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# NEW COMPETITION IN TELECOMMUNICATIONS MARKETS: REGULATORY PRICING PRINCIPLES

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## Abstract

Launching and stimulating competition in telecommunications markets is an important policy goal. It contains two elements: to encourage entry and to make competition effective such that consumers benefit. The first one requires that entrants can make profits after investing in infrastructure so that they have an incentive to invest. The second one requires prices to be sufficiently low so that consumers enjoy higher net utilities. At a first glance, these two elements seem difficult to achieve at the same time. In this paper, we consider price regulation in the retail and wholesale market and answer to what extent such regulatory policy can stimulate competition. Our main finding is that, in the short run, asymmetric access price regulation is an effective instrument to make the entrant and consumers better off.

JEL Classification: L96, L51, L13.

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# 1 Introduction

It has become conventional wisdom that competition in telecommunications (possibly subject to regulation) serves welfare and consumers better than the former state monopoly, both from a static as well as from a dynamic perspective. The British regulating authority Oftel states: "Competition is the means to best protect consumers interests. Competitive markets with incentives to innovate are fundamental to meeting consumer needs. Regulation must not undermine such incentives but instead should be directed towards achieving effective competition and, as necessary, protecting consumers before it is achieved or where there is a need for additional protection." (Oftel, 2000, 1.2–1.4). Regulation (shortly after liberalization) can thus be seen as a means to promote competition in the short and the longer run. It promotes competition in the short run if, for given entry, the pressure on prices is increased; it promotes competition in the long run if entry into the market is facilitated.

Shortly after liberalization, the regulator possibly has to intervene to avoid the exploitation of the consumers by the former state monopolist who still enjoys a dominant position. Such regulation must bear in mind that the incentives to enter and invest in infrastructure must not be undermined by such regulation. Ideally, regulatory pricing policy is designed such that it fosters competition and makes consumers better off.

Competition in asymmetric markets – and this is what "new" competition implies – and regulatory policy in such markets is the topic of this paper. Asymmetric market environments may ask for asymmetric regulation. In the policy debate the desirability of asymmetric regulation has been recognized (see, for instance, European Commission, 2000, and Oftel, 2000). Recent market liberalization in Europe has allowed new competitors into the market, some of which are busy to build up their own networks. Central to the success of an entrant is its access to the end users. If entrants are to build their own consumer base they have to build up their own access network (local loop) or have to engage in unbundling agreements with the owner of the local loop. In the former case one speaks of facilities-based competition, in the latter of local loop unbundling.

In this paper we present a simple model of competition in telecommunications market in which entrants have already made the necessary investments (or contractual arrangements) to compete in a particular telecommunications market. An entrant operator has access to consumers either by its own facilities or through local loop unbundling. Hence, we consider a situation of two-way interconnection. Our main question is: How should one design regulation with the purpose of stimulating competition, ensuring that consumers benefit from entry and operators have sufficient interests to be active in the market?

Different from most of the literature, our focus is on asymmetric initial market conditions and asymmetric regulation. The literature on the economic theory of two-way interconnection has been initiated by the papers of Armstrong (1998), Laffont, Rey and Tirole (1998), and Carter and Wright (1999). This work and follow-ups have been reviewed by Laffont and Tirole (2000) and Armstrong (2001); see also De Bijl and Peitz (2000). In De Bijl and Peitz (2000, 2001) and Peitz (2001), we develop models that allow us to address some of the asymmetries that have received little attention in the existing theoretical literature.[1] We draw heavily on this earlier work. In this paper our focus is on policy relevant conclusions that emerge from access price regulation in an evolving industry.

In our market, the entrant initially lacks a track record of quality whereas the incumbent already has such a track record. This captures the reliability of the networks and the reputation for quality. Given that the entrant is active, its track record improves exogenously over time and the asymmetry between the operators becomes smaller as the entrant gains experience and reputation. Operators compete in two-part tariffs, that is, they set a price per call minute and a monthly subscription fee. In the present paper we present and discuss some of the results within a particularly simple setting. Also, we start from a benchmark model of regulated per-minute retail prices which serves as a benchmark. We solve this model analytically (see Peitz, 2001).

The main insight of the current paper is that asymmetric access price regulation is a powerful policy instrument that benefits the entrant and consumers.[2] This provides a policy recommendation for the regulation of the wholesale market.

To the extent that wholesale price regulation on its own still leaves room for the former state monopolist to exploit consumers, regulation of retail prices may be desirable: since the incumbent initially enjoys substantial market power, a price cap regime in the retail market may be needed in addition to asymmetric access regulation in order to protect consumers from excessive retail prices. Binding price caps on the incumbent's subscription fee make, however, the incumbent operator more aggressive, which possibly reduces or eliminates the incentives for an entrant to undertake the necessary investments to compete in the market. Hence, such retail price regulation

[1] There does not exist a consensus in the literature whether regulation should be allowed to be asymmetric or not (see Perrucci and Cimatoribus, 1997).

[2] This insight is also obtained in De Bijl and Peitz, 2001, and Peitz, 2001. In the current paper, we combine analytical and simulation work in a particularly simple model.

has to be applied very carefully.

Section 2 presents the model, the solution procedure, and a short discussion of the first-best outcome (including a discussion of the costs and benefits of liberalization). Based on Peitz (2001), section 3 analyzes the model under the restriction that per-minute prices are fixed equal to true marginal costs so that operators only compete in subscription fees. This modes is solved analytically and serves as a benchmark. Based on De Bijl and Peitz (2001), section 4 analyzes the model in which pricing in the retail market is not restricted. It also considers price cap regulation in the retail market: namely, the regulator may wish to impose a (temporary) price cap on the incumbent's subscription fee. Section 5 provides a discussion of results and a discussion of related policy questions.

# 2 A Model of Facility-Based Entry

We consider two operators, an incumbent (operator 1) and an entrant (operator 2). The model is a simplified version of the model used in De Bijl and Peitz (2001).

Assume that the two networks have a full-coverage network. This is a natural starting point when analyzing fixed telephony. The networks consist of a long-distance backbone, a local access network, and switches. In each period $t = 1, ..., T$, each operator $i$ chooses a per-minute price $p_i^t$ and a subscription fee $m_i^t$. The market shares resulting from competition and consumers' choices are denoted by $s_1^t = s_1[p_1, p_2, m_1, m_2; t]$ and $s_2^t = s_2[p_1, p_2, m_1, m_2; t]$.

