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by

Jan Yngve Sand

NCFS Working Paper Series in Economics and Management
No. 08/03, December 2003

Department of Economics and Management
Norwegian College of Fishery Science
University of Tromsø
Norway

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Jan Y. Sand*

University of Tromso,

NFH, Department of Economics, N-9037 Tromso, Norway

Jan.Sand@nfh.uit.no

Abstract

This paper considers the problem of excess entry in vertically related markets when the regulator can regulate market structure and access charges. The endogenous access charge introduces an asymmetry between firms which affects the degree of excess entry. I find that the excess entry result of Mankiw and Whinston (1986) does not generally carry over to vertically related markets. It is shown that regulating access charges combined with no structure regulation is always the best option. For an interval of the downstream fixed cost, no regulation of the access charge yields the same level of welfare as the regulated case.

JEL Classification: L13, , L22, L51, L96

Keywords: Market structure, regulation, excess entry

*I am grateful for very valuable comments from Kåre P. Hagen, Nils-Henrik von der Fehr, Derek Clark, and Gianni De Fraja. Part of this work was undertaken while visiting Department of Economics and Related Studies at the University of York, whose hospitality is greatly appreciated. This work has received financial support from Ingegerd og Arne Skaugs Forskningsfond and Norges Banks Fond til Økonomisk Forskning. This is a revised version of chapter 4 in my Ph.D. thesis.

1 Introduction

Allocative efficiency and entry conditions are two important issues that occupy many regulators, as ensuring that scarce resources are used efficiently is one on the main goals of regulation. Regulators aim at determining the correct (regulated) prices from a static allocative efficiency point of view, and prices that ensure that the degree of entry into the industry is socially optimal. This involves, among other things, removing inefficient entry barriers to encourage firms to enter the industry. In the absence of fixed costs, we know that more competition yields a better result. However, if there are fixed costs the welfare loss due to fixed cost duplication must be measured against the benefits of increased competition.

With imperfect competition and free entry there will, under certain conditions, be a tendency towards excessive entry (Mankiw and Whinston, 1986). The main trade-off in the determination of the access charge is then whether it should be set to create a level playing field or to limit the potentially excessive entry. The literature on excessive entry with imperfect competition typically only examines a single market. One of the goals of this paper is to examine whether the excessive entry result carry over to a setting with vertically related markets, where the input market may be subject to price regulation due to monopolisation and where the input monopolist may not be allowed to enter the downstream market. Mankiw and Whinston (1986) show, under the assumptions made in the present model (specifically ignoring the integer constraint), that more firms will enter in equilibrium than is socially optimal. In their model, however, there is only one market to consider. In the present model, firms operate in vertically related markets and the firm supplying the essential input may also serve the final product market. Furthermore, the price of the essential input may or may not be subject to regulation. I show that the excessive entry result arises as a special case in the present model.

In the present model it is assumed that the regulator has two main regulatory instruments at his disposal. First, the regulator may impose entry restrictions on the upstream monopolist. Entry into downstream markets by the upstream monopolist may be restricted if the regulator fears that a firm producing an essential input (an upstream monopolist) may foreclose rival firms in the downstream industry.[1] It is assumed that there is free entry for all independent firms, with the only obstacles to entry posed by the fixed costs incurred when entering. Second, the regulator may decide on the appropriate access charge.[2] The access charge will also affect the independent firms' profitability of entering. It is assumed throughout the paper that the regulator cannot subsidise access by setting an access charge lower than the upstream monopolist's marginal cost of providing the access, and the regulator cannot use lump-sum transfers.

The role of the access charge from a social point of view is twofold, and in setting the appropriate access charge there are some potentially opposing effects. First, it can be used to correct for the potential allocative loss downstream as a result of imperfect competition. Second, the access charge can be used to limit socially costly duplication of fixed costs. As long as there is imperfect competition downstream, there will be an allocative loss. The regulator may choose to set the access charge high enough to foreclose the rival firms if the fixed costs are sufficiently high.[3] An alternative policy to the regulation of access charge to avoid duplication of fixed costs is either to restrict the upstream monopolist's opportunity to enter into vertically related markets, or to limit entry by independent firms.

If we examine the upstream market in isolation, static allocative efficiency calls for pricing the input at marginal cost.[4] However, from the theory of second-best we know that when there are distortions in the economy, first-best pricing is generally not welfare maximising.[5] With imperfect competition (here, Cournot-competition) in a vertically related market (the downstream market), it may be necessary to subsidise entry to foster competition by pricing access below marginal cost. Realistically, such subsidies will be difficult to implement and financing such subsidies would normally require distortionary taxation which creates efficiency losses. In particular, in global markets where international trade agreements and cross-border competition policy agreements restrict the opportunity for subsidising production such subsidies are usually not viable. A policy of subsidised entry results in an increase in the downstream output, which consequently leads to consumers' welfare increasing. On the other hand, setting too low an access charge may encourage excess entry and too much duplication of fixed costs.

The vertical structure of the type of model considered here is compatible with a number of industries. All network industries typically consist of vertically related markets. The market for Internet access is one example. An essential input for the Internet access providers (IAPs) is access to the local loop, a service which usually is provided by telecommunications firms, many of which have substantial market powers. The pricing of local access is usually subject to regulation by national regulators. The final product market can be thought of as a market for broadband communication services. I have in mind a situation where the upstream firm provides transportation network services that may be used as an essential input to produce services to consumers, but the analysis applies more generally than this. The model presented below is stylised, but it is still general enough to be appropriate for the analysis of other cases where there is a distribution network (essential facility) and imperfect competition in a downstream market (electricity transmission and production, railroad, airline market and landing slots, etc.).

