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17. Competitive Entry into Local Cable Transmission*

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I. THE RESEARCH ISSUE

This study is an investigation of the economies of scale in cable television operations, and of the variation in these economies over the range of output. The results are intended as an empirical contribution to the question of whether competition among rival cable television operators is likely, an issue of significant interest for regulatory policy towards the new medium.

Methodologically, the study proceeds by specifying a multi-product function. The statistical estimation is based on data for 4,200 U.S. cable systems.

The U.S. television industry is presently undergoing rapid change. Where once there was a limit on viewing options imposed by the scarcity of electromagnetic spectrum, confining most viewers to a handful of channels, cable television is emerging as "the television of abundance."

Yet ironically, the market structure of "abundant" cable television is more restrictive than that of "scarce" broadcast television, since the present franchising system has arranged the medium into parallel local distribution monopolies, one for each franchising area. This raises concern about a cable operator's ability, if left unconstrained, to charge monopolistic prices to subscribers, and, more significantly, to control the content of dozens of program channels. A variety of reform proposals have therefore been made, seeking to impose some form of either conduct regulation, public ownership, common carrier status, or competitive market structure. The latter approach, in particular, has been taken by the Federal Communications Commission, whose philosophy it has become to permit entry and encourage inter-media competition between cable and other video technologies such as direct broadcast satellite (DBS), subscription television (STV), and multipoint distribution service (MDS).

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A second and distinct competitive approach is to rely on *intra-medium* competition among cable companies. The likelihood of such entry, however, is based on the assumption that more than one cable company could successfully operate in a territory. But such competition is not sustainable if cable television exhibits strong economies of scale and economies of scope, i.e., cost advantages of diversified production.[1]

Previous studies of cable television have typically centered on questions of demand analysis and of audience diversion. They are mostly dated, since their impetus was the 1966 FCC rules restricting CATV (Mitre 1974; CTIC 1972; Mitchell and Smiley 1974; Crandall and Fray 1974; Noll, Peck, and McGowan 1973; Panko et al. 1975). As pointed out in an article jointly authored by a comfortable majority of the economists engaged in cable television research (Besen, Mitchell, Noll, Owen, Park, and Rosse, in MacAvoy 1977): "All of these models are synthetic and eclectic, drawing their cost data for the specific components of a system from engineering specification and field experience; no satisfactory data set exists from which to estimate econometric cost or production functions" (p. 66)[2].

Since that observation, several empirical studies on the demand for pay-cable services were undertaken (Block and Wirth, 1982; Dunmore and Bykowsky 1982; Smith and Gallagher 1980). However, no comparable research on the production side was undertaken with the recent exception of Owen and Greenhalgh (1982)[3]. This then is the task of this study.

II. THE MODEL

For purposes of analysis and estimation, consider the multi-product cost function of firm i, uniquely corresponding to the production function under duality assumptions,

$$C_i = f_i(P_i \ldots P_n; Q_1 \ldots Q_q; M) \quad (1)$$

where C_i are total costs of production, Q_q is the output vector, P_i are the prices for input factors i, assumed to be independent of output, and M is the maturity of the system in terms of operating experience. Under the assumption of cost-minimization, we have from Shepherd's lemma an identity of the cost-price elasticities E_{CP}; with the share of each input factor in total cost, i.e.,

$$S_i \equiv \frac{{}_{P_i}X_i}{C} = \frac{\partial \ln C}{\partial \ln P_i} = E_{CPi} \quad (2)$$

where X_i is the quantity of input i.

