Discussion Paper No. 478

REGULATION OF GROUPS OF FIRMS *

by

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April 1981

* This work was supported by the Transportation Center, Northwestern University. Special thanks to Dave Baron, Ron Braeutigam, Jay Hillman, John Kwoka, Leon Moses, Ed Prescott, Mike Scherer and Bob Taggert for useful conversations and suggestions.

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Distribution of this paper was supported under the Sloan Foundation grant for a workshop in applied microeconomics at Northwestern University.

1.0 Introduction

A common denominator of the vast majority of analyses of price regulation is that the regulatory restrictions in question can be examined at the level of an individual firm without reference to other firms in the industry. This reflects a view that either the analysis can be generalized to a multi-firm industry via replication (i.e. all firms act the same) or the industry is comprised of one firm (the monopoly case). Examples of the former situation are the standard analyses of price supports in agriculture and minimum wage legislation in perfectly competitive labor markets (see for example, Mansfield [1975]). The latter view has been exhaustively examined in the extensive Averch-Johnson literature (see, for example, Baumol and Klevorick [1970]), where a firm is price-regulated via a rate-of-return restriction. In both situations the analysis incorporates the notion that the firm's profit-maximizing strategies are only restricted by the regulation, and that the regulation falls inescapably on the firm in question.

In general, however, there are a number of regulated industries that are not properly modelled in the aforementioned fashion. These industries are composed of a number of firms of different sizes, yet subject <u>as a group</u> to regulatory control. For example, the Civil Aeronautics Board has used industry average rate-of-return for airlines to judge the reasonableness of fare adjustments (see Douglas and Miller [1974]). In the area of natural gas production, the Federal Energy Regulatory Commission (formerly the Federal Power Commission) established regional wellhead prices (MacAvoy [1979]), the main impetus being the number of firms being regulated and the resulting administrative difficulty of providing a case-by-case analysis. For many years the Interstate Commerce Commission regulated trucking via a group constraint known as the operating ratio; this will serve as a vehicle for our

analysis of group regulation. Insurance rates are often set by state regulators to cover losses, expenses and a profit factor based on aggregate industry experience (see Joskow [1973]). Adjustments (increases) to the number of taxicub licenses in Chicago are made if the ratio of operating expenses to gross revenues of all existing licensees falls below 84.5 percent (see Kitch et al [1971]). Finally, World War II price controls were, to some extent, based on using average cost data for each industry (see Harris [1945]).

As indicated above this paper will examine some of the effects on firm behavior of group regulation via a specific example of group regulation, namely the operating ratio in trucking (the ratio of operating costs to operating revenues). Previous analytical literature in this area is sparse. Nevel and Miklius [1968] pose a one-firm model with the firm attempting to minimize the ratio. Cherry [1978] and Moore [1978] pose a one-firm model with the firm maximizing profits subject to meeting a lower bound on the operating ratio; they find a labor-bias, complementary to the Averch-Johnson capital-bias. Studies of operating ratio regulation in general (though still with respect to a single firm) include Braeutigam [1980] and Westfield [1974].

In contrast, this paper will address the multi-firm aspect of such regulation. We will show that important anti-competitive effects can be generated: efficient firms have an incentive to help inefficient firms continue to exist. Moreover, this can lead to regulated prices being set above the monopoly price! This result follows not so much from the specific type of regulation (i.e. use of the operating ratio) as it does from the fact that firms face the restriction as a group, instead of individually.

Plan of the Paper

Section two provides a formal model of operating ratio regulation of an industry (in particular, a two-firm model with a low-cost and a high-cost firm). We see that, like Cherry [1978] and Moore [1978], a labor-bias (complementary to the capital-bias in the Averch-Johnson literature) exists. However, unlike Cherry and Moore, this bias directly affects the leader only; the follower is always on it's efficient expansion path.

More importantly, the two-firm model lets us examine a bias in price-setting by the leader so as to help the follower stay in business. In section two we find conditions under which market-sharing is optimal and provide a class of examples wherein the regulated price exceeds the monopoly price that would have occurred in an unregulated environment.

Section three provides some statistical support for the regulatory-induced inefficiency implied by the market-sharing analyzed in section two; it also provides a simple estimate of the cost of the regulation to shippers. Finally, section four provides a summary and conclusions.

2.0 Modelling Group Regulation via the Operating Ratio

Institutional Overview of Regulated Trucking[1]

Motor carriers have been subject to Federal regulation since 1935; for a review of the events leading up to the Motor Carrier Act of 1935 (and its incorporation into the Interstate Commerce Act in 1940) see Lockln [1972]. Not all motor carriers were regulated; for example, the hauling of agricultural and horticultural goods was specifically exempted, as were firms called "private carriers" whose carriage was limited to hauling goods for their own use or as a part of their business, wherein the actual trucking was a not-for-hire activity (e.g. stores with their own fleet of trucks for delivery of goods).

In 1943 the ICC decided to use the operating ratio (the ratio of operating costs to operating revenues) as the main test of reasonableness of motor carrier rate levels and earnings (see Dobesh [1973]). In particular, the ICC set a minimum operating ratio of 93 percent. As Dobesh [1973] shows, depending on a firm's investment levels, the operating ratio can be related to the firm's rate-of-return[2]. It is important to note, however, that the regulation was applied to groups of firms in a region organized into rate bureaus rather than to any one firm. Thus the criterion implied, often, a distribution of operating ratios, the standard procedure being for a rate bureau to submit a rate-level increase (often in the form of an across-the-board percentage rate increase[3]) along with a sample of members (volunteers) operating ratios. If the average operating ratio met the criterion of 93 percent, then the rate increase was allowed.

Rate bureaus exist as exceptions to usual anti-trust law: they are groups of firms that may legally discuss, and propose to the ICC, joint pricing strategies without fear of anti-trust prosecution.[4] Rate bureaus are geographically defined (for example, the Central States Motor Freight Bureau) and usually are large in terms of member firms. In general, the industry is characterizable as being composed of a few large firms and a number of small firms. In spite of regulation, all firms have some pricing power in a specialized way: often across-the-board rate increases were followed by individual firms requesting specific rate reductions for particular movements. Since these tariffs often represent the movement of a particular commodity associated with a particular shipper, such actions can be viewed as fine-tuning by a motor carrier so as to operate along it's demand curve.

