

Bergman, Mats

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When Should an Incumbent Be Obligated to Share its Infrastructure with an Entrant Under the General Competition Rules?

Mats A. Bergman
Department of Economics
Uppsala University
PO Box 513
SE-751 20 Uppsala
Sweden

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Abstract

According to the essential facilities doctrine, competition law requires an infrastructural monopoly to provide access. Under the "Bronner criterion", proposed by the EC Court, the doctrine is only applicable when an infrastructural duopoly is non-viable.

This paper uses a simple model to illustrate that, from a welfare point-of-view, the Bronner criterion may provide too little monopoly protection for the incumbent in high-risk new markets, while requiring too much investments from the entrant in moderately mature markets.

Key Words: Infrastructure, access regulation, competition law, antitrust, Bronner

JEL classification: L43, L51

1 Introduction

The starting-point for the large literature on the optimal regulation of bottlenecks is the following question: Given that we want to regulate an industry, what is the optimal regulation? A potentially equally interesting question, but one which has received much less interest among economists, is the following: When is it optimal to regulate an industry, given that we can impose fair and non-discriminatory access pricing if the industry is regulated?

One of the most contested elements of competition (antitrust) law is the essential-facilities doctrine. Under both European and US competition rules, this doctrine can apply to firms that hold a monopoly in a critical stage of production in an industry, a "bottleneck", but which faces actual or potential competition in other stages of production. Under the doctrine, such firms may sometimes be obliged to "provide access", which has the implication that the monopoly must sell services produced in the bottleneck stage to its rivals at a "non-discriminatory" price. Typically, the critical stage is an infrastructure, such as a port, a telecom network or a rail network. In such industries, industry-specific regulation often stipulates that access should be granted. Such specific access regimes are largely independent of the requirements that may follow from general competition law and the essential-facilities doctrine.

Independently of the basis for the requirement of access, a critical issue is at which price such transactions should take place. According to the efficient component pricing rule, advocated by some economists, the monopolist should be compensated for forgone monopoly profits (Willig, 1979). In practice, some kind of fully distributed (backward-looking) cost pricing that does not compensate for lost monopoly profits have typically been used by the regulators. Backward-looking cost based price regulation, however, have well-known disadvantages. In particular, backward-looking regulation gives weak incentives for cost control. This has triggered a move towards forward-looking cost-based pricing, e.g., LRIC (forward-looking long-run incremental costs).

The pricing issue has received a lot of attention from economists, see, e.g., the discussion in Laffont and Tirole (2000, chapters 3 and 4). There exists a large literature on how to set prices in a static asymmetric-information context, where the main focus is the trade-off between rent extraction, risk allocation and incentives for cost reduction (Laffont and Tirole, 1993). An important innovation, from a practical point of view, was the introduction of price-cap regulation in Britain in the early 1980s. Under price-cap regulation,

any cost savings that can be achieved will increase the profit of the regulated firm. This is in contrast with cost-based price regulation, under which cost savings must be passed on to the consumers (Armstrong *et al*, 1994).

The question *when* an obligation to provide access should be imposed has primarily been analysed in the law literature,¹ while in the economics literature, the analysis has typically been based on the implicit assumption that the access price *should* be regulated. As far as industry-specific regulation is concerned, whether or not there should be an access-price regulation is decided by the legislative bodies, i.e., in a political process. Given that it has been established that a regulation is desirable, the regulation can in principle be tailored to the particular characteristics of the industry at hand. In generally applicable law, however, it is important to have robust and predictable criteria for when a certain obligation is effective; such criteria have been developed within the essential-facilities doctrine.

2 The essential-facilities doctrine

The essential-facilities doctrine is not a piece of law in itself. Rather, it is a systematic interpretation of how the courts have applied European competition law and American antitrust law in a particular class of situations. Roughly speaking: when there exists a sufficiently severe bottleneck problem, extraordinary obligations (i.a., the obligation to provide access) will be imposed on the dominant firm. The legal basis for these obligations is, in Europe, the prohibition against abuse of a dominant position, i.e., Article 82 of the EC Treaty, and its correspondence in national legislation. This prohibition imposes obligations on dominant firms that smaller firms do not have, i.e., it is an asymmetric regulation. In the US, the legal basis for the essential-facilities doctrine is Section 2 of the Sherman Act, under which it is unlawful to monopolize or attempt to monopolize a market.²

The conclusion of the legal literature, based on a large number of court

¹For a survey and analysis, see Bergman (2001).

²Several firms that jointly control a bottleneck may also fall under the essential facilities doctrine. In the US, the legal basis for the doctrine would then be Section 1 of the Sherman Act, under which conspiracies in restraint of trade are unlawful. In Europe, the legal basis would still normally be Article 82, but it is conceivable that Article 81, which prohibits agreements that restricts competition, could also be applicable. See Bergman (2001) for details.

rulings, is that the essential-facilities doctrine is applicable if i) there exists one facility (one infrastructure) only, ii) access to this facility is necessary in order to compete in a related market (e.g., the downstream services market), iii) competing firms lack a realistic ability to duplicate the facility and iv) it is possible for the monopoly to provide access.

