Economies of Scale in Cable Television: A Multiproduct Analysis

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CONTENTS

I. THE RESEARCH ISSUE

This study is an investigation of the economies of scale in cable television operations. 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.

The study proceeds by specifying a multiproduct function, and incorporates the effects of regulation in the multi-equation model. The statistical estimation is based on data for all 4,800 U.S. cable systems in operation in 1981.

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" (Sloan Commission 1971). Yet ironically, the market structure of "abundant" cable television may be more restrictive than that of "scarce" broadcast television, since the present franchising system has led to the establishment of parallel local franchises, one for each franchise area. This raises concern about a cable operator's ability, if left unconstrained by competition or regulation to charge monopolistic prices to subscribers, and, more significantly, to control the content of a large number of program channels. A variety of policy proposals have therefore been made, seeking to reach 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 is to permit entry and encourage *inter*-media competition between cable and other video technologies.[1]

A second and distinct competitive approach is to rely on *intra*-medium competition among cable companies. In New York State, for example, a governor's bill, based on recommendations by Alfred Kahn and Irwin Stelzer had sought to open each cable franchise area to additional cable companies, thereby reducing their local economic power. 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 normally not likely to be sustainable, absent collusion, if cable exhibits strong economies of scale and economies of scope, i.e., cost advantages of size and of diversified production.

The question of cable television's economies of scale also has implications on the scope of local regulation (Schmalensee 1979) and on the treatment of the medium as a "public utility," issues that have arisen in a number of court cases.[2] (In one decision, for example, the court declared that "CATV is not a natural monopoly. Thus, the scope of regulation which is necessary in the natural monopolies is not here necessary . . . (and) CATV is not a public utility . . . (*Greater Freemont, Inc. v. City of Freemont*, 1968)." Information on scale elasticities is also important in assessing the likelihood of future consolidations into regional or national cable systems, finding the economically most efficient subdivision of large cities into franchise zones,[3] and in analyzing the price structure of cable television.[4]

Despite the relevance of the question of cable television economies of scale and scope, it has not received much empirical investigation.[5] Previous studies of cable television have typically centered on questions of demand analysis and of audience diversion. Most are dated, since their impetus was the 1966 FCC rules restricting CATV (Mitre 1974; CTIC 1972; Mitchell and Smiley 1974; Crandall and Fray 1974; Noll et al. 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 et al. 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).[6]

Since that observation, several empirical studies on the demand for pay-cable services were undertaken (Bloch 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 (1983).

The Owen and Greenhalgh study, though it also relies on a cost function approach, 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 form of "gamesmanship," and including those made by losing and therefore possibly inefficient bidders. Furthermore, no capital measures are available. Nevertheless, the Owen-Greenhalgh study is a great improvement over the previous state of knowledge. Webb (1983) also includes a brief and simple estimation of economies of scale, but the magnitudes of the elasticities are so vast (in the order of 4 to 10) as to be unpersuasive.

II. THE MODEL

Economies of scale and natural monopoly are closely related but not identical concepts.[7] Baumol (1977) together with Bailey and Willig (Baumol et al., 1977), formalized the analysis of these terms for the multiproduct case, defining natural monopoly as "[a]n industry in which multifirm production is more costly than production by a monopoly (subadditivity of the cost function)." Accordingly, to establish a natural monopoly anywhere along an output ray, it is necessary and sufficient to demonstrate strict ray subadditivity, i.e., that the costs of joint production by one firm are less than the cost of separate production by several firms for any scale of output mix Q. The existence of subadditivity is difficult to prove.[8] However, a number of conditions exist that are sufficient—though not necessary—for ray subadditivity. Among these is the proposition that increasing returns to scale up to output combination Q imply decreasing ray average costs and ray subadditivity up to Q. Hence, a showing of increasing returns to scale for the output range below Q would demonstrate a natural monopoly along that output ray.[9]

For purposes of analysis and estimation, consider the multiproduct cost function of i, uniquely corresponding to the production function under duality assumptions,

$$(1)\quad C_i = f_i\,(P_1 \ldots P_n;\ Q_1 \ldots Q_q;\ M_m)$$

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 of the system, and M_m are a set of other variables that may affect cost. 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.,

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

where X_i is the quantity of input i. (The estimation of these cost-share equations jointly with the cost function increases the degrees of freedom and the statistical weight of an empirical estimation.)

Furthermore, let the cost function f be given by the translog function, a second-order logarithmic approximation to an arbitrary twice-differentiable transformation surface (Griliches and Ringstad 1971; Jorgenson et al. 1971). The translog function imposes no restrictions of production such as homogeneity, homotheticity, or unitary elasticities of factor substitution, and is hence convenient for testing the existence of these properties.[10] A major problem with the application of a multiproduct 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. As Caves, Christensen, and Tretheway (1980), pointed out, the use of the log metric for outputs in the generalized translog function is unnecessary for a homogeneity of degree one in factor prices, a condition which is usually imposed. Instead, one can substitute the Box-Cox metric

$$(3)\ g_i(Q_q) = \frac{Q_q^{\ w} - 1}{w}$$

which is defined for zero values, and which approaches the standard natural logarithm lnO_q as $w \rightarrow O$. Using this expression, we can define the "hybrid" multiproduct translog cost function.

