Deregulation in Network Industries: A Policy in Search of a Rationale?

Stefan Bühler[1]

Abstract

This paper analyzes market structure variations in a vertically related industry that are associated with different strategies of "deregulation", defined as the introduction of downstream competition. In this industry, an upstream monopolist operates a network that is used by downstream firms to produce differentiated final products. The potential drawbacks of deregulation include double marginalization, underinvestment and vertical foreclosure. Using a simple downstream duopoly model, I explore under which conditions these drawbacks dominate the positive effects of competition and discuss when deregulation may be appropriate.

1 Introduction

In the heyday of the British privatisation programme, Kay and Thompson (1986) published a highly controversial paper claiming that it essentially lacked "any clear analysis of purpose or effects" (p. 19). At the same time, they offered a less critical view of the role that competition could play in industries traditionally regarded as natural monopolies. In a more recent survey on the state of the debate, Newbery (1997) takes a similar view, arguing that introducing competition is the key to achieving the full benefits of privatization in previously monopolized and regulated network industries, such as telecommunications, electricity or railways. The recent wave of "deregulation" in these industries – i.e. the introduction of (downstream) competition into statutory monopolies – is certainly consistent with this view.

Industrial organization theory suggests, however, that the introduction of imperfect downstream competition in network industries is subject to the following problems:

- *double marginalization*: the introduction of imperfect downstream competition leads to successive markups.[2]

[1] University of Zurich, Socioeconomic Institute, Hottingerstrasse 10, 8032 Zurich, and University of St. Gallen, Research Institute for Empirical Economics and Economic Policy; Switzerland; sbuehler@soi.unizh.ch.

[2] The classic reference is Spengler (1950); Tirole (1988, Chapter 4) and Perry (1989) provide surveys on market outcomes in vertically related industries.

- *underinvestment*: downstream competition tends to reduce the network operator's incentive to invest in network quality or productive efficiency.[3]
- *vertical foreclosure*: the network monopolist may attempt to raise the downstream rivals' costs by charging excessive wholesale or access prices.[4]

The present paper takes these potential drawbacks of restructuring network industries seriously and studies both pricing and investment behavior under the most common forms of market structure, i.e. (i) *vertical integration* without downstream competition, (ii) *vertical separation*, where the upstream monopolist is separated from the imperfectly competitive downstream market, and (iii) *liberalization*, where the upstream monopolist is allowed to operate in the downstream market.[5] It is important to note that the paper deliberately abstracts from access or retail price regulations, thus isolating the effects generated by the restructuring of the industry and the introduction of competition. As a result, we may discuss the role that access or retail price regulations might play in moving the industry from one equilibrium to another, rather than imposing a particular equilibrium by imposing arbitrary rules of price regulation.

The main results are the following. *First*, retail prices may turn out to be higher under deregulation than under statutory, integrated monopoly. This follows from the fact that the (partial) vertical separation of the industry associated with deregulation reduces the upstream monopolist's perceived price elasticity of demand. *Second*, the monopolist's incentives to invest in cost reduction may be smaller under deregulation than under statutory, integrated monopoly. This result reinforces higher prices under deregulation. *Third*, contrary to what one might expect, the network monopolist does not necessarily wish to foreclose its downstream rivals.

The remainder of the paper is organized as follows. Section 2 gives the basic setup of the duopoly model. Section 3 compares equilibrium prices and investment under the different market configurations. Section 4 provides a simple example with a linear demand system. Section 5 concludes.

2 The Basic Setup

The production and selling of a differentiated final product provided over a network is modelled as an industry with a vertical structure. Suppose that in order to sell the final good (e.g. railway services), the seller needs access to an intermediate good produced by a monopolist. For simplicity, assume that to provide one unit of the final product (e.g. one passenger mile), one unit of the

[3] See Bühler et al. (2002) for an analysis of the monoplist's incentive to invest in infrastructure quality.

[4] See Klass and Salinger (1995) for a survey on the theory of vertical foreclosure and its antitrust implications. Riordan (1998) and Ordover et al. (1990) provide further references and critical reviews of recent contributions.

homogenous intermediate good (e.g. one mile of track) is required. For simplicity, there are only two differentiated final products with demand $D_i(p_i, p_j), i, j = 1,2, i \neq j$. Aggregate demand for the intermediate good is thus given by $D(p_1, p_2) = D_1(p_1, p_2) + D_2(p_2, p_1)$. The variable cost $c(e)$ of providing the intermediate good depends on the level of effort *e* that is exerted by the network operator; implementing a nonnegative effort is costly, which is reflected in a convex cost function $\psi(e)$. Finally, there is a fixed cost *F* of operating the network.

