# THE ROLE OF FIRM SIZE IN BILATERAL BARGAINING: A STUDY OF THE CABLE TELEVISION INDUSTRY

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Abstract—We examine the effect of buyer merger on bilateral negotiations between a supplier and *n* buyers. Merger may have bargaining effects in addition to the usual efficiency effects. The effect of merger on the buyers' bargaining position depends on the curvature of the supplier's gross surplus function: merger enhances (worsens) the buyers' bargaining position if the function is concave (convex). Based on a panel of advertising revenue in the cable television industry, our estimates indicate that the gross surplus function for suppliers of program services is convex. This result suggests that cable operators integrate horizontally to realize efficiency gains rather than to enhance their bargaining position vis-a-vis program suppliers.

## I. Introduction

THE CABLE-TELEVISION industry's trade press often claims that large, horizontally integrated cable operators, some involving hundreds of local systems, are able to bargain for lower prices in their negotiations with suppliers of program services.<sup>1</sup> This claim is not unique to cable; for many industries, the received wisdom in the business press is that buyer size confers a bargaining advantage.<sup>2</sup> There is some empirical support for the received wisdom: crosssectional studies have shown that downstream concentration is negatively correlated with upstream profitability.<sup>3</sup>

In the theoretical section of the paper, we provide a model that can be used to explain why large buyers may obtain lower transfer prices in negotiations with suppliers. The model endogenizes buyer size by allowing buyers to merge ex ante and characterizes all buyer-supplier transactions as bilateral bargaining processes. Several striking results emerge from the analysis. First, we catalogue a number of possible efficiency and bargaining effects of buyer merger. We show that it may be impossible to distinguish empirically among the various motives for merger using only information on transfer prices. Second, we derive an empirically testable condition necessary and sufficient for a buyer merger to have

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<sup>1</sup> See, e.g., Shooshan (1988).

<sup>2</sup> Scherer and Ross (1990, chapter 14) summarize the conventional wisdom in the business press. For recent examples, see Strauss (1987), Wolfe and Asch (1992), Schiller and Zellner (1992), and Cox (1994).

<sup>3</sup> These studies include Brooks (1973), Porter (1974), Buzzell et al. (1975), Lustgarten (1975), McGuckin and Chen (1976), Clevenger and Campbell (1977), LaFrance (1979), and Martin (1983).

a positive bargaining effect. The condition involves the curvature of the supplier's gross surplus function.

This second result provides the basis for the empirical section of the paper. We test to see if mergers between cable operators improve their bargaining position vis-a-vis suppliers of program services (e.g., ESPN and MTV). The test involves estimating a gross surplus function for a representative supplier and determining the curvature of the function. In the cable industry, the gross surplus function for a program-service supplier equals advertising revenue minus the cost of producing the program. Because virtually all production costs are fixed (independent of the number of subscribers receiving the channel), it is necessary only to estimate the curvature of the function relating advertising revenue to the number of subscribers.

Section IV presents empirical estimates of the curvature of the advertising revenue function in cable. We use a panel data set of advertising revenues for 21 large, advertisementsponsored program services, for up to nine years. This data set allows us to control both for unobserved program service heterogeneity and for potential endogeneity between revenues and subscribers in estimating the shape of the advertising revenue function.

The result emerging consistently from the alternative methodologies is that the surplus function of programservice suppliers is convex. Under the maintained assumptions of the theoretical model, this result implies that large buyers do not benefit from positive bargaining effects in the cable television industry. Why does the shape of the supplier's gross surplus function determine the sign of the bargaining effect? In the modeled bargaining process, each buyer takes as given the fact that the supplier will trade with the other buyers and so considers itself the marginal buyer. If the buyer's contribution to the supplier's gross surplus is greater than the inframarginal buyers', it is better off remaining unintegrated and negotiating over its marginal contribution; if its contribution is less than the inframarginal buyers', it prefers to merge and negotiate over the average contribution. Assuming the supplier's gross surplus function is globally concave, then inframarginal buyers contribute more to surplus than the marginal buyer. Merger has a positive bargaining effect and merging buyers will pay lower prices to the supplier, in accordance with the received wisdom in the business press cited above. If, however, the function is globally convex, as we have estimated for the cable industry, then buyers will not improve their bargaining position by merging. Thus, our estimates of the supplier's surplus function call into question the popular claim that the prevalence of horizontal integration among cable operators is motivated by bargaining effects. The prevalence of horizontal integration-and the associated lower prices for

larger buyers—may instead be due to associated efficiency gains.

The implications of our model are general and apply to any industry; our empirical analysis of cable provides but one illustration. In many other industries, what we term the supplier's gross surplus function is simply the negative of its cost function (true if the supplier has no external source of revenue besides payments from buyers). Testing for the presence of bargaining effects of buyer merger would then reduce to estimating the shape of the supplier's cost function. A finding that the supplier's average cost is increasing, for example, would imply that buyer merger has a positive bargaining effect.

Most of the previous empirical work studying the effect of buyer size on buyer-supplier transactions has been crosssectional (see footnote 3). Intra-industry studies by Adelman (1959) (grocery industry) and McKie (1959) (tin-plate industry) provide evidence of lower prices for larger downstream firms. Chipty (1995) finds that large downstream firms in the cable industry charge lower final-good prices. These intra-industry studies do not test for the basic conditions that are necessary and sufficient for positive bargaining effects; their results could be interpreted as deriving from efficiency effects of buyer merger.

The papers most closely related to the theoretical section are Stole and Zwiebel (1996a,b). The authors construct a model of bilateral bargaining between a single firm and nworkers in which parties have the right to cancel a contract at any time: the firm by firing the worker and the worker by quitting the firm. By contrast, if bargaining between a buyer and the supplier breaks down in our model, the parties that did reach an agreement in the bargaining phase are bound by their contracts. Thus, any out-of-equilibrium renegotiation proceeds from a different status quo point here than in Stole and Zwiebel. Allowing firing and quitting is realistic in a labor-market setting (the focus of their paper), and disallowing it may be appropriate in an industrial-organization context (the focus of the present paper). Although the specific results are different in the two papers, our condition guaranteeing that buyer merger has a positive bargaining effect is qualitatively similar to the condition in Stole and Zwiebel (1996b) for workers to find unionization profitable.<sup>4</sup>

## **II.** Industry Structure

In the cable industry, suppliers such as ESPN and MTV sell program services to cable system operators, which in turn distribute program services to consumers in franchise areas. This structure is depicted in figure 1. Program services sell highly differentiated programming. While there are many program services, most have at least some brand loyalty and market power. Cable operators serve exclusive franchise areas, and suppliers strive to obtain channel space on as many cable systems as possible in order to maximize their viewing audience. Suppliers may also reach consumers through alternative forms of distribution, such as subscription master antenna television (SMATV) or digital satellite systems (DSS). Cable television is currently the dominant form of distribution in all markets, however, and was even more dominant during the time period covered by our data. If a cable operator refuses to carry a program service, the service loses its primary source of distribution. Operators are aware of their control over the supplier's access to consumers, and it is this control that may give large operators an advantage in negotiations with suppliers.

There is much variation in operator size, where size is measured as the number of households served by the cable operators. Cable operators can increase their size by integrating horizontally with cable operators in other franchise areas. We say that two downstream firms have merged if a single cable operator controls two cable systems; more generally, we say that k firms have merged if a single cable operators controls k systems. In 1991, 1,600 cable operators served 11,000 franchise areas. The largest cable operator, TCI, controlled systems in about 1,200 franchise areas, approximately 20% of all households nationally. During the time period covered by our data, virtually all franchise areas had a monopoly distributor of cable television, so merger would not affect concentration in the final-good market. Horizontal integration may have allowed operators to achieve certain economies, and it may have affected operators' negotiations with program suppliers.

Besides the widespread horizontal integration among cable operators, another noteworthy feature of the cable industry is the prevalence of vertical integration between cable operators and program services. A question of substantial policy interest is whether vertically integrated cable operators foreclose substantial segments of the viewing market to competing services.<sup>5</sup> While recognizing that vertical integration is an important aspect of market structure in cable, in the theoretical section we abstract from issues of vertical integration and focus on the less-studied question of the effect of horizontal integration on buyers' bargaining position. It should be emphasized that the empirical results do not depend on assumptions concerning vertical integration, although the vertical structure of cable may influence the conclusions drawn from the results.