$$(4)\ lnC(P_i, Q_q, M_m) = a_0 + \sum_i a_i lnP_i + \sum_q a_q\left(\frac{Q_q^{\ w} - 1}{w}\right)$$
$$+ \sum_m a_m lnM_k + \frac{1}{2}\sum_i\sum_j a_{ij} lnP_i lnP_j + \frac{1}{2}\sum_q\sum_p a_{qp}\left(\frac{Q_q^{\ w} - 1}{w}\right)\left(\frac{Q_p^{\ w} - 1}{w}\right)$$
$$+ \frac{1}{2}\sum_m\sum_n (lnM)^2 + \sum_i\sum_q a_{iq} lnP_i\left(\frac{Q_q^{\ w} - 1}{w}\right)$$
$$+ \sum_m\sum_i a_{im} lnP_i lnM + \sum_m\sum_q a_{qm}\left(\frac{Q_q^{\ w} - 1}{w}\right) lnM$$

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

$$(5)\ E_{CPi} = a_i + \sum_j a_{ij} lnP_j + \sum_q a_{iq}\left(\frac{Q_q^{\ w} - 1}{w}\right) + \sum_m a_{im} lnM$$

$$(6)\ E_{CQq} = Q_q^{\ w}\left(a_q + \sum_p a_{qp}\left(\frac{Q_p^{\ w} - 1}{w}\right) + \sum_i a_{iq} lnP_i + \sum_m a_{qm} lnM\right)$$

$$(7)\ E_{CMm} = a_m + a_{mm} lnM + \sum_i a_{im} lnP_i + \sum_q a_{qm}\left(\frac{Q_q^{\ w} - 1}{w}\right)$$

Several parametric restrictions must be put on the cost function. The cost shares must add to unity which implies that $\Sigma E_{CPi} = 1$; under symmetry conditions, the cost function must be linearly homogeneous in factor prices at all values of factor prices, output and maturity. That is,

(8) $\sum_i a_i = 1; \qquad \sum_i a_{ij} = \sum_i a_{iq} = \sum_i a_{im} = 0$

and, the cross partial derivatives of the translog cost function must be equal, by its second-order approximation property, i.e., the symmetry condition exists

(9) $a_{ij} = a_{ji}$ and $a_{qp} = a_{pq,}$ where $i \neq j, p \neq q$

The cost function is homothetic if and only if it can be written as a separable function of factor prices and outputs (Shepherd 1970). The optimal factor share combination is then independent of output, i.e., the expansion path is linear. From equation (5), it then must be

(10) $a_{iq} = 0$

which imposes $n-1$ independent restrictions, where n is the number of inputs i. Furthermore, the function is homogeneous at the sample mean if overall cost elasticity with respect to output is constant, i.e., if the conditions hold

(11)[11] $a_{qp} = a_{iq} = a_{qm} = w = 0$

For a test of constant returns to scale to exist, we add the independent restriction,

(12) $a_q = 1$

Finally, for a neutrality of technical change, we impose the $n-1$ independent restrictions, for an M that measures time,

(13) $a_{im} = 0$

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 (Hanoch 1975). 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 of scale elasticity, E_S. For the multiproduct case, local overall scale economies, as shown by Fuss and Waverman (1982), are

(14) $E_S = \dfrac{1}{\sum_q E_{CQq}}$

so that

$$(15)\ E_S = 1/\sum_q \left(Q_q{}^w \left(a_q + \sum_p a_{qp} \left(\frac{Q_p{}^w - 1}{w} \right) + \sum_i a_{iq} lnP_i + \sum_m a_{qm} lnM \right) \right)$$

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

$$(16)\ E_{Sq} = \frac{IC_q}{Q_q \dfrac{\partial C}{\partial Q_q}}$$

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

$$(17)\ \ IC_q = C(Q_1, \ldots Q_N) - C(Q_1 \ldots Q_{q-1}, 0, Q_{q+1} \ldots Q_N)$$

This elasticity can be rewritten as

$$(18)\ E_{Sq} = \frac{IC_q}{C} \Big/ E_{CQq}$$

which is

$$(19)\ E_{Sq} = \frac{IC_q}{C} \Big/ Q_q{}^w \left(a_q + \sum_p a_q \frac{Q_q{}^w - 1}{w} \right) + \sum_i a_{iq} lnP_i + \sum_m a_{qm} lnM \Big).$$

For the hybrid translog function, sample mean values are $P_i = Q_q = M = 1$; thus the cost functions simplify to

$$(20)\ C(Q_1 \ldots Q_N) = \exp(a_0)$$

so that equation (19) for the product-specific economies of scale becomes

$$(21)^{12}\ C(Q_1 \ldots Q_{q-1},\ 0,\ Q_{q+1} \ldots Q_N) = \exp\left(a_0 - \frac{a_q}{w} + \frac{a_{qq}}{2w^2} \right)$$

$$(22)\ E_{Sq} = \frac{\exp(a_0) - \exp\left(a_0 - \dfrac{a_q}{w} + \dfrac{a_{qq}}{2w^2} \right)}{\exp(a_0) \cdot a_q}$$

The degree of overall economies of *scope* is the proportion of the total cost of joint production that is saved by joint production

$$(23)\ S_C = \frac{\left(\sum_q^N C_q(Q_q)\right) - C(Q_1 \ldots Q_N)}{C(Q_1 \ldots Q_N)}$$

At the sample mean, we observe that the product-specific cost function $C_q\ (Q_q)$ is

$$(24)\ C_q(Q_q) = C(0, 0 \ldots, Q_q, \ldots 0) = \exp\left(a_0 - \sum_{g \neq q}^{N} \frac{a_g}{w} + \frac{1}{2w^2} \sum_{g}^{N} \sum_{s}^{N}{}_{g,s \neq q} a_{gs}\right)$$

