Regulation and Innovation: The Case of Piggybacking

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Introduction

When two technologies exist for the production of the same good or service, the possibility arises that a combination of some features of each technology can exploit the advantages of both. In surface freight transportation, one such hybrid technology which combines rail and truck transport is called piggybacking. Highway truck trailers are placed on flat cars for line haul by railroads. This innovation is also called "trailer-on-flat-car" (TOFC) service.

Piggybacking's advantages have long seemed obvious to industry, regulators, and economists. TOFC service combines the flexibility of trucking in pick-up and delivery with the line haul efficiency of railroads. Piggybacking was expected, at its inception, to replace both small rail shipments and long haul trucking.[1] Yet, after twenty years of service, piggybacking accounted for a trivial proportion of freight traffic.[2] By comparison with the expectations that it engendered, TOFC has been a recognized disappointment. In this paper, I will explore the extent to which the economic regulation of railroads during this period (1954–1974) was responsible for this failure.

ICC Regulation

The Interstate Commerce Commission (ICC) regulates virtually every aspect of the rail freight industry in the United States. Two of the most important are rates and structure. If regulation forced piggybacking rates too high to attract shippers, or if the structure of the industry gave railroads the wrong incentives for developing piggybacking, then at least some of the lack of growth of TOFC service can be attributed to the ICC.

The ICC has frequently been criticized by economists for setting rates at higher levels than is optimal. In the case of the "Big John" innovation, the ICC suspended the proposed rates for carrying grain in the new type cars because the rates were too low, i.e., because the rates, although above variable costs, were below "fully allocated" costs. The Big John case went to the courts after the ICC's ruling; the courts did not agree with the ICC, and the proposed rates went into effect with the ICC's approval three years after the initial filing of the rates.[3] Regulatory review and judicial

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[1]The ICC expressed its confidence in piggybacking in the two major decisions setting policy for TOFC service [11,12]. Railroad industry enthusiasm is typified by the glowing press releases of the Association of American Railroads, for example [1]. The trade journal runs one issue a year on piggybacking; these are virtually interchangeable in their rosy forecasts [7]. Economists expecting piggybacking to fill a niche in surface freight transportation include Friedlaender [2], Meyer et al. [4], and Nelson [6].

[2]In 1971, Reebe Associates found that piggybacking accounted for only 4 percent of intercity nonbulk freight tonmiles [10]. In 1977, railroads derived only 6 percent of their revenue from piggybacking.

[3]The last ICC ruling in the case has a brief summary of the whole case [13].

review delayed the full implementation of this innovation for three years. Could the same rate regulation tale account for the lack of piggybacking?

There are several reasons for doubting the influence of rate regulation on the dearth of TOFC service. Since the ICC regulates nominal rates, railroads can lower real rates during periods of inflation by doing nothing. If the ICC had forced TOFC rates to be too far above costs, rate regulation would have delayed the development of piggybacking until rate adjustment by inflation had occurred. Further, rate regulation would have, if responsible, delayed the development of piggybacking for eight times the length of the delay in the Big John case. In the few TOFC cases that have come before the ICC in the last twenty-five years, the ICC has consistently maintained its support for piggybacking. If it has delayed the diffusion of piggybacking, the ICC has not done so by regulating rates. If rates are too high to attract traffic, it is because the costs are too high for the service provided. Railroads, given the structure of the industry, have chosen a system of TOFC service that does not meet the competition of trucking. Insofar as it is responsible for the structure of the industry, the ICC has, contrary to its stated policy, inhibited the diffusion of piggybacking.

The ICC did not invent the Balkanization of the railroads; the pattern of many different firms serving different sets of cities developed in the nineteenth century. The ICC has merely poured molasses, if not concrete, on that structure. The ICC's approval is necessary for railroads to merge. Before the passage of the Railroad Revitalization and Regulatory Reform (4R) Act in 1976, the process of reviewing proposed mergers had no time limit. Merger review could and sometimes did take years. Between 1955 and 1972, the average time between application and final decision was 40 months.[4] The ICC has, and has exercised, the power to impose conditions on a merger. The most commonly applied conditions fall into two groups: those that preserve existing traffic patterns and those that protect railroad employees. Both types of conditions reduce the benefits to a merger in the first years after the merger; both decay over time.