Of these criteria, the most critical is perhaps the third: that competing firms lack a realistic ability to duplicate the facility. Depending on how this criterion is interpreted, the essential-facilities doctrine could have far-reaching effects, or it could be applicable only in very particular circumstances; an expenditure that is quite reasonable for one firm may be unreasonable for another firm. An extreme stand-point would be that in order for a facility to be essential, it must be *impossible* to duplicate it. However, all physical facilities can be duplicated at some cost. Whether a facility is duplicable or not is always, or almost always, determined by economic or legal considerations, rather than by the laws of nature.³ Hence, it is normally recognised that it is not necessary to demonstrate that a facility cannot be duplicated in a physical sense. Another extreme stand-point is that the doctrine should be applicable as soon as *some* firm lack the resources to duplicate the facility. In the American case *Hecht v. Pro Football*, the following statement appeared: "To be 'essential' a facility need not be indispensable; it is sufficient if duplication of the facility would be economically infeasible and if denial of its use inflicts a severe handicap on potential market entrants."⁴

In the *Bronner* case, the EC Court addressed more or less directly the question for whom it should be not be realistic to duplicate the facility, and exactly how "not realistic" should be interpreted.⁵ The Court's statements can be interpreted in the following way: When analysing a market, take the actual level of technology and the actual demand as given. Assume then a hypothetical situation in this market, where supply is provided by a symmetric duopoly. If each of the two firms' combined profit in the infrastructural market and in the related potentially competitive market would be non-negative,

³A possible exception may be radio spectrum. However, it appears that for practical purposes, the availability of radio spectrum is mainly determined by government decisions concerning, i.a., military use of the spectrum.

⁴*Hecht v. Pro Football, Inc.*, 570 F.2d 982, 992 (D.C. Cir. 1977), cert.denied, 436 U.S. 956 (1978).

⁵C-7/97; Oscar Bronner GmbH & Co. KG vs. Mediaprint Zeitungs- und Zeitschriftenverlag GmbH & Co. KG et al. See Bergman (2000) for a more elaborate discussion of the *Bronner* case.

then the essentials facilities doctrine is *not* applicable. If, on the other hand, it would *not* be possible for a firm with half of the market to set up its own facility (infrastructure), and earn a non-negative profit, then the doctrine *is* applicable. That is, the doctrine is applicable if a symmetric duopoly with two vertically integrated firms is not economically viable.

The *Bronner* criterion has a natural attractiveness. It is relatively easy to understand and it seems intuitively appealing to oblige a monopoly to share its infrastructure with its rivals only as a last recourse, when there is no hope that competition could evolve in the absence of such an obligation. Similarly, it appears reasonable *not* to impose such an obligation when there is a prospect for a sufficiently dedicated entrant to set up a profitable rivalling infrastructure.

However, a short-coming of the essential-facilities doctrine is that it is not based on an ex ante perspective. That such a perspective is desirable has indirectly been recognized in the law literature. For example, Areeda (1990) has proposed that the doctrine should only be applied when its application is likely to increase competition substantially, and that it should not be applied when its application is likely to reduce the incentives for investments. Similarly, in the literature on the appropriate level of the access price, it is recognised that there is a trade off between intense ex post competition (through low access prices) and ex ante competition in investments (through higher access prices).⁶ In an analysis of telecom regulation, Hausman (1999) addresses this issue in a real-options setting. He derives the mark-up above the so-called TSLRIC (Total Service Long-Run Incremental Cost) that establishes the correct incentives for investments. Even so, it seems that the ex ante - ex post distinction has rarely been discussed in the context of *when* the essential-facilities doctrine should be applied.⁷

The main contribution of this article is that it analyses the *Bronner* criterion from an ex ante perspective. Using a stylised model, a conclusion is

⁶Phrased differently, there is a trade-off between static efficiency and dynamic efficiency.

⁷Bergman (2001). An interesting study, that do address the conflict between incentives for investments and strong post-investment competition, is Gans (2001). He derives an access-pricing scheme that induces investment at the socially optimal time, while the marginal access fee is equal to the marginal cost of providing access. This is achieved by having the entrant pay a fixed access fee that equals a rising fraction of the cost of investment. At the socially optimal time of investment, the fraction is exactly equal to one half. However, the implementation of such a policy is possible only in a full-information setting.

that applying the *Bronner* criterion introduces a double risk of inefficient regulation. In high-risk new markets, the doctrine may be applied too readily. The incumbent firm will invest too little, because it will need to share the fruits of successful investments with its rival. On the other hand, in slightly more mature markets with lower risk, the doctrine may be applied too sparingly. The entrant firm may be forced to invest in an infrastructure of its own, before this is warranted from a social point of view.

3 The Model

Assume that in order for anything to be produced in an industry, an infrastructure must be put in place, and the producing firm must have access to the infrastructure. Assume also that once there exists at least one infrastructure, there are no capacity constraints, but the owner of the infrastructure can control its use. Implicitly, a constant marginal cost of production is also assumed. There will be a fixed cost for building an infrastructure.

The timing of the game to be analysed is the following. A number of parameters are provided by nature, including a distribution from which the level of demand will later be drawn. These parameters are known to the two possible entrants. In addition, the regulator (the government or the courts) have decided how to interpret the access rules - or the essential-facilities doctrine. In particular, the market participants will be aware of *when* the access rules (the doctrine) will be applicable and what access price the regulator will then impose. To simplify the analysis, I assume that access will have to be provided at average cost. This means that the regulator's choice set is reduced to choosing between the two regimes "access" and "non-access".

Then, in the first stage of the game, one firm (the incumbent) is given the opportunity to invest in infrastructure. After that, the level of demand is realised and the access rules are interpreted - i.e., the second firm (the entrant) will learn whether or not it can claim access according to the essential-facilities doctrine. In the second stage, the entrant will decide whether or not to build its own infrastructure. Finally, the market will be realised and the firms will be awarded their profits.