Therefore, equation (23) becomes

$$(25)\ S_C = \frac{\left(\sum_q^N \exp\left(a_0 - \sum_g^N \frac{a_g}{w} + \frac{1}{2w^2} \sum_g^N \sum_s^N a_{gs}\right)\right) - \exp(a_0)}{\exp(a_0)}$$

In order to solve this equation, 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 (1977a) have shown, it is a sufficient condition for economies of scope for the twice differentiable multiproduct cost function to have cost complementarities of the form

$$(26)\ \frac{\partial^2 C}{\partial Q_q \partial Q_p} < 0$$

which can be expressed by

$$(27)\ \frac{\partial^2 C}{\partial Q_g Q_q} = \frac{C}{Q_q Q_g}\left(\frac{\partial lnC}{\partial lnQ_q} \frac{\partial lnC}{\partial lnQ_q} + \frac{\partial^2 lnC}{\partial lnQ_q lnQ_p}\right) < 0$$

At the sample mean of the hybrid translog cost function, this condition is met when $a_q a_g < -a_{qg}$ for each combination of outputs q and g, with $q \neq g$.

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 (4), the behavioral equations (2) and (5)–(7), and the restrictions (8) and (9).

Several alternative models are considered. First, we estimate different multiproduct models. Model A imposes no restrictions as to homotheticity, homogeneity, constant returns to scales, or neutrality. Model B imposes homotheticity (restriction (10)). Model C imposes homogeneity (restriction (11)). Model D imposes constant returns to scale (restrictions (11) and (12)). Model E imposes neutrality (restriction (13)). All models include the linearity restrictions (8) and (9).

The form of estimation that is used to determine this system follows Zellner's (1962) iterative method. That technique is a form of generalized least squares, shown to yield maximum likelihood estimates that are invariant to which of the cost-share equations is omitted (Barten 1969). In estimating such a system, it is generally assumed that disturbances in each of the share equations are additive, and that they have a joint normal distribution. These assumptions are made here too.[13]

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 (Christensen and Greene 1976). We define the determinants of the restricted and unrestricted estimates of the disturbance covariance matrix values. We then have

$$(28)\quad \lambda = (|\Omega|_R / |\Omega|_U)^{-N/2}$$

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,[14] operating and accounting in a single-plant mode, supplying their local market only, and reporting data according to the fairly detailed categories of a mandatory federal form.[15]

The data covers virtually all 4,800 U.S. cable systems,[16] and is composed of four disparate and extensive files for each of the years

1978 to 1981 for technical, programming, financial, local community, and employment information. The financial data includes both balance sheet and income figures.[17]

All variables are standardized around the sample mean in order to overcome the problem of arbitrary scaling that can become an issue in translog functions.[18]

A. Labor Inputs[19]

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.).

B. Capital Inputs

Accounting data for different classes of assets is reported to the FCC in book value form. Although the great bulk of assets in the cable television industry have been acquired within the past decade, thus limiting the extent of inflationary distortion, 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. In that report, the required investment flow in a medium-sized cable system over a period of ten years was calculated.[20] We assume that this time distribution of investment over the first ten years holds proportionally for all systems, with investment in the eleventh year and further years identical to that of the tenth year in real terms, and that the cost of acquiring capital assets required in a cable television system increases at the rate of a weighted index of communications and utilities equipment.[21]

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 $= t$).[22]

$$(29)\ P_K = r_E \cdot \frac{E}{K} + r_D(1 - t)\frac{D}{K}$$

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 (Sharpe 1964; Lintner 1965), an estimate of β for a specific firm is 8.8 times β, where β is the measure of nondiversifiable (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 percent over the treasury bill rate.[23]

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 (Moody's 1981). 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.[24]

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

C. 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 trivial exceptions,[25] programming is supplied by broadcasters and program networks.[26] Program costs are both direct and indirect. Direct costs are the outlays for program services, for example to pay-TV networks and to suppliers such as Cable News Network (CNN), which charge operators according to the number of their subscribers, plus the cost of program importation and its equipment. Direct costs, however, are only part of the programming cost; indirect costs that must also be considered are the foregone net earning from advertising. For example, CNN is able to sell some of its "air" time to advertisers. This time is in effect a compensation in kind by the cable operator to CNN for the supply of the program. Similarly, local broadcasters are carried by cable for free, and the programming cost of these "must carry" to cable operators, too, is the foregone earnings, largely in advertising revenues.[27]

Direct costs are reported to the FCC and are available. Included are also such capital cost 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 net of cost. Actual figures are reported to the FCC; potential revenues are estimated by reference to the average net advertising revenue in television broadcasting per household/and viewing time.[28] The unit price of programming inputs is their total divided by the number of program hours and channels.

It is one of the convenient properties of cable television that it uses very little in inputs beyond those of capital, labor, and programming. It does not use raw materials of intermediate inputs to speak of, apart from programming. Even its energy requirements are quite small, in the order of .7 percent of total expenses, if capital expenses are included (Weinberg 1972, tables C-1 and C-2). Office supplies, telephone, postage, insurance etc. add another 1.8 percent of costs that include capital inputs. For consistent treatment of inputs and outputs, this small residual input is added to the inputs K, L, and P; since one cannot determine for what the residual input is a substitute, we prorate K, L, and P.