The rest of the paper is organised as follows: Section 2 presents the model and the formal analysis. Section 3 provides the welfare analysis under various policy combinations and evaluates how free entry compares to the social optimal degree of entry. In section 4, some concluding remarks are made.

2 The framework

In the model considered below there is only one upstream firm. The number of downstream firms is determined endogenously as a result of the regulatory policy. The analysis is conducted in the setting of a multi-stage game. In the *first stage* either the upstream firm or the regulator decides on an access charge. In the *second stage*, firms choose simultaneously to enter or not. In the *final stage*, firms compete simultaneously in quantities. The final stage of the game is unregulated. The choice of whether the upstream monopolist should be subject to entry restrictions is taken by the regulator prior to the access charge is being determined. We are looking for the subgame perfect equilibrium in the game.

The downstream firms are assumed to compete in quantities. The justification of Cournot competition in the final product market is that firms, prior to the final stage competition, need to choose the capacity of the transport network. This capacity choice amounts to building up a transport network, or leasing transport capacity from another firm (see Hansen, 1999). Thus, the quantity choices these firms make in the final stage of the game is in reality a choice of capacity.[6]

If the upstream monopolist is allowed to enter the downstream market, its profits consist of both the profit it earns from selling access and the profit from selling the final product to consumers. Firm v's upstream profit only is given by:

$$\pi^u = (w - \beta) \sum_{i=0}^{n} q_i \tag{1}$$

where $q_0 \geq 0$ is the output of the downstream subsidiary of the upstream monopolist and $q_i \geq 0$, $i = 1...n$, are the downstream output levels of the independent firms. The parameters w and β are the access charge and upstream marginal cost. I assume that the upstream firm must be financially viable as a separate entity, and that the regulator cannot (or will not) use transfers to compensate the upstream monopolist for any access deficits. I will therefore make the following assumption:[7]

Assumption 1 *The regulated access charge must ensure coverage of costs; i.e.,* $w \geq \beta$.

Fixed costs upstream is an important characteristic of most local access technologies, and is a major reason for the lack of competition in the local loop of telecommunication networks. In many networks the investments in infrastructure are already sunk, and play no role in the determination of the access charge. An *ad hoc* justification of leaving fixed costs in network provision out of the analysis is that the game which is played in the current paper takes place after investments are sunk. The level of these sunk costs is assumed to be high enough to deter entry into the upstream segment.

The profit obtained downstream for firms $i = 0, 1, ..., n$, is given by:

$$\pi_i = (P - w - c)\, q_i - F \tag{2}$$

where $P = a - \sum_{i=0}^{n} q_i$, is the inverse demand function. Let Q be the total quantity produced downstream, given by: $Q = \sum_{i=0}^{n} q_i$. Downstream marginal cost, c, is the same for all firms. All downstream firms pay the same access charge w, but for a vertically integrated firm the access charge is simply a transfer price. We assume that all firms must pay the same fixed costs, F, for establishing downstream operations. [8]

The regulator's welfare is given by:

$$W = \begin{cases} CS^{nsr} - (c+\beta)\sum_{i=0}^{n} q_i - (n+1)\, F \\ CS^{sr} - (c+\beta)\sum_{i=1}^{n} q_i - nF \end{cases} \tag{3}$$

where $CS^k = aQ_k - (Q_k)^2/2$, for $k = nsr, sr$, is the gross consumers' surplus under the cases of no structure regulation (nsr) and structure regulation (sr), respectively. In the latter case, the upstream monopolist is not allowed to enter the downstream market.

2.1 Output and entry decisions

Let us assume that firm v is active in both markets. Potential rival firms can enter the downstream market freely. The inverse demand function is then given by: $P = a - \sum_{i=0}^{n} q^i$, where firms $i = 1, ..n$ are the independent rival firms and firm 0 is the downstream subsidiary of the upstream monopolist. When there is free entry, the total number of rivals will be determined by the zero profit condition for all independent firms i:

$$\left(a - \sum_{i=0}^{n} q^i - c - w\right) q^i \geq F \tag{4}$$

Ignoring problems of indivisibilities, we can assume that the inequality is satisfied as an equality in equilibrium.[9] Since we assume that all potential entrants are symmetric, all active downstream rivals produce the same quantity; $q^i = q$,

$\forall i = 1, ..n$. The downstream subsidiary of the upstream monopolist faces the same downstream marginal cost as the independent firms. Any cost differences between the downstream competitors will therefore be due to the access charge being different from the marginal cost of providing access. This implies that the vertically integrated firm may have a different level of production. The total downstream quantity is given by $Q = nq + q_0$.

Cournot equilibrium In the final stage of the game firms compete in quantities, taking the access charge as given. It can be shown that when there are n entrants and the upstream monopolist is allowed to enter the competitive segment, the Cournot quantities for a given level of the access charge will be:

$$q^* (w, n) = \frac{a - c - 2w + \beta}{n + 2} \tag{5}$$

$$q_0^* (w, n) = \frac{a - c - (n + 1) \beta + nw}{n + 2} \tag{6}$$

where q^* and q_0^* represent the choice of output for each rival firm and for the vertically integrated firm. Note that in some of the cases considered below, the vertically integrated firm may enjoy a monopoly situation downstream, with the resulting monopoly output $Q_0^m = (a - c - \beta) / 2$.

The total downstream quantity is given as:

$$Q^* (w, n) = q_0^* (w, n) + nq^* (w, n) = \frac{(n + 1) (a - c) - nw - \beta}{n + 2} \tag{7}$$

If the network monopolist is not allowed to enter the downstream market, then it can be shown that the (symmetric) Cournot output for a single firm is given by:

$$\widetilde{q}^* (w, n) = (a - c - w)/(n + 1) \tag{8}$$

I will below discuss parameter restrictions which ensure that output is positive.