## 2.1 Consumer Demand

The consumer side consists of consumers with mass $n$ who all are subscribed to either one network. To avoid head-to-head competition á la Bertrand, we assume that networks are horizontally differentiated. Consumers are assumed to be uniformly distributed on the $[0, 1]$-interval. Operator 1 is located at $l_1 = 0$, and operator 2 at $l_2 = 1$. Consumer $z \in [0, 1]$ incurs a disutility $-\theta|l_i - z|$, which is linear in the distance between consumer location and the location of the operator. The parameter $\theta$ expresses the substitutability between networks: if $\theta = 0$ networks are perfect substitutes; the larger $\theta$ the more differentiated networks are.[3]

Each consumer subscribes to exactly one operator. The consumer who is identified by its location $z$ subscribes to operator 1 if $v_1[p_1, m_1; t] - \theta z >$

[3]This is the Hotelling specification that has also been used in the seminal papers by Armstrong (1998) and Laffont, Rey, Tirole (1998).

$v_2[p_2, m_2; t] - \theta(1-z)$,where $v_i[p_i, m_i; t]$ denotes the conditional indirect utility of a network at the ideal location $z$. The realized market share of operator $i$ is equal to:

$$s_i^t = \frac{1}{2} + \frac{v_i[p_i^t, m_i^t; t] - v_j[p_j, m_j; t]}{2\theta}.$$

An operator's market share increases if the operator offers a relatively larger level of net utility to consumers, and decreases otherwise. One can observe that larger values of $\theta$ make it more difficult to gain market share.

Conditional indirect utility for a network at an ideal location takes the following form:

$$v_i[p_i, m_i; t] = U_i[t] - m_i + u[x[p_i]] - p_i x[p_i].$$

This indirect utility consists of a traffic-independent part and a traffic-dependent part. Clearly, net utility is decreasing in prices. We implicitly assume that net utility of each network is positive for all consumers, that is, $v_i - \theta > 0$.

First, consider the traffic-dependent part. Given a price per-minute equal to $p_i$, each consumer has an individual demand of $x[p_i]$ call minutes, and derives utility $u[x]$ from calling $x$ minutes.[4]

Second, consider the traffic-independent part. Here, the consumer has to pay the subscription fee $m_i$. A consumer derives a fixed (and possibly operator-specific and time-dependent) utility from subscribing to network $i$, $U_i[t]$, which is independent of the number of telephone calls that are made.[5] We postulate that the fixed utility can be written as $u_i^0(1 - q_i[t])$. The different terms are understood as follows: the first term $u_i^0$ is an individual effect, which are long-run fixed utilities. In our analysis we assume that networks are symmetric in the long run so that $u_1^0 = u_2^0 = u^0$. The second term $q_i[t]u_i^0$ reflects the disutility due to the (partial) lack of track record of network $i$, $q_i[t]$, where $1 \geq q_i[t] \geq 0$ and $\lim_{t\to\infty} q_i[t] = 0$. With respect to this track record we postulate that there exists an asymmetry between the incumbent and the entrant: an entrant has to build up the reliability of its network and the reputation for quality. Hence, in early periods we have $q_2[t] > q_1[t]$. In particular, in our simulation we assume that the incumbent does not suffer from such an initial lack of a track record so that $q_1[t] = 0$ for all $t$. Depending on the reliability and reputation of the former state monopolist, this assumption can be modified.

[4]Since individual demand of a subscriber to operator $i$ is defined by $x[p_i] = \arg\max_x\{u[x] - x\, p_i\}$, individual demand is derived by solving the first-order condition for utility maximization $u'[x] = p$.

[5]Asymmetries on the demand side have been introduced by Carter and Wright (1999, 2001) and De Bijl and Peitz (2000, 2001). Note that we do not allow utility to depend on the number of received calls. On this see Jeon, Laffont and Tirole (2001).

The track record captures utility differences between operators stemming from quality differences which may exogenously vanish over time. Entrants may be quick to roll out networks to offer voice telephony and gain market share, but initially, their networks may not satisfy the same quality standards as the incumbent's network.[6] The track record also captures the utility derived from availability and quality of services that are additional to basic telephony (e.g. wake-up calls, information services, voice mail) that may be added by the entrant over time. An alternative specification in which previous market share enters is provided by De Bijl and Peitz (2001) (see also De Bijl and Peitz, 2000).

*Example:* one concrete specification of demand and utility functions would be the following: $u[x] = ax - \frac{1}{2}bx^2 \ \ (a, b > 0)$ so that $x[p_i] = (a - p_i)/b$ and $v_i[p_i, m_i; t] = U_i[t] + \frac{1}{2}(p_i - a)^2/b - m_i$. For the purpose of illustration, utility is assumed to increase linearly with the track record of the new firm up to some period $t^*$. We write $q_2[t] = 1 - \min\{t - 1, (t^* - 1)\}/(t^* - 1)$. This is also the specification that will be used in the simulations.[7]

## 2.2 Costs, Traffic Volume, and Profit Functions

Following the theory on competition in telecommunications (e.g. Laffont and Tirole, 2000) we distinguish between three different types of costs: fixed costs that are independent of traffic and the number of consumers served, connection-dependent but traffic-independent "fixed" costs, and traffic-dependent costs.

The first type of costs, $C_i$, is independent of the number of connections. Such costs may be incurred initially, for instance, the costs of building a backbone, and are possibly sunk when pricing decisions are taken.

The second type of costs is connection-dependent but traffic-independent: the per-period and per-connection fixed cost of the local access network, which will also be denoted as the fixed cost of the local loop. This cost captures, for instance, the maintenance cost of the local loop, and may also include the investment cost that has to be recovered. Operator $i$'s fixed cost of the local loop is denoted by $f_i$. Connection-dependent but traffic independent costs affect the gain per consumer and therefore operators' pricing decisions.

[6] For the sake of simplicity, we did not make endogenous the decisions such as to what extent to upgrade a cable network. We purely focus on pricing decisions and see our specification as an interesting starting point because some asymmetries between networks are likely to persist in the medium term independent of the decisions of the new operators.

[7] We specify demand as linear. This can be seen as the linear approximation of a nonlinear demand function. For this it would be important to have a good estimate of the slope of the demand curve in the neighborhood of the realized equilibrium.

The third type of costs are traffic-dependent. Marginal costs of telephony are close to zero, if one strictly applies the definition of marginal costs. In reality, operators typically impute fixed costs to telephony traffic, enabling them to define a reference point for prices (although these costs do not directly depend on traffic). We follow this latter understanding of costs and define "marginal costs" as the costs that a sales/marketing department attributes to traffic when making pricing decisions.[8]

Costs which are also perceived as traffic-dependent costs are charges for interconnection and access. These charges are typically incurred on a per-minute basis. Total traffic-dependent costs therefore include an operator's marginal cost, as defined in the previous paragraph, and charges paid to other operators for interconnection and access. Let $c_{ik}$ denote operator $i$'s traffic-dependent cost per-minute associated with a telephone call of type $k$, as explained below. We will follow the convention in the literature, where it is typically assumed that the marginal cost of the local loop is the same for originating and terminating traffic:

$$c_{i1} - c_{i2} = c_{i3}.$$

In the case of off-net calls and incoming calls, the operator of the network where the call originates pays a per-minute terminating access fee to the operator of the network where the call terminates. Period-$t$ terminating access prices paid to operator $i$ are denoted by $\tau_i^t$. Access prices are *reciprocal* in period $t$ if $\tau_1^t = \tau_2^t$ and non-reciprocal or asymmetric otherwise. We distinguish three types of telephone calls:

- **on-net calls**: calls that originate and terminate on a single operator's network ($k = 1$) with associated costs $c_{i1}$ for operator $i$;
- **off-net calls**: calls that terminate on another operator's network ($k = 2$) with associated costs $c_{i2} + \tau_j^t$ for operator $i$;
- **incoming calls**: calls that originate from another operator's network ($k = 3$) with associated costs $c_{i3} - \tau_i^t$ for operator $i$.