D. Outputs

Costs and revenues in cable television are nearly entirely for subscription rather than actual use. Pay-per-view billing systems are rare, and in their absence there are only negligible marginal costs to the operator for a subscriber's actual viewing of the channels. Interactive communications services, though maybe of future importance, are very rare at present. Advertisements, similarly, are largely supplied by program providers as part of an exchange arrangement; as discussed above, they are an input. Hence, the number of actual and potential subscribers—as opposed to their viewing—are the measures of the operator's outputs.

Cable television operators' major outputs then are of the following dimensions: (a) basic service subscriptions; (b) pay-TV service subscriptions; and (c) the size of the market developed, measured by the number of *potential* subscribers that are reached. The latter is reflected by the number of "homes passed" by cable. The larger this number, the more subscribers can be potentially enrolled. Cable trunk lines or feeder lines pass their house; only drops need to be added for their inclusion as paying customers.[29]

E. Other Variables

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

This variable may be thought of as if it were an output factor. Quite possibly, it is substitutable for the more conventional input factors of capital and labor, reflecting improvements in productivity of a firm whose experience shifts the cost function downwards. The variable also allows to reflect different technological vintages, and a possible tightening of franchise contract requirements over time. There is no clear-cut relation of time and size per se. Old systems include both the smallest backwoods operators and the largest, due to the time available for penetration.

Two additional variables are introduced in order to adjust for differences in the cable systems that may affect costs of production and ability to attract subscribers. The density of population has a role in determining cost. The further houses are from each other physically, the more capital and labor inputs must go into reaching each. To allow for density variations, we define *D* as the length of cable trunk lines per household passed. The resultant ratio is used as a proxy for density.[30]

A third variable is the number *E* of video channels offered by a cable operator. Clearly, the more channels offered, the more inputs are required. At the same time, one would expect subscription outputs to be affected positively, *ceteris paribus*, since the cable service is more varied and hence probably more attractive to potential subscribers.[31]

IV. RESULTS

Table 3.1 represents the parameter estimates for the five models (A-E), for the multiproduct specification, for the year 1982.

The system has a good fit, with system R^2 values above .97 for the models. Similarly, the coefficients are generally significant at the .05 level, and common parameters are of similar size. High R^2 values are found for the cost share equations, when these are estimated separately.[32]

Overall elasticity of scale is calculated, using equation (14), as E_S = 1.096. That is, a 10 percent increase in size is associated with a unit cost decrease of about 1 percent.

We are also able to calculate, using equation (19), measures for the product-specific economies of scale for the three outputs. They are:

E_S (Homes passed) = 1.020
E_S (Basic subscriptions) = 1.054
E_S (Pay subscriptions) = 1.072

Economies of scale are thus observed for two outputs—basic and pay subscriptions. However, for "Homes passed," these are relatively small; it may be recalled that this output description refers to a physical measure, namely the extent of the cable network in accessing a market.[33]

The implication from this result is that scale economies do not appear to exist primarily in the technical distribution aspects of cable television, as reflected by "Homes passed." Instead, they are observed for the output definitions that include a strong element of marketing success.

It is particularly interesting to observe that the overall economies of scale are larger than the product-specific economies of scale. There are then economies to joint production, or of "scope."

It is, however, one thing to observe that economies of scope must exist, and quite another to actually apply the equations of the analytical part to their estimation in order to get a specific number. As discussed above, one cannot, at least for cable television, observe zero production levels or stand-alone production for separate products except—rarely—

Table 3.1. Cost Function Parameters Output Definition: Multiproduct

Parameter	*Model A: unrestricted*	*Model B: homotheticity*	*Model C: homogeneity*	*Model D: constant returns*	*Model E neutrality*
a(0)	−0.4295	−0.3551	−0.2669	−0.4353	−0.3780
	(21.0098)	(16.3044)	(14.1049)	(9.2915)	(18.4553)
a(P1)	0.3349	0.2824	0.2150	0.4507	0.2889
	(12.4595)	(9.4205)	(8.2853)	(13.3905)	(11.2621)
a(P2)	0.3417	0.2490	0.1584	0.3947	0.2831
	(10.2453)	(7.2420)	(6.3529)	(11.5193)	(8.6899)
a(P3)	0.3233	0.4685	0.6265	0.1545	0.4278
	(7.6582)	(10.1526)	(27.2923)	(4.9320)	(10.3827)
a(Qa)	0.2920	0.3219	0.5476	0.5399	0.2858
	(4.1001)	(5.4185)	(12.7492)	(12.6206)	(4.0156)
a(Qb)	0.1211	0.1629	0.1972	0.2977	0.2762
	(1.5862)	(2.0956)	(3.7183)	(2.0495)	(3.5872)
a(Qc)	0.4987	0.3622	0.1970	0.5585	0.4314
	(13.5994)	(9.2298)	(11.5557)	(22.4069)	(11.8519)
a(D)	0.1927	0.0844	−0.2019	−0.1778	0.0029
	(2.4782)	(1.0149)	(2.8993)	(0.9504)	(0.0407)
a(E)	0.4407	0.4219	0.5284	0.0204	0.4089
	(6.1587)	(5.4698)	(7.2090)	(0.1173)	(6.0793)
a(M)	−0.0092	−0.0587	−0.0296	0.0209	0.0552
	(2.0556)	(1.6472)	(0.6157)	(0.1649)	(1.1232)
a(P1)(SQ)	0.0192	0.0169	0.0653	0.1096	0.0318
	(1.2457)	(1.2603)	(5.0556)	(5.4497)	(2.1764)
a(P1)(P2)	0.1757	0.0126	−0.0996	−0.1322	0.0297
	(4.5319)	(0.5000)	(4.4764)	(3.6293)	(0.8589)

