THE COST OF FREIGHT TRANSPORT CAPACITY ENHANCEMENT: A COMPARISON OF ROAD AND RAIL

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ABSTRACT

This paper reviews economic theory and some international experience in a comparison of the costs of expanding South Africa's freight infrastructure capacity in the road and rail modes. It critically examines the view that external economic and environmental benefits of rail are sufficient to outweigh any intrinsic financial disadvantage that it may have compared to road transport. The argument is illustrated by a review of the cost of expanding general cargo freight capacity on the Gauteng-Durban corridor. It is argued that additional capacity could be created far more cheaply in the road mode than in the rail mode. In a brief consideration of external costs, it is argued that these costs would almost certainly favour additional highway investment over attempts to increase general cargo railway capacity.

1. INTRODUCTION

This paper argues that it would be much more efficient in economic terms, and probably in socio-economic and environmental terms too, if the majority of the expected growth in South Africa's general cargo freight were accommodated by expanding the national road network rather than by trying to significantly expand the capacity of the rail network. The essential reason given in this paper to support this view is that the railway mode is technologically inferior to road transport technology for the majority, though not all, of today's transport needs.

Before providing practical evidence for this assertion in terms of the efficiency, environmental performance and infrastructure costs of the rail mode, a brief review of economic theory will provide helpful context for the points being made.

2. ECONOMIC THEORY BACKGROUND

As a branch of economics proper transport economics should seek to apply findings of economic theory to its own sphere.

Three areas of economic theory that are relevant to a consideration of the merits of different transport technologies are:

- The theory of comparative advantage;
- The role of technology in economic growth;
- The theory of economic regulation of industries.

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2.1 The Theory of Comparative Advantage

Professor Paul Samuelson, probably the greatest living teacher of economics, was once asked in an interview if he could identify one single economic idea that he thought should be retained even if all other economic insights were lost forever. He replied, 'the theory of comparative advantage'.

This theory states that the wealth of a nation or society will be maximised if it concentrates its resources on those sectors that it is better at, irrespective of whether the relativities are different to those that may apply in another country. For example, in country A it may be more economic to produce metal tools than say, woollen textiles, whereas in country B it may be more economic to produce woollen goods than metal tools.

What the theory of comparative advantage states is that unless country B concentrates more of its resources on woollen goods and country A on metal tools, they will both be less well-off than they could be. This applies irrespective of whether the *absolute* costs for both are lower in one of the countries. Wealth creation is optimised only if each country takes note of the *comparative* efficiencies of production in its own economy, and prioritises accordingly.

While this may sound simple like rather basic logic, in practice factors other than relative economic efficiencies often influence economic policy makers. A policy maker in country B might, for example, argue that metal tool manufacture creates more jobs in the country.

In response to this, the theory of comparative advantage states that if factors other than comparative economic production cost are allowed to determine investment priorities, then a country will be less well off than it might otherwise be.

2.2 Technology and Economic Growth

Although economic *history* may identify a number of fairly clear factors in explaining occasions of accelerated economic growth in a nation, pure economic *theory* has struggled to clearly explain the phenomenon of economic growth.

One reason for this is that economists' attention tends to be drawn by the political priorities of the day to explain why growth is slow, or how can economic recession be avoided, or how can the benefits of growth be spread more widely. But it is less easy to explain what actually causes new growth in an economy.

One of the more convincing attempts, in the present writer's judgement, at explaining growth was a 1964 paper by Professors Frank Hahn and RCO Matthews entitled: 'The Theory of Economic Growth – A Survey'. Although this was a complex mathematical treatise, a simple insight that it offered was that the variable most strongly associated with economic growth over the long term was 'technology'.

Technology is the quality or sophistication of the 'technical tools' at the disposal of policy makers and economic actors. Hahn and Matthews' conclusion means simply that two economies with similar resource endowments and policies may achieve different levels of economic growth if they have different levels of technology.

An example from history is the acceleration of economic growth in Britain in the late 18th century following the discovery mechanical aids to both manufacturing and agricultural production. A much more recent example, and one where the benefits have spread much more rapidly, is the IT revolution of the past 20 years. Where this technology and its applications have been more embraced, higher and more sustained economic growth has tended to occur.