To derive profit functions, we have to specify consumers' calling patterns. We assume that when a consumer makes a telephone call, the receiver of the call can be any other consumer with equal probability, independent of

[8]This should be kept in mind when making welfare comparisons: per-minute prices equal to these marginal costs may not be welfare-maximizing because in the first best per-minute prices are equal to true marginal costs (below we abstract from such considerations).

the network she is subscribed to. In the aggregate, the shares of on-net and off-net calls of an operator are equal to its and its competitor's market share, respectively.[9]

Profits are generated from different sources. The expressions for these terms of the profit function are easily expressed (see Table 1).

| **source** | **operator 1** | **operator 2** |
|---|---|---|
| on-net traffic | $n\, s_1^t s_1^t x[p_1^t](p_1^t - c_{11})$ | $n\, s_2^t s_2^t x[p_2^t](p_2^t - c_{21})$ |
| off-net traffic | $n\, s_1^t s_2^t x[p_1^t](p_1^t - c_{12} - \tau_2^t)$ | $n\, s_2^t s_1^t x[p_2^t](p_2^t - c_{22} - \tau_1^t)$ |
| incoming traffic | $n\, s_2^t s_1^t x[p_2^t](\tau_1^t - c_{13})$ | $n\, s_1^t s_2^t x[p_1^t](\tau_2^t - c_{23})$ |
| subscriptions | $n\, s_1^t(m_1^t - f_1)$ | $n\, s_2^t(m_2^t - f_2)$ |

Table 1: Net revenues

Operator $i$'s period-$t$ profits, denoted by $\pi_i$, are the sum of profits from on-net traffic, profits from off-net calls, profits from incoming traffic and profits from subscription minus fixed costs that are independent of the number of subscribers. Profit functions depend of both operators' prices, which reflects that the operators strategically interact with each other. Fixed costs not attributed to traffic or connection, although they clearly affect profits, do not influence pricing decisions.

## 2.3 Equilibrium

To conclude the description of the model, we recapitulate the structure of the game. Operators take terminating access prices $\tau_1^t$ and $\tau_2^t$ in each period as given. They simultaneously choose per-minute prices $p_1^t$ and $p_2^t$, and (monthly) subscription fees $m_1^t$ and $m_2^t$. Consumers observe these prices, choose where to subscribe and make their telephone calls in period $t$. Operators receive profits $\pi_1[p_1, p_2, m_1, m_2; t]$ and $\pi_2[p_1, p_2, m_1, m_2; t]$ in period $t$.

Operators maximize period profits while taking the prices chosen by its rival firm as given. Equilibrium values of functions and variables will be marked with superscript $*$. For example, in an equilibrium in period $t$, operator 1's per-minute price is denoted by $p_1^{t*}$. A Nash equilibrium in period $t$, which is characterized by prices $(p_1^{t*}, p_2^{t*}, m_1^{t*}, m_2^{t*})$, satisfies the following conditions:

[9] For instance, given prices and realized market shares, the total volume of call minutes that originates on network 1 is equal to $n\, s_1 x[p_1]$. Then a fraction $s_1$ of this volume, that is, $n\, s_1 s_1 x[p_1]$, terminates on network 1. Similarly, the traffic volume terminating on network 2 is $n\, s_2 s_1 x[p_1]$.

1. Each operator's prices $p_i^{t*}$ and $m_i^{t*}$ maximize its profits given the other operator's prices $p_j^{t*}$ and $m_j^{t*}$, for $i = 1, 2$, where $i \neq j$.

2. Consumers choose a network and a quantity of call minutes to maximize net utility, and the operators take this behavior into account while choosing prices.

In an equilibrium in period $t$, none of the operators has an incentive to deviate from its pricing strategy $(p_i^{t*}, m_i^{t*})$, if

$$\begin{aligned} \pi_1[p_1^{t*}, p_2^{t*}, m_1^{t*}, m_2^{t*}; t] &\geq \pi_1[p_1, p_2^{t*}, m_1, m_2^{t*}; t] \text{ and} \\ \pi_2[p_1^{t*}, p_2^{t*}, m_1^{t*}, m_2^{t*}; t] &\geq \pi_2[p_1^{t*}, p_2, m_1^{t*}, m_2; t] \end{aligned}$$

for all admissible $p_1, p_2, m_1, m_2$. In our simulations we check that the solutions to the system of first-order conditions, $(p_i^{t*}, m_i^{t*})$, are a global maximizer of $\pi_i[\cdot, \cdot, p_j^{t*}, m_j^{t*}; t]$. For details see De Bijl and Peitz (2001).

We consider a sequence of Nash equilibria for periods $t = 1, ..., T$. This sequence generates the same outcome as the subgame-perfect equilibrium of the game which encompasses all $T$ periods as different stages.

## 2.4 Surplus and Welfare

The market outcome and the impact of regulation can be evaluated by assessing consumers surplus, profits and market share of each operator, and welfare. It is possibly important to consider not only welfare but also consumers surplus because regulation may decrease the former but increase the latter (and transfers from producers to consumers may only be achieved through regulation). A regulator wishing to ensure that consumers benefit from entry and competition, may be interested in maximizing consumers surplus under the constraint that the operators make enough profits to have incentives to invest in infrastructure and quality of service. Alternatively, it may want to maximize a weighted average of consumer surplus and profits for each firm.

Producers surplus in period $t$, $PS^t$, is equal as the sum of profits in the industry. Consumers surplus in period $t$, $CS^t$, defined as the consumers' aggregate net utility, is equal to

$$\begin{aligned} CS^t &= n\, s_1[p_1^t, m_1^t; t] v_1[p_1^t, m_1^t; t] + n\, s_2[p_2^t, m_2^t; t] v_2[p_2^t, m_2^t; t] \\ &\quad - \frac{n\,\theta}{2} \left( \left( s_1[p_1^t, m_1^t; t] \right)^2 + \left( s_2[p_2^t, m_2^t; t] \right)^2 \right). \end{aligned}$$

The last term in the expression for consumer surplus is the disutility that consumers incur owing to the subscription to a network that does not possess ideal characteristics. The welfare level in period $t$, $W^t$, is equal to the total surplus that is realized in the market, $W^t = PS^t + CS^t$.