Furthermore, there is anecdotal evidence that the smaller firms follow the lead of the larger firms in terms of the rate bureau discussions concerning proposals for across-the-board rate increases.[5] To capture the main aspects of this mixed environment we will view the industry as representable as a price-leader or Stackelberg equilibrium. In particular, we will characterize the industry as composed of an oligarchy and followers, with the firms in the oligarchy acting in unison vis-a-vis the followers. The followers are assumed to act in a Cournot-Nash fashion, i.e. they take the actions of all other firms as fixed when they make their decisions. All firms enjoy some pricing power and thus face a demand curve. We will abstract from service (quality) differences and assume a homogenous product and thus the decision variable for the firm is the amount of output to provide; this will lead to an aggregate output level for the industry. Since the industry (and each member firm) is assumed to know the demand curve, this will result in a price being set (i.e. proposed to the ICC via an across-the-board rate increase)

The use of a Stackelberg model, with the oligarchy viewed as the leader, of course eliminates consideration of interaction among members of the oligarcy. Since our main focus is on the interactions between the oligarchy and the followers, and not the sharing within the oligarchy, we will assume that the oligarchy has reached some market sharing arrangement (internally) and can act in unison as one firm.

Two other points deserve mentioning. First, the 93 percent criterion was applied to minimum and maximum rates, thereby neatly restricting all rate changes. Second, the ICC doggedly pursued the operating ratio criterion (of 93 percent) for twenty years (from 1943 to 1963) despite clear evidence of substantial rates-of-return in the industry. Dobesh [1973] shows a consistent ICC policy of rejecting rate-of-return-based protests of rate increases. In 1958 the ICC stated that such evidence needn't be discussed since "similar evidence, considered in several prior proceedings of this nature, was found to have no merit" (Dobesh, [1973], p. 62). As an example of such evidence, the USDA presented estimates in 1950 (undisputed, but rejected) that a proposed rate increase would result in a motor carrier rate-of-return on net investment of 53.8 percent (Dobesh, [1973], p. 61). Since the proposed increase met the 93 percent operating ratio criterion, it was allowed.

Thus an admittedly simplified, but reasonably accurate, representation of motor carrier regulation during the 1943-1963 time period would be the following:

1) Regionally defined groups of firms (rate bureaus) were regulated as to allowable price increases based on the group meeting a single criterion (the 93 percent operating ratio)[6].

2) Rate proposals were generally across-the-board rate changes by the rate bureau and can be viewed as based on a price-leader model, with firms facing a demand function.

3) The operating ratio was the single active criterion used in judging rate proposals; moreover, regulatees could generally depend upon the ICC to allow proposals that met the criterion in the face of protests based on other criteria (e.g. rate-of-return).

A Formal Model of Operating Ratio Regulation

Consider a two firm industry,[7] using capital and labor to produce a homogenous product, and facing an (inverse) industry demand function $P(\cdot)$. Both firms face known factor prices r (for capital) and w (for labor) and maximize profits (subject to any externally imposed constraints). Firm i faces a production function $F^i(K^i,L^i)$ and produces output Q^i. Thus, the associated cost function for firm i is $C^i(Q^i,r,w)$, and by Hotellings Lemma (See Varian [1978]) the factor demand functions are

$$L^i(Q^i,r,w) = \partial C^i(Q^i,r,w)/\partial w$$

and

$$K^i(Q^i,r,w) = \partial C^i(Q^i,r,w)/\partial r.$$

We will assume that the firms (either through historical accident or other forces) face different costs of production and we will assume that firm one enjoys the lower costs, i.e.:

$$C^1(Q,r,w) < C^2(Q,r,w) \quad \forall Q > 0.$$

Moreover, we will assume that firm one (due, perhaps, to its lower costs) acts as a price leader. In other words, firm two will be assumed to pick its output level on the assumption that firm one's level is fixed. More formally, firm two solves the following problem (we suppress r and w except where they are necessary for the analysis):

Firm Two: For given Q_1

$$\max_{Q^2} P(Q^1 + Q^2)\cdot Q^2 - C^2(Q^2) \ .$$

In what follows we assume that the demand function is downward sloping and that both cost functions are convex. Firm two can now be represented by a reaction function ϕ:

$$Q^{2*} = \phi(Q^1),$$

i.e. optimal output for firm two is directly linked, via ϕ, to the output level of firm 1. The following well-known result on reaction functions is provided as a theorem for the convenience of the reader.

Theorem If demand is downward sloping and concave and the firm's cost function is convex, then the reaction function ϕ has the property that $\phi' \varepsilon (-1,0)$.

Proof The first order conditions for the firm are that

$$P + P'\cdot Q^2 - C^{2'} = 0.$$

Differentiating and solving for dQ^2/dQ^1, we find that:

$$\phi' \equiv \frac{dQ^2}{dQ^1} = \frac{-(P' + P''\cdot Q^2)}{2P' + P''\cdot Q^2 - C^{2''}}.$$

The denominator is simply $MR^{2'} - MC^{2'}$, which by assumption is negative. Also by assumption, the numerator is positive. Thus $\phi' < 0$. Furthermore,

$$1 + \phi' = \frac{P' - C^{2''}}{2P' + P''\cdot Q^2 - C^{2''}} > 0 \implies \phi' > -1$$

Thus, under the condition of the theorem $\phi' \varepsilon (-1,0)$. In what follows we will assume that the conditions of the theorem are satisfied.

