THE REGULATION OF COMMERCIAL PETROLEUM PIPELINE OPERATIONS: A SOUTH AFRICAN EXAMPLE

*W J Pienaar**

Abstract

This paper provides an overview of a study of economic regulatory aspects of commercial petroleum pipeline operations. It addresses (1) the market structure, ownership patterns, and relative efficiency of petroleum pipeline transport; (2) pipeline operating costs; (3) proposed pricing principles. The research approach and methodology combine (1) a literature survey; (2) analysis of the cost structures of large commercial petroleum pipeline operators; and (3) interviews conducted with specialists in the petroleum refining and pipeline industries. The potential value of the research lies mainly in the developed guidelines for the economic regulation of market entry and pricing of the carriage of petroleum commodities by pipeline.

Keywords: regulation, market entry, petroleum, pipeline

**Stellenbosch University, Department of Logistics, Private Bag X1, Matieland 7602, South Africa*
Tel: 27 21 808 2251, Fax: 27 21 808 3406
e-mail: wpienaar@sun.ac.za

1. INTRODUCTION

The commercial transportation of crude oil and petroleum products by pipeline and envisaged new investment in this mode of transport are receiving increased attention in South Africa. With a mounting supply crisis resulting from the capacity constraints experienced by Transnet Freight Rail (the South African national rail freight carrier) and by the existing petroleum pipelines and local refineries, petroleum marketers are finding themselves increasingly compelled to transport petroleum products across the country by road.

Transnet Pipelines recently obtained permission from the National Energy Regulator of South Africa (NERSA) to construct and operate a new 60 cm diameter petroleum products pipeline 704 km in length from Durban to Gauteng (Transnet Pipelines 2008). In addition, the newly formed Petroline consortium recently obtained permission to construct and operate a 30 cm petroleum products pipeline 199 km in length from Maputo in Mozambique to Nelspruit in South Africa, with a 249 km extension later to Kendal, where it can link with the present Transnet pipeline network (Petroline 2008). Another prospective market participant is PetroSA, which recently announced its intention to construct a petroleum refinery at Coega in the Eastern Cape, and to connect it with a pipeline to the interior market in South Africa (PetroSA 2008).

The paper is an overview of an inquiry into an investigation of economic aspects of commercial petroleum pipeline operation. The following aspects of pipeline transport are analysed, discussed and concluded upon: (1) market structure and ownership patterns; and (2) principles of efficient pricing.

The potential value of the research lies mainly in the economic regulatory framework and guidelines for market entry and the pricing of the carriage of petroleum commodities by pipeline. The research approach combines a literature survey, an analysis of the cost structure of large commercial petroleum pipeline operators, and interviews conducted with specialists in the petroleum refining and pipeline transport industries. The author had access to confidential cost details and forecasts of the operations of existing and envisaged petroleum pipelines in South Africa. In this paper the results of these cost analyses are portrayed graphically and described qualitatively.

2. MARKET STRUCTURE AND OWNERSHIP PATTERNS

Pipeline transport is usually provided by private users for their own (ancillary) purposes, or by a common carrier acting on behalf of all the shippers linked to the pipeline. Examples of the former are crude oil, refined petroleum products and natural gas pipelines owned and operated by petroleum and gas companies (such as the 110 km Chevron pipeline that carries crude oil from the PetroSA storage facility at Saldanha Bay to the Chevron refinery in Cape Town). Examples of the latter are pipeline operators that are constituted as public enterprises, which provide common carriage to the petroleum industry – such as Transnet Pipelines in South Africa (Transnet Pipelines 2008), and third-party operators that are constituted as private enterprises (such as a private company or partnership),

which provide common carriage to shippers – as will be the case with the envisaged Petroline pipeline from Maputo via Nelspruit to Kendal (Petroline 2008).

In terms of the number of market participants pipeline transport is the most highly concentrated of all transport modes. The absolute number of participating businesses is low, but the significant measure of concentration is the number of participants in a specific transport market segment or transport corridor. With a few exceptions, there is normally just one crude oil, one products and one natural gas pipeline connecting producing areas or refineries and areas of consumption. This high degree of monopoly results from declining unit costs with increases in indivisible capacity, so that the lowest costs are achieved by a concentration of output in a single pipeline. A high degree of concentration is efficient, and changes towards a more competitive market structure through economic regulation would entail high losses in efficiency. Therefore, pipeline operations that can fulfil entire market demand are pure natural monopolies (Meyer *et al*. 1960).

