Extending Market Power through Vertical Integration*

by

Catherine de Fontenay *and* Joshua S. Gans**

First Draft: 15th October, 1998
This Version: 24th October, 2001

This paper derives a model of vertical integration when it is difficult to write binding long-term supply price contracts. Thus, a vertically separated monopolist is vulnerable to hold-up. Without integration, we demonstrate that a bottleneck monopolist has an incentive to encourage more firms in a related segment than would arise in a pure monopoly. Having more firms mitigates the hold-up power of any one. This, however, distorts the cost structure of the industry toward greater industry output and, hence, lowers final good prices. Vertical integration mitigates the hold-up problem faced by the monopolist. It allows it to generate and appropriate a greater share of monopoly profits. Horizontal competition mitigates the anti-competitive effects of integration. *Journal of Economic Literature* Classification Number: L42

Keywords. vertical integration, monopolization, bargaining, hold-up

---

* The authors would like to thank Tim Bresnahan, Stephen King, Preston McAfee, Scott Stern, Lars Stole and, especially, Jeff Zwiebel for helpful comments. Responsibility for all errors remains our own. The latest version of this paper is available at http://www.mbs.edu/home/jgans.

** Melbourne Business School, University of Melbourne. Correspondence to Joshua Gans, Melbourne Business School, 200 Leicester Street, Carlton, Victoria, 3053, Australia; Fax: +61-3-9349-8169; E-mail: J.Gans@unimelb.edu.au.

I. Introduction

Ever since the Chicago School critiques[1] economists have tended to view with scepticism the idea that integration can be used to extend, or "leverage," market power across related markets. They argued than an upstream monopolist can engender and appropriate monopoly profits from a downstream segment without resorting to integration. However, at a regulatory level, concerns remain. Competition authorities have long been concerned that vertically integrated owners of essential facilities (for example, energy distribution, transportation or telecommunications networks) can secure monopoly pricing to final services in ways that would not be available if they did not own downstream assets.[2]

For this reason, recent research into strategic motives for vertical integration has concentrated on contractual problems that may make the realization of industry monopoly outcomes difficult and may be overcome by ownership. Rey and Tirole (1996) provide the representative model of that literature.[3] They demonstrate that the possibility of secret discounting constrains the supply contracts an upstream monopolist can sign with downstream firms; yielding a competitive outcome. Integration resolves such difficulties by giving the monopolist a direct interest in downstream profits, thereby preventing it from engaging in ex post opportunism.

This paper provides a model that demonstrates how vertical integration can be used to leverage market power that is complementary to the existing literature. It is

---

[1] Most famously, Posner (1976) and Bork (1978).
[2] See, for example, the discussions in Armstrong, Cowan and Vickers (1994) and Rey and Tirole (1996).
[3] Other examples include Hart and Tirole (1990), O'Brien and Shaffer (1992) and McAfee and Schwartz

constructed in a setting where the contracting difficulties studied in the existing literature do not arise.[4] Instead, we emphasize an upstream monopolist's incentives to manipulate the outcome of negotiations with downstream firms and how this generates a strategic motive for vertical integration. Our principal departure from the previous literature – that assumes the monopolist can make take-it-or-leave-it offers to downstream firms – is to provide a model where downstream firms cannot be easily replaced in the short-run and so have some bargaining power. This gives the monopolist an incentive to take actions that diminish the bargaining position of downstream firms so that they can appropriate a greater proportion of industry profits.

Specifically, the monopolist has an incentive to distort downstream industry structure (away from its monopoly level) and to supply more firms. This arises because, in our model, opportunities for renegotiating supply agreements arise more frequently than opportunities for downstream firms to enter – freely or at the behest of the monopolist.[5] Expanding the number of downstream firms reduces the hold-up power of any one in supply negotiations, giving the monopolist greater revenues. However, this expansion involves higher fixed costs downstream. As industry capacity is greater, ex post profit maximization, therefore, involves greater production and lower industry profits than would be case under monopoly.[6]

(1994). See Segal (1999) for a synthesis of these models.

[4] Specifically, we assume that downstream firms are capacity constrained, thereby removing the opportunity for secret discounting to impose contractual externalities.

[5] In effect, we suggest that choices regarding market structure and integration are more difficult to change than contracting choices; a framework that is similar to developments in the theory of the firm. See Grossman and Hart (1986) and Hart and Moore (1990).

[6] Chemla (2000) also provides a model (developed contemporaneously with ours) where downstream firms have some bargaining power; providing an incentive for the monopolist to avoid dealing with one or a few downstream firms. His 'negotiation' effect is similar to that identified in this paper but the bargaining model is more stylized with the division of rents between the monopolist and downstream firms parameterized. As such, that model cannot be used to consider the extent of integration and other issues we explore below. Chemla does, however, nest the secret discounting concerns in his model (where

Vertical integration has a powerful role to play in this environment. Because other inputs are assumed to be non-specific in this model, asset ownership is the source of hold-up. Integration provides the monopolist with control over its own downstream units, and assures it of some production even if independent firms refuse to deal. Hence, integration increases the monopolist's outside option in ex post price negotiations leading to higher supply prices. More importantly, in so doing, integration reduces the incentive of the monopolist to grant access to a larger number of downstream firms, thereby reducing industry output and raising final good prices. If there were no additional costs associated with integration, the monopolist would choose to integrate completely. When integration is only mildly costly, the outcome is partial integration, as the monopolist integrates some of the downstream firms to depress the bargaining power of remaining firms.

The outline for the paper is as follows. In section II, we set up the model structure focussing on the case of an upstream monopolist selling to a number of downstream firms. To determine prices ex post, we model the multi-agent bargaining game using the framework of Stole and Zwiebel (1996a, 1996b) which applies naturally in the vertical supply environment we consider here. In section III, we consider bargaining outcomes. In this paper, we assume that downstream firms are capacity constrained. This means that, if a breakdown in negotiations led a downstream firm to exit production, the upstream monopolist could not substitute for the lost production using remaining downstream firms. In Section IV, we demonstrate that, without integration, industry output exceeds its monopoly level and that integration results in a reversion towards monopoly output. To examine the effect of horizontal competition, in Section V, we consider briefly the case

---

downstream firms are not capacity constrained) and demonstrates that this gives rise to a separate motive where the downstream firms attached to one upstream supplier (as part of a network) compete with the downstream firms of a rival upstream supplier. Industry output is higher (under non-integration and integration), integration incentives are diminished, and the integration decisions of upstream firms are strategic substitutes (i.e., integration helps rival upstream suppliers). A final section concludes and offers directions for future research.