Now consider firm one, the firm with lower costs. We assume that firm one can calculate ϕ, and thus can act as a leader. This is not an unreasonable assumption, since often regulation of firms is accompanied by public disclosure of much firm specific cost information. Furthermore, some regulatory regimes allow for firms to get together to propose price changes (as is true of regulated trucking). Thus the profit function for firm one is taken to be

$$\pi^1(Q^1) = P\left(Q^1 + \phi(Q^1)\right)\cdot Q^1 - C^1(Q^1) .$$

Introducing the Regulatory Constraint

As the price leader, however, firm one must pick a price such that the industry satisfies the regulatory constraint. Let $\overline{OR}$ be the required ratio of the aggregate wage bill[8] to aggregate total revenues (i.e. $\overline{OR}$ is the minimal operating ratio for the industry). Formally, this translates into the following constraint:

$$w\{L^1(Q^1) + L^2(Q^2)\} \geq \overline{OR} \cdot \{P(Q^1 + Q^2) \cdot (Q^1 + Q^2)\}$$

where we have tacitly assumed that neither price nor aggregate output $Q^A(=Q^1 + Q^2)$ is equal to zero.

If the factor demand functions are convex in output then, under the previous assumptions on the demand function, the operating ratio translates into a restriction on (Q^1, Q^2) that can result in a non-convex feasible region. This is true since the above constraint concerns <u>upper</u> level-sets of a convex function, which are not, in general, convex. This is precisely the same problem as that observed by Takayama [1969] in the Averch-Johnson analysis. As Takayama notes, a constraint qualification is satisfied (via Theorem 3 in Arrow, Hurwicz and Uzawa [1961]) that allows us to use the usual Kuhn-Tucker-Lagrange conditions.

The Regulatory Constraint and Labor-Bias

The operating ratio constraint generates a labor-bias for firm one in the sense that the price of labor is effectively reduced relative to the price of capital. This effect (which was observed by Cherry [1978] and by Moore [1978] in the one firm case) only affects the leader; firm two is unaffected and operates where the marginal rate of technical substitution $\left(-F_K^2/F_L^2\right)$ is equal to the slope of an isocost line $(-r/w)$.

To see these results, we consider the first order conditions for firm one as it maximizes profit subject to the operating ratio constraint (we supress arguments of functions where convenient and we assume that second order conditions are met and that marginal products are positive):

$$1) \quad P + P'F^1(1+\phi') + \lambda^*\left[wL^{2\prime}\phi' - \overline{OR}\left(P + P'\cdot(F^1+\phi)(1+\phi')\right)\right] = r/F_K^1,$$

$$2) \quad P + P'F^1(1+\phi') + \lambda^*\left[w\left(\frac{1}{F_L^1} + L^{2\prime}\phi'\right) - \overline{OR}\left(P + P'\cdot(F^1+\phi)(1+\phi')\right)\right] = w/F_L^1,$$

$$3) \quad \lambda^* \geq 0,$$

$$4) \quad w\left[L^1(F^1) + L^2\left(\phi(F^1)\right)\right] = \overline{OR}\left(P(F^1+\phi(F^1))\cdot(F^1+\phi(F^1)\right).$$

Conditions (1) and (2) imply that

$$(5) \quad \frac{F_L^1}{F_K^1} = \frac{w(1-\lambda^*)}{r}.$$

Thus $\lambda^* \varepsilon [0,1)$, due to (3) and the assumption of positive marginal products. In particular, since we will assume that the regulatory constraint holds as an equality and is effective (i.e. depresses firm one's profits relative to the unconstrained case) then $\lambda^* \varepsilon (0,1)$.

Therefore, the effective wage rate $w_\lambda = w(1-\lambda^*) < w$, i.e. the firm's expansion path is more labor intensive, for a given level of output, under the regulation then it would be in an unregulated situation.

Notice that this bias does not extend to firm two. Firm two maximizes profit conditional on the level of output of firm one; thus, it does not directly face the regulatory constraint, and therefore it will equate the marginal rate of technical substitution and the slope of the isocost line. This is not, however, the end of the story, as we shall see below.

The Regulatory Constraint and Market Sharing.

Under what conditions is it optimal (for firm one) to share the market? To see, we consider the first order conditions for firm one, written in terms of the output space variables:

$$6)\quad P + P'Q^{1*}(1 + \phi') + \lambda^*[w(L^{1\prime} + L^{2\prime}\phi') - \overline{OR}\,(P + P'\cdot(Q^{1*} + \phi)(1 + \phi'))] = C^{1\prime}$$

$$7)\quad \lambda^* \geqslant 0$$

$$8)\quad w[L^1(Q^{1*}) + L^2(\phi(Q^{1*}))] = \overline{OR}\,(P((Q^{1*}) + \phi(Q^{1*}))\cdot(Q^{1*} + \phi(Q^{1*})).$$

Notice that firm one will set a price (and produce output Q^1*) that implies market sharing with firm two if

$$(9)\quad \{P + P'\tilde{Q}^1\,(1 + \phi') + \tilde{\lambda}\,[w(L^{1\prime} + L^{2\prime}\phi') - \overline{OR}\,(P + P'\cdot(\tilde{Q}^1 + \phi)(1 + \phi'))] - C^{1\prime}\}\,|_{\phi=0} < 0,$$

for $\tilde{Q}^1$such that $\phi(\tilde{Q}^1) = 0$ and for all $\tilde{\lambda}\varepsilon[0,1)$, i.e. if the derivative of the firm one Kuhn-Tucker-Lagrange function is negative when $\phi=0$ (when firm two isn't producing). This can be shown to be equivalent to the non-existence of a Kuhn-Tucker multiplier for the additional constraint $\phi(Q^1) \geqslant 0$ at the solution $\tilde{Q}^1 > 0$, $\phi(\tilde{Q}^1) = 0$. Since we know a solution (and a corresponding multiplier on $\phi(Q^1) \geq 0$) exists then this means that the constraint $\phi(Q^1) \geq 0$ must be slack in an optimal solution. This, in turn, implies condition (9) for market sharing. Intuitively, if we consider the Kuhn-Tucker-Lagrange function to be firm one's actual profit function, then condition (9) expresses the situation wherein, by supplying the entire market, firm one has driven marginal profits negative, and thus firm one should reduce output and share the market.

