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Models of vertical market relations

Roman Inderst *

University of Frankfurt and Imperial College, University of Frankfurt, IMFS, Grüneburgplatz 1, D-60323, Frankfurt am Main, Germany

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ABSTRACT

I contrast various models of vertical contracting that view upstream interactions either through the lenses of bilateral contracting and negotiations or through the lenses of a "market interface" with uniform contractual terms. Existing models contrast starkly in their policy implications, in particular when imperfect horizontal competition, on either the upstream or the downstream level, interacts with differential buyer power. Depending on industry characteristics, different assumptions on contracting may be appropriate. Even though the quest for an all-encompassing modelling framework seems vain, existing models can still be made more flexible, so as to be of greater practical usage.

1. Introduction

The case where a vertically integrated firm serves its final customers without (much) contractual interaction with other firms is clearly more the exception than the rule. Vertical relations are ubiquitous in real-world markets. Moreover, many of the cases dealing with vertical restraints that have been investigated by antitrust authorities, e.g., on rebates, foreclosure, or buyer power, relate to such vertical relations between firms. This article provides a very selective review of some of the recent contributions to model vertical relations in markets.

The article first provides a brief introduction to the different modelling choices. While some models view vertical relations through the lenses of bilateral contracting, be it through take-it-or-leave-it offers or through a fully fledged model of negotiations, other models view vertical interactions through the lenses of a "market interface" with uniform contractual terms. Either modelling approach may be suitable for a particular application, namely a particular industry or a particular policy question. Nevertheless, *prima facie* a framework of bilateral negations should be more applicable in tight bilateral oligopolies with heterogeneous products, long-term relationships, individually negotiated contracts, and wholesale price discrimination. Instead, a market interface with uniform contractual terms should be more applicable if upstream firms are relatively homogeneous or if there is less scope for price discrimination, as downstream firms are prepared to mix and match between suppliers, and if most of the purchases are made at list prices.

A further distinction that is made in the literatures is that between linear and nonlinear contracts. When contracts are linear, the objective of rent distribution in the channel can no longer be separated from that of joint profit maximization ("channel coordination"). Models of contracting also differ in whether (and when) bilateral contracts are observed by upstream and downstream competitors. Further, they may make different assumptions on the distribution of bargaining power. In what follows, I first turn to such models of bilateral contracting, before then discussing models that use a "market interface".

2. Benchmarks of vertical contracting

I derive next "benchmarks" of vertical contracting. These make simple modelling assumptions and, thereby, allow to obtain (relatively) clear-cut results.

2.1. Bilateral monopoly

The benchmark of a bilateral monopoly is a useful first step to consider the implications of various contractual forms. Without additional complexities, such as the presence of (*ex-ante* or *interim*) private information at either the upstream or downstream level, the key distinction is between linear contracts and nonlinear contracts, such as two-part contracts, which allow for an up-front transfer, or "quantity forcing" contracts, which specify a fixed volume in exchange for a fixed payment. The key difference is that linear contracts give rise to double marginalization and prevent firms from maximizing joint profits (i.e., from achieving full "channel coordination").

2.2. Non-observable contracts to downstream competitors

Once the framework is extended, so as to allow for downstream competition, while still preserving an upstream monopoly, the

* Tel.: +49 69 798 34023; fax: +49 69 798 33912.
E-mail address: inderst@finance.uni-frankfurt.de.

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question of contract observability arises. A large literature, going back to Hart and Tirole (1990), has shown that non-observability exposes the supplier to *intrabrand* competition.[1] In each bilateral negotiation, the supplier has an incentive to secretly offer a discount, which has a negative externality on the contracts with all other buyers. This opportunism problem can become so severe that the supplier prices at marginal cost.

An important implication of the preceding observation is that, if the opportunism problem is indeed sufficiently severe, then the upstream market structure becomes largely irrelevant for competition. Through intrabrand competition the supplier becomes himself his own worst competitor, while it matters less whether other suppliers' products represent more or less attractive substitutes.

2.3. Observable, nonlinear contracts

In stark contrast, when the supplier can offer observable contracts and can commit not to secretly renegotiate, then in the simplest model (cf. the discussion below) his choice of wholesale contracts will completely eliminate intrabrand competition. Then, contracts in the upstream industry will ensure that up- and downstream firms joint profits are maximized.

