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MARKET DOMINANCE AND MARKET POWER: A CASE STUDY OF DISAGGREGATE RAILROAD PRICING UNDER DEREGULATION

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Abstract

Deregulation in the US railroad market introduced the notion of market dominance into regulatory proceedings. In this paper we examine the theoretical basis for market dominance. We find three special cases of a general model of pricing. These include strict, constrained and no market dominance.

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INTRODUCTION

The relationship between the degree of market dominance and the degree of market power is a cornerstone of antitrust policy and of economic regulation of industry. In both, market dominance involves an assessment of the competitive alternatives available to demanders. Competitive alternatives may involve product, geographic, service, and/or price dimensions. Identification of these dimensions is the focus of regulatory assessments of the degree of market dominance. However, assessments often involve only identification of existing and potential competitive alternatives without consideration of the feasibility of those alternatives. In this paper, we study the pricing behavior of a monopolist and the resulting degree of market dominance when the monopolist is serving demanders with competitive alternatives. Three cases of market dominance result. These include no market dominance, strict market dominance, and constrained market dominance.

The relationship between competitive alternatives and market dominance enters both antitrust and economic regulation proceedings in preliminary stages. In judging the degree of monopolization in antitrust proceedings, identification of competitive alternatives is emphasized and is used to define markets and market shares. A problem with this approach is the interpretation given to either the existence of or the lack of competitive alternatives. First, the finding of numerous competitive alternatives may be the result of pricing power of the incumbent firm. With higher prices, competitive alternatives (with higher costs) may be bid into the market. Second, the finding of no competitive alternatives may result because the incumbent firm has priced higher cost alternatives out of the market.

In economic regulation of railroads, market dominance is a trigger for Interstate Commerce Commission (ICC) jurisdiction over prices. Market determined prices apply unless the railroad is found to have market dominance. If the railroad is found to have market dominance only then may the reasonableness of the rate be questioned by the ICC. Market dominance, in railroad policy, is a qualitative evaluation of product, geographic, intermodal, and intramodal competitive forces. Proponents argue that these competitive alternatives force the railroad to price competitively because the railroad can ill afford to price its shippers out of the market. Adversaries point out that a mere demonstration that the railroad in question is not a monopolist (mere identification of competitive alternatives) does not necessarily imply that competition is an effective constraint on pricing.

In this paper competitive alternatives enter directly as a constraint on pricing by a monopolist. The model is cast in terms of railroad pricing and used to interpret the economic content of legislated market dominance. The legislative history and previous research provide a setting for the model and an understanding of the goals of market dominance in transportation policy. The model of railroad pricing results in a metric of market dominance which can be calculated and used to judge the effectiveness of competitive alternatives in regulating prices.

MARKET DOMINANCE AND REGULATION

Historically, the ICC has had broad jurisdictional powers over determination of interstate rail rates. Prior to passage of the Rail Revitalization and Regulatory Reform Act of 1976 (4-R Act), the ICC had jurisdiction over all interstate railroad rates, using a "just and reasonable" standard, mandated by the Interstate Commerce Act of 1887. Beginning with the 4-R Act and culminating with the Stagger's Rail Act of 1980, transportation policy focuses on the ability of the marketplace to regulate prices. For example, the Stagger's Rail Act amended transportation policy affecting the railroad industry "...to allow, to the maximum extent possible, competition and the demand for services to establish rates for transportation by rail."

Passage of the 4-R Act defined market dominance and introduced the concept to the regulatory environment. As defined by the 4-R Act, market dominance pertains to "an absence of effective

competition from other carriers or modes of transportation for the traffic or movement to which a rate applies." The ICC subsequently established guidelines for market dominance (Ex Parte No. 320, Special Procedures for Findings of Market Dominance, 353 ICC 874, modified, 355 ICC 12 (1976)). These guidelines included criteria, any one of which, if established, provided the ICC with jurisdiction to consider the reasonableness of the rate under question. These criteria included a market share criterion (whether the railroad had over 70 percent of the traffic) and a performance criterion (whether the rate relative to variable cost was over 160 percent). A third criterion, not relevant to this paper, was whether shippers subjected to the rate had made substantial investments in rail equipment and/or facilities rendering an absence of feasible transportation alternatives.