Let the cost function f be given by the translog function, a specification that imposes no restrictions such as homogeneity, hometheticity, or unitary elasticities of factor substitution, and which is hence convenient for testing the existence of these properties. A major problem with the application of a multi-product specification of a cost function is that if even one of the products has the value zero, the observation's value becomes meaningless. For that reason, it is necessary to specify an alternative functional form that is well-behaved. Thus, one can substitute the Box-Cox metric and define the "hybrid" multi-product translog cost function.

$$\ln C(P_i, Q_q, M) = a_0 + \sum_i a_i \ln P_i + \sum_q a_q\left(\frac{Q_q^w - 1}{w}\right) + a_m \ln M + \frac{1}{2}\sum_i\sum_j a_{ij}\ln P_i \ln P_j$$
$$+ \frac{1}{2}\sum_q\sum_p a_{qp}\left(\frac{Q_q^w - 1}{w}\right)\left(\frac{Q_q^w - 1}{w}\right) + \frac{1}{2}a_{mm}(\ln M)^2 + \sum_i\sum_q a_{iq}\ln P_i\left(\frac{Q_q^w - 1}{w}\right) + \sum_i a_{im}\ln P_i \ln M$$
$$+ \sum_q a_{qm}\left(\frac{Q_q^w - 1}{w}\right)\ln M$$

The partial elasticities of total cost are then the logarithmic partial derivatives.

Several parametric restrictions must be put on the cost function. The cost shares must add to unity which implies that

$$\Sigma E_{CP_i} = 1$$

Hence, the cost function must be linearly homogeneous in factor prices at all values of factor prices, output and maturity. Furthermore, the cross partial derivatives of the translog cost function must be equal, by its second order approximation property, i.e., the symmetry condition exists.

Economies of scale must be evaluated along output rather than along input-mix, since the relative composition of inputs may change over the range of output. Only when the cost function is homothetic will the two be identical. The implication is that scale economies are better described by the relation of cost to changes in output rather than by that of outputs to changes in inputs, which makes a cost function an advantageous specification. Following Frisch (1965), the cost elasticity with respect to output E_{CQ} is the reciprocal scale elasticity E_S. For the multi-product case, local overall scale economies, as shown by Fuss and Waverman (1977), are

$$E_S = \frac{1}{\sum_q E_{CQ_q}} = 1/\sum_q\left(Q_q^w\left(a_q + \sum_p a_{qp}\left(\frac{Q_p^w - 1}{w}\right) + \sum_i a_{iq}\ln P_i + a_{qm}\ln M\right)\right) \qquad (4)$$

Product specific economies of scale are, using the definition in Baumol, Panzar, and Willig (1982)

$$E_{S_q} = \frac{IC_q}{Q_q \dfrac{\partial C}{\partial Q_q}} \qquad (5)$$

where IC_q are the incremental costs of producing product q. This incremental cost is described by

$$IC_q = C(Q_1, \ldots Q_N) - C(Q_1 \ldots Q_{q-1}, O, Q_{q+1} \ldots Q_N) \qquad (6)$$

For the hybrid translog function, sample mean values are $P_i = Q_q = M = 1$; thus the cost functions simplify so that equation (6) for the product-specific economies of scale becomes

$$E_{S_q} = \frac{\exp(a_o) - \exp\left(a_o - \frac{a_q}{w} + \frac{a_{qq}}{2w^2}\right)}{\exp(a_o)\cdot a_q} \qquad (7)$$

The degree of overall economies of *scope* is the proportion of the total cost of joint production that is saved by joint production. In order to solve this, it is necessary to observe, for each product, the costs of separate and independent production. Since this is not feasible in the case of cable television, a test for economies of scope must proceed differently. As Panzar and Willig (1977) have shown, it is a sufficient condition for economies of scope for the twice differentiable multi-product cost function to have cost complementarities of the form

$$\frac{\partial^2 C}{\partial Q_p \partial Q_p} < 0 \qquad (8)$$

If some but not all products can be observed at the zero output level, *product-specific*—rather than overall—economies of scope can also be measured. These are defined as the degree of cost reduction due to the joint rather than separate production of q together with the other N-1 products.

The model for estimation is the multivariate regression system comprising the cost function (3), the behavioral equation (2), and various restrictions. The inclusion of the cost share equation (1) does not add unrestricted regression coefficients, but contributes additional degrees of freedom.

Several alternative models are considered. First, we estimate different multi-product models. Model A imposes no restrictions as to homotheticity, homogeneity, constant returns to scale, or neutrality. Model B imposes homotheticity. Model C imposes homogeneity. Model D imposes constant returns to scale.

