AN EMPIRICAL EXAMINATION OF MARKET ACCESS

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ABSTRACT

We examine firm decisions to enter markets under conditions of joint production and entry regulation. When firms provide capacity to one market they necessarily provide capacity to additional markets. To utilize capacity, firms must incur access costs. Access costs vary across firms, and low-cost firms earn profits. Entry regulation restricts access to markets that otherwise would receive service resulting in unused capacity and artificial rents. In the empirical application, we observe truckers with and without operating authority and find firm regulatory status and other firm attributes dramatically influence firm decisions to access markets resulting in unused capacity and profits.

INTRODUCTION

In this paper, we consider the effects of price and entry regulation under conditions of joint production. In the model, firms producing in one market necessarily provide capacity to a second market. Whether firms produce in this second market depends critically on the costs of accessing the second market. Empirically, the cost of accessing markets is a function of firm attributes. The most notable attribute is whether entry

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regulation restricts the firm from producing in a subset of the markets. In the empirical examination of truck markets, we find significant differences across firms in accessing secondary markets. These differences likely result in profits or returns to operating authority, depending on the source of the differences.

Most economists agree that entry restrictions generally create artificial "regulatory" rents. In general, these studies have entry regulation retarding entry by new firms, with the entry restrictions resulting in greater profits to incumbent (regulated) firms.[1] For example, Paul (1982) found that licensure restrictions in the medical profession transfer wealth from consumers to producers,[2] while Eckard (1985) finds a similar result in the state regulation of entry into the car dealer market.[3] A host of others studies take the result that entry restrictions increase profits to incumbent firms as given and examine the determinants of the level of profits associated with entry restrictions. For example, Kitch, Isaacson and Kasper (1971) use taxicab medallion prices in Chicago, while Breen (1977), Moore (1978), and Frew (1981) use the price of operating rights as a measure of value of monopoly rights in truck markets. In truck markets, entry has historically been restricted by the Interstate Commerce Commission (ICC). To provide service to all but a select few commodities (e.g., unprocessed agricultural commodities) a trucker must have the authority to operate. The authority for interstate transportation of commodities is granted by the ICC. However, the authority once granted is commonly leased or traded among firms (subject to ICC approval). In the context of this paper, the use of prices at which authority is traded is the value of the "right to access" markets.

In this research, we extend the empirical results of entry restrictions to multiple markets. While the effects of entry restrictions on a market are well known, the effects of entry regulation in multiple markets are not well known and have not been fully evaluated empirically.[4] Further, much has occurred since the research of Breen, Moore, and

Frew in the trucking industry. In 1980, the industry was substantially deregulated and regulatory impediments to entry have declined.[5] However, our empirical results together with the perceptions of truckers suggest entry restrictions still impede and, in fact, are significant in reducing market access.

Our empirical model applies to truckers primarily engaged in the transportation of agricultural commodities. When transporting agricultural commodities, truckers do not face economic regulation of entry or prices. However, on return movements (or the second leg) of a round trip, truckers commonly face entry restrictions. Since truckers, in our study, generally operate from origin A to destination B and back to A,[6] they produce round trips. In providing round trips, they provide capacity to non-regulated markets (A to B market) and the regulated market (B to A) market. Thus, the data provide an excellent opportunity to evaluate the influence of entry restrictions under conditions of severe cost complementarities.

JOINT PRODUCTION AND PRICES IN TRANSPORT MARKETS

There have been several studies examining the effects of joint production in motor carrier markets. First, there are several studies that examine the effects of traffic imbalances between fronthaul (high demand) and backhaul (low demand) markets on price levels in each market.[7] In Nicholson (1958), fronthaul prices adjust to compensate the carrier for round trip costs while prices in backhaul markets are bid to the "small" incremental costs of a backhaul.[8] In contrast, Miklius and DeLoach (1965) maintain that firms make decisions on an expected round trip profit basis. Thus, fronthaul prices need not compensate for the entire round trip costs.[9] Wilson (1987) provides some empirical evidence that is consistent with the one-way compensation hypothesis that prices adjust to the no-backhaul firm (Nicholson). However, these findings were based on data taken

from the pre-1980 period, and therefore, do not reflect the effects of deregulation. Further, the effect of regulation on firm decisions to access backhaul markets was not considered empirically.

If prices support the marginal firm, but all firms are equally efficient, the round trip compensation hypothesis would likely hold. With no artificial restrictions on entry, no firms earn profits, capacity is fully utilized, etc. However, if there are differences in costs and the one-way compensation result holds, the non-marginal firms may earn scarcity rents if backhaul prices are more than the small incremental marginal cost of a backhaul. Further, if regulation causes firms to have unequal access to markets, the result under the one-way compensation principle gives the potential for profits to be earned by firms with access advantages.

Felton (1981) casts the symmetry of production in fronthaul and backhaul markets in a competitive equilibrium.[10] He finds conditions that fronthaul prices need not be compensatory, but there are no empty return trips. Round trip revenues share the marginal costs of loaded round trips. However, when empty return movements are present, fronthaul prices are compensatory. That is, fronthaul prices reflect costs of the no-backhaul firm. In the backhaul market, prices are bid to the marginal cost of the backhaul traffic.

A second area of research concerns the determinants of firm decisions to travel empty. Empirically, this has been addressed by Beilock and Kilmer (1986) and Wilson (1987). Beilock and Kilmer (1986) used a logit model based on an expected profit context in which the firm decides whether to obtain a backhaul. They found distance, size of firm, operating authority (the presence of asymmetric entry restrictions across firms), market conditions through time, and whether firms have a fronthaul load setup to be the critical determinants in the likelihood of a firm being loaded. Of particular interest to this work

is their finding that the probability of being loaded varies by firm attributes. They found fleet carriers with authority were the most likely firms to be loaded on the backhaul movement, while private carriers without authority were the least likely to be loaded. Wilson (1987) found that market conditions through time, market conditions across markets, and firm experience are significant factors in the firm's ability to attract backhauls. Both studies provide considerable evidence of asymmetries across firms in accessing markets.