<sup>&</sup>lt;sup>4</sup> A number of other related theoretical papers deserve mention. Horn and Wolinsky (1988) and McAfee and Schwartz (1994) show that productmarket competition may affect downstream firms' negotiations with an input supplier. (Given our interest in cable, an industry in which downstream firms are virtually all local monopolists, our model abstracts from downstream competition.) Another literature explains volume discounts as a possible feature of optimal nonlinear tarrifs when the seller is imperfectly informed about the buyers' valuation of the good (Maskin & Riley, 1984) and in a bargaining model (Gertner, 1989). Snyder (1996, 1998) develops an infinitely repeated game with competing suppliers in which the ability of suppliers to sustain collusion is limited in the presence of large buyers.

<sup>&</sup>lt;sup>5</sup> See Krattenmaker (1994) and Federal Trade Commission (1996).





In constructing an empirical strategy to infer the effects of operator size on the bargaining process, it is necessary to understand the nature of contracts between buyers and suppliers. Specifically, do firms in the cable industry bargain over linear prices, or are nonlinear prices (including fixed fees) possible? Under the assumption that transfer prices are linear in the number of subscribers, it may be possible to use information on final-good prices to infer the effect of buyer size on buyer-supplier negotiations. This is the approach taken in Chipty's (1995) study of the effect of ownership structure on final-market prices and penetration rates. Under the maintained assumption of linear transfer prices, her findings are consistent with the hypothesis that large buyers have more bargaining power than small.

In the present study, we adopt the assumption that buyers and suppliers bargain over nonlinear transfer fees in the

cable industry. Although transfer prices in cable are often quoted as per-subscriber-per-month fees, a number of facts suggest that these price quotes are average wholesale prices reflecting fixed payments from operators to program services. First, it is often the case that the supplier secures subscriber commitments from operators. In a survey conducted by Cablevision, new program service suppliers report the number of subscribers guaranteed at the time of launch; for example, CNN Financial Network and BET on Jazz reported subscriber commitments of 4,000,000 and 800,000, respectively, at launch.<sup>6</sup> Further, many program services directly reported that the level of the license fee is a function of the expected number of subscribers. For example, the Cartoon Network reported that its license fees vary from five to fifty cents, depending on subscriber commitments.7 Court TV entered the market with a license fee of eleven cents, with an understanding that it could be renegotiated up to fifteen cents in five years. They reported that operators who could guarantee 50% penetration rates might have been able to freeze rates.8

With nonlinear transfer prices, final-market outcomes cannot, in general, be used to infer the effect of ownership structure on wholesale prices. We develop a model of pairwise bilateral bargaining the implications of which can be subjected to empirical examination to identify the effect of operator size on the bargaining process.

## III. The Model

A supplier with market power produces a homogeneous good demanded by *n* buyers indexed by i = 1, ..., n. Let  $v_i(q_i)$  be the gross surplus which buyer *i* obtains if it purchases  $q_i$  units of the good. We refer to the fact that  $v_i$  does not depend on  $q_j$  for  $j \neq i$  as buyer independence, a natural assumption if buyers are downstream monopolists on separate markets or if buyers are simply consumers of the final good produced by the supplier. In the cable industry, downstream firms (the local cable operator) typically are monopolists within their service territories. In this case,  $v_i(q_i)$  represents downstream firm *i*'s gross profit (gross of any payments to the supplier) from using  $q_i$  units of the intermediate product.

Suppose each buyer *i* purchases  $q_i$  units of the product, implying that the supplier produces a total of  $Q = \sum_{i=1}^{n} q_i$ units. Let V(Q) be the supplier's gross surplus from production (surplus gross of payments from buyers). One component of V(Q) is the total cost of producing Q. In many applications, this will be the main component of V(Q). There may also be cases, however, in which the sale of the Q units generates revenue that accrues directly to the supplier. In these cases, V(Q) would have a component reflecting this external revenue as well. In the cable-television industry, for example, suppliers of program services such as ESPN or

<sup>8</sup> Cablevision, April 20, 1992, "The Verdict on Court TV," pp. 33–37.

<sup>&</sup>lt;sup>6</sup> Cablevision, November 27, 1995, "Can They Survive," pp. 92–93.

<sup>&</sup>lt;sup>7</sup> Cablevision, May 4, 1992, "The New Crop," pp. 55-61.

MTV earn advertising revenue which is a function of their total subscriber base, Q. The gross surplus functions V(Q) and  $v_i(q_i)$  are assumed to be twice continuously differentiable.

The supplier enters into simultaneous negotiations with each of the buyers separately. Negotiations determine the quantity to be traded,  $q_i$ , and the tariff for the bundle,  $T_i$ . This specification allows the supplier and buyer to bargain over general nonlinear pricing schemes.<sup>9</sup>

We assume that the outcome of the negotiations is given by the Nash bargaining solution. Let  $q^* = (q_1^*, \ldots, q_n^*)$  be the vector of quantities purchased by the buyers that maximize the total surplus of the supplier and buyers; i.e.,

$$q_i^* = \arg \max_x \{V(Q_{[i]}^* + x) + v_i(x)\},\$$

where  $Q_{[i]}^* \equiv \sum_{j \neq i} q_j^*$ . The Nash bargaining solution is characterized as follows:<sup>10</sup>

Nash Bargaining Assumption The outcome from negotiations between the seller and buyers maximizes joint surplus and therefore involves the trade of  $q_i^*$  units to each buyer i for all i = 1, ..., n. The seller and buyer i split evenly the incremental surplus generated by their trade under the belief that all buyers  $j \neq i$  purchase the efficient amount  $q_j^*$ .

Note that all agents believe efficient trade will occur, and this belief is justified in equilibrium. Further, note that beliefs are important in this model even though buyers are independent. If the seller made take-it-or-leave-it offers to the buyers, then beliefs would not matter: the seller would transfer  $q^*$  to the buyers and would charge each buyer *i* an amount equal to *i*'s gross surplus  $v_i(q_i^*)$ . In our model, beliefs determine the gains from trade over which each buyer and supplier negotiate.

The vector of quantities purchased by the buyers,  $q^*$ , is immediate from the Nash bargaining assumption. To complete the specification of equilibrium, we compute the transfers from the buyers to the supplier,  $T^* = (T_1^*, \ldots, T_n^*)$ . We adopt the accounting convention that  $T_i^* > 0$ represents a positive net payment from buyer *i* to the supplier. Given  $q^*$  and  $T^*$ , the net surplus accruing to each player in equilibrium can be computed.

<sup>10</sup> It can be shown that this outcome emerges as a limiting perfect Bayesian equilibrium of an extensive-form game. In this game, a supplier engages in simultaneous negotiations with each buyer; each negotiation is an alternating-offers bargaining game with exogenous probability that bargaining breaks down, analyzed by Binmore et al. (1986). The limit is taken as the probability of the breakdown of bargaining approaches zero. To fully specify the equilibrium, buyer *i* can be assumed to believe that negotiations with buyers  $j \neq i$  reach an efficient outcome regardless of the offers *i* receives from the supplier. Such beliefs are "passive" in the terminology of McAfee and Schwartz (1994).

Consider the negotiation between the supplier and buyer *i*. If bargaining between them breaks down, the supplier earns  $V(Q_{[i]}^*) + \sum_{j \neq i} T_j^*$ , because the negotiations between the supplier and the other buyers  $j \neq i$  continue. The supplier provides  $q_j^*$  units to each buyer  $j \neq i$  for a payment of  $T_{j}^*$ . Buyer *i* earns no surplus. If bargaining is successful between the supplier and buyer *i*, the supplier earns  $V(Q^*) + \sum_{i=1}^n T_{i}^*$ , where  $Q^* = \sum_{i=1}^n q_i^*$ , and the buyer earns  $v_i(q_i^*) - T_{i}^*$ . Nash bargaining implies that  $T_i^*$  is set to equalize the gains from trade:

$$V(Q^*) + \sum_{i=1}^{n} T_i^* - \left[ V(Q_{[i]}^*) + \sum_{j \neq i} T_j^* \right] = v_i(q_i^*) - T_i^*.$$

Solving for  $T_{i}^{*}$ ,

$$T_i^* = \frac{1}{2} \left[ v_i(q_i^*) + V(Q_{[i]}^*) - V(Q^*) \right].$$
(1)

Substituting  $T_i^*$  back into the expressions for the supplier's net surplus, in equilibrium, the supplier earns

$$V(Q^*) - \frac{1}{2} \sum_{i=1}^{n} \left[ V(Q^*) - V(Q^*_{[i]}) \right] + \frac{1}{2} \sum_{i=1}^{n} v_i(q^*_i)$$

Buyer *i*'s net surplus in equilibrium is

$$\frac{1}{2}[v_i(q_i^*) + V(Q^*) - V(Q_{[i]}^*)].$$
(2)

The expression for buyer *i*'s net surplus in equation (2) is quite intuitive. As a result of Nash bargaining, buyer *i* obtains half of the increment to total surplus generated by its trading with the supplier. The increment to total surplus is the sum of the increment to downstream surplus,  $v_i(q_i^*)$ , and the increment to upstream surplus,  $V(Q^*) - V(Q_{[i]}^*)$ .

