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Working Paper No. 12/92

October 1992

DEPARTMENT OF ECONOMETRICS

ISSN 1032-3813

ISBN 0 7326 0362 5

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Revised July, 1992*

* Waterman, D., Weiss, A. (1990). The Effects of Vertical Integration Between Cable Television Systems and Pay Cable Networks: 1988-1989. Modelling Research Group Working Paper #M9010, Economics Department, University of Southern California.

We are grateful to A. C. Neilsen Co. for providing statistical data.

ABSTRACT

THE EFFECTS OF VERTICAL INTEGRATION BETWEEN PAY CABLE NETWORKS AND CABLE TELEVISION SYSTEMS

We find that integration between pay networks and cable systems has substantial effects on final market outcomes. Cable systems owned by the two MSOs (Multiple Cable Television System Operators) having majority ownership ties with major pay cable networks tended to carry their affiliated networks more frequently and rival networks less frequently than did the average non-integrated system. Systems of at least one of these MSOs offered fewer pay networks in total than the average non-integrated system. With respect to pricing and other marketing behavior, results suggest that systems in these MSOs favor affiliated networks, but there was less evidence that they discriminate against rival networks.

I. INTRODUCTION

Several empirical studies have established or implied that vertical integration resolves transactions externalities at the input level (Masten, 1984; Spiller, 1985; Joskow, 1985; Johns and Weitz, 1988; Lieberman, 1991; Kaserman and Mayo, 1991). However, there has been little direct evidence of what effects, if any, vertical integration has on prices or output at the final market level.

The cable television industry affords an unusual opportunity to infer the effects of vertical integration on final market outcomes under a particular market circumstance: that of a multi-product monopoly retailer integrated with the supplier of some, but not all, of the differentiated products it could offer. In this paper, we compare the availability, retail prices, and output (*i.e.*, subscribership) of the four largest vertically integrated monthly subscription pay cable networks (HBO, Cinemax, Showtime, The Movie Channel (TMC)) on integrated vs. non-integrated cable systems. We employ a sample of systems owned and operated in 1989 by the largest 25 MSO's, three of which had vertical ties to the four subject pay networks.

There is no lack of models which make predictions of the possible effects of vertical integration on final market outcomes. (See Blair and Kaserman, 1983; Ordover and Saloner, 1989; and Perry, 1989 for surveys.) A recent paper by Salinger (1991) considers the effects of partial integration by a multi-product monopolist which follow from the realization of vertical contracting efficiencies. Salinger's model, which we discuss further below, makes ambiguous predictions of the effects of vertical integration on final prices, outputs, and consumer welfare. While this model provides a partial foundation for the present study, either "efficiency" or cost-raising, "vertical foreclosure," scenarios are conceivable in the cable industry. The scope of the present research does not permit us to formally distinguish between such alternative models, but one of our objectives is to provide suggestive evidence in this respect.

In addition to familiar concerns about consumer economic welfare we address, the effects of vertical integration are of special interest in consumer information industries, such as cable television. "First Amendment" concerns about preserving freedom of access by information providers to the public, or of achieving maximum diversity of information products, frequently surface in academic and judicial debates about public policy toward cable and other information industries (U.S. Congress, 1989, 1990; see also Brenner, 1988; Brennan, 1990; Owen, 1975.). Pay cable networks, in particular, do not usually have viable alternative means of distribution to potential consumers other than local monopoly cable systems.[1] The extent to which we may find evidence that integrated cable systems "favor" their affiliated products with respect to carriage or marketing behavior, or offer a larger or smaller menu of products, thus has implications for these debates.

Among earlier empirical studies attempting to measure or infer effects of vertical integration on final market outcomes, Wildman (1978) and Fournier and Martin (1983) compare advertising rates of network vs. non-network owned and operated television stations, but report different conclusions as to the presence or absence of such effects. Research reported by the Federal Communications Commission Network Inquiry Special Staff (1980) showed that network-owned television stations tend to clear somewhat higher percentages of network programs than non-owned affiliates. The present study is also preceded by several preliminary investigations of the effects of vertical integration in the cable industry.[2]

[1]The local cable systems operating in 1989 rarely faced substantial competition from other cable systems. Competition from "bypass" delivery systems, such as Multi-point Distribution Systems (MDS) or back yard satellite dishes (TVROs), which often carry pay networks, was relatively insignificant; in 1988, all non-cable, non-traditional broadcast video delivery systems accounted for less than 1% of the monthly subscription pay television market (Cable TV Programming, February 1988, p. 1).

[2]Using 1987 data for the four largest integrated pay networks, Salinger (1988) found cable systems integrated with these networks tended to carry affiliated pay networks more frequently and rival networks less frequently than average, and offered suggestive evidence that integrated systems carry fewer pay networks overall. Salinger also reports price estimates, but he did not obtain meaningful results. Klein (1989), relying primarily on descriptive data in a study conducted for the National Cable Television Association, argued that the effects of integration between systems and pay or basic cable networks were relatively insignificant. Waterman, Weiss, and Valente (1989) considered integration of five pay networks with eight MSOs using 1983 data. They found evidence that on the sys-

We begin in Section I.A. with a brief description of the pay cable industry as of mid-1989. In Section II, we consider possible theoretical effects of vertical integration in the cable industry. In Section III, we present empirical results, and conclude in Section IV.

I.A. THE PAY CABLE NETWORKING INDUSTRY IN 1989

The channel menus offered by local cable television systems generally begin with a "basic" package for a single monthly bundled price. This package typically includes local broadcast stations, distant broadcast signals (such as "superstation" WTBS), and various "cable-originated" basic networks which mostly depend on advertising (such as CNN and MTV). The "premium" or "pay" networks with which we are concerned carry no advertising and are offered *a la carte*, or optionally in packages of two or more, for extra monthly charges. Consumers cannot subscribe to premium networks without also buying the basic service.

Table 1 gives basic statistics about nationally distributed pay networks and their ownership affiliations as of December, 1988. The five largest networks accounted for approximately 91% of all pay cable subscriptions (col. 4). Of these five networks, four were vertically affiliated with MSOs and hence local systems: HBO and Cinemax by means of Time, Inc.'s 82% ownership of ATC and 50% share of Paragon, and Showtime and The Movie Channel by means of Viacom Inc.'s sole ownership of Showtime Networks, Inc. (col. 5). The Time, Inc. networks thus accounted for a dominant 59% of pay cable subscriptions, while the Viacom-affiliated networks had a 24% market share.

While all three of the MSOs integrated with the four largest pay networks were relatively large compared to other MSOs, they accounted for relatively small national market shares. According to A.C. Neilsen, ATC owned 137 systems having 7.1% of all basic cable

tems of some MSO's, affiliated networks were carried more frequently than average, and rivals less frequently, but also that there were significant differences in carriage patterns across MSOs that were apparently unrelated to ownership ties. In an earlier version of the present paper, Waterman and Weiss (1990) compared pay network carriage, pricing, and subscribership differences among each of the 25 largest MSOs, and found that differences from the average for ATC and Viacom systems tended to be extreme relative to the other 23 MSOs in the sample.

subscribers as of August, 1989 (making it the second largest MSO in the U.S. in terms of subscribers), while Viacom, with 23 systems, had 2.5% of basic subscribers (and was the 12th ranked MSO in size). The subscribership share of Paragon was 1.6% (the 16th largest MSO).

The four integrated networks selected for this study (HBO, Cinemax, Showtime, and TMC) are distinguished both by their market importance and the apparent similarity of their programming menus. Each of the four offered the same core menu of recent Hollywood theatrical movies. They differentiated among themselves to varying degrees, however, by also offering specials, sports events, "made-for-pay" feature films, and especially, theatrical films on an exclusive basis. The only other competitor with substantial market share, the Disney Channel, offered original programming, including made-for-pay movies and various classic, family-oriented movies. In addition to AMC's menu of American classic films and BRAVO's foreign and other "art" film fare, nearly all remaining competitors were regional sports networks.[3]

In further reference to Table 1, Columns (2) and (3) reflect significant variations in the availability of pay cable networks to subscribers. One evident source of these variations is the channel capacity of cable systems. The distribution of systems by capacity is shown in Table 2 and reflects rapid technological advance in cable hardware, as well as greater network availability, during the 1970's and 1980's. Even in 1989, however, few systems could accommodate all eleven of the nationally-distributed pay networks in addition to the 70-odd basic cable networks and numerous local broadcast, regional, and other channels available. In particular, the data of Table 3 show the wide variation in the number of different premium channels which systems chose to offer. An important concern of this study is thus whether cable networks are able to obtain "shelf space," *i.e.*, carriage, on local systems.