In this research, we expand the general framework to reflect long-run equilibrium under entry regulation and asymmetric costs across firms in accessing markets. The results allow for the identification of the potential for scarcity or regulatory rents from the presence of entry regulation. Critical to the results are asymmetries in access costs across firms. This research extends the previous literature by using data pertaining clearly to firms operating in symmetric markets. This allows the effects of entry regulation to be isolated on joint production.[11]

THEORY

We base the theory on price-taking firms supplying capacity (round trips) between two markets labeled the fronthaul (f) and the backhaul (b). The capacity supplied by firms can be used in either the fronthaul or the backhaul markets after incurring access costs of a^f and a^b, respectively.[12] The cost of supplying capacity, C(T), is the round trip cost between markets without being loaded on either leg, while the access costs are the incremental costs of finding and delivering a load on either leg.

Firms, facing prices P^f and P^b, choose the level of capacity (T) and the particular set of markets to access. Let δ^f and δ^b be binary variables taking a value of one if the indexed market is served and zero otherwise. There are four possible sets of markets

(δ^f,δ^b) the firm can choose to access. They are: 1) both markets (1,1); 2) only the fronthaul market (1,0); 3) only the backhaul market (0,1); and 4) neither market (0,0).

At a minimum, the market price must, at least, compensate access costs for a particular market to receive service. Hence, $P^f \geq a^f$ and $P^b \geq a^b$ are necessary conditions for the firm to access the fronthaul and the backhaul market, respectively. We define these conditions as the "market access conditions." Let Φ be the set of satisfied market access conditions. Then the firm's profit maximization framework can be written

$$(1) \qquad \text{Max } \pi = \Sigma_{i\in\Phi}(P^i - a^i)T - C(T).$$

The first order condition is

$$(2) \qquad \frac{\partial \pi}{\partial T} = \Sigma_{i\in\Phi}(P^i - a^i) - C'(T) \leq 0.$$

By equation (2), at least one of the market access conditions must be satisfied. However, for any service to be provided, equation (2) must be satisfied in the interior. That is, round trip revenues net of access costs must compensate the marginal capacity cost of providing the round trip. Round trip revenues consist of the fronthaul and the backhaul revenues (case 1), the fronthaul alone revenues (case 2), or the backhaul alone revenues (case 3). If revenues from the round trip net of access costs do not compensate marginal capacity costs at any level of service, then no service is provided (case 4). We define the condition that round trip revenues compensate both access and marginal capacity costs as the "market service condition."

We illustrate the results in Figure 1. Note that cases 2 and 3 are symmetric and that if case 4 holds, no capacity is observed in the market. Thus, we focus only on cases 1 and 2. In case 1, the market access conditions for each market and the market service conditions hold. Each market then at least compensates access costs, and the pair of

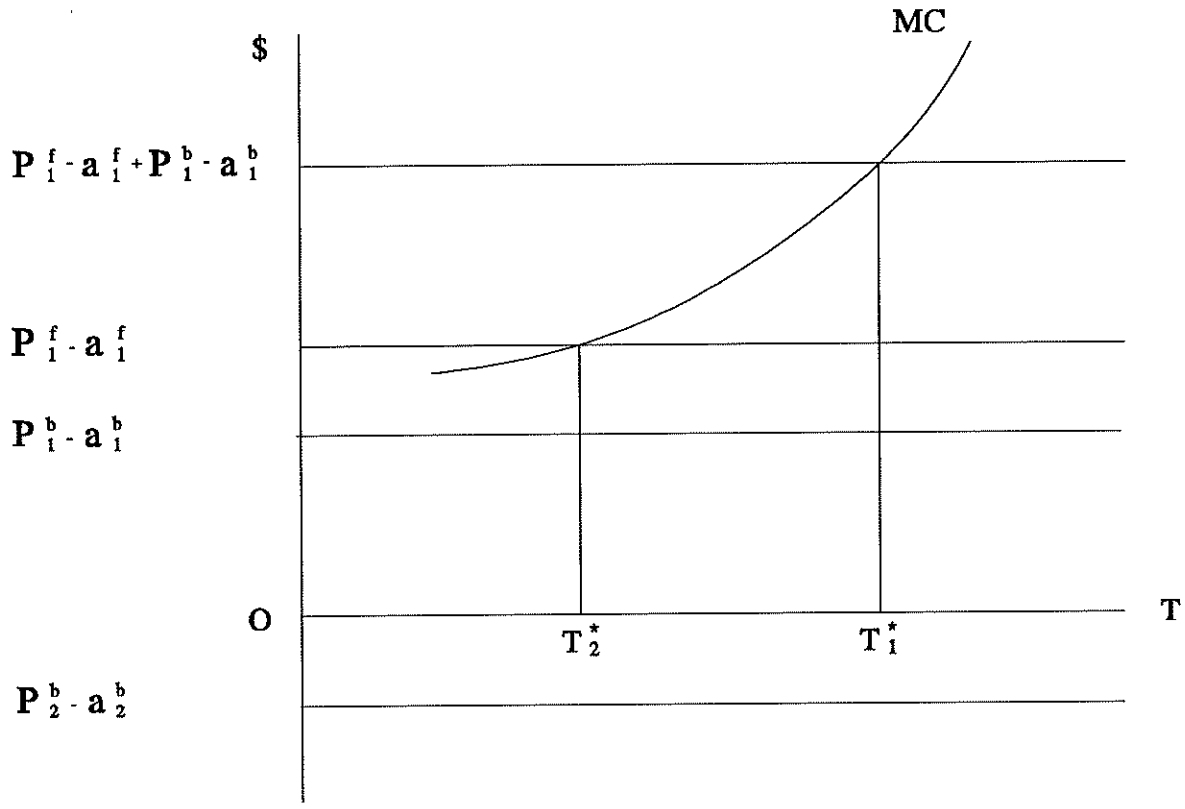
markets compensates marginal capacity costs. The firm, therefore, serves both markets and provides a capacity level of T_1^*.