Railroads can merge, but more slowly and with fewer benefits than in the absence of regulation. As a result, in 1972, there were more than 30 Class I railroads and more than a hundred Class II railroads.[5] In some markets, railroads compete; in others, they coordinate by offering interline service. Frequently, the same railroads are competitors in some markets and coordinators in others. This industrial structure has implications for all railroad operations, but I will only deal with the implications for piggybacking.

Effects of Railroad Structure

It is helpful to start by outlining a system of TOFC service that would effectively compete with trucking for traffic. Such a system is technically possible; pieces of it already exist.

An efficient system of piggybacking operations would consist of large mechanized terminals in major cities, and frequent through trains that travel origin to destination without going through intermediate yards. Where such trains traveled over the track of several railroads, revenues would be shared by agreement of the participating railroads. Two studies done by the U.S. Department of Transportation have concluded that such a system would provide service that was as fast as trucking for long distances with lower costs.[6]

[4]For the 14 cases in this period, the time from application to decision ranged from one month to six years and nine months [8].

[5]The number of railroads at any one time is not obvious. The ICC's list of railroads includes some that have been wholly-owned by other railroads for years. For this study, I traced the ownership and control of railroads using Moody's Transportation Manuals [5].

In fact, Balkanization renders the possibility of achieving such a system remote. Under present arrangements, there are too many terminals, each too small, in too many places. TOFC traffic often moves in regular trains, which are broken up at interchanges between railroads, if not in intermediate yards on the same railroad. And through service across contiguous roads is discouraged by the regulation of the division of revenue. Railroads cannot freely contract with each other to split the revenue from joint service; the division is ruled by division factors.

Balkanization has fostered the wrong choice of terminal technology. The small ramp loading system is found almost everywhere; the large mechanized system exists in only a few places. The ramp system has lower cost per unit loaded at small volumes; the mechanized system, at high volumes. Each railroad owns its own terminals; in any given place, the number of seperate rail terminals is determined by the number of railroads, not the volume of traffic. As a result, traffic at any one point for any one railroad is generally too small to justify a large mechanized terminal. Traffic for all railroads through that point may well be large enough.

In theory, railroads could realize the economies of scale in terminal operations by sharing terminals. In regular freight traffic, railroads do have joint terminals at major traffic points; these terminals are owned and operated by a separate company which is a jointly-owned subsidiary of the participating railroads. At volumes below that which justify an entirely separate corporation, railroads do not share terminals.

There are economic and institutional reasons for railroads' reluctance to share terminals. Within its own terminals, a railroad controls the scheduling of operations: which trains are made up first, which shipments have priority. A railroad also blocks cars into trains in order to minimize its own costs, with the costs of connecting railroads a secondary consideration. At very large volumes, the economies of scale dominate the costs of control loss and the costs of agreeing to a set of rules governing operation of a terminal.

The institutional barriers to joint terminals are due to regulation. Regulation inhibits joint operations by imposing the same shipper and employee protection rules for a terminal consolidation that the ICC routinely imposes as a condition for a merger. These attempt to ensure that no worker is penalized and no shipper inconvenienced by the changeover, and effectively limit the realization of economies of joint operations.

Regulation discourages joint terminals; economies of scale encourage joint terminals. If piggybacking traffic gets large enough, joint terminals will probably appear as they have for regular freight traffic. Unfortunately, this may take a very long time. Regular freight traffic grew large enough for joint terminals in the days before trucking competition came on the scene. TOFC service faces stiff competition from trucking and so has not yet reached high volumes in most markets. And the absence of shared terminals inhibits the diffusion of piggybacking. The small terminals have higher unit costs than the large ones; piggybacking, using small terminals, is more costly than it would be with large terminals. The lack of shared terminals also means that interlined traffic that is interchanged (i.e., is not on a through train) must travel through two yards with switching in between. The resulting delay erodes the quality of service. Piggybacking can compete with trucking by being as fast and cheaper or by

[6]The first of these studies was an estimation of the feasibility of a national intermodal network [10]. The second involved engineering cost estimates of freight transport modes [9].

being faster and costlier. It cannot divert truck traffic by being both expensive and slow. The system of small terminals, owned by individual railroads, is incompatible with efficient service. Balkanization induces the wrong choice of scale (and hence technology) of terminals.