Entry decisions The entry decision by each independent firm is taken at the intermediate stage of the game, in which the equilibrium quantities from the final stage of the game are used to determine the profitability of entry. The zero-profit condition, eqn. (4), dictates the total number of rivals the industry can support for a given set of parameter values. By inserting for eqn. (5) into (4), we obtain the following expression which determines the number of firms, $n \geq 0$, that enters the downstream industry:

$$n \leq \widehat{n}(w) \equiv \frac{a - c - 2w + \beta - 2\sqrt{F}}{\sqrt{F}} \tag{9}$$

where $\widehat{n}$ is the value of n which ensures that (4) is satisfied as an equality. The actual number of firms, n, that enters will be the largest positive integer satisfying (9). By inserting for the chosen access charge, we can determine how many firms that actually enter.

When the upstream monopolist cannot enter the downstream market, the number of firms entering is determined by:

$$n \leq \widetilde{n}(w) \equiv \frac{a - c - w - \sqrt{F}}{\sqrt{F}} \tag{10}$$

If there are no fixed costs associated with entry and if the access charge is set equal to marginal cost of providing access ($w = \beta$), then $q^* = \widetilde{q}^*$. In this case, the number of firms entering the industry tends to infinity (since $\Pi^i \to 0$ only as $n \to \infty$).[10]

The entry dynamics implies that the regulator can determine the degree of entry into the industry if the access charge is regulated. We know from Mankiw and Whinston (1986) that there is a tendency for excess entry in markets with imperfect competition when the business stealing effect is significant. In this case, the profit of new firms entering the industry comes at the expense of incumbent firms' profits. This implies that the gain to society of a new firm entering is less than the gain to the entering firm.

I will assume that the following condition is satisfied:

Assumption 2 *To ensure that downstream output for the independent firms is positive, we must have the following:* $w \leq (a - c + \beta)/2$.

A necessary, but not sufficient, requirement for entry by independent firms is that the Cournot output is positive, which is ensured by assumption 2. Assumption 2 also ensures that the price-cost margin of the downstream firms is non-negative, and that the total equilibrium downstream output, Q^*, increases when more firms enter; i.e., $\partial Q^*/\partial n \geq 0$. Thus, under assumption 2 we know that the introduction of another firm in the downstream market implies that there is a *market expansion effect*.

Furthermore, assumption 2 ensures that each downstream firm's equilibrium quantity decreases in the number of firms: i.e., $\partial q^*/\partial n \leq 0$ and $\partial q_0^*/\partial n \leq 0$. This implication of assumption 2 captures the *business stealing effect* of new entry.[11] For each new entrant in the market, that particular firm brings an added social gain due to the market expansion effect. However, part of the profit of the potential new entrant comes from stealing some of the existing firms' market shares and profits. Thus, from a social point of view the profit of a given new entrant, which is the basis for the entry decision of that firm, is higher than the value to society of that new entrant.[12]

Consequently, there are opposing effects on welfare due to entry. First, consumers are better off due to the fact that quantity increases in the number of firms entering downstream. On the other hand, there are real economic costs due to entry, due to higher output and more duplication of fixed costs. The socially optimal entry implies balancing these costs and benefits.

2.2 Access charges

Both in the unregulated case (the upstream firm determines the level of the access charge) and in the regulated case (a regulator determines the access charge), the process of determining the level of the access charge may be seen as a problem of *outsourcing* a production activity. Generally, the desirability of outsourcing an activity will depend on cost differences between downstream firms (production efficiency). In the present model, this issue is irrelevant since firms have identical downstream costs. In the unregulated case, profit shifting between the network monopolist and independent firms will influence the outsourcing choice. In addition, and most importantly in the present model, the regulator faces a trade-off between increasing the downstream production through entry and the socially costly duplication of fixed costs. The optimal access charge is determined by the optimal trade-off between the regulator's concern to achieve allocative efficiency (to which the process of free entry yields insufficient entry) and the business stealing effect (which tends towards excess entry).

The main focus of this paper is not on the determination of access charges, but when examining excess entry under the various regimes the access charge is indirectly utilised. Consequently, both the unregulated and regulated access charges are reported in this section.[13]

Lemma 1

When the access charge is unregulated, we have the following:

i) Without structure regulation, the vertically integrated firm will choose an access charge to completely foreclose its downstream rivals.

ii) With structure regulation, the access charge is implicitly determined by: $\widehat{n}\widetilde{q}^{*} + (w-\beta)\frac{\partial \widehat{n}}{\partial w}\widetilde{q}^{*} + (w-\beta)\,\widehat{n}\frac{\partial \widetilde{q}^{*}}{\partial w} = 0$. *The closed-form solution is:* $w_r^{ur} = \frac{1}{2}\left(a - c + \beta - \sqrt{F}\right)$.

The vertically integrated firm will never find it profitable to allow symmetric rivals to enter the downstream industry, as this would simply mean shifting profit from the vertically integrated firm to the independent rival firms. If structure regulation is imposed, the upstream firm will necessarily have to allow entry by independent downstream firms.

Lemma 2

The socially optimal access charges are given by:

i) Without structure regulation, the access charge is implicitly determined by: $\frac{dCS(\widehat{n}(w),w)}{dw} - (c+\beta)\frac{dQ^{*}(\widehat{n}(w),w)}{dw} - \frac{\partial \widehat{n}}{\partial w}F = 0$. *The closed-form solution is:* $w^{*} = \beta + \sqrt{F}$.

ii) With structure regulation, the access charge is determined by: $\frac{d\widetilde{CS}(\widetilde{n}(w),w)}{dw} - (c+\beta)\frac{d\widetilde{Q}^{*}(\widetilde{n}(w),w)}{dw} - \frac{\partial \widetilde{n}}{\partial w}F = 0$. *The closed-form solution is:* $w_r^{*} = \beta$.