In case 2, the market access condition holds for the fronthaul market ($P_1^f \geq a_1^f$), but not for the backhaul market ($P_2^b < a_2^b$). In this case, the market service condition can be satisfied only from fronthaul revenues. Thus, the firm serves only the fronthaul market and produces T_2^*. In comparing cases 1 and 2, when backhaul prices net of access costs in case 1 ($P_1^b - a_1^b$) decline, the firm responds by providing less capacity. When backhaul prices are bid to access costs ($P_1^b - a_1^b = 0$), T_1^* collapses to T_2^*. In this context, both the one-way compensation (e.g., Nicholson) and round trip compensation (e.g., Miklius and DeLoach) principles are consistent with profit maximizing behavior of firms. Under the one-way compensation standard (Nicholson), firms provide capacity to both markets, but access only one market. Under the round trip compensation standard (Miklius and DeLoach), firms provide capacity to and access both markets. Further, only in the former case (in the existing model) can there be excess capacity as measured by empty trips (Felton).

In truck markets, we observe simultaneously firms which are loaded and firms that are not loaded. In the above model, this case can hold only if prices in one leg are bid to access costs. However, if prices are in excess of access costs, the models cannot explain excess capacity. We generate the result by expanding the model for asymmetries in access costs across firms. From this framework, we are able to observe excess (unused) capacity as measured by empty trips on one leg. Yet, both markets receive service and prices in each market are not necessarily bid to access costs. In this framework, firms that access both markets may earn profits.

Let prices in the backhaul market be exactly the same under case 1 and case 2 (i.e., $P_1^b = P_2^b$). Then the only difference between the cases rests with access costs ($a_1^b \leq a_2^b$). If both types of firms exist in the industry simultaneously, the market service condition for

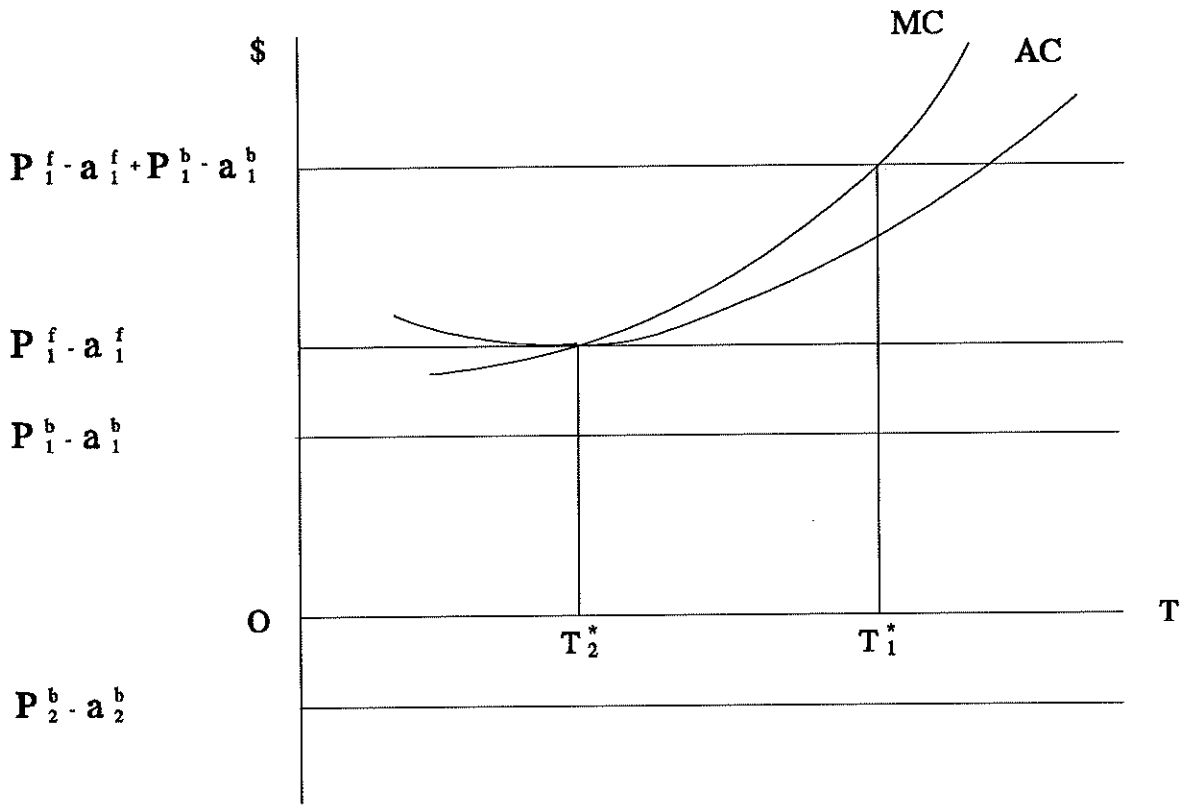
Figure 1.--Joint Production and Market Access Conditions.



the high cost firm requires that the fronthaul prices net of access costs (net fronthaul prices) must compensate round trip marginal (capacity) costs. In the long run, net fronthaul prices must compensate average total capacity costs. If the low cost firm earns profits of $P_1^b - a_1^b > 0$, the low cost firm earns profits of $\Pi_1 = (P_1^f - a_1^f + P_1^b - a_1^b) T_1^* - C(T_1^*)$ (Figure 2). Thus, capacity of the high cost firm remains unused by the backhaul market.