In cases such as geographically separated oilfields or ports of entry, where the distance between supply points is great in relation to the delivery distance to the market area, such an area's fuel demand can often be most efficiently fulfilled by two or more different pipeline operations. For example, from 2012 the province of Mpumalanga in South Africa will receive petroleum products via the Transnet products pipeline from refineries close to the Port of Durban and the Petroline products pipeline from the Port of Maputo in Mozambique. In the latter case, a pipeline transport oligopoly (in this case, more specifically a duopoly) will exist.

Because of the high capital costs associated with a pipeline, the financial barrier to entering the market is high. Owing to the inflexible capacity limits of a pipeline once installed and the maximum flow rate at which pumping can take place, a new method of moving the product (such as by road or rail) needs to be found when the flow rate reaches pipeline capacity and if replacement with a pipe of larger diameter or a second pipe is not feasible.

In view of these considerations financial stakeholders in pipeline operations tend to consolidate and start with a large initial investment, which tends to yield higher returns, partly because of economies of scale and partly because of inherent performance characteristics. For example, a 30 cm pipe operating at capacity transports three times the quantity carried by a 20 cm pipe (Papacostas and Prevedouros 2001).

The gains from scale are substantial. Cookenboo (1953), for example, showed that the lowest cost for a throughput of 100,000 barrels of crude oil per day in a 45 cm pipeline would be approximately double the cost per barrel when compared to carrying 400,000 barrels per day in an 80 cm pipeline over the same distance.

The implications for the industry are important. It would be extremely wasteful, for example, for four competing refineries in a consuming area, which each use crude oil from the same area of origin to build four pipelines (Lansing 1966). If, for example, each requires 100,000 barrels per day, then building four parallel 45 cm pipelines instead of a single 80 cm pipeline would double the transport cost per barrel. In such circumstances, efficiency dictates common use of the same pipeline. It also follows that costs for carrying petroleum commodities on a route that has a large pipeline will be much lower than on other routes not thus provided. There are external economies to be gained by locating large refining capacity in the same area.

The South African inland fuel market is at present served by a state-owned pipeline operator, Transnet (trading as Transnet Pipelines), which has a de facto monopoly in commercial petroleum pipeline transport. One of the means to limit abuse of market power and potentially restrictive practices is by the existence of competition. The promotion of competition into the South African pipeline market is one of the objectives of the Petroleum Pipelines Act, 2003 (Act No. 60 of 2003). Implementation of the Petroline pipeline will introduce pipeline competition into the inland fuel market (South Africa 2004).

In considering Petroline's application to construct a petroleum products pipeline from Komatipoort (on the Mozambican border with South Africa) to Kendal via Nelspruit there were not many precedents upon which the Energy Regulator (NERSA) could act. According to NERSA (2007): 'It is a very rare phenomenon in the world and a particularly challenging one, in this instance, to introduce pipeline competition led by private-sector investment into a market dominated by a state-owned monopoly.'

The White Paper on Energy Policy (South Africa 1998) sets out government policy in the following terms:

'The cornerstones of future Government policy –

- Deregulation
- The stable and continued availability of quality product throughout the country at internationally competitive and fair prices
- Adequate provision for national strategic considerations relating to security of supply
- A low-cost pipeline and storage infrastructure suitably regulated to encourage optimum investment, to prevent the abuse of these natural monopolies and to prevent the exclusion of new entrants.'

Regarding the decision to grant Petroline a licence to construct a petroleum products pipeline, each of these policy goals is next considered in turn.

Deregulation

It is not known when the government will deregulate fuel prices, or to what extent. However, the existence of pipeline competition as a result of awarding

Petroline an operating licence will serve the government's policy goal of deregulation. The introduction of another artery of supply into the inland fuel market has the following advantages (NERSA 2007):

- It represents a diversification of supply points away from the present place of entry (Durban).
- It is remote from the Transnet pipeline. Therefore, if any natural or social *force majeure* event occurs it is less likely to affect both pipelines simultaneously.
- The pipelines would be operated by different companies, reducing the detrimental effect of any corporate financial collapse.
- The Petroline pipeline will be able to operate bi-directionally, thus providing an export outlet for inland refineries should they find that the inland market becomes overtraded in future.