A minor amount of rearranging of terms results in the following equivalent condition for market sharing by the two firms under the regulatory constraint (at $\phi(\tilde{Q}^1) = 0$) :

$$(10) \qquad (P + P'\cdot\tilde{Q}^1)(1 - \tilde{\lambda}\ \overline{OR})(1 + \phi') - P\cdot\phi' < C^{1'} - \tilde{\lambda} w(L^{1'} + L^{2'}\phi')$$

The following Lemma provides a sufficient condition which we will use later.

<u>Lemma</u>: If $L^{1'} + L^{2'}\phi' \geq 0$ at $\tilde{Q}^1$ such that $\phi(\tilde{Q}^1) = 0$ and if

$$(11) \qquad (P + P'\cdot\tilde{Q}^1)(1 + \phi') - P\cdot\phi' < C^{1'} - w(L^{1'} + L^{2'}\phi')$$

at $\tilde{Q}^1$ such that $\phi(\tilde{Q}^1) = 0$, then market-sharing will occur.

<u>Proof</u>: Under the conditions of the lemma it is trivial to show that the right-hand-side of (11) is strictly less than the right-hand side of (10), since $\tilde{\lambda} < 1$. Similarily, the left-hand-side of (10) is strictly less than the left-hand-side of (11).

Therefore, given a cost function for firm one, the reaction function ϕ, the labor factor demand equations and the product demand functions, we can use

(11) to test for the optimality of market-sharing by the two firms.

An Example of Optimal Market-Sharing with Regulated Prices Exceeding the Monopolizing Price.

Let the (inverse) product demand function and the firm production functions be, respectively:

$$P(Q^A) = a-bQ^A \qquad a > 0,\ b > 0,$$

and

$$F^i(K^i,L^i) = A^i(K^i)^{1-\alpha}(L^i)^\alpha \qquad \alpha\varepsilon(0,1),\ i=1,2.$$

Then the cost functions and factor demand functions are straight-forward:

$$C^i(Q^i) = \gamma^i Q^i$$

$$L^i(Q^i) = \alpha\gamma^i Q^i/w \implies wL^{i\prime} = \alpha\gamma^i \qquad i=1,2,$$

where γ^i is a constant for each firm that is determined by A^i, α, r and w. In particular,

$$\gamma^1 < \gamma^2 \iff A^1 > A^2$$

Finally, let $\gamma^2 = (a + \gamma^1)/2 + \varepsilon$ (or more precisely, assume a value for A^2 so that this is true), with $\varepsilon \geqslant 0$. Then if firm one maximizes $\pi^1(Q^1)$ without being restricted by the operating ratio constraint, it is easy to show that firm one is a monopolist (i.e. $Q^{2*} = 0$) if $\varepsilon \geqslant 0$. In particular, if $Q^{1*} = (a-\gamma)/2b$ then the resulting price-output triple $\left(P(Q^{1*} + \phi(Q^{1*})),\ Q^{1*},\ Q^{2*}\right)$ is an equilibrium in the unconstrained two-firm model.

What happens if the operating ratio constraint is applied? Clearly, market-sharing ($Q^{2*} > 0$) would require a price <u>higher</u> than the unconstrained monopoly equilibrium price. To see if (and when) market-sharing can occur, we turn to condition (11). After a little algebra we have the following:

$$Q^{2*} > 0 \text{ if } \frac{2}{3b}\left(1 - \frac{\alpha}{2}\right)\left(a - \gamma^1\right) < \left(\tilde{Q}^1 \mid_{\phi=0}\right)$$

At $\phi = 0$, $\tilde{Q}^1$ is (from the unconstrained model) $\frac{1}{2b}\left(a - \gamma^1\right)$. Thus, condition (11) reduces to (assuming $a > \gamma^1$):

(12) $$Q^{2*} > 0 \text{ if } \frac{1}{2} < \alpha.$$

i.e., market-sharing will be optimal for firm one if the production function is labor-intensive.

<u>Implications of the Example and of Group Regulation</u>

Thus, for $\alpha\varepsilon\left(\frac{1}{2}, 1\right)$ market-sharing occurs even if the marginal cost for firm two is so high that the firm would not exist in the unregulated monopoly equilibrum. This occurs because it is profitable for firm one to set the price above the monopoly level and keep firm two operating rather than face the operating ratio constraint by itself. What seems to be a counter-intuitive result that regulation will lead to prices higher than the monopoly price is understandable if we recognize that the constraint acts to suppress revenues relative to short-run costs, and that one way to supress revenues is to raise prices above the unconstrained monopoly profit maximizing level. This result also accords with our intuition that a constraint on an industry average can provide an incentive for efficient firms (with comparatively low operating ratios) to want inefficient firms (with comparitively high operating ratios) to be around so as to "pad" the average.

We can see this effect diagrammatically by an appropriate manipulation of the firm one problem. Assume that long-run costs are separable into two parts: operating costs and non-operating costs i.e. $C^i(Q) = OC^i(Q) + NOC^i(Q)$. Thus, for example $OC^i(Q) = wL^i(Q)$ and $NOC^i(Q) = rK^i(Q)$ (where L^i accounts for the fixed proportions one driver - one truck relationship and K^i accounts for terminal facilities, etc.) This means that the optimization problem for firm one can be reposed as

$$\max\ P\left(Q^1 + \phi(Q^1)\right)\cdot\left(Q^1 + \phi(Q^1)\right)\cdot(1-\overline{OR}) - \Pi^2(\phi(Q^1)) - \left(NOC^1(Q^1) + NOC^2(\phi(Q^1))\right)$$

where $\Pi^2(\cdot)$ is firm two's profit function. For convenience, assume $NOC^2(\cdot)=0$, i.e. firm two is simply composed of rented trucks and drivers, with no fixed plant (terminals) to speak of. This is not unlike many of the small firms in the industry. Since $(\Pi^2)' = 0$ then the first order conditions for the above problem are simply:

$$(1 - \overline{OR})(1 + \phi')\ MR^T = MNOC^1$$

where MR^T is the aggregate marginal revenue and $MNOC^1$ is the marginal non-operating cost for firm one. Figure 1 below represents this result. In the diagram D^T is aggregate demand, MC^1 is firm one's marginal cost function, Q^{1M} is the quantity that firm one would supply as a monopolist at price P^M. The line labelled $(1 - \overline{OR})(1 + \phi')\ MR^T$ cuts $MNOC^1$ at the regulated output $(Q^1 + Q^2)^R$ which is sold at price $P^R > P^M$. Moreover, at $\widetilde{OR} > \overline{OR}$, (and for

