GLOBAL BENCHMARKING OF SOUTH AFRICA'S FREIGHT RAIL SYSTEM – A MACROECONOMIC VIEW

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ABSTRACT

South Africa's rail system is investigated by comparing certain indicators with other railways around the world. It compares well on a country by country basis but there is however no clear direction or comparison as far as a business model is concerned. The research confirms that a path of deregulation, rationalisation, investment and efficiency such as in North America, nor a development state path of network growth and high relative employment, such as in the RIC countries were followed. These countries are geographically significantly bigger than South Africa, but the challenges are similar: long transport distances, high transport demand and spatial issues. The research indicates how an analysis of various productivity indicators can be used to develop themes for improvement.

Keywords: Freight rail benchmarking, infrastructure investment, South Africa

INTRODUCTION

At 12.7% of GDP, South Africa's freight logistics costs are higher than those of its key trading partners (Simpson and Havenga, 2011). Out of thirty three countries for which this indicator could be calculated, South Africa ranks 26th (Havenga and Pienaar, 2012a). High logistics costs are partly a result of relatively disproportionate transport demand – South Africa has approximately 1% of the world's population, produces less than 0.4% of the world's GDP, and yet requires more than 2% of global freight transport in terms of ton-kilometres. This situation has arisen firstly due to the country's economic development around inland mining deposits which resulted in dense centres of production and population far from the coastal areas, and secondly due to economic policies which promoted a relatively open mineral-export economy, and a beneficiated product- and energy import economy. These factors resulted in long export and import corridors (Havenga and Pienaar, 2012b). The situation is however compounded by a modal imbalance in serving this demand – 68% of South Africa's logistics costs are incurred on long distance surface freight transport corridors, while 88% of this cost is attributable to road transport (Simpson and Havenga, 2011). The dense long-distance corridors are ideal candidates for intermodal solutions and nationally there is a will to re-invest in rail with the national rail owner and operator implementing a R300bn investment plan over the next 7 years.

The purpose of this paper is to compare the positioning and performance of the local freight railway system with its global counterparts in order to inform this significant investment. To facilitate these comparisons, South Africa's rail system's data is split between the world-class ring-fenced export coal and iron ore lines, and the general freight business, as these two segments of the railway can operate completely independently of each other. The export lines are heavy haul lines that connect a few mines to the coast and often, in similar cases overseas, are built and operated by the mines as an extension of the mines' production system. In fact, one of these lines were built by a mine, but transferred to the railway. Their operations, design and even traction systems differ from the rest of the systems. The other part of the railway is more comparable to global general freight railways with mostly block trains between terminals or siding to siding block or wagon load operations.

The paper sets out by contextualising South Africa's railway system in global terms. This is followed by a comparison of global railways' size and productivity indicators with those of South Africa. A key driving force behind identified discrepancies is proposed and discussed, followed by concluding remarks.

SOUTH AFRICA IN THE CONTEXT OF GLOBAL RAIL SYSTEMS

Global railways can be classified into five macro rail sectors, the two most extensive being the North American systems of the USA, Canada and Mexico with a combined route length of 337 791 km, dominated by American Class 1 railroads and Canadian National; and the more independent systems of the Russian, Indian and Chinese railways (RIC) (with 268 652 km route length). This is followed by the European rail system with 212 785 km route length, dominated by France and Germany, and the South American systems of mostly the Argentinian and Brazilian railways.[1] The Southern African Development Community's (SADC)[2] system of about 40 126 km is next, dominated by South Africa's 22 051 km. Figure 1 confirms the dominance of the North American and RIC railways. These countries have 58% of the world's railway route kilometres, 73% of the world's railway employees, 62% of the world's locomotives and produces 93% of the world's ton-kilometres.

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[1] Because the South American systems are often in various stages of concessioning the data for these systems are highly unreliable and cannot be normalised. It is excluded from most of the research This shortcoming will be adressed in follow-up research.

[2] SADC is a regional economic community comprising 15 Southern African states: Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Established in 1992, SADC is committed to regional integration and poverty eradication within Southern Africa through economic development and ensuring peace and security (SADC, 2012).

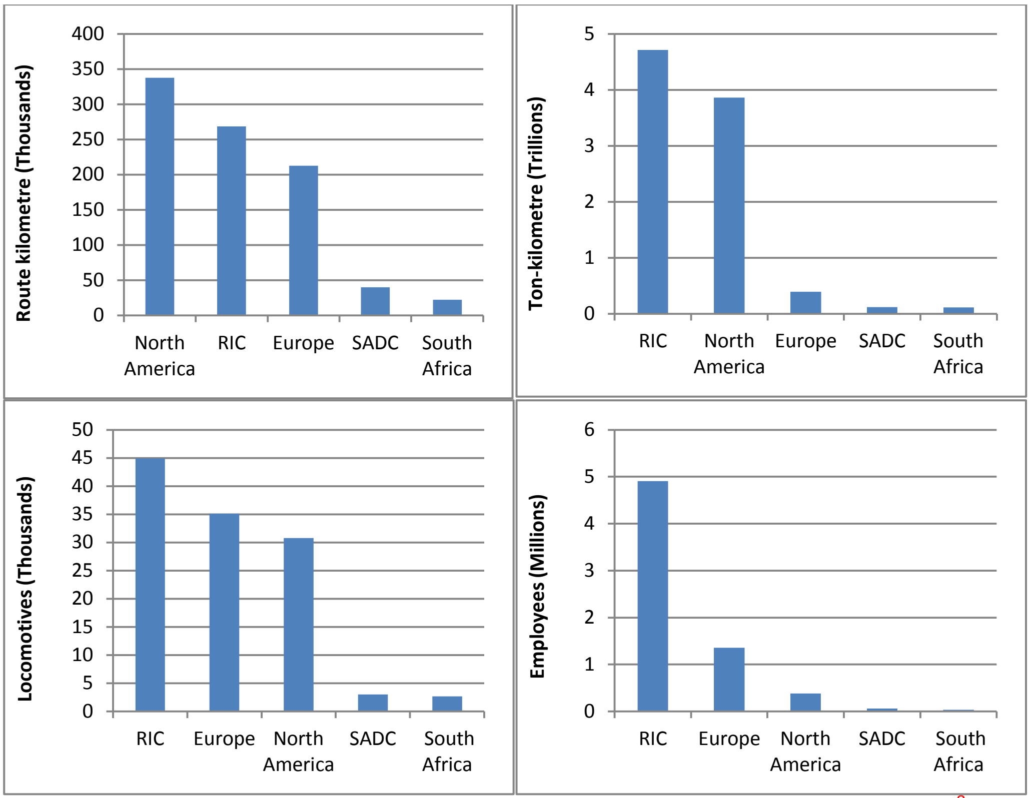

Figure 1: Relative sizes of world railway systems (Piasecka, 2007)[3]

On a country-by-country basis, the geographical extent of South Africa's total rail system however striking: it is the 12th largest in the world by route kilometre and by far the largest system of note in Africa. South Africa also has the 11th position both in terms of ton-kilometres and locomotives, and the 21st position in terms of staff (Figure 2). South Africa's railway therefore has a relatively small staff complement given its size. This is discussed in more detail under the section on productivity indicators.