An evident factor determining the availability and market shares of particular pay

[3]By 1989, both AMC and Bravo had partly converted from pay to basic networks.

networks is industry history. As launch dates of the networks in Table 1, col. (1) suggest, the market structure of pay cable networking has evolved over a relatively short time period. Most entry occurred just prior to and during a period of explosive cable industry growth in the late 1970's and early 1980's. The best established pay network and current market leader, HBO, was the first to be launched (1972). Time, Inc. was already the owner of ATC when it acquired HBO in 1975. Cinemax was then started by Time as its second pay network in 1980. Paragon's joint venture relationship with Time, Inc. was relatively recent, having been established in 1987.

Showtime, the second major premium network entrant, was launched in 1976 by its present owner, Viacom, Inc. Viacom's relationship with TMC is more recent. First started by Warner-Amex Cable in 1979, TMC merged with Showtime in September, 1983, and after a period of joint management by Warner Cable and Viacom, became 100% owned by Viacom in 1986. As the pay networking industry went through a period of slowing subscribership growth and consolidation in the mid-1980's, several smaller networks fell by the wayside. The Disney Channel, the last major entrant and only other major competitor remaining, has never had cable system ties.

Cols. (2) and (3) of Table 1 further show that both carriage of and subscribership to Cinemax is less than that for HBO, and similarly for TMC in comparison to Showtime. Apart from their launch dates and possible variations in product quality, these differences are also likely to reflect product bundling strategies of the Time, Inc. and Viacom networks. Cinemax and TMC are usually marketed by systems to subscribers as "second tier" services, so that subscribers tend to accept them only in addition to one of the two market leaders, HBO and Showtime. Time, Inc., in fact, markets Cinemax to systems as a "companion" network with HBO. Viacom pursues this same strategy with Showtime and TMC, though to a lesser extent. In 1988, a little over half of basic cable subscribers, or about 29% of all TV households, accepted at least one pay network (Cablevision, March 14, 1988). Many households accepted more than one; the average number of pay networks sold per basic household in 1988 was 1.7 (The Kagan Media Index, December 24, 1991, p. 12).

By mid-1989, the pay cable industry had reached a relatively mature stage in terms of subscribership growth and the stability of market shares. Annual pay subscription growth had slowed from its decade high of 51% in 1981 to 10% (Pay TV Newsletter, July 19, 1989), apparently because of increased competition from prerecorded videocassettes and a slowing of the growth of basic cable subscribership to about 1% per year. It is in this competitive environment that we consider the effects of vertical integration between MSOs and pay cable networks.

II. THEORETICAL EFFECTS OF VERTICAL INTEGRATION IN CABLE TELEVISION

Contracts between cable systems in MSOs and pay cable networks are negotiated at the MSO level. The resulting "master contracts" typically establish a variety of terms and conditions governing all the systems within the MSO that offer the network,[4] although which individual systems actually carry the network is generally left to the MSO's discretion.

Economic theory offers ambiguous predictions of how this negotiation process might be expected to result in different final market outcomes in the presence vs. the absence of vertical integration.

Salinger (1991) considers double marginalization or other transactions effects of partial integration by a two-product monopolist in a neoclassical model. As in the well-known single-product case (Spengler, 1950), a reduction in the marginal input price of (say) product A, due to integration with its upstream producer, will initially result in a lower final price for A. If A and B are partial substitutes, however, the monopolist may then want to change the price of B, which may in turn lead to another change in the price of A,

[4] The information about master contracts in this paragraph and subsequently in the paper was obtained from sample contracts and field interviews with cable industry executives.

etc. Moreover, the rival producer might react by reducing B's input price. Salinger shows that the eventual change in final prices could be nearly anything, including the theoretical possibility of an increase in the prices of both A and B.[5] While the pricing problem in the cable industry is somewhat more complex, as we discuss below, these ambiguities clearly apply.

Although Salinger does not explicitly consider product variety, it is evident from his model that variety could rise or fall due to integration. For example, if network B's incremental net revenues to the system, given the system's optimal pricing or promotion strategy for B, drops below some per-channel technological or marketing cost, or below some opportunity cost of not carrying other networks, B would become unprofitable to offer, and variety at the local level would be reduced. On the other hand, integration resolves transactions externalities in this model, suggesting a higher probability that additional networks could profitably enter the market as integrated firms. One can easily construct examples in which pay network variety rises or falls, depending on per channel carriage costs, whether or not the networks are good substitutes, and on the magnitude of the transactions efficiencies realized.

Even if integration results in no transactions efficiencies, however, it might cause different final market outcomes if a cost raising strategy were profitable. (See Salop and Scheffman, 1983, for a general analysis).[6] By disadvantaging or excluding rival networks from the local cable markets it controls, an integrated firm's combined profits from those markets would clearly fall. But if there are economies of scale in cable networking, such a strategy might increase the rival network's average costs per subscriber, thereby limiting

[5]The possibility that final price of both products will move in the opposite direction to a change in the input price for one of them has been labelled "Edgeworth's Paradox of Taxation," in reference to the counterintuitive nature of Edgeworth's theoretically equivalent result that a tax on one of two substitute products offered by a multi-product monopolist could cause the final prices of both products to fall (Edgeworth, 1925; Hotelling, 1932).

[6]Ordover, Sykes and Willig (1985) consider a highly abstract model of pay cable network rivalry as an illustration of how a vertical price squeeze can be implemented. As they acknowledge, their model does not seem to represent the complexities of the cable industry with which we are concerned.

its access to programming, or possibly forcing it from the industry altogether.[7] Details of this scenario are provided in Waterman and Weiss (1990).

While the above discussion of vertical integration's theoretical effects is clearly not exhaustive, it makes clear the variety of possible results of integration on pay network carriage, prices, and subscribership which might occur. These include the possibility that integration will induce integrated firms to "favor" affiliated products by means of relatively low prices, greater promotional effort, or elimination of rivals from their product menus. Determination of these effects is therefore an empirical question, and we now turn to our analysis.

III. EMPIRICAL ANALYSIS

We consider the effects of vertical integration in two stages: on the cable system's decisions to carry pay networks (Section III.A.), and on the pricing and subscribership of networks which are carried (Section III.B.).

Except for one model, we confine our analysis to the four largest integrated networks, HBO, Cinemax, Showtime, and TMC. Our sample is a subset of 1646 cable systems in the largest 25 MSO's. Considering only systems in these MSOs permits comparison of integrated system behavior with that of a large, presumably comparable group of non-integrated systems. These 25 MSOs (which include ATC, Viacom and Paragon) accounted for approximately 59% of all U.S. basic cable subscribers in 1989.

Table 4 describes the specific variables we employ. Our primary data base is the A. C. Neilsen Cable On-Line Data Exchange, with supplementary data from the Paul Kagan Associates' *Cable TV Census*. Details of these data are given in Appendix A.

A. CARRIAGE DECISIONS

1. Carriage Decision Models

In general, a given pay network will be added to a local cable system's menu if the

[7] Allegations of anticompetitive foreclosure due to Time, Inc.'s joint ownership of ATC, HBO and Cinemax are one subject of private antitrust litigation filed by Viacom, Inc. against Time, Inc. in March, 1989 (Viacom, Inc., et al, vs. Time, Inc., et al, 1989).

operator expects it to yield positive incremental profits, given some optimal strategy of pricing and promoting it to subscribers. To model this decision, we hypothesize the existence of underlying latent variables, $NET^*_{ij}, i = 1, \ldots, 1646$, and $j = 1,2,3,4$ (for HBO, Cinemax, Showtime, and TMC, respectively), that measure the propensity of each system to carry each of the four different pay networks. Each NET^*_{ij} is defined as a function of relevant demand, cost, or other factors likely to affect the carriage decision (including the presence of a vertical ownership relation), and of the propensities to carry other pay networks:

$$NET^*_{ij} = X'_i\alpha_j + \sum_{k=1;k\neq j}^{4} \delta_{jk}NET^*_{ik} + \mu_{ij} \tag{1}$$

where the X_i vector represents demand, cost, and other franchise- specific factors, plus dummy variables for the three integrated MSOs, and the $\mu_{ij}, j = 1, \ldots, 4$, are jointly normally distributed. From these structural models, we obtain the reduced form equations:

$$NET^*_{ij} = X'_i\beta_j + \omega_{ij} \tag{2}$$

The normalization rule for the intercept implies that if $NET^*_{ij} > 0$, we observe that the network is carried.

To model the effects of vertical integration on the overall level of pay network variety offered to subscribers, we employ two measures: $NPAY4^*$, which indicates the aggregate propensity to carry zero through four of the four subject movie-based pay networks, and $NPAYALL^*$, which measures the aggregate propensity to carry all of the pay networks then in business. We define:

$$NPAY4(ALL)^*_i = X'_i\gamma_j + \varsigma_{ij} \tag{3}$$

where $j = 1$ for $NPAY4^*$ and $j = 2$ for $NPAYALL^*$. Consider first the expected directions of the effects of the cost, demand, and other franchise-specific variables in the aggregate carriage equations, (3).