The level of demand will not be realised until one infrastructure has been built. Hence, if firm 1 chooses not to invest, the level of demand will not be known when firm 2 makes its decision. If it invests, the level of demand is

realised and then firm 1 is again given the option to invest, but it will now have the position of an entrant, while firm 2 is the incumbent. The solution to this problem is identical to the initial problem; hence it will not be further addressed. (The entrant's profit will never be higher than the incumbent's profit.)

Total welfare W in this market is given by:

$$W(D, n, m) = \begin{cases} 0 & n = 0 \\ D - F & n = m = 1 \\ \alpha D - F & n = 2, m = 1 \\ \alpha\beta D - 2F & n = m = 2 \end{cases} \quad \text{if} \quad (1)$$

where D is a realisation of a measure of demand drawn from a distribution function $f(D)$. Possibly, this distribution can be degenerate so that there is no uncertainty and, hence, D is known with certainty. The number of producing firms is given by $n = 0, 1, 2$, while $m = 0, 1, 2$ is the number of installed infrastructures, F is the cost of building an infrastructure and α and β are constants. Assume that $\alpha > 1$, reflecting that welfare is higher under duopoly than under monopoly, for a given number of infrastructures (e.g., because of less deadweight loss), and that $1 < \beta < 2$, reflecting that less of the cost of duplicating the infrastructure, efficiency and welfare will increase if there is competition also in the infrastructure.⁸ In order to ascertain that investment will be socially beneficial, assume that $E[D] - F > 0$.

The profit of the "incumbent" firm, or the first firm to invest in infrastructure, is given by

$$\pi_1(D, n, m) = \begin{cases} 0 & n = 0 \\ \gamma D - F & n = m = 1 \\ \alpha\gamma\delta D - \frac{1}{2}F & n = 2, m = 1 \\ \alpha\beta\gamma\delta D - F & n = m = 2 \end{cases} \quad \text{if} \quad (2)$$

where $\gamma, \gamma < 1$ reflects the share of consumer surplus that the monopoly can capture. The constant $\delta, \delta < 1/(2\alpha\beta)$, reflects that each firm's profit under duopoly is less than half of the monopoly profit and that total industry profit is always lower under duopoly than under monopoly. The above profit expression builds on the assumption that if there are two firms, they have

⁸The alternative $n = 1, m = 2$ is not considered, as this would never be the outcome of profit maximising. The condition that $\beta < 2$ implies that at least for some levels of demand, welfare is maximised if only one infrastructure is built.

equal marginal costs, they share the cost of the infrastructure in proportion to their respective output and, because of the symmetry, will get equal market shares. The profit of firm 2 (as well as that of firm 1) is therefore given by row three and four in eq. (2).

The firms' objectives are to maximise profits, they are assumed to be risk neutral and they behave non-cooperatively.

4 Analysis

4.1 *Social optimum*

I begin the analysis by looking at the socially optimal solution, given that the regulator can only chose between "access" and "non-access". In particular, the regulator cannot directly set the firms' quantities or prices. However, it can induce the firms to operate, even if this results in negative profits, for example by providing subsidies.

From eq.(1), note that welfare is non-decreasing in D . Since $\alpha > 1$, as soon as there is one infrastructure, both firms should be allowed to enter the market. If there is no uncertainty, welfare maximisation requires that an infrastructure is installed if $D > \frac{1}{\alpha}F$. With uncertainty, an infrastructure should be installed if $E[D] > \frac{1}{\alpha}F$.⁹ Without uncertainty, two infrastructures should be installed if welfare is higher with two infrastructures than with one or zero, i.e., if $D \geq \frac{1}{\alpha(\beta-1)}F$.¹⁰ Since there is no uncertainty when the investment decision of firm 2 is made, this condition applies in the second stage also when there is initial uncertainty. However, this opportunity for additional welfare increases the value of building the first infrastructure under uncertainty. Given that the upper support for the distribution of D is higher than $\frac{1}{\alpha(\beta-1)}F$, the threshold criterion for making the first infrastructural investment is reduced. I.e., if it is the case that for some high realisations of

⁹Disregarding the option value that accrue to the possibility of investing in an additional infrastructure, should the demand turn out to be sufficiently high.

¹⁰From the assumptions, it follows that when welfare is higher with two infrastructures than with one, then it is also the case that two infrastructures are preferable to none. This can be shown as follows.

Given that:

$$W(D, 2, 2) - W(D, 1, 1) = \alpha\beta D - 2F - (\alpha D - F) = \alpha D(\beta - 1) - F > 0,$$

and that $1 < \beta < 2$, it follows that $W(D, 1, 1) = \alpha D - F > \alpha D(\beta - 1) - F > 0$.

From the initial assumption, it follows that $W(D, 2, 2) > 0$.

demand, it will be profitable to build two infrastructures, then the first investment should be made if $D \geq \mu \frac{1}{\alpha(\beta-1)} F$, for some $\mu < 1$, where μ depends on $f(D)$.

The socially optimal outcome is illustrated in Figure 1 by the thick segments of four lines. These four lines represents welfare for the four combinations of n and m in eq. (1). For low realisations of demand, no infrastructure gives the highest welfare (0). For higher levels of demand, welfare is maximised with two firms using one infrastructure. When demand is higher still, two infrastructures and two competing firms gives the highest welfare. Note that one firm and one infrastructure is never optimal.