The form of estimation that is used to determine this system is Zellner's (1962) iterative method for seemingly unrelated regressions. The testing of the hypotheses of homogeneity etc. can be accomplished by likelihood ratio tests, since the iterative Zellner method results in maximum-likelihood estimates of parameters. We define $|\Omega|_R$ and $|\Omega|_U$ as the determinants of the restricted and unrestricted estimates of the disturbance covariance matrix values. We then have

$$\lambda = (|\Omega|R / |\Omega|U)^{-N/2} \quad (9)$$

where N is the number of observations. $-2 \ln \lambda$ is distributed asymptotically as chi-squared with degrees of freedom equal to the number of independent restrictions imposed, and can be tested.

III. DATA

The empirical estimation of this study is based on an unusually good body of data for several thousand cable television systems, all producing essentially the same service, operating and accounting in a single-plant mode, supplying their local market only, and reporting data according to the fairly detailed categories of mandatory Federal forms[4].

The data covers virtually all 4,200 U.S. cable systems, and is composed of four disparate and extensive files for 1980 and 1981 for technical and programming, financial, local community, and employment information. The financial data includes both balance sheet and income information[5].

Labor Inputs[6]

The factor quantity is the number of full time employees (with part-timers added at half value). Its cost is the average salary of employees, weighted according to their classification by nine job categories (professionals, technicians, unskilled laborers, etc.).

Capital Inputs

Accounting data for different classes of assets is reported to the FCC in book value form. It was considered prudent to revalue these assets. To do so, the study took advantage of a highly detailed engineering study, commissioned by the federal government, on the cost and pattern of investment in the construction of cable systems (Weinberg 1972).

For each observation, we know the first year of operation and the aggregate historical value of capital assets. It is then possible to allocate capital investments to the different years and different types of investment, and to inflate their value to the prices of the observation year. The input price P_K of this capital stock K is determined by its opportunity cost in a competitive environment, consisting of potential returns r on equity E and payments for debt D, with an allowance for the deductibility of interest expense (tax rate = w).

$$P_K = r_E.(E/K) + r_D(1-w)(D/K) \quad (10)$$

The required return on equity is determined according to the risk premium ρ required above the return on risk-free investments, R_F; that is, $r_E = R_F + \rho$. Ibbotson and Sinquefield (1979) found ρ for the Standard & Poor 5000 to be 8.8 for the period 1926-1977. Hence, using the capital asset pricing model, an

estimate of β for a specific firm is 8.8 times β, where β is the measure of non-diversifiable (systematic) risk. The average β for cable companies listed by Moody's is, for 1980, $\beta = 1.42$, resulting in a risk premium of 12.49% over the treasury bill rate.

For r_D, the return on long-term debt, the following method was employed: for each observation it was determined, using several financial measures, what its hypothetical bond rating would have been, based on a company's financial characteristics. These "shadow" bond ratings for each observation were then applied to the actual average interest rates existing in the observation years for different bond ratings. This procedure is novel, but is based on a series of previous studies in the finance literature of bond ratings and their relation to financial ratios[7].

Tax rate w is defined as the corporate income tax rate (federal and average net state). Debt is defined as long term liabilities.

Programming Inputs

The third production factor of the model is the input of programming. A cable system that carries no communications messages would be of no interest to subscribers. Therefore, cable operators supply programs in addition to providing the communication wire. These programs are not produced or generated by the operators; with minor exceptions, programming is supplied by broadcasters and program networks. Program costs are both direct and indirect. Direct costs are the outlays for program services; indirect costs that must also be considered are the foregone earnings from advertising. For example, CNN is able to sell some of its "air" time to advertisers. Similarly, local broadcasters are carried by cable for free, and the programming cost of these "must carry" channels to cable operators, too, is the foregone earnings, largely in advertising revenues.