There are at least two situations in which these cases can arise. These are an extreme case of absolute entry restrictions on a subset of firms in the market and a less extreme case of different access costs (perhaps exacerbated by entry restrictions). In the

Figure 2.--Asymmetric Access Costs and Long-Run Equilibrium.



extreme case, if a carrier is restricted from engaging in backhaul activities (entry regulation), round trip revenues consist only of fronthaul revenues. Similarly, if the carrier is restricted from engaging in fronthaul activities, round trip revenues consist only of backhaul revenues. In either case, entry regulation in one market places the burden of compensation for the entire round trip capacity cost on the non-regulated market. Further, in this extreme case, regulation artificially prohibits capacity from serving all markets. As a result, there is unused capacity in the market.

In the second case, different firm attributes lead to different levels of access costs. In general, we expect access costs to reflect pickup and delivery, terminal costs, added line haul costs, search costs, etc. In practice, firms face both regulated and non-regulated sets of traffic in both the fronthaul and the backhaul markets. A carrier with operating authority has access to all types of traffic. A carrier without operating authority has access to only non-regulated traffic. As a result, access costs are likely greater for non-regulated carriers. Therefore, they are less likely to access non-originating traffic. To say these firms do not have access to regulated traffic is an overstatement. However, to gain access to regulated traffic, a non-regulated firm either travels illegally (with higher access costs from the threat of fines) or must access the load through an intermediary (e.g., trip-lease from a broker).

Careful identification of the source of access cost asymmetries is essential to interpreting the results. If access cost asymmetries are large and due primarily to entry regulation, deregulation will improve capacity utilization and remove artificial regulatory rents. Alternatively, if access costs asymmetries are large, but external to regulation (i.e., driven by firm attributes), deregulation will not improve capacity utilization. Any rents that firms earn are scarcity rents.

DATA SOURCES AND SUMMARIES

The primary source of data for the empirical application is a survey of motor carrier firms hauling grain (a non-regulated commodity) from North Dakota. The data comprising this analysis were the result of two mailings, follow up telephone calls to non-respondents, and personal and telephone interviews conducted from August of 1987 through October of 1988.[13] In total, there are 113 usable surveys out of 449 estimated possible respondents representing a 25.1 percent response rate. Firms were asked to

provide responses to questions comprising revenue, cost, and backhaul information, as well as firm characteristics (e.g., years in business, regulatory status, and size).

Virtually all of these truckers live in the same (or a nearby) community of the origin of an agricultural movement. In most cases, the truckers travel to the terminal market and return to the origin of the agricultural movement. On returning to the origin, the trucker may or may not be loaded. However, when loaded on the return trip, truckers generally compete for loads that are subject to ICC controls or a few commodities (e.g., fertilizer) that are not subject to regulation.

We observe in the data the number of trips taken and the proportion of the trips that the firm is loaded on the return trip. Overall, truckers are loaded 56 percent of the time on the return trip. However, the extent that firms are loaded on the return trip varies dramatically across firms with and without operating authority. There are 68 firms without ICC operating authority and 45 firms with ICC operating authority. Firms without operating authority are loaded about 45 percent of the time, while firms with operating authority are loaded 72 percent of the time (Table 1).

There are a variety of characteristics which might explain the asymmetries across firm types. These include the effects of entry regulation and firm attributes. While the Motor Carrier Act of 1980 substantially reduced entry restrictions, entry restrictions still exist and our evidence suggest they are constraining. Specifically, truckers without operating authority cite the lack of operating authority as the number one factor that discourages them from accessing backhaul markets (Table 2). In contrast, the lack of operating authority was rarely cited for carriers with operating authority (Table 2). Other factors reported by truckers as discouraging operations in backhaul markets all reflect considerations of the market access condition. These factors include low rates, brokerage commissions, and search time.

Table 1. Firm Summary Statistics

Firm Attribute	Nonregulated	Regulated	All Firms
Percent Loaded Backhaul Trips	45%	72%	56%
Years in Business	12.8	15.9	14.2
Size (number of tractors)	1.6	4.8	2.9
Size (number of annual trips)	307	534	398
Size (annual miles traveled)	128,138	442,604	253,368
Average Length of Haul	343	553	427
Hire brokers (Yes=1)	42%	64%	51%
Trip Lease (Yes=1)	32%	49%	39%
In-house Broker	4%	35%	17%
Elevators are Regular Customers	75%	50%	65%

Table 2. Factors Discouraging Operations in Backhaul Markets.

Discouraging Factor	Firms[1]					
	Nonregulated		Regulated		All Firms	
	Number	Percent	Number	Percent	Number	Percent
Operating Authority	31	58.5	2	6.5	33	39.3
Low Rates	24	45.3	17	54.8	41	48.8
Brokerage Commission	19	35.8	7	22.6	26	31.0
Search Time	14	26.4	12	38.7	26	31.0
Equipment	2	3.8	1	3.2	3	3.6

[1]There were 84 firms providing responses. Of these firms, 31 (37 percent) firms have ICC authority and 53 (63 percent) firms do not have ICC authority.