Inderst and Shaffer (in press-b) analyze such a setting for the case where downstream firms differ in their competitiveness, e.g., as they have different own marginal costs, k_i. Using standard notation and restricting attention to only two downstream firms, $i=1,2$, with two-part tariff contracts the respective marginal wholesale prices, w_i, satisfy

$$w_i = \left(p_j - k_j\right)\left(-\frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i}\right) \geq 0, \tag{1}$$

where I use for simplicity that the supplier has zero own marginal cost.[2]

Condition (1) says that the wholesale price charged to firm i should equal the joint profit margin of firm j and the supplier from sales of firm j's product, $p_j - k_j$, times the diversion ratio between firm i and j's products at the equilibrium final-goods prices, where the diversion ratio is defined as the fraction of sales lost by firm i that are gained by firm j when i's final-goods price increases. Intuitively, the higher is the diversion ratio between products, and the higher is the joint profit margin of the supplier and firm j from sales of j's product, the more attractive it is for the supplier to favour firm j. (Note that under observable, nonlinear contracts, the monopolistic supplier's take-it-or-leave-it offers allow him to extract all industry profits.)

With linear demand, where the diversion ratio in Eq. (1) is constant, the wholesale price favours the firm that has a larger margin, i.e., firm $i=1$ with $w_1 < w_2$ when $p_1 - c_1 > p_2 - c_2$. When firms have different margins as they have different own marginal cost, say $k_1 < k_2$, this creates a competitive advantage for the firm that is more competitive, $i=1$. The differential wholesale prices compensate for the fact that, otherwise, the more cost-efficient firm would end up with too small a market size, given that any price cut is more expensive as it reduces the margin on a large quantity of ("infra-marginal") sales. Based on this insight, Inderst and Shaffer (in press-b) show further how a ban on wholesale price discrimination reduces welfare and consumer surplus.[3]

2.4. Linear contracting

In the simplest models, I observed that nonlinear contracts either lead to perfect monopolization or to an extreme opportunism problem. The use of linear contracts provides, instead, often for less extreme outcomes, which in turn allow to generate comparative statics results.

The analysis with linear contracts is based on Inderst and Valletti (2009, in press-b). While real-world contracts are typically more complex, most models that use either linear contracts or a particular form of nonlinear contracts, such as two-part tariff contracts, should not be read as suggesting that this particular type of contract can be identified in practice. Instead, with linear contracts, the key implication is that more preferential terms enhance a buyer's competitive position in the downstream market, leading also to lower prices and thus, ceteris paribus, higher consumer surplus. At least in the short term, this would not be the case when only the fixed part in a two-part tariff contract was adjusted, instead.

Inderst and Valletti (in press-b) show that the positive pass-on under linear contracts can generate a so called "waterbed effect". There, we stipulate that buyers have access to an alternative supply option, albeit only at cost $F>0$. The analysis allows for buyers to differ in size, either as one buyer controls more operations in separate downstream markets ("outlets") or as one buyer is more cost efficient, as in Inderst and Shaffer (in press-b). Given reduced-form profits $\pi(w_1+k_1, w_2+k_2)$ for firm $i=1$ in a symmetric downstream market, as well as a marginal price $\bar{w}$ for the alternative supply, the two *participation constraints* of a buyer $i=1$ with own marginal cost k_1 and $n \geq 1$ "outlets" and of a buyer $i=2$ with own marginal cost k_2 and a single "outlet" become

$$\begin{aligned} n\pi(k_1 + w_1, k_2 + w_2) &\geq n\pi(k_1 + \overline{w}, k_2 + w_2) - F. \\ \pi(k_2 + w_2, k_1 + w_1) &\geq \pi(k_2 + \overline{w}, k_1 + w_1) - F. \end{aligned} \tag{2}$$

Intuitively, from optimality of the supplier both constraints in Eq. (2) will bind, provided that $F>0$ is not too large and that the supplier does not have a too large cost advantage, given that his own (constant) marginal cost of production is close to $\overline{w}$. For the following argument, I set, as above, the supplier's own cost equal to $\overline{w}. = 0$.