In principle, the market share criterion introduced both intramodal and intermodal competition explicitly into the regulatory framework. The performance criterion, on the other hand, provides an explicit measure of the effectiveness of that modal competition. These measures of market dominance, in the case of homogeneous products, are implied by one another given the formal linkage between the Lerner Index (percentage markup of price over marginal cost) and market shares (Raab 1980; Saving 1978). Wilson et al. (1988) extend that model to the case of differentiated products and applied the result empirically to the transportation industry.

Prior to passage of the Staggers Rail Act of 1980, the market dominance criteria were rebuttable in the sense that only if market dominance was established and not effectively refuted, would the ICC had jurisdiction over the rate. On the other hand, if the market dominance criteria were not satisfied then the shipper(s) could rebut the finding of no market dominance. In regulatory practice, under these rules, Friedlaender and Spady (1981) noted that "The commission has interpreted the existence of 'market dominance' in a narrow fashion... and generally prevented rate increases in the case where only one railroad serves a given area, even though trucks may offer substantial competitive alternatives."

Passage of the Staggers Rail Act of 1980 fundamentally changed market dominance standards in two ways. First, the performance standard (revenue to variable cost) thresholds were established through time and were made non-rebuttable if satisfied. That is, if the rate to variable cost ratio was below the current threshold, the rate was immune from ICC jurisdiction (ie the railroad is not market dominant). Second, the Act introduced product competition to be considered in determination of rate reasonableness. In light of these changes, the ICC subsequently replaced its earlier market dominance rules with a qualitative evaluation of product, geographic, intramodal, and intermodal competition (Ex Parte No. 320 (Sub. No. 2), Market Dominance Determinations and Consideration of Product Competition, 365 ICC 118 (1981)). Product competition was interpreted essentially as the economic capability of a shipper (supplier or receiver) to use an alternative or substitute product rather than the product transported. Geographic competition pertained to the capability of a receiver or supplier to originate the product from another source, or to ship it to another destination.

As discussed in Eaton and Center (1985), these concepts have been widely employed and are founded in antitrust litigation. They note that the fundamental criterion for product competition is the cross elasticity of demand and/or supply between the product and its substitute. On the other hand, interpretation of geographic competition is based on the area beyond which the company can sell its product. The salient aspect of geographic competition in transportation markets then becomes one of the areas a shipper and/or receiver obtains the product from, based on delivered prices.

MARKET DOMINANCE AND PRICING

Currently, market dominance is a qualitative finding with evaluation on the basis of modal, product, and geographic competitive pressures. Little, if any, research has been conducted to bridge the gap between theory and regulatory practice leaving the concept of market dominance without economic content. A model of railroad pricing encompassing both legislative and economic concepts of market dominance allows formal interpretation of market dominance.

Central to the model of pricing is the behavior of demand, which has received considerable attention in the transportation literature. Winston (1981, 1983, 1985) delineates these studies in two dimensions: aggregate and disaggregate. In aggregate studies, multiple shipments over some time horizon is the activity modeled (eg Oum 1979; Friedlaender and Spady 1980; Boyer 1977; Levin 1978). In disaggregate studies, decisions pertaining to mode, quantity, and/or geographic market for a single shipment at a given point in time is the activity modeled (eg Winston 1981; Daughety and Inaba 1981; McFadden et al. 1985). Some researchers have maintained that in many cases the disaggregate approach to modeling demand is preferred to the aggregate approach. For example, Winston suggests that the disaggregate approach is more firmly grounded in the institutional realities of decision making, allows a "richer" empirical specification, and allow a better understanding of competitive elements. In addition, as will be demonstrated in this section, the disaggregate approach is useful insofar as it provides a methodology to examine the impact of competitive pressures on railroad prices in a disaggregate setting and to develop a measurable index for market dominance.