The stable and continued availability of quality product throughout the country at internationally competitive and fair prices

The Petroline pipeline promises to improve the availability of fuel in the parts of the country that it will serve, as it will provide an additional means of transport to the road and rail infrastructure, thereby reducing the risks associated with supply interruptions and significantly increasing the 'stable and continued availability of product'.

Adequate provision for national strategic considerations relating to security of supply

This policy goal is also expressed in the objectives of the Petroleum Pipelines Act, 2003 (Act No. 60 of 2003). An objective of the Act is to ensure an 'appropriate supply of petroleum to meet market requirements' (South Africa 2004). No published government policy on security of supply currently exists.

A low-cost pipeline and storage infrastructure suitably regulated to encourage optimum investment, to prevent the abuse of these natural monopolies and to prevent the exclusion of new entrants NERSA has a role in protecting new petroleum pipeline entrants and preventing market abuse. By granting a licence to Petroline, effective entry is established into the pipeline part of the liquid fuels supply chain, facilitating the private-sector investment that is funding this pipeline and providing a signal to other potential entrants that entry into this industry is indeed a possibility (NERSA 2007).

NERSA had to consider the fact that the opposition to the Petroline application emanated from the government itself, the owner of Petroline's commercial competitor. Furthermore, in weighing up the various provisions of the Petroleum Pipelines Act, 2003 (South Africa 2004), NERSA had to consider the impact of a signal to the market that could be interpreted as suggesting that the state might be 'crowding out' private-sector investment. There is no provision of that Act that requires NERSA to favour state-owned enterprises over private-sector enterprises. It is quite conceivable that, when setting tariffs in future, NERSA will endeavour to ensure that unreasonable expenditure is avoided and not rewarded and to be even-handed towards both privately owned and government-owned competitors (NERSA 2007).

3. EFFICIENT PRICING OF PIPELINE SERVICES

Pipeline pricing guidelines

Efficient transport service pricing for a pipeline operator with common carrier obligations requires that the price be set equal to marginal cost. Unlike most other transport services, pipeline transport supply is relatively homogeneous and there is not a particularly severe peak demand problem (Bonsor 1984). In Figure 1, the demand for pipeline transport service is portrayed by *D*, the average variable cost curve by *AVC*, and the short-run marginal cost by *SRMC*. Efficient resource allocation occurs at price $P_{A,}$ where the demand curve intersects the *SRMC* curve.

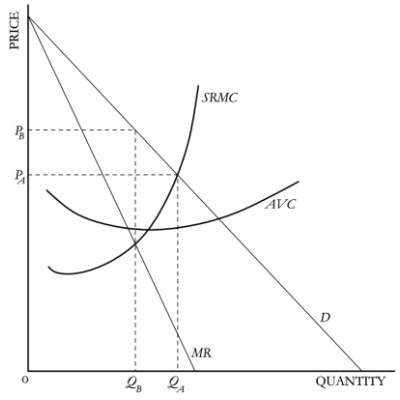

Figure 1. Pricing of pipeline services in the short run

Source: Bonsor 1984

It is unlikely, however, that an unregulated monopoly pipeline transport supplier would produce at, or near, this short-run optimum. Overland pipelines enjoy a large cost advantage over other transport modes, with road transport the most costly, and rail transport the second most costly of the three modes of land transport. Without regulatory restraint, the monopoly supplier would maximise profits at throughput level Q_B and price P_B. From the viewpoint of society, this output is inefficient, since the price exceeds marginal costs. Therefore, the prevalence of monopoly power leads to a divergence between the private and social optima. Through the years, there has never been any incentive for Transnet Pipelines, or its predecessor, Petronet, which to date has been a de facto monopoly, to have acted otherwise.

Whereas a perfectly competitive market in equilibrium ensures the complete absence of market power, the ability of a monopoly pipeline operator to set a specific price level anywhere between the price of the second cheapest mode of transport (rail transport) as ceiling, and its own marginal cost as floor, is absolute. Transnet is the owner of both Transnet Freight Rail and Transnet Pipelines. These entities are de facto monopolies within their respective technological modes of operation. It would, therefore, be possible for Transnet to set its petroleum product rail freight rates just below the cost of private sector road freight operations, or to withhold its rail tank wagon fleet from operating in parallel with its pipelines. In the absence of the economic regulation of petroleum pipeline operations, this would have left room for Transnet to set pipeline rates higher than would have been in the public's interest, as it is unfeasible to serve the inland petroleum market without the present (or similar) pipelines.