4.2 Constrained optimum under certainty

Note that the above analysis is made under the assumption that the firms can be subsidised, if they earn negative profits. It is also assumed that the social cost of public funds equal the nominal cost. Alternatively, it can be assumed that welfare should be maximised under the constraint that no public funds are used. Under certainty, this gives the following maximisation problem:

$$\max_{n,m} W(D,n,m) \quad (3)$$

$$\text{st } \pi_1, \pi_2 \geq 0,$$

$$n, m \in \{0, 1, 2\} \quad (4)$$

where $W(D, n, m)$ is given by eq. (1) and π_i is given by eq. (2). The solution to this problem is characterised by the following proposition.

Proposition 1. Under certainty, constrained welfare is maximised if

$$\begin{array}{ll} n = m = 0 & \pi_1(D, 1, 1) < 0 \\ n = m = 1 & \pi_1(D, 1, 1) \geq 0 \text{ and } \pi_1(D, 2, 1) < 0 \\ n = 2, m = 1 & \text{if } \pi_1(D, 2, 1) \geq 0 \text{ and} \\ & [\alpha D(\beta - 1) - F < 0 \text{ or } \pi_1(D, 2, 2) < 0] \\ n = m = 2 & \pi_1(D, 2, 2) \geq 0 \text{ and } \alpha D(\beta - 1) - F \geq 0 \end{array}$$

Proof.

Line 1. By assumption, $\pi_1(D, 1, 1) > \pi_1(D, n, m)$, for $(n, m) \neq (1, 1)$. Hence, if $\pi_1(D, 1, 1) < 0$, then $\pi_1(D, n, m) < 0$ for all n, m .

It follows that the only alternative that satisfies the no-subsidy constraint when $\pi_1(D, 1, 1) < 0$ is $n = m = 0$.

Line 2. From eq. (1), we know that for all D , $W(D, 2, 1) > W(D, 1, 1)$. Hence, $n = m = 1$ can only be optimal if $\pi_1(D, 2, 1) < 0$ (and $\pi_1(D, 1, 1) \geq 0$). By comparing eq. (1) with eq. (2), we see that $W(D, 1, 1) > \pi_1(D, 1, 1)$. Hence, if $\pi_1(D, 1, 1) > 0$, then $W(D, 1, 1) > W(D, 0, 0)$. Furthermore, it can never be the case that $\pi_1(D, 2, 2) \geq 0$, while $\pi_1(D, 2, 1) < 0$. To see this, note that if $\pi_1(D, 2, 1) < 0$, then $2\pi_1(D, 2, 2) - 2\pi_1(D, 2, 1) = 2(\alpha\beta\gamma\delta D - F) - 2(\alpha\gamma\delta D - \frac{1}{2}F) = 2[\alpha\gamma\delta D(\beta - 1) - \frac{1}{2}F] < 2[\alpha\gamma\delta D - \frac{1}{2}F] = 2\pi_1(D, 2, 1) < 0$.

The first inequality follows from the assumption that $\beta < 2$ and since all parameters and D have non-negative values.

Line 3. We know already that if $\pi_1(D, 2, 1) \geq 0$, then $n = m = 0$ or $n = m = 1$ can never be optimal. Subtracting $W(D, 2, 2)$ from $W(D, 2, 1)$, we see that $W(D, 2, 2) < W(D, 2, 1)$ if $\alpha D(\beta - 1) - F < 0$. Hence, if the last inequality is satisfied, it is not optimal to choose $n = m = 2$. Finally, if $\pi_1(D, 2, 2) < 0$, then by assumption we cannot choose $n = m = 2$.

Line 4. It follows from the proof of Line 3 that Line 4 holds. \diamond

Intuitively, Proposition 1 is easy to understand. As soon as it is profitable for a monopoly firm to enter the market, welfare is higher under entry than under non-entry. As soon as two firms can profitably use the same infrastructure, the monopoly should be forced to provide access; hence, creating a duopoly. However, it is not the case that both firms should be required to provide their own infrastructure, as soon as this yields non-negative profits. Instead, if profits are non-negative in an infrastructural duopoly, then the benefit from the additional infrastructure should be compared with the cost of providing an additional infrastructure. Only if the benefit is greater than the cost (while simultaneously profits are non-negative) shall the infrastructure be duplicated. Ignoring the right-most solid lines in the upper and lower part of the figure, the situation is illustrated in Figure 2. Welfare is shown in the upper part of the figure and profit is shown in the lower part. Since profits are constrained to be non-negative, maximum welfare cannot always be achieved. Hence, when firm profit for a certain combination of m and n

increases and reaches zero, welfare may jump up discontinuously. (For the discrete jump down, see the discussion in the next subsection.)

We postpone the discussion of the optimal policy under uncertainty. However, we can note already at this point that there exists a possible time-consistency problem. Given that welfare is always higher when two firms use a single infrastructure, than when there is a monopoly, the regulator will always want to require access. However, under uncertainty, such a policy may deter the incumbent from investing.

4.3 *The access rules*

Based on the criterion formulated in the *Bronner* case, if the second firm wishes to enter the market, the incumbent firm (the owner of the infrastructure) may be required to sell infrastructure access at a price equal to average cost. Such an obligation will be imposed if the entrant could not earn a profit if it builds its own infrastructure, even if it captured half of the market. Formally, the incumbent will be required to provide access if

$$\pi_2(D, 2, 2) = \alpha\beta\gamma\delta D - F < 0 \quad (5)$$

The price paid for access is implicitly given by equation (2) - it will equal the average costs.

Profit maximising behaviour under certainty

The market outcome is derived backwards, starting in the second stage.