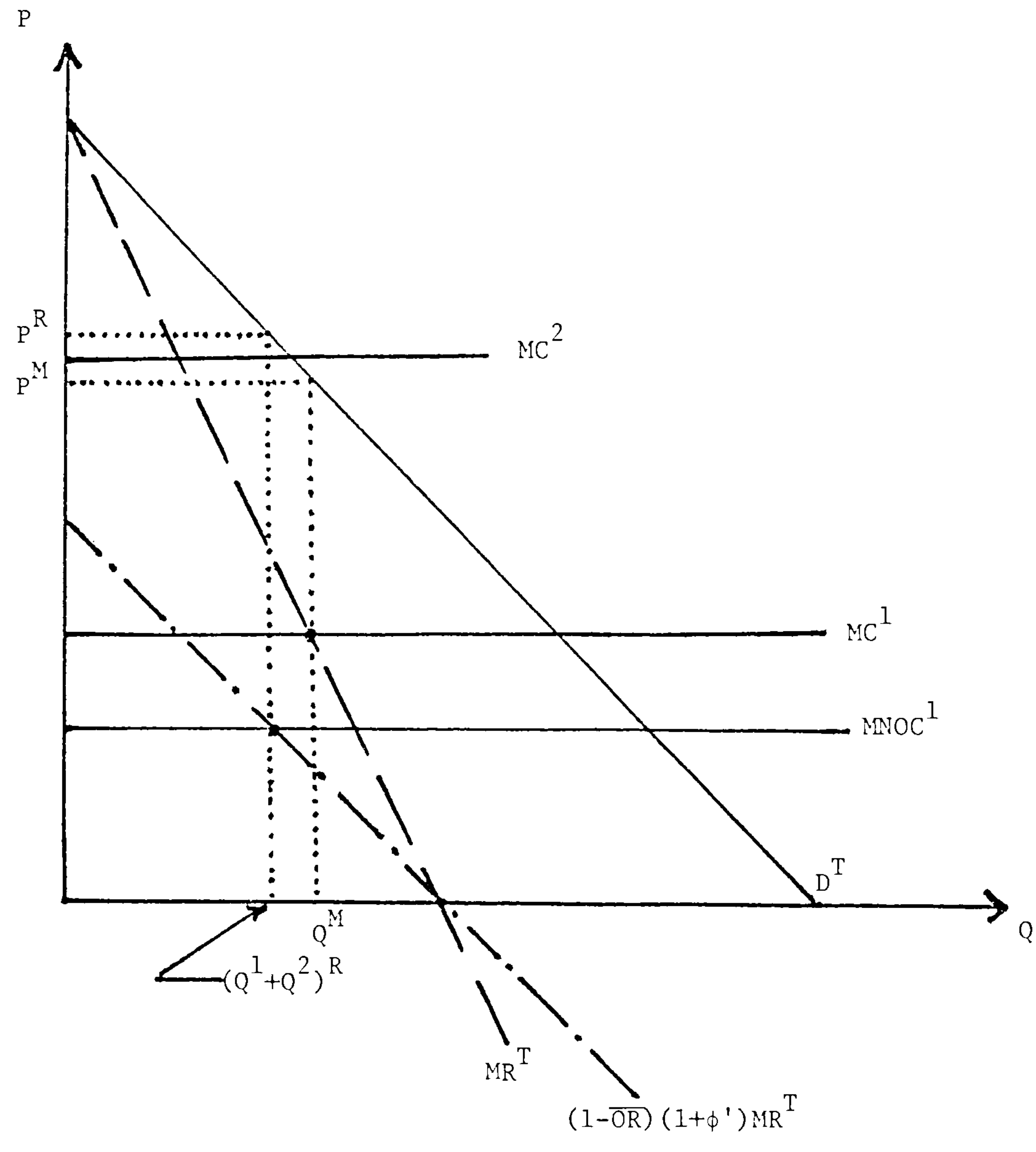

Figure 1

Group Regulation of a Two-Firm Industry

ϕ' a constant), we see that $P(\widetilde{OR}) > P(\overline{OR})$. In other words, increasing the required operating ratio can result in progressively higher and higher prices. This scenario is relatistic if opponents of the industry, observing high profits, can aggitate for an increase in the required operating ratio.

Thus, operating ratio regulation of the industry provides a number of perverse effects. First, the leader is made inefficient due to the labor-bias effect. This provides an interesting irony. The high-cost firm is not made more inefficient by this effect, since it is on its expansion path[9]; it is the low-cost firm that was made to operate in an inefficient manner. Thus, the industry as a whole is induced to be inefficient from society's point of view.

Second, we see something that cannot be observed in a one-firm model, namely that there are strong incentives for the leader to set prices so as to keep the high-cost firm in operation. This anti-competitive result is not so much an implication of using a particular regulatory measure (such as the operating ratio) as it is an implication of regulating a group of firms with respect to some average performance criterion. Such an approach encourages the low-cost firms to seek ways to subsidize the high-cost firms so as to reduce the impact of the regulation on low-cost-firm profits.

3. Testing for Market-Sharing and Calculating the Welfare Cost

The major empirical implication of the last section is market-sharing by inefficient and efficient firms. In this section we will use data on trucking firms, from the 1950 time period, to confirm the existence of market-sharing and to estimate the regulatory induced cost to shippers of maintaining such a system (i.e. the transfer from users of the service to the industry so as to maintain the market-sharing).

Market-sharing presumably leads to high profits for efficient (low average cost) firms. One would then expect to see that high-profit (hereafter referred to as hi-π) firms would have significantly lower operating ratios and average costs compared to the low-profit (low-π) firms. Moreover, hi-π firms should be few in number (compared to low-π) and probably different along other characteristics of their operation from low-π firms (for example, some measures of size of firm such as miles covered, tons hauled, etc).

