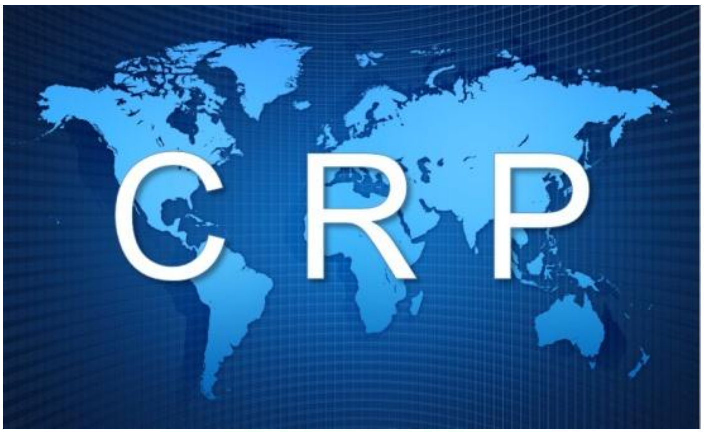

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Development and Efficiency:
Analysis of Pakistan Railways in Comparison with China and India

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Abstract

Located between the highly growing public sector railways of China and India, Pakistan Railways has been on the decline. Demand is not deficient, as indicated by relatively growing passenger and freight km. It had to face stiff competition from road transport, which received official patronage. A government failing to meet its deficit by collecting taxes has cut investment drastically. This paper analyses performance in holistic terms in a multistage framework that has four dimensions – input conditions, output, earnings and government policy. Data Envelopment Analysis is used to estimate product efficiency, earning effectiveness and financial efficiency to understand the reasons of decline of Pakistan Railways compared to China and India. Pakistan Railway is found to be product inefficient in the usage of inputs that led to financial inefficiency as costs unrelated to service delivery rose sharply. The same service had to be performed with fewer inputs. Chinese railways is product and financial efficient, which is leading to earning efficiency. Indian railway is product efficient but struggling with earning and financial efficiency. The lesson drawn for Pakistan is that product efficiency leads to other efficiencies and railway development can be sustained by managerial autonomy and steady public investment.

Key words*: Development, public investment, efficiency, railway, Data Envelopment Analysis, Pakistan, China, India*

JEL classifications: *H42, L91, L92, L98, O18*

INTRODUCTION

When the British built railways in the areas now in Pakistan in the nineteenth century, they were away from the population and economic activity. In the coming years, it was a source of introducing technology and innovation in production process and a means of enterprise, transport and socioeconomic change. Now over 80 per cent of Pakistan's population and economic activity is within 50 km of the main railway line from the port city of Karachi through Lahore to Peshawar, yet the story of Pakistan Railways (PR) is one of rising expectations of users, inefficient operations, declining revenue, weak regulation and poor safety record. It is perceived that railway cannot be clean, fast and punctual. There is contraction in every indicator from route kilometers to passenger services, to freight and the number of locomotives to revenue. The net result appeared as a crisis in public transportation network and a burden on public exchequer in form of losses and subsidies. By 2009-10, the accumulated railway deficit reached US$ 618 million (ADB, 2011). The government resources allocated to railway infrastructure were far less than the amount spent on the road sector (GOP, 2005). It was never at the head of transport policy, which has been pro road (GOP, 1991; Imran, 2009). Now it seems to have lost all charm for the policy makers. Since late 1980s, Pakistan has been in and out of various IMF programmes. A policy of liberalization, deregulation and privatization was adopted. In 1993, PR was placed on the list of Privatization Commission. A decision to privatize was announced in April 1997, followed by A World Bank supported restructuring effort to prepare for eventual privatization (World Bank, 1998). While no privatization took place, the government put investment in PR on hold. Privatization policy changed in 2010 from strategic sale of majority shares to public private partnership mode. PR was included in the 23 entities chosen for this mode of privatization and in the eight entities to be restructured first (GOP, 2006; 2010a). A business plan was prepared by the PR (GOP, 2010c).

Fuel efficiency and environment friendly features have led to a worldwide revival of railways. Light rail transit has spurred investment in rolling stock. Railway was built for product, not financial, efficiency. It was a symbol of modernity and industry. Closing down the railway lines for overcoming the losses is a policy that neglects the issues of harmony, deprivation and social connectivity (Collins, 2001; Toshiya and Nakamura, 2010; Meunier, 2002; Wolmar, 2001). Inadequate investment is the core reason for deterioration. The rising passenger as well as employees' unrest has shifted the responsibility towards more generalized issues of corruption and over-employment, burdens which become worse in an era of contracting business. Financial efficiency becomes an issue when the state itself is financially inefficient due to a declining tax/GDP ratio. In the first five-year plan, Pakistan formulated a strategy to rehabilitate track first and rolling stock later (GOP, 1957). It was never followed. Track length declined and the rehabilitation of rolling stock has been unsteady. The strategy was not matched with the required state funding, which in recent years of macroeconomic difficulties has substantially declined.

As opposed to Pakistan, Chinese Railway (CR) and Indian Railway (IR) have set the pace by investing huge amounts in railway infrastructure. China is emerging as a leader in providing railway facilities and equipment. In the eleventh five-year plan, it projected an investment of $292 billion (China; Hui, 2006). Chinese leadership position in supply chain has revived interest in railways in other parts of the world. Inheriting the same system as Pakistan, India has successfully maintained and expanded it considerably. In its eleventh five-year plan, railway investment is targeted at $ 48 billion (GOI, 2008).

This paper aims to understand railway inefficiency, as it is important for access to infrastructure – a key factor in development. The three railways operate as systems. This paper examines them in holistic terms by using a multistage framework dividing performance in four dimensions – input conditions, output, earnings and government policy. Operational, financial and product performance of PR, CR and IR is analysed by applying Data Envelopment Analysis (DEA). This juxtaposition of the three countries is the first of its kind. The DEA approach is chosen because it takes a holistic view of systems instead of looking at train wise or route wise performance. It enables the identification of factors contributing to the sustained development of IR and the emergence of CR as a frontrunner. The DEA allows the analysis of PR inefficiencies in a comparative perspective. The purpose is not to replicate the CR or IR reform but to analyze railway performance with a view to avoiding some costly reform.

The paper has five sections. Following this introduction is the second section outlining the basic features of the three systems and an historical perspective on the role of the British in colonial India. Section 3 lays out the analytical framework and the data used along with its limitations, while Section 4 contains the main analysis. Key findings and conclusions are presented in the last section.

BASIC FEATURES OF THE THREE SYATEMS

Historical Perspective on Railway in British India

In 1947, Pakistan inherited the railway system established by the British in colonial India. The first phase of railway construction was started during 1849-69 by companies under the guaranteed system. Free land was provided to the companies and there was a guarantee to allow 4.5-5 per cent interest on capital. In the second phase (1869-1880), the construction was undertaken by the state (Malik, 1962). The objectives of railway policy in British India were described as military hold and market for trade. Railway was built for strategic value of military occupation and as a sentimental symbol of enterprise and power. It also allowed Britain to maintain its monopoly in railway equipment and stores[1]. The railway would also provide comfort to the Manchester manufacturers by providing a competing source to the American cotton to ensure uninterrupted supply and keep the prices in the bound. These motives determined the gauge of lines, broad gauge for military purposes for the main line in the Punjab and North West Frontier provinces of Pakistan as the first Anglo-Afghan War in 1840 and the annexation of Punjab in 1849 opened a new chapter in British history, and narrow gauge (light line) for passenger and freight in the Indus valley, also in what is now Pakistan.

Railway was considered a young member of transportation in the early part of the nineteenth century. Policy makers did raise the question of economic efficiency as railway required huge and speedy investment funds, but the view that it symbolized modernity, grandeur, civilization and connectivity prevailed (Collins, 2001; Headicar, 2009).

Pakistan

PR had to face unfavourable conditions at the time of independence. There were heavy arrears, operating units were in Calcutta (India) and majority of skilled railway men migrated to India. In 1947 the country won freedom but railway lost it (Malik, 1962). The management of railways reverted to the position of 1892 and it became like any other department of central government. The working of the railways was left in the hands of those who lacked technical and professional experience (Mian, 2007).