The results presented in Lemma 2 are equivalent to Vickers (1995).

In the absence of fixed costs we know that the number of firms entering the downstream market approaches infinity, and it can be shown that $\partial W/\partial w < 0$. Consequently, the regulator will choose to determine an access charge as low as possible without violating the constraint $w \geq \beta$ (i.e., $w^* = \beta$). A benevolent regulator will want to determine an access charge to obtain the socially optimal mix between maximising consumers' surplus and utilising the economies of scale that are present in the downstream industry. If maximising consumers' surplus is the regulator's only concern, then this is an argument for marginal cost pricing of access which implies a higher total quantity in the downstream market. The regulator will also be concerned with the duplication of fixed costs associated with entry, which results in inefficient utilisation of economies of scale. This implies that the regulator will want to set an access charge in excess of marginal cost to limit the degree of entry. In a social optimum, the price of access should then reflect the true social cost of expanding output, which will consist of two elements: the marginal cost of access and the social cost of utilising the economies of scale of the network monopolist's own subsidiary less.

When there are fixed costs and the upstream monopolist is not allowed to enter into the downstream market, the welfare function is decreasing in the access charge for all values of w. When there are no vertical restrictions (see the previous subsection), the welfare function is strictly decreasing in the access charge only when there are no fixed costs. Transferring production between firms entails reducing the production of one independent firm and increasing it for another, and there are no losses in the economies of scale of the network monopolist's own downstream activities (of which there are none in this scenario).

3 Excess entry and welfare

In this section I will examine how actual entry compares to the socially optimal level of entry under the various combinations of policies. There are four different policy combinations to consider: 1) No structure regulation and access charge regulation, 2) no structure regulation and unregulated access charge, 3) structure regulation and access charge regulation, and 4) structure regulation and unregulated access charge. The outcomes in terms of access charge and the number of firms downstream, are summarised in the following table (AR denotes the case of access charge regulation, whereas UR denotes the unregulated access charge case):

	No structure regulation	*Structure regulation*
AR	(1) $w^* = \beta + \sqrt{F}$ $\widehat{n}^* + 1 = \frac{a-c-\beta-3\sqrt{F}}{\sqrt{F}}$	(3) $w_r^* = \beta$ $\widetilde{n}^* = \frac{a-c-\beta-\sqrt{F}}{\sqrt{F}}$
UR	(2) $w^{ur} \rightarrow$ *complete foreclosure* $\widehat{n}^{ur} + 1 = 1$	(4) $w_r^{ur} = \frac{1}{2}\left(a-c+\beta-\sqrt{F}\right)$ $\widetilde{n}^{ur} = \frac{a-c-\beta-\sqrt{F}}{2\sqrt{F}}$

In order to be able to make the welfare comparisons we need to know when there is entry by independent firms. This information is summarised in Lemma 3:

Lemma 3 *We know the following about independent firms' entry:*
1) $\widehat{n}^{ur} = 0$,
2) $\widehat{n}^* \geq 1$ *if* $a-c-\beta-5\sqrt{F} \geq 0$,
3) $\widetilde{n}^{ur} \geq 1$ *if* $a-c-\beta-3\sqrt{F} \geq 0$, *and*
4) $\widetilde{n}^* \geq 1$ *if* $a-c-\beta-2\sqrt{F} \geq 0$.

Assumption 3 *To ensure that at least one independent firm enters in the structure regulation case, let us assume* $a-c-\beta-2\sqrt{F} \geq 0$.

The welfare levels for the four cases are, respectively:

$$\begin{aligned}
1)\ W_{nsr}^* &= (a-c-\beta)\left(a-c-\beta-2\sqrt{F}\right)/2 + F \\
2)\ W_v^m &= \frac{1}{8}\left(3(a-c-\beta)^2 - 8F\right) \\
3)\ W_{sr}^* &= (a-c-\beta)\left(a-c-\beta-2\sqrt{F}\right)/2 + F/2 \\
4)\ W_r^{ur} &= \frac{3}{8}\left(a-c-\beta-\sqrt{F}\right)^2
\end{aligned}$$

In the present model, a vertically integrated monopoly is preferred to a situation with vertical separation with independent firms downstream if the access charge remains unregulated. This is due to the vertically integrated firm's ability to avoid the problem of double-marginalisation. The same applies to the situation where a benevolent regulator determines the access charge. Actual entry is larger under structure regulation, with $\widehat{n}^* < \widetilde{n}^*$, since the regulator prices access at marginal cost when combined with structure regulation. Consequently, there is more competition with structure regulation. With more competition, the (gross) consumers' surplus is higher (under assumption 3). However, since $\widehat{n}^* < \widetilde{n}^*$ we also know that the duplication costs are larger, and in the present model the duplication costs outweigh the increase in consumers' surplus from more competition.

3.1 Excess entry?

If there is free entry into a market and imperfect competition, we know from Mankiw and Whinston (1986) that free entry under certain conditions results in a socially excessive number of firms in the industry.[14] Entry by new firms expands total output, which is a benefit to consumers' surplus. However, entry also entails duplication of fixed costs. If there is excessive entry this should be interpreted in the following way: The government seeks higher total output, but by fewer firms (von Weizsacker, 1980). The socially optimal number of firms is, of course, not necessarily equal to the number of firms that ensures zero profit. In this section we will look at how entry varies with different policy combinations. I will focus on how the established result that free entry together with the business stealing effect leads to excessive entry when there is imperfect competition may change if (1) an upstream firm may serve a vertically related market, and (2) when the access charge may be subject to regulation. I consider a model similar to Mankiw and Whinston (1986), which is extended to examine vertically related markets. I obtain the excess entry result as a special case.[15] I discuss a general characterisation of free entry versus socially optimal entry, before I proceed to a more detailed analysis with a linear inverse demand function. The socially optimal level of entry is defined by the first-order condition with respect to n on the appropriate welfare function (depending on whether there are restrictions on the network monopolist's opportunity for entry into the final product market). The socially optimal level of entry will then be compared to the level of entry that takes place in the four cases of policy combinations.