Table 3.1. (Continued)

Parameter	*Model A: unrestricted*	*Model B: homotheticity*	*Model C: homogeneity*	*Model D: constant returns*	*Model E neutrality*
a(P1)(P3)	−0.2142 (5.1888)	−0.0464 (4.3946)	−0.0309 (3.4134)	−0.0870 (6.1643)	−0.0935 (2.5117)
a(P1)(Qa)	0.0814 (0.9600)	—	—	—	0.2007 (2.7285)
a(P1)(Qb)	0.2438 (2.8283)	—	—	—	0.0231 (0.3134)
a(P1)(Qc)	0.0094 (0.2667)	—	—	—	−0.0807 (2.4471)
a(P1)(D)	−0.1481 (1.7573)	−0.0095 (0.1166)	0.1114 (1.7598)	0.1900 (2.2280)	—
a(P1)(E)	−0.4059 (3.8088)	0.2317 (2.3676)	−0.0369 (0.4621)	0.0406 (0.3447)	—
a(P1)(M)	−0.0478 (0.9377)	0.1963 (4.6775)	0.0493 (1.3034)	0.0750 (1.2297)	—
a(P2)(SQ)	0.4082 (12.4739)	0.0332 (2.4624)	0.0750 (6.6422)	0.1204 (6.4273)	0.2905 (9.3819)
a(P2)(P3)	−0.9922 (13.4510)	−0.0792 (5.9905)	−0.0504 (5.4034)	−0.1086 (7.4886)	−0.6109 (10.0694)
a(P2)(Qa)	−0.2334 (2.1867)	—	—	—	0.1112 (1.1449)
a(P2)(Qb)	0.4235 (3.7497)	—	—	—	−0.0737 (0.7668)
a(P2)(Qc)	0.7728 (12.0940)	—	—	—	0.4742 (8.7495)

a(P2)(D)	−0.2435	−0.2612	−0.0077	0.0252	——
	(2.2640)	(2.7856)	(0.1290)	(0.2989)	
a(P2)(E)	−0.5717	0.3377	0.0485	0.0625	——
	(3.8874)	(3.0053)	(0.6524)	(0.5585)	
a(P2)(M)	0.3278	0.2077	−0.0280	0.0314	——
	(4.7756)	(3.3537)	(0.8139)	(0.5559)	
a(P3)(SQ)	0.6032	0.0628	0.0406	0.0314	0.3522
	(12.5321)	(7.8259)	(14.8110)	(0.5559)	(9.1544)
a(P3)(Qa)	0.1520	——	——	——	−0.3120
	(1.1172)				(2.5455)
a(P3)(Qb)	−0.6674	——	——	——	0.0505
	(4.7819)				(0.4287)
a(P3)(Qc)	−0.7823	——	——	——	−0.3935
	(9.8163)				(6.0579)
a(P3)(D)	0.3916	0.2708	−0.1037	−0.2152	——
	(2.9928)	(2.2879)	(3.5403)	(2.8686)	
a(P3)(E)	0.9776	−0.5694	−0.0115	−0.1031	——
	(5.4791)	(3.8618)	(0.3923)	(1.3260)	
a(P3)(M)	−0.2800	−0.4041	−0.0213	−0.1065	——
	(3.7788)	(5.8027)	(1.1789)	(2.3104)	
a(Qa)(SQ)	0.1509	0.2967	——	——	0.1634
	(0.9408)	(1.7608)			(1.0060)
a(Qa)(Qb)	−0.5721	−0.7997	——	——	−0.4138
	(1.6672)	(2.2508)			(1.2027)
a(Qa)(Qc)	−0.1156	0.0691	——	——	0.2345
	(0.9659)	(1.6512)			(2.0869)
a(Qa)(D)	0.2968	0.4290	——	——	0.2673
	(1.2781)	(1.7567)			(1.1416)

Table 3.1. (Continued)

Parameter	*Model A: unrestricted*	*Model B: homotheticity*	*Model C: homogeneity*	*Model D: constant returns*	*Model E neutrality*
a(Qa)(E)	0.0502	−0.0498	—	—	−0.4212
	(0.1517)	(0.1501)			(1.2502)
a(Qa)(M)	0.0305	0.0410	—	—	−0.2483
	(0.1895)	(0.2419)			(1.5042)
a(Qb)(SQ)	−0.0337	0.0334	—	—	−0.3023
	(3.3132)	(0.4302)			(3.3153)
a(Qb)(Qc)	0.2981	−0.2418	—	—	−0.2545
	(2.4572)	(5.5954)			(2.3535)
a(Qb)(D)	−0.5525	−0.5936	—	—	−0.4203
	(2.2777)	(2.3360)			(1.7505)
a(Qb)(E)	−0.5389	0.2512	—	—	0.3580
	(1.6146)	(0.7674)			(1.0777)
a(Qb)(M)	−0.0251	0.0802	—	—	0.2326
	(0.1617)	(0.4982)			(1.4746)
a(Qc)(SQ)	0.0319	0.0292	—	—	0.1710
	(9.4927)	(4.1997)			(6.0260)
a(Qc)(D)	−0.2008	−0.1169	—	—	0.0794
	(1.9116)	(1.2390)			(2.1344)
a(Qc)(E)	−0.5338	0.5509	—	—	0.1880
	(3.7968)	(4.4980)			(5.1626)
a(Qc)(M)	0.2751	0.3351	—	—	0.0190
	(4.2650)	(5.3635)			(0.9946)
a(D)(SQ)	−0.0316	0.0862	0.0972	0.1290	0.0117
	(0.3699)	(0.9853)	(2.0793)	(1.0478)	(0.1594)