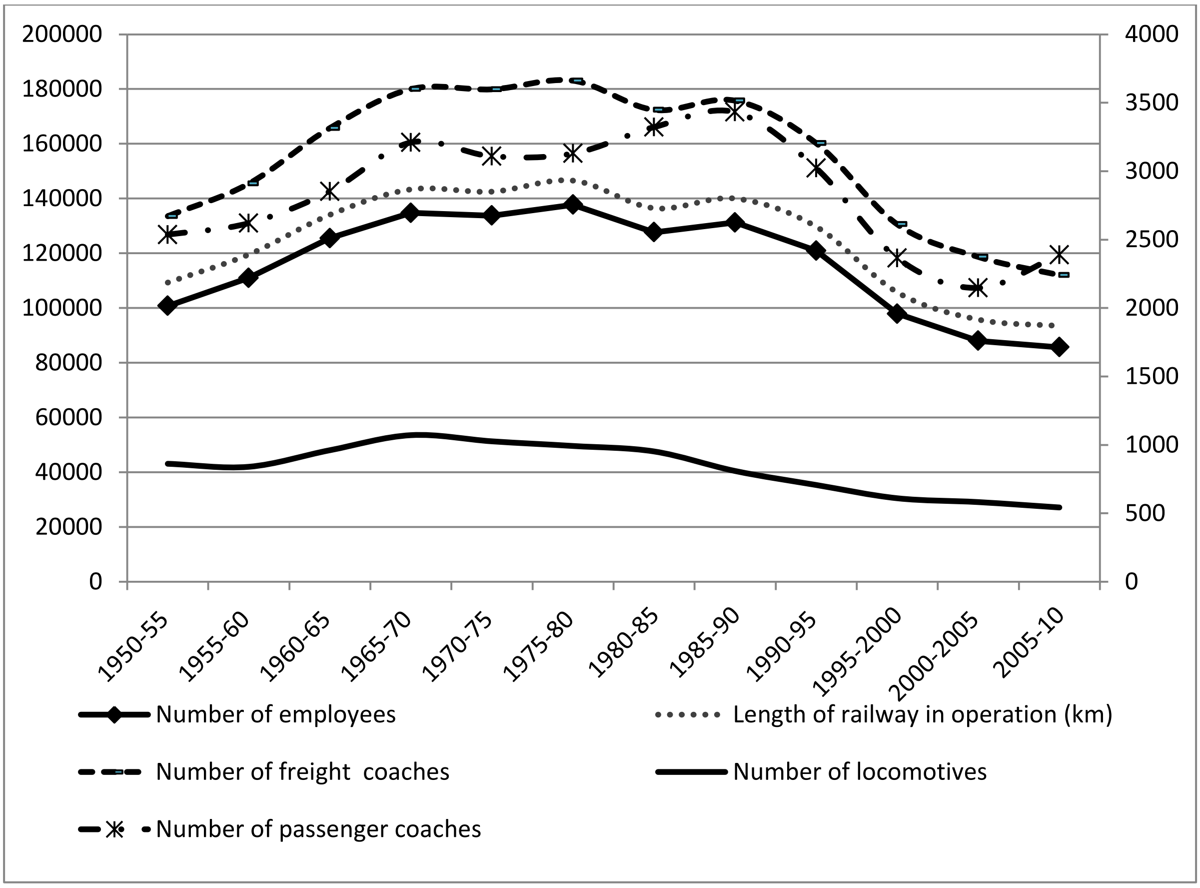
Railway quickly lost to road transport its preeminent position (Quddus, 1992, 2010; Imran 2009). Old redundant locomotives, problems in transforming railways into a more efficient modern system, lack of professional skills and increasing burden of working capital made it difficult to run the organization (Looney, 1998). The recent slowdown of growth in the economy made railway even more vulnerable, as drastic cuts in state investment brought it closer to

[1] Acton's comments on Danver's Report in a document 'A Very Few Words Respecting the Constitution of the Covenanted and Uncovenanted Services of India, Remarks on Indian Railway Reports: Reason for a Change of Policy in India (1840).

collapse. Supreme Court has had to order the government to manage its affairs better and provide funds for the repair of the locomotives.

The total route of the PR declined from 8,561 km in 1950 to 7,791 km in 2010, 7,346 km of which is broad gauge. PR is the only railway system that has contracted in route length, besides suffering from redundancy. An environment friendly rail network needs electrification because it can be powered with any fuel. Only 3.7 per cent of the track is electrified. In 1950, PR owned 862 locomotives with no capacity to repair and build. After increasing to 1,071 in 1965-70, the number has been declining. It is now as low as 528 locomotives.

Figure1. On the Journey of Downturn (Averages)



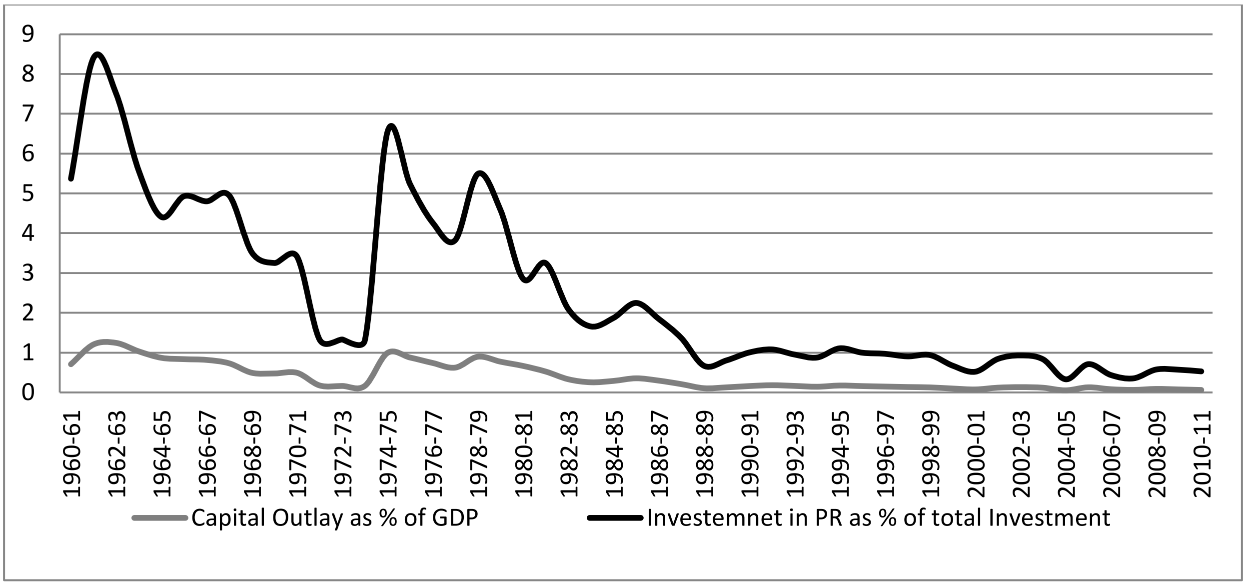
On average during 1965-2010, PR had the capacity to carry 99.26 million passengers and 9.94 million ton of freight annually. It operated with 809 locomotives and 31,092 freight wagons on average during the same period. The capacity deteriorated over the years. In the last 45 years, PR passenger traffic declined with a steady rate of 1.6 per cent annually. In 2009-10 it was able to carry merely 58.97 million passengers, well below its average. On year on year basis it contracted by 52 per cent in 45 years. The same is the story of the freight services. In 1965-66, PR had the capacity to move 7,631 million ton km freight, in 1996-97 it was 4,607 million ton km and in 2010 it dropped to 3,925 million ton km. The average works out at 6,722.5 million ton km.

Freight carrying capacity declined by almost 1.5 per cent per annum. The number of locomotives and freight wagons also contracted at the annual rate of 1.5 and 1.7 per cent respectively. In 1996-97 passenger earnings comprises 45 per cent of the railway's total revenue; in 2009-10 it was it was 54 per cent, an annual increase of 7.2 per cent. Increased railway passenger traffic had a positive impact on the revenue. The share of freight traffic declined from 45 per cent to 34 per cent, but still there was 3.5 per cent growth in the freight revenue. Average revenue per passenger in 1950-55 was Rs 1.5, which reached Rs 159 in 2005-10. Increased passenger and freight earnings, despite deterioration in rolling stock, reflect hikes in rates. Figure1sums up the PR's journey on the downturn.

The government failed to make adequate investment in railway infrastructure. The amount of resources allocated to railway has been less than the amount spends on road sector. The policy of emphasizing road sector as a substitute of railways proved disastrous for PR, which failed to compete. The rising public and staff unrest shifted the responsibility towards the more generalized issues of corruption and over-employment. Contraction of railway business, resulting from measures such as the creation of a large fleet of trucks under the National Logistics cell, made it even more difficult to overcome losses and corruption. Failing to attract business, PR tried to adopt the policy of reducing cost but without any success.

In the first five-year plan, Pakistan followed the strategy to rehabilitate track first and rolling stocks later (GOP, 1957). Despite its failure, the policy remains unchanged (GOP, 1960; 2005). In contrast, India started with rolling stocks and left the rehabilitation of the track for future. A sum of Rs 248 million was allocated for PR in the first five-year plan. But a pattern of releases lower than allocation has been observed ever since. In the annual plan 2011-12, the allocation of Rs 7.07 billion was reduced to Rs 4.84 billion (GOP, 2011). Historically speaking, investment in PR has been low. In 1962-63, capital outlay was 1.24 per cent of the GDP, which continuously declined to reach the lowest level of 0.16 per cent before it rose again in 1974-75 to 0.99 per cent. It fell again after 1980-81. This was the time when road investment and road transport gained momentum. After 1978-79, the share of railway in total investment also fell, losing its charm as a public sector investment in Pakistan. Unfortunately, this happened at a time when various costs started to rise sharply. Expenditure on fuel, administration, staff, repair and maintenance almost doubled. Declining investment in track and rolling stock raised the repair and maintenance cost. Since 1980-85, costs rose at an increasing rate.