Stage 2

Given that the entrant has to build its own infrastructure, it will enter the market if $\alpha\beta\gamma\delta D - F > 0$. In this case, entry will be profitable and the essential-facilities doctrine cannot be called upon. The entrant will want to use the incumbent's infrastructure if $\alpha\gamma\delta D - \frac{1}{2}F > 0$, but it will only be allowed to do so, if it cannot profitably build its own infrastructure, i.e., if $\alpha\beta\gamma\delta D - F < 0$. Hence, firm 2 will choose the following strategy:

$$\begin{aligned} D &< \frac{1}{2\alpha\gamma\delta}F && \text{Do not enter} \\ \frac{1}{2\alpha\gamma\delta}F &\leq D \leq \frac{1}{\alpha\beta\gamma\delta}F && \text{Enter without infrastructure} \\ \frac{1}{\alpha\beta\gamma\delta}F &< D && \text{Enter with infrastructure} \end{aligned} \quad (6)$$

Let R be the response of firm 2

Stage 1

Assume first that there is no uncertainty. Then, given that firm 1 builds an infrastructure and given the strategy chosen by firm 2 as shown by equation (6), firm 1's profit will be:

$$\pi_1(R) = \begin{cases} \gamma D - F \\ \alpha\gamma\delta D - \frac{1}{2}F \\ \alpha\beta\gamma\delta D - F \end{cases} \quad \text{if} \quad \begin{cases} D < \frac{1}{2\alpha\gamma\delta}F \\ \frac{1}{2\alpha\gamma\delta}F \leq D \leq \frac{1}{\alpha\beta\gamma\delta}F \\ \frac{1}{\alpha\beta\gamma\delta}F < D \end{cases} \quad (7)$$

Because of the assumed symmetry between the firms, we know already that firm 1's profit will be non-negative if the conditions of the second or third line hold. According to the first line, its profit will be non-negative if $\gamma D - F > 0$, i.e., if $D > \frac{1}{\gamma}F$. Since $\frac{1}{\gamma}F < \frac{1}{2\alpha\gamma\delta}F$ and $\frac{1}{\gamma}F < \frac{1}{\alpha\beta\gamma\delta}F$, it follows that firm 1 will invest if $\gamma D - F > 0$.

Proposition 2. If $1 + \beta\gamma\delta - \beta \geq 0$ and under certainty, the Bronner criterion results in the same industry structure and the same output as would follow from constrained welfare maximisation. If $1 + \beta\gamma\delta - \beta < 0$, welfare may be lower than the constrained maximum. However, under certainty the Bronner criterion will not deter the incumbent from making welfare-improving investments that would have been made in the absence of the essential-facilities doctrine.

Proof

According to eq. (5), the Bronner criterion obliges the incumbent to provide access if $\pi_2(D, 2, 2) = \alpha\beta\gamma\delta D - F < 0$. According to Proposition 1, the optimal policy prescribes that access should be provided if $\pi_2(D, 2, 2) < 0$ or if $\alpha D(\beta - 1) - F < 0$. If $\pi_2(D, 2, 2) \geq 0$ implies that $\alpha D(\beta - 1) - F \geq 0$, then the Bronner criterion results in the constrained welfare maximum. Note that both $\pi_2(D, 2, 2)$ and $\alpha D(\beta - 1) - F$ are increasing in D (since $\beta > 1$). Let D^* be such that $\pi_2(D^*, 2, 2) = 0$, i.e., the level of demand that is needed for both firms to break even with their own infrastructure. Let \tilde{D} be such that $\alpha\tilde{D}(\beta - 1) - F = 0$, i.e., the level of demand where duplication of the infrastructure gives the same welfare as no duplication and access. If $D^* \geq \tilde{D}$, then $\pi_2(D, 2, 2) \geq 0$ implies that $\alpha D(\beta - 1) - F \geq 0$. The explicit

expressions for D^* and \tilde{D} are $D^* = \frac{1}{\alpha\beta\gamma\delta}F$ and $\tilde{D} = \frac{1}{\alpha(\beta-1)}F$. Hence, $D^* \geq \tilde{D}$ if $\frac{1}{\alpha\beta\gamma\delta}F \geq \frac{1}{\alpha(\beta-1)}F$, i.e., if $1+\beta\gamma\delta-\beta \geq 0$. On the other hand, if $D^* < \tilde{D}$, there exists some \hat{D} , such that $D^* < \hat{D} < \tilde{D}$. When demand is given by \hat{D} , the Bronner criterion implies that the incumbent is *not* required to provide access. However, the entrant will enter, since this is profitable even if the firm has to build its own infrastructure. On the other hand, since $\hat{D} < \tilde{D}$, welfare is lower under duplication of the infrastructure than it would be under mandatory access.

For the last part of the proposition, note that in the absence of access rules, the incumbent invests if $\pi_1(D, 1, 1) \geq 0$. Let D' be the level of demand where $\pi_1(D', 1, 1) = 0$. From eq. (2) it is evident that $D' < D^*$. Hence, when demand is lower than D^* , the incumbent is certain that there will be no entry, while for higher levels of demand, there will be entry with duplication of the infrastructure. Assume instead that the essential-facilities doctrine applies under the set of circumstances described by the Bronner criterion. When demand is equal to or higher than D^* , the entrant will have to build its own infrastructure, just as in the absence of access rules. When demand is lower than D^* , the incumbent may have to share its infrastructure. However, the entrant will not enter unless it earns a non-negative profit. Due to the assumed symmetry, the incumbent will also earn a non-negative profit if there is entry. If there is no entry, the incumbent's profit will be same as if there were no access rules. Hence, the incumbent will not be deterred from making investments by the access rules. \diamond

The "Bronner" access rules allow the second firm to use the first firm's infrastructure when fixed costs are high relative to the level of demand. Given that the firms are not given subsidies and under certainty, this is optimal from an ex ante perspective. The incumbent is not deterred from investing by the access requirement and the entrant enters as soon as that is profitable.

