Technical Note

Vertical Rail Mergers:
Welfare Effects and Regulation Issues

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ABSTRACT

The vertical merger of railroads involves the integration of several suppliers offering perfectly complementary services into one single market for a service bundle. In this paper, the authors analyse the welfare consequences of such a merger and present a simple Pareto-superior regulation policy. The purpose of this paper is to investigate the economics of a merger of two vertical rail monopolies.

Keywords: *Mergers, Perfectly Complementary Markets, Railroads, Regulation, Service Bundle*

INTRODUCTION

In the wake of the dramatic decline of passenger rail travel starting in the late 1940s when the share in intercity travel dropped from 8 percent in 1949 to 3.7 percent in 1957, the US rail industry has seen an almost continuous series of mergers. Most of these, especially the earlier ones, were head-to-head, i.e. horizontal, like the creation of Penn Central in 1968 and Conrail in 1976, following the collapse of Northeastern railroading. However, after the 1980 Staggers Rail Act, which brought deregulation on a larger scale and both clarified and simplified the merger process, mergers became mainly end-to-end affairs. More recent examples include the take-over of Chicago & Northwestern Railway by Union Pacific 1995 and the proposed creation of North American Railways by merging Burlington Northern Santa Fe and Canadian National. It was abandoned, though, at least for the time being, following the 15-months merger moratorium imposed by the Surface Transportation Board (STB), the US rail regulator, on March 17, 2000.

Conventionally, vertical industries are imagined to consist of upstream and downstream industries, creating a chain of intermediate, successive markets, with each firm's supply being used as input in the next downstream stage, just like a string of pearls. Theoretical models follow this line. Results are ambiguous. Most research suggests that, leaving transaction cost aspects aside, vertical mergers across a one-sided monopoly or oligopolies increase output and, thus, welfare (Cf., e.g., Greenhut & Ohta,

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1979). However, this seems to depend critically on a fixed-input-coefficient assumption (see Warren-Boulton, 1984; Westfield, 1981). Bilateral monopolies cannot be modelled on the basis of a price equilibrium approach but are typically considered to evolve from negotiations along the lines of the Coase Theorem. While the negotiated quantities would be efficient in that they maximise joint profit, the division of profits between the two participants would remain indeterminate (see Machlup & Taber, 1960). Then, as long as transaction costs are negligible, a merger would be allocatively neutral, leaving the pre-merger equilibrium and welfare unchanged.

Vertical rail industries are different altogether. Consider two adjacent regional carriers serving both their respective intra-regional demand as well as the combined market for inter-regional shipping. Obviously, if traffic were exclusively intra-regional, a merger would, in the absence of synergy effects, bring no change. While one railroad may act as an agent for inter-regional services, either carrier may, unlike the "string of pearls"-image, just as well sell directly to the public. However, any prospective inter-regional shipper would have to buy simultaneously from both carriers, or none at all. A merger would thus replace two perfectly complementary markets by one market offering a service bundle.

This paper is organized as follows: the next section presents a simple model featuring two railroads serving both inter-regional and intra-regional shippers and compares the pre-merger equilibria with the post-merger solution. Regulation aspects are addressed and the final section summarises the findings and addresses briefly the consequences for rail regulation in general and the STB's merger policy in particular.

A Model of Inter- and Intra-Regional Shipping

Consider two adjacent, profit-maximising monopoly rail firms $i = 1, 2$ serving both their intra-regional clientele as well as inter-regional shippers.

Denoting the inter-regional shipping volume – identical, of course, for both carriers – by x and the respective rates charged by p_i and the intra-regional shipping volumes and rates by y_i and q_i, respectively, we will write $C_i = C_i(x, y_i)$ for the cost functions. Thus we assume that the railroads are able to discriminate between intra-regional and inter-regional traffic and that they may set the rate for intra-regional shipping, q_i, independently of the through rate, p_i. In reality, price discrimination goes even further as US rail freight rates differ according to routes, direction of travel, and commodity groups, rather than distance only. Ever since the late 19th century, this has been known in the English railway literature as "charging what the traffic will bear". However, this image may be traced further back to Adam Smith (See, e.g., Acworth, 1897).