Among the five franchise region-specific demographic variables, the probability of carriage should increase with the logarithm of household income ($LMEDIANY$), the percentage of households with heads aged 35 to 54 (*AGE*3554), and the presence of children (*CHILDREN*). Each of these factors is usually associated with high cable demand. We have no prior expectations for signage of the proportions of renters (*RENTERS*) and multi-family households (*MULTIFAM*) in the market area. These variables are likely to proxy for factors affecting cable demand, or they may represent cost factors.[8]

The number of competing broadcast stations in the market (*TV*) could have either sign; more competition should encourage operators to offer more services, but successful competition may limit the number that can be profitably offered. Similarly for the *DMA* dummy variables; larger markets tend to offer a wider range of other entertainment alternatives, but either the demand or competition effect could dominate.

The logarithm of the number of homes passed by the system (*LHPASS*) indirectly represents a cost factor; if there are economies of scale in offering and marketing networks, then the larger is the available subscriber base, the greater the product differentiation that is optimally offered. Hence we expect a positive sign for *LHPASS*. The logarithmic form reflects our expectation of diminishing marginal effects on the probability of network carriage (as also in the case of median income). Signage for another cost factor, *DENSITY*, is uncertain. More dense population could cause higher or lower marginal costs of operation, or like *MULTIFAM* or *RENTERS*, this variable might proxy for demand characteristics.[9]

A measure of discretionary channel capacity (*CHANDISC*) reflects the system operator's incentive (formerly legal obligation) to carry all "significantly-viewed" broadcast channels in the area.[10] Ideally, the operator would construct a cable plant with capacity for an optimal menu of networks. We include *CHANDISC* as a predetermined variable,

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[8]For example, multi-family dwellings are relatively cheap to wire for cable, suggesting a positive effect on carriage, while renters tend to produce a high level of "churn," potentially increasing marginal channel carriage costs and thus reducing carriage.

[9]See Mayo and Otsuka (1991), p. 403, footnote 19.

[10]The FCC's "Must Carry" rules were repealed in 1989. Also, note that *CHANDISC* is a proxy measure only since most systems also offer dedicated services such as local access channels.

however, on the assumption that fixed plant decisions are relatively inflexible in the short term.

Finally, $FRANTIME$, the elapsed time since the system's original franchise was awarded, cannot be signed *a priori*, but it may proxy for unknown characteristics, such as system management philosophy, which could influence carriage decisions.[11]

Turning to the individual carriage models, signage of the cost, demand, and other franchise-specific variables is less predictable. Other things equal, a factor encouraging a larger number of pay networks to be carried will increase the probability that any particular network will be carried. However, substitution effects working in the opposite direction could dominate for particular networks, especially with respect to demand-related variables.

In order to estimate the individual reduced form carriage equations, we define the dummy variables, NET_{ij}, s.t.:

$$\begin{aligned} NET_{ij} &= 1 \quad \text{if } NET^*_{ij} > 0 \\ &= 0 \quad \text{otherwise} \end{aligned}$$

Because the dichotomous variables NET_{ij} are observed rather than NET^*_{ij}, and the errors are assumed normally distributed, the carriage equations, (2), are estimated by probit maximum likelihood. Note that in one of the models (for HBO), all of the systems in two of the integrated MSOs (Viacom and Paragon) carried HBO. The corresponding coefficients for these MSOs cannot be estimated.

In the aggregate carriage equations, the dependent variables are modelled using ordered probit models. These are necessarily approximations to the true models, but because the true probabilities for $NPAY4(ALL)^*$ are obtained from the aggregation of probit equations like (2), it does not seem feasible to model them exactly.

2. Carriage Model Results

[11] Several previous authors estimating demand functions for cable have found this to be a significant variable. See Mayo and Otsuka, 1991, p.402, footnote 14.

Results from estimating the four individual and two aggregate carriage equations appear in Table 5. We see that the most significant effects are from the homes passed and channel capacity variables; larger systems by either dimension are likely to carry more pay networks. Competition from over-the-air broadcasters (TV) also appears to encourage pay network diversity. The demographic variables are less important, although their cumulative effects show up somewhat more consistently in the aggregate equations.

With respect to MSO dummies, results of the individual network models show that ownership by Viacom or ATC significantly influenced carriage decisions. ATC systems offered their affiliated network Cinemax more frequently than average, and offered both Showtime and TMC less frequently. Similarly, Viacom systems carried TMC more frequently and Cinemax less frequently than average. All 23 Viacom systems carried HBO, however, and there is no evidence that these systems carried Showtime with disproportionate frequency. All 29 Paragon systems offered HBO as well, but this MSO did not offer its other affiliated network, Cinemax, or either rival network more or less frequently than the average.

Finally, the aggregate carriage models indicate that by both measures, ATC systems offered fewer pay networks than did the average non-integrated system. All the Viacom and Paragon dummies were insignificant at the .10 level.

3. Carriage Model Predictions

Unlike the standard regression model, estimates of coefficients on the MSO dummies in the probit equations do not directly give the magnitude of the effects of MSO affiliation on pay network carriage. We estimate these magnitudes by using a form of the estimated probit models in Table 5 to predict the actual carriage pattern for each of the three integrated MSOs, and then comparing that pattern with the pattern we would expect to observe if each of the integrated MSOs instead behaved like the average of the non-integrated systems in the sample.

To obtain efficient predictions, it is advantageous to first reduce the size of the models in Table 5 by removing insignificant variables. This was accomplished by sequentially eliminating the least significant variables according to the Schwarz model selection criterion (Schwarz, 1978). Our specific method is detailed in Appendix B, and to save space, we do not present the smaller models.

Table 6A-B compares carriage pattern predictions using these reduced models. Column (1) of Table 6A shows the predicted percentage of systems in each of the three integrated MSOs that carry each of the four subject networks. These are obtained by generating the probability that each system carries the network (*i.e.*, that $NET_{ij} = 1$), and then summing these probabilities over the systems in the MSO. The Column (2) "normal" predictions are derived by setting the relevant MSO dummy in each model to zero, and then generating and summing the probabilities. Hence, the "normal" predictions estimate the expected number of systems in the MSO that would carry the network if those systems behaved like the average non-integrated system. A comparable methodology is applied to the aggregate carriage models (Table 6B). Column (3) shows the difference between columns (1) and (2) and *t*-ratios for these differences. For details on computation of the standard errors used to form these *t*-ratios, see Appendix B. Note that a dash (-) in Table 6 indicates that the relevant MSO dummy was either dropped in the model selection procedure or could not be estimated, and hence no prediction could be generated. Since there was no evidence of carriage differences for Time, Inc.'s 50%-owned affiliate, Paragon, no predictions are generated for that MSO.

To be expected, the variations in Table 6 correspond closely to the relative magnitudes of the probit coefficients. Of note are the relatively large variations for the "companion" networks, TMC and Cinemax, especially in the case of Cinemax on Viacom systems.

B. PRICING AND SUBSCRIBERSHIP

We use two approaches to compare the behavior of integrated vs. non-integrated systems, given their network carriage decisions. First, we estimate retail subscription price models for each of the four networks. Secondly, in order to infer the net effect of any differential pricing or promotion strategies, we estimate output, *i.e.*, pay subscribership, models.

Estimation of such models is complicated by the fact that one or more pay networks may be offered, and in turn, that these are available to subscribers only in addition to a basic cable subscription. The result is a complex system in which pay subscription rate decisions, for example, are a function of the price and characteristics of the basic service, which other pay networks are carried and their prices, and exogenous factors.[12] To determine the net effects of vertical integration on pay rates and subscribership, however, it is sufficient to derive and estimate reduced form models from this simultaneous system. Consider first the pay rate models.

1. Rate Models

Let $PRATE^*_{ij}$ denote the *a la carte* pay subscription price for network j on system i, and $BRATE_i$ denote the basic cable price. Let $RATE^*_{ij} = BRATE_i + PRATE^*_{ij}$. The model for $RATE^*_{ij}$ is given by:

$$RATE^*_{ij} = X_i'a_j + \sum_{k=1;k\neq j}^{4} b_{jk}NET_{ik} + u_{ij}, \tag{4}$$

where the $u_{ij}, j = 1,\ldots,4$, are jointly normally distributed with the μ_{ij}. The use of the same vector of exogenous variables in this as in the probit models reflects an assumption that the same factors affect supply and demand of both pay and basic networks. Other things equal, $LMEDIANY$, $AGE3554$, and $CHILDREN$ should have positive signs, since greater demand should encourage systems to charge higher rates. We would expect a larger number of competing broadcast signals to induce lower pay network prices, so that TV should have a negative sign. Similarly for DMA to the extent that larger markets have more consumer alternatives in general. We would further expect $CHANDISC$ to have a positive effect on rates to the extent that greater capacity increases demand for the basic

[12]Mayo and Otsuka (1991) discuss this interaction in general and estimate equations for basic and average pay network rates and subscribership using a simultaneous equations method.

service. We again have no prior expectation for the effects of $RENTERS$, $MULTIFAM$, $LHPASS$, $DENSITY$, or $FRANTIME$ on rates.[13]

Inclusion of the "NET" dummy variables in (4) reflects the likelihood that the rate which a system charges for one pay network will be affected by the particular combination of other pay networks also carried. Ideally we would include the possibility that the system carries any of the pay networks then in business, but as noted, the four we consider account for approximately 83% of all pay network subscriptions and evidently have the most similar subject matter.

