Capacity pricing schemes to implement open-access rail in Tanzania

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We analyze alternative capacity pricing schemes (access charges) to implement an open-access railway system in Tanzania. We show that the implementation of variable access charges widely used in the railway industry may result in levels of traffic lower than the traffic operated by an integrated railway company. We propose the use of fixed access charges to avoid this problem and discuss the main advantages and disadvantages to implement them in the context of multiple freight train services in Tanzania.

1. Rail transportation in Tanzania

In 2013, Tanzania's government committed to the implementation of one of the first open-access railway systems in the world (Big Results Now, 2013) as a way to ensure adequate level of rail service by 1) allowing efficient train operators (TO) to access the infrastructure and operate train services, and 2) providing sustainable resources through access charges to maintain the infrastructure and keep the system operative in the future. These objectives are critical to prevent future railway systems failures such as the 2001 and 2006 Tanzanian railway system concessions failures (Olievschi, 2013) that resulted in a major underinvestment in rail transportation in the country (Railistics, 2013). This underinvestment critically impacted the operating capacity and the reliability of the railway system, essential to improving accessibility to the East African landlocked countries: Rwanda, Burundi, Uganda, and Western Democratic Republic of Congo (AICD, 2008; Amjadi and Yeats, 1995; Arvis et al., 2010; Raballand and Macchi, 2009).

However, open-access rail also requires new railway regulations that clarify the roles and responsibilities of railway institutions and define a capacity pricing scheme (Railistics, 2013; World Bank, 2014). This research analyzes how alternative open-access capacity pricing schemes for freight TOs would affect the system level of service and the revenues collected to maintain the infrastructure and recover capital costs in the context of the Central Corridor in Tanzania. Tanzania's railway system provides a useful case to illustrate multiple important concepts to be considered when implementing a pricing scheme in more complex railway systems.

The rest of the article is structured as follows: Section 2 presents the main types of capacity pricing schemes and discusses the financial model used to determine the behavior of TOs under each scheme. Section 3 presents the resulting level of service that container and general cargo freight TOs would operate under alternative capacity pricing schemes. Section 4 concludes with some recommendations for open-access capacity pricing schemes.

2. Capacity pricing schemes for open-access railway system

The implementation of an open-access railway system requires some level of vertical separation between the TOs that operate the trains in the system and collect the revenues selling transportation services to the final customers and the infrastructure manager (IM) that maintains and manages the infrastructure. Vertical separation requires the definition of a capacity pricing scheme that determines the access charges that TOs pay to the IM to access and use the infrastructure (Gomez-Ibanez, 2003). The IM uses these revenues to cover infrastructure costs. The use of the state national budget to cover shortfalls is the last resort.

The railway literature proposes three cost-based capacity pricing schemes designed to allow the IM to recover maximum infrastructure costs: variable access charges, two-part tariffs (variable access charges plus a fixed access charge), and fixed access charges (Gibson, 2003). Under variable access charges, TOs pay some amount per train operated; the charge is in general a function of the type of train, distance, and tonnage. Under fixed access charges, each TO pays an annual lump sum to have a license to operate, regardless of the number of trains the TO operates during the year.

The practice and the broad economic literature in the field recommend the use of variable access charges based on marginal cost plus mark-ups (DB, 2009; UIC, 2012; World Bank, 2014). However, from an engineering standpoint, infrastructure related costs in Tanzania are mostly independent of the level of service. In other words, the short-term and long-term infrastructure marginal cost are very low and high mark-ups are required to recover infrastructure costs. This research analyzes the implications of

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resulting alternative pricing schemes for the system.

For this analysis, we compare the behavior of independent TOs with the behavior of an integrated railway company (social planner). We assume that both the independent TOs and the integrated railway company are rational agents, i.e. they determine the level of service (number of services per direction per week) by maximizing the annual operating margin (operating profits). An independent TO would only be interested in operating trains if the average annual net cash flow is positive after remunerating any invested capital at an adequate rate of return (no operation subsidies).

We use a financial model developed following (PPIAF et al., 2011) to determine the integrated railway company, independent TO, and IM's operating margin and cash flow for a representative year under different levels of service (see World Bank, 2014 for detailed assumptions). The integrated railway company faces capital costs associated with the investments in railway infrastructure, variable costs of operating trains (train lease, personnel, fuel), and obtains revenues from transporting freight. The vertically separated case is similar: the TO faces cost of accessing the tracks (access charges), variable costs of operating trains, and obtains revenues from transporting freight. The IM faces investment costs in railway infrastructure, maintenance costs, and obtains revenues from access charges.

Investment in railway infrastructure includes $300 million investment required to rehabilitate the current Tanzanian railway system (CPCS, 2013; World Bank, 2014) plus periodic investment in maintenance. The revenues of the TOs are determined multiplying the cargo transported (minimum between the capacity of the trains operated and the demand) by the shipping rate. Due to the strong competition from trucks that offer door-to-door transportation services, railway companies have an upper limit on the shipping rate they may charge and they have low control over the demand that would likely shift to rail. The state should facilitate strong intermodal integration with the port and with truck companies that provide last mile transportation to/from the terminal rail station to make rail transportation more attractive and increase the utilization of the highly underused railway capacity.