[3] South Africa's data is included in SADC, but shown separately as well to highlight South Africa's dominance in the regional economic community

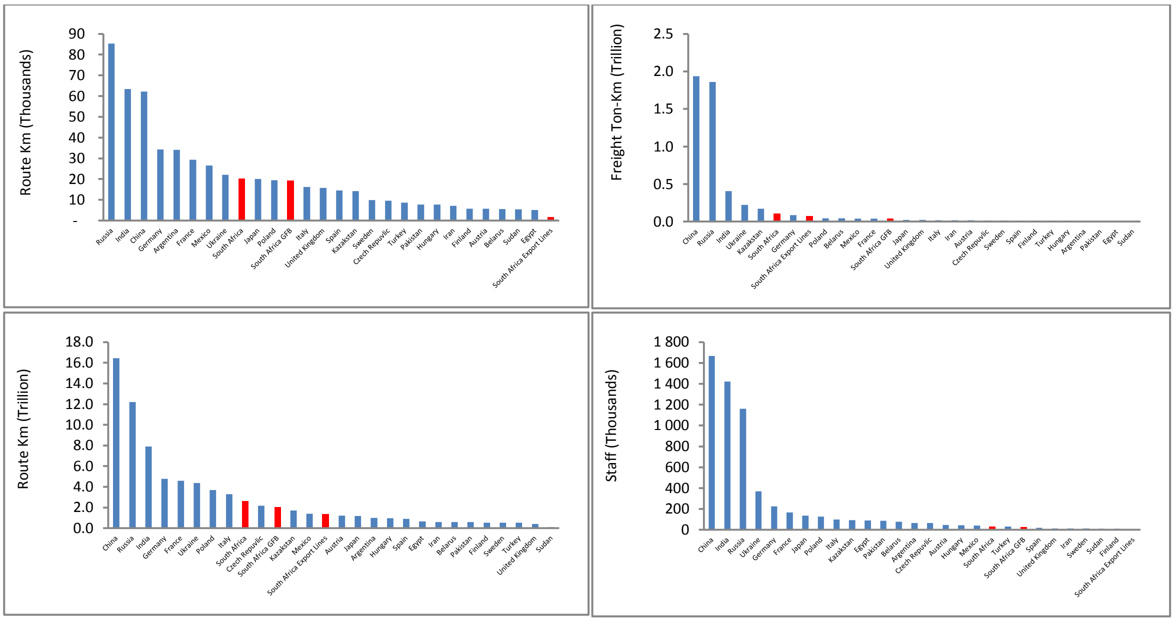

Figure 2: South Africa's global ranking in terms of key railway size indicators (Piasecka, 2007)

Time series analysis of these size indicators is, however, more revealing, and discussed in the next section.

TREND ANALYSIS OF SIZE INDICATORS

Due to data challenges, comparisons over a long time period are only possible between the USA and South Africa, and only for route kilometre. The quantum differs significantly – the USA's route kilometres were more than 20 times longer than South Africa's up to 1930, and is now approximately 12 times longer – but an indexed view makes it possible to compare growth over time as illustrated in.

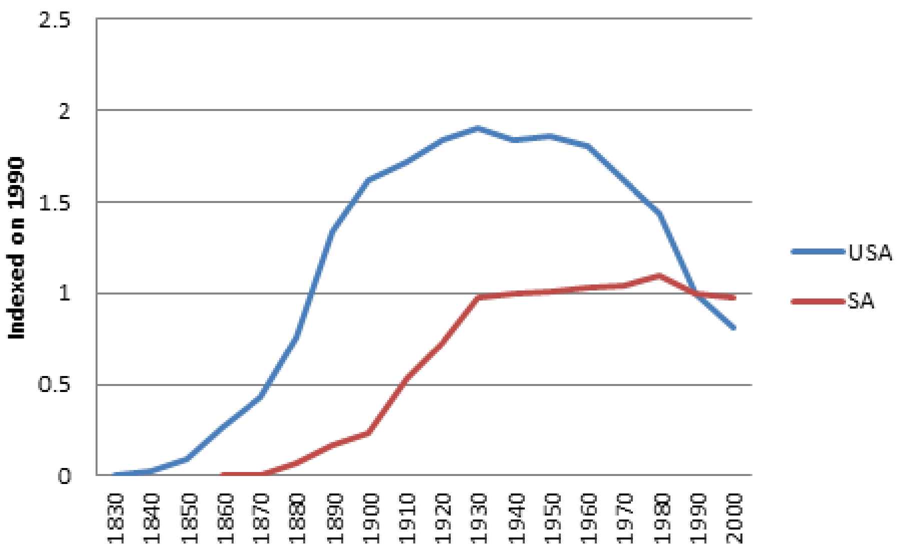

Figure 3: Growth in South Africa and USA rail route length (Perkins, 2009 and Key Stats Spoornet)

Comparisons between size indicator trends for all the major global rail systems are possible since 1980 and the linear regressions of these are depicted in Figure 4.