Direct costs are reported to the FCC and are available. Included are also such capital costs as those of origination studios and signal importation equipment and cost to carriers. The indirect cost of foregone advertising revenue is defined as the potential minus the actual advertising revenue obtained by cable operators. Actual figures are reported to the FCC; potential revenues are estimated by reference to the average advertising revenue in television broadcasting per household and viewing time[8]. The unit price of programming inputs is their total divided by the number of program hours and channels.

Outputs

Four outputs are defined. The first is the physical extent of the cable system, described by the number of "Homes Passed." A second output measure is "Basic Subscriptions," which describes the operator's actual customers, and his marketing success in transforming a potential market (homes passed) into a paying subscriber base. A third output measure is the number of pay-cable subscriptions generated and sold. These are premium channels over and above the basic subscription. The fourth measure is the total number of channels capacity constructed and supported by the cable operator.

Maturity

M, maturity in operation, is a measure for the period that a cable operator had to improve operations and to establish himself in the local market. It is defined by the number of years of actual operation.

IV. RESULTS

Table 1 represents the parameter estimates for the multi-product specification.

The estimation for models A–E have a good fit, with system R^2 values well above .95 for the models. Similarly, the coefficients (reported here only for Model A) are generally significant at the .05 level, and common parameters are of similar size. Good R^2 values are found for the cost share equations, when these are estimated separately.

Overall E_S is calculated, using eq. (4), at the mean as $E_S = .8671$, that is, below unity. It is here that the flexibility of the translog functional form pays ɔff, by permitting varying observations along the output ray rather than only at the mean, or only at a constant value. The results are reported in Table 2, which shows that scale elasticity steadily grows with size, and that economies ɔf scale exist in the range beginning 20% above the current mean system size. At present, the bulk of cable systems are small operations in rural areas. Far nore important in terms of economic and information impact are the urban ınd suburban franchises, which are substantially larger. For those systems conomies of scale are thus observed, while they do not appear to exist for the maller operations.

We are also able to calculate measures for the product-specific economies of cale for the four outputs. Again, these elasticities increase with output, except or the elasticity for homes passed, which actually falls slightly. For the abovenean sample, for example, E_S (Homes Passed) falls to .8912. Fairly pronounced conomies of scale are thus observed for the three outputs basic and pay subcriptions and channel capacity. However, for "Homes Passed," we cannot eject the hypothesis of constant returns to scale. It may be recalled that this utput description refers to a physical measure, namely the extent of the cable etwork in accessing a market.

The implication of this result is that scale economies do not appear to derive rom the technical distribution aspects of cable television, as reflected by Homes Passed." Instead, they are observed for the output definitions that ıclude a strong element of marketing success[9].

If the estimation results are accepted, their implications are that large cable ɔrporations have cost advantages over smaller ones when they function as ıore than a mere distributor. Based on the results, a pure distribution network ith no major programming or marketing role, such as a passive common car-

TABLE 1. Cost Function Parameters: Output Definition, Multi-product (t-statistics in parentheses)