## 2.5 Welfare: The Costs and Benefits of Liberalization

Consider two technologically symmetric networks, that is, their cost structures are identical. In this case, we ask: is a cost-based duopoly superior to a cost-based monopoly in terms of welfare? Note that first-best pricing involves per-minute prices equal to (true) marginal cost, that is, $p_i = c_{11}$. Since we assume that all consumers participate in the market, the level of the subscription fee is arbitrary.[10] We can consider subscription fees equal to the fixed costs of a connection, $m_i = f_i$.

In our model, a duopoly leads to the following social costs, compared to monopoly:

- connection-independent fixed costs, $C_i^t$, are duplicated,
- the entrant initially lacks a track record of quality.

In our model, a duopoly leads on the other hand to social benefits:

- the differentiated duopoly better fits a consumer population with heterogeneous tastes.

Other social benefits (that are not incorporated into the model) are those associated to competition reducing the X-inefficiency of the incumbent, i.e., socially wasteful expenditures can be avoided. Such expenditures were possibly included in the profits of the incumbent. Also, mature competition creates a level-playing field, and this possibly reduces the social costs of regulation, which were not introduced into the model. Last but not least, it is often claimed that a protected monopoly leads to dynamic inefficiencies by not providing the right incentives to invest.

If fixed costs $C_i^t$ are negligible in the long run duopoly is welfare improving upon monopoly (at cost-based prices). This is so because in the long run the entrant will have built up a track record of quality and offers the same utility $v_i$ as the incumbent at prices $p_1^t = p_2^t$, $m_1 = m_2$. Because of the initial lack of a quality track record, the entrant's network offers lower fixed utility in early periods. Therefore, a duopoly is welfare improving upon monopoly in the short run if the better average fit owing to product differentiation overcompensates the lower utility associated to the lack of track record in the short run. Considering intertemporal welfare, if the discount factor is sufficiently close to 1 and the time horizon $T$ sufficiently long, then

[10] Clearly, for high subscription fees some consumers eventually no longer subscribe so that the assumption of full participation only makes sense for sufficiently low subscription fees.

a cost-based duopoly dominates a cost-based monopoly in terms of welfare for sufficiently low fixed costs $C_i^t$.

Even if a cost-based duopoly leads to lower welfare in our model, one can still make the case for competition by referring to unmodelled advantages of competition such as those mentioned above. Below, we take the decision to introduce competition as given.[11]

# 3 A First Analysis

The analysis in which per-minute prices are flexible is too complex to allow us to obtain analytical expressions for prices, market share and profits. Therefore, we present in this section a simple model in which per-minute retail prices are fixed at true marginal cost levels, that is, $p_i = c_1$, $i = 1, 2$.[12] Operators are not allowed to adjust per-minute prices to perceived marginal costs. This implies that under positive access markups both operators will suffer from losses for off-net traffic whereas on-net traffic does not contribute to profits. Profit functions can be written as

$$\begin{aligned}\pi_i &= ns_is_jx[c_1](c_1 - c_2 - \tau_j) + ns_is_jx[c_1](\tau_i - c_3) + ns_i(m_i - f_i) \\ &= ns_i(s_2x[c_1](\tau_i - \tau_j) + m_i - f_i).\end{aligned}$$

By looking at the profit functions we make the following remark:

**Remark 1** *In the model with fixed per-minute prices, profits are neutral to the level of reciprocal access prices. This holds not only if the market is symmetric but also if it is asymmetric.*

In the model with flexible per-minute prices profit neutrality can be shown under symmetric competition but not under asymmetric competition.[13] This suggests that our simple model does abstract from an important element which arises from differences in individual demand due to different per-minute prices under asymmetric competition. Nevertheless, we will see that our simple model is quite useful for the analysis of asymmetric access price regulation.

[11] Nevertheless, before the government decides to liberalize a market it is important to ask whether competition (regulated or not) indeed improves upon a regulated monopoly.

[12] For a detailed analysis, see Peitz (2001).

[13] In their simulations De Bijl and Peitz (2000) observe that the larger operator does not gain from an access price different from marginal costs. This is formally shown in Carter and Wright (2001). We also would like to point out that in our simple model a reciprocal access price cannot be used as a collusive device.

We obtain a unique equilibrium candidate that solves the first-order conditions of profits maximization.[14] If asymmetries between networks are sufficiently small then the solution to the first-order conditions indeed is an equilibrium. In particular, we assume that the expression for $m_i^*$ and $s_i^*$ below are positive for both operators (under cost-based access price regulation). This means that we implicitly assume that networks are not too asymmetric. Subscription fees have equilibrium values

$$m_i^* = \frac{1}{3}(2f_i+f_j)+\theta+\frac{1}{3}(U_i-U_j)+\frac{1}{3\theta}((U_i-U_j)+(f_j-f_i))x[c_1](\tau_i-\tau_j). \quad (1)$$

Market shares, in equilibrium, are[15]

$$s_i^* = \frac{1}{2} + \frac{(U_i - U_j) + (f_j - f_i)}{6\theta}.$$

The market share is positive if $(U_i - U_j) + (f_j - f_i) + 3\theta > 0$. We can now make the following remark:

**Remark 2** *In the model with fixed per-minute prices, in an interior equilibrium, market shares are independent of access prices.*

This implies that total surplus is independent of access prices. Equilibrium profits reduce to

$$\pi_i^* = \frac{n}{36\theta^2}((U_i - U_j) + (f_j - f_i) + 3\theta)^2(2\theta + (\tau_i - \tau_j)x[c_1]).$$

From these expressions we immediately obtain a number of interesting and intuitive comparative statics results.

**Result 1** *In the model with fixed per-minute prices*

*(i) a higher access price of operator $i$ leads to higher profits of operator $i$ and lower profits of operator $j$, $j \neq i$;*

*(ii) lower fixed costs of the local loop of operator $i$ lead to higher profits of operator $i$ and lower profits of operator $j$, $j \neq i$;*

*(iii) similarly, a higher fixed utility offered by network $i$ leads to higher profits of operator $i$ and lower profits of operator $j$, $j \neq i$;*

*(iv) if networks become more differentiated profits of both operators increase.*

[14] Note that "typically" ($|\tau_1 - \tau_2|$ not too large) best responses are upward sloping and networks are strategic complements.

[15] We require that the expression for $m_i^*$ and $s_i^*$ are positive for both operators (under cost-based access price regulation). This gives restrictions on the asymmetry between networks.

Our main question is what regulatory policy should be adopted such that it satisfies three objectives: a high total surplus (as a measure of welfare), a high consumer surplus (because competition is supposed to ultimately benefit consumers), and high profits of the smaller network (to stimulate entry). The proposition above tells us that the profits of operator 2 are increased by setting asymmetric access prices with $\tau_2 > \tau_1$. If we see operator 2 as the entrant that offers initially a lower brand utility then asymmetric access price regulation that favors the entrant achieves that the entrant's profits are higher than under cost-based access price regulation. This means that asymmetric access price regulation is a tool to stimulate entry.