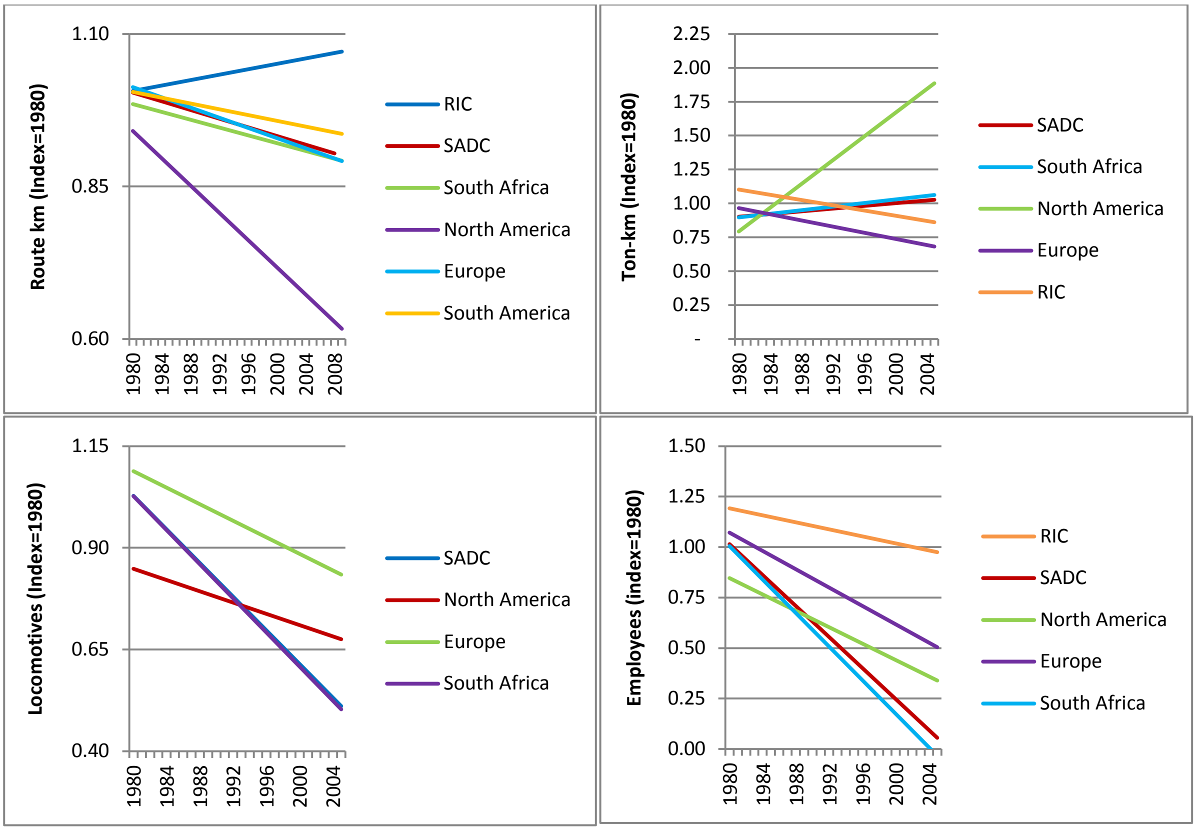

Figure 4: Linear trend of global rail systems' indicators (Piasecka, 2007)[4]

During this time period, the North American system's route kilometres were rationalised by 40% while the RIC railways' route length actually increased (all three countries now have longer route lengths than in 1980). North America's ton-kilometres soared. The lowest drop in employment is observed in the RIC countries.

South Africa's rationalisation of motive power and employment is the most significant in this comparison. The country's network size (in terms of route kilometre) however remained almost unchanged, placing a heavy burden of fixed costs on a railroad that is now in effect understaffed for its size. South Africa's relative growth in output (ton-kilometres) was a direct result of the relative performance of the two ring-fenced export lines.

[4] Because a linear trendline is fitted to data that originate at 1.0 in 1980 the derived formula will yield data yield values that are higher or lower for 1980

PRODUCTIVITY INDICATORS

Employee productivity

South Africa's employees per route kilometre (Figure 5) are low and comparable with most North American lines – with much lower densities that is to be expected. Ton-kilometre output per employee is however relatively high in South Africa, driven by the ring-fenced export lines (Figure 6).

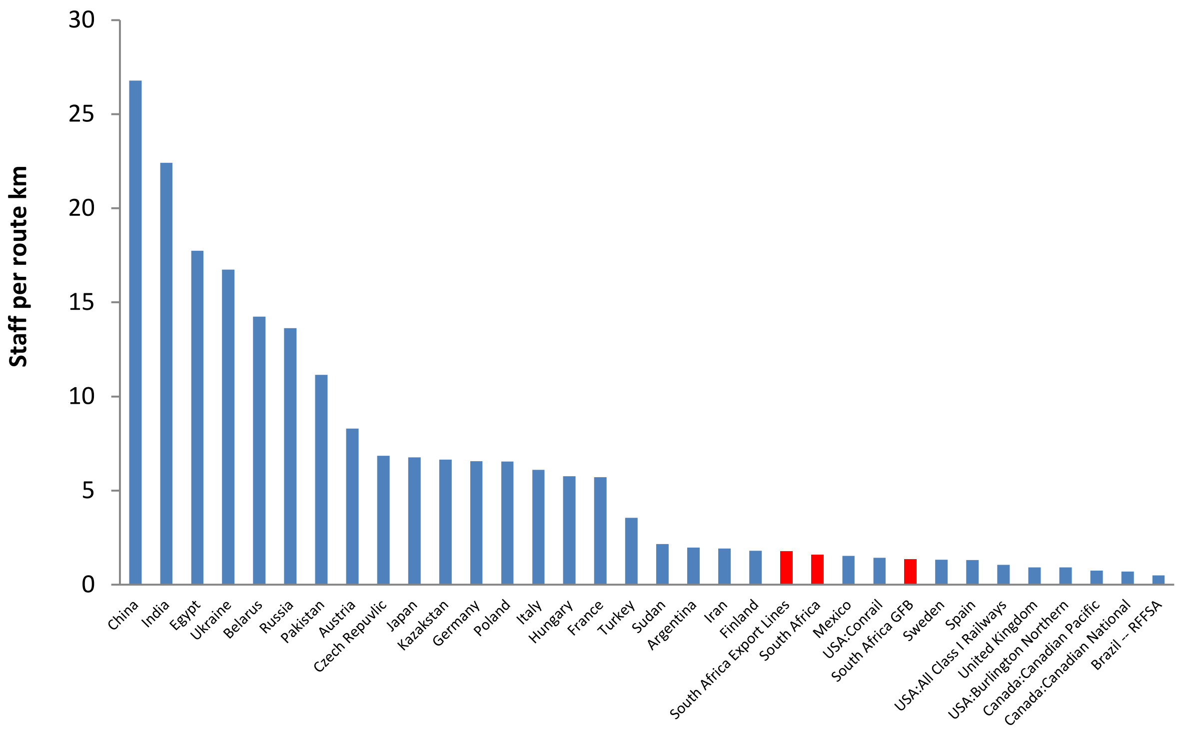

Figure 5: Current employees per route kilometre (Piasecka, 2007)