Other firm specific attributes also may explain different levels of backhaul market access. These attributes include both experience {e.g., Wilson (1987)} and size {e.g.,

Beilock and Kilmer (1986)). In general, firms with authority tend to be more experienced, larger, and more aggressive in searching for backhaul traffic (Table 1). The greater experience of firms with authority, however, is only about 3 years. Overall, these truckers seem to be more experienced (about 14 years in business). The reported results also suggest that firms with authority have about three times the tractor capacity, travel over three times the miles, and take nearly twice as many trips as firms without authority (Table 1).

Finally, there is some information available on the level of fronthaul and backhaul prices per-mile received by the trucker. This evidence suggests that at the sample mean there is little difference between fronthaul and backhaul prices. However, there are differences across the regulated status of firms.[14] As expected, regulated truckers receive higher prices in backhaul markets than non-regulated carriers. However, in no event are the backhaul prices they are received consistent with the notion that backhaul prices are bid to a relatively low incremental cost of a backhaul.

In summary, the data pertain to truckers that travel in round trips. The round trip consists of a set of markets that are not directly regulated (the fronthaul) and a set of markets that are directly regulated (the backhaul). All firms access the fronthaul market, while the level of access in the backhaul market varies substantially across firms and across firm types. There are two distinct firms in the industry. These include firms with and without operating authority. The firms with operating authority tend to be larger and more experienced than the firms without authority. As a result firms with operating authority tend to access backhaul markets more often than firms without operating authority. Separating the artificial and non-artificial determinants of market access is the focal point of the empirical model.

EMPIRICAL MODEL AND PROCEDURES

The objective in estimation is to explain firm decisions to access backhaul markets.[15] The firm is taken to serve the market if $P^b - a^b \geq 0$. In evaluating this process, returns associated with accessing the backhaul market by the ith firm are given by

$$(3) \qquad P_i^b - a_i^b = f(X_i;\beta) + \varepsilon_i$$

where β is a vector of coefficients to be estimated, X_i is a set of factors explaining differences in returns across firms, and ε_i is a disturbance term capturing unobserved factors. The probability of a firm accessing the market is given by

$$(4) \qquad Prb(P_i^b - a_i^b \geq 0) = Prb(\varepsilon_i \geq -f(X_i;\beta))$$

The ε_i's are assumed to be independent and logistically distributed resulting in the following specification

$$(5) \qquad Prb(access) = \frac{1}{1 + e^{-f(X;\beta)}}.$$

The proportion of loaded return trips to total trips taken (p_i) is the dependent variable. It represents T_i trials for the ith firm on the market access condition. Given p_i, upon specification of $(X_i;\beta)$ equation (5) is estimated with maximum likelihood procedures on equation (5).[16]

Following the previous literature and the discussion above, the explanatory variables include fleet size (SIZE), age in business (YEARS), a binary variable taking a value of one if the firm has ICC operating authority (ICC), and the one-way distance to market (DIST).

As in Beilock and Kilmer (1986), larger firms are expected to be more active in backhaul markets than smaller firms because of their greater size. With greater resources, large firms tend to employ individuals who specialize in getting backhauls and to be

more aggressive in utilizing equipment. Similarly, following Wilson (1987), we expect that with more time in business, firms gain experience in profitably accessing backhaul markets. The greater experience results in a broader network of contacts, better search strategies, and better reputations, all leading to lower costs, perhaps higher revenues, but generally higher access returns.

Regulatory operating authority is the focal point of this paper. ICC operating authority is expected to have positive and significant effects on the probability of a firm receiving a backhaul. A firm without authority must incur higher costs to access the set of backhaul markets. Specifically, they must pay for the use of another carrier's authority to haul regulated commodities or must incur higher search costs to access the subset of backhaul markets consisting of commodities not subject to regulation.

The one-way distance to market (DIST) is expected to have a positive influence on the probability of getting a backhaul. As shown by Beilock and Kilmer (1986), the profit motive drives firms to search more intensively for a backhaul as the distance between markets increases. In our model, if access costs are invariant to distance and the price of a backhaul (per trip) increases with distance, returns to access are higher. Finally, as control variables for local demand and supply conditions, we include in some parameterizations a set of eight regional dummy variables taking a value of one if the trucker is based in that region and zero otherwise.[17]

EMPIRICAL RESULTS

The model was estimated using a variety of estimation methods and specifications.[18] The specifications are summarized in Table 3. Model M1 is the base model consisting of a constant, a dummy variable for the regulatory status of firms, distance to market, experience, and size. In model M2, a size and year interaction variable is added.

Table 3. Model Specifications and Variable Definitions

Model	Specification
M1	X = ONE, ICC, DIST, YEARS, SIZE
M2	X = ONE, ICC, DIST, YEARS, SIZE, SIZE*YEARS
M3	X = ONE, ICC, LOG(DIST), LOG(YEARS), LOG(SIZE), LOG(SIZE*YEARS)
M4	X = M1, CRD2, CRD3, CRD4, CRD5, CRD6, CRD7, CRD8, CRD9
M5	X = M2, CRD2, CRD3, CRD4, CRD5, CRD6, CRD7, CRD8, CRD9
M6	X = M3, CRD2, CRD3, CRD4, CRD5, CRD6, CRD7, CRD8, CRD9
Variable	**Definition**
ONE =	Constant
ICC =	1 if the firm has ICC operating authority and zero otherwise.
DIST =	The average one-way distance of a trip.
SIZE =	The number of tractors owned by the firm.
CRD_i =	1 if the firm's base location is in the ith crop reporting district, (i= 1,2,3,4,5,6,7,8,9). CRD1 is the base district.

The continuous variables are specified in logs in model M3. Models M4, M5, and M6 are identical to M1, M2, and M3, respectively, except they include dummy variables identifying the region where the trucker is located.