However, according to the access rules, the second firm may have to install its own infrastructure too early, i.e., if $\frac{1}{\alpha\beta\gamma\delta}F < D$. The effect is illustrated by the discontinuous jump down of the right-most solid line segment in the upper part of Figure 2. Here, the benefit of competition in infrastructures is not large enough to off-set the social cost of duplicating the infrastructure.

Comparing the optimality condition for installing the second infrastructure, $\frac{1}{\alpha(\beta-1)}F < D$, with the actual rule, we see that there is a discrepancy between the two rules. Only when $\beta = \frac{1}{1-\gamma\delta}$ will the two rules have the firm invest at the same minimal level of demand. For relatively small values of β , $\beta < \frac{1}{1-\gamma\delta}$ (i.e., when the gross benefit from duplicating the infrastructure is small), the entrant will be forced to invest in its own infrastructure too early. For relatively large values of β , it would be socially optimal to duplicate the infrastructure for lower levels of demand than what is required. However, this would force both firms to run a loss and would, hence, require subsidies. In conclusion, the access rules allows entry in the downstream (service provision) market at the right level of demand, but they may force the incumbent to enter the infrastructure market too early.

Profit maximising behaviour under uncertainty

Assume instead that there is uncertainty and assume that the realisation of actual demand is drawn from the uniform distribution over the interval $[\underline{D}, \overline{D}]$. The above analysis is still valid for the second stage. However, the first-stage behaviour will depend on the level of uncertainty. In particular, the following proposition holds.

Proposition 3. Under uncertainty, access rules based on the Bronner criterion may deter welfare-improving investments.

Proof

It suffices with an example to demonstrate the proposition. Let $\alpha = 1.2$, $\gamma = 0.5$, $\delta = 1/3$, $F = 2$ and $E[D] = 4.5$. Let $\underline{D} = E[D] - s$ and let $\overline{D} = E[D] + s$. It is welfare improving to invest with expected demand at this level; $W(4.5, 1, 1) = 2.5$ and $W(4.5, 2, 1) = 3.4$. Without uncertainty, it would be privately profitable for the incumbent firm to invest, since $E[\pi_1] = E[\gamma D - F] = \gamma E[D] - F = 0.25$. The entrant would not enter, since $\pi_1 = \pi_2 = -0.1$ in a duopoly. Similarly, if there were uncertainty but if there were no access rules, the expected profit would still be 0.25, since profit is then (by assumption) linear in the realised demand. However, if we introduce uncertainty as previously and given the existence of access rules, the expected profit of firm 1

is given by:

$$\begin{aligned} E[\pi_1 \mid s, s > 0.5] &= \left(\int_{4.5-s}^5 \left(\frac{1}{2}x - 2\right)dx + \int_5^{4.5+s} \left(\frac{1}{5}x - 1\right)dx \right) / 2s = \\ &= (0.2125 + 0.15s - 0.15s^2) / 2s \end{aligned}$$

Evaluating the expression shows that the incumbent's profit will become negative for $s \gtrapprox 1.79$. For example, when $s = 2$, the expected profit of firm 1 will be -0.021875 . When the expected profit is negative, the incumbent will not invest in infrastructure. This, in turn, will result in an expected welfare loss of 2.5, relative to a situation without access rules. \diamond

The intuition for Proposition 3 is the following: In favourable (high demand) states of the nature, the incumbent will have to share its profits with the entrant. However, in unfavourable (low demand) states of nature, it will have to bear the full investment cost itself. Such a regulation will of course reduce the incumbent's expected profit and reduce the incentives to invest. Consequently, a higher level of expected demand is needed in order to make an investment profitable for the incumbent.

5 Conclusions

Ideally, the essential-facilities doctrine should prescribe access in such a way that welfare-improving investments are not deterred, while encouraging competition in the downstream market, in order that efficient use is made of the existing infrastructure. Furthermore, welfare-improving duplications of the infrastructure should be stimulated, while welfare-reducing duplications should be avoided.

The *Bronner* criterion for when the essential-facilities doctrine can be applied have the advantage of being well defined and conceptually relatively easy to understand. It appears also to have a "natural appeal". When only one firm is capable of building an infrastructure it must, according to the Bronner criterion, share this infrastructure with its competitors. Once there is an economic possibility for a competitor to duplicate the facility, this obligation is lifted.

However, the analysis in section 3 showed that this criterion may result in inefficiencies, for at least two reasons:

First, if there is substantial uncertainty as to the level of future demand for services based on the infrastructure and if the expected profitability is relatively low even for a monopoly, the obligation to share the infrastructure with a rival can make it unprofitable for the incumbent to invest in the first place. This investment-detering effect can reduce welfare, relative to a monopolised market.

Second, the limitation of the doctrine to situations where duplication of infrastructure is not economically viable may force the entrant to invest too much (in too small a market), from a welfare point-of-view. When duplication of infrastructure is just marginally viable, it can be more efficient to maintain the obligation for the incumbent to allow access.