2.3 Regulatory Economics

A logical development beyond the recognition of the role of technology in economic growth has been what the art of managing technology, or regulatory economics. Its role is to identify the institutional conditions that enable the benefits of a technology to be realised and the undesirable side effects to be mitigated. The telecommunications industry is an example of an industry where the absence of effective regulatory structures can keep product prices much higher than they need to be thus denying the benefits of the technology to large numbers of people. This in turn brings greater inefficiency to all other sectors of an economy.

One of the purposes of regulatory economics is to ensure that all the technologies available in an economy, particularly the infrastructure technologies of transport, telecommunications, water and electricity utilities, are deployed in a manner that allows their benefits to be fully manifested and their weaknesses to be mitigated.

2.4 Application to Transport

The objective of this theory lesson is to provide context for the main thesis of this paper; that railway technology is inferior to road technology for most freight transport needs.

The three economic principles reviewed here have the following implications when applied in the field of transport infrastructure investment:

- Comparative advantage theory teaches: 'Allow an infrastructure technology do what it is best at and, by extension, let it avoid what it is less good at;
- Economic growth theory teaches: 'Identifying and prioritising investment in the most efficient transport technologies available will optimise economic growth;
- Economic regulatory theory teaches: 'Arrange institutions so as to release the strengths and mitigate the weaknesses of each transport technology.

3. MEASURING THE EFFICIENCY OF RAIL TECHNOLOGY

Most transport performance indicators tend to relate cost and operational performance, for example the cost of operating a transport mode and the number of tonne kilometres moved. The ultimate test of a transport mode's technological efficiency is its ability to fully fund all its own costs, including infrastructure costs.

Another more indirect test of intrinsic technological efficiency is whether a technological application can yield tax revenues or whether it requires subsidy.

On these measures railway technology is inefficient as it is characterised by:

- Its almost universal inability to be able to pay for its infrastructure costs;
- The almost total absence of tax revenues from the rail transport industry.

In this it contrasts strongly with the highway transport sector.

3.1 The Inability of Rail to Cover its Infrastructure Costs

Rail transport has very complex infrastructure. Before an effective rail transport service can exist, the following infrastructure systems all need to be in place:

- Permanent way
- Signalling
- Power supply
- Communications
- Rolling stock
- (usually) at least two intermodal handling facilities
- (usually) at least two storage facilities.

Multiple centres of operation and control are also required as goods pass from a producer's transport system to the rail operator and back to the recipient's system.

Most countries now acknowledge that rail transport cannot cover its full infrastructure and operating costs from its own earned revenues. In many, growing awareness of escalating costs and stagnating revenues of rail transport systems has led to attempts to restructure the rail industry to help control costs.

Sweden has separated infrastructure and train operations efficiently and this has led to growth in rail freight. But the state still pays 90% of the infrastructure costs.

The Netherlands does not charge for use of its freight infrastructure but it if the infrastructure had to be paid for, most freight services would go out of business. In Japan, the entire rail infrastructure debt was removed to rail privatisation.

In the UK, an initial objective of rail privatisation was that train companies should pay fully for their use of infrastructure by means of access charges. Freight operators do now pay for the full infrastructure cost but this cost is substantially discounted; the discount being an acknowledgement by government that if a 'freight only' network existed, maintenance costs would be lower than they are now. Although early gains were made in rail's share of the national freight market, these have tailed off considerably. This is partly because of the high infrastructure costs even after the discount to freight operators but also because of the constantly improving logistics of road and cross-Channel ferry transport.

The only rail freight network that covers its infrastructure costs fully is that in the United States. To achieve this it is was necessary to remove virtually all state control from the industry and allow private businesses to determine the extent of the network, the technologies and standards, and also the prices that can be charged.

Most countries are slow in learning the lesson that rail freight's inability to cover its costs is not just a case of operational inefficiency. It is that the poor management and operational efficiency are indicators of an inefficient transport technology.

3.2 The Absence of a Tax Generating Capability in the Rail Sector

Inefficient industries that do not generate profits cannot yield significant tax revenues. The same applies, in principle, to the often indirect taxation that governments tend to levy on the use of transport infrastructures.