Balkinization also inhibits efficient line haul operations. Although some trains run through from origin to destination without interchanges, most don't. High-potential piggybacking markets are generally long haul markets, and thus more likely to involve more than one railroad. In the absence of a special agreement to offer through service, interline traffic moves on regular trains. The originating railroad makes up a train to go from the origin to the point of interchange. At the interchange point, the train is broken up and the cars for the interline movement are switched to the connecting railroad which then makes up its own trains. Interchanges involve some costs and lots of time. The potential market for piggybacking consists of manufactured commodities for which the inventory costs of time in transit are important. Interline piggybacking is therefore too slow to compete with trucks unless interchanges are eliminated by the use of through trains.

Although there are some through trains in existence, railroads have been slow to develop more of them. For two or more railroads to agree to offer through service, each participating railroad must find the service profitable. Their perspectives are usually quite different. For example, the originating railroad must acquire the necessary equipment; its costs of doing so depend on how much traffic it has terminating at this point. The terminating railroad is concerned with the disposal of the equipment; its costs of doing so depend on how much outbound traffic it has.

In economic theory, if the service is profitable for the two railroads considered as a unit, then there is some division of the revenue from the coordinated service that will induce the two railroads acting independently to offer the service. However, there are institutional constraints on railroad bargaining. For all interline traffic, the division of revenue between carriers is regulated. The standard division factors can be changed for any particular traffic, but at least one railraod will always be reluctant to do so for fear that such action would be cited against it in a future division argument before the ICC. In the beginning, the eastern railroads had dense traffic patterns and lower unit costs than the southern or western railroads; division of revenue based on costs favored the southern and western railroads. Times have changed, but not division factors. When the eastern railroads argued that, since their costs were higher, they deserved a larger share of the revenue, the southern and western railroads responded that their shares were returns to efficiency in lowering costs and should not be changed. The adjustments to division factors in that case were small; the case itself was long and costly.[7]

By regulating the structure of the railroad industry—and, in most cases, thereby impeding changes that the railroads themselves desire—the ICC has inhibited the development of efficient terminals, through trains, and revenue-sharing agreements that would have facilitated the diffusion of TOFC.

When railroads merge, they can circumvent the difficulties of interline traffic as competitive piggybacking requires. A single railroad can eliminate interchanges without the negotiating problems of through trains. It can schedule shipments from origin to destination so as to minimize travel time for high-value freight. And it can consolidate terminals, although the gains of doing so are likely to be limited by regulation.

[7]Division cases provide a wealth of information for aficionados of ICC reports. Particularly interesting are the attempts of the commission to solve bilateral monopoly bargaining problems when the cases involve two rate bureaus. The final report on the division between eastern and southern railroads includes a summary of the earlier proceedings [14].

Merger between connecting railroads converts interline service into intraline service. The resulting improvement in the quality of service cannot help increasing piggybacking. Merger between competing railroads encourages the consolidation of terminals in the origin and in the destination cities. To the extent that economies of scale in terminal operations are realized through merger of parallel routes, this change in structure would encourage the growth of piggybacking. All mergers should have positive effects on piggybacking, and end-to-end mergers should result in the greatest increase in TOFC service. This hypothesis, and the underlying argument that the preservation of Balkanization by regulation inhibits piggybacking, can be tested.

Hypotheses and Data

When railroads merge, the effects on different city-pair markets served by those roads will vary according to the configuration of the railroads in each market. I will use the taxonomy of Levin and Weinberg;[8] within a market, a merger is one of four types:

1. Parallel—Prior to their merger, railroads R and S both provide intraline service.
2. End-to-end—Before merging, railroads R and S coordinate in offering interline service. The merger converts the interline route to an intraline route.
3. Mixed—Before merging, only one of the railroads offered intraline service. The other participated in interline service, either with its merger partner or with another railroad.
4. Unaffected—Only one of the merging railroads serves the city pair (on an intraline route). The other railroad is not present in this market.