In the various industry configurations, the provision of the final good is modelled as a simple two-stage game with the following course of events.

- Stage 1: The network monopolist chooses both the cost-reducing effort *e* and the access tariffs a_1 and a_2.
- Stage 2: Observing the access tariffs, each downstream firm sets its retail price $p_i, i = 1,2$, for the provision of the final good.

In the case of vertical integration, the network monopolist owns both retail firms and thus faces a simple optimization problem. In the case of vertical separation, the network operator and the downstream competitors play a sequential game which can be solved using backward induction. In the case of liberalization, where the network operator is vertically integrated with one downstream firm and faces downstream competiton, a sequential game between the integrated network operator and its downstream competitor is played.

Throughout the paper, it is assumed that in the vicinity of the equilibrium, the following basic assumptions are satisfied:[6]

(A1) The differentiated final products are demand substitutes and strategic complements.

(A2) Demand functions are symmetric.

(A3) The own effect of a price change dominates the cross effect both in terms of the level and the slope of demand.

(A4) The final products remain demand substitutes from the network monopolist's point of view when the industry is vertically separated.

(A5) The marginal cost of the network monopolist is decreasing in effort, and the cost of providing effort is positive and increasing.

Taken together, these assumptions assure that the model is a tractable and stable representation of a network industry providing differentiated final products to customers.

---

[5] See Bühler (2002) for a more general analysis including the proofs of the results discussed in the present paper.

[6] See Bühler (2002) for formal statements of these assumptions.

3 Market Configurations

This section compares the equilibrium outcomes under the three market configurations. The benchmark case is vertical integration. We then analyze the equilibria under vertical separation and liberalization.

3.1 Vertical Integration: The Benchmark Case

Suppose that there is a vertically integrated monopolist whose divisions $i = 1,2$ serve both markets for the final good, i.e. the integrated monopolist sets a market price p_i^I for each division *i*. Its profit maximizing problem is then given by

$$\Pi^I(p_1, p_2) = \sum_{i=1}^{2} [p_i^I - c(e)] D_i(p_i, p_j) - \psi(e) - F.$$

The first-order conditions are given by

$$\frac{p_i^I - c(e^I)}{p_i^I} = \underbrace{\frac{1}{\varepsilon_{ii}^I}}_{\text{inverse price elasticity}} - \underbrace{\frac{[p_j^I - c(e^I)] D_j^I \varepsilon_{ji}^I}{R_i^I \varepsilon_{ii}^I}}_{\text{pricing externality}}, \quad i, j = 1,2, j \neq i \tag{1}$$

and

$$-c'(e^I) D(p_1^I, p_2^I) = \psi'(e^I) \tag{2}$$

where $R_i \equiv p_i D_i$ is the revenue of division *i*, and

$$\varepsilon_{ji} \equiv -\frac{(\partial D_j / p_i) p_i}{D_j}$$

denotes the price elasticity of demand in market *j* with respect to the price of division *i*. Equation (1) is the familiar Lerner index for a multiproduct monopolist with separable costs and dependent demands (Tirole, 1988, p. 70). It is important to note that a vertically integrated monopolist takes into account that the final products offered by its divisions are substitutes $(\varepsilon_{ji} < 0, j \neq i)$ and thus sets higher markups than each of its divisions would set individually to internalize the pricing externality.

3.2 Vertical Separation

Under vertical separation, there is an upstream monopolist and two independent downstream firms. Each downstream firm *i* chooses its retail price so as to maximize

$$\Pi_i(p_i, p_j, a_i) = [p_i - a_i] D_i(p_i, p_j).$$

The equilibrium retail prices under separation are thus given by

$$\frac{p_i^S - a_i^S}{p_i^S} = \frac{1}{\varepsilon_{ii}^S}, \tag{4}$$

where ε_{ii}^S is the own-price-elasticity of demand for firm *i*'s services, now evaluated at the retail prices (p_1^S, p_2^S) rather than (p_1^I, p_2^I). Since the downstream firms' prices are functions of the access prices, the upstream monopolist's problem is given by

$$\Pi^U(a_1, a_2, e) = \sum_{i=1}^{2} [a_i - c(e)] D_i(p_i^S(a_i, a_j), p_j^S(a_j, a_i)) - \psi(e) - F.$$