II. Basic Set-Up

We consider the case of an upstream monopolist who sells a necessary input to downstream producers.[7] There are N downstream producers, I of whom may be integrated with the monopolist. For simplicity, we assume that the monopolist faces no production costs and produces an input a unit of which can be converted by downstream firms into a unit of the final good. The goods produced downstream are perfect substitutes in the eyes of consumers, so that if downstream firms produce a total quantity, Q, this results in a market price of $P(Q)$.

Downstream firms have limited capacity and can produce at most one unit of the final good. There are no additional marginal costs associated with producing that unit other than those arising from payments upstream. There are, however, fixed costs, θ, incurred by each downstream firm. These fixed costs represent the opportunity cost for a downstream firm in committing their assets to the industry. These assumptions on

for integration.

[7] Our model could equally be applied to the situation where a single downstream firm (a monopsonist bargained with a number of upstream suppliers and considered integrating with them. The basic effects and incentives we consider here would apply in this case; in contrast to other models of vertical integration (e.g., Rey and Tirole, 1996) where the vertical 'location' of the monopoly bottleneck matters.

downstream production technology are made so as to isolate the strategic effect of vertical integration that is emphasized in this paper. We will consider the implications of relaxing these assumptions, although it is important to note that our qualitative results will remain unchanged.

The focus in this paper is on the strategic effects of vertical integration. To isolate such effects, we assume away efficiency reasons for integration, by supposing it to be mildly inefficient. Then the monopolist will only integrate for strategic reasons. A vertically integrated downstream firm is assumed to face an additional fixed cost, $\Delta > 0$, but is otherwise as efficient as non-integrated firms. While we treat this cost as exogenous here, it would be possible to interpret it as indicative of the notion that firms' incentives to undertake effort — or non-contractible investment more generally — are diminished by integration (as in Williamson, 1985). Alternatively, the appendix provides a simple demonstration of how this cost could arise as a result of internal bargaining within integrated firms. To emphasize, the role of this assumption is to provide a minimal specification that rules out integration for anything other than strategic reasons.

Let $\pi(N) = P(N) - \theta$ be the profit of a non-integrated downstream firm gross of any upstream input supply price; with $\pi(N) - \Delta$ the profits of an integrated downstream unit. Industry profit is $\Pi(N) - \Delta I = N\pi(N) - \Delta I$. A key benchmark will be the number of downstream firms, N^m, that maximizes industry profit. Notice that this monopoly outcome cannot be achieved by complete integration because of the costs associated with integration.

An important feature of this paper is the bargaining game between the monopolist and each downstream firm. In particular, we do not simply assume that the monopolist can make take-it-or-leave-it offers to designated firms. Instead, it must negotiate with each firm individually and faces prohibitively large costs in expanding the number of firms it negotiates with ex post. Our conception here is of an environment in which downstream firms enter into production far less frequently than prices are renegotiated (as a simplification, they are assumed only to enter once). Therefore, given an initial selection of downstream firms, input supply terms can be renegotiated at any time.

Specifically, the bargaining game has the following stages:

(i) The monopolist designates *N* potential firms that it will supply and integrates *I* of them.

(ii) The monopolist engages each independent firm in one-on-one negotiations over the input supply contract. This bargaining takes the non-binding form as specified by Stole and Zwiebel (1996a, 1996b).

(iii) Production and downstream competition begin.

The rationale behind stage 1 is as follows: while the monopolist has some choice over the pool of potential firms at the beginning of the game, it cannot contract these choices at stage 1 nor expand them at stage 2 — although, as we will demonstrate, it can reduce this pool. Essentially, it cannot easily replace the initial set of firms (including expanding the number it has integrated). This gives those firms some hold-up power. Nonetheless, our stage 1 specification effectively assumes that bringing productive assets into the industry at that stage is not costly. This simplification helps us to emphasize the important role played by difficulties in expanding the number of downstream firms ex post.[8]

Stage 3 bargaining over input prices takes place in a similar manner to the wage bargaining modelled by Stole and Zwiebel (1996a, 1996b), hereafter SZ. The monopolist and the firm bargain *bilaterally* over input prices in sequential transactions. Long-term price and supply agreements are not possible. So we look for solutions that are *stable* in

[8] Below we will identify the implications for our results when productive assets are costly to bring into the industry.

the sense that there is no desire on the part of either the monopolist or the individual firm to exercise their respective abilities to renegotiate supply contract terms. While it is possible for different firms to pay different prices, given the symmetry between them, this does not occur in equilibrium.

III. Bargaining Outcomes

One advantage of assuming that downstream firms produce at most one unit of output is that it is very close to the SZ context of a firm bargaining with many workers, who can produce a unit of labor or exit negotiations. In their model, negotiations are sequential and bilateral; as a consequence, the solution is not necessarily within the bargaining core. They assume that the cost of bargaining is that negotiations might exogenously break down with some infinitesimal probability. Binmore, Rubinstein and Wolinsky (1986) demonstrated that two agents, bargaining under an infinitesimal risk of breakdown, agree on the Nash outcome; namely, that each agent receives the same benefit from agreement (where benefit is measured as the gain over what the agent would earn in the event of a breakdown in bargaining). Negotiations can be reopened at any time, and are reopened if any agent is not receiving their Nash outcome.[9]

As in any model of bargaining, an important driving force is the outside options of each negotiating agent. For individual downstream firms, if they fail to secure supply of the input, they are able to recover their fixed costs, θ. For the monopolist, when negotiations with an individual firm break down, in addition to not being able to supply

[9] In point of fact, SZ restrict the opportunities for renegotiation in the bargaining process to show that their results require very limited renegotiation. The results hold when more opportunities for renegotiation exist.

that firm, it must also renegotiate pricing arrangements with other firms. So a breakdown involves an inframarginal effect, altering the monopolist's outside option.

To see this, consider the monopolist negotiating with a single firm only over the supply price for a unit of the input, $\tilde{p}(1)$. Suppose that it has no integrated units. If negotiations break down, the monopolist receives 0, while the firm avoids costs θ. If supply takes place, the downstream firm earns revenues of $\pi(1) = P(1) - \theta$. Splitting the surplus (i.e., equating upstream profits of $\tilde{p}(1)$ to downstream profits of $\pi(1) - \tilde{p}(1)$) means that $\tilde{p}(1) = \frac{1}{2}\pi(1)$.