Figure 2. Investment in Pakistan Railways

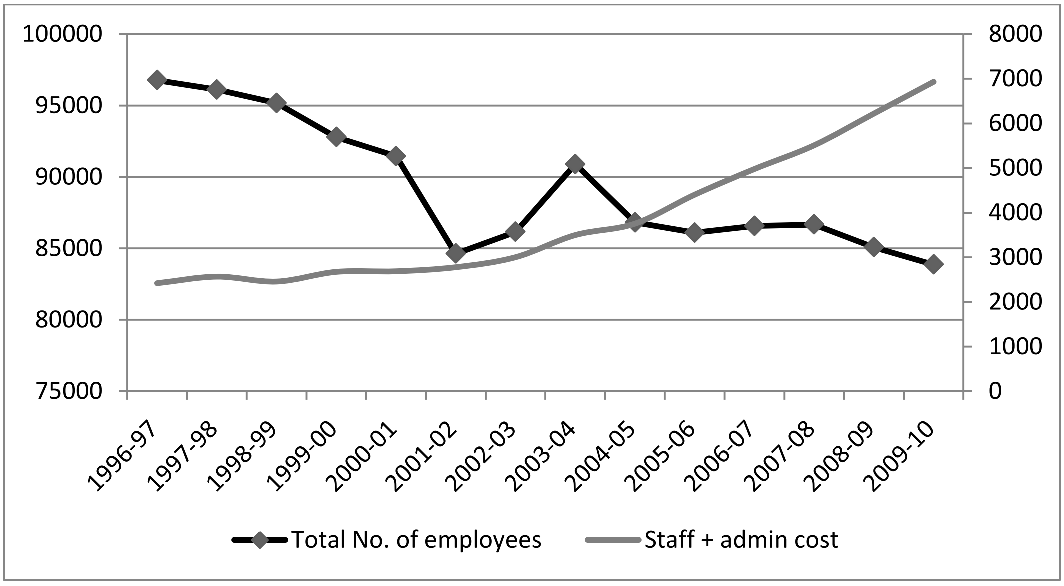


Railway was considered as an important source for employment creation in the early days after independence. Every tenth family had a member serving in railway (Malik, 1962). As an organization, it was considered important for promoting technical knowledge and organizing engineering capacity. As PR declined, the burden of bad performance was also laid on the over-employment. However, the fact is that labour cost has been squeezed since 1970. During 1955-60 total number of employees on average was 110,972, which came down to 85,655 in 2005-2010, a contraction of almost 13 per cent. This contraction is unevenly distributed over departments. Employment in stores, police and head quarter departments increased, while employment in civil and mechanical engineering, commercial and medical departments declined. The compositional shifts became more pronounced in the 2000s. Employment share of stores increased from 2 per cent in 2000-01 to 3 in 2009-10 and of police from 6 to 8 per cent. However, the share of engineering, commercial, accounts and transportation departments declined from 90 to 84 per cent.

The number of people required to keep PR running and be profitable is declining whereas those living off it have been increasing. In the beginning, PR had its own audit and accounting system that not only ensured traditional authorization but also better financial management. These departments were separated. The personnel of the audit and accounts service of the government deputed to the PR neither have a sense of ownership nor an understanding of the railway norms. It is only an additional burden on expenditure. Generalist civil servants hold leadership positions. Managed by people who lack relevant knowledge and skills, the PR has not been able to secure its commercial interest and maintain financial solvency.

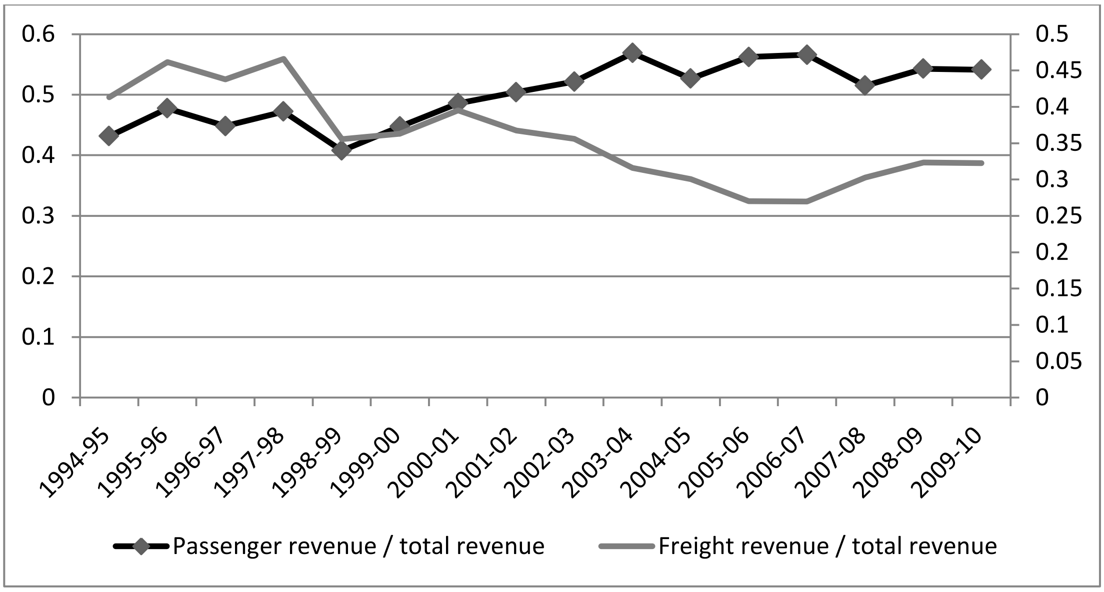
It is presumed that unit cost is very high because PR is labour intensive (ADB, 2011). During 1995 to 2010, employment in PR declined by 1 per cent, while both nominal wages and inflation increased by almost 8 per cent. There was no real increase in the wage bill. Total salaries of employees were well below the indexed level estimated on the basis of 1996 price level. The situation is worse for employees handling freight and passengers. Between 1995-96 and 2009-10, there was a 14 per cent decline in freight - the major revenue spinner. Passenger services increased by 23 per cent. What is disturbing is that while unit cost of employees had not increased, total cost did.

Figure 3. Relationship between Cost of Employees and Total Employees



PR depends heavily on government for investment and rehabilitation of rolling stock. In recent years, it has failed even to meet its operational cost. As a result of the government policy of developing road network as a rival, the PR has lost its competitive edge. The composition of its revenue expenditure has changed in perverse ways. Interest on debt was 4 per cent in 1965-66; it rose to 10 per cent in 2009-10. In the same period, expenditure on general administration declined from 16 per cent to 8 per cent and that on repair and maintenance from was 28 to 19 per cent. Operating expenses declined from 36 to 28 per cent. Against all norms of prudence, miscellaneous expenditure increased from 6 to 35 per cent.

Figure 4. Ratio of Passengers and Freight to Total Earnings



In early 1980s, railway as public transport lost its charm as it was considered second class. People came to prefer private buses and cars. Government considered its responsibility to increase the road capacity as automobiles are a source of revenue. According to the World Development Indicators, Pakistan's Logistics Performance Index was 2.62 in 2006 and 2.53 in 2009. It reflects the overall bad condition of all transportation mediums. Roads are responsible for 96 per cent of freight movement. Road density in Pakistan is 0.32 km per square km, which is still lower than India's 1.0 km per square km (GOP, 2010b). Any expansion of railway does not have to be at the expense of roads.

Pakistan has a very large railway network which is not extensively used as the road transportation threw a challenge that railway failed to meet. Initially, road was no competition to the railway. In the early 1950s roads carried only 8 per cent of the traffic. In 1955-56, there were 62 thousand km of roads which have now reached 260 thousand km, an expansion of almost 4 times. In comparison, railway route contracted by 10 per cent, from 8,561 km to 7,791. In 1955-56 there were only 75 thousand vehicles on road. At 9.413million, the number is now 125 times larger. In 2009-10, roads carried 96 per cent of inland freight and 92 per cent of passenger traffic. It includes the network of National Highway Authority (NHA), the federal agency responsible for national highways. The NHA has only 4 per cent of the road length but takes 80 per cent of commercial traffic (GOP, 2010b). During 1990-2010 PR's capacity to carry passenger and freight and number of locomotives declined almost by 30 per cent and freight wagons decreased by 53 per cent. This is the time when railway lost its priority as a public investment.