a(D)(E)	0.5141	0.4598	0.4015	0.9788	0.3799
	(2.0282)	(1.7958)	(2.7186)	(2.4377)	(1.6409)
a(D)(M)	0.1819	0.2374	0.1653	0.2217	0.1005
	(1.5034)	(1.8710)	(1.5121)	(0.7486)	(0.8209)
a(E)(SQ)	1.0449	−0.1151	0.1148	0.5262	0.2549
	(4.8100)	(0.5416)	(0.6843)	(1.1270)	(1.4826)
a(L)(M)	0.5639	−0.0926	0.4372	1.1679	0.6205
	(3.0229)	(0.4949)	(2.8572)	(2.8955)	(3.3830)
(M)(SQ)	0.1849	0.0779	0.1309	0.3789	0.2041
	(3.7133)	(1.4725)	(2.9945)	(3.4417)	(44.0412)
R^2	0.9771	0.9816	0.9707	0.8714	0.9772

for pay TV subscriptions, because no CATV operation is conceivable without homes passed and basic subscribers. And cable systems without TV tend to be small, outmoded, unrepresentative. If one relies solely on extrapolation, in these circumstances a method of dubious validity, the calculated overall economies of scope are 2.699. No claim of validity is attached to the scope figure.

The product-specific scale elasticity measures listed above also provide another insight. Since they are the ratios of average to marginal cost, their value being generally above unity reflects marginal costs that are below average costs. This suggests that in a hypothetical competitive environment, when subscriber prices are driven to marginal cost, total costs will not be recovered.

It is also interesting to look at the estimates for the effects of operational maturity M. This factor, it may be recalled, measures the effects of experience in operation. We find the elasticity of costs with respect to such maturity to be $E_{CM} = -.01$, suggesting a downward shift of the cost function with experience, with inputs and outputs held even.

It should be noted that the maturity effect M actually embodies two separate effects, that of experience, given a technology, and that of changes in the technology itself. Conceptually, it is the difference between a movement along a curve, and the shift of the curve. The separation of these effects is an item for further research.

A look at the other control variables is interesting, too. Here, we can observe that the coefficient for density (trunk length/homes passed) has a value of .19, with a good statistical significance. That is, costs are declining with density, which is an expected result, though its magnitude is not particularly great. Furthermore, cost savings decline with density and there are diminishing economies to density. This would confirm the observation that in highly dense inner city franchise areas costs increase again.

The number of channels, E, on the other hand, is associated with increasing cost; this, too, is as intuitively expected. Here, cost increases rise with channels, implying increasing marginal cost of channel capacity beyond the mean.

V. CONCLUSION

This study of the U.S. cable industry, using 1981 data from the more than 4,800 American cable companies, shows that economies of scale exist in the current range of production. On the other hand, fairly small returns to scale are observed for the separate output measure "Homes passed," which is largely a transmission definition of output. This suggests that the cost advantages of size are not derived primarily by the technical distribution network, but rather by a larger operator's greater ability to package and sell his services more effectively to potential basic and pay subscribers.

While this paper deals with scale economies of cable, such conditions are not the only factor pertinent to entry. Theoretically, it is for example possible that several rivals coexist in a market, even in the presence of subadditivity, if they enter into some form of oligopolistic agreement to assure their mutual survival. However, such interaction is less likely with a single incumbent, as is the case in cable television. A hostile entry,[34] on the other hand, is costly: since many of the cable companies operate multiple systems across the country, a hostile entry would under normal circumstances invite retaliation or a protective price cut (Milgrom and Roberts 1982).

The likelihood of competitive entry could also be affected by sunk cost of the incumbent cable operator. Sunk cost—the difference between the *ex ante* cost of investment and its *ex post* sale value—may permit strategic investment behavior in order to create entry barriers (Dixit 1979; Spence 1977). It differentiates the cost of incumbents from those of contestants, and imposes an exit cost on a contestant. Knieps and Vogelsang (1982) have shown that entry and a multifirm equilibrium may still be possible in a sunk cost situation under Cournot assumptions, provided demand is high relative to cost, but that under a Bertrand behavioral assumption entry can be deterred if a sufficiently high share of cost is sunk. It is not clear which of the assumptions better reflects a hypothetical oligopolistic interaction in cable television, or even if one can accept the simplistic assumption of invariable post-entry behavior.[35] As an empirical matter, it is very hard to assess the existence of sunk cost and to separate it from good will in cable television, although there are indications of its existence. In a sale of cable assets, the physical cable network may be acquired by other communication carriers as a broadband transmission facility,[36] possibly as a "by-pass" to telephone companies, but such use is only beginning, and probably not profit-generating for some time. In any event, it has been shown (Panzar and Willig 1977b) that competitive entry can be deterred where sunk costs are zero, if average cost is continuously diminishing; in the presence of sunk costs this result should hold all the more.

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 instances. Competitive cable television services (known in the industry as "overbuilds") exist in less than 50 franchises out of 4,800 and are usually 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. (J. Smith 1984). 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 1982:36)

The rivalry among cable operators is thus primarily for the right of first entry. Being first assures a head start and thus advantages of some economies of larger size; this, together with the likely existence of sunk costs, the ability of the incumbent to cut prices fairly rapidly, and consumers' conservative adjustment to new offerings,[37] violates the criteria for actual or potential contestability.