In contrast, consider the case when the monopolist supplies two firms. Each firm bargains *bilaterally* with the monopolist. Nash bargaining implies that each firm splits with the monopolist the surplus created by the relationship -- but what is that surplus? Part of the benefit to the monopolist of supplying a second firm is that it reduces the bargaining power of the first firm. And if negotiations break down with one of the two firms, the monopolist must renegotiate with the remaining firm, who then receives $\pi(1)$ - $\tilde{p}(1)$, as above. Thus, we obtain the price $\tilde{p}(2)$ paid by each of the two firms by equating the benefit to the monopolist and to a firm:

$$\begin{gathered}\text{Benefits to Monopolist} = \text{Benefits to a Firm} \\ 2\tilde{p}(2)\text{-}\tilde{p}(1) = \pi(2)\text{-}\tilde{p}(2)\end{gathered}.$$

For the case of N downstream firms, the same recursive structure applies: one benefit of supplying the N^{th} additional firm is the amount by which it increases the payments from the remaining (N - 1) firms. Let $\tilde{p}(N)$ be the negotiated price when the monopolist deals with N firms.

Benefits to Monopolist = Benefits to a Firm

$$N\tilde{p}(N)-(N-1)\tilde{p}(N-1)=\pi(N)-\tilde{p}(N)$$
$$\Rightarrow \tilde{p}(N)=\tfrac{N-1}{N+1}\tilde{p}(N-1)+\tfrac{1}{N+1}\pi(N)$$
$$=\tfrac{N-1}{N+1}\tfrac{N-2}{N}\tilde{p}(N-2)+\tfrac{1}{N(N+1)}\big((N-1)\pi(N-1)+N\pi(N)\big)$$
$$=\dots$$
$$=\tfrac{1}{N(N+1)}\sum_{i=0}^{N}i\pi(i)$$
$$=\tfrac{1}{N(N+1)}\sum_{i=0}^{N}\Pi(i)$$

Therefore, the revenue accruing to the monopolist becomes:

$$N\tilde{p}(N)=\tfrac{1}{N+1}\sum_{i=0}^{N}\Pi(i)\,.$$

SZ demonstrate the robustness of results based on their bargaining mechanisms by considering the outcomes in alternative environments. For example, they allow for asymmetric ex post bargaining power, and heterogeneous agents. They also demonstrate that this bargaining mechanism yields payoffs for agents that are their Shapley values in the corresponding cooperative game. Shapley values have long held intuitive appeal in normative work on bargaining.

It is important to note that the qualitative result is not driven by any sort of "small numbers" property. Very similar results are derived for the case in which there are Nh firms, each producing a quantity h of the final good for a cost θh. In the extreme (as h approaches 0), one can derive the results for infinitesimally small firms, that is, firms that lies on a continuum $[0,N]$ and produce a total of N units. In this case, the monopolist's profits become:[10]

---

[10] To see how this is derived, note that if we equate the Benefits to the Monopolist with the Benefits to the Nh^{th} firm, then

$$N\tilde{p}(N)-(N-h)\tilde{p}(N-h)=\big(\pi(N)-\tilde{p}(N)\big)h$$

This implies that,

$$\pi(N)-\tilde{p}(N)=\lim_{h\to 0}\tfrac{N\tilde{p}(N)-(N-h)\tilde{p}(N-h)}{h}=\tfrac{d}{dN}\big(N\tilde{p}(N)\big)$$

and the differential equation is solved by the stated formula. A formal proof of this is available from the authors.

$$N\tilde{p}(N) = \tfrac{1}{N}\int_0^N \Pi(i)di .$$

In the current capacity-constrained example, the monopolist's profit is

$$\tfrac{1}{N}\int_0^N \left(P(i) - \theta\right) idi ,$$

the average of industry profit (as it is in the discrete case).

This result is possible because bargaining power rests on inframarginal effects (the change in the supply price) rather than the marginal effect of any individual firm. Hence, downstream firms have some hold-up power even in the continuous case. For clarity of presentation, we will assume that the pool of downstream firms is a continuum for the remainder of this paper.[11]

IV. Market Structure and Integration

We now turn to consider the monopolist's choices of how many firms it will supply and how much downstream capacity it will integrate. As we will demonstrate, these choices impact on the ex post bargaining outcomes and the monopolist determines downstream market structure with the intention of manipulating this outcome. We deal with the case where the monopolist cannot integrate any downstream firms before turning to its integration incentives.

Monopolist's Output Choice With No Integration

In its output choice, the monopolist produces up to the point at which downstream firms do not appropriate any industry rents. To see this, let $\tilde{N}$ be the number of firms (or,

[11] All of the qualitative results below hold for the discrete case.

alternatively, the output level) that maximizes the monopolist's payoff, denoted $v(N) = N\tilde{p}(N)$. This yields the first order condition:

$$\tfrac{1}{N}\Pi(N) - \tfrac{1}{N^2}\int_0^N \Pi(i)di = \tfrac{1}{N}\Pi(N) - \tilde{p}(N) = 0$$

or $\tilde{p}(\tilde{N}) = \pi(\tilde{N})$. The profit earned by the monopolist is $v(\tilde{N}) = \Pi(\tilde{N})$; that is, it appropriates all downstream profits. The monopolist, anticipating SZ bargaining, differs from the take-it-or-leave-it monopolist by maximizing an "average" industry profit rather than profit per se. So the monopolist produces beyond the point at which marginal profit, $\Pi'(N)$, equals zero. This outcome is depicted in Figure One.[12]

Proposition 1. *Let $\tilde{N}$ be the monopolist's optimal choice of N. Then, $\tilde{N} \geq N^m$.*

> PROOF: If $\tilde{N} = N^m$, we would have $v(N^m) = \Pi(N^m)$. However the concavity of industry profits means that $\Pi(N)$ is strictly increasing until N^m. Therefore, $\Pi(N) > \tfrac{1}{N}\int_0^N \Pi(i)di = v(N)$, for all $N \leq N^m$, a contradiction. It must be the case that $\tilde{N}$ exceeds N^m.

In this environment, the monopolist is only partly able to extend its monopoly power downstream. At the monopoly output level, N^m, the monopolist can raise its own profit by adding an additional firm. Production, therefore, takes place at a level above monopoly levels for the industry. This is because the monopolist expands the number of downstream firms in order to depress the bargaining power of downstream firms as a whole.