The starting point for the analysis is an informal discussion of necessary conditions for a specific trade (trade gives rise to transportation demand) to take place between a given supplier and receiver of a product. In a price discovery framework, either the receiver or the supplier of a product quotes terms of trade which include the price, the quantity, etc. The trade takes place if and only if the offer received dominates other offers. Transportation costs must be incurred. These costs enter in terms of the offer or in terms of the decision to accept the offer. In terms of the specific product to be transported, the railroad must compete with other modes to obtain the traffic (modal competition). In addition, given the railroad is preferred to other modes for a specific movement, it obtains the traffic (origin-destination movement of a specific commodity) when that traffic (and resulting offer) is preferred to competing origins and/or destinations (geographic competition), or substitute products (product competition). The importance of such constraints on railroad pricing was demonstrated by Dempsey, who stated, "...The constraint is the fact a railroad is in business to move traffic. It has no interest in pushing the rate to a level that would force its own shipper out of the market." Of course, it is well recognized that there is traffic that the railroad does not seek (eg unprofitable branch lines). Conditions under which the railroad chooses not to dominate are identified as a special case of the ensuing model.

At the disaggregate level, the firm demanding transportation chooses not only the quantity to be shipped but also the mode by which the product is shipped. In the case of receivers, the particular product shipped and the origination of the product are also choice variables. In the case of suppliers, the terminal market (ie destination) is also chosen. With the exception of the quantities, the remaining choice variables are discrete, consisting of the mode, the origination, the terminal market, and/or the input used in production (ie the product shipped). For example, Wilson et al. (1986) investigate railroad pricing in a natural soda ash market for which a discrete alternative—synthetic soda ash—existed for the receiving firm. These choices are taken here as being discrete alternatives which may or may not be options depending upon whether a receiver or a supplier is the decision-maker. In either case, the railroad's problem is taken as choosing a price such that it maximizes profit.

Generally, transport demand decisions are reflected in the associated production technology T(Q,X), where Q is a vector of outputs and X is a vector of inputs. In recognition of the discrete nature of transportation decisions, the transformation function is taken as a set of discrete alternatives represented by

$$T(Q,X) = \{T_1(Q_1,X_1), \ldots, T_N(Q_N,X_N)\} \quad (1)$$

where

$T_i(Q_i,X_i)$ represents the ith technology;

Q_i represents the output vector under the ith technology; and

X_i represents the input vector under the ith technology.

In this framework, the firm demanding transport compares each potential subtechnology and chooses the particular subtechnology and input/output combinations yielding maximum profit. For

example, a grain elevator operator might simultaneously choose the amount of grain to ship, where to ship, and by which mode to ship.

Under the assumptions of price-taking, profit-maximizing behavior, and of appropriate regularity conditions, the results of the continuous decisions for each subtechnology can be reflected in a set of profit functions indexed by the subtechnology.

$$\pi = \{\pi_1(P,W), \ldots, \pi_N(P,W)\} \tag{2}$$

where π_i = the profit function associated with the ith subtechnology; P = a vector of output prices; and W = a vector of input prices.

The firm chooses the particular subtechnology (ie mode, source, terminal, or product as appropriate) which yield the maximum profit level. The choice I at given prices must satisfy $\pi_i(P,W) \geq \pi_j(P,W)$ for all j. The demand function facing the railroad is derived through Hotelling's lemma and is given by

$$\frac{-\partial \pi_i}{\partial W_i} = X_i^*(P, W) \quad \text{for } \pi_i \geq \pi_j \tag{3}$$

All other potential inputs pertaining to alternative discrete options are not chosen and set equal to zero for $j \neq I$. In such a case demand for transportation depends critically upon the differences in the opportunity set or technology. When confronted with a change in rail rates, the subtechnology choice as well as the quantity choice are reevaluated.

A railroad pricing decision over the traffic is considered to be limited by the constraint that a substitute (competitive) technology (ie either a substitute factor of production, the same or different factor from another source, an alternative mode, or an alternative terminal) is not chosen by the demander. In addition, the model is completely general in the sense that the resulting price may also be restricted by the threat of entry by a nonexistent competitor (eg the price may be constrained by the stand-alone costs of a potential entrant). In essence, railroad cannot charge a price so high that it is no longer the preferred mode, as discussed above. In such cases the railroad's profit maximization problem is given by

$$\underset{W_i}{MAX}\ \pi = W_i X_i^*(W_i) - C(X_i(W_i)) \quad \text{s.t } \pi_i \geq \pi_j \text{ for all j} \tag{4}$$

where W_i is taken as the rail rate. The Lagrangian is given by

$$L = X_i(W_i)W_i - C(X_i(W_i)) + \lambda\{\pi_i - \pi_j\} \tag{5}$$

and the associated first order conditions by

$$\partial L/\partial W_i = \{W_i - MC_i\}\,\partial X_i/\partial W_i + X_i(W_i) + \lambda \partial \pi_i/\partial W_i \leq 0 \tag{6}$$

$$\partial L/\partial \lambda = \pi_i - \pi_j \geq 0 \tag{7}$$

By noting $\partial \pi_i/\partial W_i = -X_i$, according to Hotelling's lemma, equation (6) can be rewritten

$$\frac{W_i - MC_i}{W_i} = (\lambda - 1)/\varepsilon_p \tag{8}$$

where ε_p is the price elasticity of demand.