It is not possible to estimate (4) directly because the $PRATE^*_{ij}$ variables are only observed in those systems that carry the network, *i.e.*, where $NET_{ij} = 1$. In addition, the NET_{ik} are endogenous. Hence, following Heckman's two-stage procedure (*e.g.*, Amemiya, 1985), we take the expected value of $RATE^*_{ij}$ conditional on $NET_{ij} = 1$, to obtain, for systems with $NET_{ij} = 1$,

$$RATE_{ij} = X_i' a_j + \sum_{k=1;k\neq j}^{4} b_{jk} PROB_{ijk} + e_j \lambda(X_i'\beta_j) + v_{ij} \tag{5}$$

where

$$\begin{aligned} RATE_{ij} &= RATE^*_{ij} \text{ if } NET^*_{ij} > 0 \\ &= BRATE_i \text{ otherwise.} \end{aligned}$$

λ is the inverse Mills ratio, and

$$\begin{aligned} PROB_{ijk} &= E(NET_{ik} \mid NET_{ij} = 1) \\ &= P(NET_{ik} = 1 \mid NET_{ij} = 1) \\ &= \Phi(X_i'\beta_k, X_i'\beta_j)/\Phi(X_i'\beta_j) \end{aligned} \tag{6}$$

[13] A shortcoming of these models is that we did not have available a variable to represent the presence of MDS or other competitive non-broadcast delivery systems. As noted (footnote 1), however, such systems existed in relatively few markets in 1989, and had very low nationwide penetration. Some previous authors estimating demand functions for cable television have also included variables such as the degree of urbanization of the market and the type of broadcast stations also available. See in particular Comanor and Mitchell (1971), Park (1972), Webb (1983), Pacey (1985), Mayo and Otsuka (1991), and Rubinovitz (1991). Our models, however, include more detailed demographic data, which apparently unlike the work of these and some other previous authors, are specifically defined for the exact zip code area of each cable franchise rather than for the county, ADI, or other general market area that contains the system.

where Φ represents the c.d.f. of standard random variables with dimension given by the number of evaluation points. Hence, for example, if j = HBO, then the b_{jk} measure the effects on the pay plus basic rate for HBO of changing the probability that the other networks are carried.

Equation (5) is estimated by OLS on the systems with $NET_{ij} = 1$, with $\hat{\beta}_j$ in place of β_j in the inverse Mills ratio and $PROB_{ijk}$. Standard errors are obtained from the heteroskedasticity-consistent form of covariance matrix. The covariances needed to estimate the bivariate probabilities in (6) are obtained from the six bivariate probit models resulting from pairing the four equations in (2).[14] We experimented with including additional terms for the interaction between the *NET* dummies, but doing so only led to problems with multicollinearity .

2. Rate Model Results and Predictions

Table 7 reports estimates for the rate models. Relatively few of the demographic or cost variables are significant, although the consistently negative signs for the *DMA* dummies parallel the findings of Jaffe and Kanter (1990) that cable systems in larger markets face greater competition from substitute entertainment products. MSO dummy coefficients are significant in several cases. It is difficult, however, to interpret these coefficients because the net effect of MSO ownership on rates is derived from a combination of the direct effect through the relevant MSO dummy and the indirect effect derived from the probabilities that systems in that MSO also carry other pay networks. A convenient way to estimate the overall effect is to predict the change in the expected rate, given NET_{ij}, averaged over systems in the MSO, where the MSO dummies in the rate and carriage equations are set to zero. We thus employ a method similar to that used for the carriage models to reduce the size of the models and then predict the net effect on rates of these

[14]These coefficients, which are statistically significant at the p=.05 level in all six cases, are: for HBO/Showtime (- .57), HBO/Cinemax (.72), HBO/TMC (-.66), Showtime/Cinemax (-.34), Showtime/TMC (.18), and Cinemax/TMC (-.36). These results suggest that cable systems perceive networks of the two major rival firms to be substitutes for each other, while the "companion" pairs offered by each firm are complementary in cable system demand.

direct and indirect factors (See Appendix B). Problems with multicollinearity present in some of the Table 7 models were not present in the smaller models.[15]

Results of these predictions are reported in Table 8. For ATC systems, the predictions are not significantly different for affiliated networks, but the "normal" prediction is lower for TMC. Viacom systems, on the other hand, would be expected to charge lower rates for their rival, HBO, and higher rates for their affiliates, Showtime and TMC, if they behaved like the average non-integrated system. That is, at least the Viacom systems appear to "favor" affiliated networks in their pricing behavior, but results are mixed for both MSOs w.r.t. rivals; in two cases, prices of rivals are higher than the "normal" prediction, and in one case, lower. No predictions are generated for Paragon since no significant direct or indirect effects appeared in any of the prediction models.

4. Subscribership Models

A la carte prices are an incomplete description of cable system behavior in pricing and promoting pay networks. Personal selling, local advertising, and special promotions are other means by which cable systems might shift subscriber demand among networks at the local market level. A recent Time, Inc. promotion, for example, gave cable systems incentives to offer free installation to new cable subscribers (usually costing about $25) if HBO were accepted in addition to the basic package at the time of installation. Also, as noted, pay networks are very often bundled to subscribers in discounted packages, so that a la carte prices may not accurately represent true prices. Thus we consider actual subscribership to the four major pay networks.

Define PEN^*_{ij} as the (latent) penetration of network j on system i (as a fraction of homes passed by the system) and let

$$PEN_{ij} = PEN^*_{ij} \text{ if } NET^*_{ij} > 0$$
$$= 0 \text{ otherwise}$$

[15]Multicollinearity problems were most apparent in the coefficients on Viacom (correlated with the inverse Mills ratio, $M1$) and $HBOPROB$ (correlated with the intercept) in the Cinemax equation.

denote the corresponding observed variable.

Using a procedure analogous to that for the rate models, the following reduced form models are obtained:

$$
\begin{aligned}
LPEN_{ij} = X_i' f_j + \sum_{k=1;k\neq j}^{4} g_{jk} PROB_{ijk} + \sum_{k=1}^{4} h_{jk} LTIME_{ik} \cdot PROB_{ijk} \\
+ m_j \lambda(X_i'\beta_j) + \omega_{ij}
\end{aligned}
\tag{7}
$$

The logarithmic form of the *PEN* variable in (7) is used because the actual distribution of penetration is highly skewed to the right. Other variables are the same as in the rate equations except for the addition of the *LTIME* variables, which represent the logarithms of the number of months since the system began carrying the relevant network. These variables reflect the likelihood that consumer switching costs will advantage subscribership to a network that the system started carrying before others, or that has simply had a longer time to accumulate subscriber loyalty. The logarithmic form again reflects an expectation of diminishing effects over time. The time variables are only observed, of course, if the relevant network is carried. But since $LTIME_{ik} = LTIME_{ik} NET_{ik}$, it follows that $E[LTIME_{ik} \mid NET_{ij} = 1] = LTIME_{ik} PROB_{ijk}$. Hence, $LTIME_{ik} PROB_{ijk}$, rather than simply $LTIME_{ik}$, appears in (7). We expect the own time variables to have a positive sign, while the other time variables should have negative signs. As noted in Appendix A, the $LTIME$ data were only available for approximately 60% of cable systems in the sample, so results are based on smaller samples than are the probit models.

The individual $PROB$ variables in (7) account for the effects on subscribership to a given network that are likely to occur if the systems in the relevant MSO also offered other networks. For example, in the case of ATC systems, these variables reflect the higher subscribership to HBO that results because ATC systems carry rival networks less frequently than the average non- integrated system.

Expectations for signs of $LMEDIANY$, $AGE3554$, and $CHILDREN$ are again positive. Competition from broadcast television (TV) and from other sources ($DMA1-3$) should reduce penetration to individual pay networks, but we have no expectation for the effects of other variables in these models.

5. Subscribership Model Results and Predictions

Results are shown in Table 9. Somewhat more of the region-specific demographic variables are significant than in the rate equations, while coefficients on the "carriage time" variables suggest that consumer switching costs are indeed a demand factor.