After some algebra, the first-order condition for equilibrium access prices can be written as

$$\frac{a_i^S - c(e^S)}{a_i^S} = \underbrace{\frac{1}{\varepsilon_{ii}^S m_{ii}^S + \varepsilon_{ij}^S m_{ji}^S}}_{\text{perceived inverse price elasticity}} - \underbrace{\frac{[a_j^S - c(e^S)] D_j^S \sum_k \varepsilon_{jk}^S m_{ki}^S}{R_i^S(\varepsilon_{ii}^S m_{ii}^S + \varepsilon_{ij}^S m_{ji}^S)}}_{\text{price externality}}, \tag{5}$$

where

$$m_{ji} \equiv \frac{(\partial p_j / \partial a_i) a_i}{p_j}, \quad i, j = 1,2,$$

is the elasticity of the retail price p_j with respect to changes in the access price a_i. The first-order condition for equilibrium effort has the familiar form

$$-c'(e^S) D(p_1^S, p_2^S) = \psi'(e^S). \tag{6}$$

Inspection of (1) and (4) indicates that in the case of vertical separation, the retail prices set by the downstream firms do not internalize the pricing externalities between the two markets, i.e. downstream competition eliminates the possibility of internalizing the *pricing externality* at the retail level. For given costs, retail prices thus tend to be lower under vertical separation. At the same time, the vertical separation of the industry introduces a *double markup*. To see this, observe that on the l.h.s. of (4), the cost element in the Lerner index is represented by the access charge a_i^S rather than marginal cost $c < a_i^S$. The overall effect on retail prices is thus ambiguous in general.

To derive more precise statements on the price effects of competition in the case of vertical separation, it is crucial to observe that a *sufficient* condition for the retail prices to be higher under separation is that the access prices under separation are at least as high as the retail prices under integration. It then follows immediately from the profit maximization of downstream firms that retail prices must be higher under separation. We thus need to compare equations (1) and (5) to derive statements on the levels of retail prices under vertical integration and separation. Inspection indicates that the Lerner indices for the relevant prices look fairly similar in the two cases. Yet there are two important differences:

- Vertical separation changes the perceived price elasticity of demand in market *i* from ε_{ii}^{I} to $(\varepsilon_{ii}^{S} m_{ii}^{S} + \varepsilon_{ji}^{S} m_{ji}^{S})$. Instead of directly affecting demand (as under integration), an increase of the monopolist's price first affects the pricing decisions of the downstream firms via the elasticities of retail prices m_{ji}^{S}. The associated changes of retail prices then affect the monopolist's demand. One can show that in equilibrium downstream firm *i* does not find it optimal to fully pass on an increases of a_i to its customers, i.e. $0 < m_{ii}^{S} < 1$. Firm *j*, in turn, welcomes the increase of a_i since the associated increase of p_i shifts out its demand schedule, allowing it to increase its price p_j, i.e. $m_{ji}^{S}, j \neq i,$ is positive, thereby mitigating the substitution effect generated by the price increase for firm *i*. As a result, the perceived price elasticity of demand of the upstream monopolist is smaller than under integration $(\varepsilon_{ji}^{S} < 0)$, and the corresponding monopoly price thus tends to be higher.
- Vertical separation also affects the pricing externalities between markets (compare the second term on the r.h.s. of (1) and (5)). As under vertical integration, the upstream monopolist accounts for the externalities. But just as within each market, variations of access prices only indirectly affect the demand for the final good. Whether vertical separation increases or decreases the pricing externalities is ambiguous.

Under the assumptions (A1) and (A5) outlined above, the following central result can be shown to hold:

Result 1: Suppose that vertical separation does not reduce the pricing externalities between markets. In addition, suppose that (i) ε_{ii} is nonincreasing in (p_1, p_2) or (ii) ε_{ii} is nondecreasing in (p_1, p_2) and increases not too strongly. Then for any given effort level $\bar{e}$, retail prices are higher under separation than integration.

Proof: See Bühler (2002). ■

Clearly, the level of marginal cost is not exogenous but depends on the endogenous choice of effort. Let us thus analyze the upstream monopolist's incentive to invest in cost reduction. Consider the first-order conditions (2) and (6) for the equilibrium choice of effort. Observe that in both market configurations, the equilibrium effort ε^{*} chosen by the upstream monopolist satisfies a condition of the form

$$-c'(e^{*})D(p_1^{*}, p_2^{*}) = \psi'(e^{*}),$$

where (p_1^*, p_2^*) denote equilibrium prices. If the equilibrium retail prices were the same under integration and separation, the equilibrium effort would have to be the same in both market configurations. However, if – for a given level of effort – the equilibrium retail prices are higher under separation (Result 1), the equilibrium effort must be smaller under separation than under integration since $D(p_1^*, p_2^*)$ is decreasing in prices. As a consequence, the marginal cost of the upstream monopolist is higher under separation than under integration:

Result 2: Suppose the assumptions of Result 1 hold. Then the network operator's marginal cost is lower under integration than under separation.