[12] Note that this solution potentially involves asymmetric production – although not profits – between downstream firms. That is, if $P'(\tilde{N})\tilde{N} - P(\tilde{N}) < 0$, then it is optimal for the monopolist to contract with all firms but with only some of the firms producing output. If the idleness of other firms is not observable, this potentially makes downstream firms contracted for positive output vulnerable to the ex post opportunism of Rey and Tirole (1996). If idleness is observable, then in the extensive form game of Stole and Zwiebel (1996b), the monopolist would negotiate for idle capacity with firms first in the sequence of negotiations with positive output for those that remain. Thus, there is a potential for idle capacity in this model (regardless of the level of integration) but the results below do, in that case, depend on the observability of idleness.

Example 1. *Suppose that P(Q) = A - Q and* $A > \theta \geq \frac{1}{3}A$.[13] *Then* $Q^m = \frac{1}{2}(A-\theta)$ *while* $\tilde{Q} = \frac{3}{4}(A-\theta)$ *compared with a social optimum of A - θ.*

At this point, it is worthwhile comparing this result to previous results concerning contractual incompleteness and vertical relations. In Hart and Tirole (1990), O'Brien and Shaffer (1992), McAfee and Schwartz (1994), and Rey and Tirole (1996), the upstream monopolist is forced to increase output (or lower marginal supply price) so as to convince downstream firms, concerned about post-contractual opportunism, to accept offers. In that environment, an upstream monopolist has an incentive to restrict the number of downstream firms. However, it cannot commit to so doing, i.e., it cannot sign exclusionary, or effectively exclusionary, contracts. Our model internalizes all such concerns as the number of firms supplied is public and the monopolist can choose to restrict the number of downstream firms.[14] In principle, it could commit ex ante to exclude any firm. Nonetheless, it has an incentive to expand the number of such firms so as to mitigate the hold-up power of any one. This is because the monopolist and any individual downstream firm cannot commit not to renegotiate contractual terms ex post. In effect, the monopolist is subject to ex post opportunism that it mitigates by making its input available to more firms. Thus, monopoly power is not perfectly leveraged downstream because of a lack of commitment on price as opposed to quantity.

[13] This restriction assures that some output occurs and that no capacity is idle in equilibrium (see footnote 12 above). This eliminates the situation whereby the monopolist contracts with all suppliers but does not provide the input to a portion of them, leaving them as idle capacity.

[14] For this reason, all of the results below would carry over to the case where the bottleneck monopolist was downstream and being supplied by upstream firms with unit costs θ. This stands in contrast to Rey and Tirole (1996) who distinguished between the monopoly and monopsony cases.

The Incentive to Integrate

Downstream firms have the most bargaining power when they are few in number, so that the monopolist is on the steeply rising portion of its profit function. Supplying many firms moves the monopolist to a downward-sloping portion of its profit function; at that point, the marginal productivity of each firm is negative, and the bargaining power of the first few much attenuated.

Overproduction is a particularly costly means of reducing the bargaining power of downstream firms. In contrast, if the monopolist were to have some integrated downstream units, *thereby avoiding hold-up issues associated with renegotiation with those units*, it would never face a situation (after multiple breakdowns in negotiations) of having to negotiate with just a few firms on a steep portion of its profit function. In effect, by acquiring units, the monopolist ensures some demand that independents can never threaten to remove.

To see this, suppose that *I* firms are integrated. We can derive the price paid by the (*N* - *I*) independent firms, $\tilde{p}(N,I)$:[15]

$$\tilde{p}(N,I) = \frac{1}{(N-I)^2}\int_I^N i\pi(i)di - \frac{I}{N-I}\pi(N).$$

The monopolist's profits, denoted by $v(N,I)$, are now its revenues as a producer of *I* units, and the revenue it earns from (*N* – *I*) downstream firms:

---

[15] Again, moving from the discrete case, the benefits to the monopolist from the *Nh*[th] firm is the change in price received from independent suppliers plus the change in final price received by the *Ih* integrated units:

$$\left((N-I)\tilde{p}(N,I) + I(\pi(N)-\Delta)\right) - \left((N-I-h)\tilde{p}(N-h,I) + I(\pi(N-h)-\Delta)\right).$$

In one-on-one bargaining, this is equated to the benefit received by the *Nh*[th] firm: $\left(\pi(N) - \tilde{p}(N,I)\right)h$. This implies that:

$$\pi(N) - \tilde{p}(N,I) = \lim_{h\to 0}\frac{(N-I)\tilde{p}(N,I)-(N-I-h)\tilde{p}(N-h,I)}{h} + \lim_{h\to 0}\frac{I\left(\pi(N)-\pi(N-h)\right)}{h} = \frac{d}{dN}\left(N\tilde{p}(N,I) + I\pi(N)\right).$$

Solving this differential equation and re-arranging gives the price in the text.

$$v(N,I)=(N-I)\tilde{p}(N,I)+I\left(\pi(N)-\Delta\right)$$
$$=\frac{1}{N-I}\int_{I}^{N}\Pi(i)di-\Delta I \quad .$$

Note that, after integration, the monopolist's profits are the average from I to N, rather than from 0 to N.

Intuitively, one would expect that the profitability of integration is higher, the lower are the costs of integration, Δ. The following proposition confirms this.

Proposition 2. *Let* $\tilde{N}(I)$ *be the number of downstream firms the monopolist will trade with and* $\tilde{p}(\tilde{N}(I),I)$ *the resulting prices. The monopolist's integration choice is as follows:*

(i) *for* $\Delta=0$*,* $\tilde{I}=\tilde{N}(=N^{m})$

(ii) *for* $0<\Delta<\tilde{p}(\tilde{N}(0),0)$*,* $0<\tilde{I}<\tilde{N}$

(iii) *for* $\Delta\geq\tilde{p}(\tilde{N}(0),0)$*,* $\tilde{I}=0$ *(and* $\tilde{N}=\tilde{N}(0)$*).*

PROOF: Note that the first order condition for the choice for N, given any $I\leq N$, implies that:

$$\Pi(\tilde{N})=\tfrac{1}{\tilde{N}-I}\int_{I}^{\tilde{N}}\Pi(i)di\Leftrightarrow\tilde{p}(\tilde{N})=\pi(\tilde{N})\,.$$

Using this fact, we can see that:

$$\frac{dv(N,I)}{dI}=\frac{\partial v(N,I)}{\partial I}=-\frac{\Pi(I)}{N-I}+\frac{1}{(N-I)^{2}}\int_{I}^{N}\Pi(i)di-\Delta=0$$
$$\Rightarrow\frac{\Pi(\tilde{N})-\Pi(\tilde{I})}{\tilde{N}-\tilde{I}}=\Delta$$

Note that because Π is concave, v is concave in I:

$$\frac{d^{2}v(N,I)}{dI^{2}}=\frac{1}{N-I}\left[\frac{\Pi(N)-\Pi(I)}{N-I}-\Pi'(I)\right]<0\,.$$

Therefore the first-order condition implies that $\tilde{I}=\tilde{N}=N^{m}$ when Δ = 0; that $0<\tilde{I}<\tilde{N}$ when Δ is small; and that $\tilde{I}=0$ when $\Delta\geq\tilde{p}(\tilde{N}(0),0)$ (because in that case $dv/dI<0$ for all I).