Does the goal to stimulate entry conflict with the goal to protect consumers? As noted above (see Remark 2) market share is independent of access prices, which are fixed by the regulator (or arise through cooperative or non-cooperative choices by the operators). This implies that total welfare is independent of access prices.[16] Changes in access prices merely lead to a redistribution of surplus between operators and consumers. Consumer surplus can then be written as total surplus minus total or industry profits. That is,

$$CS = W - n\theta - \frac{n}{9\theta}((f_1 - f_2) + (U_2 - U_1))((f_1 - f_2) + (U_2 - U_1) - 3x[c_1](\tau_1 - \tau_2)).$$

Note that consumer surplus depends on the difference of access prices $\mu \equiv \tau_1 - \tau_2$. Operators can be asymmetric on the cost side or the demand side. Suppose that both have the same cost structure and that the only difference between the two operators is that operator 2 is (initially) less attractive, that is, $U_1 > U_2$. We then find that

$$\frac{\partial CS}{\partial \mu} = -\frac{3n\, x[c_1]}{9\theta}(U_1 - U_2) < 0.$$

Consequently, not only the entrant but also consumers benefit from access price regulation that favors the entrant ($\tau_2 > \tau_1$).

**Result 2** *In the model with fixed per-minute prices, asymmetric access price regulation that favors the weaker operator leads to higher profits of this operator and to higher consumer surplus while total surplus remains constant.*

We can see the unambiguous effect on consumer surplus by looking at subscription fees (using the fact that market share does not change, see Remark 2). Not only do consumers in the aggregate benefit but each individual

[16] To see this, note that access prices above costs do not distort per-minute prices because the latter are fixed. Since market share remain constant, both costs and gross utilities are not affected by changes of the access prices.

consumer benefits from asymmetric regulation because subscription fees of both operators are lower than under reciprocal access price regulation.[17]

Summarizing, this model provides strong reasons for the regulator to use asymmetric regulation in markets in which an entrant is initially at a disadvantage. We will see below that this conclusion remains essentially valid when operators are free to set per-minute price.

# 4 New Competition in Telecommunications Markets

In this section we analyze the model of Section 2 with the help of simulations. We characterize the evolution of a telecommunications market under a certain parameter constellation (see the Appendix). In contrast to the previous section, both operators are unconstrained in their choice of two-part tariffs.

## 4.1 Operators' Retail Prices

Each operator has two instruments, per-minute price and subscription fee, and can separate the building of market share in terms of subscribers from the generation of call volume for each subscriber (see, for instance, Laffont, Rey, and Tirole, 1998, p. 21). Given any prices of the competitor, profit maximizing prices of an operator involve a per-minute price equal to perceived marginal costs, formally

$$p_i^{t*} = s_i^t c_{i1} + s_j^t (c_{i2} + \tau_j^t) \text{ in each period } t.$$

In setting its per-minute price, each operator behaves as if it maximizes the difference between consumer's surplus and costs that are traffic-dependent. In this respect, it behaves like a monopolist, which uses the subscription fee to extract consumer surplus and sets the usage price equal to marginal costs. The reason is that the gain in consumer surplus from a cut in the per-minute price below perceived marginal costs is less than the associated cost that the operator incurs, whereas a reduction in the subscription fee translates one-to-one into greater consumer surplus. Hence, in competing for market share, the subscription fee is a more effective instrument than per-minute price.

[17] We see this from equation (1): the incumbent network enjoys a fixed utility advantage so that all consumers described to this network pay less as $\tau_2 - \tau_1$ is increased. Since the sign of the fixed utility difference and of the access price difference is reversed for the entrant also all consumers described to the entrant's network pay less as $\tau_2 - \tau_1$ is increased.

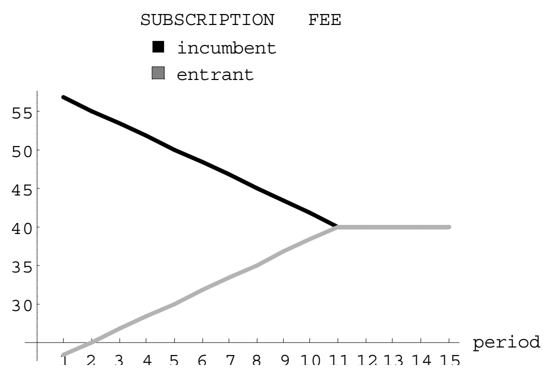


Figure 1: Cost-based regulation: subscription fees

One can show that an operator that sets its per-minute price equal to perceived marginal costs makes zero profits from the total amount of on-net and off-net traffic. Consequently, the only sources of profits are revenues from subscription and revenues from incoming traffic.[18] In equilibrium, an increase in the product differentiation parameter $\theta$ has no direct effect on per-minute prices, while it directly pushes the subscription fees upward (there are possibly also indirect effects through changes in market shares).

## 4.2 Cost-Based and Reciprocal Access Price Regulation

In our simulations the fixed utility disadvantage of the entrant decreases linearly over time up to period $t^*$, which is set equal to 11 (one period corresponds to two months). Subscription fees respond to this fixed utility difference. For instance, under cost-based regulation, in period 2 the fixed utility difference is equal to 45 Euros and the difference in subscription fees is equal to 30 Euros (period 5: 30 Euros and 20 Euros, respectively; period 8: 15 Euros and 10 Euros respectively). The evolution of subscription fees is depicted in Figure 1. Under cost-based regulation all variables can be expressed analytically and it is possible to dispose of numerical methods (see Section 3 for the analytical results with $\tau_i = c_3$).

Similar to subscription fees, also market shares evolve linearly over time until the entrant has fully built up its track record of quality. With our

[18] Per-minute price equal perceived marginal cost holds in the symmetric setup of Laffont, Rey, and Tirole (1998) and asymmetric setups as in this paper or De Bijl and Peitz (2000, 2001). Note the difference to the analysis in the previous section. Nevertheless, results in the two versions coincide under cost-based access price regulation.

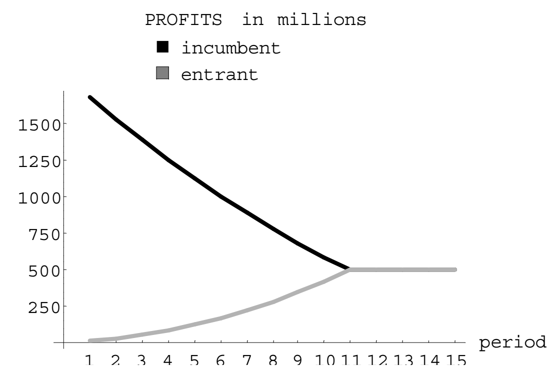


Figure 2: Cost-based regulation: profits

parameter values the entrant first gains a market share of around 8.3% which is augmented by around 4.2% each period.