Yearly data on trucking firms by region (see Appendix A for regional descriptions) covering operating ratios, revenues (including the proportion associated with intercity haulage), miles covered, tons hauled and ton-miles produced (the standard output measure) were collected for 1955 and 1957 from public records (Trincs [1956, 1958]). These two years were chosen to reflect the industry during high and low periods in the business cycle, since if evidence of market-sharing persists in the face of the cycle it would tend to support the contention that significant incentives were being provided (by the regulatory procedure) to encourage market-sharing. These data were used to construct (accounting) costs, average costs and profits. In what follows we will examine the largest region, the Central Region, in some detail. We will then expand the analysis to all regions and provide an estimate of the cost (to consumers of trucking service) of the market-sharing inefficiency.

The Central Region

In 1955 the Central Region was comprised of 378 general freight firms operating predominatly in Ohio, Indiana, Michigan and Illinois. This number fell to 167 firms in 1957, undoubtedly reflecting (among other things) the recession that started in 1957 (e.g. there were 377 firms in the Central Region at the end of 1956).

A small number of these firms were local transporters of goods, usually in the commercial zone, and thus not subject to regulation. The standard definition of such local firms is that less than 75 percent of their operating revenues are associated with intercity moves. These firms, and any remaining ones not reporting complete data, were removed from consideration, resulting in 306 firms in 1955 and 156 firms in 1957.

Firms were segmented into hi-π and low-π groups, based on accounting profits[10]; Table 1 displays information on various characteristics of the two groups. In 1955, eight firms were similar in characteristics and formed the hi-π group; 1957 had only five such firms. Since hi-π group membership is inferred via data, this is clearly a potential source of error in the results presented. However, in general (in fact in both years in almost all regions) a small group of firms would exist with significantly higher profits, lower average costs, etc.

As can be seen from Table 1, the typical 1955 hi-π firm earns ten times the revenues by producing eleven times the output (ton-miles) while hauling only six times the tons on a system that is over eleven times as large, incurring only half the average costs. Thus the average hi-π firm has a large network to operate (which can contribute to cost reductions via matching of

TABLE 1
CENTRAL REGION
1955, 1957

Average Firm Characteristics	1955 Value	1955 Ratio	1957 Value	1957 Ratio
Operating Ratio	.929[1] .963	--	.921[1] .978	--
Revenues (000)	22889 2197	10.4	28639 4462	6.4
Tons (000)	928 149	6.2	795 246	3.2
Miles (000)	35238 3310	10.6	41676 5830	7.1
Ton-Miles (000)	411471 35747	11.5	525874 67077	7.8
Average Cost	.058 .108	.53	.052 .091	.57
Profits (000)	1463 81	18.1	2074 105	19.8

1: Table entry: $\frac{\text{hi-}\pi}{\text{low-}\pi}$

loads in opposite directions -- called load-balancing), and appears to haul the higher revenue generating loads (revenue per ton is almost twice as high for hi-π firms as for low-π firms).

A similar pattern emerges for the region in 1957. Even though the industry is half as big as before, the improvement in low-π average cost clearly indicates that a major effect of the shake-out was the demise of the most inefficient firms (a reasonable result). The same pattern of high-revenue generating moves on a large network appears. Note also that both hi-π and low-π systems have, on average, expanded, no doubt through the bankruptcies that occurred in 1957 as the industry shrank in number of firms.[11]

In 1955, the hi-π firms, which were only 3 percent of the number of firms, as a group accounted for 22 percent of the revenues on almost 24 percent of the output produced; values for 1957 were 17.5 percent and 21 percent respectively. Finally, average costs and operating ratios of the hi-π firms are significantly different from those of the low-π firms (at .01 and .02 Type I error-level respectively) in both years.[12]

Given the above, it does not seem unreasonble that the hi-π firms act as industry leaders in price setting (as noted in section one; see footnote 5). The data appear to support the notion of market sharing by efficient and inefficient firms, with the result that prices must be high enough to support the existence of the inefficient firms. This occured in the face of a major recession as well as in a "boom" year.

Transfer Computations for the U.S.

This analysis has been extended to the U.S. for both years. This allows us to estimate the transfer from service consumers to the inefficient firms by multiplying this difference by the total low-π ton-miles.[13] Thus, we will assign the low-π ton-miles to the hi-π firms and assume that they can carry them at their current average costs (i.e. they face constant returns-to-scale as they expand output); this is shownin Figure 2 below. AC_2 is the average cost for a low-π firm while AC_1 is the average cost for a hi-π firm. Q_2 is the amount of ton-miles provided by the n_2 low-π firms while n_1, is the number of hi-π firms. The hatched area is the transfer.

Under these assumptions, the U.S. transfer rectangle implied for 1955 is 1.2 billion dollars while the U.S. transfer cost rectangle for 1957 is 1 billion dollars (both figures in their respective year dollars). To put this in perspective, this was 54 percent and 38 percent of the costs incurred by the intercity trucking industry in 1955 and 1957 respectively. Moreover, these transfers were 52 percent and 37 percent of intercity trucking revenues in 1955 and 1957 respectively. It should be noted that the above percentages make sense since a number of firms made negative accounting profits, and thus, for them, price was below average cost.

A caveat is clearly called for since there may be a difference in the type of goods carried and the nature of markets served by the two types of carriers. In other words, it may not be legitimate to transfer the output from the low-π firms to the hi-π firms and assume that this does not affect (i.e. raise) hi-π marginal costs. This would imply that our estimate above <u>overestimates</u> the transfer.

To capture this, let us assume that average costs for the hi-π firms rise linearly from their present level to the observed low-π firm level, as indicated by the diagonal line in Figure 2. Thus, the transfer would now still be quite sizable (at half the previous stated amounts). This would appear to be the most extreme case[14] and thus the actual transfer probably lies between the two computations.