The UK government receives £20bn per year in fuel and vehicle taxes from the road sector and spends just £5bn on its roads; a factor of 4:1 *in favour* of the Exchequer! Annual UK government expenditure on rail operating subsidies and infrastructure development and maintenance is about the same as the total for road investment, at some £5bn. The best estimate of tax revenue from the rail sector is of the order of £1bn; probably less. This yields a factor of 5:1 *against* the Exchequer.

In South Africa total government spend in the roads sector is some R15bn per year. Tax receipts from the fuel levy and vehicle taxes are about R26bn; a balance in favour of Treasury of a more modest 2:1. Government spends about R3bn per year on rail; tax revenues from rail are perhaps R0.3bn, largely arising from the coal and ore exporting businesses. This yields a factor of 10:1 against the Treasury.

In the light of the poor performance of rail from the perspective of national treasuries questions need to be raised about why governments continue to plough sop much money into this transport mode. Unless the non-financial benefits really are high then there appears to be little justification for this state of affairs.

4. THE ENVIRONMENTAL PERFORMANCE OF RAIL

Despite the public finance disaster of rail exhibited by the above data policy makers continue investing in their rail sectors. The reason often given is that socio-economic and environmental benefits are at least equal to the public finance gap.

In the UK, assumptions about the scale of these benefits have recently been tested, although not in circumstances designed specifically with this objective in mind.

4.1 Socio-Economic Benefits and the UK's Regional Multimodal Studies

During the 1990s the UK government commissioned a series of regional multimodal transport studies. This was one of the most comprehensive reviews ever undertaken in the transport sector. The purpose of the studies was to establish investment programmes for transport infrastructure and services that recognised the different priorities that may exist among the various regions.

The studies were informed by Labour government policy which sought to redress a perceived imbalance between public and private passenger transportation and between rail and road freight transport. This policy steer was itself a response to environmentalist lobbying based upon the premise that a shift from road to rail would be better for the country in both economic and environmental terms.

The terms of reference of the studies were designed to make full allowance for socio-economic and environmental factors. Socio-economic factors were included in the monetary evaluation wherever possible. There was also strong emphasis on measuring environmental impacts and on effective integration between modes.

Not unexpectedly, the studies brought forward infrastructure investment programmes that included a great deal of rail and other public transport investment with on average two thirds of the value of all proposed investment in these sectors.

In September 2002, the Government's Commission for Integrated Transport, (CfIT), conducted a review of the findings of all the studies completed to date, (Faber Maunsell and NERA for CfIT, 2002). A major concern expressed in the report was that most of the rail investments proposed could not meet government's public sector investment criteria. In other words, even with socio-economic benefits allowed for, most of the rail investments did not yield good value for public money.

4.2 Moneterising the Environmental Advantages of Rail

Environmental advantage is often rail transport's final argument in favour of otherwise uneconomic projects. In the absence of a satisfactory approach to the monetarisation of environmental parameters it has been difficult to gainsay this view. Tonne km for tonne km, rail freight does indeed add less to local pollution and global climate-related impacts. This is especially so for electric traction.

But in order to justify investments that fail to meet normal value for money criteria it is vital that to know whether or not the evident environmental superiority of the rail mode is sufficient to overcome the inferiority it exhibits for all but high bulk, long distance haulage. This writer is not aware that any comprehensive attempt has ever been made to quantify, and also monetarise, the full range of environmental impacts of the respective transport modes.

The UK's Strategic Rail Authority (SRA) has gone some way in this direction in its recently published research on 'Sensitive Lorry Miles', (Strategic Rail Authority, May 2003). The context was the need to refine a system of grants available to industry to encourage investment in rail transport infrastructure. This was the 'Freight Facilities Grant' and the 'Track Access Grant'. In order to qualify for such grants businesses had to quantify the number of lorry miles that would be diverted onto rail from different categories of road as a result of the proposed investment.

The value of the investment subsidy from the SRA was calculated by ascribing a monetary value to each lorry mile saved. The value was initially derived solely from vehicle operating cost changes and measures of congestion reduction. These were treated as a proxy for the value of the environmental damage savings.

After some years of operation, the SRA conceded the need to provide a higher degree of integrity to the valuation of the saved lorry miles, especially in respect of the implied evaluation of environmental externalities. A study was therefore commissioned to try to disaggregate the environmental component in the road transport cost savings from aspects such as infrastructure and operating costs.