The properties of the cost functions, most notably its mixed derivatives, $\partial^2 C_i / \partial x \partial y_i$, and thus the way intra-regional shipping volumes affect marginal costs of inter-regional shipping, *et vice versa*, will play a key role in the analysis below. It is not obvious beforehand what sign these derivatives should have. However, we will rely essentially on the case of rising marginal cost cross effects, $\partial^2 C_i / \partial x \partial y_i > 0$, which can be interpreted to reflect a situation where intra-regional and inter-regional traffic compete for limited track capacity.

Denoting demand for inter-regional traffic by $x = x(p)$, where p is, of course, the combined through rate $p_1 + p_2$, and demands for inter-regional shipping by $y_i(q_i)$, and writing $\pi_i = p_i x(p) + q_i y_i(q_i) - C_i(x(p), y_i(q_i))$ for profits, a Cournot-type Nash equilibrium at prices $(p_1^C, p_2^C, q_1^C, q_2^C)$ implies the first order conditions

$$\frac{\partial \pi_i(p_1^C, p_2^C, q_i^C)}{\partial p_i} = x + \left(p_i - \frac{\partial C_i}{\partial x}\right)\frac{dx}{dp} = 0, \quad (1)$$

$$\frac{\partial \pi_i(p_1^C, p_2^C, q_i^C)}{\partial q_i} = y_i + \left(q_i - \frac{\partial C_i}{\partial q_i} \right) \frac{dy_i}{dq_i} = 0, \quad i = 1,2. \tag{2}$$

Now, evaluate joint profit of the merged railroad system:

$$\pi(p_1, p_2, q_1, q_2) = \pi_1(p_1, p_2, q_1) + \pi_2(p_1, p_2, q_2)$$

at the Nash equilibrium $(p_1^C, p_2^C, q_1^C, q_2^C)$. Differentiating first with respect to inter-regional rates, p_i, one finds:

$$\frac{\partial \pi(p_1^C, p_2^C, q_1^C, q_2^C)}{\partial p_i} = \left(p_{j\neq i} - \frac{\partial C_{j\neq i}}{\partial x} \right) \frac{dx}{dp} < 0, \quad i,j = 1,2 \tag{3}$$

where the sign follows immediately from (1). Note that by these first order conditions the margins $p_i - \partial C_i / \partial x$ are not only positive but, in addition, also equal for both companies. This means that raising either or both inter-regional rates would lower joint profit. Hence, to maximise profit the merged company would definitely *lower* the combined inter-regional rate $p_1 + p_2$, as compared to the pre-merger situation.

For a merger this result may be unexpected, yet the reason is clear: lowering the rate on any one line generates, by increasing demand for the connecting line, a positive external effect. As neither railroad has reason to take into account the other railroad's profit, prices would be too high and output too low in any pre-merger Nash equilibrium. This parallels the well-known Pareto-inferiority of the private provision of public goods. When the lines are merged, however, joint profit maximisation would bring about the internalisation of this positive externality and thus a fall in the combined through rate.

Differentiating then joint profit with respect to intra-regional rates, q_i, we have, using (2),

$$\frac{\partial \pi(p_1^C, p_2^C, q_1^C, q_2^C)}{\partial q_i} = \frac{\partial \pi_i(p_1^C, p_2^C, q_i^C)}{\partial q_i} = 0, \quad i = 1,2, \tag{4}$$

which suggests that a merger would leave intra-regional rates untouched. However, this holds only at the margin. Differentiating (4) once more with respect to any inter-regional rate, we find, using again (2),

$$\frac{\partial^2 \pi(p_1^C, p_2^C, q_1^C, q_2^C)}{\partial q_i \partial p_j} = -\frac{\partial^2 C_i}{\partial y_i \partial x} \cdot \frac{dx}{dp} \cdot \frac{dy_i}{dq_i} < 0$$
$$\Leftrightarrow \quad \frac{\partial^2 C_i}{\partial y_i \partial x} > 0, \quad i,j = 1,2.$$

This shows that – under our working assumption $\partial^2 C_i / \partial y_i \partial x > 0$ – marginal joint profit with respect to intra-regional rates would eventually rise as inter-regional rates are lowered which, in turn, calls for an increase in intra-regional rates. The underlying reason is again straightforward: as long as the additional inter-regional traffic resulting from the decline in inter-regional rates raises marginal costs of intra-regional shipping, the intra-regional rates have to be adjusted correspondingly.