In the late 1980s, the government shifted its infrastructure spending to roads. This was not due to PR's failure to deliver, but a pro-road policy dictated by political visibility, import and industrial policies related to automobiles and unfair allocation of public sector freight. In all development plans, roads got more allocation than the railways. PR has been denied adequate funding for operations and maintenance. Subsidies have been given for the working expenses but no major rehabilitation investment in tracks and rolling stock has taken place. For instance, the latest annual plan for 2011-12 allocates Rs 23.7 billion for NHA and Rs 7.07 billion for PR (GOP, 2011)

China

In 1945, CR had 27,000 km of rail track. Today it has 85, 517 route km. It began to modernize in 2003. There was rapid and sustained growth in passengers and freight services after the reform of 2005. The old railway bureau and branch system was replaced by a reformed four tier system in an effort to increase productivity and effectiveness (Li and Hu, 2011). Efficiency of a railway can be measured on the basis of average haul/trip length. Evidence suggests that longer hauls are more economical to operate than shorter hauls. China has the longest average length of haul in the world, *i.e.,* 838 km; it is 782 km in Pakistan and 661 km in India.

The first CR train was operated in 1876 (Lee, 1977). The British built the railways in Pakistan in 1861 and in India 1851 (Garratt, 1988). CR is the largest railway network in the world. It is the cheapest means of transportation with the energy consumption ratio of transportation by air, road and railways being 11:8:1 (Hui, 2006). It is also the quickest mode available for moving 75 per cent of coal, 66 per cent of ore, 62 per cent of iron and steel, and 56 per cent of grain. CR is in the top five operational railways of the world, with a length of 62,389 km in 1994 reaching 85,518 km in 2009-10. The track length was increasing by 2 per cent annually during 1994-2009. It has been able to connect the highest tracks, 5,072 meters above the sea level at one point and more than 4,000 meters above the sea level for 960 kilometers. Its share in the world railway is 6 per cent and is responsible of moving 23 per cent of world's passengers and freight. There are 110 thousand freight cars available while the actual demand is 280 thousand. CR owns about 594,388 freight wagons, 47,436 passenger coaches and 17, 825 locomotives. Despite moving about 25 per cent of world railway traffic with only 6 per cent of railway mileage, CR is still unable to satisfy the rising social demand resulting from double-digit GDP growth. CR is working on the principle of building technically efficient railways first and financial efficiency later. (Li and Hu, 2011)

China is heavily investing in the railway sector. It has allocated US$ 730 billion for construction of 40 thousand km of new railway lines during 2008-2020. China's leadership has embraced a highly ambitious plan to expand the country's intercity rail network, reaching 93,000 miles by 2020 (including 16,000 miles of high-speed lines). With mushrooming subway and light rail lines, China is expected to account for more than half of global rail equipment expenditures in coming years. Stiff local-content rules stipulate that 70-90 per cent of rail equipment be manufactured domestically. Technology transfer agreements with foreign suppliers have permitted Chinese manufacturers to reproduce vehicle designs in local factories. The country's two dominant rail manufacturing companies, China South Locomotive and Rolling Stock Group (CSR) and China North Locomotive and Rolling Stock Group (CNR) together employ more than 200,000 people directly. Bombardier (Canada), Alstom (France), and Siemens (Germany) have been the leading international manufacturers of rail and transit vehicles, but they are increasingly challenged by CSR and CNR. Global demand for passenger and freight rail equipment, infrastructure and related services in 2007 was $169 billion and is projected to grow to $214 billion by 2016 (Lugar, 2008).

India

India has 225,000 freight wagons, 45,000 passenger coaches and 8,300 locomotives. IR is the second largest in the world in passenger trains and the fourth largest in freight trains. In 1947, IR had 53, 596 route km of track, which has increased to 63, 974 route km (GOI, 1951; Thorner, 1955). The route length has expanded but without much structural change. In 2009-10, it earned a modest profit. IR is responsible for moving coal, iron ore, cement and food grains - almost 75 per cent of the total freight. The capacity to move freight has continuously increased from 112 million ton km in 1951 to 350 million ton km in 2010. As the freight wagons increased rapidly compared to freight, the load capacity declined from 70 per cent to 64 percent in same years. The investment plan for IR in 2010-11 was proposed at Rs 414.3 billion. With India's entry into the high growth league, rising overall demand for passenger and freight transport requires capacity expansion, technological improvement for better maintenance, more attention to safety and passenger facilitation and competitive price to face the challenge posed by the road transport and to move beyond its present share of 22 per cent in the passenger transport market. Passenger business accounts for around one-third of the revenue. It is significantly cross-subsidized by freight revenue (Ramanathan, 2004; George and Rangaraj, 2008).

Comparative Growth Performance

There are standard indicators for comparative performance (TERA, 2006). Table 1 gives a comparison of important rail indicators for the three countries in terms of annual compound growth in 1995-2010. All have negative growth in the number of employees, the highest in China. Pakistan emerges as the worst performer. It had negative growth in the length of railway in operation, total locomotives, freight cars and freight ton km. There was a small increase in passenger coaches and a significant increase in passenger km. Despite the edge to passenger over freight, the revenue growth from freight is higher than the revenue from passengers. But the overall transportation cost increased at the much higher rate of 10 per cent compared to the overall transportations revenue growth of only 5.9 per cent. The rise in costs was attributable mainly to aging assets and rising fuel prices. In contrast, India experienced a slightly higher growth in transportation revenue than costs and China reduced costs at a very high rate. As opposed to Pakistan, both countries enjoyed a higher revenue growth from passengers than freight. This is despite the fact that PR has a very small share in total freight. In 2009 IR carried 24 per cent freight ton km as compared to CR and PR carried only less than one per cent of freight ton km compared to IR, declining from 7 per cent in 197?. PR carried 4.63 million ton freight in 2009-10 and CR moved 3,333 million ton. Average length of haul and average per trip km indicators for Pakistan are reasonable, in fact, better than India. This is important for an efficient railway system.

Table1. Key Indicators: Comparative Annual Growth 1995-2010 (%)

Country	China	India	Pakistan
Total employees (10000)	-1.3	-1.0	-1.0
Length of railway in operation	2.1	0.1	-0.6
Fixed assets	8.5	11.7	7.2
Total locomotives (unit)	1.1	0.3	-3.3
Passenger coaches	2.6	2.0	0.4
Freight cars	2.1	-2.2	-2.6
Freight ton km (100 million ton-km)	4.6	4.8	-0.7
Railways passenger km (100 million passenger-km)	5.5	5.7	8.6
Revenue from passenger traffic	11.1	10.6	28.3
Revenue from freight traffic	10.5	10.1	36.0
Total transportation costs	-11.8	10.5	10.0
Total transportation revenue	12.3	10.3	5.9

Traffic density (000,000)	40.5	19.8	3.8
Average length of haul	838	661	782
Average per trip km	527	118	310

The 1980s was the time of declining rail investment in many countries, including Pakistan. The unregulated and rapidly growing road transport became the source of revenue. Public transport and military controlled freight companies were set up in Pakistan. Government spent more on the road sector. It was the time when road building outpaced railway transport in the world. Many countries recognized the need for developing integration between rail and the road. In Pakistan, India and China, no such coordination was witnessed. Railways had to deal with increasingly intensive competition for the passenger and freight with road transport companies. But these countries were not prepared for it. In other countries, freight ton kilometer increased manifolds. Road become popular due to its speed and convenience. A new corporate culture emerged and coordination between rail and road was adopted. Financial economies and competition were introduced in railways. Technological innovation increased, and diesel locomotives were replaced by electric traction, which enhanced the speed and safety of the rail and attracted the railway traffic back to the tracks. PR, CR and IR missed this opportunity. In the 2000s, China and India have accelerated investment in railways, while PR has plunged into the worst financial crisis of its life.

ANALYTICAL FRAMEWORK

The analysis focuses on operational, consumption and rate of return performance. We analyse operations performance for identification of product inefficiencies. Then we focus on the output consumption efficiency, called service efficiency, followed by the analysis of cost efficiency. This would allow us to understand the system of railways as whole in Pakistan, China and India. Data Envelopment Analysis (DEA) is used for computing technical and allocative efficiency. Technical efficiency means least amount of inputs for a given level of output. Technical inefficiency is an outcome of unwarranted use of inputs. Allocative inefficiency is the result of wrong proportion of inputs.

Leleu and Briec (2009) use allocative efficiency without price data for derivation of bound allocative efficiency. Zhiqing et al. (2010) analyse operational performance of urban public transport in Hebei province. They concluded that only 20 per cent urban transport companies are scale efficient. Growitsch and Wetzel (2007) applied DEA for finding the impact of vertical integration on 54 European railway companies from 2000 to 2004. They found that most of the railway companies in Europe have the economies of scope and integrated firms have slightly better efficiency performance. Chapin and Schmidt (1999) used the DEA approach to measure efficiency of US Class I railroad companies since deregulation. Cowie (1999) adopted the DEA method to compare Switzerland's public and private railways by constructing technical and managerial efficiency frontiers and then measuring both efficiencies. Oum and Yu (1994) applied DEA to evaluate efficiency of 19 OECD countries rail companies from 1978 to 1989. Freebairn (1986), Salerian (1993), and Waters and Tretheway (1999) used the system as a whole to understand the performance of railway in various countries by applying DEA model. Bosco (2010) employed the excess expenditure method to assess the European railway performance by using distance input function. An inverse demand function was estimated to derive the cost function shares. Public transport was found to be less allocative efficient and ownership structure was not important. Managerial autonomy and regulatory framework was more relevant to the performance of railways in Europe.