3. Discussion of the results

In this section, we discuss the main results obtained for alternative capacity pricing schemes designed to recover maintenance and financial infrastructure costs and to ensure that TOs can viably operate (positive profits) in Tanzania in two scenarios: 1) considering only container TOs, and 2) considering both container and general cargo (non-container freight) TOs.

3.1. Container traffic

Figure 1 shows the annual operating margin and the

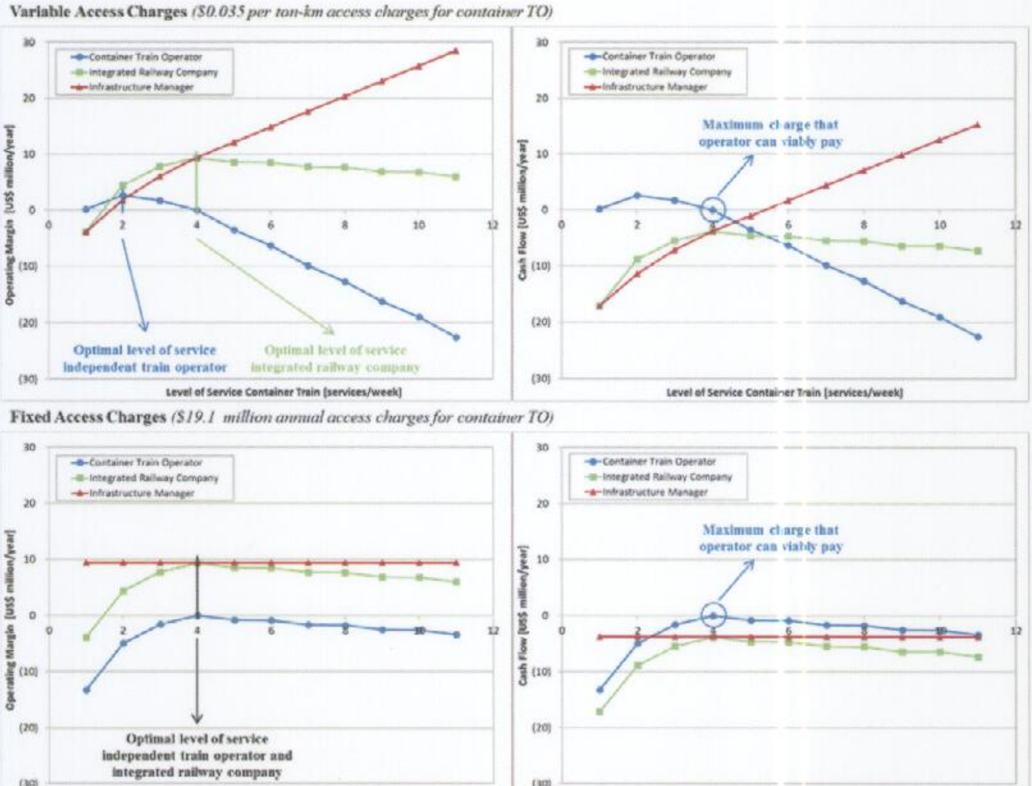

Figure 1. Operating margin and cash flow for different levels of service with variable and fixed access charges.

cash flow for an independent container TO, for the IM, and for an integrated railway company in Tanzania under variable and fixed access charges when no other type of TO operate in the line. Both access charges have been calculated to recover as much of the infrastructure costs as possible, while ensuring that the operating margin and the net cash flow of the independent TO are positive. Note that it is not possible to recover all the infrastructure cost ($22.9 million per year in Tanzania) only with container services. The maximum charges that an independent TO could viably pay are $0.035 per ton-km (variable) or $19.1 million per year (fixed). We compute these numbers estimating the TO maximum revenues, the variable and fixed costs, and therefore the maximum fixed and variable access charges that the TO can viably pay to achieve an annual net cash flow equal to zero.

The results also show that under only variable access charges, a rational independent TO would operate only two trains per direction per week while the social planner would operate four. This mismatch happens because when the social planner tries to maximize its operating margin, it operates a train when the additional revenues produced are higher than the additional variable costs (train lease, personnel and fuel). For the social planner, most infrastructure investment cost is a sunk cost: it is already made and it is independent of the level of service. Under variable access charges in contrast, the infrastructure costs are charged as variable costs for TOs. Therefore, a rational TO would only operate a train if the additional revenues produced are higher than the true variable costs plus a share of the infrastructure cost that appears now as an artificial variable cost (the variable access charge).

Under fixed access charges, the infrastructure costs are charged as a fixed cost for TOs. Therefore, this cost will also be a sunk cost for the TO. Consequently, the TO will operate a train when additional revenues produced are higher than the true variable operation costs and there is no mismatch with the level of service of the social planner.

3.2. Container and general cargo traffic

The previous subsection considers container traffic because container shippers have high willingness to pay to ship containers. Nonetheless, there is plenty unused capacity in the Tanzanian railway system and there are other types of customers interested in transporting non-containerized freight (general cargo) along the corridor. We carried out a similar analysis of costs and revenues for general cargo services (World Bank, 2014) 0 per ton-kilometer (variable) or $10.5 million per year (fixed). In both cases an integrated railway company and an independent TO would operate ten services per week.