Since 2004 petroleum pipeline operations in South Africa have been subject to economic regulation by the central government (South Africa 2004). The essence of economic regulation is the replacement of competition with governmental orders as the principal institutional device for assuring good performance (Kahn 1988). The fact that the cost of pipelines will be lower if they consist of a single supplier creates the efficiency case for monopolistic organisation and, along with the importance of the service and the relative price inelasticity of demand for the fuel, the need for regulation to protect the consuming public. Transnet Pipelines provides service to the entire wholesale petroleum industry. This industry in turn has the entire retail fuel industry as its customers.

The efficient pricing of pipeline services in the long run is more complex than the short-run situation. In Figure 2 the demand curve intersects the long-run average and long-run marginal cost curves (i.e. *LRAC* and *LRMC* respectively) in the region where substantial spare capacity exists. Without regulation, a profit-maximising monopolist would opt to carry output Q_B and charge a price of P_B. In this situation the socially efficient level of output occurs where the demand curve intersects *LRMC*, corresponding to an output of Q_A. In this situation the efficient price P_A will not result in all production costs being recovered. In this case, the appropriate remedy is to apply a two-part tariff strategy, where the unit price is set at *LRMC*, and the resulting deficit is met by charging users a fixed charge (Kahn 1988).

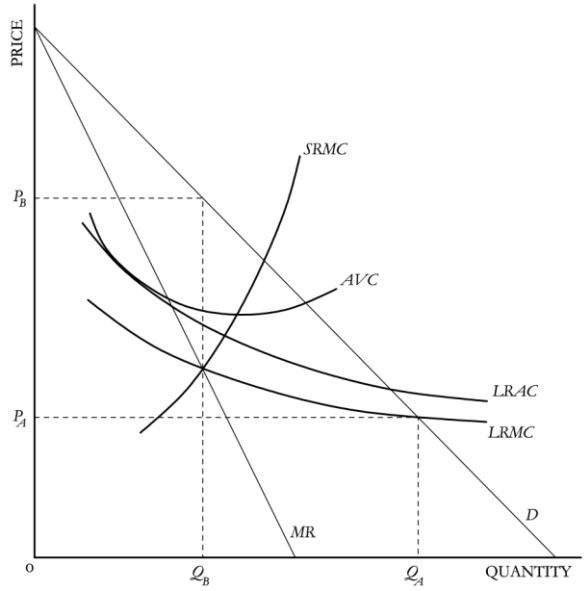

Figure 2. Pricing of pipeline services in the long run

Sources: Based on Bonsor 1984; Pienaar 1998

Commercial petroleum pipeline operators supply a common service to wholesale petroleum product suppliers. The aim of a commercial enterprise is to recover full costs plus a return on investment. Because the clients of commercial pipelines are direct competitors in the wholesale fuel market, they should bear full cost responsibility for the service rendered by the pipeline. Service below total cost to a client implies that it is subsidised by its competitors. The only instances in which delivery can take place below total cost are in the following circumstances (Pienaar 1998):

- The necessary spare capacity exists to accommodate the consignment, i.e. the opportunity for another consignment to be delivered at full cost is not jeopardised. (This situation could possibly arise when Transnet's proposed new 60 cm pipeline is in operation, with a comparable cost situation to the one illustrated in Figure 2.)
- All the avoidable (i.e. short-run) cost is covered and some contribution to unavoidable (i.e. fixed or long-run) cost is made.
- The consignment delivery would not have taken place at a price covering full costs.

Although natural-monopoly pipeline transport operators are not common carriers with social obligations, they should nevertheless strive to operate in a way that is beneficial to the public interest. Their price must always be sufficiently lower than the second cheapest existing mode of transport and low enough to prevent new pipeline competitors entering and sharing in the market.