Note the simple intuition of Result 2. According to Result 1, retail prices are higher under separation than under integration (under some conditions). As a consequence, the aggregate demand for the intermediate good is smaller under separation, and hence the incentive to invest in cost reductions is also smaller. This result reinforces the finding that retail prices are higher under vertical separation than under integration, since the markup of the access price is now based on a higher level of marginal cost.

3.3 Liberalization

Suppose that in the case of liberalization, the upstream monopolist is integrated with downstream firm 1. For the independent dowstream firm 2 the pricing rule is similar to that under separation, i.e.

$$\frac{p_2^L - a_2}{p_2^L} = \frac{1}{\varepsilon_{22}^L}. \tag{7}$$

The upstream monopolist, in turn, maximizes

$$\Pi^U(p_1, a_2, e) = [p_1 - c(e)]D_1(p_1, p_2) + [a_2 - c(e)]D_2(p_2, p_1) - \psi(e) - F .$$

The equilibrium is thus characterized by the pricing rules

$$\frac{p_1^L - c(e^L)}{p_1^L} = \frac{1}{\varepsilon_{11}^L} - \frac{[a_2^L - c(e^L)]D_2^L \varepsilon_{21}^L}{R_1^L \varepsilon_{11}^L} \tag{8}$$

and

$$\frac{a_2^L - c(e^L)}{a_2^L} = \frac{1}{\varepsilon_{11}^L m_{11}^L + \varepsilon_{12}^L m_{21}^L} - \frac{[p_1^L - c(e^L)]D_1^L \varepsilon_{12} m_{21}^L}{R_1^L(\varepsilon_{11}^L m_{11}^L + \varepsilon_{12}^L m_{21}^L)}, \tag{9}$$

as well as the standard rule

$$-c'(e^L)D(p_1^L, p_2^L) = \psi'(e^L) \tag{10}$$

for the choice of effort. Similar arguments to those outlined for vertical separation show that even under liberalization, retail prices may be higher than under integration (and equilibrium effort may thus be lower). It should be clear, however, that the sufficient conditions for the retail prices to be higher under liberalization than under integration are somewhat stronger than those given for separation, since the vertically integrated monopolist does not suffer from a double markup and has an incentive to set a relatively low retail price in market 1 to divert demand from the independent downstream competitor.

In addition, the integrated monopolist may also divert demand to market 1 by setting a relatively high access price a_2^L, i.e. "raising rival's cost" (Salop and Scheffman 1987). Following the recent literature, we say that there is *vertical foreclosure* if the access price for downstream firm 2 is higher under liberalization than under integration. It is not difficult to show that the monopolist's pricing behavior under liberalization will in fact be different from that under separation. Whether foreclosure will emerge in equilibrium generally depends on the specific functional form of demand. The next result summarizes this finding.

Result 3: It is ambiguous in general whether vertical foreclosure is profitable, i.e. the network monopolist does not necessarily wish to foreclose its downstream rivals.

4 The Linear Demand Example

Let us consider an example with two downstream firms facing a symmetric linear demand system given by

$$D_i(p_i, p_j) = \alpha - \beta p_i + \gamma p_j, \quad i, j = 1,2, i \neq j,$$

with $\alpha, \beta > 0$ denoting demand parameters and γ the substitutability of products.[7] In this simple setting, explicit solutions for both access and retail prices can be derived. Figure 1 shows the equilibrium prices in the various market configurations for the parameter values $\alpha = 10, \beta = 2, c = 0$.

To start with, consider a change of market structure from integration to separation. As outlined above, the retail prices turn out to be higher under separation than under integration. That is, double marginalization dominates the competitive effect for the linear model.[8] Now compare the equilibrium outcomes under separation and liberalization. Inspection of Figure 1 indicates that a vertically integrated monopolist may actually desire to *reduce* its downstream competitor's costs rather than raising them: With the simple demand system used here, vertical foreclosure does not

[7] With $\gamma = 0$ each downstream firm (division, respectively) is a monopolist.

[8] In fact, the retail prices under integration are just equal to the access prices under separation.

emerge in equilibrium $(a_2^L < a_2^S)$. While it is true that the vertically integrated upstream monopolist is able to place its downstream competitor at a competitive disadvantage $(p_1^L < p_2^L)$, it attains this result by reducing its own retail price rather than increasing its rivals' access price relative to separation. As a result, retail prices under liberalization are strictly lower than under vertical separation $(p_i^L < p_i^S, i=1,2)$. In fact, the integrated firm's retail price is even below its price under integration, whereas the independent downstream competitor's price is higher than under integration.