Considering these numbers, the IM would need to charge a variable access charge of $0.023 per ton-kilometer (variable) or $12.4 million per year (fixed) to the container TO to recover all infrastructure costs. Note that if the container TO was charged only $10.5 million per year or $0.010 per ton-km it would not be able to recover infrastructure costs (only $21.0 and $15.9 million per year respectively). This shows, first of all, that discriminate pricing would be needed to recover infrastructure costs. Although a general cargo TO cannot viably pay as much as a container TO per ton to access the infrastructure, allowing access to the infrastructure to general cargo TOs 1) allows the IM to recover infrastructure costs (not possible only with container TOs), 2) allows container TOs to pay lower charges to access the infrastructure, and 3) improves welfare (for general cargo TOs and general cargo shippers) from a state point of view.

Although these charges are consistent with the industry benchmark (World Bank, 2014), a regulator needs considerable information (operation costs, demand estimates) to determine the maximum access charges that each TO is able to pay. Lower charges would not allow the IM to recover infrastructure costs; higher charges (particularly for general cargo in this case) would not allow TOs to viably operate trains in the system.

With a variable access charge of $0.023 per ton-kilometer, an independent container TO would only operate three (note that the variable charges are now lower than in 3.1.) train services per direction per week (instead of the four that a social planner would operate). Under fixed access charges, the level of service of independent TOs in equilibrium matches the level of service that an integrated railway company would operate. The main challenge to implement fixed access charges in this case consists of determining the share of infrastructure costs ($22.9 million per year) that each TO should pay. Nonetheless, our computation shows that the level of service operated by the TOs is robust when the distribution of fixed access charges change: the container and the general cargo TO would be able to pay up to $19.1 million and $10.5 million per year respectively while still being profitable. Any choice such that the annual fixed access charge for the container TO is lower than or equal to $19.1 million, for the general cargo TO is lower than or equal to $10.5 million, and the sum of both charges is $22.9 million would improve level of service with respect to variable charges while enabling infrastructure cost recovery. This result has important implications: 1) it relaxes the constraint on how much information the regulator needs to determine fixed access charges, and 2) it allows the regulator to design the fixed charge level for TOs with different objectives: such as ensure equity, ensure efficiency, ensure general cargo services.

Under fixed access charges with no variable charges per train, states could implement different schemes to allocate operating licenses among potential TOs. First, the regulator could determine a fee (fixed access charge) that a container and a general cargo TO would have to pay to get the license to recover infrastructure costs ($22.9 million per year). If the charges allow the operators to viably operate, they would apply for the license and retain the additional profits ($19.1 or $10.5 million per year minus access charge for each type of TO). Second, when there are several companies willing to operate trains, the state could implement an auction to allocate the license to operate in each market. If the license is awarded to the TO with higher willingness to pay at each market, the most efficient container and general cargo TOs would bid $19.1 and $10.5 million respectively. In this case, the publicly owned IM would obtain $29.6 million per year (instead of $22.9). The IM can either use the additional revenues to invest in infrastructure in the future or transfer them to the government. If the license is awarded to the TOs that offer best shipping rate to customers provided that the IM can recover infrastructure costs, the IM would recover $22.9 million per year, the TOs would recover their costs with some return, and the customers would benefit from a discount in their shipping rate of $6.7 million per year ($29.6 minus $22.9). Further options can be explored when more than one license per market (container and general cargo) are allocated.

4. Conclusions

In this article, we analyze different capacity pricing schemes designed to recover infrastructure costs (periodic maintenance and financial costs) and to ensure that TOs can viably operate (positive net cash flow) in Tanzania. The insights derived from this case are useful to design open-access railway systems in other countries.

First of all, we show that the adoption of variable access charges widely used in the railway industry may create incentives for rational TOs to operate fewer trains than an integrated railway company (social planner). We show that the use of fixed access charges aligns the behavior of vertically separated firms with the behavior of an integrated railway company. This result is important in the railway industry because most infrastructure costs are fixed, i.e., for the most part they do not vary with the level of service as is generally assumed.

The results obtained also show that: 1) discriminate pricing may be needed to be able to recover infrastructure costs when different types of TOs face very different levels of cost and revenues, 2) regulators need considerable information about the sector (demand and cost) to determine adequate access charge levels that TOs can viably pay, 3) the level of service offered by TOs is robust for a wide range of fixed access fees, relaxing the regulator needs of information, 4) different levels of fixed access charges can be designed with different objectives, and 5) the state choice of different capacity pricing schemes has implications on the welfare distribution among stakeholders.

Future work should analyze further how to implement fixed access charges effectively, especially in cases with competing TOs in the same market to avoid barriers to entry. Future research should also determine how these conclusions change with demand uncertainty, elasticity in the demand, and imperfect information, in instances in which infrastructure capacity is limited or there are important network effects in the system, and in instances in which the capacity of the regulator is limited.

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