The empirical results are presented in Table 4. In general, the models fit the data quite well, with correlations between the predicted and observed proportions ranging from .74 to .83. Except for model M1, all coefficients are of the correct sign and significant, and generally fit the data as expected. In model M1, the negative sign on experience was inconsistent with *a priori* expectations. However, the negative sign is reversed when regional dummy variables and an interaction between size and experience are added. For the latter, the error term consisting of unobserved factors determining backhaul market

Table 4. Coefficient Estimates, for Models M1, M2, and M3.

Variable	M1	M2	M3
ONE	-1.7735* (0.0266)	-2.0231* (0.0317)	-8.2819* (0.1168)
ICC	0.5833* (0.0270)	0.6220* (0.0270)	0.7489* (0.0284)
DIST	0.0046* (0.0001)	0.0043* (0.0001)	1.3969* (0.0189)
YEARS	-0.0159* (0.0009)	0.0020 (0.0014)	0.0547* (0.0240)
SIZE	0.1450* (0.0040)	0.2171* (0.0076)	0.9860* (0.0371)
SIZE*YEARS	Not applicable	-0.0031* (0.0002)	-0.2244* (0.0129)
CORR(p,p̂)	0.74	0.74	0.76
Log-Likelihood	-21,438	-21,313	-20,685

[a]Standard errors are in parentheses. A * denotes significance at the 5 percent level.

access likely leads to faster growth rates in firms. Consistent with this hypothesis is the observation of equally sized firms of differing experience levels, where the younger firms have greater access to backhaul markets. The result is the negative effect of experience. In recognition of this possibility, the interaction variable between size and age was included in other specifications. With this exception, the other specifications yield qualitatively equivalent and numerically similar results.

From the results, it is clear that market access is not random and depends critically on entry restrictions and other firm attributes. Firms without regulatory authority do not have the same access to backhaul markets as firms with regulatory authority. In all specifications the coefficient on ICC is positive and significant ranging in

Table 4 (continued). Coefficient Estimates for Models M4, M5, and M6.

Variable	M4	M5	M6
ONE	-2.1751* (0.1116)	-2.3938* (0.1137)	-11.9394* (0.2058)
ICC	0.4431* (0.0312)	0.5528* (0.0317)	0.8856* (0.0341)
DIST	0.0059* (0.0001)	0.0056* (0.0001)	1.8817* (0.0254)
YEARS	0.0050* (0.0010)	0.0282* (0.0016)	0.4056* (0.0282)
SIZE	0.1684* (0.0040)	0.2187* (0.0065)	1.1967* (0.0340)
SIZE*YEARS	Not applicable	-0.0034* (0.0002)	-0.2810* (0.0131)
CRD2	-1.3456* (0.1127)	-1.5231* (0.1156)	-1.4949* (0.1177)
CRD3	-1.0058* (0.1044)	-0.9452* (0.1065)	-0.6421* (0.1092)
CRD4	6.6376* (0.7153)	6.6099* (0.7156)	6.6544* (0.7161)
CRD5	-0.6216* (0.1078)	-0.7858* (0.1102)	0.1856 (0.1137)
CRD6	-0.1477 (0.1042)	-0.2330* (0.1066)	0.0304 (0.1095)
CRD7	1.1613* (0.1125)	1.1500* (0.1141)	2.5334* (0.1234)
CRD8	-0.6843* (0.1170)	-0.7381* (0.1195)	-0.6780* (0.1206)
CRD9	0.2972* (0.1110)	0.2940* (0.1131)	0.5846* (0.1179)
CORR(p,$\hat{p}$)	0.81	0.81	0.83
Log-Likelihood	-19,369	-19,228	-18,238

[a]Standard errors are in parentheses. A * denotes significance at the 5 percent level.have

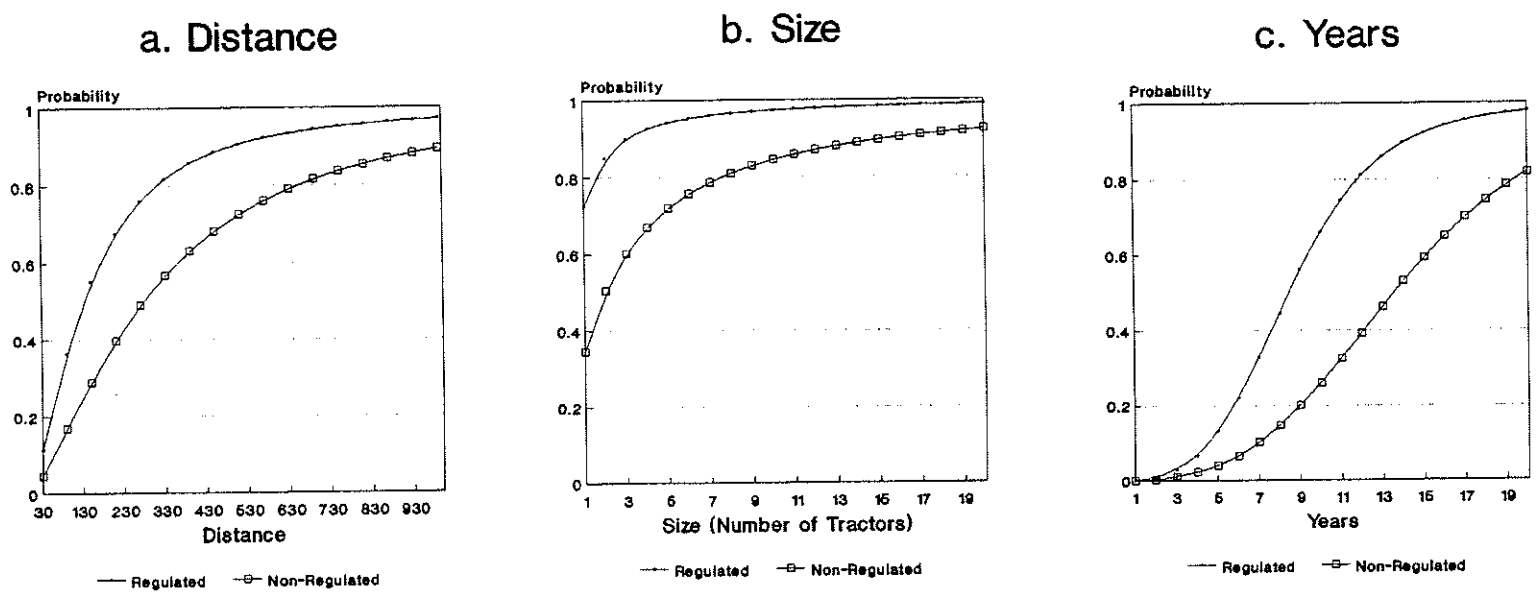
value from 0.44 to 0.89 (Table 4). At an average probability of about .56, the "marginal" effect ranges from 11 percent to 22 percent.