When the regulator allows the network monopolist to enter the downstream market, the number of firms entering is determined by eqn. (9), whereas when he is not allowed to enter the number of firms is determined by eqn. (10). When the regulator chooses to determine the access charge, he implicitly affects the degree of entry. Similarly, if the regulator chooses *not* to regulate the access charge, he also makes an implicit choice about the level of entry. In this section, the analysis is not an attempt to shed light on subgame perfect policies, but rather to examine whether the excess entry result of Mankiw and Whinston (1986) carries over to each of the four scenarios analysed in the present paper. This implies that I only examine whether free entry results in excessive, socially optimal, or insufficient entry for each of the cases (i.e., for the given level of access charge in each case).

3.1.1 The general case

In order to determine the socially optimal level of entry, denoted n^*, the welfare maxmising regulator maximises eqn. (3) with respect to n (ignoring the integer constraint):

$$W'(n) = \frac{\partial CS(n,w)}{\partial n} - (c+\beta)\frac{\partial Q^*(n,w)}{\partial n} - F = 0 \tag{11}$$

where $CS = \int_0^{Q^*(n,w)} P(s)\,ds$ is the consumers' surplus, and $Q^*(n,w) = q_0^*(n,w) + nq^*(n,w)$ is total output. Eqn. (11) can be rewritten as (for all n):

$$W'(n) = (P-c-\beta)\left[\frac{\partial q_0^*}{\partial n} + n\frac{\partial q^*}{\partial n}\right] + \pi_n^* + (w-\beta)\,q^* = 0 \tag{12}$$

by noting that the equilibrium profit for the (symmetric) independent firms when n firms enter is $\pi_n^* = (P-c-w)\,q^* - F$. From Assumption 2 we know that both $\partial q_0^*/\partial n \leq 0$ and $\partial q^*/\partial n \leq 0$. By Assumption 1 and 2 $(P-c-\beta) \geq 0$, and Assumption 1 ensures that $(w-\beta)\,q^* \geq 0$.

To examine whether there is excess entry, we need to examine how the independent firms' level of profit varies with entry and we also need to examine the relationship netween $W'(n)$ and π_n^*, where π_n^* is defined as the equilibrium profit for an independent firm when n firms enter. It is easily shown that $\partial\pi^*/\partial n < 0$. Since the free entry level n^e is determined by $\pi_{n^e}^* = 0$ and $\partial\pi^*/\partial n < 0$, then $n^* \leq n^e$ if $\pi_{n^*}^* \geq 0$.

From eqn. (12) we observe that if

$$(P - c - \beta)\left[\frac{\partial q_0^*}{\partial n} + n\frac{\partial q^*}{\partial n}\right] + (w - \beta)\, q^* \leq 0 \tag{13}$$

then $W'(n) \leq \pi_n^*$,for all n, which implies that $\pi_{n^*}^* \geq 0$. Then, $n^e \geq n^*$. However, the two elements in (13) have opposing signs, which makes it difficult to ascertain whether free entry and imperfect competition yields excess entry. If the access charge is sufficiently high, we may obtain both socially optimal entry or insufficient entry. In the special case where $w = \beta$, which essentially corresponds to the Mankiw and Whinston (1986) model, it is easily seen that $W'(n) \leq \pi_n^*$. Thus, when $w = \beta$ there is excess entry in the downstream market. In the present model, the regulator will choose marginal cost pricing of access if structure regulation is imposed. In Mankiw and Whinston (1986) free entry is socially efficient if the marginal entrant does not produce any net social gain (i.e., if $P - c - \beta = 0$). In the present model, this is only true is access is priced at marginal cost. If $w > \beta$ and $(P - c - \beta) = 0$, then there is insufficient entry. The reason is that part of the cost of producing in the downstream market - the access charge - is endogenous and in excess of the social cost of providing access. This reduces the Cournot output of the independent firms, and, consequently, reduces the profitability of entry.

When the network monopolist is allowed to enter the downstream market, the condition (13) for excess entry (for a given access charge) can, when using the linear model, be rewritten as:

$$(w - \beta) - \frac{n+1}{n+2} q_0^* (n, w) \leq 0 \tag{14}$$

When the network monopolist is not allowed to enter the downstream market, the condition (13) can be rewritten as:

$$(w-\beta)-\frac{n}{n+1}\left(\frac{a-c-(n+1)\beta+nw}{n+1}\right)\leq 0 \tag{15}$$

If the inequality in either (14) or (15) holds strictly, there will be excess entry. If the inequality is reversed and holds strictly, there is insufficient entry, whereas if (14) or (15) holds as an equality free entry is socially efficient.

To evaluate if free entry yields excess entry, insufficient entry, or socially optimal entry I will turn to the linear specification of the model.