Interpretation of (8) is illustrated with Figure 1. First, λ must lie in the closed interval [0,1]. At values greater than one, the railroad is the high cost producer and cannot compete even at marginal cost with the other discrete options (ie substitute subtechnologies) of the demanding firms. In Figure 1, this case pertains to prices where the constrained price (W^*) is less than the competitive ideal (W^c) ($W^* < W^c$). In such a case, by definition the railroad cannot be considered market dominant. At values less than zero the railroad is not profit maximizing and can increase profit by reducing its price ($W^* > W^m$). Values of λ at the extremes, zero and one, reflect the standard

models of monopoly (W^m) and competition (W^c). The closer λ is to one, the closer the market will be to yielding competitive results, while the closer λ is to zero, the closer the market will approach a monopoly solution.

The concept of market dominance can be interpreted directly from these results. When the railroad is the low cost discrete alternative, at least the possibility for market dominance exists. However, market dominance cannot be considered as a discrete finding except in the case where $W^* \geq W^m$. That is, when the railroad is the low cost producer, it is considered strictly market dominant only when the monopoly price is obtained. Of course, a monopoly is by definition market dominant. In the intermediate range, $W^c < W^* < W^m$, market dominance is a matter of degree. Competitive pressures constrain the market power of the railroad such that the observed price lies between the monopoly price and the competitive price. The range of prices over which competitive pressures may be effective depends on the price elasticity of demand for transport. When demand is relatively elastic, the range of rail prices is quite small. On the other hand, when demand is relatively more inelastic, the possible range of price is larger.

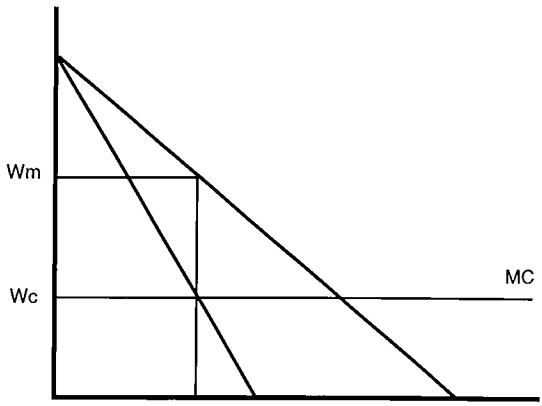

Figure 1 Market dominance outcomes

In evaluating the effectiveness of competitive pressures in restricting rail rates the model points to a number important considerations. First, the critical variable in evaluating the effectiveness of product, geographic, modal, and/or "hit and run" entry by a stand-alone competitor is that rail rate which causes the shipper/receiver to use a different product (eg a substitute input), to ship to or receive from a different location, or to use an alternative mode. Since differing discrete alternatives have different attributes, direct comparisons of rates and/or cost of providing the services are only relevant insofar as defining the rail rate necessary to induce demanders to switch to another discrete alternative.

The disaggregate demand literature has evolved into a framework that is useful in defining determinants of demander discrete decisions. Probability estimates are commonly formed for receivers or shippers in choosing a discrete alternative, given prices of differing alternatives and associated service attributes. The observed rail rate, in the context of this model, is the monopoly rate when the railroad is strictly market dominant or is that market dominant rate necessary to induce the demander to choose the railroad over other modes or other discrete alternatives. In cases where competitive pressures are effective, the model predicts that the associated probability is close to the probability estimate of the next best alternative. For example, the simple case of a binary choice problem (eg rail versus truck), the resulting probability would be predicted to be close to .5. In cases where competitive pressures are not effective, the probabilities may still be close, although clearly this need not be the case.