## A. Buyer Merger

In this section, we examine the effect of buyer merger on both the net surplus of the merging buyers and the payments made by the merging buyers to the supplier. Without loss of generality, a merger between buyer 1 and 2 is considered. We compare the *m*-equilibrium—the equilibrium in which buyer 1 and 2 are merged-to the s-equilibrium-the equilibrium in which buyer 1 and 2 are separate entities. To distinguish the s- from the m-equilibrium, the variables associated with the s-equilibrium are indicated with superscript s and the variables associated with the *m*-equilibrium with superscript *m*. Thus,  $q^s = (q_1^s, q_2^s, q_3^s, \dots, q_n^s)$  represents the vector of quantities purchased by the buyers in the s-equilibrium; further,  $Q^s \equiv \sum_{i=1}^n q_i^s$ ,  $Q_{[i]}^s \equiv \sum_{j \neq i} q_j^s$ , and  $Q_{[i,j]}^s \equiv \sum_{k \neq i,j} q_k^s$ . Let  $T_i^s$  be the transfer from buyer *i* to the supplier in the s-equilibrium. For conciseness, define  $v_i^s \equiv$  $V_i(q_i^s)$ . Recall that, under Nash bargaining,  $q^s$  maximizes

<sup>&</sup>lt;sup>9</sup> By contrast, Horn and Wolinsky (1988) have the parties negotiate a linear price at the bargaining stage; in a subsequent stage, the buyer can choose whatever quantity it wishes given the linear price.

total surplus:

$$q_i^s = \arg \max \{ V(Q_{[i]}^s + x) + v_i(x) \} \quad i = 1, \dots, n$$

By focusing on a single action before the negotiation stage—the merger decision of buyers 1 and 2—we have implicitly ruled out a number of other actions available to agents:

- The supplier cannot sign contracts committing individual buyers not to merge with other buyers. One justification for this restriction is that contracts preventing merger are inherently incomplete and unenforceable by a court. In practice, such contracts are rarely observed.
- The supplier cannot vertically integrate with a buyer. This restriction can be justified, following Grossman and Hart (1986), if the allocation of control rights after the merger (say the supplier gains control of the downstream assets) would result in serious problems of underinvestment ex ante.
- The supplier cannot change the shape of V(Q), say by making a cost-reducing investment, after the buyers make their merger decision.<sup>11</sup> If the supplier could affect V(Q), then this would affect the buyers' ex ante incentives to merge and the relationship between the shape of V(Q) and buyer merger derived below would not necessarily hold. Thus, we implicitly assume either V(Q) is exogenously given or that V(Q) is endogenous, but any changes made by the supplier to V(Q) are sunk before the buyers decision to merge.

In the *m*-equilibrium, there are n - 1 buyers: the merged buyer labeled buyer 1 + 2, and the remaining buyers i = 3, ..., n. In this equilibrium,  $q^m = (q_{1+2}^m, q_3^m, ..., q_n^m)$ represents the quantities purchased by the buyers; further,  $Q^m$ ,  $Q_{[i]}^m$ ,  $T_i^m$ , and  $v_i^m$  are defined analogously to their *s*-superscripted counterparts. The quantities purchased by the buyers maximize total surplus, so

$$q_{1+2}^m = \arg \max_x \left\{ V(Q_{[1+2]}^m + x) + v_{1+2}(x) \right\}, \text{ and}$$
  
 $q_i^m = \arg \max_x \left\{ V(Q_{[i]}^m + x) + v_i(x) \right\} \quad i = 3, \dots, n$ 

This specification allows the quantities purchased by the buyers to differ between the two equilibria. Equilibrium quantities would differ, for example, if merger affected downstream marginal cost due to economies of scale. Absent scale economies, it may still be possible to obtain cost reductions by reallocating output between the two units if one is more efficient than the other. Since the equilibrium purchases by the nonmerging buyers i = 3, ..., n depend on the purchases by the merging buyers,  $q_i^s$  may differ from  $q_i^m$ for i = 3, ..., n if  $q_1^s + q_2^s \neq q_{1+2}^m$ .

Referring to the expression for net buyer surplus (2), it can be seen that the net surplus of buyer 1 and 2 is greater in the *m*-equilibrium than in the *s*-equilibrium if and only if

$$v_{1+2}^{m} + V(Q^{m}) - V(Q_{[1+2]}^{m}) > v_{1}^{s} + V(Q^{s}) - V(Q_{[1]}^{s}) + v_{2}^{s} + V(Q^{s}) - V(Q_{[2]}^{s}).$$
(3)

It is possible to manipulate equation (3) into a form in which the motives for buyer merger (efficiency motives, bargaining motives, etc.) can be distinguished. In particular, define

$$DE \equiv v_{1+2}^m - v_1^s - v_2^s$$
  

$$UE \equiv [V(Q^m) - V(Q_{[1+2]}^m)] - [V(Q^s) - V(Q_{[1,2]}^s)]$$
(4)  

$$BP \equiv [V(Q_{[2]}^s) - V(Q_{[1,2]}^s)] - V(Q^s) - V(Q_{[1]}^s)].$$

In brief, downstream efficiency DE captures the effect of the merger on the merging buyers' gross surplus. If merger leads to fixed-cost savings or a reduction in marginal costs for buyer 1 and 2, then DE > 0 since the merging buyers' gross surplus will be higher in the *m*-equilibrium than in the s-equilibrium. Upstream efficiency UE captures the indirect effect of merger on the supplier's gross surplus. If merger leads to a change in the quantity purchased by buyer 1 and 2, it will lead to a change in the increment to the supplier's gross surplus due to the transaction with buyers 1 and 2. If merger does not change the combined output of buyer 1 and 2, then UE = 0. The final term, *BP*, captures the effect of the merger on the merging buyers' *bargaining position* vis-a-vis the supplier. An important result is that the bargaining effect depends only on the curvature of the supplier's gross surplus function. Even if buyer merger has no associated efficiency effects (so that DE = UE = 0) buyer 1 and 2 will merge in order to extract more surplus in negotiations with the supplier if BP > 0.

In terms of DE, UE and BP, condition (3) becomes

$$DE + UE + BP > 0. \tag{5}$$

Condition (5) is quite intuitive. Buyers 1 and 2 have a greater incentive to merge the greater are the downstream efficiencies, upstream efficiencies, and positive bargaining effects of merger.

The payment from buyer 1 and 2 to the supplier is higher in the *s*-equilibrium than in the *m*-equilibrium if and only if  $T_1^s + T_2^s > T_{1+2}^m$ . This condition, using equation (1), is

<sup>&</sup>lt;sup>11</sup> In the case of cable, program suppliers could affect the shape of the advertising revenue function, an important component of V(Q), by renegotiating the terms of their contracts with advertisers. If such contracts are unobservable to cable operators, then such renegotiation may have little impact on the subsequent bargaining between program suppliers and cable operators.

equivalent to

$$v_1^s + V(Q_{[1]}^s) - V(Q^s) + v_2^s + V(Q_{[2]}^s) - V(Q^s)$$
  
>  $v_{1+2}^m + V(Q_{[1+2]}^m) - V(Q^m).$ 

Rearranging and substituting DE, UE, and BP, we have

$$-DE + UE + BP > 0. \tag{6}$$

Condition (6) implies that the greater is DE, the higher is the payment from the buyers to the supplier in the *m*equilibrium relative to the s-equilibrium. This is a natural result in a bargaining model: if merger increases the buyers' gross surplus, this increased surplus must be shared with the supplier in the form of a higher payment for the good. Condition (6) also implies that the greater is UE, the lower the buyers' payment in the *m*-equilibrium relative to the s-equilibrium. This result, too, is intuitive: if merger increases the upstream firm's surplus, this increased surplus must be shared with the buyers in the form of a lower payment for the good. Finally, condition (6) implies that the greater is BP, the lower the buyers' payment in the *m*-equilibrium relative to the *s*-equilibrium. Intuitively, if merger enhances the buyers' bargaining position, they should be better able to extract price concessions from the supplier in the negotiation process. Summarizing the results contained in conditions (5) and (6), we have

**Proposition 1** Buyers 1 and 2 strictly prefer to merge if and only if DE + UE + BP > 0. Their total payment to the supplier strictly declines as a result of merger if and only if -DE + UE + BP > 0.