3.1.2 Structure regulation

Let us first consider the case where the network monopolist only serves the access market (i.e., the situation with structure regulation). In this case, the only major difference to Mankiw and Whinston (1986) is that the marginal cost of the downstream firms is endogenously determined. If the access charge is regulated we observe that entry is twice as large as in the unregulated case ($\widetilde{n}^{*}=2\widetilde{n}^{ur}$), which implies that the regulator will choose a level of access charges such that more firms find it profitable to enter.[16] This result is summarised in the following remark:

Remark *If the market for the intermediate good (access) is unregulated and the monopolist provider of access cannot operate in the final product market, then free entry and imperfect competition results in a lower level of entry than if the access charge is regulated.*

From eqn. (15) we observe that the profit margin on access is crucial in determining whether there is excess entry. In the regulated case, with marginal cost pricing of access, we know that the present model is essentially identical to Mankiw and Whinston (1986). Thus, taking the access charge as given there is excess entry. Inserting for the unregulated access charge w_r^{ur} from Lemma 1, we find that the left-hand side of the inequality in (15) will be:

$$-\frac{1}{2(n+1)^2}\left(a-c-\beta-(2n+1)\sqrt{F}\right)$$

The sign of this expression will depend on both the level of fixed costs and the number of firms entering. Naturally, there is an inverse relationship between F and n; as F increases less firms will want to enter. If the access charge is regulated, (15) can be rewritten as:

$$-\frac{n}{(n+1)^2}(a-c-\beta) \tag{16}$$

The comparison between the actual entry and the socially optimal level of entry is summarised in the following proposition:

Proposition 1 *Assume that at least one independet firm enters the downstream market. If the network monopolist is not allowed to enter the downstream market:*

a. The regulation of the access charge implies that the excess entry result of Mankiw and Whinston (1986) is retained.

b. If the network monopolist determines the access charge, then there may be either socially optimal or insufficient entry. If fixed costs are sufficiently high, such that $\left(a-c-\beta-(2n+1)\sqrt{F}\right)=0$*, the free entry equilibrium is socially efficient* $(n^e=n^*)$*. For lower fixed costs, there is insufficient entry.*

Proof. If $\left(a-c-\beta-(2n+1)\sqrt{F}\right)=0$, then $W'(n)=\pi_n^*$. This implies that $\pi_{n^*}^*=0$, and $n^e=n^*$. Furthermore, $n^*=n^e=1$. If $\left(a-c-\beta-(2n+1)\sqrt{F}\right)>0$, then $W'(n)>\pi_n^*$ and $\pi_{n^*}^*<0$. Thus, $n^e<n^*$ and $n^e>1$. If $2\sqrt{F}<a-c-\beta<3\sqrt{F}$, then $W'(n)<\pi_n^*$ and $\pi_{n^*}^*>0$. Thus, $n^e>n^*$. ■

As the result above suggests, the unregulated monopolist will determine an access charge which may induce the socially optimal number of firms to enter but may in some cases induce insufficient entry. This result is contrary to what is obtained by Mankiw and Whinston (1986). A welfare maximising regulator will choose an access charge which induces more entry than what is socially optimal. Levelling the playing field by using marginal cost pricing of access does not incorporate the effect of business stealing by entering firms, but takes only into account the direct cost of entry (the cost of production and the duplication costs). The unregulated network monopolist will attempt to capture some of the (total) downstream profit by determining an access charge in excess of marginal cost, and realises that some of the profit a new entrant earns is a result of business stealing. Consequently, the network monopolist finds it less profitable to let a new firm enter and (partly) internalises the external effect posed by business stealing. If fixed costs are so high that it is socially optimal to only have one downstream firm, the network monopolist prices access to induce optimal entry and earns a positive profit.[17]

3.1.3 No structure regulation

If we examine the situation where there is no structure regulation where the network monopolist can serve the final product market, then a similar result is obtained. When the access charge is determined by the network monopolist, the access charge is set high enough to deter all entry by independent firms (Lemma 1), which implies that there is only one active firm in the downstream market. If, however, the regulator determines the level of the access charge he cannot do worse in terms of entry than in the unregulated case. Provided that the level of fixed costs is not too high, regulating access charges will lead to a higher degree of entry than in the unregulated case (specifically, if $a - c - \beta \geq 4\sqrt{F}$, then $\widehat{n}^* \geq \widehat{n}^{ur}$). This can be summarised as follows:

Remark *Assume there is free entry and imperfect competition downstream. Setting socially optimal access charges when the network provider is allowed to serve the downstream market will always result in at least the degree of entry that prevails if the access charge is set by the network provider.*

The relationsship between the socially optimal level of entry and the free entry level is determined by (14), and can when the access charge is regulated be written as:

$$-\frac{(n+1)}{(n+2)^2}\left[(a-c-\beta)-\left(3+\frac{1}{(n+1)}\right)\sqrt{F}\right]=0 \tag{17}$$

If access charge is unregulated the network monopolist will foreclose all independent rivals, with $w^{ur} = \frac{1}{2}\left(a - c + \beta - (n+2)\sqrt{F}\right)$. Given this access charge, it can be shown that it is socially optimal to have zero entry. Consequently, when the access charge is unregulated $n^e = n^* = 0$.

Proposition 2 *Assume that the network monopolist is allowed to enter the downstream market.*

a. There will be no entry if the monopolist determines the access charge. This corresponds to the socially optimal level of entry for $w = w^{ur}$.

b. If the access charge is subject to regulation and at least one independent firm chooses to enter, there is excess entry. The degree of excess entry is less pronounced without structure regulation than in the case with structure regulation.

c. If the level of fixed costs prohibits profitable entry by independent firms, there may be insufficient entry.