The proposition shows that the monopolist chooses partial integration when the costs of integration (Δ) are small, and full integration when there are no such costs. When these costs are zero, complete integration is worthwhile as the monopolist does not face a hold-up problem. It does not need to expand production to reduce the bargaining power of independent firms. However, when Δ exceeds average profits without integration, it is never worthwhile to integrate. This is because integration recovers the hold-up value of an individual firm. At the optimal *N*, this is simply average profits.

These results can be illustrated using our running example.

Example 2. *Returning to our previous linear demand example, it is easy to show that* $\tilde{N} = \min\left[\frac{A-\theta+2\Delta}{2}, \frac{3(A-\theta)}{4}\right]$ *and* $\tilde{I} = \max\left[\frac{A-\theta-4\Delta}{2}, 0\right]$. *Note that as* Δ *goes to zero, all downstream firms are integrated, while for* Δ *too high* ($\geq \frac{A-\theta}{4}$)*, no integration occurs.*

The following proposition characterizes the equilibrium in the interesting case; that of small integration costs, Δ. Integration raises the equilibrium price at any *N*, by reducing the downstream firms' bargaining power. As a result, the monopolist has less incentive to distort downstream supply towards excess supply, and the equilibrium output is lower. Even under partial integration, the monopolist extracts the entire surplus at the equilibrium number of firms, and that surplus is now higher.

Proposition 3. *For an intermediate value of* Δ *(if* $0 < \Delta < \tilde{p}(\tilde{N}(0), 0)$*):*

(i) $\tilde{p}(N, I) > \tilde{p}(N, 0), \forall N, \forall I < N$;

(ii) $N^m < \tilde{N}(\tilde{I}) < \tilde{N}(0)$;

(iii) $\tilde{p}(\tilde{N}(\tilde{I}), \tilde{I}) = \pi(\tilde{N}(\tilde{I})) > \pi(\tilde{N}(0)) = \tilde{p}(\tilde{N}(0), 0)$.

PROOF: (i) Integration has the following effect on the negotiated price:

$$\frac{\partial \tilde{p}(N, I)}{\partial I} = \frac{2}{(N-I)^2}\left[\frac{1}{(N-I)}\int_I^N i\pi(i)di - \frac{\Pi(N) - \Pi(I)}{2}\right]$$

Given the concavity of Π, the average of its value from I to N (the first term in the brackets) is always greater than the average of its value at I and N (the second term in brackets).[16]

(ii) For intermediate levels of Δ, the number of firms chosen exceeds the take-it-or-leave-it number, N^m (Proposition 1). Note that around the chosen level of N, the mixed partial derivative of v with respect to I and N is negative. That is,

$$\frac{\partial^2 v}{\partial I \partial N} = -\frac{2}{(N-I)^2}\left(\frac{1}{N-I}\int_I^N \Pi(i)di - \frac{\Pi(N)+\Pi(I)}{2}\right) = -\frac{\partial p(N,I)}{\partial I},$$

which is negative for all $I < \tilde{I}$. Hence, starting from I = 0, as I increases, the marginal return to N falls. Hence, $\tilde{N}(I) \leq \tilde{N}(0), \forall I < \tilde{I}$.

(iii) Recall from the proof of Proposition 2 that at the optimal $\tilde{N}$, $\tilde{p}(\tilde{N}) = \pi(\tilde{N})$. Therefore if $\tilde{N}(I) \leq \tilde{N}(0)$, $\tilde{p}(\tilde{N}(\tilde{I}),\tilde{I}) = \pi(\tilde{N}(\tilde{I})) > \pi(\tilde{N}(0)) = \tilde{p}(\tilde{N}(0),0)$.

Proposition 3 demonstrates that, by integrating, the monopolist can credibly reduce the pool of independents it sells to. Integrating more firms reduces the number of independents supplied to for two reasons. First, the integrated capacity substitutes partly for that of independents. Second, and most importantly, the presence of integrated units diminishes the bargaining position of independents. $\tilde{p}(N,I)$ is increasing in I. This effect is so strong that over the range where integration is profitable (i.e., where the cost of integration is not too high), the number of independents falls by more than the increase in

[16] If Π is concave, any two points I and N must satisfy

$$\Pi(\lambda N + (1-\lambda)I) \geq \lambda\Pi(N) + (1-\lambda)\Pi(I), \forall \lambda \in [0,1].$$

Summing over all possible values of λ from 0 to 1 yields the following inequality:

$$\int_0^1 \Pi(\lambda N + (1-\lambda)I)d\lambda \geq \int_0^1 \lambda\Pi(N) + (1-\lambda)\Pi(I)d\lambda$$

Then a change of variables to $i = \lambda N + (1-\lambda)I$ yields:

$$\frac{1}{N-I}\int_I^N \Pi(i)di \geq \underbrace{\frac{1}{N-I}\int_I^N \left[\Pi(I) + \frac{(i-I)}{N-I}\big(\Pi(N)-\Pi(I)\big)\right]di}_{\frac{1}{2}(\Pi(N)+\Pi(I))}$$

integrated firms, and therefore the *total* number of downstream firms falls. Both of these effects are depicted in Figure Two.