Under cost-based regulation, none of the operators obtains profits from incoming calls and profits in equilibrium are $\pi_i^t = ns_i^t(m_i^t - f_i) - C_i^t$. Here, we look at profits gross of fixed costs $C_i^t$. Since the entrant's market share and subscription fee increase linearly over time, profits are increasing and convex over time until the entrant has caught up with the incumbent. Correspondingly, the incumbent's profits are decreasing and convex over time (see Figure 2).

As explained in Section 2, welfare in a mature duopoly dominates welfare under monopoly for $C_i^t$ sufficiently small because of beneficial product differentiation. In initial periods, there is a social cost to duopoly because of the lack of the entrant's track record. If those social costs are high, welfare is possibly higher under a regulatory regime which makes it harder for the entrant to gain market share in early periods. The trade-off between the gradual built-up of a track record, which makes the entrant more attractive, and the gain in market share explains why welfare can be decreasing over time in early periods, as demonstrated in Figure 3. As competition matures, the incumbent's profits decline and this is only partially offset by the increase of the entrant's profits so that producer surplus is declining over time. At the same time consumers gain from more mature competition, which is reflected by the increasing trajectory of consumer surplus (see Figure 3).

In our simulations, introducing a reciprocal access markup does not substantially change the picture in terms of the slopes of the trajectories of the variables. The only notable exception is the per-minute price which was constant under cost-based regulation. Since per-minute price equals perceived marginal costs, the entrant's per-minute price is decreasing over time as it

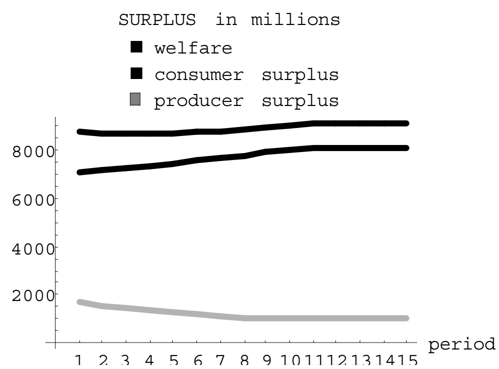


Figure 3: Cost-based regulation: surplus

builds up a track record of quality. The reason is that it has a small market share in early periods leading to relatively high perceived marginal costs. These costs are significantly higher than those of the incumbent because a call originating on the incumbent's network is most likely to terminate on the incumbent's network when the incumbent's market share is large.

Under a positive reciprocal access markup, the entrant has a lower market share than under cost-based access pricing because of its higher perceived marginal costs. Whether or not the entrant is doing better under reciprocal access price regulation in a period in which it has not yet fully built up its track record cannot be said unambiguously. Our simulations give the result that aggregated over time it receives lower profits under a reciprocal access price markup than under cost-based regulation.[19] In the long run, profits are not affected by a symmetric access markup: in a symmetric market losses in profits from subscription are exactly offset by gains in profits from incoming calls when comparing a positive access markup to access price equal the marginal cost of the local loop (the profit neutrality results in mature markets has been pointed by Laffont, Rey, and Tirole, 1998).

Clearly, a positive reciprocal access markup reduces welfare and consumers surplus in the long run because perceived marginal costs deviate from true marginal costs giving rise to a deadweight loss.

## 4.3 Asymmetric Access Price Regulation

Asymmetric access price regulation treats entrant and incumbent differently. We consider regulation which favors the entrant in early periods of competi-

[19] On reciprocal access price regulation in an asymmetric market see De Bijl and Peitz (2000, Chapters 3 and 4), De Bijl and Peitz (2001) and Carter and Wright (2001).

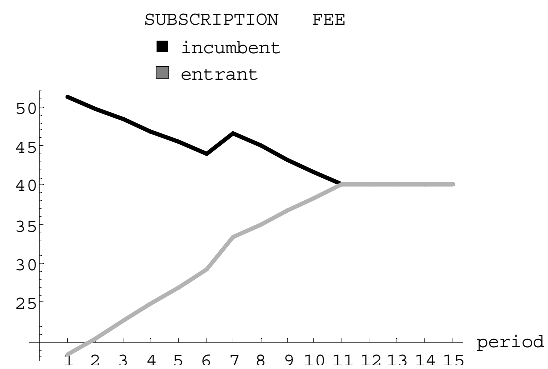


Figure 4: Asymmetric access price regulation: subscription fees

tion by fixing an access price above marginal costs for calls terminating on the entrant's network. In our simulations reported here, this access markup prevails for six periods. The incumbent and, in later periods, also the entrant, are subject to cost-based regulation. This asymmetric regulation generates positive profits from incoming calls for the entrant.

While building up its track record the entrant gains market share so that it becomes more likely over time that a consumer who is subscribed to the incumbent's network makes an off-net call. Hence, under our asymmetric regulatory regime the incumbent's perceived marginal costs are increasing over time as long as the entrant is allowed to charge a fixed access markup (see Figure 5); the incumbent sets a higher per-minute price than under cost-based regulation. The more aggressive behavior of the entrant can be explained as follows: an additional consumer not only generates profits for the entrant through its subscription but also generates additional incoming calls, which are valuable to the entrant. It turns out that under mutual best replies both operators price more aggressively than under reciprocal access price regulation.[20] For early periods, in which the per-minute price of the incumbent does not differ much between cost-based and asymmetric regulation (this can be seen by comparing Figure 4 with Figure 1).

The difference between true and perceived marginal costs is quite small initially due to the small market share of the entrant (so that the analysis of Section 3 comes quite close to what is observed in our simulation results). Nevertheless, competition is strongly affected because the entrant gains from incoming traffic. In our simulation, the evolution of market share is only slightly better for the entrant under asymmetric regulation than under cost-

[20]This result appears to be robust in our simulations. It would be desirable to have this as a general (analytical) result, as in Section 3.

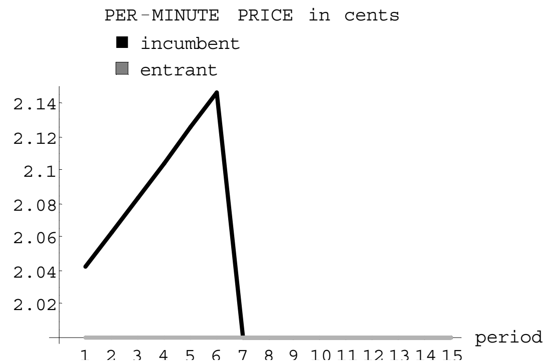


Figure 5: Asymmetric access price regulation: per minute prices

based regulation (they do not change in the version of Section 3) but its profits in early periods are much larger in relative terms.