4. CONCLUSIONS

The high degree of monopoly power op pipeline operations results from declining unit costs with increases in capacity, so that the lowest costs are achieved by a concentration of output in a single pipeline. Therefore, pipeline operations that can fulfil entire market demand are pure natural monopolies. Where the distance between supply points (such as geographically separated oilfields or ports of entry) is high in relation to the delivery distance to the market area, such an area's fuel demand can often be most efficiently fulfilled by two or more different pipeline operations (i.e. one pipeline from each port of entry).

The South African inland fuel market is at present served by a state-owned pipeline operator, Transnet Pipelines, which has a de facto monopoly in commercial crude oil and petroleum products pipeline transport. The introduction of pipeline competition as a result of awarding Petroline an operating licence will promote deregulation. This introduction has the following advantages:

- It represents a diversification of supply points away from the present place of entry.
- It is remote from the Transnet pipeline. Therefore, if any natural or social *force majeure* event occurs, it is less likely to affect both pipelines simultaneously.
- The pipelines would be operated by different companies, reducing the detrimental effect of any corporate financial collapse.
- The Petroline pipeline will be able to operate bi-directionally and thus provide an export outlet for inland refineries should they find the inland market overtraded in future.

When setting tariffs in the future, the Energy Regulator should endeavour to ensure that unreasonable expenditure is avoided and not rewarded, and to be even-handed towards privately owned and government-owned competitors.

The clients of a common carrier are direct competitors in the wholesale fuel market, therefore they should bear full cost responsibility for the service rendered by the pipeline. Service below total cost to a client implies that it is subsidised by its competitors. The only instances when delivery can take place below total cost is when:

- the necessary spare capacity exists to accommodate the consignment;
- all the avoidable cost is covered and some contribution to unavoidable cost is made; and
- the consignment delivery would not have taken place at a price covering full costs.

References

1. BONSOR, NC (1984). *Transportation Economics: Theory and Canadian Policy*. Toronto: Butterworths.
2. COOKENBOO, L (1953). 'Economies of scale in the operation of crude oil pipelines'. PhD dissertation. Cambridge, Massachusetts: Massachusetts Institute of Technology.
3. KAHN, AE. (1988). *The Economics of Regulation: Principles and Institutions*. Cambridge, Massachusetts: The MIT Press.
4. LANSING, JB (1966). *Transportation and Economic Policy*. New York: The Free Press.
5. MEYER, JR, MJ PECK, J STENASON AND C ZWICK (1960). *The Economics of Competition in the Transportation Industries*. Cambridge, Massachusetts: Harvard University Press.
6. NATIONAL ENERGY REGULATOR OF SOUTH AFRICA (NERSA) (2007). 'Licence to Construct a Petroleum Pipeline System Including Storage Facilities by Petroline RSA (Proprietary) Limited (Petroline) Regarding the Construction of a Petroleum Pipeline from the Border with Mozambique near Komatipoort to Kendal via Nelspruit and The Construction of a Petroleum Storage Facility in Nelspruit, Mpumalanga'. 29 March. Available: http://www.dme.gov.za (accessed on 2 June 2008).
7. PAPACOSTAS, CS AND PD PREVEDOUROS (2001). *Transportation Engineering and Planning*. Third edition. Englewood Cliffs, New Jersey: Prentice Hall.
8. PETROLINE (2008). 'Environmental impact assessment for Petroline RSA (Pty) Ltd for a proposed liquid fuels pipeline from Komatipoort to Kendal and a liquid fuel storage facility near Nelspruit'. Available: http://www.petroline.co.za (accessed on 14 October 2008).
9. PETROSA (2008). 'PetroSA increases the capacity of its planned Coega crude refinery'. Available: http://www.petrosa.co.za (accessed on 27 October2008).
10. PIENAAR, WJ (1998). 'Report to Petronet on the development of a defensible pricing mechanism'. Contract report produced for Petronet. Stellenbosch: Department of Logistics, Stellenbosch University.
11. SOUTH AFRICA (1998). 'White Paper on Energy Policy'. Department of Minerals and Energy. Available: http://www.dme.gov.za/pdfs/energy/planning/wp_energy_policy_1998.pdf (accessed on 2 June 2008).
12. SOUTH AFRICA (2004). Petroleum Pipelines Act, Act 60 of 2003. *Government Gazette* 26434, 7 June.
13. TRANSNET PIPELINES (2008). Available: http://www.transnet.co.za/Pipelines.aspx (accessed on 14 October 2008).