It is worth emphasizing that the basic strategic effect here, that integration allows the monopolist to both improve its bargaining power and commit to a more concentrated market structure downstream, would be preserved even if downstream firms were not capacity constrained and could produce many units but otherwise had quasi-convex costs.[17] In this situation, however, the relative bargaining position of downstream firms would be worse because, in the event of a disagreement, the monopolist could expand its supply to remaining downstream firms. In addition, if integrated firms were relatively less efficient at the margin, then with variable quantities, integrated firms' production could be limited in equilibrium with the monopolist using the threat of expanding their output only in the event of a disagreement with independent firms.[18] However, relaxing the assumption of variable quantities would re-introduce the contracting externalities emphasized by Rey and Tirole (1996); complicating the analysis by introducing additional strategic motives for integration, while otherwise preserving the strategic effect we have identified here.[19]

[17] The effects of changing the assumption that it was not costly to bring productive assets into the industry (in the long-term) are more complex. Suppose, for example, that dealing with more downstream units required the monopolist to invest in dedicated facilities or interfaces for each one (as in Chemla, 2000). This sunk cost would not be recovered in subsequent negotiations and hence, would diminish the monopolist's incentive towards over-production. Otherwise the effects we address here would be unchanged. On the other hand, if the downstream firms had to sink costs in order to enter production, they would face some hold-up by the monopolist and the monopolist could be constrained in its ability to attract assets to the industry; also mitigating over-production. Moreover, integration could exacerbate this problem. Indeed, it may be better for the monopolist to commit not to integrate in these circumstances. Given the complexity of such effects, we leave these issues for future research.

[18] Indeed, if production by integrated firms involved higher marginal cost compared with independent firms, one could show that the monopolist would find it optimal to integrate some firms, commit their assets to the industry, but otherwise not use them to produce in equilibrium. Hence, integrated firms would serve merely as idle capacity to improve the monopolist's bargaining position.

[19] As mentioned earlier, Chemla (2000) does consider a Rey and Tirole type effect as well as a negotiation effect similar to that in this paper. Our framework here provides a more complete specification of the nature of multilateral bargaining and hence, allows a consideration of the extent of integration as well as issues of network competition that are explored below.

V. Network Duopoly

Next we turn to consider the incentives for integration by upstream duopolists. In so doing, we suppose that competition takes place between complete networks, or in other words, that downstream firms are specific to a particular upstream firm. This allows us to focus on the impact of downstream competition on upstream competition. There are many industry examples of this form of systems competition. For example, many mobile phone networks have independent service providers that retail their products and cannot easily switch to other network operators.

In this environment, the assumed game becomes:

(i) Each upstream firm, j designates N_j potential downstream firms that it will deal with and integrates I_j of them.

(ii) The monopsonist and each independent firm engage in one-on-one negotiations over input supply terms. This bargaining is of the SZ type.

(iii) Production and downstream competition begin.

Once again we assume that upstream firms have only one opportunity to integrate downstream but that price can be renegotiated thereafter.

The final price earned in one network is now a function of own supply and supply from its competitor, $P(N_j, N_{-j})$. The payoff to a duopolist j given the number of downstream firms tied to the other duopolist, N_{-j}, is:

$$v(N_j, I_j; N_{-j}) = \frac{1}{N_j - I_j} \int_{I_j}^{N_j} i\left(P(i, N_{-j}) - \theta\right) di - \Delta I_j$$

where $\Pi(N_j, N_{-j})$ has been spelt out explicitly. Notice that the choices of the other duopolist interact with the duopolist's payoff only through downstream demand. In particular, as N_{-j} rises, it reduces the marginal incentive to expand output and the marginal return to integration:

$$\frac{\partial^2 v}{\partial N_j \partial N_{-j}} = \frac{P_2(N_j, N_{-j})N_j}{N_j - I_j} - \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(i, N_{-j})di \leq 0$$

$$\frac{\partial^2 v}{\partial I_j \partial N_{-j}} = -\frac{P_2(I_j, N_{-j})I_j}{N_j - I_j} + \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(i, N_{-j})di \leq 0$$

where the inequality follows if it is assumed that $P_{12} \leq 0$.[20]

Thus, the converse holds true for an increase in I_{-j}, which will reduce N_{-j}, as we have seen. A competitor's decision to integrate increases the returns to expanding output and integrating. This implies that each upstream firms' choice of integration are strategic complements. Fundamentally, the reason is that a competitor who integrates reduces its

[20] The proof of these inequalities are as follows. For the first inequality,

$$\begin{aligned}\frac{\partial^2 v}{\partial N_j \partial N_{-j}} &= \frac{P_2(N_j, N_{-j})N_j}{N_j - I_j} - \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(i, N_{-j})di \\ &\leq \frac{P_2(N_j, N_{-j})N_j}{N_j - I_j} - \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(N_j, N_{-j})di \text{ as } P_{12} \leq 0 \\ &= \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} N_j P_2(N_j, N_{-j})di - \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(N_j, N_{-j})di \\ &= \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} (N_j - i)P_2(N_j, N_{-j})di \leq 0\end{aligned}$$

And for the second inequality,

output, leaving the firm with higher effective demand and higher profits. But at the same time as profits increase, so does the bargaining power of downstream firms, and therefore the distortion in N and I increases as well.

Example 3. *Returning to our example, once again assume a homogenous goods industry with linear demand. With SZ bargaining, an upstream firm and its downstream retailers agree to terms that maximize their joint profits given the decision of the other upstream firm. In equilibrium, an upstream firm will not designate a downstream firm it does not intend to utilize. Hence, one can conceive of upstream firms in quantity competition with one another. Given this, in equilibrium,* $N_j = \min\left[\frac{A-\theta+2\Delta}{3}, \frac{3(A-\theta)}{7}\right]$ *and* $I_j = \max\left[0, \frac{A-\theta-7\Delta}{3}\right]$*. Industry output is, therefore,* $Q = \min\left[\frac{2(A-\theta+2\Delta)}{3}, \frac{6(A-\theta)}{7}\right]$ *compared with* $\frac{2(A-\theta)}{3}$ *under Cournot duopoly when upstream firms have all the bargaining power. Compared with the monopoly case, a smaller proportion of output produced is produced by integrated firms and the critical cost threshold of* Δ *that leads to no integration is lower.*

Example 4. *We can extend the above example to the case of* $m > 2$ *upstream firms. In this case, in equilibrium,* $N_j = \min\left[\frac{A-\theta+2\Delta}{1+m}, \frac{3(A-\theta)}{1+3m}\right]$ *and* $I_j = \max\left[0, \frac{A-\theta-(1+3m)\Delta}{1+m}\right]$*. Industry output is, therefore,* $Q = \min\left[\frac{m(A-\theta+2\Delta)}{1+m}, \frac{3m(A-\theta)}{1+3m}\right]$ *compared with* $\frac{2(A-\theta)}{1+m}$ *under Cournot duopoly when upstream firms have all the bargaining power. Note that as m gets large, outcomes become perfectly competitive. More importantly, however, for strictly positive* Δ*, no integration is chosen when m rises above a finite number* $\left(\frac{A-\theta-\Delta}{3}\right)$.

