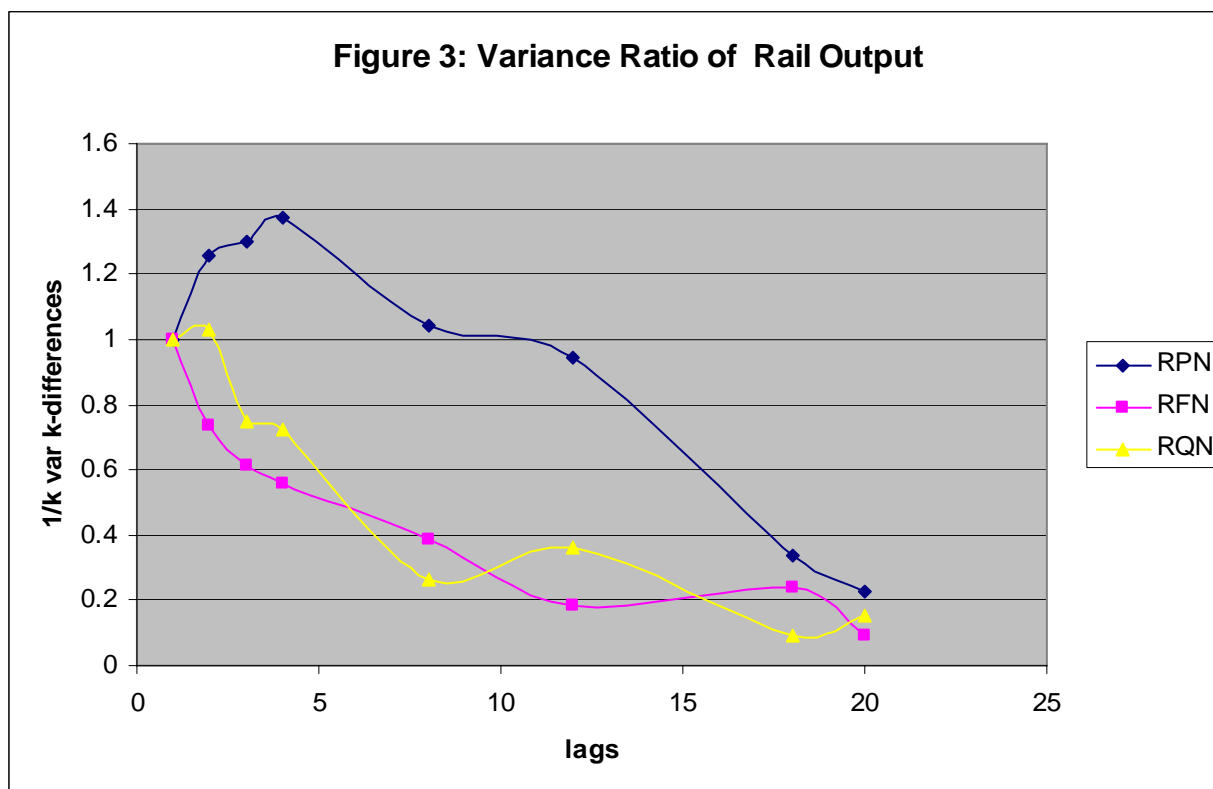
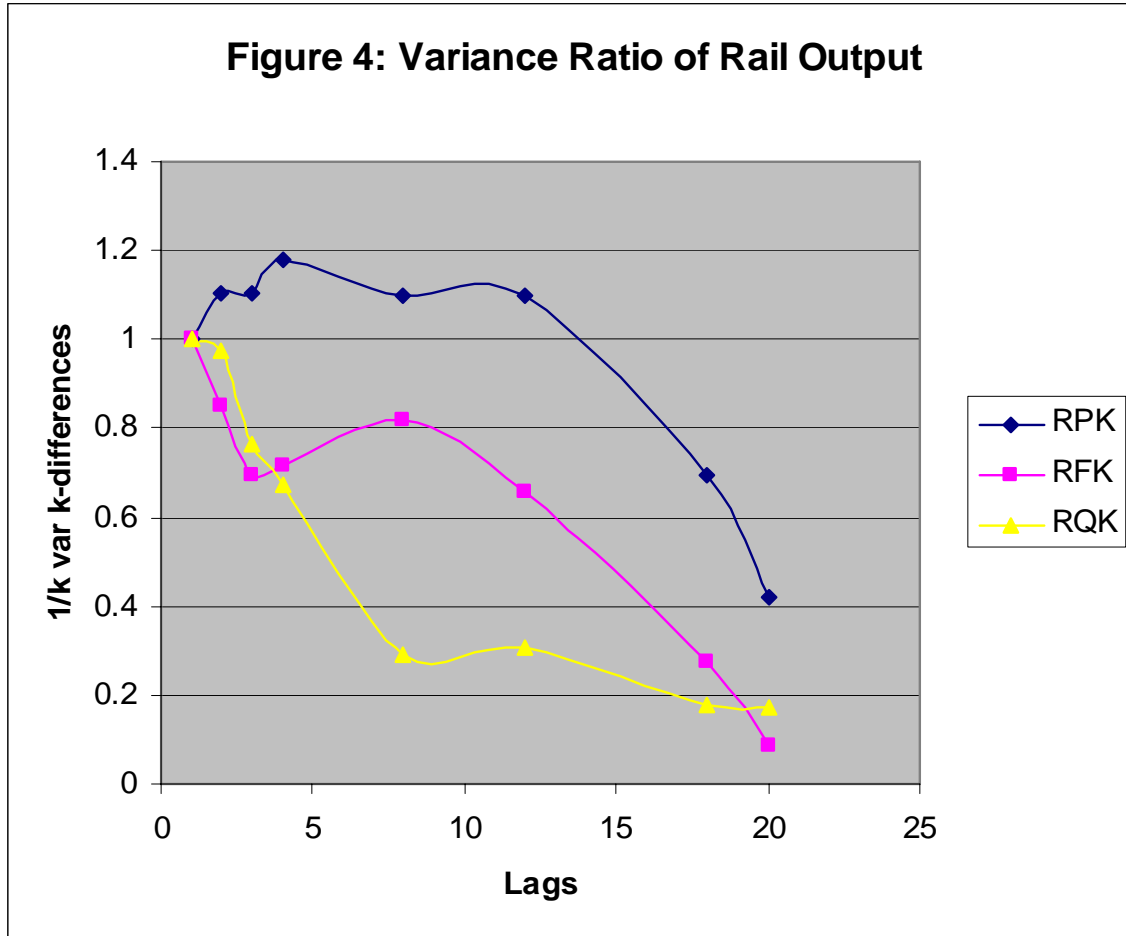


Figure 2: Ratio of Railway Output to GDP (1973-2003)







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