Static efficiency in a given period is measured by CCR (Charnes, Cooper and Rhodes)-DEA input minimization model and BBC-DEA output maximization models (Li and Hu, 2011). DEA is used to calculate the relative efficiency of a homogenous set of decision-making units. Charnes, Cooper and Rhodes (1978) developed DEA for measuring the output under constant returns to scale. It uses multiple inputs and outputs with no assumptions about the functional form of the production function, profit function or cost. It is an efficiency measurement technique using extreme points for comparison but not the theoretical maxima. Further, it evaluates output of all other units relative to the best output of particular units. Each unit's output uses varied amount of inputs. The basic assumption behind the DEA is that production process can be fully replicated. If a production process produces best output with the combination of inputs, it is possible to repeat the same performance with other units. This is a process of finding best performance within the system.

To find frontier of inputs and outputs, DEA uses linear programming approach. It assigns value of 1as efficiency score when comparing it with other units and value of less than 1 to inefficient units. Inefficient units thus show deviations from the production frontier.

For analyzing operational efficiency we used input oriented DEA model. It focuses on the minimization of the input for producing a certain level of output. The linear programming problem is solved as follows:

$$min_{\theta,\ y}\ \theta$$

$$st - y_i + Y\lambda \geq 0$$

$$\theta\, x_i - X\lambda \geq 0, \qquad i = 1, 2, 3, \ldots\ldots\ldots, N$$

$$\lambda\ \geq 0,$$

Where N stands for the number of years, K inputs and M output vectors. X is a K xN input matrix, Y is an M xN output matrix, and λ is a constant vector. The obtained value of θ will be the technical efficiency (TE) score for the ith DMU.

The BCC-DEA model allows the estimation of pure technical efficiency (PTE). We can use production efficiency and earning effectiveness for the measurement of scale efficiency. Scale Efficiency=*Technical Efficiency* Inputs used for measuring operational efficiency are the number of employees, the length of railways in operation, investment, the number of locomotives, and the number of passenger trains. Output is measured as passenger kilometers and freight kilometer.

$$\text{Scale Efficiency} = \frac{Technical\ \ Efficiency}{Pure\ Technical\ Efficiency}$$

Output Oriented Model

We used output maximization model for estimation of earning effectiveness and financial efficiency. At this stage it is an output oriented model with constant returns to scale. Inputs used are passenger and freight kilometer and output is freight revenue and passenger revenue. The methodology for measurement of earning effectiveness is the same used by Li and Hu (2011). The purpose is to maximize revenues while keeping inputs fixed. An important issue raised in the case of PR is that it is neither cost effective nor a financially viable investment. For tackling this question we measured financial efficiency. We used the assumption that profit can be maximized on the basis of revenue maximization. Due to the non-availability of fuel expenditure data of IR, we had to divide cost into two categories for comparability: employees and administration cost and other cost.

$$\max W = \sum_{r=1}^{s} u_r y_{rp}$$

$$S.t: \sum_{i=1}^{m} v_i \ x_{ip} = 1$$

$$\sum_{r=1}^{s} u_r \ y_{rj} - \sum_{i=1}^{m} v_i \ x_{ip} \leq 0, \quad j = 1, 2, \ldots \ldots n$$

$$u_{r,} \ v_i \geq \epsilon, \qquad r = 1, \ldots \ldots . s, i = 1, \ldots \ldots m$$

Each decision making unit (DMU) in DEA can be used to benchmark efficient units in comparison with inefficient units. It is a diagnostic tool and reengineering strategies can be prescribed on the basis of efficient units. It is possible that these units are simply not comparable because they differ in operating practices. In measuring the relative efficiency it is also possible that an efficient unit turns out inefficient just because of unrestricted weight flexibility. This problem can be overcome by using cross efficiencies (Talluri, 2000), which helps identify good overall performers and effectively rank DMUs. An efficient DMU must have high cross efficiency score along its column in cross efficiency matrix (Sexton et. al., 1986). Sarkis and Talluri (1999) suggested cross evaluation on the basis of a combination of qualitative and quantitative factors for effective ranking of DMUs.

To overcome these problems we used window analysis. It permits us to assess the efficiency change over time by allowing the tracking of efficient units over time. If there are 'n' units and k period of time we need to assess 'nk' units simultaneously. In this paper we have three units (Pakistan, China and India) and 16 years to track the efficiency of each railway system. We used modified window analysis approach of dropping the worst performer to challenge the best previous performance.

Data and its Limitations

We used the annual data on railway system in Pakistan, China and India. Data on PR is taken form its yearbooks (GOP, 1999-2011), while financial data is extracted from the yearbooks of the Federal Bureau of Statistics (GOP, 1960-11). Five yearly average data for 1950- 2010 is used for analyzing the structural inefficiency in PR as a whole. Yearly data for 1965-2010 is used for the descriptive analysis of Pakistan's railway – average annual compound growth rates for inputs, outputs, financial conditions, and the role of the government in regulating the railways. But this longest data set is not used for the DEA due to the limitations imposed in obtaining corresponding data on IR and CR. The CR data is extracted from the statistical yearbooks (China, 1993-09) and UIC (2010). IR data was taken from its yearbooks (GOI, 2000-10; 2001-10)

Although we tried our best to remove all the inconsistencies and gaps in data, but some still remain. Break up of all costs is not available in case of India, forcing us to manage with working expenses. Data on costs and revenues was converted into $US on the basis of average annual market exchange rates taken from IMF (2011). Locomotive kilometer was not included as output indicator due to non-availability of IR data. Similarly, data on fuel, pensions, passenger fares and freight charges was also not available.

EFFICIENCY ANALYSIS

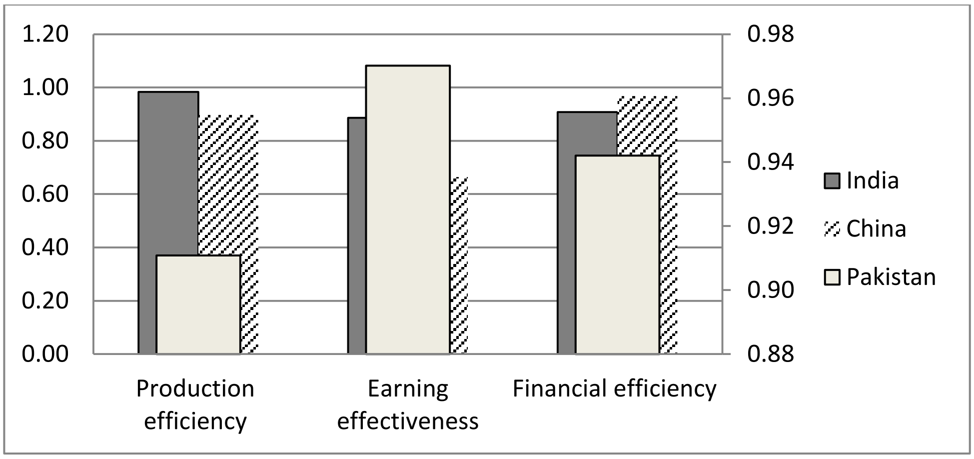
We started the efficiency analysis by looking at the correlation coefficients (Table 2). As PR failed to increase the route length and investment, these are almost constant having zero correlation with all the variables. Number of employees has significant correlation with passenger coaches, locomotives, freight cars and insignificant correlation with route and fixed assets. Number of employees has negative correlation with passenger ton km. In China and India, number of employees is negatively correlated with all inputs and outputs.

There is weak and negative correlation between inputs comprising total employees, route, and number of locomotives, passenger coaches and freight coaches with output comprising freight ton km and passenger ton km. Investment has positive but weak correlation with the operating capacity. These results clearly depict that output is not increasing but inputs like freight cars and passenger coaches increased slowly. PR system seems in dire need of creating long term capital assets. (See Appendix Table 4)

Comparative Efficiency

We compared operational, earnings and financial efficiency of PR with IR and CR. We computed the average efficiency score and found that IR has the highest and PR has the lowest operational efficiency. CR has the lowest earnings efficiency. When it comes to the financial efficiency, CR is the most efficient system. It can be concluded that if a system loses operational efficiency as in case of PR, earning efficiency has no meaning.

Figure 5. Comparative Efficiency Analysis



In Table 2, we show the statistical distribution of all three measures of efficiency. According to Li and Hu (2011) 'star' DMU has highest value of all three efficiencies and the system has the highest advantage. In case of PR, all values reached the highest level only in 1994-95. This is the lone star year. The 'thin-dog' category is for the worst performer which happened in 2003-04 when the railway as a system failed to achieve any efficiency in terms of its own repeated performance. PR was the worst performer in all three departments. All other years lie in the 'middle belt', with earning effectiveness and financial efficiency but without operational efficiency. Since 2004-05, PR has lost financial efficiency. There is no star railway system but CR's performance in the last five years was impressive, beating all its previous bad performance record.