Depending on whether condition (5) and (6) hold, the effects of a buyer merger fall into one of four possible categories. An exhaustive list of cases is contained in table 1. In the first two cases, *DE* swamps the other terms. In the first case, merger increases downstream gross surplus so much that merger must be profitable regardless of its other effects. This increase in downstream gross surplus is shared with the supplier in the form of higher payments from the buyers. In the second case, merger reduces downstream gross surplus so much that merger is unprofitable. If the merger were undertaken, the buyers would be able to negotiate a lower price with the supplier, but not low enough to compensate for other losses from the merger.<sup>12</sup> In the last two cases, |DE|is relatively small, so the effect of buyer merger is determined mainly by the sum of the other terms, UE + BP. To clarify the discussion of these cases, suppose that DE = 0. If in addition UE + BP > 0, then merger is profitable solely because the buyers' total payment to the supplier is reduced as a result of the merger. On the other hand, if in addition UE + BP < 0, then merger is unprofitable solely because the

TABLE 1.—COMPARATIVE-STATICS EFFECTS OF BUYER MERGER

Condition	(5) Holds?	(6) Holds?	Merger Effects
$ UE + BP  < DE < \infty$	yes	no	merger profitable but increases payment to supplier
$-\infty < DE < - UE + BP $	no	yes	merger unprofitable but reduces payment to supplier
-(UE + BP) < DE < UE + BP	yes	yes	merger profitable and reduces payment to supplier
UE + BP < DE < -(UE + BP)	no	no	merger unprofitable and in- creases payment to supplier

buyers' payment to the supplier is increased as a result of the merger.

This analysis provides some useful empirical insights. In our framework, it is possible to observe large buyers paying lower prices to sellers because of either positive bargaining effects or upstream efficiency effects. Separating these effects requires information on the supplier's gross surplus function. Mergers that result in positive bargaining effects may indeed generate a negative correlation between buyer concentration and seller profitability, as found by several cross-industry studies. However, given that the downstream markets in these cross-industry studies largely involved competing firms, their results could also be explained by positing that concentrated downstream markets produce a lower output and that mergers generate upstream inefficiencies. To our knowledge, the previous literature has ignored this possibility. Secondly, it is clear in our framework that buyers may merge even though large buyers pay higher prices to sellers: all that is required to resolve this apparent conflict is the presence of downstream efficiencies.

The next subsection presents a detailed analysis of the bargaining effects of buyer merger. A detailed analysis of the efficiency effects of buyer merger is contained in appendix A.

## B. Bargaining Effects

The sign of the bargaining effect BP depends only on the curvature of V(Q). To see this, note the definition of BP from equation (4) implies

$$BP = - \left\{ \left[ V(Q_{[1,2]}^{s} + q_{1}^{s} + q_{2}^{s}) - V(Q_{[1,2]}^{s} + q_{2}^{s}) \right] - \left[ V(Q_{[1,2]}^{s} + q_{1}^{s}) - V(Q_{[1,2]}^{s}) \right] \right\}$$
$$= - \int_{0}^{q_{1}^{s}} \int_{0}^{q_{2}^{s}} V''(Q_{[1,2]}^{s} + q_{1} + q_{2}) dq_{1} dq_{2}.$$

Therefore, the following proposition is immediate:

**Proposition 2** If V''(Q) > for Q > 0, then BP < 0. If V''(Q) < 0 for Q > 0, then BP > 0. If V''(Q) = 0 for Q > 0, then BP = 0.

Intuition for the results in Proposition 2 is provided by figure 2. For simplicity, figure 2 depicts the case in which

<sup>&</sup>lt;sup>12</sup> We can show that, if DE > 0 and if equilibrium output for buyers increases with their merger, then UE + DE > 0.

 $q_1^s = q_2^s$ . If buyers 1 and 2 do not merge, the negotiated tariffs  $T_1^s$  and  $T_2^s$  depend on their marginal contribution to the supplier's gross surplus, labeled *M* in the figure. If the buyers merge, the negotiated tariff  $T_{1+2}^m$  depends on buyer 1's marginal contribution *M* plus buyer 2's inframarginal contribution to the supplier's gross surplus, labeled *IM* in the figure.<sup>13</sup> If V(Q) is concave as in the upper panel of figure 2, then buyer 2's contribution as the marginal buyer is less than its contribution as an inframarginal buyer, so merger improves the buyers' bargaining position. If V(Q) is convex as in the lower panel of figure 2, then buyer 2's contribution as an inframarginal buyer is greater than its contribution as an inframarginal buyer, so merger worsens buyers' bargaining position.<sup>14</sup>

V(Q) Concave: Absent efficiency effects, if V(Q) is globally concave, then buyer size confers positive bargaining effects. Indeed, the model predicts that buyers should merge to form a single large buyer. If V(Q) = R(Q) - C, where R(Q) is the supplier's external revenue function (revenues not including the payments from the buyers  $\sum_{i=1}^{n} T_{i}^{*}$ , and C is a fixed cost, then V(Q) is concave if and only if R(Q) is concave, implying that buyer merger and buyer size improve buyers' bargaining position if and only if R(Q) is concave. If V(Q) = R - C(Q), where R is a fixed external revenue term and C(Q) is the supplier's cost function, then V(Q) is concave if and only if C(Q) is convex. Equivalently, V(Q) is concave if and only if MC(Q) is increasing, where MC(Q) is the supplier's marginal cost function, C'(Q). This is the typical structure behind a U-shaped average cost function.

V(Q) Convex: If V(Q) is convex, then all of the previous implications are reversed. Size does not improve bargaining outcomes. Absent efficiency effects, buyers should bargain separately as atomistic units. If V(Q) = R(Q) - C (i.e., all costs are fixed), then V(Q) is convex if and only if R(Q) is convex. If V(Q) = R - C(Q) (i.e., all external revenues are fixed), then V(Q) is convex if and only if C(Q) is concave, or equivalently, if and only if MC(Q) is decreasing. Of course, if MC(Q) is everywhere decreasing, then AC(Q) must be everywhere decreasing as well, implying that upstream production exhibits increasing returns to scale.

V(Q) S-Shaped: An intermediate case between global concavity and global convexity is an S-shaped surplus function, convex for low Q and concave for high Q. This





case is particularly interesting since the associated equilibrium may exhibit partial integration, i.e., it can be shown that the downstream market structure that maximizes the share of surplus accruing to the buyers may involve several firms of moderate size as opposed to a single buyer (complete integration) or a continuum of atomistic buyers (complete nonintegration). Of the three cases discussed in this section (concave, convex, S-shaped), only the last is consistent with observed partial integration in the cable industry (with approximately 1,600 operators serving 11,000 franchise areas in 1991).

Appendix B contains a detailed discussion of S-shaped surplus functions. We show that buyer size is related to the

<sup>&</sup>lt;sup>13</sup> Equivalently,  $T_{1+2}^m$  can be thought of as depending on buyer 2's marginal contribution and buyer 1's inframarginal contribution to the supplier's gross surplus.

<sup>&</sup>lt;sup>14</sup> In terms of the extensive-form game outlined in footnote 10, one can think of merger as forcing buyer 1 to internalize buyer 2's welfare. When it is time for a buyer to respond to an offer made by the supplier, it can threaten to reject unless the supplier's offer to both buyers was generous enough. This threat enhances buyers' bargaining position if V(Q) is concave. If V(Q) is convex, on the other hand, the supplier can force a buyer to make concessions by threatening to reject both buyers' offers.