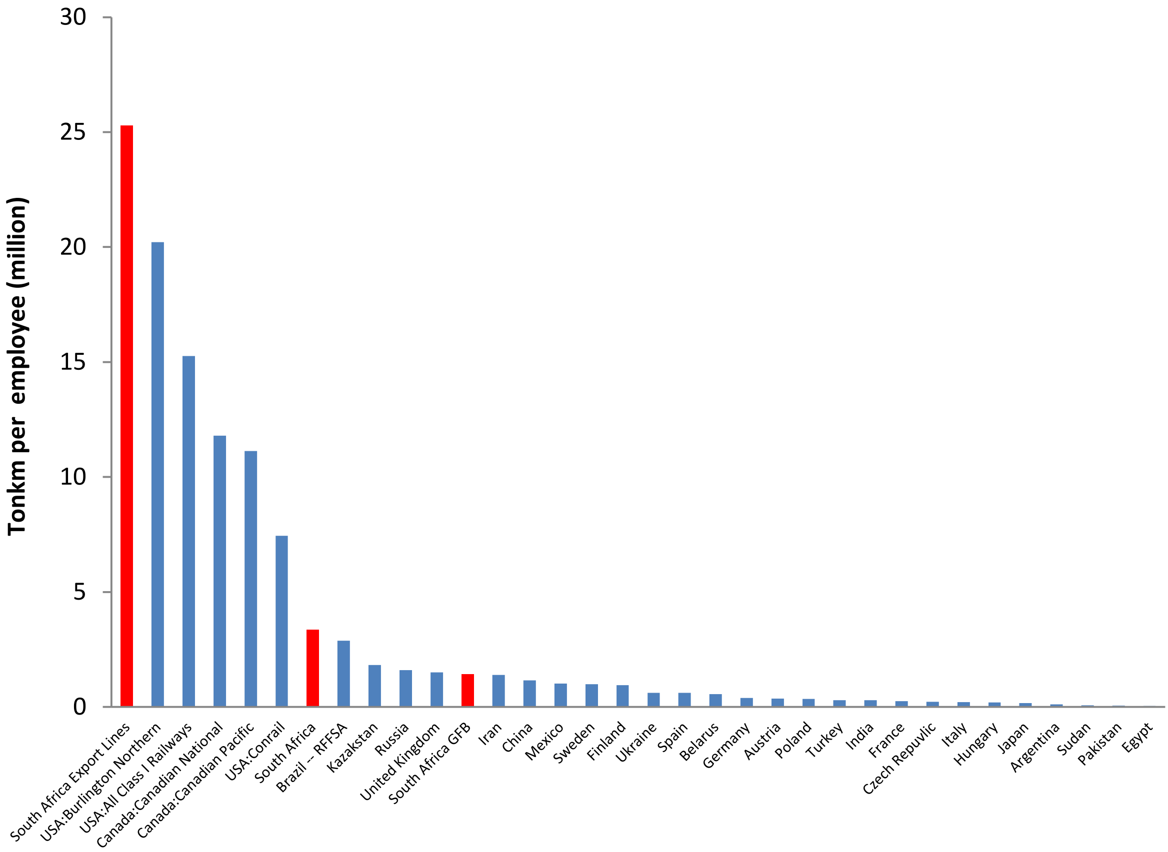

Figure 6: Ton-kilometre per employee (Piasecka, 2007)

Route kilometre per employee can also be compared directly (Figure 7), illustrating the dominance of the USA, Canada, Russia India and China and the USA's relative low employment compared to route kilometres.

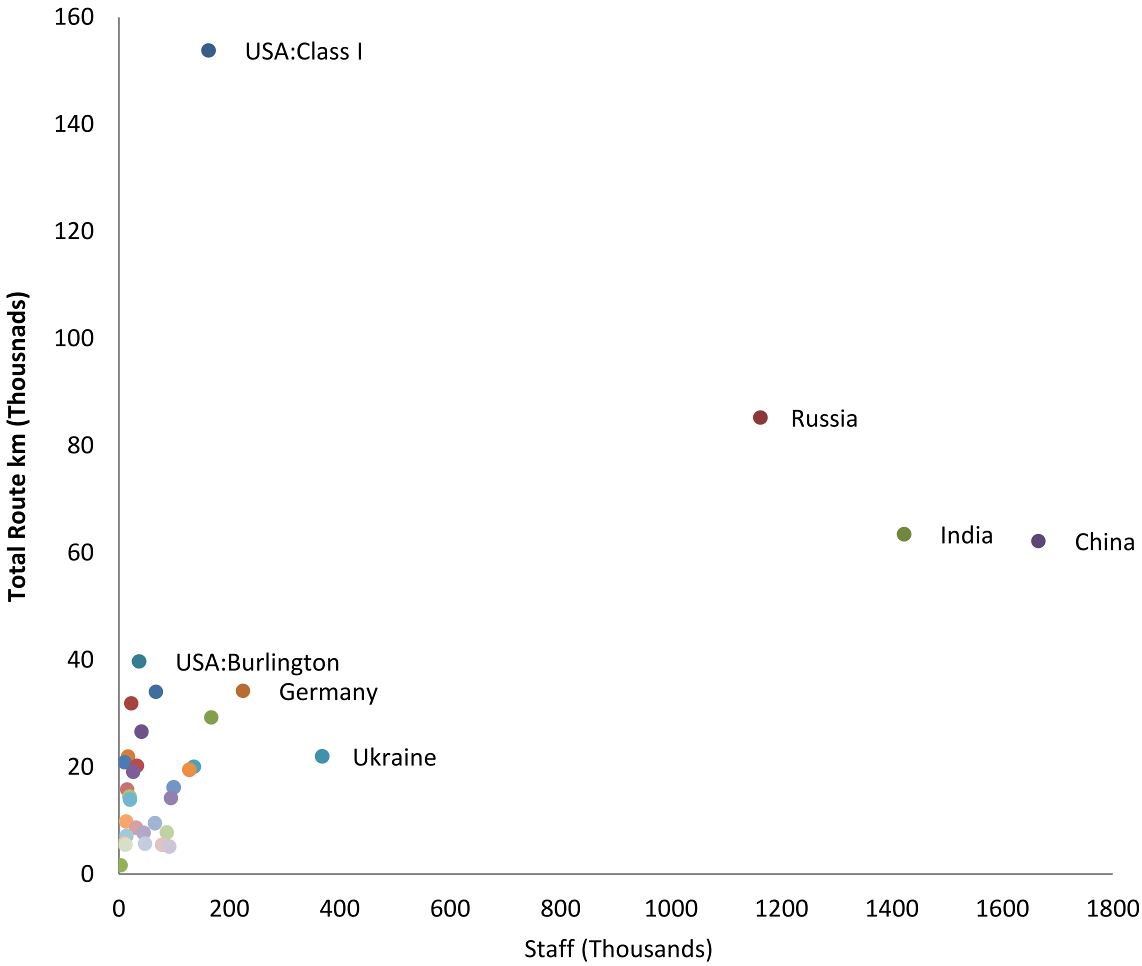

Figure 7: Route and employment comparison (Piasecka, 2007)

When these dominant countries are removed South Africa's smaller workforce relative to route kilometre size can be seen (Figure 8).