Closing down operations due to lack of investment in rolling stock ultimately reduces future stream of income, making it difficult to sustain earning effectiveness and financial efficiency. If a system is operationally efficient as in case of CR, it has the potential to achieve financial efficiency even if it lacks earning effectiveness. China was not earning efficient in the early period of this study but it achieved its earning efficiency after 2005. On average, none of these systems has attained efficiency in use of inputs or output. CR's values are consistent and have the highest rank.

Table 2. Statistical Distribution of Efficiency

	PR			CR			IR		
Efficiency score	Operational	Earning	Financial	Operational	Earning	Financial	Operational	Earning	Financial
1 - >1	6	8	9	4	2	5	7	3	2
0.90 -0.99	3	6	3	5	0	11	4	4	5
0.80 - 0.89	5	2	2	2	2	0	1	4	5

0.70- 0.79	2	0	2	5	3	0	0	0	0
0.60- 0.69	0	0	0	0	5	0	0	1	0
0.50 - 0.59	0	0	0	0	1	0	0	0	0
0.40 - 0.49	0	0	0	0	2	0	0	0	0
0.30 - 0.39	0	0	0	0	1	0	0	0	0

Tables 3 and 4 show how the inefficient years can be converted into efficient years by effective use of inputs. The PR needs to cut down 12 per cent of employees, 10 per cent of route, 29 per cent of fixed assets, 13 per cent of locomotives, 15 per cent of passenger coaches and 21 per cent of freight cars. There is 1 per cent extra capacity in freight and 3 per cent in passenger km. The IR needs effective use of 18 per cent employees, 17 per cent route length, 6 per cent capital, 20 per cent locomotives, 15 per cent passenger coaches and 23 per cent freight cars. It needs an increase of 2 per cent in passenger million km. CR needs effective use of 27 per cent employees and 10 per cent locomotives. There will thus be an output gain of almost 23 per cent passenger km and 29 per cent freight km.

Table 3. Improvement in Technical Efficiency

	PR	IR	CR
Total employees	12.4	17.79	26.8
Route	10.28	17.32	6.7
Fixed assets	28.52	5.59	0
Total Locomotives	13.25	19.89	10.39
Passenger coaches	14.81	14.67	4.41
Freight Cars	21.12	23.14	0.31
Freight Km	1.16	0	22.7
Passenger Km	2.62	1.6	28.69

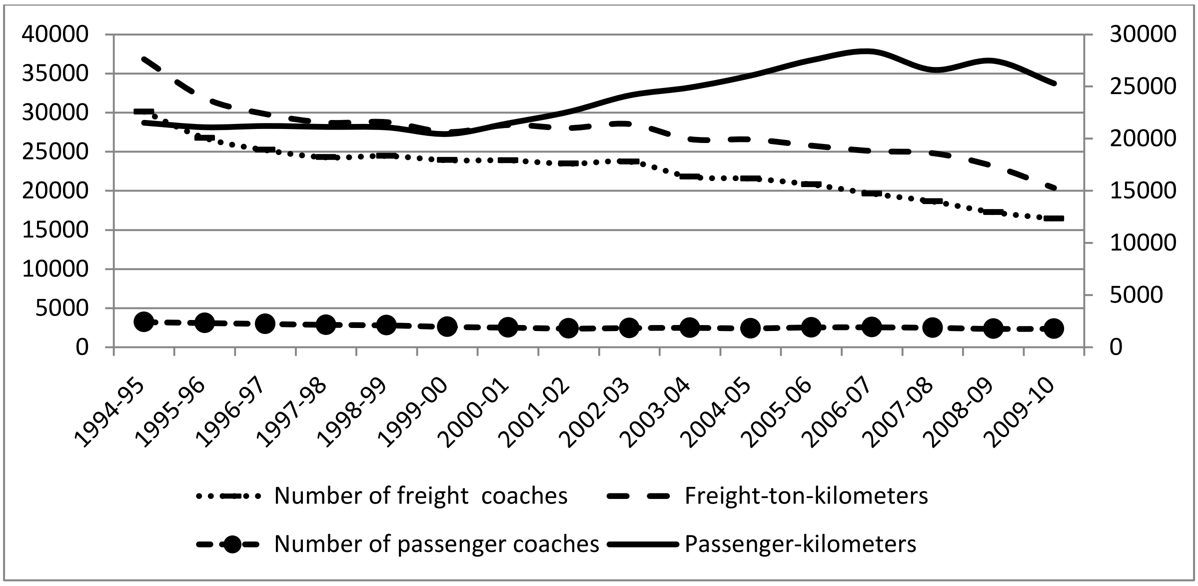
Table 4. Improvement in Earning Effectiveness

	PR	IR	CR
Freight ton km	8.56	4.56	4.42
Passenger ton km	0	0.77	0.19
Freight revenue ($million)	50.66	37.74	51.1
Passenger revenue ($million)	40.76	56.93	44.3

Efficiency Analysis of PR

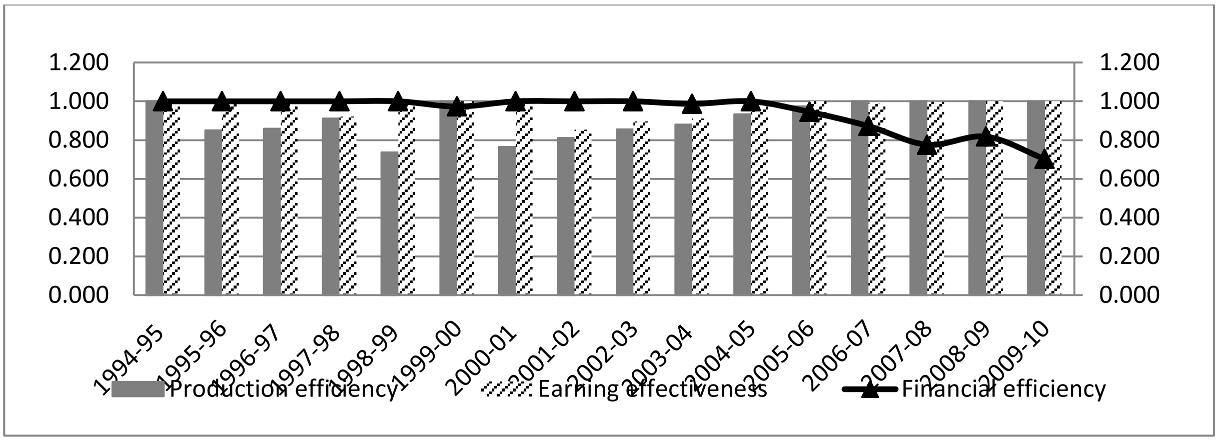
PR can be summed up as a system of unutilized and redundant capacity. Hardly a source of innovation and technology, it was not able to achieve a priority position in public transportation in Pakistan. Population in Pakistan has increased almost at a rate of 2 per cent annually and GDP between 4-5 per cent. The demand for railways is derived in nature. It is hard to understand why railway should lag behind in a growing economy with poor access to infrastructure. Figure 6 shows all trends downwards.

Figure 6. Operating Conditions in the Railway 1994-2010



PR business is shrinking and all inputs are declining - freight cars, passenger coaches, locomotives, employees and investment. A redeeming factor is increase in passenger km, due mainly to the railway being the only mode of transportation in remote areas and to the poverty stricken class for larger distances. As the deteriorating 'feel and look' of PR has reduced it to a means of transportation of the poor, it stands low in the priorities of the government and lost its competitive edge in freight business.

Figure 7. Efficiency Analysis of PR

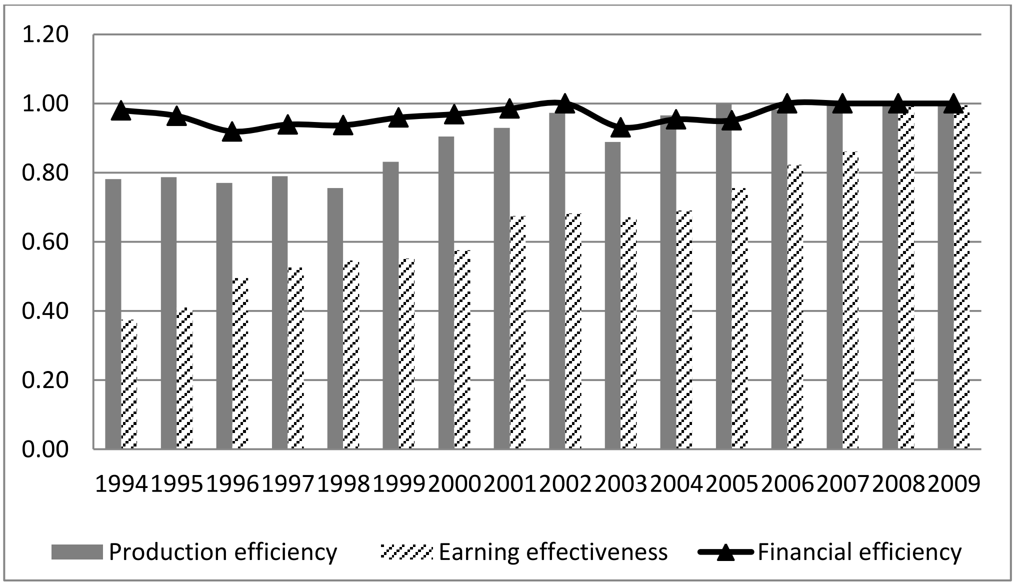


PR's efficiency was estimated for 1994-2010 (Figure 7). It turned out product efficient in 1998-99, 2006-07, 2007-08, 2008-09, and 2009-10. This only means that in these years PR used its inputs better than all other years. Out of 17 years, only 5 years were product efficient. All other years were inefficient. It meant, for instance, that in 1995, PR used only 73 per cent of its resources, wasting 27 per cent. Efficiency here only means that PR is producing freight and passenger ton km with less input. The story of railway efficiency is contraction and declining business.