In summary, our discussion of duopoly here demonstrates the effect of indirect competition upstream (namely, when its effect is felt only through downstream competition). Integration by one upstream firm has a positive externality on the other.

$$\frac{\partial^2 v}{\partial I_j \partial N_{-j}} = \frac{-P_2(I_j, N_{-j})N_j}{N_j - I_j} + \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(i, N_{-j})di$$

$$= \frac{-1}{(N_j - I_j)^2}\int_{I_j}^{N_j} I_j P_2(I_j, N_{-j})di + \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(i, N_{-j})di$$

$$\leq \frac{-1}{(N_j - I_j)^2}\int_{I_j}^{N_j} I_j P_2(i, N_{-j})di + \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} iP_2(i, N_{-j})di \text{ as } P_{12} \leq 0$$

$$\leq \frac{1}{(N_j - I_j)^2}\int_{I_j}^{N_j} (i - I_j)P_2(i, N_{-j})di \leq 0$$

Given the (social) inefficiency of integration, competition fails to restrict the otherwise socially harmful incentive to integrate.[21]

VII. Conclusions and Directions for Future Research

This paper's contribution is to provide a leverage-based rationale for vertical integration that arises precisely because the monopolist does not have all the ex post bargaining power as downstream entry is restricted in the short-run. The monopolist has market power, however, and can choose to limit supply to downstream firms in order to raise price. This choice is not contractible and any rents earned are subject to hold-up by those downstream firms. By supplying more of them, the monopolist can reduce the bargaining power of those firms. This, however, results in overcapitalization and too much output downstream. Integration, by changing the monopolist's outside options, raises the return to exercising its market power by limiting supply. Hence, even if technically inefficient, vertical integration can be a profitable strategy for the monopolist to leverage its market power downstream.

This model of vertical integration sits well with the empirical literature. One prediction of the model is that the number of downstream firms is fewer in a market with some vertical integration compared to a market with complete separation. In studies of the U.S. cable industry (where the bottleneck is downstream), Waterman and Weiss (1994) and Chipty (2001) demonstrate that the number of channels on local networks that are owned by channel providers is less than on independently owned networks. Scott-Morton and Zettelmeyer (2000) and Chitagunta, Bonfrer and Song (2000) find that

[21] We leave for later work the case of duopolists in direct competition for downstream suppliers.

supermarket chains develop ‘store brands’ partially to improve their bargaining position with respect to independent suppliers. Finally, de Fontenay and Gans (1999) found that monopsony sugar mills in Honduras bought up a number of their supplying farms when a new law permitted integration. Integration significantly reduced the price paid to remaining independent farms.

Our approach holds promise for re-considering other motives for integration besides monopoly leverage. The theory of vertical foreclosure, for one, suggests that a supplier might integrate downstream to harm his competitors (see, among others, Ordover, Saloner and Salop, 1990, and Hart and Tirole 1990). In this paper, we examined the case of competition between two networks composed of one upstream and several downstream firms. This simple case showed that the foreclosure literature has overlooked possible positive effects of integration on competitors. Future work would involve extending our framework to consider what happens when downstream firms can switch between upstream suppliers. In particular, given the flexibility of our model in dealing with many upstream and downstream firms, we believe it well suited for this broader agenda.

Appendix: A Model of Costly Integration

Suppose that downstream production requires an asset (say, a machine) and a single worker. Suppose also that the worker is costly to replace ex post. For example, the worker may develop specialized skills that require the use of less productive replacements, training costs or search costs. Those costs are denoted by Δ.

We compare outcomes where the worker owns the asset (i.e, the downstream firm is independent) compared to where the asset is owned by the upstream monopolist who employs the worker. The downstream profit of both integrated and non-integrated downstream firms is $\pi(N)$. An integrated firm now bargains both with its workers (over a wage, $\tilde{w}(N,I)$) and with independent firms. For consistency, both types of negotiations take a Stole-Zwiebel form.

In bargaining with one of its workers, in the event of a breakdown, the integrated firm can replace that worker at a cost of Δ. Thus, splitting the difference implies that:

$$\tilde{w}(N,I) = \left(\pi(N) - \tilde{w}(N,I)I\right) + (N-I)\tilde{p}(N,I) - \left(\left(\pi(N) - \tilde{w}(N,I)I\right) + (N-I)\tilde{p}(N,I) - \Delta\right)$$

which implies that $\tilde{w}(N,I) = \Delta$.[22] On the other hand, when bargaining with an independent firm, splitting the difference implies that:

$$\begin{aligned}\pi(N) - \tilde{p}(N,I) &= \left(\pi(N) - \tilde{w}(N,I)\right)I + (N-I)\tilde{p}(N,I) - \left(\left(\pi(N) - \tilde{w}(N-1,I)\right)I + (N-I-1)\tilde{p}(N-1,I)\right) \\ &= \pi(N)I + (N-I)\tilde{p}(N,I) - \left(\pi(N-1)I + (N-I-1)\tilde{p}(N-1,I)\right)\end{aligned}$$

which yields the same outcome for $\tilde{p}(N,I)$ as in Section IV. Hence, the upstream firm incurs an additional cost of Δ for integrated units (a pure fixed cost).

Intuitively, the additional cost of integration arises because workers of integrated units have some bargaining power afforded by the costs associated with replacing them. In contrast, if those workers own downstream assets, a breakdown in negotiations causes them to take those assets from the industry without any additional replacement cost (as we assume replacement of assets by the upstream firm is not possible). Replacement costs only generate rents for the workers under integration as this is the only circumstance under which they may be credibly incurred.

[22] Workers could have a positive reservation wage but it is easy to show that the cost of integration would still be Δ in this case as the reservation wage is an opportunity cost for integrated and non-integrated firms alike.