MCCARTY FARMS AND MARKET DOMINANCE

Market dominance as developed above is illustrated by using observed economic data taken from the recent McCarty Farms case. The McCarty Farms case pertains to the movement of wheat and barley from Montana origins to Pacific Northwest destinations. Such a market represents an interesting case to illustrate market dominance in that the length of haul is in excess of 1000 miles and truck is not typically a viable competitor. In 1980, McCarty initiated proceedings against the Burlington Northern (BN) charging unreasonable transportation charges and seeking reward of reparations. In 1981, an ICC Administrative Law judge found that the BN had market dominance and rates were unreasonable insofar as they exceeded two hundred percent of the variable cost of service. Recently, the McCarty Farms case has been decided in favor of the complainant—The Burlington Northern was found to be market dominant. The primary focus of the case has been to establish whether the BN was market dominant. Some of the evidence presented by complainants along the lines of intramodal, intermodal, product, and geographic dimensions are summarized in Table 1 and below.

Table 1 Market dominance evidence

Competitive Dimension	Evidence submitted
1) Intramodal	BN owns 91 percent of trackage.
	BN handles 99 percent of rail traffic.
	BN serves 98 percent of grain elevators.
	Other railroads, UP and Soo Line, serve 2 and 7 elevators, respectively.
2) Intermodal	BN handles 82 and 70 percent of wheat and barley, shipped to the PNW. Competing mode costs exceed BN's costs by 61 to 85 percent.
3) Product	Montana hard red wheat used for different end product than softer red and white wheat exported through the PNW.
	Montana hard red wheat higher in quality than those produced in other regions (higher premium for protein content).
4) Geographic	PNW ports handle 96% of wheat exported to Pacific Rim (primary market for Montana wheat)

Source: State of Montana, Department of Commerce.

Insofar as the variable cost measurement used in these proceedings is a reasonable approximation of marginal costs values for λ, the percent mark-down from the monopoly price can be calculated (Thompson 1982; Tye 1984a, Tye 1984b). Using this assumption, equation (8) is written in terms of the revenue/marginal cost ratio:

$$W/MC = 1/\{1 + (1 - \lambda)/ \varepsilon_p\} \quad (9)$$

The performance standards reported for the movement of Montana wheat and barley to the Pacific Northwest (PNW) were revenue-to-variable cost ratios of 240 and 250 percent, while from all other origins these ratios are 186 to 156 percent, respectively, were reported (Montana State, Department of Commerce). In equation (9), under the assumption that VC $\approx$ MC, W/MC is 240 and 250 in Montana, while from other regions W/MC is 186 and 156, for wheat and barley, respectively. If the BN is market dominant in the sense that 240 and 250 represent monopoly solutions, the implied elasticities of transport demand are -1.714 and -1.66, respectively. The corresponding implied elasticities for other regions are -2.163 and -2.7857 (if $\lambda = 0$). If the structural elasticity of demand at the monopoly point is considered to be represented by the Montana solution, while the corresponding elasticity of demand represented by other regions is a constrained solution, then the implied values for λ are 40.41 percent in the case of barley and 20.75 percent in the case of wheat. That is, in areas outside of Montana, competitive pressures mark the monopoly price downward by 20.75 and 40.41 percent for barley and wheat, respectively.

The estimates of the markdown of the monopoly price measured by λ may be reflective of a variety of different factors. The evidence submitted suggests railroads are generally the "low cost" mode. However, as stated earlier, differing modes have differing service attributes. The value demanders place on such attributes is critical to the demanders' decisions of which mode to use. An estimate of the value of these service attributes can be made to characterize the level of intermodal competition, as follows. First, if the railroad is taken to price up to the constraint that the demander is indifferent between modes of transportation. Second, in equilibrium, the price of the competing mode is written as a markup or a markdown of the set rail price as follows:

$$t = rs \tag{10}$$

where

t is the price associated with the other mode;

r is the price associated with the rail mode; and

s is the percentage premium markup ($s > 1$) or discount ($s < 1$) associated with the alternative mode relative to the rail mode.