FIGURE —3.—REVENUE SOURCES FOR 27 LARGEST ADVERTISER-SUPPORTED PROGRAM SERVICES



Data source: The Economics of Basic Cable Networks (1993).

width of the concave portion of the function: in equilibrium there cannot be two buyers so small that they fit together within the concave portion of the function. (They would benefit from merging.) This lower bound on the size of firm pairs can be used to test the bargaining theory in empirical applications in which the estimated surplus function is S-shaped. We also provide a numerical example in which partial integration arises in equilibrium.

#### **IV.** Supplier Surplus in Cable Television

This section provides an empirical analysis of the effect of buyer size on the bargaining process in the cable-television industry. In our framework, whether cable-system-operator size confers positive bargaining effects in negotiations with a program service supplier depends on the shape of the supplier's gross surplus function. Gross surplus is defined as revenue, excluding transfer payments from operators, minus cost. Suppliers earn revenue from three sources: advertising revenue, license fees, and other revenue. Although the license fees and other revenue represent a growing portion, advertising revenue continues to be the largest portion of supplier revenue. Figure 3 presents a breakdown of total revenues for the 27 largest advertiser-supported services.

We assume that advertising revenues are a function,  $R_k(Q_k)$ , of the total subscribers,  $Q_k$ , that ultimately receive supplier k's service. Furthermore, we maintain that suppliers are likely to exhibit large fixed costs  $F_k$  and zero or constant

TABLE 2.—LIST OF VARIABLES

Variable	Acronym
Gross advertising revenue (million 1982 dollars)	ADREV
Program expenses (million 1982 dollars)	EXPS
Number of subscribers receiving program service (million)	SUBS
Number of systems carrying program service	SYSTEMS

Notes: Data sources: ADREV, EXPS, and SUBS from The Economics of Basic Cable Networks (1993). SYSTEMS is from various issues of Cablevision (second quarter each year). Producer price index used to deflate ADREV and EXPS is from the Statistical Abstract of the United States (1994).

marginal costs  $c_k$ . Thus, the supplier's gross surplus function has the form

$$V_k(Q_k) = R_k(Q_k) - c_k Q_k - F_k.$$

Under the maintained assumption that  $V_k(Q_k)$  has this form, the curvature of  $V_k(Q_k)$  is identical to the curvature of  $R_k(Q_k)$ . Our empirical strategy is thus to estimate the shape of the advertising revenue function  $R_k(Q_k)$ , exploiting the variation in advertising revenues and subscriber base across program services. The direction and magnitude of the effect of merger on buyers' bargaining position can be inferred from the shape of the advertising revenue function.

We estimate the advertising revenue function in cable using panel data drawn from various sources listed in table 2. *The Economics of Basic Cable Networks* (1993) provided gross annual advertising revenue (*ADREV*), total number of subscribers (*SUBS*), and annual program expenses (*EXPS*) for each of the 27 largest advertiser-supported cable program services, for up to nine years. We added information on the number of cable systems that carried each of these 27 program services, drawn from the second-quarter issue of *Cablevision* for each of the nine years. We employ the annual producer price index from the *Statistical Abstract of the United States* (1994) to convert advertising revenue into 1982 dollars.

Upon dropping observations for missing values, we are left with an unbalanced panel consisting of 21 program services, totalling 158 observations. Table 3 presents descriptive statistics for the resulting data set. Some additional notation will be useful in subsequent discussion. Let *K* be the total number of program services, indexed by  $k = 1, \ldots, K$ . Let  $\underline{T}_k$  and  $\overline{T}_k$  be, respectively, the first and last years program service *k* exists in the data set. Let time be indexed by  $t = \underline{T}_k, \underline{T}_k + 1, \ldots, \overline{T}_k$ . Let  $T_k$  be the total number of years program service *k* is in the data set; i.e.,  $T_k = \overline{T}_k - \underline{T}_k + 1$ . As table 3 shows,  $T_k$  ranges from four to nine years in our data set.

We model advertising revenues as

$$ADREV_{kt} = f(SUBS_{kt}, \beta) + \delta EXPS_{kt} + \gamma_t + \alpha_k + \omega_{kt} + \epsilon_{kt},$$
(7)

where k indexes program services,  $\gamma_t$  is a time effect,  $\alpha_k$  is a time-invariant fixed effect,  $\omega_{kt}$  is a time-varying ownership effect, and  $\epsilon_{kt}$  is the an error term. The shape of f is

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			Means by Program Service			
Program Service	Owners <sup>a</sup>	Years	EXPS	ADREV	SUBS	SYSTEMS
A&E	ABC, NBC, Radio City Music	8	25.8	30.8	35.8	3,975
Black Entertainment	Johnson, TCI, Time Warner	9	7.7	15.2	19.7	1,365
CNBC	NBC	9	21.1	30.0	30.8	2,600
CNN	Turner	9	102.8	135.9	45.2	9,974
Country Music	Gaylord, Group W	8	0.8	2.4	8.8	1,192
Discovery Channel	Cox, Hendricks, Newschannel, TCI	7	26.6	30.1	38.2	5,304
E! Entertainment	Comcast, Continental, Cox, Newschannel, Time Warner	5	8.9	7.3	15.0	546
ESPN	ABC	9	161.2	148.9	47.1	17,474 <sup>b</sup>
Family Channel	Int'l Family Entertainment, TCI	9	24.5	51.5	40.7	7,711
Learning Channel	Cox, Hendricks, Newschannel, TCI	7	3.2	6.6	11.2	1,102
Lifetime	ABC, Viacom	9	40.9	64.1	37.7	3,741
MTV	Viacom	9	45.0	92.2	40.2	5,218
Nickelodeon	Viacom	9	33.9	41.2	39.4	6,007
Nostalgia	Publicly Held	5	2.0	2.6	9.3	480
TBS	Turner	9	83.9	213.1	45.4	10,837
TNN	Gaylord	9	33.4	38.8	38.1	6,933
TNT	Turner	4	163.0 <sup>c</sup>	95.5	46.0	5,571
Travel Channel	Landmark	5	3.0	3.7	14.1	598
USA Network	MCA, Paramount	9	90.5	116.2	42.7	8,267
VH-1	Viacom	7	11.4	17.1	31.0	2,595
Weather Channel	Landmark	9	10.8	13.0	33.4	3,073
Whole Sample Means;		7.8	44.3	68.9	33.1	5,493

TABLE 3.—DESCRIPTIVE STATISTICS FOR PANEL DATA SET

Notes: There are 21 program services; the number of observations for each is given in the Years column. The panel has 158 total observations. See table 2 for data sources. <sup>a</sup> Firms holding at least a 1% share of program service's stock in any year in the sample. ABC includes subsidiaries Hearst and Cap City/ABC; TCI includes subsidiary Liberty Media Inc.; Time Warner includes subsidiary HBO.

<sup>b</sup> Includes cable television systems, SMATV, and other distribution technologies.

° Includes expenses incurred for other Turner services.

determined using a series estimator. That is, we specify

$$f(SUBS_{kt}, \beta) = \sum_{l=0}^{L} \beta_l SUBS_{kt}^l,$$
(8)

where the degree of the polynomial, L, is determined through cross-validation. The term  $\alpha_k$  captures the demographic characteristics of a program service's audience, and the program service's format and content (to the extent these remain constant over time). Fixed-effects and first-difference estimators can control for the unobservable effects embodied in  $\alpha_k$ . Consider, finally, the term  $\omega_{kt}$ . Table 3 shows that a number of the program services are commonly owned. For example, Viacom owns part of Lifetime and all of MTV, Nickelodeon, and VH-1. Advertising rates for these program services may be related: this would be the case if advertising on the four program services is bundled, or if Viacom's management uses a common strategy in negotiating with advertisers over rates. To the extent that these ownership effects are constant across time, they are already embodied in  $\alpha_k$ , and are thus controlled for by fixed-effects and first-difference estimators. To account for time-varying ownership effects, we include owner-cross-time dummies in all specifications.<sup>15</sup> For example, the owner-cross-time dummy for "Viacom, 1992" equals one for the four program services mentioned above in which Viacom owned stock in

1992; the dummy equals zero for all other observations in the panel (Viacom-owned programs in years other than 1992 and non-Viacom-owned programs in all years). Some program services are owned by more than one firm: e.g., Lifetime is owned by Viacom and ABC. For such program services, more than one owner-cross-time dummy may equal one. Note that a firm must own at least 1% of a program service's stock to be classified as an owner. Formally, we specify the ownership effect  $\omega_{kt}$  as follows:<sup>16</sup>

$$\omega_{kt} = \sum_{o=1}^{O} \theta_{ol} \mathbf{1} \{ k \in S_{ot} \}, \tag{9}$$

where *o* indexes owners, *O* is the total number of different owners,  $\theta_{ot}$  is an owner-cross-time fixed effect to be estimated,  $\mathbf{1}[\cdot]$  is an indicator function, and  $S_{ot}$  is the set of program services in which *o* has at least a 1% ownership share at date *t*.