If the estimation results are accepted, their implications are that large cable corporations have cost advantages over smaller ones when they function as more than a mere distributor. Under the results, a pure distribution network with no programming or marketing role, such as a passive common carrier, is likely to have some but not large cost advantage over potential rivals. The imposition of such a pure transmission 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 nontransmission activities such as program selection, but it would also reduce the cost-advantage protection of incumbents against entry.

On the other hand, the conclusions require a reassessment of the pro-separations 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 in 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 primarily derived from a naturally monopolistic distribution stage.

Instead, the cost advantages appear to lie in the economies of scope (of integration) which provide cable television firms with some protection against rivalry in the distribution phase of their operations by other cable entrants. There are therefore some efficiency losses in operations associated with a separation policy, which must be weighed against the greater competitiveness in program supply.

Notes

1. For example, conventional commercial television, subscription television (STV), direct broadcast satellites (DBS), or multipoint distribution (MDS) (FCC 1980f).

2. In *Community Communications Co. v. City of Boulder,* (1981), 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."

3. An example for the present ad hoc approach to this question is the cable plan for New York City. In that two-volume report, which recommends several franchise areas, the entire analysis of economies of scale consists of the following nonsequitur: "there were only twelve—of more than 4,000 operating cable systems in the United States—which served more than 50,000 subscribers. Unquestionably, this is an acceptable minimum for the size of a franchise area. Moreover, economies of scale would also exist for smaller franchise areas." Arnold and Porter, (1982:1:135).

4. If average costs fall continuously, marginal costs are below average cost, and at a nondiscriminatory price $P = MC$, a cable company will operate at a loss. (Scherer 1980). If prices are regulated at a uniform level $P = AC$, there are no losses, but allocative inefficiency exists, since some consumers are left without service who would have been willing to pay above marginal cost. A set of discriminatory prices is therefore most likely.

5. Examples of research on scale economies exist for other industries; in particular, for electric generation, Christensen and Greene (1976), Gollop and

Roberts (1981), Nerlove (1968), Belinfante (1978), Dhrymes and Kurz (1964). For telephone service, the controversy over the nature of telecommunications has sparked studies in the United States and Canada, including Vinod (1972); Sudit (1973); Dobell et al. (1972); Fischelson (1977); Eldor et al. (1979). Recent noteworthy treatments have been Nadiri and Schankerman (1981), and Denny et al. (1981a, b). In a multi-product setting, such work has included Fuss and Waverman's (1981) study of telephone service, Caves et al. (1980). For a review of this and related literature, see Bailey and Friedlaender (1982).

6. More precisely, earlier 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.

7. The concept of natural monopoly, introduced (with a different terminology) by John Stuart Mill (1848), and refined by Richard R. Ely (1937:628), has been used as a prime argument for regulation. "Natural monopoly is traditionally the classic case for extensive regulation" (Kaysen and Turner 1959:14–18), though others disagree (Posner 1969; Lowry 1973). Kahn, in his treatise on regulation (1971:2:119–23), properly distinguishes the case of natural monopoly from one of mere duplication of facilities, an insufficient condition. He describes the "critical and—if properly defined—all-embracing characteristic of natural monopoly (as) an inherent tendency to decreasing unit cases over the entire range of the market." Kahn lists factors that make a natural monopoly likely: large fixed investments; a fixed and essentially immovable connection between suppliers and customer; a nonstorable type of service; obligation of instantaneous supply; wide fluctuations in demands for service. Of these, all but the last appear to apply to cable television. Schmalensee (1979) extends this analysis to distribution networks and shows that continually decreasing costs of transmission can be treated in the same way as Kahn's decreasing unit costs. On the regulation of natural monopolies, see Demsetz (1968), Posner (1969, 1970), and Comanor and Mitchell (1970).

8. "Unfortunately, the intuitive appeal of the subadditivity concept is counterbalanced by its analytical elusiveness . . . there apparently exist no straightforward mechanical criteria that permit us to test whether or not a particular function is subadditive." (Baumol et al. 1982:170.) One insight of the multiproduct analysis is that the multiproduct firm may enjoy economies of scope with or without economies of scale.

9. Propositions 7D2 and 7D1 (Baumol et al. 1982:175).

10. Furthermore, as Diewert (1976) has demonstrated, a Divisia index of total factor productivity that is based on a translog function is exact rather than approximate. The cost function is generally superior in allowing for an endogeneity of inputs when nonconstant returns exist; Belinfante (1978). The choice among flexible functional forms is discussed by Berndt and Khaled (1979).

11. The imposition of $w = 0$ leads to a general multiproduct cost function, and this is reasonable. For the concept of homogeneity to be meaningful, all

output quantities must be able to vary, and none can be restricted to zero, obviating the need for the transform (3).

12. Without the hybrid specification, an equation of type (21) could not be numerically expressed in translog form.

13. The parameter w is found by minimizing the residual sum of squares $0^2(w)$. (Madalla, 1977:315).

14. Reporting is according to local operations; national cable companies (Multiple Systems Operators, or MSOs) must therefore report their different operations separately.

15. These reports are likely to be fairly accurate due to cable companies' vulnerability to FCC charges of misreporting in a period in which they are actively seeking new franchises.

16. Cable franchise areas are not identical with communities, since most cities subdivide their area into different franchise zones; subscriber size for a cable operation—once one goes beyond small communities—therefore does not necessarily correlate with community size. This holds even more for the major media market-size definition of population. Variations in system size are therefore not systematically related to different forms of urban governance, regulation, or number of other media outlets.