Efficiency Analysis of CR

As can be seen in Figure 8, CR struggled with operational efficiency in 1994-2005, but has recovered since, progressing steadily and consistently. In 1994 its operational efficiency was 78 per cent, reaching 100 per cent in 2005 and then never looking back.

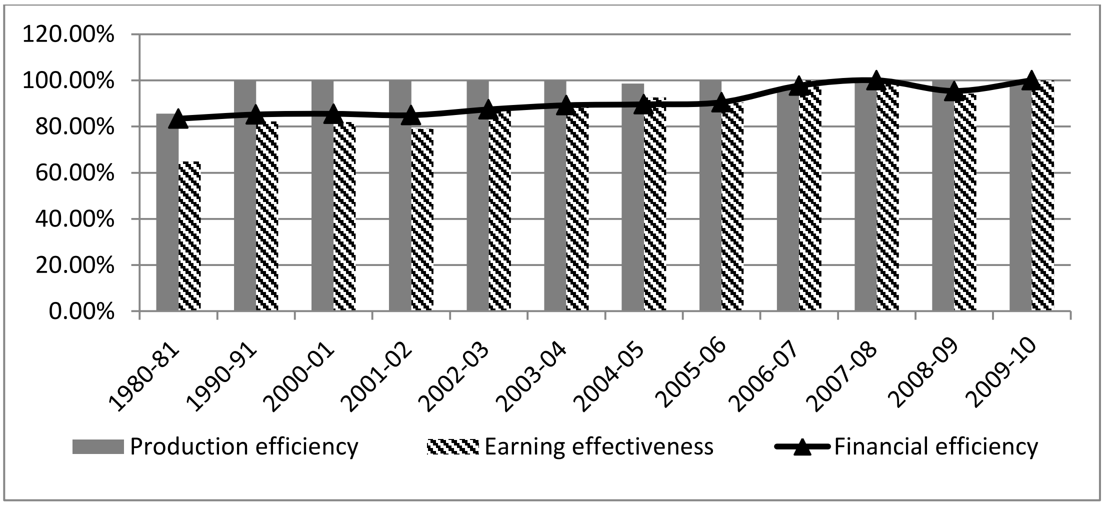
Figure 8. Efficiency Analysis of CR



Efficiency Analysis of IR

IR turned out product efficient during 1999, 2000, 2001, 2003, 2005, 2008 and 2009. In 1980-81, it was inefficient as it wasted 15 per cent of its inputs. On the whole, it was operational efficient during 2001-2010. By looking at cross efficiency, which gives a more accurate idea of efficiency, IR was efficient only in 2005-06. Figure 9 illustrates the results for IR.

Figure 9. Efficiency Analysis of IR



CONCLUSION

This paper has analysed the factors responsible for the deteriorating performance of railways in Pakistan. For further understanding and developmental implications, it also analyses comparative performance of Pakistan, China and India. Data Envelopment Analysis is applied for the first time to model the three systems, all under public control. China introduced a set of reforms in 2005 in which railway was divided into regions. India has introduced partial privatization. Both invested heavily in the railways, which helped to turn them around. Both India and China are in the top five railway systems of the world and have built the capacity to produce railway equipment. Pakistan has failed to introduce any major reform. Railway performance was estimated on the basis of production, earnings and financial efficiency. Previous studies analyzed production and earning efficiency of railways but ignored financial efficiency. A number of studies found that it is not only the revenue maximization that is important, but cost effectiveness and composition of cost structure are also to be considered.

Our major finding is that Pakistan Railways has the lowest production and financial efficiency. There is a strong link between production inefficiency and overall performance of the railway. Production inefficiency is the main reason for technical inefficiency. There is a declining trend in all the inputs but the demand for railway service is the reason for increased revenue. Financial inefficiencies are substantial and significant since 2005. In the last few years, Pakistan Railways has lost its financial efficiency. Chinese railway is also low in the production efficiency. India has the highest production efficiency and earning efficiency but lost financial efficiency.

Pakistan Railways is the story of bad operations and financial imprudence. The government, the management and the public perceptions have all contributed to the failure of Pakistan Railways to change and develop. The government has been pro roads. The age of motorways ended in the world in1980s due to high prices of energy and environmental degradation, but not in Pakistan. Petroleum is an important source of revenue in a country that has a very low tax to GDP ratio. As government finances are in a mess, so are those of railways. The result is the failure to maintain infrastructure, especially railways. Allocation of development funds for roads is far higher than railways. Unfair allocation of public sector freight, creation of a huge military controlled trucking industry and the influence of automobile import and assembly lobby played their own role. Railway also suffered from federal interference as it is merely a government department working under a ministry. Not left with enough autonomy to take decisions, the railway is handicapped to operate as an efficient system. It could not establish linkage with the industry in Pakistan, nor was it able to build technology as it depends for equipment on the big players in the world railway supply system. Employment in all productive departments of the railway declined and wage bill increased. Political patronage rather than skills has become the basis of entry. Perks and privileges for the upper echelons is the reason and cuts are applied on the welfare schemes of the lower echelons. Passenger and freight ton km increased but share in earnings declined. Route length and investment declined which resulted into redundant locomotives and untidy trains. Resultantly, untidy and never on time is the perception of those who opt to travel in these trains. There is a stigma attached that railway is for the poor second class citizens, while the rich have an unending passion for cars.

The argument that railway in Pakistan deteriorated because it is not commercially viable investment, is weak. Its revival requires investment, and more. Its governance must also change to maximize the productivity of investment. A number of proposals have been advanced. These include a fully autonomous railway board, provincialization, public-private partnership and outright privatization. Elsewhere, privatization, concessioning and franchising have had a mixed success. The achievements have generally been related to increased efficiency and market orientation. It took three decades in England to decide on privatization and the idea came from the treasury. There is a view that privatization may change the financial outlook of the rail as an enterprise but it never brings a change for the benefit of its passengers or labour. It brings tangible change in revenue that may be important for the growth of the industry but damages the rail industry culture. There is also the question of social railway or a profitable private enterprise. Provincialization is suggested for better use resources, in particular, land which can be sold for expansion and investment. The 1973 constitution kept railways on the federal legislative list part II dealing with inter-provincial subjects. Provinces thus already have a role through the Council of Common Interests. What is required is to allow Pakistan Railways full financial and managerial autonomy, which it lost soon after the independence of Pakistan, and selective public private partnership.

To sum up, Pakistan Railway is product inefficient in the usage of inputs that led to financial inefficiency because costs unrelated to service delivery have risen sharply. Route length, number of employees, locomotives, passenger coaches and freight cars has declined. The same service has to be performed with fewer inputs. Our analysis shows Chinese railways is product and financial efficient, which is leading to earning efficiency. India is product efficient but struggling with earning and financial efficiency. The lesson drawn for Pakistan is that product efficiency leads to other efficiencies and railway development can be sustained by steady public investment and autonomous and professional management.