We compute three different estimators of the parameters. First, we compute a fixed-effects estimator. Second, we compute a first-difference estimator. Comparing the fixed-effects and first-difference estimators will allow us to determine the presence of misspecification. Third, we compute an instrumental variables, fixed-effects (IV fixed-effects) estimator. This third estimator instruments for *SUBS*, which is possibly endogenous. The instrumental variables include powers of *SYSTEMS*<sub>kt</sub>, the number of systems that carry program service k in year t. We expect that *SYSTEMS*<sub>kt</sub> is correlated with *SUBS*<sub>kt</sub>; that is, the

<sup>&</sup>lt;sup>15</sup> We omit the dummy if the owner owned only one program service: keeping the dummy in this case would be equivalent to dropping the observation. We omit it for one year for all owners to avoid multicolinearity. We omit it for Cox and for Hendricks since these dummies are linear combinations of the others.

<sup>&</sup>lt;sup>16</sup> We thank a referee for suggesting this notation.

Variable	One Power of SUBS			Two Powers of SUBS			Three Powers of SUBS		
	Fixed Effects	First Difference	IV Fixed Effects	Fixed Effects	First Difference	IV Fixed Effects	Fixed Effects	First Difference	IV Fixed Effects
SUBS	1.08	0.08	1.03	-1.02	-1.70	-0.80	2.09	0.30	3.32
	(0.17)	(0.41)	(0.20)	(0.55)	(0.67)	(0.64)	(1.14)	(1.69)	(1.81)
$SUBS^2$	_	_	_	2.92	2.88	2.63	-8.42	-3.64	-13.37
$(\times 10^{2})$				(0.72)	(0.90)	(0.88)	(3.76)	(5.17)	(6.65)
SUBS <sup>3</sup>		_				_	1.20	0.69	1.80
$(\times 10^{3})$							(0.40)	(0.54)	(0.70)
EXPS	0.63	0.44	0.64	0.53	0.40	0.54	0.47	0.40	0.40
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.08)
Ν	158	137	158	158	137	158	158	137	158
Adjusted $R^2$	0.863	0.491	_	0.887	0.566		0.899	0.571	

TABLE 4.—ESTIMATION RESULTS

Notes: Time dummies and owner-cross-time dummies included in all specifications. Standard errors shown in parentheses below coefficient estimates. For the IV Fixed-Effects specification, the instruments for SUBS include powers of SYSTEMS up to the sixth.

number of subscribers a service has is directly affected by the number of systems that carry the service. On the other hand, we maintain that  $SYSTEMS_{kt}$  does not directly affect  $ADREV_{kt}$ ; that is, advertising revenue should only depend on the number of final subscribers, independent of the distribution of these subscribers across systems.

Estimation results for the first three powers of SUBS are summarized in table 4. Comparing the fixed-effects and first-difference estimates, the point estimates for firstdifference estimator are smaller than those of the fixedeffects estimator for all but one coefficient. A bias toward zero for the first difference is suggestive of correlation between the regressor and the error term (Hausman & Griliches, 1986). Further, the fixed-effects and firstdifference estimates are significantly different from each other as indicated by a Hausman test.<sup>17</sup> Table 4 also presents the IV fixed-effects estimates. Much of the variation in SUBS is captured by the first-stage regression of SUBS on the instruments: the adjusted  $R^2$  for the first-stage regression with SUBS is 0.879, for SUBS<sup>2</sup> is 0.917, and for SUBS<sup>3</sup> is 0.898. In all specifications, the owner-cross-time dummies are jointly significant at the 5% level.18

A series estimator for the function f in equation (7) was derived by allowing the order of polynomials in *SUBS* to increase until a criterion function was minimized. The criterion function which we adopt is a sum of squared, adjusted residuals:

$$\sum_{k=1}^{K}\sum_{t=\underline{T}_{k}}^{\overline{T}_{k}}\left[X_{kt}^{\prime}(X^{\prime}X)^{-1}X_{kt}\hat{\boldsymbol{\epsilon}}_{kt}\right]^{2}$$

where  $\hat{\mathbf{\epsilon}}_{kt}$  is the estimated residual from equation (7), *X* is the matrix of regressors, and  $X_{kt}$  is the row vector of regressors

<sup>18</sup> One interesting finding is that the Turner ownership dummy is significantly negative at the beginning of the sample period but becomes significantly positive by the end of the sample period.

for observation *kt*. The series estimator was calculated for both the fixed-effects and the IV fixed-effects specifications. With both, the criterion was minimized by a third-order polynomial in *SUBS*. Figure 4 provides a graphical illustration of the results from the series estimation. The quadratic curve is globally convex for both estimators. The cubic curve, which minimizes the criterion function, has an inverse S-shape: concave for low values of *SUBS*, and convex for high values. Intuitively, since the theory developed in the previous section identifies the sign of the bargaining effect with curvature of the surplus function at the margin, the relevant portion of the estimated advertising revenue function is that for high values of *SUBS*. The fact that this portion is convex suggests that mergers between cable operators would have a negative bargaining effect.

Our formal tests of the preceding claims are discussed with the aid of figure 5. Figure 5 isolates the cubic specification for the fixed-effects and IV fixed-effects estimators and presents a confidence sleeve around the curves. For each value of *SUBS*, the predicted value of advertising revenue lies within the sleeve with 95% confidence. Given the estimated form of the advertising revenue function,

$$f(SUBS, \hat{\beta}) = \hat{\beta}_1 SUBS + \hat{\beta}_2 SUBS^2 + \hat{\beta}_3 SUBS^3, \quad (10)$$

the curvature of f can be computed from the second derivative

$$\frac{\partial^2 f}{\partial SUBS^2} = 2\hat{\beta}_2 + 6\hat{\beta}_3 SUBS.$$

Note that the curvature of the estimated f is not global but depends on the magnitude of *SUBS*. For each value of *SUBS*, we test the null hypothesis of no curvature

$$H_0: \frac{\partial^2 f}{\partial SUBS^2} = 0$$

versus the two-sided alternative. We perform a Wald test, equivalent to testing a linear restriction on the coefficients  $\hat{\beta}$ . The null could not be rejected at the 5% level for the values

<sup>&</sup>lt;sup>17</sup> For the regression with one power of *SUBS*, the Hausman test statistic for equality between the fixed effects and first difference parameter estimates (distributed  $\chi^2_{64}$  under the null) is 58.2, significant at the 1% level. Hausman tests for the regressions involving higher powers of *SUBS* rejected parameter equality with equal significance.

FIGURE 4.—SERIES ESTIMATION OF ADVERTISING REVENUE FUNCTION

FIGURE 5.—CUBIC ADVERTISING REVENUE FUNCTION WITH CONFIDENCE SLEEVE





of *SUBS* in the region of figure 5 between the dotted lines. The second derivative was significantly negative in the region labelled "concave" and significantly positive in the region labelled "convex." The mean of *SUBS* in the data set (32.4 million) and the median (32.5 million) both lie in the convex region, implying that the surplus function is significantly convex for the average program service.