To facilitate the comparison between cost-based and asymmetric access price regulation we present in Tables 2 and 3 profits and consumer surplus for the period 1 and period 6. Note that the results in the first and second column are analytical results that correspond to cost-based regulation and asymmetric access price regulation such that the incumbent's per-minute price is fixed to true marginal costs (see Section 3). The third column is derived from simulations. Numbers show that asymmetric access price regulation is effective in stimulating competition by increasing the entrant's profits and consumer surplus.

| | cost-based access prices | asymmetric access prices with fixed per-minute prices | asymmetric access price regulation with flexible per-minute prices |
|---|---|---|---|
| $\pi_1^1$ | 1680.56 | 1428.47 | 1429.04 |
| $\pi_2^1$ | 13.89 | 15.97 | 15.97 |
| $CS^1$ | 7073.61 | 7323.62 | 7323.01 |
| $W^1$ | 8768.06 | 8768.06 | 8768.02 |

Table 2: Profits and surplus in period 1 – cost-based versus asymmetric access price regulation

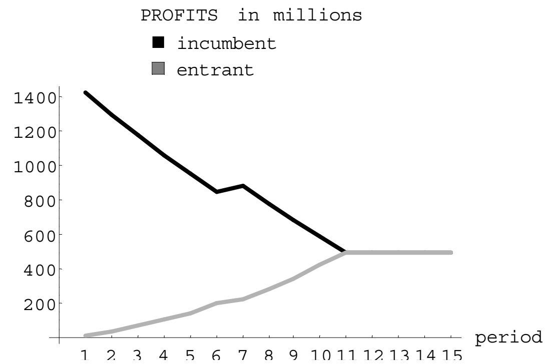


Figure 6: Asymmetric access price regulation: profits

| | cost-based access prices | asymmetric access prices with fixed per-minute prices | asymmetric access price regulation with flexible per-minute prices |
|---|---|---|---|
| $\pi_1^6$ | 1003.47 | 852.95 | 854.03 |
| $\pi_2^6$ | 170.14 | 195.66 | 195.53 |
| $CS^6$ | 7568.40 | 7693.40 | 7692.15 |
| $W^6$ | 8742.01 | 8742.01 | 8741.71 |

Table 3: Profits and surplus in period 6 – cost-based versus asymmetric access price regulation

Trajectories of profits under asymmetric regulation are depicted in Figure 6. Using our parameter constellation, profits in period 1 are 16 instead of 14 million Euros and, in period 6, they are 196 instead of 170 million Euros (see Tables 2 and 3). This makes asymmetric access price regulation a powerful instrument to improve the entrant's profits in early periods. Entrants whose fate depends on short-run profit evaluations of financial markets may need such an initial regulatory stimulus to become or remain active in the market.

More intense competition in early periods works in favor of consumers so that consumers surplus is higher under asymmetric regulation than under cost-based regulation. Welfare is lower for two reasons: first, a small number of consumers subscribe to the entrant's network who would have subscribed to the incumbent under cost-based regulation. Due to the initial lack of the entrant's track record this constitutes a loss in social surplus. Second, the deviation of the incumbent's per-minute price from true marginal costs creates a deadweight loss. Both these effects are rather negligible in our simulation. (In our analysis with fixed per-minute prices, regulation was neutral to welfare and purely redistributive.)

Comparing our analysis in this section to the one in the previous section, Tables 2 and 3 suggest that the analysis of Section 3 is a helpful approximation of the results obtained by simulation (see Peitz, 2001). We observe that the distortionary effect due to higher per-minute prices is small. Net utilities of consumers and market shares are hardly affected, although there is a significant effect on the incumbent's retail prices: for instance, in period 6, the incumbent's subscription fee is approximately 44 Euros when per-minute price is flexible whereas it is approximately 46 Euros when per-minute price is fixed at true marginal costs.

## 4.4 Price Cap Regulation

If the incumbent is subject to price cap regulation that includes a restriction on its subscription fee, the price cap is likely to be binding in early periods when the incumbent still enjoys substantial market power. In these periods the forces of competition may be insufficient from the viewpoint of the regulatory authority to guarantee "reasonable" prices for consumers. We remark that price cap regulation that achieves this goal does not need to be phased out; it automatically becomes obsolete as competition matures, that is, as competitors gain strength. So it can remain in place without inflicting any harm. We consider a price cap that is only applied to retail prices; the wholesale price (that is the access price) is separately regulated.

Concerning retail prices the regulator may have different concerns. To eliminate a deadweight loss he may force the incumbent to set its per-minute price equal to true marginal costs (see Section 3). To avoid that consumers have to pay an "excessive" subscription fee he may separately impose a maximal retail price. Only one of these two prices may be fixed or both of them.[21]

As in De Bijl and Peitz (2001), we only consider a price cap on subscription fees (for more on price cap regulation see De Bijl and Peitz, 2000, Chapters 3 and 4). This reflects the importance that a regulator may attach to universal service provision, which is typically embodied in a low subscription fee. For example in the Netherlands, telecommunications authority Opta has made sure that the former incumbent KPN Telecom offers a budget subscription (among other contracts). The aim of this contract is that every customer is able to be connected, can be reached, and can make phone calls if needed, although the per-minute price is usually higher for budget contracts.

Consider a price cap on subscription fees together with asymmetric access price regulation. We comment on results obtained from simulations for

[21] The regulator may alternatively impose a joint retail price cap so as to make a connection together with a certain number of call minutes available at a certain price.

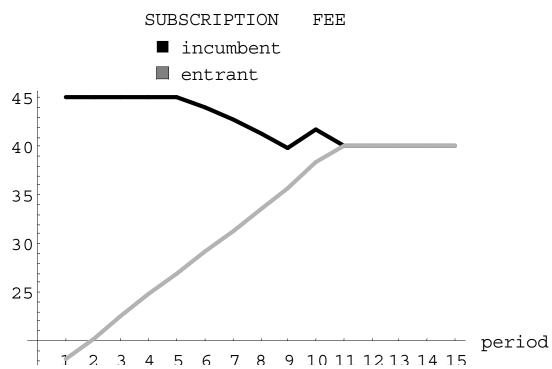


Figure 7: Price cap regulation: subscription fees

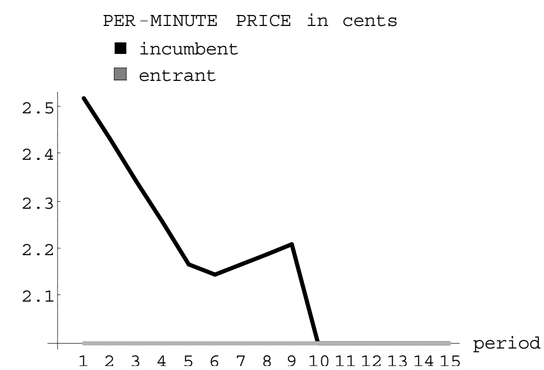


Figure 8: Price cap regulation: per minute prices

asymmetric access price regulation in place for 9 periods.[22] As argued above, a subscription fee is binding in those periods in which the incumbent enjoys a considerable degree of market power, as can be seen in Figure 7. Because the incumbent is not restricted in its per-minute price, it increases the per-minute price above perceived marginal costs in those periods in which the price cap is binding for the subscription fee. As time passes, the market power of the incumbent declines; this implies that the shadow price on the price cap restriction decreases and the per-minute price decreases, ceteris paribus. This tendency of a lower per-minute price is only partially offset by an increase in perceived marginal costs (see Figure 8).