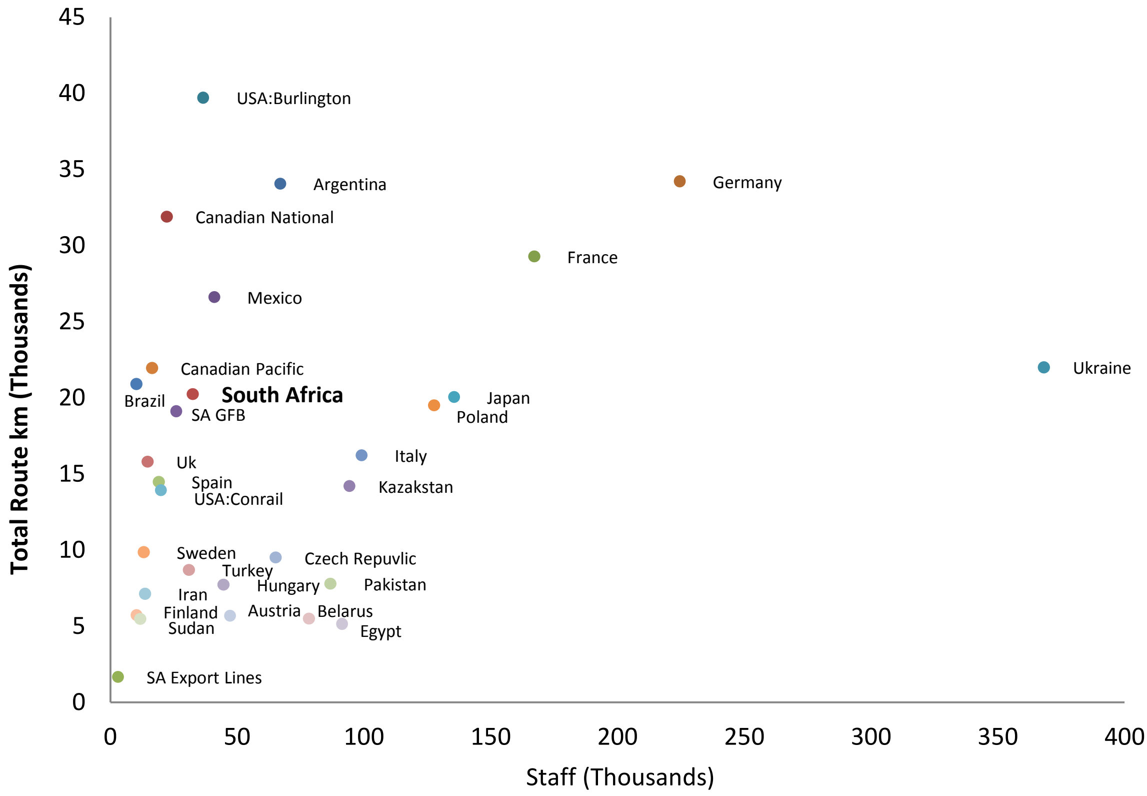

Figure 8: Route and employment comparison (macro systems removed) (Piasecka, 2007)

Ton-kilometre per employee can be compared in the same way (Figure 9) and illustrates the relatively high productivity of the North American railroads. It also confirms South Africa's reasonably favourable position if the macro rail systems are removed (Figure 10), although a distinct difference between the export lines and GFB can be observed here.

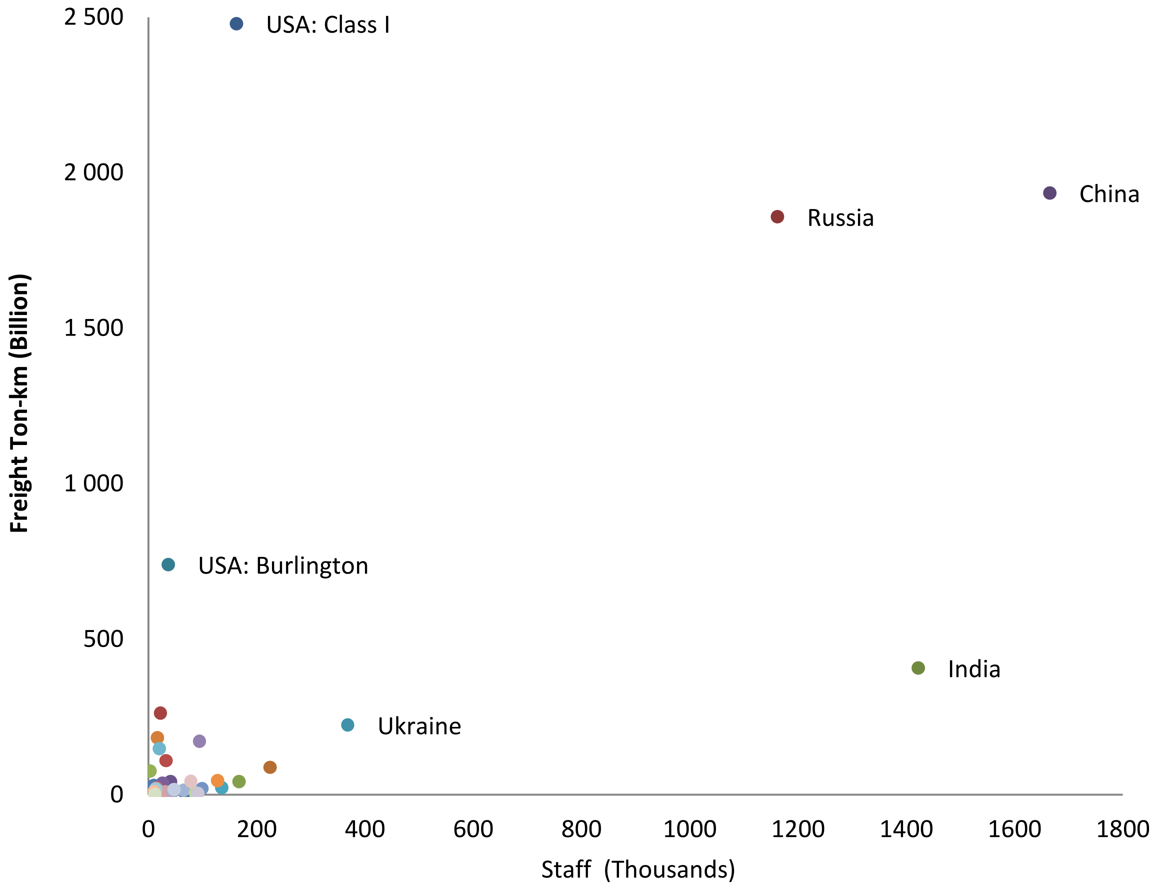

Figure 9: Ton-kilometre per employee (Piasecka, 2007)