Parameter	Model A Unrestricted	Parameter	Model A Unrestricted	Parameter	Model A Unrestricted
a_O	−0.2499 (17.5612)	a_{LQ4}	0.0342 (1.2427)	a_{Q1Q1}	0.6008 (3.5986)
a_L	0.2964 (12.3013)	a_{LM}	−0.2041 (3.1726)	a_{Q1Q2}	0.5072 (2.1465)
a_K	0.5696 (17.5014)	a_{KK}	0.6256 (19.9049)	a_{Q1Q3}	−1.7461 (7.2407)
a_P	0.1340 (3.3138)	a_{KP}	−1.5964 (22.5398)	a_{Q1Q4}	−0.0933 (1.1827)
a_{Q1}	0.2920 (4.1001)	a_{KQ1}	1.1306 (9.7990)	a_{Q1M}	0.0964 (0.6638)
a_{Q2}	0.3369 (6.8839)	a_{KQ2}	0.3374 (3.6746)	a_{Q2Q2}	−0.3037 (3.3132)
a_{Q3}	0.3356 (5.0525)	a_{KQ3}	−1.7027 (11.9145)	a_{Q2Q3}	−0.0405 (0.2317)
a_{Q4}	0.1887) (6.2827)	a_{KQ4}	0.1746 (4.2123)	a_{Q2Q4}	0.2353 (3.7567)
a_M	−0.0308 (0.7219)	a_{KM}	−0.1603 (2.2196)	a_{Q2M}	−0.5851 (4.2839)
a_{LL}	0.0106 (0.6978)	a_{PP}	0.9814 (19.8149)	a_{Q3Q3}	0.6323 (3.0140)
a_{LK}	0.3452 (8.2012)	a_{PQ1}	−1.6560 (12.1770)	a_{Q3Q4}	−0.1482 (1.8231)
a_{LP}	−0.3663 (7.5959)	a_{PQ2}	−0.1674 (1.8494)	a_{Q3M}	0.2429 (1.2704)
a_{LQ1}	0.5253 (6.6028)	a_{PQ3}	1.8710 (10.9708)	a_{Q4Q4}	0.0420 (2.3353)
a_{LQ2}	−0.1700 (3.6628)	a_{PQ4}	−0.2087 (4.2008)	a_{Q4M}	0.8849 (2.2955)
a_{LQ3}	−0.1683 (2.0224)	a_{PM}	0.3644) (4.1167)	a_{MM}	−0.1386 (2.2292)
				W	.8100
				System R^2	0.9666

TABLE 2. Elasticity of Scale Over the Range of Productivity

Percentage of Mean Output	Elasticity of Scale
−50%	.6808
−10%	.8289
0	.8671
+10%	.9062
+20%	.9874
+50%	1.0751
+100%	1.329
+200%	2.1167

rier, is not likely to have cost advantage over potential rivals. The imposition of such a common carrier status would therefore be doubly injurious to the cable television industry (which strenuously opposes it): it would not only eliminate operators' control over and profit from non-transmission activities such as program selection, but it would also reduce the cost-advantage protection of incumbents against entry[10].

On the other hand, the conclusions require a subtle change in the proseparations argument. That position—held by institutions as disparate as the Nixon White House and the American Civil Liberties Union—is normally presented as one of protection against a vertical extension of the natural monopoly of one stage of production (transmission) upstream into other stages such as program selection. The implications of our estimation, however, do not support the view that such advantages are derived from a naturally monopolistic distribution stage. Instead, the cost advantages appear to lie in the *integration* of transmission and marketing activities, and the benefits of this integration accrue more to large firms than to small ones.

FOOTNOTES

[1] In *Community Communications Co.* v. *City of Boulder,*———U.S.——— (1981); (1981-2) Trade Cas., P 64,300, Sept. 22, 1981, (previously also 630 F2d 704 (10th Cir. 1980) (Boulder I), 485 F. Supp. 1035 (D. Colo. 1980)), recently decided by the U.S. Supreme Court, the city's moratorium on expansion had been challenged by the local cable company. "The City concluded that cable systems are natural monopolies. Consequently, the City became concerned that CCC, because of its headstart, would always be the only cable operator in Boulder if allowed to expand, even though it might not be the best operator Boulder could otherwise obtain..." Yet the factual issue is hotly disputed, as a dissenting judge notes: "the city's sole defense is to pretend disingeniously and contrary to the extensive, uncontradicted testimony and the findings of the trial judge,...that cable television is a natural monopoly."

[2] More precisely, the only attempts at cost studies of cable television have been chapters in two doctoral dissertations on the economics of Canadian television (Good 1974; Babe 1975), which include simple regressions of cost per size for several Canadian systems and which come to conclusions that are contradictory to each other.

[3] That study, though it also relies on a cost function approach, is methodologically simpler, and is empirically based on figures from the applications by competing franchise bidders in 34 cities. As the authors themselves note, these figures do not represent actual operational data, but rather promises, possibly based on some for of "gamesmanship," and including those made by losing and therefore possibly inefficient bidders. Furthermore, no capital measures are available. Nevertheless, the Owen-Greenhalgh study can serve as a useful check to the present study, and is a great improvement over the previous state of knowledge.

[4] FCC, Cable Bureau, Physical System File, Community File, Equal Employment Opportunity File, and financial data reporting.