The per-minute price is an imperfect instrument for the incumbent to make profits compared to the subscription fee. In equilibrium, both operators

[22] A more detailed analysis of simulations is found in De Bijl and Peitz (2001). Some numbers have to be rescaled to account for differences in market size.

make lower profits than in the absence of price cap regulation because the incumbent prices more aggressively. Consumers on the other hand gain from price cap regulation.

Compared to cost-based regulation, the entrant may do better than under combined price cap and asymmetric access price regulation. This is not necessarily so: a tough price cap regime may even inflict losses on the entrant so that it may refrain from entering in the first place. This makes price cap regulation a difficult policy instrument because one has to balance consumer interests with the goal of stimulating entry. Furthermore, price cap regulation such as pure subscription fee regulation can lead to strong distortions in the incumbent's pricing structure away from true marginal costs, and such pricing leads to a welfare loss.

The effect of price cap regulation on the per-minute price can be avoided if the incumbent's per-minute price is regulated separately. Under such a more intrusive regulation the regulator can fix the incumbent's per-minute price at its socially efficient level, that is, at true marginal costs. A binding price cap on the subscription fee then makes the incumbent compete more aggressively than under cost-based regulation (as well as under regulation that only fixes the subscription fee). This affects the entrant's profits negatively. A temporary access markup for the entrant generates positive profits from incoming calls thus enabling the entrant to approach or reach profit levels that would be realized under cost-based regulation.

To summarize, also when imposing separate price caps on both retail prices of the incumbent, the regulator can ameliorate the prospects of the entrant by complementing the price cap with asymmetric access price regulation.

# 5 Discussion and Conclusion

This paper has explored the role of regulation in an asymmetric market. First, consider wholesale price regulation. In early periods after liberalization the entrant is at a disadvantage (because of lower fixed utility). We have shown that, in early periods, asymmetric access price regulation that gives a positive access markup to the entrant and is cost-based for the incumbent is an effective instrument to increase consumer surplus and to enhance profits of the entrant. An access markup for the entrant makes entry more attractive and, given entry, increases competition. Once an entrant has gained competitive strength so that, under symmetric regulation, it competes more or less on equal terms with the incumbent, asymmetric regulation should be replaced by cost-based regulation if regulation is not abolished.[23] This conclusion is consistent with the general objectives and principles on effective competition spelled out by the British regulator Oftel (see Oftel, 2000, Appendix I).

**Regulatory pricing principle for the wholesale market:** *In early periods after liberalization the regulator should set asymmetric access prices such that only the entrant enjoys an access markup. This has two positive effects on competition: a potential entrant is more likely to enter and, given entry, competition is more intense. In later periods access price regulation should be cost-based. This type of wholesale price regulation is effective in protecting consumers and encouraging entry at the same time; welfare losses are likely to be small.*

Even under such asymmetric wholesale price regulation the incumbent may enjoy substantial market power so that the regulator may want to intervene in the retail market directly to protect consumers. A price cap on the incumbent's subscription fee serves the goal to make a connection available to all consumers at an "affordable" price. Note, however, that such regulation leads to lower profits of the entrant so that the goal to protect consumers in the short run has to be carefully weighed against the goal to encourage entry (see also Chapters 3 and 4 in De Bijl and Peitz, 2000). Also, the deadweight loss from distorted per-minute prices may be substantial.

**Regulatory pricing principle for the retail market:** *A price cap on the incumbent's subscription fee leads to "affordable" subscriptions for all consumers. Profits of both operators suffer so that entry becomes more difficult. This type of retail price regulation is effective in protecting consumers but it may discourage entry. Welfare losses can be substantial.*

We briefly discuss two further issues related to asymmetric regulation that have not been addressed in our analysis. These considerations are important for the application of asymmetric regulation.

In our analysis, regulatory policy did not depend on market outcomes. Owing to the initial uncertainty on the side of the regulator how the market will evolve, it seems problematic to implement a policy in practice that does not depend on realized market outcomes. On the other hand, if the replacement of asymmetric by reciprocal access price regulation depends on market

[23] Regulation is not needed in our model in the long run if in the absence of regulation, operators negotiate the reciprocal access price. In this case they choose access price equal to marginal costs in our model.

outcomes, operators can strategically exploit the endogeneity of regulatory variables by taking into account the effect of their decisions on the relevant market outcomes. This may be harmful for competition. For instance, a market share-based criterion gives incentives to incumbents and entrants to behave less aggressively: the incumbent prefers a rapid replacement of asymmetric regulation and the entrant the opposite. Both operators thus have an incentive to raise their subscription fees.

In our analysis, we also postulated that in the long run both operators are equally efficient. If some of the asymmetries between operators are time-persistent, the regulator has to worry about inefficient entry. Note that even under cost-based regulation operators with different cost levels can both enjoy positive profits in an oligopolistic market in which price-cost margins are not competed away. When applying asymmetric instead of cost-based access price regulation and thus providing a temporary advantage for entrants, the regulator must keep in mind that this may attract less efficient entrants.

**Appendix: Parameter Constellation**

We spell out our parameter configuration in the following list.

| | | |
|---|---|---|
| demand parameters | $a$ | 20 Euro-cents |
| | $b$ | 0.015 Euro-cents |
| | $\theta$ | 20 Euros |
| | $u^0$ | 50 Euros |
| | $\alpha_1 = \alpha_2$ | 1 |
| | $t^*$ | 11 |
| | $n$ | 50,000,000 |
| | $s_1^0$ | 1 |
| cost parameters | $c_{11} = c_{21}$ | 2 Euro-cents |
| | $c_{12} = c_{22}$ | 1.5 Euro-cents |
| | $c_{13} = c_{23}$ | 0.5 Euro-cents |
| | $f_1 = f_2$ | 20 Euros |

The regulatory regimes are as follows: under cost-based regulation, the (reciprocal) access price is set equal to 0.5 Euro-cents in all periods. For the reciprocal access markup we set the access price equal to 1 in all periods. Asymmetric access price regulation is invoked for a limited number of periods and replaced afterwards by cost-based regulation. We consider asymmetric access prices for six and for nine periods. In the former case we speak of short-lived asymmetric regulation, in the latter of long-lived asymmetric regulation. In the moderately asymmetric regime the price to access the entrant's network is 1 Euro-cent, whereas in the strongly asymmetric regime the price to access the entrant's network is 2 Euro-cents. Under price cap regulation we consider moderately asymmetric access prices and a price cap on the incumbent's subscription fee of 45 Euros per period.

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