As a direct test of the hypothesis that the bargaining effect of buyer merger is negative, we compute an estimate,  $\widehat{BP}$ , of the theoretical bargaining term, BP, using our data. That is, we substitute the estimated cubic advertising-revenue function in the formula for BP from equation (4). Although the theoretical model has one supplier, in cable there are many suppliers of program services. Thus, the bargaining effects  $\widehat{BPk}$  for individual program services must be summed to produce an estimate of the total bargaining effect:  $\widehat{BP} = \sum_{k=1}^{K} \widehat{BP_k}$ . Let  $q_1$  and  $q_2$  be the number of subscribers for cable operators 1 and 2. Upon substituting equation (7) into equation (4) and rearranging,

$$\widehat{BP}_k = f(SUBS_k - q_1) + f(SUBS_k - q_2) - f(SUBS_k) - f(SUBS_k - q_1 - q_2),$$

where the  $\hat{\beta}$  argument of *f* has been suppressed. Note that the terms besides *f* in equation (7) cancel out. Substituting from equation (10) for *f* and summing over *k*, it can be shown that  $\widehat{BP}$  is proportional to

$$-(2\hat{\beta}_{2}+6\hat{\beta}_{3}\overline{SUBS})+3\hat{\beta}_{3}(q_{1}+q_{2}), \tag{11}$$

where

$$\overline{SUBS} = \frac{1}{K} \sum_{k=1}^{K} SUBS_k$$

The expression in equation (11) has a simple interpretation. The first term is the second derivative of *f* evaluated at the mean of subscribers. This has been shown to be significantly negative. The second term is increasing in the size of the merged cable operator (true since  $\hat{\beta}_3 > 0$ ). For very small cable operators, the second term will be negligible; since we have shown the first term is significantly negative,  $\hat{B}P$  will be significantly negative. If the cable operators are large enough, the second term may swamp the first and their

merger may have a positive bargaining effect. In graphical terms (refer to figure 5), the cable operators may be so large that subtracting their joint size from the size of the average program service puts them in the concave region.

In fact, even for the largest cable operators, equation (11) is significantly negative. We evaluate (11) using 1991 data for  $q_1$ ,  $q_2$ , and SUBS and using the largest two cable operators for  $q_1$  and  $q_2$ .<sup>19</sup> With the fixed-effects estimator, equation (11) equals -0.084 with a standard error of 0.016; with the IV fixed-effects estimator, equation (11) equals -0.108 with a standard error of 0.029. In both cases, equation (11) is significantly negative at the 1% level. For cable operators smaller than the largest two,  $\widehat{BP}$  would be even more negative. It is possible to calculate the size of the cable operators necessary for the bargaining effect to be positive: using the fixed-effects estimator, the cable operators would need to serve over 39.1 million subscribers jointly (36.3 million using the IV fixed-effects estimator). This is well over twice the combined size of the largest two cable operators in 1991.

The general finding of convexity is striking because it appears to contradict the empirical result found in various articles in the marketing literature that consumers' response to advertising is concave in the level of advertising expenditures (Simon & Arndt, 1980). The contradiction disappears upon further consideration. First, the marketing literature focuses on the frequency of ads rather than the extent of the population covered, as we do in the present paper. Further, as argued by Mahajan and Muller (1986), even if the advertisingresponse function were convex, it would be difficult to uncover this fact using consumer-level data due to pulse advertising: by alternating between low and high advertising levels, advertisers can effectively linearize any convex portion of the response function. In addition, the marketing literature is not unamimous on the concavity finding. For example, Kanetkar et al. (1986) find that high levels of advertising exposure tend to decrease consumers' price sensitivity even if substitute products are being advertised.

Three possible explanations for the convexity of the advertising-revenue function can be gleaned from the marketing literature. A first explanation relies on the existence of the word-of-mouth effects of advertising: i.e., some consumers may learn about a product's existence or attributes indirectly through others who were previously exposed to advertising. Bass's (1969) model, which incorporates word-of-mouth effects, shows that the rate of adoption of a durable by consumers may be increasing in the number of consumers who have adopted. Applied to the case of advertising, this would imply a convex advertising-effectiveness func-

tion, and thus a convex advertising-revenue function.<sup>20</sup> A second explanation relies on the existence of scale economies for advertising agencies. For example, there may be fixed costs of producing television commercials; the larger this fixed cost, the greater the net benefit per subscriber from advertising on a large scale. Alternatively, advertising agencies that are able to deal with a few large media outlets may economize on transactions costs.<sup>21</sup> Empirically, Silk and Berndt (1993) find highly significant scale economies for advertising agencies, especially those involved in national television advertising. A third explanation relies on competition among advertisers who produce substitute products. In equilibrium in Villas-Boas's (1993) model, competing firms engage in pulse advertising out of phase with competitors' pulses. The marginal effectiveness of advertising remains high even at high advertising levels because rivals' advertising levels are low. Villas-Boas's empirical results confirm the prevalence of pulse advertising in eight of nine different product categories.

### V. Conclusion

The conventional wisdom—that larger buyers pay lower prices to sellers—motivates our study of the effects of buyer size on the bargaining process. Our theoretical model involves a seller with market power (the upstream firm) and many buyers (the downstream firms, assumed to be monopolists in their respective markets). The seller simultaneously bargains with each buyer, and each outcome is characterized by the Nash bargaining solution. The analysis focuses on the equilibrium downstream structure, allowing buyers to merge (and thus alter their size) prior to negotiations with the seller.

We decompose the effect of buyer merger into three categories: downstream efficiencies, upstream efficiencies, and bargaining effects.

- Merger may alter buyers' efficiency for the usual reasons. We show that efficiency-improving mergers may actually increase the merging buyers' payment to the seller because the seller appropriates some of the buyers' increased surplus through the bargaining process.
- A merger that makes the merging buyers more efficient may increase the quantity purchased from the seller. An increase in the quantity purchased from the seller may affect its marginal surplus, an effect labeled *upstream efficiency*. We show that buyer mergers with a positive upstream-efficiency effect may reduce the merging buyers' payment to the seller.
- Merger may also alter buyers' bargaining outcome, in the absence of efficiency effects, depending on the

<sup>&</sup>lt;sup>19</sup> Data on the size distribution of cable operators in 1991 was taken from *The Cable TV Financial Databook* (1991). We combined operators that were determined from previous work (Chipty, 1995) to be subsidiaries of a common owner. The largest cable operator in 1991 was TCI, at <u>10.3</u> million subscribers, followed by Time Warner, with 6.6 million. *SUBS* equals 43.2 million in 1991.

<sup>&</sup>lt;sup>20</sup> Bass's (1969) model produces an S-shaped function for adoption rates, initially convex and eventually concave. It is plausible that cable advertising is used for products on the convex portion of their adoption curves, i.e., early in their product life-cycle. See Bass et al. (1994) for an extension of the basic model to account for price and advertising effects.

<sup>&</sup>lt;sup>21</sup> We thank a referee for providing this explanation.

shape of the seller's gross surplus function (gross of buyers' payments). Unmerged buyers negotiate over their marginal contribution to seller surplus, but merged buyers negotiate over the average of their combined contributions to seller surplus. It follows that merger enhances buyers' bargaining position if the seller's gross surplus function is concave in total quantity and not if it is convex. Other forms for the function may lead to mixed downstream industry structures.

We provide direct empirical evidence on the effect of buyer merger on the bargaining process, using panel data from the cable-television industry. The robust result emerging from a number of different specifications is that the gross surplus function for a program service supplier is convex in the relevant region. This finding implies that merger worsens rather than enhances buyers' bargaining position. In other words, absent production efficiencies, merger reduces the surplus appropriated by operators during negotiations with a program service supplier. Thus, within the framework of the model, efficiency effects (upstream or downstream) are the remaining explanation of the observations that buyers do merge and large buyers reportedly are more successful in their negotiations with sellers.

In focusing on pure bargaining effects, our framework abstracts from a number of potentially salient issues in cable television; therefore, we have not ruled out all alternative mechanisms through which buyer size can affect market outcomes in this industry. For example, buyer size may affect the transfer price by changing incentives for vertical integration<sup>22</sup> or by stimulating increased competition among rival suppliers.<sup>23</sup> One interesting alternative which has been the subject of a number of empirical studies is that program services may integrate vertically with cable operators to foreclose rival program services. Salinger (1988) and Waterman and Weiss (1996) find that cable operators that are vertically integrated with premium program services tend to carry affiliated pay channels and to exclude rival pay channels. Chipty (1997) finds this exclusionary behavior extends to basic program services. Our work should be thought of as highlighting the importance of understanding how these other mechanisms may operate in the cable industry.

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<sup>22</sup> See Katz (1987) for a theoretical discussion of the possibility of backward integration in the presence of upstream economies of scale.

<sup>23</sup> See Snyder (1996, 1998) for a theoretical discussion of the effect of buyer size on the ability of suppliers to sustain collusive transfer prices.