Figure One: Choice of Independent Firms

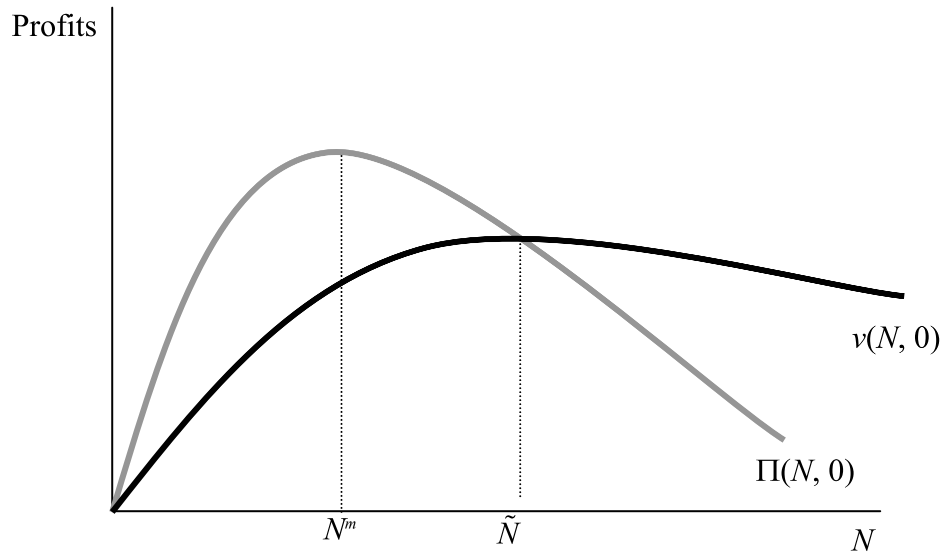
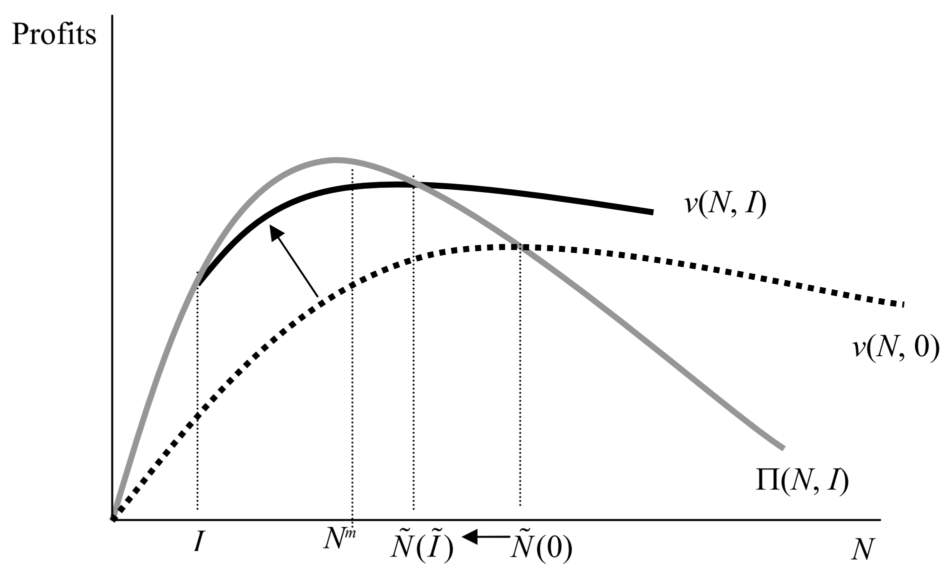


Figure Two: Effect of Integrating *I* Firms (Δ = 0)



References

Armstrong, M., S. Cowan and J. Vickers (1994), *Regulatory Reform: Economic Analysis and British Experience*, MIT Press: Cambridge (MA).

Binmore, K., A. Rubinstein and A. Wolinsky (1986), "The Nash Bargaining Solution in Economic Modelling," *RAND Journal of Economics*, 17, 176-188.

Bork, R. (1978), *The Antitrust Paradox: A Policy at War with Itself*, New York: Basic Books.

Chemla, G. (2000), "Downstream Competition, Foreclosure and Vertical Integration," *Discussion Paper*, No.2647, CEPR.

Chintagunta, P.K., A. Bonfrer and I. Song (2000), "Studying the Impact of Store Brand Entry: A Within Category Analysis," *mimeo*., Chicago.

Chipty, T. (2001), "Vertical Integration, Market Foreclosure and Consumer Welfare in the Cable Television Industry," *American Economic Review*, 91 (3), pp.428-453.

de Fontenay, C. and J.S. Gans (1999), "Vertical Integration as a Source of Bargaining Power: Application to Contract Farming," *mimeo*., UNSW.

Grossman, S. and O. Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94, 691-719.

Hart, O. and J. Moore (1990), "Property Rights and the Theory of the Firm," *Journal of Political Economy*, 98 (6), pp.1119-1158.

Hart, O. and J. Tirole (1990), "Vertical Integration and Market Foreclosure," *Brookings Papers on Economic Activity, Microeconomics*, 205-285.

McAfee, R.P. and M. Schwartz (1994), "Opportunism in Multilateral Vertical Contracting: Nondiscrimination, Exclusivity and Uniformity," *American Economic Review*, 84 (1), 210-230.

O'Brien, D.P. and G. Shaffer (1992), "Vertical Control with Bilateral Contracts," *RAND Journal of Economics*, 23 (3), 299-308.

Ordover, J., G. Saloner and S. Salop (1990), "Equilibrium Vertical Foreclosure," *American Economic Review*, 80 (1), 127-142.

Posner, R.A. (1976), *Antitrust Law: An Economic Perspective*, Chicago: University of Chicago Press.

Rey, P. and J. Tirole (1996), "A Primer on Foreclosure," *Handbook of Industrial Organization*, Vol.III, North Holland: Amsterdam (forthcoming).

Segal, I. (1999), "Contracting with Externalities," *Quarterly Journal of Economics*, 114 (2), pp.337-388.

Scott Morton, F. and F. Zettelmeyer (2000), "The Strategic Positioning of Store Brands in Retailer-Manufacturer Bargaining," *Working Paper*, No.7712, NBER.

Stole, L. and J. Zwiebel (1996a), "Intra-firm Bargaining under Non-binding Contracts," *Review of Economic Studies*, 63 (3), 375-410.

Stole, L.. and J. Zwiebel (1996b), Organizational Design and Technology Choice Under Intrafirm Bargaining," *American Economic Review*, 86, 195-222.

Tirole, J. (1988), *The Theory of Industrial Organization*, MIT Press: Cambridge (MA).

Waterman, D. and A.A. Weiss (1993), *Vertical Integration in Cable Television*, MIT Press: Cambridge.

Williamson, O.E. (1985), *The Economic Institutions of Capitalism*, Free Press: New York.