Though the analysis in Inderst and Valletti (in press-b) is more general, suppose that downstream firms compete pairwise in a (fully covered) Hotelling market. From the binding constraints (2), one can obtain that, as the wholesale price of the larger firm $i=1$ decreases, following a reduction in k_1 or an increase in n, the wholesale price of the competing buyer, $i=2$, increases by

$$dw_2 = (-dw_1)\frac{1}{6t}\frac{w_2}{y_2},$$

with $y_2 \in (0, 1)$ denoting the respective market share and t being the "shoe leather cost". In the Hotelling model, the "waterbed effect" is thus stronger the more the negatively affected buyer is already squeezed, given that his own wholesale price, w_2, is high and his market share, y_2, is low. This is, in turn, more likely if the difference in buyer power is more pronounced, say as firm $i=1$ owns more "outlets" (higher n).

As a final remark, note that without the presence of a binding outside option, DeGraba (1990) has shown that it is the more efficient and thus ultimately larger buyer who is forced to pay a higher linear wholesale price. Intuitively, this is the case as his purchases constitute for the supplier the less elastic (derived) demand. Arguably, to study price discrimination and the implications of various policy alternatives in an industry where "strong" buyers obtain a discount, these implications make the framework of an unconstrained supplier less suitable.

[1] See Rey and Verge (2004) for a comprehensive treatment.

[2] Note that, for simplicity, I assume a "retailing technology" where the downstream firm simply passes on the supplier's product. All insights hold when the downstream technology uses fixed proportions.

[3] With linear demand, it is shown that the uniform wholesale price exceeds both discriminatory prices, which is due to the fact that the uniform price is used as a "metering" device, so as to extract more surplus from the more cost-efficient firm.

2.5. Bilateral contracting in bilateral oligopolies

Admittedly, none of the previously discussed papers allows for strategic interaction in a bilateral oligopoly. As has been recognized by several authors, the benchmark model where competing upstream firms simultaneously make take-it-or-leave-it offers to competing downstream firms, may fail to have an equilibrium in pure strategies.[4] In case it is feasible to stock more than one good, the reason for the failure of existence is that in any hypothesized equilibrium, downstream firms must be indifferent to purchasing from each supplier, and given this it is in the interest of any one supplier to deviate by slightly lowering its wholesale price. This will cause the receiving downstream firm(s) to drop one of the supplier's rivals, thereby inducing a first-order gain in its profit. In an application to market-share discount contracts, in the same spirit as the models presented so far, Inderst and Shaffer (in press-a) circumvent this problem by supposing that one upstream product is supplied competitively.[5] Hence, while in contrast to the aforementioned problems more than one upstream good is supplied in equilibrium, still only one supplier acts strategically. Other papers, such as Dobson and Waterson (2007), rely on linear prices together with a particular linear demand specification. Though it seems fair to say that further progress is needed in this area (cf. the contributions of Patrick Rey that were presented in the same session), the encountered problems may alternatively suggest to take an entirely different approach to extract key insights for competitive interactions in bilateral oligopolies. I thus turn next to a brief discussion of models where vertical relations are seen through the lenses of a "market interface".

3. Models of "market interfaces"

A standard reference for models with a market interface at the upstream level is Salinger (1988). With Cournot competition in homogeneous goods, upstream and downstream goods are sold at a uniform price. Models in this vein have been used, in particular, to study the implications of vertical integration, most notably input foreclosure. Inderst and Valletti (2007, 2008, in press-a) use a market interface to study two issues that seem to be of relevance for (European) competition policy: i) the impact of indirect constraints and ii) incentives for input foreclosure. In what follows, I will only cover the second contribution and use this to, once again, introduce a more flexible modelling approach.

3.1. Incentives for input foreclosure

The European Commission's 2007 non-horizontal merger guidelines propose, as one of three steps, to assess the *incentives* of a vertically integrated firm to foreclose rivals. In the guidelines, the Commission suggests to use pre-merger margins on the upstream and downstream market as a predictor of the incentives to foreclose. Inderst and Valletti (2008) challenge this view, using for the comparative analysis the following model of the upstream market.