Proof. The proof of part a. is straightforward and hence omitted. From Lemma 3 we know that $(a - c - \beta) - 3 - 5\sqrt{F} > 0$ to have entry by independent firms, and when this inequality is satisfied, the sign of eqn. (17) is negative for all n. Then, $W'(n) < \pi_n^*$ and $\pi_{n^*}^* > 0$. Thus, $n^e > n^*$. By comparing (16) and (17), we observe that the former is more negative than the latter. Thus, $\pi_{n^*}^*|_{SR} > \pi_{n^*}^*|_{NSR}$, and, consequently, $n^*|_{SR} < n^*|_{NSR}$ since $\partial\pi/\partial n < 0$. ■

Consequently, leaving the pricing of access services unregulated results in a degree of entry which is lower than the level induced by a welfare maximising regulator, due to complete foreclosure. Again, contrary to the result obtained by Mankiw and Whinston (1986), there is no excessive entry in the present model of vertically related markets provided that the price of the intermediate product is unregulated (even if there is both imperfect competition and business stealing effect of new entry). However, if the access charge is subject to regulation then there is excess entry, but to a lesser extent than in the case with both access charge regulation and structure regulation. Note that with marginal cost pricing of access, there is a substantial degree of excess entry when the network monopolist is allowed to enter the downstream market. In the case with a regulated access charge, there may be socially insufficient entry. The level of fixed costs may be high enough to deter profitable entry, even if such entry is socially beneficial. The reason being that the entrant cannot capture the entire social surplus of entry.

3.2 Access regulation, structure regulation or no regulation?

In this section I will examine which policy or combination of policies, that yields the best outcome in terms of welfare for different levels of the fixed costs. One question we may ask is whether there are conditions under which regulation of access charges always dominates unregulated access charges. It turns out that the level of welfare in the scenarios with a regulated access charge only dominate the unregulated access charge scenarios when the size of the market is large relative to the level of fixed costs. It may, in certain situations, be better in terms of welfare not to regulate the access charge.

The results of the welfare comparisons are gathered in the following proposition:

Proposition 3 *Welfare comparisons:*

1. If $a - c - \beta \geq 6\sqrt{F}$, in which case at least one independent firm enters (independent of regulatory structure), then $W^*_{nsr} > W^*_{sr} \geq W^m_v > W^{ur}_r$.

2. If $6\sqrt{F} > a - c - \beta \geq 5\sqrt{F}$ in which case at least one independent firm enters (independent of regulatory structure), then $W^*_{nsr} > W^m_v > W^*_{sr} > W^{ur}_r$.

3. If $5\sqrt{F} > a - c - \beta \geq 4\sqrt{F}$ in which case no independent firms enter without structure regulation, then $W^*_{nsr} = W^m_v > W^*_{sr} > W^{ur}_r$.

Proof. It is easily shown that $W^m_v > W^{ur}_r$ and $W^*_{nsr} > W^*_{sr}$. Provided that at least one independent firm enters under structure regulation (with and without access charge regulation), $W^*_{nsr} > W^*_{sr} > W^{ur}_r$. Furthermore, welfare is never higher than W^*_{nsr}, and W^*_{nsr} is strictly higher than the (best) alternative if $a - c - \beta - 5\sqrt{F} \geq 0$. If $\widehat{n}^* \geq 1$, we can show that $W^*_{nsr} > W^m_v$ and if $\widehat{n}^* = 0$, $W^*_{nsr} = W^m_v$ since firm v enjoys a de facto monopoly in both scenarios. What can also be shown is that $W^*_{sr} \geq W^m_v$ only if $a - c - \beta - 6\sqrt{F} \geq 0$, with $W^*_{sr} > W^m_v$ if $a - c - \beta - 6\sqrt{F} > 0$. ■

Consequently, we find that when the level of fixed costs is relatively low compared to the size of the market, regulating access charges will always yield at least the same level of welfare as the next best policy combination. For sufficiently low fixed costs, regulation of the access charge is always strictly better than the best alternative. If, however, fixed costs are sufficiently high, not regulating access charges in combination with the absence of structure regulation may yield higher welfare than regulating access charges and imposing structure regulations. Furthermore, for an interval of fixed costs, leaving access charges unregulated may be as good as regulating access charges (assuming that there is no structure regulation). This is due to the fact that no independent firms find it profitable to enter if fixed costs are sufficiently high, since $w^* = \beta + \sqrt{F}$.

We see that the lower the level of fixed costs associated with entry into the downstream market, the better does the regulation of access charges do. Intuitively, it may be reasonable to assume that low levels of fixed costs, or equivalently low barriers to entry, necessitates less regulatory intervention. This is, however, not the case. Low fixed costs implies a higher degree of entry, *ceteris paribus*, provided that the access charge is regulated. If there is no regulation of the access charge we have seen that the subgame perfect equilibrium may entail complete foreclosure of all rival firms (Lemma 1). This suggests that at least some form of regulatory intervention may be desirable. Regulating the access charge only will, provided that the fixed costs are low enough, result in entry which is beneficial for consumers, and will never be worse than a double monopoly. For sufficiently low fixed costs, the expansion in output due to entry, with entry aided by access charge regulation, outweighs the social cost of duplication. Another alternative is to only impose structure regulation, which may be superior in terms of welfare compared to the complete foreclosure case, as it entails at least some degree of entry and output expansion. If the fixed costs are not too high, the gain to consumers' surplus outweighs the cost of duplication.

4 Concluding remarks

This article has studied socially optimal regulatory policies in vertically related markets, where the regulatory instruments available are access charge and structure regulation. Furthermore, it is examined whether the excess entry result obtained by Mankiw and Whinston (1986) carries over to a situation with vertically related markets. It is shown that free entry may or may not induce excessive entry in an imperfectly competitive downstream market depending on the regulatory policy chosen.