As a more direct measure of the effects of entry regulation, we calculated the average probability of market access for each firm if it has authority and if it does notauthority. These probabilities were calculated at observed values of each sample point (isolating the direct effects of entry regulation). At these values, the average probability without authority is .53 and with operating authority is .67. For firms "currently" restricted, the average predicted probability was .44. If those firms were given authority, the predicted probability increases by .15 to .59. Conversely, for firms currently with authority, the average predicted probability was .78. If authority was taken away, the average probability falls by .12 to .66.

We also estimated the number of empty trips that were made due to regulatory constraint. The non-regulated truckers made a total of 20,900 round trips. Of these trips, 13,918 (66 percent) trips were empty. With operating authority, the number of empty trips is estimated to fall by 3,072 to 10,846. Aggregating to the population, entry restrictions in this market translate to 12,240 trips that were empty due to regulatory constraint. At an average one-way haul of 307 miles for nonregulated carriers, these figures translate to 3,757,680 miles and 835,040 gallons of fuel.

Other firm attributes not directly controlled by policy-makers - one-way distance to market, size, and experience - also dramatically influence access to markets. To summarize the effects of these variables, we plot the probability schedules and calculate the marginal effects. The probability schedules, summarized in Figure 3, were calculated at cell averages (Table 1) and exclude the interaction effect of size and year which proxy missing values.[19] The marginal effects of the variables represent firm-average marginal effects of the variable (not the log of the variable).

Figure 3.--Probability of Market Access.



One-way distance to market has a profound influence on the probability of accessing backhaul markets (panel a). Firms are more willing to search for backhaul loads as distance increases. For local hauls (less than 100 miles), there are dramatic differences between firm types. Regulated firms are twice as likely to access backhaul markets than non-regulated firms (panel a). At the mean distance of 398 miles, the difference between the types of firms is about 20 percentage points. This difference dissipates as distance increases. At long distances, truckers are motivated to access backhaul markets, regardless of authority. At the margin, a 100 mile increase in distance increases the probability of market access by about 15 percentage points for non-regulated carriers and about 11 percentage points for the regulated truckers.

Firm attributes include size and experience. Each of these variables was expected to enhance the likelihood of market access. Indeed, this is the case (panel b). The effect of firm size differs by firm type. On average, the regulated carriers (4.8 tractors) are about twice as likely as nonregulated carriers (1.6 tractors) to access backhaul markets. For regulated carriers, the probability of market access begins quite high (over 70 percent) and remains high throughout the range of the data.[20] For firms without authority, the initial probability of access is low (less than 40 percent), and increases steadily throughout the range of the data. At the margin, the average effect of one more tractor increases the probability of market access by about 3.7 percentage points for regulated truckers, but about 16 percentage points for non-regulated carriers.

Years in business is the remaining firm attribute. As with size, years in business has only a small effect for regulated firms, but a larger effect for the firms without authority (panel c). At mean values, the marginal effect of an additional year of experience only increases the probability of market access by about one percentage point for non-regulated firms and less than one percentage point for regulated firms. However,

new firms without operating authority are severely disadvantaged in accessing backhaul markets. New firms, regardless of regulatory status, only rarely access backhaul markets, and the disadvantage in market access persists for a long time.

The results strongly indicate that access costs vary significantly across firms due to entry restrictions and attributes of the movement and firm. Nonregulated firms have a smaller set of markets to search over or must pay to access backhaul markets. Thus, nonregulated carriers have lower access returns and therefore, are less likely to be loaded than firms with authority. Distance is the market attribute. Increases in distance lead to higher access returns and therefore, a greater incentive for firms to access backhaul markets. Size and years represent attributes of the firm that affect access returns. Firms with greater experience and larger size have lower access costs to backhaul markets, and therefore, are more likely to be loaded.

SUMMARY AND CONCLUSIONS

In this paper, we extend earlier research on the effects of entry regulation in a single market to multiple markets characterized by joint production. Firms provide capacity to multiple competitive markets under conditions of joint production. To employ that capacity in any subset of markets the firm must incur access costs. Firms differ in the cost of accessing markets. As a result, some firms choose not to serve particular markets where access costs exceed price.

The market access condition requires that a firm must at least be compensated for its access costs. The market service condition requires that market access conditions be satisfied and that revenues from all markets served at least compensate the firm for access and capacity costs. When access costs vary across firms, the market service condition requires that prices must compensate the marginal supplier or the high access

cost firms. The remaining firms then earn profits (or returns to access investments if applicable) from the remaining markets if prices exceed access costs.