Virtually none of the three MSO dummy variables are significant, but again, these coefficients must be interpreted with caution because of the indirect effects working through the probability variables in the models. Again, we reduce the size of the models and generate "actual" vs. "normal" predictions as detailed in Appendix B.

Predictions for ATC and Viacom systems appear in Table 10. In all four possible cases, predicted "normal" subscribership rates are lower for the affiliated networks; that is, these MSOs appear to "favor" their affiliates with respect to overall marketing behavior. Results are again mixed w.r.t. rival networks, however: ATC systems would be expected to have lower penetration for TMC if they behaved like the average non-integrated system; Viacom systems would be expected to have higher penetration for HBO, but lower penetration for Cinemax. Note the relatively small number of systems on which some of these predictions are based (due both to data limitations and in some cases, the infrequency of carriage events). There were again no significant coefficients for Paragon in the relevant prediction models.

IV. SUMMARY AND DISCUSSION

With limited exceptions (the ubiquity of HBO on Viacom systems and one insignificant case), we find that cable systems operated by ATC and Viacom, the two MSOs having majority ownership ties to major pay cable networks in 1989, offered their affiliated networks more frequently and rival networks less frequently than did non-integrated cable systems. Carriage differences were particularly large for the "companion" networks, Cinemax and TMC. ATC systems offered significantly fewer pay networks in total than the average non-integrated system, while variations from this average were insignificant for Viacom systems.

With respect to pricing and other marketing behavior, our predictions show that given carriage, Viacom and ATC systems charged lower prices and/or achieved higher subscribership than the average system for their affiliated networks in each of the six cases which were significant. Two other cases were insignificant. Results were mixed w.r.t. pricing and promotion of rival networks. Subscription prices of rivals were higher than average or subscribership lower in three significant cases, but to the contrary in three others. Two cases were insignificant.

We find no evidence of ATC's corporate influence on Paragon systems with respect to either pay network carriage decisions or pricing and marketing behavior.

Generalizations from these results are limited, of course, by the very few different corporations whose behavior we have considered. A variety of institutional or historical factors peculiar to those firms could affect our findings, such as management organization or the dates which the subject MSOs may have acquired systems from independent operators or other MSOs. In fact, neutrality of the Paragon results might reasonably be explained by that MSO's relatively recent, as well as minority ownership, relationship with Time, Inc. Also, some results, particularly with respect to the pricing and subscribership of rival "companion" networks, involved very few individual cable systems. Such systems might be "outliers" to the MSO in some sense, perhaps following from a degree of local management autonomy.

It nevertheless seems clear that majority ownership relationships between pay networks and cable systems make a substantial difference in terms of final market outcomes. The weight of evidence further supports the conclusion that majority ownership relationships influence cable systems to "favor" their affiliated pay networks, both with respect to carriage decisions and their pricing or promotional behavior involving those networks.

The mixed results w.r.t pricing and subscribership of rival pay networks make it unclear, however, whether vertical integration leads systems to discriminate against rival networks in some absolute sense.[16] It is notable, however, that the three significant results suggesting relatively advantageous treatment of rivals (the pricing and subscribership of Cinemax on Viacom systems, and subscribership of TMC on ATC systems) involved particularly few testable cases in which systems of the integrated MSOs carried those networks.

Although we cannot directly determine whether the differences in carriage and marketing behavior we observe are due to realization of transactions efficiencies or cost raising behavior, our results are suggestive. Lower prices and/or higher subscribership for affiliated networks are consistent with efficiency gains, and one would expect the less established "companion" networks to be more susceptible to carriage variations on this basis. The vertical contracting literature further suggests likely reasons for marginal input prices to be above marginal cost in the absence of integration (Holstrom, 1979; Shavell, 1979; Grossman and Hart 1983; Katz, 1989); master contracts between MSOs and cable networks typically provide for sliding scale wholesale rates on a contingency, "per final subscriber" basis, and in at least some cases, these contracts provide for mutual sharing of marketing responsibilities. Apparently discouraging to a cost raising model, on the other hand, is a lack of evidence that the dominant firm, Time, Inc., behaves any more aggressively with respect to carriage or marketing of rival networks than does Viacom, Inc. Because of its relatively small market shares upstream and downstream,[17] and the apparently precarious financial condition of Showtime Networks, Inc. in 1989 (Paul Kagan Associates, Pay TV Newsletter, July 31, 1989,. p.1-3), the benefits which Viacom could gain from such

[16] Of course, the relatively infrequent availability of rivals on integrated systems, and the apparently more favorable marketing of affiliates where the rivals are offered, suggests that rivals are made worse off in those local markets. While this suggests in turn that barriers to network entry are likely to be increased by integration, the mere presence of apparently preferential marketing of affiliates, or the unavailability of rival products, do not in themselves demonstrate discrimination against rivals or market foreclosure in a meaningful sense. Such a conclusion would require specific knowledge of how input prices or other terms of trade at the input level are changed by integration.

[17] TCI, Inc., the largest MSO in terms of basic subscribership, announced in 1989 that it would acquire from Viacom, Inc. a 50% interest in Showtime Networks, Inc., reportedly in part to shore up the financial viability of Showtime and the Movie Channel (Paul Kagan Associates, Pay TV Newsletter, Dec. 31, 1989, p.1-2). This transaction has apparently not been made at this writing, however.

a strategy would seem to be marginal.[18] Our research nevertheless leaves this issue unresolved, and invites a broader study of the vertical contracting, product bundling, and other competitive strategies pursued by Time and Viacom in this industry.

Concerning social welfare issues, Salinger (1991) shows with his two-product model that unless the retail price of at least one product falls and the other does not rise, static economic welfare does not necessarily increase due to vertical integration. Our results are thus ambiguous in this respect; final prices are generally lower for affiliated networks, but in at least some cases, higher for rivals.[19] It is further evident from Spence (1976) and Dixit and Sitglitz (1977) that welfare might rise or fall due to any change in product variety, whatever its cause. Of course, the products we have investigated are by assumption relatively close substitutes; the closer consumers perceive these networks' characteristics to be, the less will be the economic welfare effects of differentials among them in availability or price. Our empirical results nevertheless demonstrate a main theoretical point that Salinger makes: it is hazardous to assume that integration necessarily promotes static economic welfare, even if contracting efficiencies are realized in the process.

Further, our results suggest at least some negative consequences to "First Amendment"-related social objectives in this industry due to vertical integration. One might argue that even if "access" to consumers were not lessened in an absolute sense by vertical integration, any "favoritism" of even a very similar affiliated product by an information provider with local monopoly power is undesirable on freedom of expression grounds. (Let us say, for example, that we are concerned with news, rather than movie, channels.) Such behavior might be judged particularly harshly if unaffiliated products are not available at all in the

[18]Note, however, that the issue from the standpoint of this study is not whether cost-raising strategies are being pursued by pay networking firms, *per se*, but whether vertical ownership ties facilitate the implementation of such strategies.

[19]Note that even the movement of all pay network final prices in the same direction would not be a sufficient condition to confirm an increase or a decrease in static economic welfare. One unknown is marketing expenditures, which might be systematically higher or lower in integrated markets. Also, if there are economies of scale in networking upstream, an equilibrium in which input prices of both products are below average total costs of upstream distribution could persist in integrated markets.

integrated firm's local market. Our analysis indicates such events. And at least in the case of ATC, vertical integration is accompanied by relatively low product variety.

We believe it would be unwise to conclude from the results of this paper, however, that vertical integration in cable television has negative social consequences overall. First, our analysis suggests that the differences in product menus we observe are not unlikely to be accompanied by an increase in efficiency and thus in static economic welfare. In the absence of further evidence that vertical ties are used to facilitate market foreclosure strategies (or of specific information about demand functions), should one not give the benefit of the doubt to the welfare outcome which an initial fall in the implicit input price of one product eventually produces? More important, there is a dynamic component to efficiency and social welfare. A history of backward integration into both pay and basic networking by MSOs (Klein, 1989) suggests that integration promotes innovation, and in that respect, serves to increase product variety.

These conflicting considerations in measuring the benefits and costs of vertical integration mirror important debates yet to be resolved in establishing regulatory and other public policies to control the production of information services by multi-product local monopolists. Of specific note is the incipient "creation" of information (*i.e.*, vertical integration into production of data bases such as 900 numbers and electronic yellow pages) by the Regional Bell Operating Companies due to the lifting of restrictions by Judge Harold Greene in Summer, 1991. Evident similarities in the market structures of the cable and telephone industry provision of information services–local monopolies downstream with competing suppliers of differentiated products upstream–suggest that similar empirical events, with similar social implications, are likely to occur.