Several criteria including local and global environment-related impacts were evaluated. The methods used included some direct measurement of the costs associated with impacts, such as medical costs of treating pollution related health damage, and also stated preference surveys to establish a range of values that people would be willing to pay to prevent global environmental damage.

Table 1 gives the results which offer interesting insights into the relative significance of environmental factors in transport costing generally.

The most significant detail in the table is the relatively small proportion of total externality costs that is accounted for by the local and global environmental impacts. Whether it is the road environmental costs of 15.5 pence per mile (sum of first four items in Weighted Average column – see highlighting), or the rail environmental cost of 8.8 pence per mile, (bottom – highlighted - cell in Weighted Average column), these values are small in comparison to road congestion relief which is the chief external benefit of new highway construction.

Table 1. SRA proposal for values of external benefits of rail and road freight - pence per lorry mile (from SRA, may 2003).

	Motorways – by congestion level			**London and Conurbations**		**Rural and Urban**		**Weighted Average**
	High	Medium	Low	Trunk and principle	Other	Trunk and principle	Other	
Accidents	1.5	1.5	1.5	3.8	3.1	3.8	3.1	2.9
Noise	4.0	4.0	4.0	11.0	9.0	2.0	4.0	3.8
Pollution [local]	5.7	5.7	5.7	18.8	22.8	3.9	4.8	6.3
Climate change	2.7	2.7	2.7	2.6	2.5	2.4	2.0	2.5
Infrastructure costs	5.7	5.7	5.7	9.1	28.7	11.2	35.3	12.5
Road [congestion?] costs	79.0	37.0	6.3	121.9	135.5	45.8	10.6	43.9
Unquantified	8.0	8.0	16.0	8.0	9.0	21.5	22.0	16.9
Taxation	-29.0	-29.0	-29.0	-29.0	-28.0	-29.0	-28.0	-28.9
Rail costs	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8
TOTAL	**68.8**	**26.8**	**4.1**	**137.5**	**173.8**	**52.8**	**45.0**	**51.1**

Note that the rail cost value is negative in the table because if an applicant's case for a grant were to involve moving some freight from rail to road, the value of grant for which the applicant could qualify would be reduced in accordance with these values. This could happen if, as part of a package of logistics changes, an applicant needed to move freight off one rail route in order to consolidate a larger volume of business onto a another rail route

Even with the addition of the 'Unquantified' element, which brings in driver stress and visual impacts, neither road nor rail environmental costs exceed congestion costs. Rather, the congestion costs invariably exceed all elements of environmental costs, except in the cases of low congestion motorways and rural roads.

This evidence, though produced for a very specific purpose, goes a considerable way towards establishing the proposition that, in the UK at least, the rail mode's superior environmental performance will rarely be a sufficient factor to compensate for otherwise poor socio-economic cost benefit performance in infrastructure investment appraisals.

In South Africa the balance is not likely to be different because, although congestion is not generally as serious as in the UK, environmental impacts tend to be a function of the intensity of road congestion. Lower congestion will therefore generally imply lower values for both immediate and global environmental indicators. Environmental considerations are therefore no more likely than in the UK to be a determinative factor in favour of otherwise uneconomic rail investments.

5. THE COST OF RAIL INVESTMENT

Finally, and in order to illustrate the force of the above conclusions, an example is offered based on one of South Africa's most important transport infrastructure investment decisions that has to be made in the very near future, namely how to expand freight carrying capacity on the Gauteng-Durban harbour corridor.

The following sections consider what the costs might be for the existing rail route and the N3 highway route to double their respective freight carrying capacities. At present the rail link between Durban and Gauteng carries just less than 9 million tonnes of freight. Road carries about 53 million tonnes giving a modal share on the whole corridor of 16% for rail and 84% for road. Perhaps two thirds of the road share, or 36 million tonnes, is on the N3.

5.1 Rail Corridor

It is known that there is spare capacity on the railway line itself. With appropriate investment the signalling and permanent way capacity should be able to accommodate at least double the volume that is currently being handled. The chief constraint to any significant enhancement of current capacity lies in the inefficiency of the depots at either end. It is the time taken here where rail loses most to competition from the roads sector.