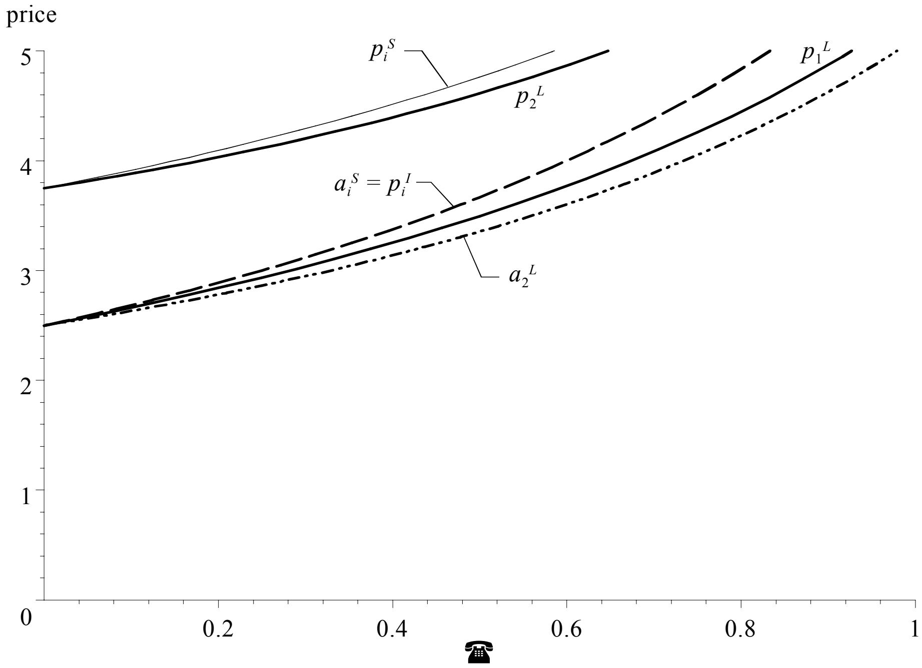

Figure 1: Integration, separation and liberalization (linear demand)

5 Concluding Remarks

The above analysis suggests that if a network industry's final products are differentiated, changing the industry's structure from unregulated, integrated monopoly to separation or liberalization may be detrimental to social welfare if not supplemented by adequate access price regulation. The argument holds a fortiori for the restructuring of a reasonably regulated integrated monopoly. Therefore, one may ask why many countries have recently attempted to restructure their network industries.

The most convincing answer to this question is probably the common view that competition in the downstream not only effectively constrains the pricing behavior of the downstream firms, but also leads to a selection of more efficient firms over time. Yet, while such selection may indeed occur and spur innovation in the process, it is unclear how entry by more efficient downstream firms can help to control the network monopolist's market power. Future research will have to address this question.

References

Bühler, S. (2002): 'The Promise and Pitfalls of Restructuring Network Industries'. *Working Paper*, University of Zurich.

Bühler, S., Schmutzler, A., Benz, M.A. (2002): 'Infrastructure Quality in Deregulated Industries: Is There an Underinvestment Problem?'. *Working Paper*, University of Zurich.

Kay, J.A., Thompson, D.J. (1986): 'Privatization: A Policy in Search of a Rationale'. *Economic Journal*, Vol. 96, 18-38.

Klass, M.W., Salinger, M.A. (1995): 'Do New Theories of Vertical Foreclosure Provide Sound Guidance for Consent Agreements in Vertical Merger Cases?'. *Antitrust Bulletin*, Fall, 667-698.

Newbery, D.M. (1997): 'Privatisation and liberalisation of network utilities'. *European Economic Review*, Vol. 41, 1357-383.

Ordover, J.A., Saloner, G., Salop, S.C. (1990): 'Equilibrium Vertical Foreclosure'. *American Economic Review*, Vol. 80, 127-142.

Perry, M.K. (1989): 'Vertical Integration: Determinants and Effects'. In: Schmalensee, R., Willig, R.D. (eds.): *Handbook of Industrial Organization*, Vol. 1, 183-255, North-Holland, Amsterdam.

Riordan, M. (1998): 'Anticompetitive Vertical Integration by a Dominant Firm', *American Economic Review*, Vol. 88, 1232-1248.

Salop, S.C., Scheffman, D.T. (1987): 'Cost-Raising Strategies. *Journal of Industrial Economics*, Vol. 36, 19-34.

Spengler, J. (1950): 'Vertical Integration and Anti-trust Policy'. *Journal of Political Economy*, Vol. 58, 347-352.

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