APPENDIX A

Our primary data base is the A. C. Neilsen Cable On-Line Data Exchange (CODE). The CODE data consist of several hundred items for each cable systems in the U.S., which as of August 19, 1989, the date our tape was produced, included 10,544 cable systems, virtually all then operating. The CODE data consist primarily of institutional and demand side items, including demographic characteristics of each franchise area, projected to 1988 by Neilsen based on U. S. Bureau of the Census data. The CODE data are continuously updated by means of telephone survey. The dates on which key items are collected are recorded with the data.

Our probit models and total pay network diversity models are based on a subset of 1646 cable systems which met two criteria. First, we excluded all systems (approximately 8.9% of the 9150 total which had complete data reported) for which basic subscribership data had not been updated since January, 1988. From the remaining systems we selected all those owned by the largest 25 MSO's in the U.S. (in terms of their national market shares of basic subscribers), after pre-January, 1988 data had been excluded. Overall, 420 systems of a total of 2210 in the top 25 MSO's were excluded due to pre-1988 data. No Viacom systems were excluded for this reason and three of ATC's 137 systems were excluded.

For subscribership estimates, we merged into our sample data the dates on which each of the four pay networks were first carried by the cable system. These data were obtained from hardcopy reports of the 1988 Kagan Cable TV Census. These data were available only for about 60% of the Neilsen systems, partly because of different definitions of a cable "system" in the two data bases. Neilsen generally defines a cable system as a single headend, or technical unit, while the Kagan Census sometimes includes several headends into a single system having common management. We attempted to eliminate ambiguous cases.

APPENDIX B

SELECTION AND ESTIMATION OF PREDICTION MODELS

1. Model Selection

If $L(k)$ is the value of the likelihood function, k is the number of parameters in the model, and n is the number of observations, then in the Schwarz criterion, k is chosen to minimize:

$$SC(k) = -2 \; ln \; L(k) + (ln \; n)k. \qquad \text{(B.1)}$$

In the standard regression model, $ln \; L(k)$ is replaced by $\frac{n}{2} \; ln \; \hat{\sigma}^2$, where $\hat{\sigma}^2$ is the mean squared error. To compare two related models, note that:

$$SC(k+1) - SC(k) = ln \; n - 2\{lnL(k+1) - ln \; L(k)\}. \qquad \text{(B.2)}$$

Hence,

$$SC(k+1) - SC(k) > 0 \;\; \Rightarrow \;\; -2\{ln \; L(k) - ln \; L(k+1)\} < ln \; n \qquad \text{(B.3)}$$

In other words, the smaller model is chosen if the likelihood ratio (LR) statistic for the exclusion of the $k+1$ st variable is smaller than $ln \; n$.

The basic algorithm we use begins with the model having all possible variables on the RHS, and reduces the size of the model according to the Schwarz criterion. At each step, the LR statistic from dropping each variable in the model is calculated, and the variable with the smallest LR statistic is dropped. The process continues until deleting any additional variables would lead to an increase in (B.1.). Unfortunately, while this ensures that the estimate of the model size, k, is consistent (*e.g.*, Geweke and Meese, 1981), it does require that a potentially large number of models be estimated. While the LR statistic is a function of the ordinary t-statistics in OLS, this is not the case in the probit and ordered probit models. To speed the computations in the ordered probit models, we approximated the LR statistic by the squares of the asymptotic t-ratios in these models.

Finally, we note that the heteroskedasticity in (5) and the equivalent equation for $LPEN$ imply that the use of $SC(k) = -\frac{n}{2} \ln \hat{\sigma}^2 + (\ln n)k$ is also an approximation. However, since the LR test based on $\ln \hat{\sigma}^2$ will still be a consistent test (even though its size will be wrong), the estimate of k will still be consistent.

2. Prediction of Carriage Equations

For each MSO, we use the reduced form models to predict the number of systems in that MSO that will carry each network, and the number of systems that will carry each network when the relevant MSO dummy is set to zero. From equation (2),

$$P(NET_{ij} = 1) = \Phi(X_i'\beta_j) \tag{B.4}$$

where Φ in the c.d.f. of the standard model. Hence, the predicted number is

$$\sum_{i=1}^{n_k} \Phi(X_i'\beta_j) \tag{B.5}$$

where $\hat{\beta}_j$ is the estimate of β_j, n_k is the number of systems in MSO k, and i runs over these systems. To assess the magnitude of the change when the coefficient on each MSO dummy is set to zero, we also calculate the standard error of the change. Using a mean value expansion, for network j and MSO k,

$$\sum_{i=1}^{n_k} \Phi(X_i'\hat{\beta}_j) - \sum_{i=1}^{n_k} \Phi(X_i'\tilde{\beta}_{jk}) = \sum_{i=1}^{n_k} \phi(X_i'\beta^*)\hat{\beta}_{jk} \tag{B.6}$$

where $\hat{\beta}_{jk}$ is the estimated coefficient on the kth MSO dummy, $\tilde{\beta}_{jk}$ is $\hat{\beta}_j$ with the coefficient on the kth MSO dummy set to zero, β^* is the mean value, and ϕ is the p.d.f. of the standard normal. The L.H.S. of (B.6.) is the predicted change in the number of systems, and its standard error is approximately

$$\sum_{i=1}^{n_k} \phi(X_i'\hat{\beta}_j) s.e.(\hat{\beta}_{jk}) \tag{B.7}$$

where $s.e.(\hat{\beta}_{jk})$ is the estimate of the asymptotic standard error β_{jk}, the coefficient on the kth MSO dummy, from the probit maximum likelihood estimation.

Results for the aggregate ordered probit equations are obtained analogously.

3. **Prediction of pay network rate and subscribership models.**

Here, we predict the change in expected $RATE$ and PEN given that the network is carried (*i.e.*, $E(RATE_{ij} \mid NET_{ij} = 1)$ and $E[PEN_{ij} \mid NET_{ij} = 1]$). From (5),

$$E[\,RATE_{ij} \mid NET_{ij}\,] = X_i' a_j + \sum_{k=1}^{4} b_{jk} PROB_{ijk} + e_j \lambda(X_i' \beta_j) \qquad \text{(B.8)}$$

so that the MSO dummies have a direct effect on $E[RATE_{ij} \mid NET_{ij} = 1]$ through X_i, but also indirect effects through the probabilities of carrying the other networks, and through the inverse Mills ratio. A mean value expansion along the lines of equation (B.7). shows that the expressions for the standard errors are quite complicated. Instead, we approximated the standard errors by the following bootstrap technique: (i) Draw random variables for the normal distribution with means equal to the coefficients on the MSO dummy in the RATE equation and in the probit equation, and variances equal to the corresponding variances of the asymptotic distributions. (ii) Evaluate the RHS of (B.8). with these random variables in place of the estimated coefficients on the MSO dummy variables. (iii) Average these predictions over the systems in the MSO. (iv) Repeat (i)-(iii) 500 times and calculate the standard deviation of the averages. (We note that this is only approximate because it assumes, for example, that estimates of the MSO dummies in the four probit equations are independent.)

For the subscribership models, we write:

$$LPEN_{ij}^* = \bar{X}_i' r_j + \sum_{k=1; k \neq j}^{4} g_{jk} NET_{ik} + z_{ij} \qquad \text{(B.9)}$$

in the obvious notation ($\bar{X}_i$ contains X_i and the $LTIME$ variables).

Then:

$$E\Big[PEN_{ij}\Big|NET_{ij} = 1\Big] = E\Big\{ \exp\ \Big[\bar{X}_i r_j + \sum_{k=1; k \neq j}^{4} g_{jk} NET_{ik} + z_{ij}\Big]\Big|NET_{ij} = 1\Big\} \qquad \text{(B.10)}$$

Unfortunately, the evaluation of the conditional expectation in (B.10.) is quite complicated due to the endogeneity of NET_{ik}, and involves the joint distribution of $NET_{i1}, \ldots, NET_{i4}$, and z_{ij}. Instead, we approximate (B.10.) by the naive prediction:

$$\exp\left[E\left(PEN_{ij} \middle| NET_{ij} = 1\right)\right] = \exp\left[\tilde{X}_i' r_j + \sum_{k=1;k\neq j}^{4} g_{jk} PROB_{ijk} + m_j \lambda\left(X_i'\beta_j\right)\right] \tag{B.11}$$

where $\tilde{X}_i$ is X_i with $LTIME_{ik}PROB_{ijk}$ in place of $LTIME_{ik}$. In the special case of no endogeneity (that is, when X_i does not contain endogenous variables and the g_{jk} are equal to zero),it is straightforward to show that

$$E\left[PEN_{ij} \middle| NET_{ij} = 1\right] = \exp\left[X_i' r_j + \frac{\sigma_j^2}{2}\right] \Phi\left(X_i' r_j + \sigma_{12j}\right) / \Phi\left(X_i' r_j\right) \tag{B.12}$$

where σ_j^2 is the variance of z_{ij} and σ_{12j} is the covariance between ω_{ij} and z_{ij}. Comparing this with the naive forecast in this case, exp $(X_i' r_j)$, shows that the latter will be biased downward. Hence, we may expect (B.11.) to be biased downward. Similarly, the prediction of the change in PEN, when the MSO dummies are set to zero, will be biased downward. But since the estimated standard error will be of the biased estimate, the significance of the change in PEN will be less affected. Finally, since $LTIME_{ij}$ is observed only when $NET_{ij} = 1$, the predictions are based only on the systems with $NET_{ij} = 1$. For systems with $NET_{ik} = 0, k \neq j, LTIME_{ik}$ is set equal to the average of $LTIME_{ik}$ on those systems with $NET_{ik} = 1$.