[8]Levin and Weinberg estimated the effect of merger type on the market shares of individual railroads. [3].

The effect or a merger on piggybacking in a particular market will depend on whether the market is an end-to-end link in the merger, a parallel link, a mixed link, or unaffected. Piggybacking on the unaffected links would only be positively affected if the merger improved the overall efficiency of the firm. Such effects are likely to be small.

When two railroads that had been offering interline service in a market merge, the end-to-end merger produces an intraline route over which service can be offered without interchanges. The elimination of an interchange both reduces cost and improves the speed and reliability of service. The internalization of the division of revenue problem corrects any perverse effects caused by discrepancies between the allocation of revenue and the incidence of costs. The increase in piggybacking resulting from the conversion of an interline route to an intraline route encourages the conversion of terminal facilities from the small-scale ramp loading to the large-scale mechanical loading type. If this conversion occurs, the growth of piggybacking will be further encouraged. For any market, the longer the distance, the smaller is the share of interchange and terminal operations in total shipment costs. The positive effects of an end-to-end merger will thus be greater for shorter distances.

When a parallel merging occurs on a link, there are likely to be small but positive effects on piggybacking. There may be line haul economies of density; the terminal consolidation encourages development of efficient terminals. Regulatory constraints on terminal consolidation limit the benefits of consolidating two terminals on a parallel link. As with end-to-end mergers, the positive effect of a parallel merger will be greater for shorter routes.

A mixed merger offers only the possibility of consolidating terminals at one end of the route. The effect on piggybacking is likely to be negligible.

Over any time period, the change in the amount of TOFC service in any one market will depend on changes in the demand for transportation in that market, changes in the cost or quality of piggybacking, and changes in the cost or quality of trucking in that market. The demand for transportation in any market depends on the demand for the goods shipped at the destination and the supply of goods shipped at the origin. In general, the amount of manufacturing activity in a city will indicate the supply of goods from that city and the demand for goods to that city. As a measure of manufacturing activity, I chose the total value of shipments published for each city annually by the U.S. Bureau of the Census. The percentage change in value of shipments between 1966 and 1972 for each origin and each destination city in the sample was computed.

Data on the costs of trucking for traffic between the sample cities are not available. Since the major change in trucking between 1966 and 1972 was an increase in speed due to the increase in interstate highway construction, the change in driving time between the sample cities will be used as an indicator of the change in the competitiveness of trucking to piggybacking. Rand McNally Road Atlases give driving times between major cities in the United States. For each city pair, I computed the driving time of the fastest route in 1966 and in 1972, and then the percentage difference between them. The decrease in driving time ranged from zero to over 25 percent. For any city pair, the greater the increase in trucking speed, the smaller the expected change in piggybacking.

The cities chosen as the units of observation in this study are a subset of the cities affected by mergers in the period 1966-1972, the years for which data are available. The list of major cities affected by mergers in this period is based on the work of Levin and Weinberg, as is the classification of merger types. The mergers in this period are listed in Table 1. Since these railroads differ in many ways, firm specific dummy variables will be included in the analysis. For one railroad in this period, the Penn Central, it is possible to predict: the firm specific dummy variable will have a negative coefficient. The Penn Central had many troubles, and it is likely that the overall firm problems affected TOFC (as well as all other) service negatively.

The data for the amount of piggybacking in these markets in 1966 and in 1972 is taken from the *One Percent Waybill Sample* of those years. These samples of rail freight shipments are collected by the ICC and coded into machine-readable form by the U.S. Department of Transportation. Three measures of the amount of piggybacking are used: the number of shipments, the total amount of revenue generated by those shipments, and the tonnage shipped. Markets in which there were fewer than ten waybills in either the 1966 or the 1972 sample were eliminated from the study. There are 49 markets which meet all the qualifications,

Table 2 summarizes the expected coefficients on the variables included in this analysis. There are several pieces of information excluded. One of the more important is the duration of the merger in the time period. Any effects of a merger should grow as the merger is fully implemented. Since the unit of analysis is a city-pair, a duration variable cannot be constructed for those units which had more than one merger during this period. Another important excluded variable is the share of piggybacking in total transportation between two cities. The pattern of TOFC service penetration of markets varies widely across markets. The growth of piggybacking in any time period is obviously related to the potential total market: the closer piggybacking is to the limit defined as the share in an unregulated market, the less room there is for growth. Estimating this limit is beyond the scope of this paper, as is computing the actual share from a combination of census and waybill data.