17. Cable Bureau, (1981). 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 specially available to the author.

18. On the statistical aspects of this scaling, which is widespread in translog estimations, see Denny and Fuss (1977).

19. 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. While some input prices may be lower for multiple system operators, there is no systematic relation between size and MSO status. TCI, the largest MSO in the country, consists primarily of small and medium wired systems.

20. The study looks into hundreds of items of equipment, different techniques for laying cable, etc. Its use here is for the relative distribution of capital investments over time (Weinberg 1972:128).

21. The formula employed is: Current Value = Book Value × T_M; where T_M is the adjustment factor

$$T_M = \frac{\sum_{i=0}^{M} T_i}{\sum_{i=0}^{M} E_i/R_S + I}$$

with M = age (in years) of system; I = annual capital investment for a cable operation in year i; R = inflation adjustment factor for years $S+i$ of cable operation; S = starting year. The inflation adjustment is defined such that R_{1980} = 1.00. R inflates the investment of earlier years, i.e., reflects on how much a one-dollar investment in year X would cost in today's prices. No deflator/inflator data are directly available for cable television. We therefore use those of two related industries, communications equipment and public utilities. Both deflator series are available from survey data by the Bureau of Economic Analysis, U.S. Department of Commerce. We use Weinberg (1972) to obtain the shares in capital of, first, headend, amplifiers, and customer converters, which is the weight applied to the series of communications, and second, the share of transmission system, which is the weight applied to the utilities series. The result is a weighted aggregate index. Investment figures are available before depreciation, permitting a calculation of depreciation from asset life figures (Weinberg 1972) rather than relying on divergent company depreciation accounting procedures.

22. There is no evidence that tax rates, or investment cycles, are systematically different by subscriber size.

23. There is no reason to assume that β is functionally related to subscriber size.

24. Such models exist since 1966 (Horrigan), and have been refined by Pogue and Saldofsky (1969), Pinches and Mingo (1973, 1975) and Altman and Katz (1976). 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 $\geq$ 9) to C ($\leq$ 1) 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 percent above prime); for the next higher ratings, interest rates were reduced proportionally until the reported ratings were reached.

25. Usually restricted to a studio for a low budget public-access channel, and of an automated news/weather display.

26. It would be faulty to view the quantity of programs themselves as the outputs of a cable operator rather than as inputs. Neither are they produced by operators, as mentioned, nor are they sold on a quantity basis. Under the presently existing subscription based system of revenue generation (as opposed to the embryonic pay-per-view system), programs serve as an incentive to buy subscriptions, not as the product itself.

27. There are constraints on the operator's choice of programming; a certain number of channels are mandated ("must carry") of broadcasters; public access, leased access, and governmental channels. This may distort inputs.

28. Calculated by dividing total TV advertising billing (McCann-Erickson, as reported in *Television Digest* 1980:76a) by a number of households (Arbitron, as reported in *Television Digest* 1980:104a), and by viewing time. Nielsen figures for average weekly viewing of TV households is 42.6 hours; of cable households, 51.7 hours (A.C. Nielsen 1981). TV advertising revenues per household viewing hour is found at close to 5.5 cents. This figure is adjusted for cable subscribers' viewing hours.

29. Owen and Greenhalgh (1982) similarly used "homes passed" as an output.

30. The density variable can correct for different transmission requirements (ducts in central cities; poles in suburban and rural areas). The flexible translog specification permits a U-shaped relation of cost and density, which one would intuitively expect.

31. Channels are not outputs; they serve to generate the revenue producing subscriptions. However, the specifications of the main equation permits an interpretation of channel capacity as an output.

32. There is a possibility that some cable systems are backwards or old; the time variable "experience" can allow for the latter; to correct for the former—and to test its validity—the model was also used with all 12-channel systems (likely to be the most "backward") excluded. The results were substantially similar, alleviating the concern.

33. The definition of output-specific economies of scale is particularly important in the analysis of an industry with the technological characteristics of cable television, where outputs are not necessarily changed along a ray, i.e., by equal proportions. For example, if two cable companies serve an area that has previously been served by only one firm, their technical outputs "homes passed" or "channels provided" are, let us assume, as large for each separate firm as they had been for the monopolist. However, their outputs "basic subscribers" and "pay subscribers" are smaller than before, since they now share the market. Multifirm rivalry would normally not be substainable if product-specific economies of scale for these products existed over the range of production of the other outputs.

34. Most cable franchises are, by their terms, not exclusive.

35. Once a more realistic variable post-entry strategic behavior is introduced, the sustainability of a single firm monopoly is subject to a variety of assumptions.

36. In 1977 the Chase Manhattan Bank analyzed the cost differences between telephone and cable transmission and concluded in an intraoffice memo: "Even with the higher installation cost which is due to them (Manhattan Cable) having to run cable into both sites and cable into the buildings, the cost saving over New York Telephone for the first year is $10,000 and $15,000 every year after. There are several other advantages in using Manhattan cable: 1) fast response to service calls, 2) use of modems with up-to-date technology, 3) very low cost for installation for any additional circuits required at these sites since buildings will be cabled" (Kalba 1977).

37. For example, a study commissioned by the National Cable Television Association found that an above average proportion of customers of both subscription (i.e., pay) television (STV) and of cable television remain with the previous system after the introduction of a new one (Pottle and Bortz 1982).