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TABLE 1
PAYCABLE NETWORKS
1988-89

NETWORK	(1) LAUNCH DATE	(2) % SYSTEMS WHICH CARRY NETWORK (Aug. 1989)	(3) % BASIC SUBSCRIBERS SERVED BY SYSTEMS CARRYING THE NETWORK (Aug. 1989)	(4) % MARKET SHARE OF PAY SUBSCRIPTIONS (Dec. 1988)	(5) MSO AFFILIATION (Aug. 1989)
HBO	1972	83%	99%	42.0%	American Television & Communications Corp (ATC) (82%); Paragon Communications (50%)
SHOWTIME	1976	50	86	16.5	Viacom Group (100%)
CINEMAX	1980	49	84	14.9	American Television & Communications Corp. (ATC) (82%); Paragon Communications (50%)
THE DISNEY CHANNEL	1983	64	95	10.7	None
THE MOVIE CHANNEL	1979	31	56	6.8	Viacom Group (100%)
THE PLAYBOY CHANNEL	1982	5	23	1.2	None
AMERICAN MOVIE CLASSICS (AMC)	1984	N.A.	N.A.	1.0	Cablevision Systems Development Corp. [b]; TCI (50%)
BRAVO	1980	N.A	N.A.	1.0	Cablevision Systems Development Corp. [b];
OTHER [a]	--	--	--	5.9	
				100.0%	

(a) Includes Sportschannel, Prism, and other regional sports, and self-booked services.
(b) Cablevision System Development Corp. owned 92% of Rainbow Enterprises, which owned 50% of American Movie Classics and 100% of Bravo.

Sources: Labels (1)-(5) [illegible] publication (various); (2), (3): A.C. Nielson CODE On-Line Data Exchange, Computer Tape produced

TABLE 2

CHANNEL CAPACITY OF CBLE SYSTEMS
LARGEST 25 MSO'S, 1989

	%
under 20	3.8%
20-35	41.6
36-53	38.9
54 & over	15.7
	100.0%

Base: 1,880 systems

Source: A.C. Nielsen Co.

TABLE 3

DISTRIBUTION OF PAY CABLE NETWORK CARRIAGE
1989

Number of Cable Systems offering:	
1 pay service:	4.7%
2 pay services:	8.5
3 pay services	19.2
4 pay services:	28.7
5 pay services:	22.1
6 pay services:	8.9
7 or more pay services:	8.0
Total Number of Operating Systems:	100.0%

Base: 1,880 systems

Source: A.C. Nielsen Co.

TABLE 4
VARIABLE DEFINITIONS

I. Dependent Variables	
NET_j	dummy variables for carriage (HBO, CINEMAX, SHOWTIME, TMC)
$RATE_j$	a la carte monthly subscription rate of the indicated pay network plus the basic cable monthly subscription rate, (LHBORATE, LCMXRATE, LSHOWRATE, LTMCRATE)
$LPEN_j$	logarithm of the number of subscribers to the indicated network as a fraction of the total number of homes passed by the cable system. (LHBOPEN, LCMXPEN, LSHOWPEN, TLMCPEN)
NPAY4	total number of the four major movie-based pay cable networks offered (HBO, Showtime, Cinemax, The Movie Channel)
NPAYALL	total number of monthly subscription pay cable networks offered by the system.
II. X: Demand, cost, and other franchise-specific exogenous variables; vertical integration dummy variables.	
LMEDIANY	logarithm of median household income, 1988 ($10,000's)
RENTERS	percentage of households who are renters, 1988
AGE3554	percentage of households with head of household who is 35-54 years old, 1988
MULTIFAM	percentage of households who live in multi-family units, 1988
CHILDREN	percentage of households with one or more children living at home, 1988
LHPASS	logarithm of homes passed by the cable system (10,000s)
CHANDISC	system channel capacity less the number of commercial broadcast stations in the market

TABLE 4
VARIABLE DEFINITIONS
(Continued)

TV	the number of competing commercial broadcast stations in the market (DMA)
DENSITY	total miles of cable plant divided by the total number of homes passed
DMA1	= 1, if system is in one of the largest 25 broadcast television markets; = 0 otherwise.
DMA2	= 1, if system is in broadcast markets 26-50; = 0 otherwise.
DMA3	= 1, if system is in markets 51-100; = 0 otherwise.
LFRANTIME	logarithm of the number of months since the system was originally franchised.
ATC	= 1, if system is owned and operated by American Television and Communication Corporation (ATC); = 0 otherwise
VIACOM	= 1, if system is owned and operated by Viacom International, Inc.; = 0 otherwise
PARAGON	= 1, if system is owned and operated by Paragon Communications, Inc.; = 0 otherwise

III. Other independent variables

$PROB_j$	the probability that the system carries the indicated network, given that it carries the network indicated by the dependent variable in the equation (HBOPROB, CMXPROB, SHOWPROB, TMCPROB)
$LTIME_j$	logarithm of the number of months since the indicated network was first carried by the system

TABLE 5
CARRIAGE MODELS

	HBO		CINEMAX		SHOWTIME		TMC		NPAY 4		NPAYALL	
C	−8.16	(2.0)**	−3.65	(1.8)*	−2.52	(1.2)	−2.05	(1.1)	−.39	(.2)	−7.53	(4.8)**
LMEDIANY	.72	(1.7)*	−.0053	(.0)	−.25	(1.1)	−.10	(.5)	−.17	(1.0)	.59	(3.7)**
RENTERS	.53	(.5)	−.63	(1.2)	.35	(.6)	−.91	(1.8)*	−.87	(2.2)**	.053	(.1)
[illegible] 3554	.01	(.0)	.016	(1.0)	3.08	(1.9)*	.33	(.2)	1.46	(1.2)	−1.02	(.9)
MULTIFAM	.45	(.4)	.61	(1.3)	.74	(1.4)	.91	(2.0)**	1.14	(3.1)**	.68	(1.9)*
CHILDREN	−2.11	(1.8)*	.98	(1.8)**	.97	(1.6)*	1.17	(2.4)**	1.62	(3.9)**	.77	(1.9)*
LHPASS	.53	(5.5)**	.21	(6.0)**	.31	(8.1)**	.18	(5.9)**	.40	(15.8)**	.38	(16.6)**
CHANDISC	.043	(4.2)**	.039	(8.3)**	.035	(7.0)**	.033	(8.8)**	.057	(18.7)**	.045	(22.3)**
IV	−.028	(.5)	.064	(3.0)**	.055	(2.3)**	.052	(2.9)**	.081	(4.9)**	.12	(8.4)**
DENSITY	−.62	(.1)	−2 [illegible]3	(.7)	6.068	(1.6)*	6.94	(2.2)**	5.05	(2.3)**	3.86	(2.3)**
DMA 1	−.11	(.3)	−.15	(.8)	−.091	(.5)	−.043	(.3)	−.10	(.7)	−.35	(2.8)**
DMA 2	−.16	(.6)	−.13	(1.0)	.070	(.5)	.062	(.5)	.031	(.3)	−.24	(2.6)**
DMA 3	−.29	(1.2)	−.030	(.3)	−.10	(.9)	.18	(1.8)*	.055	(.7)	−.082	(1.1)
LFRANTIME	−.27	(1.6)	.059	(.8)	.075	(.9)	−.14	(2.0)*	.018	(.3)	.012	(.2)
ATC	.60	(1.0)	.69	(3.6)**	−1.45	(9.9)**	−1.38	(7.9)**	−1.11	(9.4)**	−.92	(7.0)**
VIACOM	−		−2.09	(5.5)**	.71	(1.2)	1.36	(3.5)**	−.50	(1.6)	−.28	(.9)
PARAGON	−		.13	(.4)	.35	(.8)	.027	(.1)	.14	(.1)	−.18	(.9)
N	1646		1646		1646		1646		1646		1646	