TABLE 1. Railroad Mergers Between 1966 and 1972

1. New York Central + Pennsylvania Railroad + New Haven Railroad = Penn Central, February, 1968.
2. Louisville and Nashville Railroad a) acquisition of the Evansville Line of the Chicago and Eastern Illinois in June, 1969, b) merger with Monon Railroad in March 1970.
3. Chicago and North Western acquisition of the Chicago Great Western, July 1968.
4. Great Northern + Northern Pacific + Chicago, Burlington, and Quincy = Burlington Northern, March 1970.
5. Missouri Pacific acquisition of the Chicago and Eastern Illinois, May 1967.
6. Seaboard Air Line + Atlantic Coast Line = Seaboard Coast Line, July 1967.

TABLE 2. Definitions of Variables and Hypothesized Effects

Independent variables	Expected effect on growth of piggybacking
Merger type:	
Unaffected	0
Mixed	0
End-to-end	+, declining with distance
Parallel	+, small, declining with distance
% Reduction in high travel time	−
% Change in value of shipments at origin	+
% Change in value of shipments at destination	+
Railroad dummies:	
Penn Central (PC)	−
Louisville and Nashville (LN)	?
Chicago & North Western (CNW)	?
Burlington Northern (BN)	?
Missouri Pacific (MP)	?
Seaboard Coast Line (SCL)	?
Dependent variables	
% Change in shipments	
% Change in revenue	
% Change in tonnage	

Results

Table 3 shows the results for all three measures of TOFC growth, both with and without railroad dummy variables. In most cases, the coefficients do not contradict the hypotheses set forth in Table 2. End-to-end mergers have strong positive effects that decline with distance. Parallel mergers have small positive effects; in the case of revenue growth with railroad dummies, parallel mergers have strong positive effects. This suggests that parallel mergers do increase the railroad's market power. In this case, mixed mergers also have large positive effects. In the other cases, the effect of a mixed merger is positive, though small. No overall efficiency of merger effects appear; indeed, the coefficient of unaffected markets is negative more often than not and is always small.

Reductions in highway driving time deter the growth of piggybacking considerably: this coefficient is negative in all equations. Piggybacking tonnage is especially elastic with respect to driving time. During this period (1966-1972), the interstate highway system grew very rapidly; the average reduction in driving time for markets in this sample was 12.48 percent.

Growth in demand (as indicated by change in value of shipments in the destination city) strongly encourages the growth in piggybacking. The coefficient on growth in value of shipments in the origin city is usually negative, generally small, and wholly puzzling.

The railroad-specific effects are insignificant with the exception of the Penn Central. As expected, the Penn Central dummy always has a large negative effect.

