Transportation Research Part E 49 (2013) 176–189

Contents lists available at SciVerse ScienceDirect

Transportation Research Part E

journal homepage: www.elsevier.com/locate/tre

Auction pricing of network access for North American railways

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ARTICLE INFO

Article history:
Received 17 January 2012
Received in revised form 5 May 2012
Accepted 9 August 2012

Keywords:
Railway scheduling
Timetabling
Pricing
Train pathing

ABSTRACT

The question of pricing train paths for "open access" railway networks in North America is discussed. An auction process is suggested as necessary to maintain transparency in the contracting process. Multiple random samples of auction pricing for a single track railway line demonstrate that the infrastructure entity will receive approximately 15.6% less than the true value of the contracted train paths. This loss of revenue threatens the objective of reducing government subsidy for the railway network.

1. Introduction

Today nearly all the railways of North America and Europe are managed as commercial firms. They are nominally expected to allocate resources and select investments according to the best return on investment. However, there are still significant differences in the funding of track or infrastructure. European railways, the Boston to Washington, DC corridor in the United States, and other dedicated passenger services in North America largely receive their infrastructure funding through government allocation. North American freight railways are by most measures funding their infrastructure through private equity markets.

Two separate political objectives in the United States are raising the question of how to price and market train paths on a railway network, and consequently whether these political objectives are feasible and likely to satisfy the motivating desires. One interest group seeks greater competition within freight railway services, while another interest group seeks a breakup of the Amtrak monopoly on passenger services. These two groups have disparate political alignments, but they share a practical requirement of pricing network resources that currently compose a unified monopoly.

This paper contributes to the literature new insight into the relevance of auction pricing to North American railway services. This paper applies an auction based pricing mechanism to a single track railway with trains of different speeds in opposing directions, a typical North American network, and explores the resulting revenue implications under an absolute revenue maximizing objective. Approximately 70% of North American main routes are single track (Richards, 2006), but prior publications on this topic do not consider single track operations, and do not explicitly model the track infrastructure. The timetable optimization model applied in this paper, a *microscopic* model, does explicitly model individual track occupancy conflicts. Twenty replications drawn from a random distribution of train characteristics are solved with a multiple round auction where each round returns a revenue optimal and operationally feasible network schedule according to the bids submitted in that round. The net revenue to the network operator is estimated under a range of auction rules and is compared to the true package value.

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http://dx.doi.org/10.1016/j.tre.2012.08.003

1.1. Market structure of railway firms

A railway may either be vertically integrated or allow "open access". North American freight railways represent a classical vertical integration, where a single firm owns the trackbed, operates all trains, and markets both as a single unified service. Until twenty years ago, the national railways of Europe were also vertically integrated, but operated as government services or utilities. Since then, the European railways have made significant progress towards implementation of open access. Under this scheme, the national railway remains the owner and manager of the track network, but any qualified independent operator may contract for the right to operate their own train on the network and to determine their own pricing and customer relationship. This applies to both passenger and freight traffic.

European railways have completed this transition with generally positive economic results (Friebel et al., 2010). Independent train operators contract with the track infrastructure firm for train paths that provide an agreed route between two stations at an agreed time and speed. These negotiations are usually completed before the seasonal publication of network timetables. Other than differences in the train speed and movement characteristics, the same procedures apply uniformly to freight and passenger trains.

Train paths may be valued according to a number of different schemes. The fundamental categories are:

Fixed allocation or average cost model. Train paths are priced by some fixed accounting rule, such as distance or tons carried (and on electric lines by the amount of electricity consumed). The intent is to "fairly" allocate fixed and marginal costs amongst separate trains or train paths. This is difficult and subject to dispute due to the very long investment periods for rail infrastructure and the integer character of many investment decisions. For example, if a new siding is required, is that cost allocated only to the new trains that motivated it, or to all traffic?

Marginal cost The marginal cost of permitting a given train on the network is calculated and accepted as the path cost, also possibly measured by distance or tons carried. This also raises allocation fairness questions, but at least reduces the number of expenses in dispute. The first cost construction expense would not be included in this price, as well as administrative and research and development expense. However, there remain renewal expenses that are difficult to allocated to specific trains. For example, a railway curve has an ideal angle of tilt for a given speed of train. A mismatch of the speed of train to the tilt results in higher rates of rail wear. For a given curve shared by slower freight and faster passenger trains, should the additional replacement cost be allocated to the passenger or to the freight train?

Value of service Train paths are priced according to their estimated relative value of service, usually a function of their cargo value. This is another traditional pricing regiment, where for example, a common dry box car will pay a fixed tariff that varies according to the cargo it contains. This method is an attempt to price by what the market will bear, but its primary difference from yield management is that pricing is public, and congestion is less likely a factor in price setting. This method is largely archaic.

Yield management Train paths are priced by the seller, prices are confidential between the seller and the buyer, and the seller will actively discriminate between buyers by pricing according to an estimate of the buyer's willingness to pay. Very often network congestion is a major factor in the price setting, as well as various game theoretic strategies that treat network paths as perishable commodities. Fundamentally, yield management disconnects revenue from any specific cost rule but is expected to return, in the aggregate, more revenue than a formulaic pricing rule.

Auction or competitive bid. Train paths are priced and assigned through an open auction or bidding process. The seller has limited control over the individual buyer price, and buyers will be aware of the prices received by other buyers. Similar to yield management, this method also disconnects revenue from underlying costs.

The first three methods have played familiar roles in the age of regulated railway services prior to 1980 in the United States. The Interstate Commerce Commission (ICC), the US regulatory authority, developed elaborate accounting systems to allocate costs according to various political and social objectives. Marginal costs were frequently invoked by the ICC as the measurement by which to determine whether to grant permission to abandon a service. Of course it is impossible to operate a railway with revenues determined solely by marginal cost. The enormous fixed capital expense of the network must be funded with revenues in excess of marginal cost (this was one of the regulatory flaws that led to deregulation in 1980). Value of service pricing allowed the ICC to insert social and political goals into railway regulation, as well as balance the deficits caused by required marginal cost services. Each of these methods is flawed because they are not responsive to the utilization level of the network.

Yield management seeks, among other objectives, to encourage more use of the fixed network when excess capacity exists, when utilization is low, and to extract more value from the network when it is congested. If you are a frequent airline flier, then no further description is necessary. Yield management is relevant when a large fixed commitment to provide transportation services has been made (an airline departure), and any unused capacity is perishable. For an extensive review of yield management, see McGill and Van Ryzin (1999). Talluri and Van Ryzin (1999) establish minimum trip prices according to the sum of trip segment bid prices. Ciancimino et al. (1999) investigates specific examples from the Ferrovie dello