The analysis above is undertaken in a very stylised model, which does not capture all aspects of vertically related industries and network industries in particular. First of all, the model assumes that there are no economies of scope between network provision and service provision. This may be a simplification in, for instance, the telecommunications industry where network providers often argue that there are substantial synergy effects between these two production elements. This implies that there are additional benefits to society from vertical integration that are not taken into account in the present analysis. The presence of economies of scope will only strengthen the result that the subgame perfect regulatory policy involves regulation of access charges and vertical integration. Allowing for economies of scope may, however, change the ranking of some of the socially suboptimal regulatory policies. In other related settings, it is not so obvious that there are economies of scope - for instance between content provision and distribution services in the Internet industry. The data flow from content provision provided over the Internet is often transported through the traditional telecommunications network, and it is not necessarily the case that the traditional telecom firms are better at providing content than independent firms. In some cases, for instance news and certain types of information, it seems reasonable that some independent firms are better equipped for producing content. Economies of scope may also have an impact on the degree of excess entry into the downstream market, since such a cost structure contributes to the asymmetry between independent firms and the vertically integrated firm. If the network monopolist is allowed to enter the downstream market, the presence of economies of scope between upstream and downstream activities introduces a cost advantage for the integrated firm in the downstream market which may reduce the profitability of entry for independent firms. Consquently, less independent firms will enter and the degree of excess entry is reduced.

The present paper does not examine network externalities, which are essential in the industries that have motivated this research. How the introduction of such effects will influence the outcome depends on the way the network externalities work. Let us, for instance, assume that the level of the network effect is determined, in part, by the total quantity (of, e.g., network subscriptions) in the downstream market. If all networks are perfectly interconnected, all firms enjoy the same level of network effects for all configurations of the industry. This will increase the size of the total market, but not the distribution of market shares. If network externalities are increasing in the downstream output, then the regulatory policy that results in the highest level of output will also generate the highest level of externalities. This will be an additional social benefit not taken into account in the present analysis. In the present model, the output is largest when structure regulation is combined with regulation of the access charge. Network externalities that are related to output are also likely to increase society's value of entry, and the socially optimal level of entry is likely to be higher than in the absence of of such effects. This may mitigate the excess entry result obtained in one case, but will strengthen the insufficient entry result obtained in another case. Imperfect interconnection quality, or network effects that accrue asymmetrically to firms will affect the desirability of entry by independent firms.

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Notes

[1]An alternative to control the number of downstream firms is to restrict entry by the use of licenses. This is, however, not considered in the present paper.

[2]One might argue that regulating the final product prices is another alternative. However, as is argued by, e.g., Laffont and Tirole (2000), the more severe monopoly problem is in the upstream market with (potentially) significant economies of scale. The downstream market is more competitive. This leads us to the conclusion that the more appropriate regulatory policy would be to direct the attention to the bottleneck segment (network services) which is the real problem, and regulate access charges rather than regulating the prices of the final products.

[3]If we allow for differences in marginal cost downstream, the regulator may decide to foreclose (some of) the rival firm(s) if the rival firm is very inefficient relative to the downstream subsidiary of the access provider.

[4]If there are fixed costs upstream, the access charge must be in excess of the marginal cost of providing access. Furthermore, dynamic efficiency aspects may call for access charges in excess of marginal costs in order to provide the appropriate investment incentives for the network owner. Such dynamic aspects are not considered in the current paper.

[5]The classical reference on second-best theory is Lipsey and Lancaster (1956).

[6]It is often argued that a more realistic assumption is that firms compete in prices, not quantity. However, the Cournot outcome can, provided that certain assumptions are met, be seen as the outcome of a two-stage game where capacity choice precedes price competition (Kreps and Scheinkman, 1983).

[7]Note that assumptions 1 and 2 both put restrictions on the magnitude of the endogenous variable w. However, it turns out that both the unregulated and regulated access charges all satisfy the restrictions imposed by assumptions 1 and 2 if the level of the fixed costs satisfies the following inequality; $a - c - \beta - 2\sqrt{F} \geq 0$.

[8]This could be costs associated with setting up a distribution and sales network, marketing expenses, and it is reasonable that both firms face the same fixed costs. The fixed costs could also be attributed to a USO-fee (USO - Universal Service Obligation) payable by all downstream firms.An extension to the present model could be that the regulator determines the level of the fixed costs by the choice of a USO-fee.

[9]In reality, there are of course indivisibility and the zero profit condition is satisfied as an equality only by coincidence. The true number of firms which will enter is the largest positive integer which satisfies the zero profit condition, and this will in general imply that firms earn positive profits downstream. However, to simplify the analysis I abstract from this problem.

[10]This is the same result as in Mankiw and Whinston (1986), who find that if the fixed cost of entry approaches zero the bias towards excessive entry tends to infinity. However, they prove that the welfare loss caused by having too many firms approaches zero in this case. A similar result is also obtained by Novshek (1980).

[11]Seade (1980) discusses the presence of business stealing in a conjectural variation model.

[12]Assumption 2 satisfies all the conditions laid down by assumption 1-3 in Mankiw and Whinston (1986), in which case free entry in imperfectly competitive markets tends towards excessive entry.

[13]For a more detailed analysis of the access pricing see Sand (2002).

[14]The tendency towards excessive entry in markets with imperfect competition is also discussed by Perry (1984) and von Weizsacker (1980).

[15]The main difference to the general formulation of the excess entry problem below is that I, contrary to Mankiw and Whinston (1986) assume that production costs are linear in output. A more general cost function could be formulated without changing the results, but would complicate the analysis since the present model incorporates an access charge (not present in Mankiw and Whinston, 1986).

[16]We know from Lemma 1 that an unregulated network monopolist can only capture his monopoly profit through the access charge, and will, since he is restricted to a linear tariff scheme, choose an access charge in excess of marginal cost to capture some of this profit, which results in a lower level of entry. A welfare maximising regulator, however, chooses to use marginal cost pricing of access.

[17]A higher access charge than w_r^{ur} will result in no entry and zero profit for the network monopolist. A lower access charge induces more firms to enter, but the first-order loss from a lower access charge dominates the second-order gain from output expansion.