There are $m \in M = \{1,\ldots,M\}$ different inputs and $n \in N = \{1,\ldots,N\}$ final goods. Denote the quantity of input m that goes into the production of good n by q_n^m and aggregate the respective quantities by $q_n := \sum_{m \in M} q_n^m$ and $q^m := \sum_{n \in N} q_n^m$, respectively. For convenience, suppose that output x_n satisfies $x_n = q_n$. Now, to ensure that, for the purpose of a clean comparative statics analysis, total downstream production costs are not affected by the number of competing products, suppose that there is an aggregate downstream production *capacity* equal to $K>0$, representing the measure of plants. Each plant, when having inputs $\tilde{q}^m$, can produce at total costs

$$\sum_{m \in M} \left[\delta(\tilde{q}^m)^2/2 + \tilde{q}^m(p^m + \beta)\right],$$

where p^m represents the uniform price of input m. This linear–quadratic cost function allows firms to mix and match between different inputs so as to minimize costs. If capacity K is allocated symmetrically and if input price differences are not too large, then the optimal procurement strategy gives rise to the following marginal cost function for the production of good n:

$$C'(q_n) = \bar{p}_{\varnothing} + \beta + q_n \frac{\delta}{K \cdot M}, \text{where } p_{\varnothing} := \sum_{m \in M} p^m / M.$$

The presented linear–quadratic specification for downstream firms, which can be easily enriched further to include asymmetries, allows to obtain a number of comparative statics results, in particular in terms of primitives that affect pre-merger competition and, thereby, upstream and downstream margins. Inderst and Valletti (2008) show, in particular, that with linear demand one obtains the following predictions for the incentives to fully foreclose downstream rivals after vertical integration: When downstream markets are more competitive, e.g., as products are less differentiated (higher θ) or owned by more independent firms, or as firms "play" Bertrand instead of Cournot, upstream margins are higher and downstream margins are lower, though then foreclosure is *more* likely. This, at first counterintuitive, result is due to the fact that the pass-through effect is higher in a more competitive downstream market, implying that an integrated firm's continued participation in the "merchant market" would have a larger (negative) effect on the profits of its downstream operations.

3.2. Bilateral contracting vs. market interface

Above, I already suggested that the choice of the modelling approach should depend on observable characteristics, relating to contracts and market structure. Furthermore, for antitrust purposes, the predictions of the respective models should be used, at least qualitatively, to assess whether an anti-competitive effect based on a particular form of market interaction seems plausible. For instance, the "standard" theory of competitive harm arising from increased buyer power under a "market interface" suggests that the respective buyer must withhold demand, which in turn improves purchasing conditions for all other buyers as well. Such a theory could be checked against data or stylized facts. Likewise, to assess the effects of an envisaged vertical merger, it could be analyzed whether pre-merger suppliers were unable to exclude intrabrand competition ("opportunism problem") or whether they were able to substantially dampen downstream competition through the use of nonlinear contracts. If this seems unlikely and if, in addition, there is little evidence of wholesale price discrimination, assuming a market interface at the upstream market may provide a convenient and, at least in terms of implications, realistic alternative.

In its ruling on the Schneider and Legrand merger, the Court of First Instance overruled the Commissions' decision to block the merger. The (overlooked) role of "indirect constraints" from self-supply plaid hereby a crucial role. Furthermore, the Commission had argued that the high level of downstream competition (in this case, among wholesalers that were supplied by the two merging firms) increased upstream market power, as it undermined buyers' ability to exert countervailing power. By using a model of market interface, Inderst and Valletti (2007, in press-a) show, instead, that the ability to exert market power at the upstream (merchant) market diminishes

[4] Greg Shaffer and Leslie Marx have called this the "bumping problem".

[5] There, it is shown that while the prohibition of various forms of *own-supplier* discounts has no implications on the equilibrium outcome, through the use of market-share discounts total industry profits increase at the cost of welfare and consumer surplus.

with downstream competition. Could, instead, a model based on bilateral contracting provide support for the Commission's "theory"?

Antitrust authorities should be encouraged to always provide a first *formal* consistency check of a particular "vertical theory of harm" that they use. The presented, increasingly flexible novel models of vertical relationships provide ample scope for this. If it is not feasible to write down a simple model that supports some theory of harm, then this should be seriously reconsidered. If, instead, such a theory is supported by one or more models, in a next step it should be checked whether the respective assumptions and (empirical) implications can be supported by the observed characteristics of the industry. Market models, such as in Inderst and Valletti (2008), may then be even brought to the data.

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