Spoornet is planning a multi billion rand recapitalisation of its infrastructure and rolling stock assets. The amounts quoted by Transnet vary between R10bn and R40bn. For present purposes it is assumed that up to R15bn of this is to be spent on upgrading the Gauteng-Durban rail freight corridor. Although some on-route infrastructure upgrading would be included, most of the investment would be in rolling stock renovations and new purchases, handling equipment at City Deep and Durban Port, together with extensive management and logistics improvements.

It is reasonable to suppose that R15bn spent over perhaps 10 years, could indeed result in a doubling of capacity on the rail route. This would increase rail capacity by around 9 million tonnes thus providing an extra 15% of total corridor capacity compared to the current total of 62 million tonnes, (53 million road + 9 million rail).

5.2 Road Corridor

What might the same spend purchase in the road transport mode? At an all-in cost for civil works, structures, junctions etc. of R25mn per km, the same R15bn spend could purchase a new 600 km freight-only dual-2 highway paralleling the N3.

The existing freight load of 36 million tonnes on the N3 is carried in the midst of a mix of all traffics including private cars, minibus taxis and buses. A dedicated freight facility of similar overall standard could well handle up to 72 million tonnes per year, an addition of almost 60% to total corridor capacity; (36/62 = 58.1%).

5.3 Comparison of Road and Rail Infrastructure Enhancement Cost

For the same spend of R 15bn, the dedicated freight highway option could create up to four times more new freight transport capacity than if the same amount of money were spent in the rail mode.

Moreover, the immediately apparent externalities enhance the cost comparison in favour of the freight highway option:

- Relieving the existing N3 highway of heavy goods vehicles would also create huge new capacity for passenger and smaller goods vehicle travel, as well as the safety benefits arising from the greatly reduced levels of freight traffic.

- Relieving the rail line of most of the general cargo traffic would also free up capacity for other, more rail friendly traffics that Transnet might not have to cross-subsidise in the way that they do their present general cargo business.

Although this paper has clearly not covered all the logistics, socio-economic and environmental calculations that need to be done for a full comparison of road and rail infrastructure capacity enhancement it is very doubtful that the 4:1 initial investment cost advantage of a freight highway solution could be overturned.

6. CONCLUSION

This paper was introduced with the assertion ‘that it will be far more efficient in economic terms, and probably socio-economic and environmental terms too, for South Africa to accommodate the majority of the future growth in its freight transport requirements by expanding the national road network rather than by trying to significantly expand the capacity of the rail network’. It was further asserted that ‘the underlying reason for this proposition is that railway technology is fundamentally inferior to road transport technology for the majority, though not all, of today’s transport needs’.

It has been argued from economic theory that:

- Each transport mode should be used for the types of business it is better at and that business for which another mode has the advantage should be foregone. Prioritising investment in accordance with the relative efficiency of transport modes will enhance economic growth; to do otherwise will retard growth. The transport industry will contribute most effectively to national economic competitiveness if there is the transport regulatory regime seeks to enhance the strengths and mitigate the weaknesses of available modes of transport.

It has been shown that rail is an inefficient transport technology when tested against the criteria of ability to pay for its own infrastructure and also the ability to generate a tax revenue based on normal commercial profitability.

It has also been argued that for general cargo freight at least this basic inefficiency is unlikely to be fully compensated for by either socio-economic benefits or rail’s acknowledged superior performance in terms of environmental externalities.

Finally, a sketch of the comparative costs of adding to freight transport capacity on the Gauteng-Durban corridor showed that new freight transport capacity could be created up to four times more efficiently in the road mode as in the rail mode. The implications of these conclusions for national infrastructure investment priorities are:

6.1 Recommended Rail Transport Policy

- Identify market sectors in which rail does have an economic advantage.
- Invest in these sectors only and disinvest from sectors with no such advantage.
- Create a regulatory environment that incentivises this prioritisation.

6.2 Recommended Road Transport Policy

- Acknowledge road freight’s intrinsic technological advantages more candidly.
- Allow infrastructure investment priorities to be fully shaped by this knowledge.
- Create a regulatory framework that supports the technological efficiencies of road transport, but strongly mitigates its negative environmental externalities.

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