TABLE 3. Results

Independent Variable	Dependent Variable: % Change					
	Shipments		Revenue		Tonnage	
Constant	−.4651**	.0015	.1484	1.0123**	−.2580	.2297
	(.2165)	(.3146)	(.3207)	(.4343)	(.2877)	(.4014)
End-to-end	.4191**	.6998*	.3843	.5017	.8211***	.7031
	(.1774)	(.4070)	(.2628)	(.5619)	(.2357)	(.5193)
Distance X End-to-end	−.00010	−.00021	−.00001	−.00006	−.00031*	−.00025
	(.00012)	(.00020)	(.00018)	(.00027)	(.00016)	(.00025)
Parallel	.0481	.2266	.0942	.4911**	.1644	.3729*
	(.1284)	(.1622)	(.1902)	(.2239)	(.1706)	(.2070)
Distance X Parallel	.00000	−.00005	−.00013	−.00031	−.00023	−.00027
	(.00021)	(.00022)	(.00031)	(.00030)	(.00028)	(.00028)
Mixed	.06184	.2221	.0579	.3832*	.0857	.2879
	(.1225)	(.1476)	(.1815)	(.2038)	(.1628)	(.1883)
Unaffected	−.0657	.0723	−.0716	.0028	−.0104	−.0108
	(.0741)	(.1599)	(.1097)	(.2208)	(.0984)	(.2041)
Highway Time Reduction	−.5190	−.7964	−1.0999	−1.0005	−2.2885*	−2.3184
	(.5678)	(1.2550)	(1.3539)	(1.7324)	(1.2140)	(1.6010)
Change in Value of Shipments-Origin	.1547	−.2671	−.4350	−1.3648**	.2535	−.4137
	(.4146)	(.4700)	(.6141)	(.6488)	(.5509)	(.5997)
Change in Value of Shipments-Destination	1.1056***	.9008**	1.2244***	.8300*	1.3112***	1.1126**
	(.2949)	(.3442)	(.4368)	(.4752)	(.3918)	(.4392)
PC RR		−.5676**		−1.1039***		−.6534
		(.2816)		(.3888)		(.3594)*
LN RR		−.4336		−.7130		−.1945
		(.4482)		(.6187)		(.5718)
CNW RR		−.1417		−.1840		.1334
		(.2002)		(.2764)		(.2555)
BN RR		−.3020		−.4836		−.2571
		(.2671)		(.3688)		(.3409)
MP RR		−.4088		−.2239		−.0442
		(.3877)		(.5352)		(.4947)
$N = 49/R^2 =$	0.48	0.54	0.36	0.51	0.48	0.58

*t-statistic exceeds critical value at .1 level.
**t-statistic exceeds critical value at .05 level.
***t-statistic exceeds critical value at .01 level (standard errors in parentheses).

The effects of changes in railroad structure in a market can be more clearly seen by computing the partial derivatives of the dependent variables with respect to each type of configuration. Using the equations in Table 3 containing the railroad-specific dummies, these derivatives (evaluated at average distances) are shown in Table 4. The railroad dummies must be added to the derivatives to give the effects for a particular railroad. Two cases are shown in Table 4. A Penn Central parallel merger in a market of average distance would be 36.55 percent below the average growth of shipments in a market. The effect of a Penn Central parallel merger is negative on all three types of piggybacking. A Burlington Northern end-to-end merger has positive effects on shipments (17.65%) and

TABLE 4. Effects of Merger Types

Effect of	*Effect On*		
	% Δ *Shipments*	% Δ *Revenues*	% Δ *Tonnage*
End-to-end merger	.4785	.4366	.4481
Parallel merger	.2021	.3504	.2474
PC: parallel	−.3655	−.7536	−.4060
BN: end-to-end	.1765	−.0470	.1910

tonnage (19.10%) but a negative effect on revenue (−4.70%). The Burlington Northern merger may have lowered costs (and thus prices) enough to offset the increase in revenues expected from the demand shift caused by the improved service.

Ignoring railroad-specific effects, an end-to-end merger affects piggybacking growth more than a parallel merger does. The difference is smaller for the growth of revenue than for the growth of shipments or tonnage. The increased market power from a parallel merger may be responsible for the larger effect on revenues.

Summary

The effects of changes in structure on piggybacking are unsurprising: end-to-end mergers encourage the growth of piggybacking. Other types of mergers may have positive effects undetected by this analysis. In particular, parallel mergers may have positive effects that will not appear until the conditions imposed by the ICC on terminal consolidation have been worked off. The effect of any type of merger may well depend on the individual railroads involved and the very process of merging.

Regulation of railroad industry structure has prevented the rationalization of the rail network. To a very large extent, the United States still has the patchwork of large and small railroads of the nineteenth century. This structure has effects on many areas of railroad operations. In this paper, the negative consequences of Balkanization for an innovation—TOFC service—have been shown. The problems of piggybacking are not technical; they are the result of a fractured system faced with a network innovation. Inhibiting mergers with a long regulatory process and reduced benefits due to conditions on mergers, the ICC is responsible for the structure of the industry and its consequences, including the failure of an obvious innovation to reach its potential in a quarter century of operation.

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