Short-run equilibrium in the alternative mode market requires

$$t = MC_t \tag{11}$$

where MC_t is the marginal cost of providing the service. Observed in the evidence is the percentage markup of the rail rate to variable costs (k) and the relationship of alternative mode (truck - barge) costs to rail costs (F).

$$(r - MC_r)/r = k \tag{12}$$

Substitution of (10) into (11) for t and the result into (12) yields (13) after rearrangement.

$$s = \frac{MC_t(1-k)}{MC_r} \tag{13}$$

In (13) s is interpreted directly as a markup (markdown) factor associated with values placed on differing service attributes. In effect, the larger is s, the larger is the value demanders place on alternative mode attributes relative to the rail mode. Hence, even though the railroad is the low cost mode (ie on a marginal cost basis), the rate charged is constrained by the implicit premiums placed on service attributes. When s=1, relative service attributes are valued the same. In this case, the railroad price is constrained simply to the difference in costs between the two modes. Specifically, prices are the same, the other alternative is priced at marginal cost. The larger is the value placed on service attributes on the alternative mode relative to the rail mode (s>1) the smaller is the departure of the rail price from the other modes cost. On the other hand, when the railroad has preferred service attributes (s<1), the greater is the departure from the other modes cost—rail pricing power is enhanced. In the evidence, MC_t/MC_r ranges from 1.61 to 1.85, while k is 0.6 for barley and 0.583 for wheat. Substitution of these values into (13) yields values of s as given in Table 2.

Table 2 Markup factors (derived s values)

Cost Factor	Barley (k = 0.6)	Wheat (k=0.583)
1.61	0.644	0.67
1.85	0.74	0.77

Using a 70 cent per bushel rail rate as an example, these results imply a truck/barge rate of 54 cents per bushel of wheat to the PNW using a cost factor of 1.85. The result is a 16 cent service quality.

Comparison of R/VC ratios across similar shippers and of cost across competing modes are commonly followed practices in market dominance proceedings. The conceptual model presented

in the last section yields consider-able insight into railroad pricing as was illustrated in this section. First, the value of competitive pressures can have a significant impact on rail prices as measured by the markdown from the monopoly price. Second, even if competitive pressures are successful in reducing rail prices, the amount by which prices are reduced depends explicitly on the cost differential between the two modes and the relative value demanders place on service attributes.

SUMMARY AND CONCLUSIONS

Over the last decade, the general thrust of legislation affecting the railroad industry has been toward increasing the emphasis on market fundamentals in the determination of rail rates. While not totally deregulated, rail rates are only subject to reasonableness scrutiny if the railroad is found to be market dominant. Currently, a finding of market dominance is the result of a consideration of intramodal, intermodal, product, and geographic competition. The central contribution of this paper is an explicit representation of the market dominance criteria in a model of railroad pricing.

In general, the market dominance criteria are represented in demander decisions which form a constraint on railroad pricing. Specifically, the potential for demanders switching between alternative inputs (modes, production factors, etc) and/or production technologies is the salient feature of the competitive standards as defined by the market dominance rules. The switching basically refers to conditions necessary for transportation by rail to occur. Integration of such conditions into the railroad pricing decision yields three central results. *First*, if the railroad is the high cost alternative and does not have preferred service attributes, the railroad will not be market dominant--they are not the demander preferred option. *Second*, if demander alternatives are not effective in limiting rail rates, the railroad is market dominant in the traditional sense of a monopoly. *Third*, in all other cases the railroad rate is constrained by demander alternatives. The resulting rail rate does not imply market power is not being exploited, but rather that the degree of market power exploitation is limited by demander alternatives consisting of either product, geographic, and/or modal discrete alternatives.

In effect, the pricing power of the railroad, when limited by market dominance standards, is reflected by demander decision rules. Such rules depend on differences in technological processes, geographical alternatives, as well as other modes and the associated service attributes. These differences are measurable in terms of profit between differing alternatives and have formed the basis for the recent empirical research concerning transport demand. In that research the value of service attributes and/or the impact of service attributes and differing demander alternatives have been critical. As applied here, when differences in profit between transportation alternatives narrows the more effective becomes competitive pressures in constraining railroad market power. Railroads have less market power (product competition) when receivers are viewed as demanders, or as differing subtechnologies are readily adaptable. When demanders (receivers or suppliers) view differing modes as close substitutes or can send or receive the product to or from a variety of differing locations, modal and/or geographic competition are more prevalent and railroad market power is lessened.

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