Consequently, the essential-facilities doctrine should be applied according to a set of criteria such that i) when access is mandated, welfare is higher under access than under duplication of infrastructure, unless ii) a rational agent, taking the access requirement into consideration, would be deterred from making the initial investment. Naturally, the entrant will only claim access when doing so is profitable. The drawback with such a rule is that it would have to rely both on the level of demand uncertainty before the investment was made and on the consumer surplus under the different regimes considered. In contrast, the Bronner criterion is based only on the firms' profits under the different regimes.

In fact, unless such information is available, it is not even possible to determine whether an infinitesimal modification of the Bronner criterion would improve welfare. This can be illustrated with a simple example. Let D'' be the lowest level of demand where the entrant finds entry with access profitable. Assume that the Bronner criterion is modified so that entry is only allowed if demand is higher than $D'' + \varepsilon$, for some small ε . If there is no uncertainty, this modification reduces welfare, according to proposition 2. The reason is that welfare is always higher with two active firms than with just one, while investments are never deterred under certainty. However, if there is uncertainty, it follows from proposition 3 that the modification may improve welfare. This will be the case if the modification makes it profitable for the incumbent to make a welfare-improving investment that would have been deterred otherwise.

Despite this, a tentative suggestion is that the level of uncertainty prior to

the incumbent's investments should be taken into consideration. When there is little uncertainty, the applicability of the essential-facilities doctrine may be expanded, relative to the Bronner criterion. When the ex ante uncertainty is high, on the other hand, the applicability of the doctrine should be reduced. More specifically, when the level of uncertainty is low, the doctrine may be applied even if a symmetric infrastructure-and-services duopoly would be marginally profitable. Furthermore, when the level of uncertainty is high, the doctrine should *not* be applied if the firms in a symmetric duopoly with access to a single infrastructure would only make a small profit. The proposed ranges of application are schematically represented in Figure 3.

Note that if uncertainty is sufficiently high, it follows that the essential-facilities doctrine should not be applied at all. In a sense, this has been recognised in legal practice: it has been claimed that the doctrine should be applied more sparingly in relation to intellectual property.¹¹ A rationale for this claim is that the level of uncertainty is typically higher for R&D investments, than for investments in physical assets.

For the sake of completeness, it should be noted that application of the doctrine to intellectual property would normally *not* imply that the entrant could use the intellectual property (patent, et cetera) for free. Instead, the natural interpretation is that the entrant would pay a license fee, such that if the entrant had half the market, it would pay half of the net present value of the R&D investment. If, on the contrary, the entrant could use the intellectual property for free, it is obvious that investment incentives would be drastically reduced.

The analysis presented in this paper is related to that of Hausman (1999). Hausman assumes that access prices are always regulated and then derives an access-pricing formula that gives the incumbent firm the correct incentives to invest. In his model, higher uncertainty will result in a higher mark-up above the (ex post) cost of providing access. Hausman makes assumptions on realistic parameter values for the telecom industry and calculates the optimal mark-up; according to his estimate, a mark-up of approximately 3.3 over costs should be applied to the investment cost component of providing access. In the present paper, it is assumed that the access price will be set equal to the (ex post) cost of providing access, while instead the incumbent will only sometimes have an obligation to provide access. Although these are alternative ways of compensating the incumbent for the ex ante investment

¹¹Ritter et al. (1991), pp. 310-312, and Glasl (1994).

risks, the analysis of this paper follows more closely the logic of the essential-facilities doctrine.

An issue that is not analysed in this paper, but which is a possible subject for future research, is the risk that the entrant will not be able to reach a symmetric market position, i.e., a similar profit level as the incumbent. Under the *Bronner* criterion, no explicit account is taken for this risk. Hence, the competitive situation of the entrant may be such that it would make a profit if it attracted half of the customers and obtained half of the industry profit, while it in practice has no reasonable chance of doing so.

Another topic for future research are the incentives for, and the effect of, collusion.