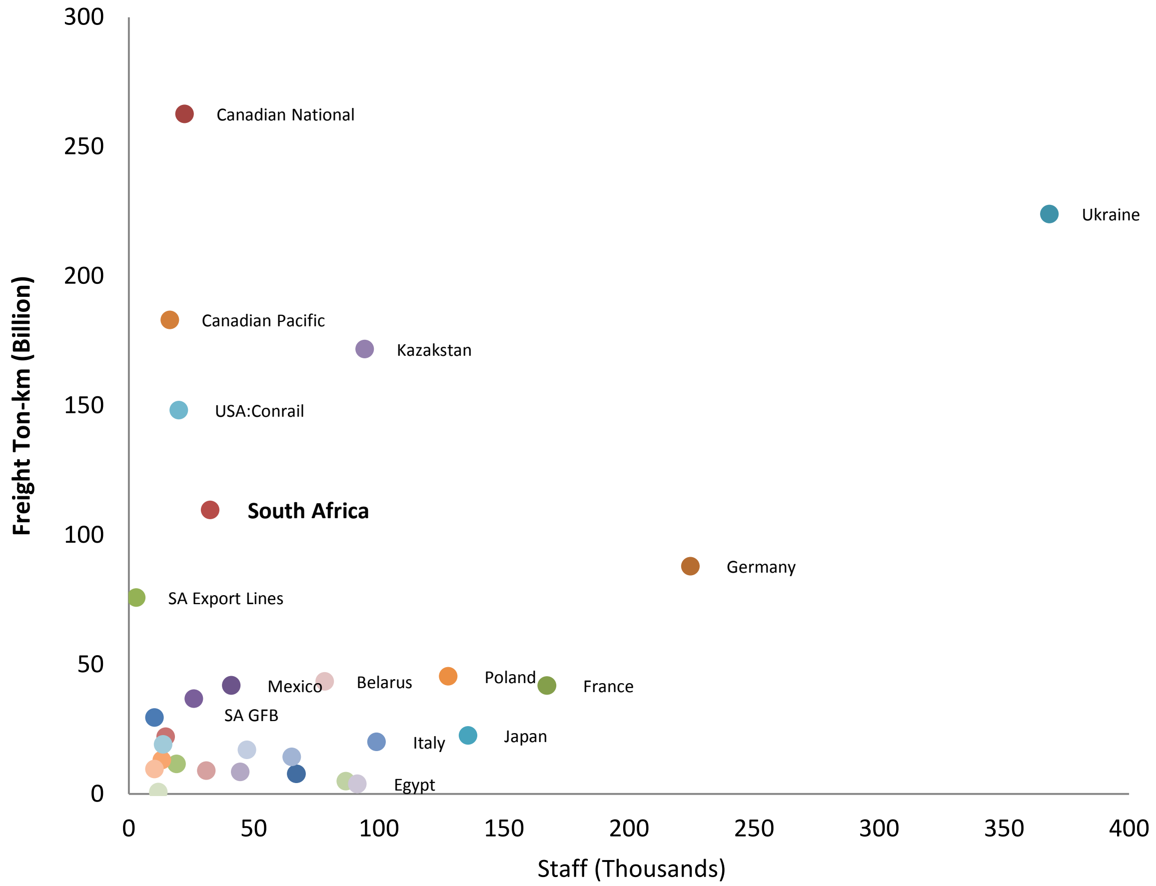

Figure 10: Ton-kilometre per employee (macro systems removed) (Piasecka, 2007)

Densities

The relationship between ton and route kilometres is best described by line density, i.e. *Density* = $\frac{Tonkilometer}{Route\ kilometer}$. *Density* = $\frac{Tonkilometer}{Route\ kilometer}$. This relationship is important due to the high fixed cost component of railways compared of railways compared to other industries, compounded by the long lifespan of rail as opposed to other transport to other transport assets, both illustrated in

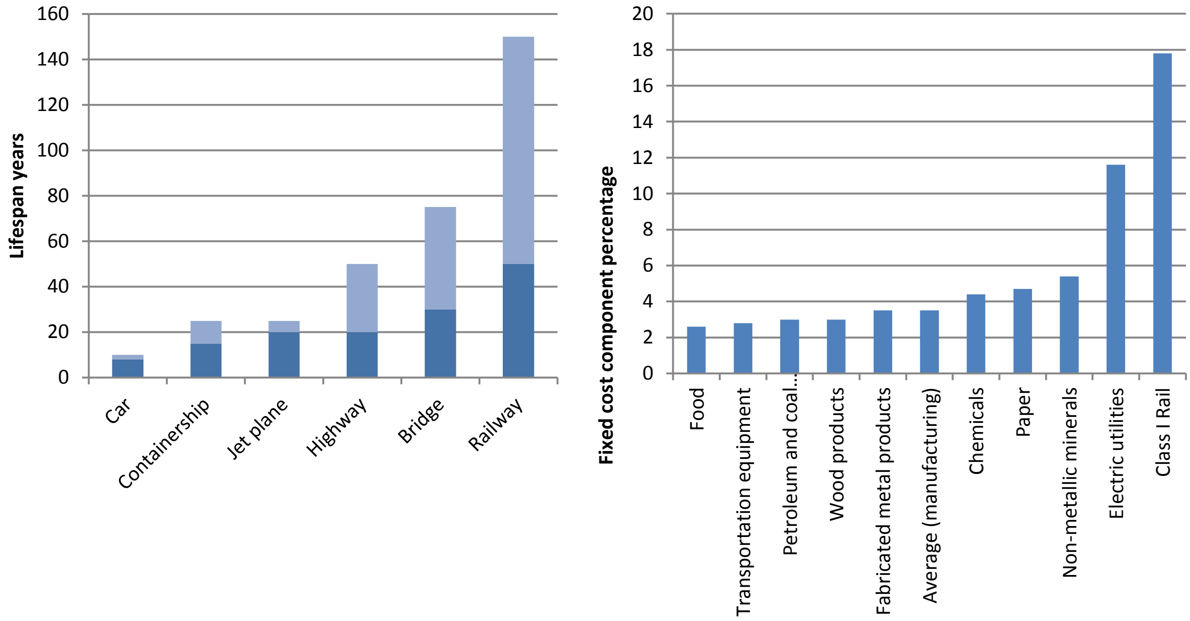

Figure 11. Given rail's high fixed cost, higher density means that the cent per tonkm cost of a railroad will decrease with each additional tonkm of activity over the same track length (Havenga et al., 2011).

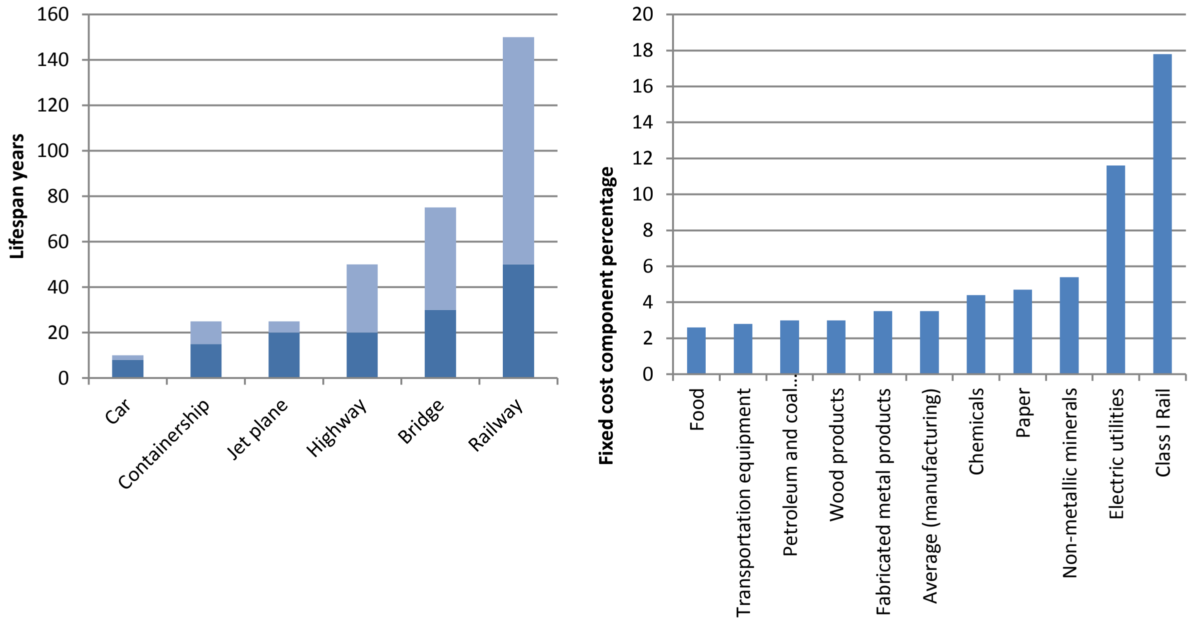

Figure 11: Lifespan of major transport assets and fixed cost as percentage of revenue for different industries (WWF, 2006)

The movement of higher volumes over shorter networks improves the density relationship and allows for the efficiencies achieved by American railroads (Figure 12).