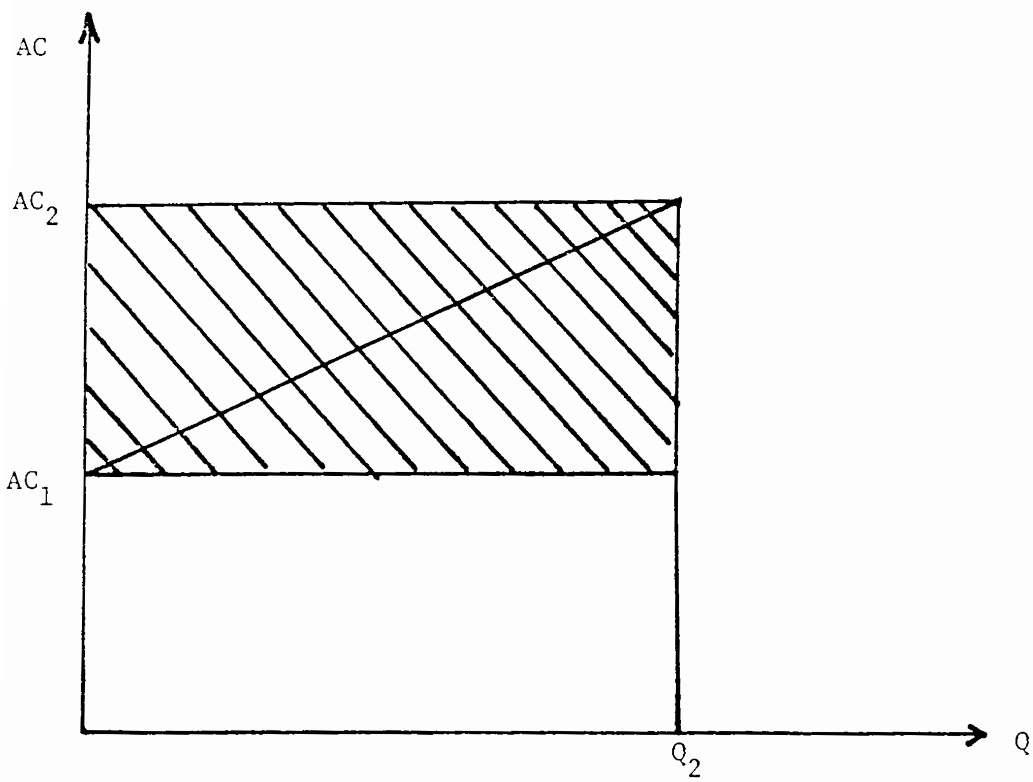

Figure 2

Transfer Computation

4.0 Summary and Conclusions

The previous three sections have provided an institutional, theoretical and empirical analysis of regulation of groups of firms, especially considering the operating ratio in trucking. Following from the institutional discussion in section two, we posed a model of a regulated, two firm industry with the leader maximizing profits subject to the industry meeting a regulatory constraint. Under the assumption that labor was a major factor in operating costs, we analyzed the operating ratio constraint as complementary to a classical Averch-Johnson model and found the standard result, namely that a labor bias would exist. This bias, however, was seen to be unevenly distributed: only the leader suffered from it. Such a bias would tend to disappear (or become trivial) in industries significantly less labor intensive than trucking.

More importantly, we found the intuitively reasonable result that regulation based on group averages can provide anti-competitive incentives in terms of market-sharing by efficient firms with inefficient firms, with the further undesirable result of regulatory-induced high prices. In particular, a class of examples was produced wherein the regulated price would be set above the unregulated monopoly price, clearly not an activity that a regulator should engage in. This last result is attributable directly to the procedure of setting and using group criteria. While we examined this in the framework of the operating ratio (and in terms of labor expenses as the determinant of operating cots), it would seem intuitive that using group procedures (as opposed to restrictions actually imposed on the individual firms) will typically generate anti-competitive actions on the part of firms.

In section three we examined data from the trucking industry for the years 1955 and 1957. The data strongly support the notion of market-sharing with a few high-profit, low average cost, large firms coexisting with many low-profit, high average cost firms. The market-sharing existed in spite of significant swings in the business cycle or region of the country. In particular, we estimated that the cost of regulatory-induced market-sharing was approximately one billion dollars a year, or approximately one-half the total intercity trucking transport bill during those years.

Thus, the costs of using group regulation can be formidable. Clearly, such regulation was sometimes employed due to the perceived costs of a case-by-case approach, as occurred in natural gas (see MacAvoy [1979]). Since, as Hughes [1977] points out, our national history involves a long sequence of examples of market interference and that "not only are our controls congenial to our social system, but the controls are believed to be desirable for their own sakes" (Hughes [1977], p. 10), then to the degree that one would expect to see regulation expand towards industries with large numbers of firms (or products as, for example, the use average fuel efficiency requirements in the automobile industry; see Kwoka [1980]), this trade-off between individual firm restrictions and group restrictions will be encountered again and again. As we have seen above, the alternative of group regulation can imply very high costs.

FOOTNOTES

1. Two sources have been used extensively for this subsection. First, an excellant institutional discussion of motor carrier financial regulation can be found in Dobesh [1973]. Locklin [1972] provides a general review of motor carrier regulation.

2. Dobesh provides a hypothetical example for a firm with a 95 percent operating ratio that corresponds to a 20 percent rate-of-return (see Dobesh [1973], p. 51).

3. The ICC has encouraged general rate increases, as opposed to firm-by-firm review, almost since the beginning of motor carrier regulation; see Dobesh [1973], pp. 182-184.

4. Recently, rate bureau discussions have become significantly more restricted then was true earlier. Of course, firms always had the right of independent action. For a discussion of rate bureaus and anti-trust law, see Davis and Sherwood, [1975].

5. This comes from private discussions with officials of trucking firms.

6. There is some confusion in the literature about how this is calculated. The aggregate operating ratio should be the ratio of aggregate costs to aggregate operating revenues (aggregation over the group of firms). It appears that the average of the operating ratios may have been used, which clearly diverges from the aforementioned ratio, since market shares are unequal. To the extent that this second measure was used, and to the extent that the firm market share is negatively correlated with firm operating ratio, then the use of the average of the operating ratios benefits large efficient firms.