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APPENDIX

Table1. Pakistan

	N	Minimum	Maximum	Mean	Std. Deviation
Route kilometer	15	7791	8775	8053.33	450.30
Freight-ton-kilometers (millions)	15	3612	6178	4790.47	699.04
Locomotives No.	15	520.00	633.00	579.0667	33.07
Freight wagons	15	16450	27251	22309.13	3255.48
Number of passenger coaches	14	1763	2239	1920.14	145.33
No of employees	15	83868.00	97678.00	89780.4667	4873.77
Freight traffic revenue	14	3955	7494	5149.00	1069.67
Passenger traffic revenue	14	4517	12583	7983.00	2901.60
Repairs and maintenance cost	14	3770	10086	5914.21	2094.72
Fuel cost	14	1624	11055	4636.50	3244.65

Staff + admin cost	14	2420	6931	3848.29	1514.01
No of passengers million	15	58.97	83.78	72.7360	7.39
Freight carried million ton	15	4.63	7.23	6.0787	0.72
Total revenue receipts	15	9331.00	23181.30	15011.6573	4689.80
Total revenue expenditure	15	12928.60	54373.00	23702.8867	12302.33
Passenger-kilometers million	14	18495.00	26446.00	22238.9286	2898.16

Table 2. China

	N	Minimum	Maximum	Mean	Std. Deviation
Total employees	15.00	166.56	225.70	190.81	18.89
Length of railway in operation	15.00	6.24	8.55	7.21	0.64
Fixed assets	14.00	3613.60	12347.00	7270.75	2847.29
Locomotives No.	15.00	14472.00	17825.00	15891.47	1058.75
Locomotives km	15.00	93.00	128.60	105.70	11.66
Freight 100 million ton km	15.00	12560.10	25239.20	17479.86	4782.32
Passenger ton km	15.00	3347.60	7878.90	5247.69	1551.11
Revenue from passenger traffic	14.00	201.50	981.12	492.23	235.59
Freight revenue	14.00	357.60	1593.22	807.86	395.39
Total cost	14.00	97.16	1589.40	849.63	487.75
Total revenue	14.00	632.10	3588.30	1562.07	838.83
Passenger coaches	15.00	32404.00	47436.00	38239.13	4198.46
Freight cars	15.00	432731.00	594388.00	493409.73	62321.07

Table 3. India

Total employees	15	9136000	16518000	1.40E+07	1.76E+06
Total investment in $	15	1795.92	44464.04	19069.73	13090.85
Freight revenue	15	98.2	23414.44	10889.13	8184.974
Passenger revenue	15	139.3	56911.51	24951.24	19380.75
Staff + admin cost	15	113.8	51236.75	18249.16	14987.46
Total revenue	15	263.3	89229.29	39614.62	30574.52
Total cost	15	215.74	83665.2	34678.35	26583.09
Total length	15	53596	64015	61809.13	3037.14
Locomotives	15	7566	11158	8667.93	1210.476
Passenger coaches	15	19628	57535	43544.4	10280.01
Freight coaches	15	204034	400946	253391.9	69413.92
Freight ton km	15	37565	600548	332361.3	178324
Passenger ton km	15	66517	903465	477881.5	272852.5

Table 4. Correlation Matrix

	Number of employees	Length of railways	Investment	Passenger coaches	Number of locomotive	Freight coaches	Freight ton km	Passenger ton km
Number of employees	1.00	0.00[a*] -0.79[b] -0.68[c]	-0.02* -0.89 -0.19*	0.83 -0.94 -0.69	0.80 0.20* -0.44	0.66 0.75 -0.59	-0.41* -0.91 -0.58	-0.71 -0.91 -0.59
Length of railways	0.00* -0.79 -0.68	1.00	0.00* 0.79 0.78	0.00* 0.84 0.98	0.00* -0.61 0.92	0.00* -0.89 0.96	0.00* 0.90 0.97	0.00* 0.89 0.97
Investment	-0.02* -0.89 -0.19*	0.00* 0.79 0.78	1.00	0.09* 0.99 0.79	0.24* -0.08* 0.81	0.31* -0.61 0.74	0.38* 0.97 0.77	0.13* 0.97 0.78
Passenger coaches	0.83 -0.94 -0.69	0.00* 0.84 0.98	0.24* 0.99 0.79	1.00	0.49* -0.17* 0.92	0.55* -0.70 0.95	-0.28* 0.99 0.96	-0.48* 0.99 0.95
Number of locomotives	0.80 0.20* -0.44*	0.00* -0.61 0.92	0.09* -0.08* 0.81	0.49* -0.17* 0.92	1.00	0.86 0.77 0.97	-0.35* -0.30* 0.97	-0.80 -0.27* 0.95
Freight coaches	0.66 0.75 -0.59*	0.00* 0.89 0.96	0.31* 0.61 0.74	0.55* 0.70 0.95	0.86 0.77 0.97	1.00	-0.47* -0.77 0.99	-0.77 -0.76 0.96
Freight ton km	-0.41* -0.91 0.58*	0.00* 0.90 0.97	0.38* 0.97 0.77	-0.28* 0.99 0.96	-0.35* 0.30 0.97	-0.47* -0.77 0.99	1.00	0.74 1.00 0.99

Passenger ton km	-0.71 -0.91 -0.59*	0.00 0.89 0.97	0.13* 0.97 0.78	-0.48* 0.99 0.95	-0.80 -0.27* 0.95	-0.77 -0.76 0.96	0.74 1.00 0.99	1.00

Figure 1. Country Comparison of Investment in Railway as GDP per 1000

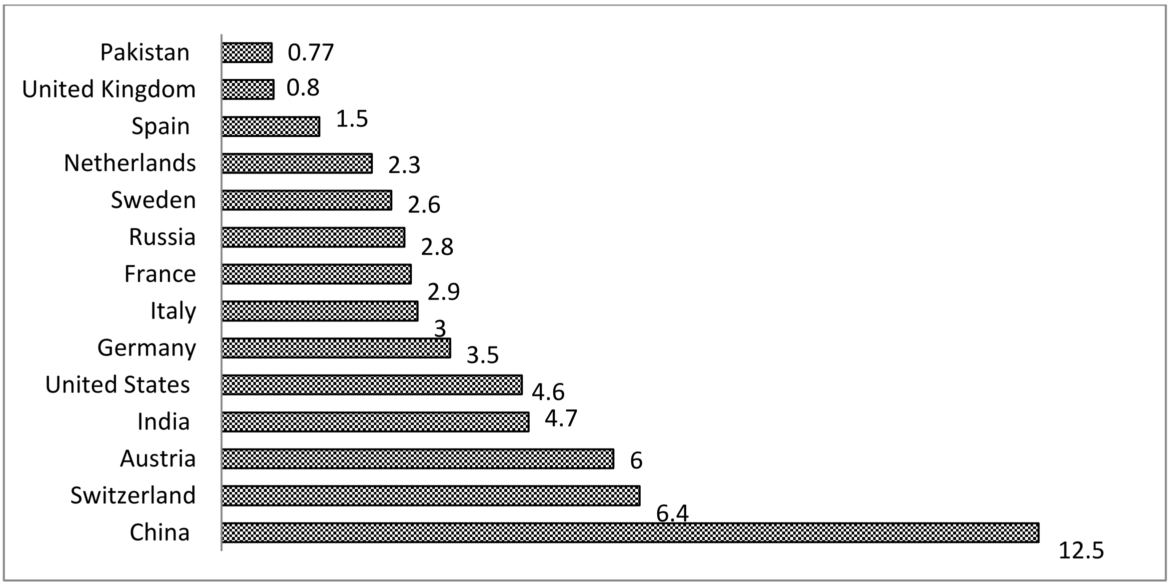

Figure 2. Relationship between Fuel Cost and Operating Capacity

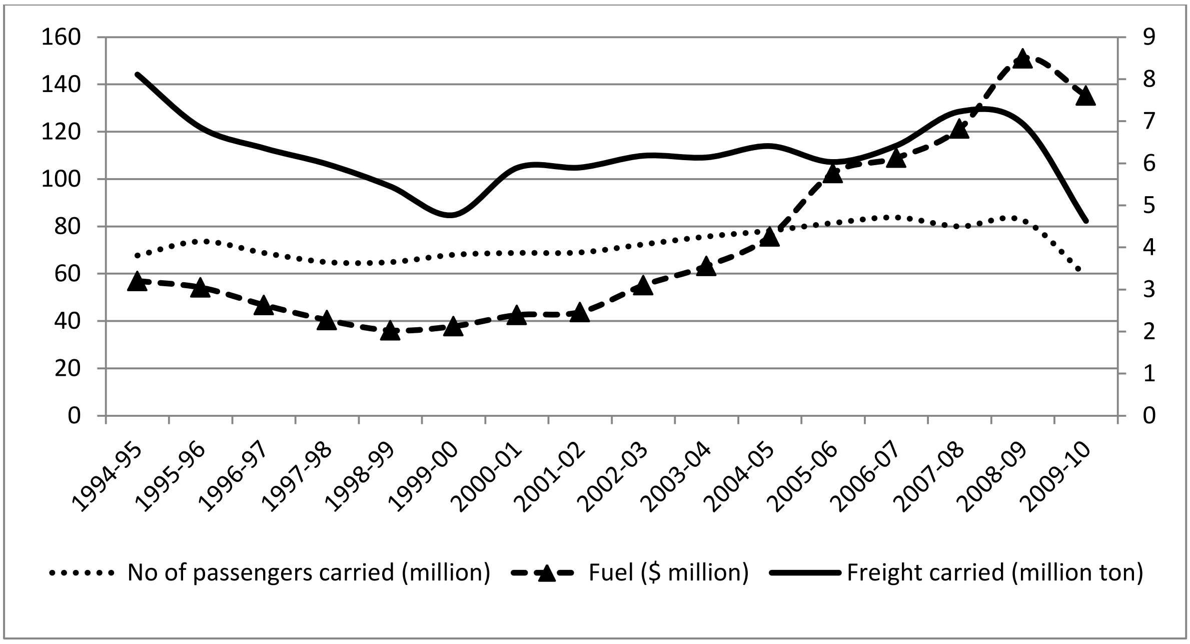

Figure 3. Freight Employee Ratio and Passenger Employee Ratio