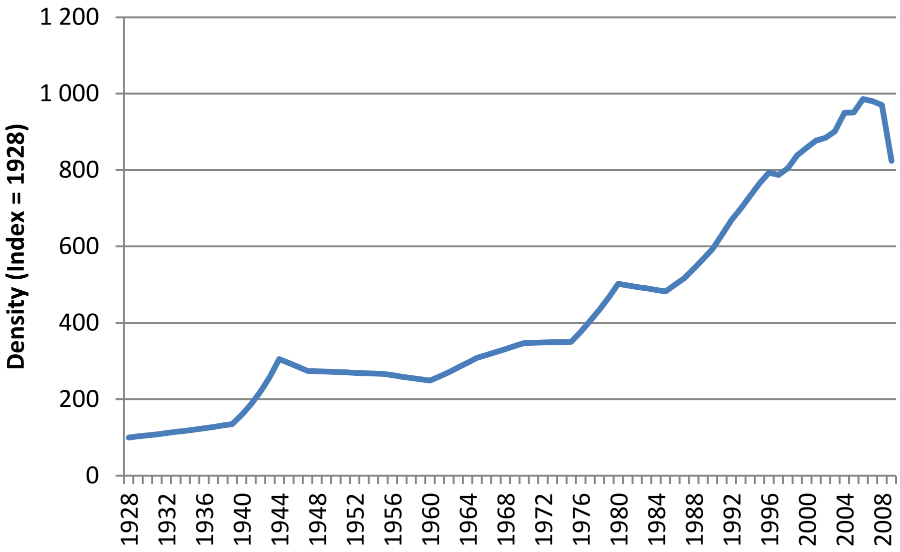

Figure 12: American railroad densification

These efficiencies translate directly into phenomenal productivity improvements (Figure 13).

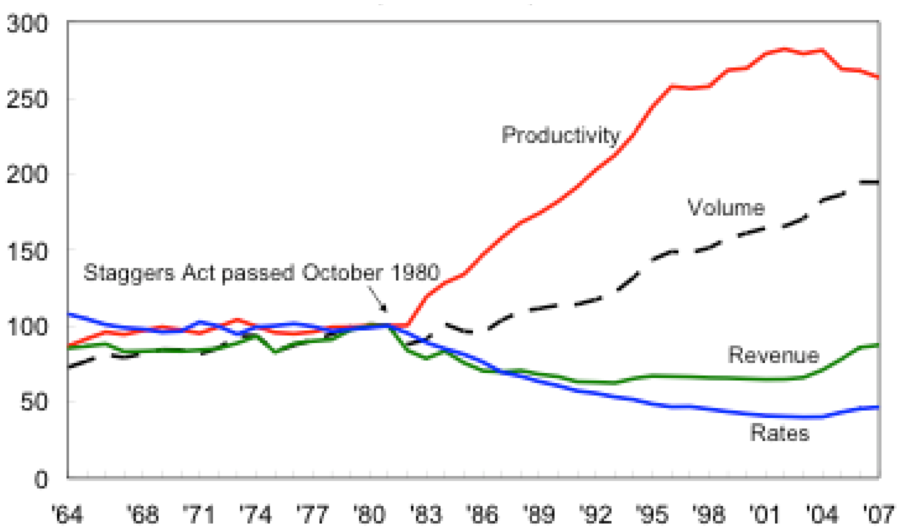

Figure 13: American railroad productivity improvements (Associations of American Railroads, 2011)

South Africa's railway did not have the opportunity to rationalise the GFB network after deregulation in 1990 due to political pressure, couldn't attract sufficient investment to ensure the maintenance of rail-friendly traffic and a vicious circle of underinvestment, lower service levels and loss of freight were experienced (Figure 14)

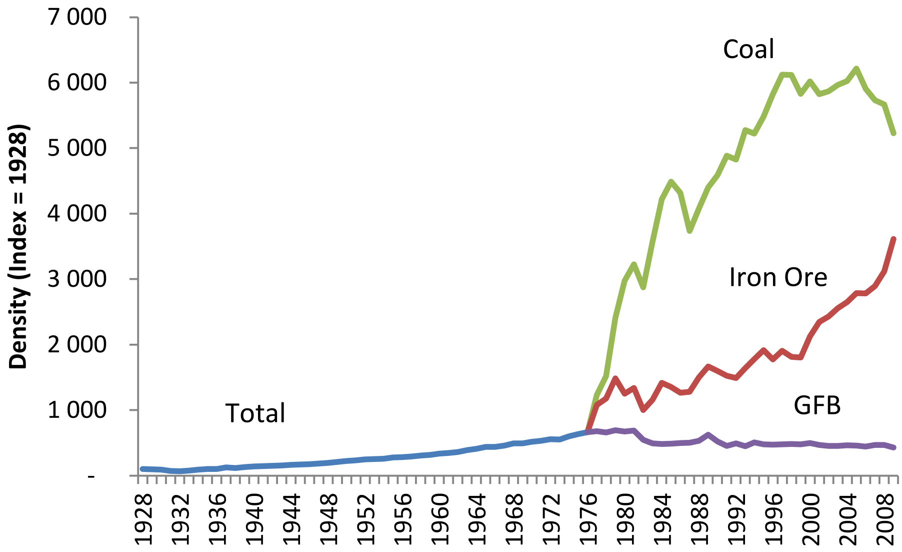

Figure 14: Decline in South Africa's general freight rail density (Key Stats Spoornet. 2008)

Three major events in the rail system's history requires clarification. A heavy haul coal line was developed by the railway in 1976. The line has been benchmarked seperately by Mercer as one of the most efficient rail systems in the world. The initial capacity of 30 million tons per annum (which falls within the heavy haul definition) has been steadily increased to 70 million tons and will probably be increased to 100 million tons in the next decade. At the same time the iron ore line was commisioned by the iron ore mine operator in a completely different location within South Africa. The operations of the 20 million ton line (initially) were transferred to the railway which steadily increased capacity to the current 60 million tons. South Africa's transport system was officially deregulated in 1990. Before 1990 long haul road haulage was not allowed except if a permit could be issued to the road haulier or freight owner. The pressure to obtain permits or devise reasons to get these, steadily increased since its institution in the 1920's, which mean that road haulage steadily grew since then anyway. The effect of these events were profound as it led to a slow (and on a year on year basis nearly invisible) shift of rail focus from the general freight system to the heavy haul operations.