REGULATION

So far, it has been assumed that none of the shipping markets was regulated. Now, suppose that the inter-regional rate for, say, railroad 2 is capped. Totally differentiating the first-order conditions for profit maximisation (1) and (2) and solving for dp_1 / dp_2 and dq_i / dp_2, we have

$$\frac{dp_1}{dp_2} = \frac{\dfrac{dx}{dp} \cdot \dfrac{\partial^2 \pi_1}{\partial q_1^2}}{\dfrac{\partial^2 \pi_1}{\partial p_1^2} \cdot \dfrac{\partial^2 \pi_1}{\partial q_1^2} - \left(\dfrac{\partial^2 \pi_1}{\partial p_1 \partial q_1}\right)^2} - 1 \quad (5)$$

and

$$\frac{dq_i}{dp_2} = \frac{\dfrac{\partial^2 C_i}{\partial x \partial y_i} \cdot \left(\dfrac{dx}{dp}\right)^2 \cdot \dfrac{dy_i}{dq_i}}{\dfrac{\partial^2 \pi_1}{\partial p_1^2} \cdot \dfrac{\partial^2 \pi_1}{\partial q_1^2} - \left(\dfrac{\partial^2 \pi_1}{\partial p_1 \partial q_1}\right)^2} \cdot \frac{\dfrac{\partial^2 \pi_1}{\partial q_1^2}}{\dfrac{\partial^2 \pi_i}{\partial q_i^2}}, \quad i = 1,2. \quad (6)$$

Invoking the (sufficient) second-order conditions which require the second partials $\partial^2 \pi_i \,/\, \partial q_i^2$ to be negative and the denominator in (5) and the corresponding expression in (6) to be positive, we have from (5) $dp_1 \,/\, dp_2 > -1$ which implies

$$\frac{dp}{dp_2} = \frac{d(p_1 + p_2)}{dp_2} = \frac{dp_1}{dp_2} + 1 > 0.$$

Hence, capping either one railroad's inter-regional rate would lower the combined through rate even though these rates may be strategic substitutes. However, as may be concluded from (6) provided the working assumption $\partial^2 C_i \,/\, \partial x \partial y_i > 0$ applies, both intra-regional rates would rise – just as in the case of the unregulated merger discussed in the previous section.

As long as the two railroads are still separate companies, regulating only one company's inter-regional rate would not do away with the externality problem because, just as in the Nash equilibrium, the unregulated firm would still not take into account the positive effect of lowering its inter-regional rate on the other firm's profit. Thus, the through rate could be lowered without affecting total industry's profit, or profit could be increased without raising the through rate. In theory, the regulator could eliminate the remaining efficiency loss by capping both rates. However, to be able to maximise joint profits subject to a through rate constraint he would need to know the exact demand and cost conditions.

When the two railroads are being merged, the task of the regulator becomes almost trivially simple. As shown above, the merged company would lower the combined inter-regional rate anyway. All the regulator would have to do to make no party worse off is to require that no intra-regional rate be raised above its pre-merger level. This should be an easily acceptable condition because lowering the inter-regional rate in isolation would already raise joint profit. If, contrary to our working assumption, marginal costs were in fact not rising or even falling, i.e. $\partial^2 C_i \,/\, \partial x \partial y_i \leq 0$, the condition of the regulator would do absolutely no harm as the merged railroad would be inclined on its own to maintain or even lower intra-regional rates.

CONCLUDING REMARKS AND QUALIFICATION

The economics of vertical railroads show that a vertical merger both leads to lower inter-regional rates, leaving the railroad company and inter-regional shippers better off, and facilitates less inefficient regulation. Maybe somewhat surprisingly, it is only intra-regional shipping which might be put at a disadvantage. Yet, as demonstrated above, a simple policy is at hand to prevent this.

One qualification has to be made. Throughout the analysis it was assumed that a merger would not affect the cost structure. Should synergy gains materialise, our conclusions obviously strengthen, but they would be in jeopardy if a merger were to raise variable costs. However, the likelihood of this to happen should not be overestimated, especially as the merged railroad, while still able to reap rewards of the merger, may choose to retain the pre-merger operational divisions of the old railroads.

Provided variable costs may be expected not to be negatively affected, our analysis demonstrates that the STB, given the option to impose ceilings on intra-regional rates to safeguard those shippers' interests, should be well advised to approve any proposed vertical merger.

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