[5] To assure confidentiality, financial data had been aggregated in the publicly available FCC documents; particularly detailed subaggregations—for each state according to seven size categories, and with many such categories of financial information—had been made especially available to the author.

[6] All input prices are assumed to be independent of production level. Furthermore, input prices are not controlled by cable operators. This seems unexceptional in light of the mobility of capital and labor. For programming, some market power will exist in the future if cable should become a dominant medium. As an advertising outlet, cable television has no particular market power.

[7] The model used here is taken from the Kaplan and Urwitz survey (1979, Table 6, Model 5) which determines bond rating with a fairly high explanatory power ($R^2 = .79$). The financial variables used in that model are: (a) "cash flow before tax/interest charges; (b) long term debt/net worth; (c) net income/total assets; (d) total assets; (e) subordination of debt. Bond ratings ranging from AAA (Model values ≥ 9) to C ($\leq$) can then be obtained for each observation point by substitution of the appropriate financial values. Bond rates are those reported by Moody's (1981). For low ratings, no interest rates are reported by the services. For the lowest rating (C), the values estimated by an investment banker specializing in cable television were used (4% above prime); for the next higher ratings, interest rates were reduced proportionally until the reported ratings were reached.

[8] Cable television is a stand-by service which sells a consumption *potential* to households. The marginal cost to the operator for the *actual* use by a household is trivial. This is likely to change under a billing system where charges are imposed for actual viewing, and the revenue for each viewing is shared with program suppliers; but in 1980 less than five systems out of more than 4,200 had such billing capacity.

[9] Product-specific economies of scope were estimated for pay-cable subscriptions, since for that output one could observe zero production. However, the related estimation of "stand-alone" costs of production requires an extrapolation of the cost function and the results must be viewed with caution. The results show the existence of product-specific economies of scope for pay subscriptions, with a cost-saving degree of -0.3686.

[10] Beyond the theoretical arguments, there is also the reality of competitive entry, or rather the lack thereof. In practice, there are no second entrants, apart from minor cream skimming. Competitive cable television services (known in the industry as "overbuild") exist in less than ten franchises out of 4,200, and are unusually caused by disputes about the scope of the initial franchise award. Of these operations, only those in Allentown, Pennsylvania, and Phoenix, Arizona are of appreciable size. (*TVC,* December 1, 1981). Despite rivalry, subscriber rates in Allentown are above the national average. "Where cities have tried to spur competition during refranchising by inviting competitive bidding, they have been unable to inspire even a nibble of interest from any companies other than the incumbent operator" (Stoller 1982).

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18. Market Delineation, Measurement of Concentration, and F.C.C. Ownership Rules*

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I. INTRODUCTION

In July of 1982, the Federal Communications Commission (1982) issued a *Notice of Proposed Rulemaking* that suggested elimination of the broadcast network-cable system crossownership prohibition. The Commission noted that the quantity of video programming available had increased, and cited various alternative delivery systems that may substitute for cable or broadcast television. The *Notice* also asked for comment on possible "rules of thumb" to be used in place of the current rules to evaluate mergers, and how to delineate markets appropriately for this task. In response to a request from Commissioners, the Commission's Office of Plans and Policy prepared a report on market delineation and measurement of concentration (Levy and Setzer, 1982). That report, which was placed in the cable-network docket for public comment, forms the basis of the present paper.

II. COMMISSION GOALS

In the cable-network *Notice,* the Commission quoted its rationale for adopting the rule in 1970, a rationale that expresses its goals for ownership regulation generally:

> Our adoption of these provisions—designed to foster diversification of control of the channels of mass communications—was guided by two principal goals. . . . One of these goals is increased competition in the economic marketplace; the other is increased competition in the marketplace of ideas.[1]

While both goals are important, the Commission

> has placed principal reliance on insuring diversity in sources of information because of the part such diversity serves in reaching First Amendment goals. (FCC, 1979)

* The opinions expressed herein are those of the authors. They do not necessarily reflect the views of the Federal Communications Commission.