6 Acknowledgments

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Appendix: Figures

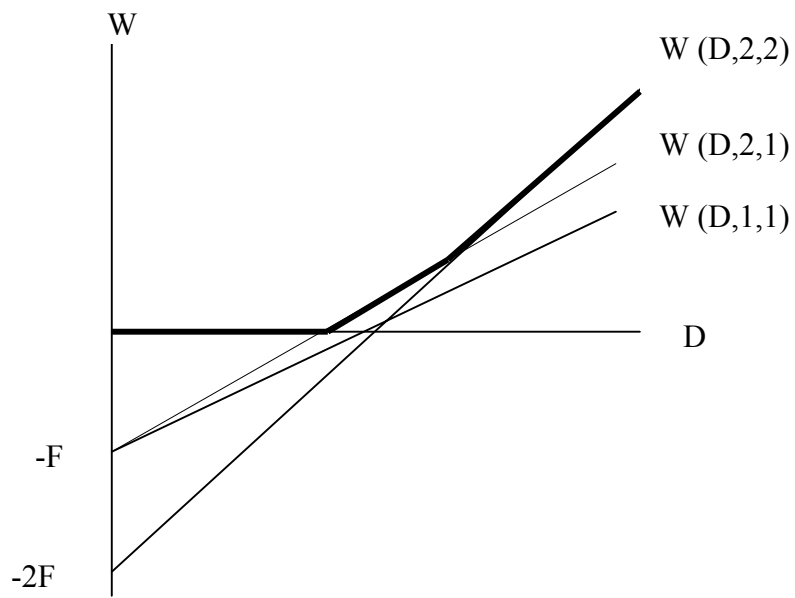


Fig. 1. Welfare

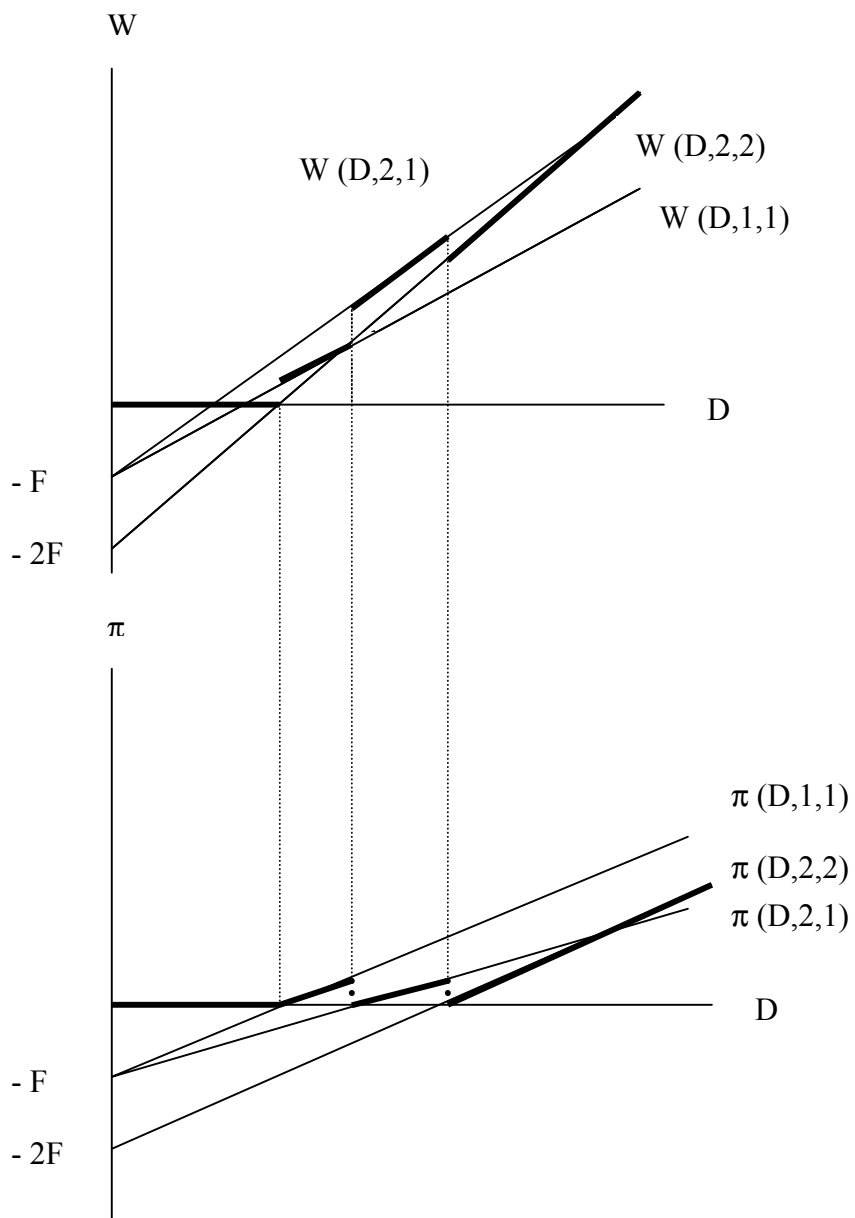


Fig. 2. Welfare and profit

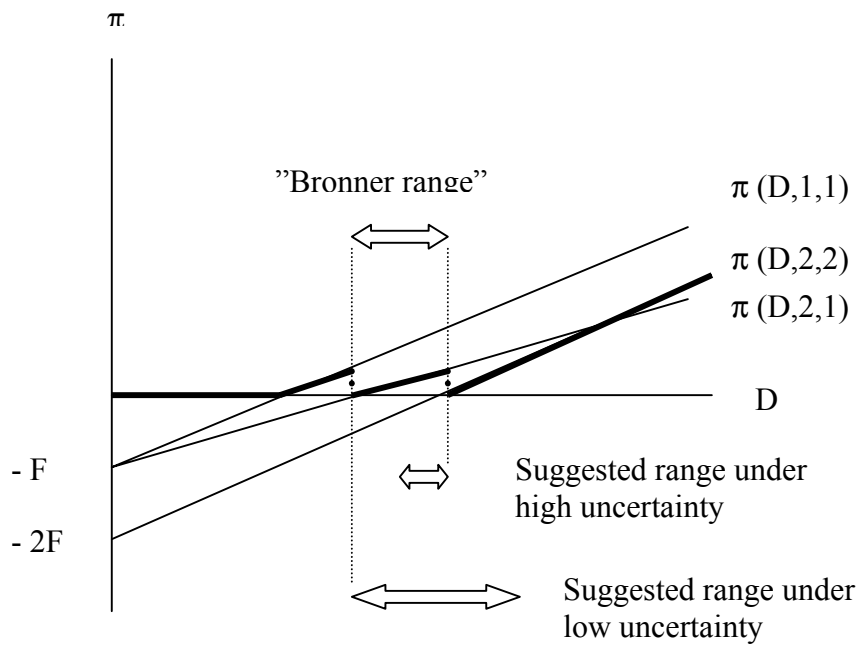


Fig. 3. Actual applicability of the essential facilities doctrine (the "Bronner range") and suggested ranges of applicability under high and low uncertainty