7. Superscripts will be used to denote individual firm functions. Primes and subscripts (usually letters) will denote derivatives and partial derivatives.

8. For analytical convenience, we shall adopt the representation used in Cherry [1978] and Moore [1978] of operating costs as labor costs. As Moore observes [1973, p. 331], labor costs are over 60% of operating costs in this industry.

9. Of course, since the labor-bias in firm one affects its choice of output level, then the labor-bias indirectly affects firm two.

10. Of course, one would expect the leaders to be characterized by large market shares and high profits relative to the followers. In general, we shall see that the high profit firms have (relatively) large share of the market. One could also segment based on output; this was done and similar results were found except that operating ratios for the two groups were essentially the same showing that there are a few large firms which are inefficient (relatively). Thus, we have chosen to use profit as a segmenting measure, so as to separate the firms into groups reflecting some notion of efficiency.

11. While some of the difference between the two years can be attributed to non-reporting, the reported 1957 miles covered is approximately ninety percent of the reported 1955 miles. Thus the conclusion that most of the shrinkage in numbers of firms between the two years is due to bankruptcy and merger appears to be supported.

12. Based on a difference of means test under unknown and unequal variances; see Kendall and Stuart [1973].

13. In 1955 and 1957 the Midwestern region segmentation on the basis of profits did not yield low-π average costs above hi-π average cost (they were approximately equal). This was also true for the Mid-Atlantic region in 1955. All other regions in both years evidenced low-π average costs above hi-π average costs, usually by a factor of 1.5 or greater.

14. Obviously, an even more extreme case is to assume average costs jump to the low-π level when any positive amount is transfered from low-π to hi-π firms. This is unreasonable however; while the product mix carried and markets served by hi-π firms undoubtedly differs from that carried and served by low-π firms, hi-π firms do handle some of the same type of traffic as the low-π firms. Thus, a reasonable extreme case is the one posed.

Appendix A
REGIONS

New England
- Connecticut
- Maine
- Massachusettes
- New Hampshire
- Rhode Island
- Vermont

Middle Atlantic
- Delaware
- District of Columbia
- Maryland
- New Jersey
- New York
- Pennsylvania
- West Virginia

Southern
- Alabama
- Florida
- Georgia
- Kentucky
- Mississippi
- North Carolina
- South Carolina
- Tennessee
- Virginia

Central
- Illinois
- Indiana
- Michigan (lower peninsula)
- Ohio

Northwestern
- Michigan (upper peninsula)
- Minnesota
- North Dakota
- South Dakota
- Wisconsin

Midwestern
- Iowa
- Kansas
- Missouri
- Nebraska

Southwestern
- Arkansas
- Louisiana
- Oklahoma
- Texas

Rocky Mountain
- Colorado
- Idaho
- Montana
- New Mexico
- Utah
- Wyoming

Pacific
- Arizona
- California
- Nevada
- Oregon
- Washington

References

Arrow, K.J., L. Hurwicz and H. Uzawa, "Constraint Qualifications in Maximation Problems," Naval Research Logistics Quarterly, Vol. 8, No. 2, June 1961, pp. 175-191.

Baumol, W.J. and A.K. Klevorick, "Input Choices and Rate-of-Return Regulation: An Overview of the Discussion," The Bell Journal of Economics and Management Science, Vol. 1, No. 2, Autumn 1970, pp. 162-190.

Braeutigam, R.R., "The Regulation of Multiproduct Enterprises by Rate of Return, Markup, and Operating Ratio," forthcoming in Research in Law and Economics.

Cherry, R., "The Operating Ratio Effect and Regulated Motor Carriers," in Proceedings of a Workshop on Motor Carrier Economic Regulation, National Academy of Sciences, Washington, D.C., 1978, pp. 269-289.

Davis, G.M. and C.S. Sherwood, Rate Bureaus and Antitrust Conflicts in Transportation, Praeger, New York, 1975.

Dobesh, L.J., Earnings Control Standards for Regulated Motor Carriers. Unpublished Ph.D. dissertation, Washington State University, 1973.

Douglas, G.W. and J.C. Miller, III, "The CAB's Domestic Passenger Fare Investigation," The Bell Journal of Economics and Management Science, Vol. 3, No. 1, Spring 1979, pp. 205-222.

Harris, S.E., Price and Related Controls in the United States, McGraw-Hill, New York, 1945.

Hughes, J.R.T., The Governmental Habit, Basic Books, New York, 1977.

Joskow, P.L., "Cartels, Competition and Regulation in the Property-Liability Insurance Industry," The Bell Journal of Economics and Management Science, Vol. 4, No. 2, Autumn 1973, pp. 375-427.

Kendall, M.G. and A. Stuart, The Advanced Theory of Statistics, Vol. II, Third Edition, Hafner, New York, 1973.

Kitch, E.W., M. Issacson and D. Kasper, "The Regulation of Taxicabs in Chicago," The Journal of Law and Economics, Oct. 1971, pp. 285-350.

Kwoka, J.E., "The Behavior of Auto Firms Under the Fuel Economy Constraint," Working Paper, Department of Economics, Northwestern University, 1980.

Locklin, D.P., Economics of Transportation, Seventh Edition, Richard D. Irwin, Homewood, Illinois, 1972.

MacAvoy, P.W., The Regulated Industries and the Economy, Norton, New York, 1979.

Mansfield, E., Microeconomics, Second Edition, Norton, New York, 1975.

Moore, T.G., "The Beneficiaries of Trucking Regulation," The Journal of Law and Economics, 1978, pp. 327-343.

Nevel, R. and W. Miklius, "The Operating Ratio as a Regulatory Standard," Transportation Journal, Winter, 1968, pp. 15-18.

Takayama, A., "Behavior of the Firm Under Regulatory Constraint," American Economic Review, June, 1969, pp. 255-260.

Trinc's Blue Book, 1956 Edition, 1958 Edition, Trinc, Washington, D.C., 1956, 1958.

Varian, H., Microeconomic Analysis, Norton, New York, 1978.