[illegible] p < .10

** p < .05

TABLE 6
CARRIAGE PREDICTIONS

A: INDIVIDUAL MODELS

	(1) Predicted carriage (%)	(2) Predicted carriage if systems behaved as average non-integrated system (%)	(3) Predicted Absolute percentage change in carriage (%) ((2) - (1))	
ATC				
HBO	98.2%	-		-
CINEMAX	90.7	77.6%	- 13.1%	(2.2)**
SHOWTIME	46.2	85.3	+ 39.1	(3.2)**
TMC	12.2	51.9	+ 39.7	(5.4)**
VIACOM				
HBO	99.9	-		-
CINEMAX	14.6	74.7	+ 60.1	(4.8)**
SHOWTIME	82.4	-		-
TMC	85.1	49.9	-35.2	(3.1)**

B: AGGREGATE MODELS

	(1) Predicted # of networks carried	(2) Predicted # of networks carried if system behaved as the average non-integrated system	(3) Predicted Absolute change in #carried ((2) - (1))	
ATC				
NPAY 4	2.56	3.08	+ .52	(2.6)**
NPAYALL	3.64	4.55	+ .91	(2.7)**
VIACOM				
NPAY 4	2.98	-		-
NPAYALL	4.61	-		-

*p < .10; **p < .05

TABLE 7
MONTHLY SUBSCRIPTION RATE MODELS
(BASIC + PAY RATE)

	HBORATE		CMXRATE		SHOWRATE		TMCRATE	
C	20.26	(3.9)**	33.08	(1.0)	16.09	(1.9)*	13.40	(1.5)
LMEDIANY	.30	(.5)	.83	(1.2)	.17	(.3)	–.55	(.7)
RENTERS	.48	(.3)	2.10	(1.2)	–.072	(.0)	1.37	(.7)
AGE 3554	2.69	(.6)	–1.28	(.2)	3.97	(.7)	–1.60	(.3)
MULTIFAM	1.90	(1.4)	2.47	(1.5)	3.02	(2.0)**	1.31	(.8)
CHILDREN	.41	(.3)	.21	(.1)	–.23	(.1)	.38	(.2)
LHPASS	.15	(.7)	.13	(.5)	.16	(.6)	.43	(1.7)*
CHANDISC	.033	(1.2)	.04	(1.2)	.017	(.5)	.024	(.7)
TV	.43	(.7)	–.029	(.4)	.063	(.9)	.16	(1.9)*
DENSITY	–14.34	(1.3)	–18.0	(1.4)	–27.96	(2.0)*	–1.74	(.2)
DMA 1	–.79	(1.8)*	–.41	(.8)	.79	(1.6)*	–.63	(1.0)
DMA 2	–1.35	(4.2)**	–1.10	(2.9)**	–1.28	(3.5)**	–1.04	(2.1)**
DMA 3	–1.14	(3.9)**	–.98	(2.8)**	–1.15	(3.3)**	–.55	(1.2)
LFRANTIME	–.13	(.5)	.063	(.2)	–.19	(.5)	–.29	(.6)
ATC	–4.19	(2.0)**	–6.13	(2.1)**	–4.31	(1.4)	–4.3	(1.0)
VIACOM	6.39	(2.0)**	11.29	(2.4)**	2.32	(.6)	4.05	(.9)
PARAGON	–1.40	(1.8)*	–1.10	(1.1)	–1.66	(2.0)*	–1.25	(1.1)
HBOPROB			–10.96	(.4)	5.15	(1.6)*	3.82	(1.8)*
CMXPROB	2.76	(.8)			.40	(.1)	.27	(.1)
SHOWPROB	1.90	(.9)	–3.53	(1.3)			3.51	(.8)
TMCPROB	–9.89	(2.9)**	–9.39	(2.2)*	–6.01	(1.3)		
M1	–2.13	(1.4)	–5.11	(1.5)	1.94	(.8)	6.15	(1.6)*
R^2/F	.06/4.8		.07/4.2		.07/4.3		.06/2.3	
N	1551		1122		1202		711	

*$p < .10$
**$p < .05$

TABLE 8
MONTHLY SUBSCRIPTION
RATE PREDICTIONS
(BASIC + PAY RATE)

	(1) Predicted rate ($)	(2) Predicted rate if systems behaved as average non-integrated system ($)	(3) Predicted Absolute percentage change in rate ($) ((2) - (1))
ATC			
HBO	$24.41	$24.22	− $.19 (.8)
CINEMAX	23.75	23.95	+ .20 (.4)
SHOWTIME	23.30	24.17	+ .87 (1.3)
TMC	26.08	24.06	− 2.02 (6.7)**
VIACOM			
HBO	$25.86	$24.32	- $1.54 (2.0)**
CINEMAX	23.30	24.22	+ .92 (2.6)**
SHOWTIME	23.12	24.88	+ 1.76 (5.5)**
TMC	23.14	24.35	+ 1.21 (4.7)**

*$p < .10$
**$p < .05$

TABLE 9
SUBSCRIBERSHIP PENETRATION MODELS

	LHBOPEN		LCMXPEN		LSHOWPEN		LTMCPEN	
C	−8.82	(10.0)**	26.93	(2.3)**	−9.98	(4.9)**	−2.94	(1.5)
LMEDIANY	.49	(5.7)**	.090	(.6)	.52	(3.6)**	.082	(.6)
RENTERS	.57	(2.7)**	.59	(1.6)	.58	(1.8)**	.57	(1.5)
AGE 3554	1.49	(2.6)**	1.33	(1.2)	−.13	(.1)	1.35	(1.0)
MULTIFAM	.54	(2.7)**	−.17	(.5)	.027	(.0)	.16	(.4)
CHILDREN	.83	(4.4)**	.44	(1.4)	1.08	(3.4)**	.57	(.1)
LHPASS	−.020	(.6)	−.087	(1.4)	1.83	(.4)	.0073	(.1)
CHANDISC	−.0014	(.4)	.26	(.4)	.50	(.7)	−.0014	(.2)
TV	.99	(1.0)	.022	(1.4)	.00096	(.1)	−.022	(1.0)
DENSITY	2.14	(1.5)	.0069	(.1)	.36	(.2)	.45	(.2)
DMA1	.10	(1.5)	−.15	(1.4)	.11	(1.1)	.073	(.5)
DMA2	.14	(2.8)**	−.072	(.6)	.14*	(1.9)	−.085	(.8)
DMA3	.023	(.5)	.031	(.4)	.00047	(.0)	−.25	(2.8)**
LFRANTIME	−.031	(.5)	.91	(.5)	−.11	(1.2)	−.13	(1.1)
ATC	.20	(.4)	−.067	(.9)	−.63	(.9)	−.68	(.8)
VIACOM	.08	(.1)	1.09	(.9)	.82	(1.0)	1.02	(1.2)
PARAGON	−.10	(.9)	−.23	(1.5)	.10	(.4)	−.32	(1.6)*
HBOPROB			−30.45	(2.8)**	−.39	(.4)	.15	(.2)
CMXPROB	.69	(1.0)			1.30	(1.5)	1.48	(1.8)*
SHOPROB	−.49	(1.1)	.30	(.4)			−2.38	(1.7)*
TMCPROB	.86	(1.2)	−.084	(.9)	.41	(.4)		
HBOTIME x HBOPROB	.24	(6.1)**	.042	(.6)	−.051	(1.3)	−.032	(.8)
CMXTIME x CMXPROB	−.011	(.8)	.21	(3.7)**	−.12	(6.2)**	−.15	(6.2)**
SHOWTIME x SHOWPROB	−.058	(4.9)**	−.058	(2.7)**	.28	(4.8)**	−.11	(4.2)*
TMCTIME x TMCPROB	−.10	(6.4)**	−.12	(4.2)**	−.09	(4.0)	.22	(3.7)**
RMILLS	1.51	(2.8)**	−.76	(.9)	.89	(1.4)	−.12	(.2)
r^2/F	.36/17.96		.19/5.63		.27/8.79		.26/4.96	
N	778		568		588		357	

*p < .10 ; **p < .05

TABLE 10
SUBSCRIBERSHIP PENETRATION
MODEL PREDICTIONS

	(1) Predicted penetration (%)	(2) Predicted penetration if systems behaved as average non-integrated system (%)	(3) Predicted absolute percentage change in penetration (%) ((2) - (1))		Na
ATC					
HBO	21.40%	14.90%	− 6.50%	(5.1)**	50
CINEMAX	9.33	6.58	− 2.75	(2.8)**	18
SHOWTIME	5.61	5.72	+ .11	(.2)	45
TMC	4.00	3.85	− .15	(1.9)*	4
VIACOM					
HBO	11.96	15.84	+ 3.88	(4.7)**	10
CINEMAX	6.68	5.55	− 1.13	(3.1)**	2
SHOWTIME	10.46	6.64	− 3.82	(4.8)**	10
TMC	4.70	3.44	− 1.26	(6.3)**	8

*$p < .10$; ** $p < .05$

a The number of systems in the subject MSO carrying the network which were in the sample used to generate the prediction.