BUSINESS MODEL AS DRIVING FORCE

Trends in size- and productivity indicators for the three biggest global rail systems (North American, RIC and European railway systems) were driven by three distinct business models. After deregulation, North American railroads' rationalisation resulted in private companies with extremely low cost bases, increased efficiencies and high densities, who managed to hold on to rail-friendly traffic in a deregulated environment, thereby attracting private sector investment. This rationalisation strategy or business model, in turn led to significant staff rationalisation. The relationship between deregulation and rationalisation was direct. Successful competition was only seen as possible in an environment where companies were allowed to rationalise route and staff at will. This lowered the cost basis, freed capital for investment in competitive solutions and attracted freight on dense routes, further allowing for lower costs and higher densities.

The RIC railroads were seen as tools for development, and their relative employment is extremely high (51% of the world ton-kilometres on 26% of the world's route kilometres are observed on RIC railways, while 68% of the world's railway workers are employed there, as illustrated in Figure 1), but the railroads remained strong and expansive, with direct government involvement and the railroads very much part of the development state agenda.

In this environment European railways are a bit of an enigma. Transport distances are short, railways by definition less competitive and passengers "consume" a large portion of the output, because of dense living conditions and production facilities. Railroads contribute to lower congestion and are seen as important to alleviate environmental concerns. The relative small size of the many countries in Europe, that are all locked in the same rail system, made open access an absolute necessity in order for the railways to survive, increase its footprint and achieve the societal goals that was set for it. Even so most of the larger countries see their railways as important national assets, keep them vertically integrated, but are forced into open access regimes for the reasons given.

These distinct business models are driven by three conscious paradigms. The North American paradigm is that very low transport cost will also keep the "social cost" of transport low – transport is a derived demand or a utility to solve the place element of the time and place discrepancy in logistics. Like all utilities a lower cost of the utility will lead to greater social benefits. This also means that funds are available for developmental projects, investment and social upliftment. The railways will attract private sector investment and will therefore not require subsidies. In the RIC countries, the relationship is more direct. Distances are so long and the road mode so uncompetitive that higher rail costs that contribute directly to social spending are tolerated. In short, in North America the drive is lower social cost; in RIC higher social employment. Large dense vertically integrated railways can support either low social cost or high social employment. The existence of separate, independent vertically integrated railways operating in parallel, isonly observed in the USA, where the biggest rail company, Burlington Northern's, route kilometre is only surpassed by Russia, India and China (i.e. Burlington Northern in its own right could be described as the fourth biggest railway system in the world).

South Africa does not fit in anywhere in this picture. It is big enough to become like an American Class 1 railway if it remains vertically and systemically integrated and is allowed to be restructured into a rationalised, freight-densified company. This new business will concentrate on long-haul block trains for large industrial customers and mines, and intermodal for 3PL's. It will then move vertically upwards on some of the comparisons with less employees per route kilometre, more ton-kilometres per employee, much higher densities and lower costs. Alternatively it could become a social instrument such as for the RIC countries. Transport costs in the economy will not only stay the same, but increase over time as the railway becomes less effective and efficient and the costs of alternatives rise because of increased fuel and environmental costs. It will also require direct government involvement and investment.

There is a middle road between these two extremes: to create very clear "Chinese walls" between a core- and a development state network. The aim of the core network is to operate as a profitable business with returns that can satisfy both shareholders' and infrastructure capacity requirements, while reducing the country's freight transport bill (in essence, delivering savings to freight owners), and alleviating the risk of fuel imports, fuel price instability and externalities (especially congestion and emissions). The development state network (referring mostly to the current low density branch line network) will require government involvement, but it will facilitate the ideals of rural employment and equitable access to the core transport network, while the cost to the state for subsidies will be minimal, relative to the saving on the transport bill on the core network, job creation potential and future access benefits. Furthermore, portions of the development state network could become viable in future (i.e. requiring fewer subsidies), when the costs of alternative transport increases (due to the rising oil price and environmental charges) amidst anincreasing demand for freight transport.

CONCLUSION

South Africa's rail system compares well on a country by country basis with other nations around the world. There is however no clear direction or comparison as far as a business model is concerned. It did not follow a path of deregulation, rationalisation, investment and efficiency such as in North America, nor a development state path of network growth and high relative employment, such as in the RIC countries. Even though these countries are geographically significantly bigger than South Africa, the challenges are similar: long transport distances, high transport demand and spatial issues. If the railway were to survive on private sector funds the network would have to be rationalised and follow the North American route. Proper equipment and infrastructure investment will be possible and rail-friendly freight can return to rail, increasing density, driving down costs and increasing investment attractiveness. Then the secondary network can become a social construct with subsidies. The alternative can only be a less effective network with direct government funding a necessity. The strategy described above does not exclude investment in the densified core by government. That would however be investment in an expected profitable business where returns can be generated and which can be sold eventually, as was the case with other state-owned enterprises such as Telkom, Sasol and Mittal Steel.

REFERENCES

Associations of American Railroads. 2011. Class 1 Railroad Statistics. [Online]. Available: http://www.aar.org/NewsAndEvents/Press-Releases/2011/08/05-Analysis-Class-I.aspx. [20/09/2011]

Grenzeback, L.R. 2002. Freight trends and freight rail. Presentation: Delaware Valley Goods Movement, Task Force, 10th Anniversary Meeting Philadelphia. Presented by Grenzeback, L.R

Havenga, J.H. and Pienaar, W.P. (2012a). Quantifying freight transport volumes in developing regions: Lessons learnt from South Africa's experience during the 20th century. Economic History of Developing Regions 27(2):87-113.

Havenga, J.H. and Pienaar, W.P. 2012b. The creation and application of a national freight flow model for South Africa. Journal of the South African Institution of Civil Engineering Vol 54 No 1, April 2012, Pages 2–13, Paper 734.

Havenga, J.H., Simpson, Z., Fourie, P. and de Bod, A. 2011. Sustainable freight transport in South Africa: Domestic intermodal solutions. Journal of Transport and Supply Chain Management. November 2011, pp. 149-169.

Key Stats Spoornet, National Statistics, 1910 - 2008

Perkins, P. 2009. Historic data and economic history research in South Africa. Presentation: ERSA, workshop, 1-3 April 2009, Broederstroom.

Piasecka, A. 2007 World Bank Rail Database. [Online]. Available: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/EXTRAILWAYS/0,,contentMDK:22614614~menuPK:7260743~pagePK:210058~piPK:210062~theSitePK:515245~isCURL:Y,00.html. [23/09/2011]

SADC, 2012. About SADC, available at: http://www.sadc.int/about-sadc/ (14 May 2012).

Simpson, Z. and Havenga, J.H. 2011. Logistics costs – lower relative costs, higher risk. In Gearing up for change: the 8th Annual State of Logistics Survey for South Africa. Published by Imperial Logistics, Stellenbosch University and CSIR. www.csir.co.za/sol

World Bank. 2011. Rail lines (total route kilometre). [Online]. Available: http://data.worldbank.org/indicator/IS.RRS.TOTL.KM. [20/09/2011]

WWF. 2006. Living Planet Report. [Online]. Available: http://www.footprintnetwork.org/download.php?id=303. [20/09/2011]