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## APPENDIX A: EFFICIENCY EFFECTS OF BUYER MERGER

As has been modeled formally by Grossman and Hart (1986), horizontal merger may increase or decrease buyers' productive efficiency. Thus, *DE* may be nonzero. Indirect evidence on the magnitude of *DE* can be obtained from analyzing the effect of buyer merger on final-good prices. Let  $v^m(q_1, q_2)$  denote the gross surplus function of buyers 1 and 2 if they are merged, as distinct from gross surplus functions  $v_1^s(q_1)$  and  $v_2^s(q_2)$  if they are separate. Suppose that buyer merger has no effect on the gross surplus functions of the downstream firms; i.e.

$$v_{1+2}^m(q_1, q_2) = v_1^s(q_1) + v_2^s(q_2).$$

In view of the objective functions determining  $q_i^m$  and  $q_i^s$ , it is immediate that  $q_{1+2}^m = q_1^s + q_2^s$  and  $q_i^m = q_i^s$  for i = 3, ..., n, implying that final-good price is unaffected by merger. Consequently, if buyer merger affects the final-good price, then merger must change the downstream gross surplus functions; and so the efficiency effects *DE* and *UE* will be (generically) nonzero.

Under plausible conditions outlined in the subsequent discussion, the direction of the effect of merger on the merging buyers' output of the final good can serve as a proxy for the sign of DE + UE: if merger increases the output of buyers 1 and 2, then DE + UE > 0; otherwise, DE + UE < 0. Suppose that the effect of merger on the gross surplus of buyers 1 and 2 can be parameterized by  $\alpha \in \mathbf{R}$ :

$$v_{1+2}(q_1, q_2, \alpha) = \begin{cases} v_1^s(q_1) + v_2^s(q_2) & \alpha = \alpha^s \\ v_{1+2}^m(q_1 + q_2) & \alpha = \alpha^m \end{cases}$$

where, without loss of generality,  $\alpha^m > \alpha^s$ . With this parametrization, merger enhances downstream efficiency if  $\partial v_{1+2}/\partial \alpha > 0$ . The increment to total surplus provided by buyers 1 and 2, depending on whether they are merged, can be written as

$$V_{1+2}(q_1, q_2, \alpha) + V(Q_{[1,2]}^*(\alpha) + q_1 + q_2) - V(Q_{[1,2]}^*(\alpha)),$$
(12)

where we have defined  $Q_{[1,2]}^*(\alpha^m) \equiv Q_{[1+2]}^m$  and  $Q_{[1,2]}^*(\alpha^s) \equiv Q_{[1,2]}^s$ . The following proposition provides sufficient conditions for the aggregate efficiency effect of merger to be positive:

**Proposition 3** Suppose  $\partial v_{1+2}/\partial \alpha > 0$ . If  $q_{1+2}^m > q_1^s + q_2^s$ , then DE + UE > 0 whether V(Q) is globally concave or convex.

**Proof.** Let  $\Delta(\alpha)$  denote the function in equation (12). By the envelope theorem,

$$\begin{aligned} \frac{d\Delta}{d\alpha} &= \frac{\partial V_{1+2}}{\partial \alpha} + \left[ V'(Q^*(\alpha)) - V'(Q^*_{[1,2]}(\alpha)) \right] \frac{dQ^*_{[1,2]}(\alpha)}{d\alpha} \\ &= \frac{\partial V_{1+2}}{\partial \alpha} + \frac{dQ^*_{[1,2]}(\alpha)}{d\alpha} \int_{Q^*_{[1,2]}(\alpha)}^{Q^*(\alpha)} V''(Q) \, dQ, \end{aligned}$$

where  $Q^*(\alpha) = Q^m$  if  $\alpha = \alpha^m$  and  $Q^*(\alpha) = Q^s$  if  $\alpha = \alpha^s$ . By assumption, the first two derivatives of the last line are positive. We are left to determine the sign of the integral.

Suppose first that  $V''(Q) \ge 0$ . For i = 3, ..., n, the first-order condition for the optimal quantity  $q_i^*$  is

$$v'_i(x) + V'(Q^*_{[i]}) = 0.$$

This first-order condition is increasing in the output of buyers 1 and 2 and is increasing in  $q_j^*$  for  $j \neq i$ , 1 + 2. By Theorem 4 of Milgrom and Roberts (1994),  $q_i^*$  is increasing in the output of buyers 1 and 2 for i = 3, ..., n. Hence,  $dQ_{[1,2]}^*(\alpha)/d\alpha > 0$ . Similar calculations can be used to show that if V''(Q) < 0, then  $dQ_{[1,2]}^*(\alpha)/d\alpha < 0$ . *Q.E.D.* 

Intuitively, the proposition states that the total efficiency term DE + UE is positive if equilibrium output for buyers increases with their merger and if the downstream efficiency term DE is positive.

### APPENDIX B: S-SHAPED SURPLUS FUNCTION

Assume V(Q) is S-shaped, and let  $Q^{\text{p.o.i.}}$  be the point of inflection. Suppose that there are no efficiency effects of merger, so that  $Q^s = Q^m = Q^*$ . Suppose further that, prior to a merger stage, buyers are atomistic; i.e.,  $q_i^s$  is infinitesimal. Let  $I^s$  be the index set for the continuum of buyers, so

$$\int_{I^s} q_i^s = Q^*.$$

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Suppose that, in a merger stage, buyers can freely form larger buyers of size  $q_i^m$ , i = 1, ..., n. It turns out that the downstream market structure that maximizes the share of the surplus accruing to the buyers, called the *optimal buyer configuration*, can be characterized by the following proposition:

**Proposition 4** Suppose that V(Q) is S-shaped, that initially infinitesimal buyers can merge to form discrete-sized buyers and that these mergers only have bargaining effects. In the optimal buyer configuration,  $V'(Q - q_i^m) = V'(Q - q_i^m)$  for all *i*, *j*. Further,  $q_i^m + q_i^m > Q^* - Q^{p.o.i.}$  for all *i*, *j*.

*Proof.* The optimal buyer configuration involves the choice of  $q_i$  for i = 1, ..., n to maximize

$$\sum_{i=1}^{n} \left[ V(Q^*) - V(Q^* - q_i) \right]$$

subject to  $\sum_{i=1}^{n} q_i = Q^*$  and  $q_i \ge 0$  for i = 1, ..., n. The associated Lagrangian is

$$\angle = \sum_{i=1}^{n} \left[ V(Q^*) - V(Q^* - q_i) \right] + \lambda \left[ Q^* - \sum_{i=1}^{n} q_i \right] - \sum_{i=1}^{n} \mu_i q_i$$

The first-order necessary conditions are

$$V'(Q^* - q_i) = \lambda + \mu_i$$

for i = 1, ..., n. The complementary slackness conditions,  $\mu_i q_i = 0, i =$  $1, \ldots, n$ , imply that

$$V'(Q^* - q_i) = V'(Q^* - q_j)$$

for *i*, *j* such that  $q_i, q_j > 0$ . Suppose there exist *i*, *j* such that  $q_i + q_j < Q^* - Q^{\text{p.o.i.}}$ . Since V(Q) is concave in the relevant region. Proposition 2 implies that BP > 0. Since, in addition, we have assumed there are no other effects of merger besides bargaining effects, buyers *i* and *j* would gain from merger; so the proposed configuration cannot be the optimal configuration of buyers. Q.E.D.

The first result implies that buyers provide the same marginal contribution to the supplier's gross surplus in the optimal buyer configuration. The second result implies that buyers cannot be too small in the optimal buyer configuration. If buyers are small enough, the portion of V(Q) that determines their marginal contribution to the supplier's gross surplus is concave; applying the results from Proposition 2, these buyer can increase their surplus by merging.

Using Proposition 4, the optimal buyer configuration can be computed in particular examples. Consider an example in which

$$V(Q) = Q^2 + 0.089Q^3 - 0.033Q^4$$

and in which  $Q^* = 5$ . It can be shown that Proposition 4 rules out all industry configurations except for three: a single firm of size 5, two firms of size 5/2, and three firms of size 5/3. For example, to see that the two-firm industry configuration must involve firms of size 5/2, note Proposition 4 implies that buyer sizes  $q_1$  and  $q_2$  must solve  $V'(5 - q_1) = V'(5 - q_2)$  and  $q_1 + q_2 = 5$ , simultaneously. The calculations for configurations involving more than two buyers is left to the reader. Finally, it can easily be calculated that the configuration with two firms of equal size provides the buyers with more surplus than either the single- or three-firm configurations.