Entry regulation affects the truck market by restricting the set of markets a firm without authority can serve, thereby increasing access costs. Thus, firms with authority have greater market access and, therefore, the possibility of profits (return to access investment). The results can be generally applied to any set of markets subject to entry regulation.

The empirical application focuses on the market access condition. Truckers provide capacity to two markets, producing round trips. On one leg of the round trip the truckers haul grain. Grain is a commodity that does not require operating authority and whose prices are not regulated. On the other leg of the round trip, truckers haul a variety of products, most of which are subject to ICC regulation. To access regulated markets, truckers must own operating authority or lease it. Prices in these markets are at least subject to ICC overview. Therefore, the prices generally are not flexible downward. Thus, the data employed provide an excellent opportunity to evaluate the effects of entry regulation under conditions of joint production.

The empirical results indicate considerable heterogeneity in firms' access to markets. Large and experienced firms with operating authority traveling long distances are the most likely to access backhaul markets. Small and inexperienced firms traveling short distances without operating authority are the least likely to access backhaul markets.

In terms of operating authority, the ownership of authority has a significant positive effect on market access. The results further indicate that backhaul prices received by the firm are about equal to fronthaul prices. They certainly are not as small as might be expected if prices reflect the marginal costs of a backhaul. If fronthaul prices

compensate the no-backhaul firm, the results are consistent with the notion that firms earn profits (returns to access investment) as a result of entry regulation.

The interpretation of asymmetric access costs as indicative of profits, scarcity rents, returns to access investment, etc. is unclear. In this paper, the costs of obtaining operating authority were not considered. From a firm's perspective, they should be willing to pay up to the level of profits to be earned from operating authority. The payment may be to a pre-existing holder of the authority as in Breen (1977), Moore (1978), and Frew (1981) or to the lawyers and expert witnesses in an entry case. Thus, our conclusions may simply reflect return to access investment. If authority is easy to obtain, but costly, it may be a case of deadweight loss that could be removed by total deregulation of the industry.

ENDNOTES

1. As Noll (1989) states, "...all forms of regulation are likely to retard entry by new firms either directly by franchising [Stigler (1971)] or indirectly by imposing higher costs on potential entrants." p. 1266.

2. Paul's focal point is the result that self-regulating (e.g., elected by the profession) mechanisms increase profits more than external (e.g., government appointed) mechanisms.

3. It is also noted that other authors, Olsen (1972) and Sanders (1981) have considered the use of regulation in Noll's terms "...as a means of stripping scarcity rents from especially low-cost producers."

4. See the theoretical papers by Tschirhart (1989), which considers partial regulation of a multiproduct monopoly, and Baseman (1981), which considers the case of a multiproduct firm confronting entry.

5. Associated with lower regulatory impediments are findings that certificate values fell after deregulation. Some have argued that this correlation confirms the notion that certificate values represent regulatory rents. See Joskow and Rose (1989), Moore (1986) and Mabley and Strack (1982) for further discussion.

6. Virtually, all grain truckers live in the same community or a nearby community as the grain elevator they normally serve.

7. There are many definitions of a fronthaul and a backhaul that depend somewhat on the application. See, for example, Pederson, Mittelhammer, and Casavant (1979), who consider the backhaul problem as one of "respotting" equipment with spatial imbalances in demand and supply. Similarly are a variety of other papers, including Min and Cooper (1990) and Jordan (1987), who minimize costs in network flow decisions by consolidating traffic between terminals. Finally, a paper by Baesemann, Daughety, and Inaba (1977) considered cost complementarities under conditions of joint production when firms are allowed to only carry a fraction of its capacity on the round trip.

8. These costs include search costs, a minor increase in running costs, perhaps some added deadhead costs, etc.

9. Kahn (1971) and Mohring (1976) provide similar results in discussions of joint production and/or destructive competition and the need (or lack of the need) for regulation.

10. See also the studies by Kahn (1971) and Mohring (1976).

11. Wilson did not consider directly the effects of entry regulation. Beilock and Kilmer did find some effects of entry regulation but did not extend the result to joint production.

12. Access costs are taken as constant for our application to truck markets. However, non-linear access costs are certainly plausible, and may well be important in other applications (e.g., opening offices in geographically separate markets.

13. Complete discussion of the sample is available in Dooley, Bertram, and Wilson (1989).

14. We also attempted to estimate rate schedules. The results suggest that rates increase with distance. We also included a dummy for the regulatory status of firms in these data. The coefficient on the dummy variable, while positive, was small in magnitude and not statistically significant.

15. All firms in the sample provide capacity to at least the outbound or the inbound market. Thus, the market service condition is satisfied for all firms in the market.

16. Estimation can also proceed with weighted least squares on

$$\log(p_i/(1-p_i)) = f(X;\beta) + \varepsilon_i$$

where the weights are given by $1/\sqrt{V_i}$ where V_i is $T_i p_i(1-p_i)$.

17. The regions employed are crop reporting districts. Regions 1, 2, and 3 represent the north-west,north-central, and north-east regions of North Dakota. Regions 4, 5, and 6 represent the central-west, central-central, and central-east regions, while regions 7, 8, and 9 represent the south-west, south-central, and south-east regions.

18. The methods included both minimum chi-square and probit. In the logit models, we used minimum chi-square estimates as starting values. Probit specifications yield comparable results.

19. We plotted the probability schedules at sample averages as well as including the total effect of the size and experience variables. All plots yield similar results as those in Figure 3. In aggregating across regions we calculated the probability for each region and calculated a weighted average probability based on the number of firms in each region.

20. These firms travel longer distances and have substantial levels of experience and unobserved attributes.

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