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The strength of the waterbed effect depends on tariff type

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HIGHLIGHTS

- The waterbed effect is the pass-through of a price change to a firm's other prices.
- It is much stronger if the latter include subscription rather than only usage fees.
- In mobile network competition, it is full (partial) with two-part (linear) tariffs.

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ABSTRACT

We show that the waterbed effect, i.e. the pass-through of a change in one price of a firm to its other prices, is much stronger if the latter include subscription rather than only usage fees. In particular, in mobile network competition with a fixed number of customers, the waterbed effect is full under two-part tariffs, while it is only partial under linear tariffs.

1. Introduction

The "waterbed effect" describes the interdependence between prices at multiple-good firms and multi-sided platforms. As much as a waterbed rises on one side if it is pressed down on the other, firms may optimally change prices if some other price is forced to a different level, for example through regulatory interventions. The extent of the waterbed effect can be a contentious issue when it would weaken the effectiveness of the regulatory measures. In the debate about the downward regulation of the charges paid by fixed networks to mobile networks for routing calls from the former to their receivers on the latter, the so-called mobile termination rates, mobile networks have claimed that the result would be higher retail prices for mobile customers, while regulators argued there would be no effect.[1]

In this note we show how the waterbed effect depends on the type of tariff that is charged to the unregulated side of the market. On the regulated side, the firm receives a fixed payment per customer of the unregulated side. This payment can be the profits from fixed-to-mobile termination of calls, or advertising, or any other profits that depend on the customer's existence (rather than his usage). We determine the pass-through for two-part tariffs, where customers pay for subscription and usage, and for linear tariffs where they only pay for usage.[2] We show that the waterbed effect is much stronger under two-part than under linear tariffs; in particular, under the assumption of a fixed number of mobile subscribers we show that under two-part tariffs the waterbed effect is full, while it is only partial with linear tariffs. This implies that downward regulation of some price leads to a stronger negative effect on clients of the other services if the latter are charged a multi-

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[1] See Schiff (2008) for an introduction to the waterbed effect and a discussion of these issues.

[2] In the market, these types of contract are normally denoted as "post-pay" or "pre-pay/pay-as-you-go" tariffs.

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part tariff. In particular, this result contracts mobile networks' contention that lower fixed-to-mobile termination rates would disproportionately hurt customers on pre-pay tariffs.

The issue of the strength of the waterbed effect has been studied in both in theoretical and empirical work. Wright (2002) remains the most important theoretical treatment of fixed-to-mobile interconnection. He shows, generically, that if the pass-through of fixed costs to profits is full (partial), networks are indifferent about termination rates (jointly want to set them at the monopoly level). Below we show that these cases arise due to competition in two-part or linear tariffs, respectively.[3]

Genakos and Valletti (2011a,b) provide an empirical study of the waterbed effect with simultaneous fixed-to-mobile and mobile-to-mobile interconnection. They show that the waterbed effect is significantly stronger for post-pay (two-part) than for pre-pay (linear) tariffs. They ascribe this difference to how the regulation of mobile termination rates affects the interconnection of calls between mobile networks, and therefore indirectly changes how intensively networks compete for subscribers. While their argument is certainly correct, it does not take into account that the actual direct pass-through of fixed-to-mobile termination profits depends on the type of tariffs in the mobile market. In this note, we isolate this factor by considering the two types of termination separately.

2. Model setup

The model setup is a generalization of Laffont et al. (1998) to many networks and general (instead of Hotelling) subscription demand. We assume that there are $n \geq 2$ symmetric mobile networks $i = 1, \ldots, n$ which compete in tariffs. In the main text we consider linear and two-part tariffs that do not discriminate between calls within the same network (on-net calls) and those to rival networks (off-net calls), while in the Appendix we analyze tariffs which price discriminate between these types of calls. Thus for now we assume that network i charges a price p_i for each call minute. In case networks compete in two-part tariffs it also charges a fixed fee F_i.

The marginal on-net cost of a call is $c > 0$ and the cost of terminating a call is $c_0 > 0$. Networks charge each other the access charge a per incoming call minute. Thus the marginal cost of an off-net call is $c+m$, where $m = a-c_0$ is the termination margin. There is a monthly fixed cost f per customer, and networks receive further monthly profits of Q per customer that do not originate from payments for retail services offered to them. Our focus will be on how equilibrium profits depend on Q.

From making a call of length q, a consumer obtains utility $u(q)$, where $u(0) = 0$, $u' > 0$ and $u'' < 0$. For call price p, the indirect utility is $v(p) = \max_q u(q)-pq$, call demand is $q(p) = -v'(p)$ with elasticity $\eta(p) = -pq'(p)/q(p)$. Receiving a call of length q yields utility $\beta u(q)$, where $\beta \geq 0$ indicates the strength of the call externality. Letting $v_i = v(p_i)$ and assuming a balanced calling pattern (i.e. subscribers call any other subscriber with the same probability) the surplus of a consumer on network i is given by

$$w_i = v_i + \beta \sum_{j=1}^{n} \alpha_j u_j - F_i,$$

where F_i is zero for a linear tariff. The market share of network $i = 1, \ldots, n$ is assumed to be

$$\alpha_i = A\left(w_i - w_1, \ldots, w_i - w_n\right),$$

where $A_n : \mathbb{R}^n \to \mathbb{R}$ is strictly increasing and symmetric in its arguments, with $0 \leq \alpha_i \leq 1$, $\sum_{i=1}^{n} \alpha_i = 1$, from which follows that $A(0, \ldots, 0) = 1/n$. Let $\sigma = dA(x, 0, \ldots, 0)/dx|_{x=0}$.[4]

Denote the profits from a pair of originated and terminated calls between networks i and j as $P_{ij} = (p_i - c - m)q_i + mq_j$, $i, j = 1, \ldots, n$ (access payments cancel for on-net calls). Network i's profits are

$$\pi_i = \alpha_i \left(\sum_{j=1}^{n} \alpha_j P_{ij} + F_i - f + Q \right).$$

3. Equilibrium profits and the waterbed effect

We will now derive equilibrium profits and determine their dependence on profits Q, for both linear and two-part tariffs. As for the latter, network i's first-order condition for a profit maximum is

$$0 = \frac{\partial \pi_i}{\partial F_i} = \frac{\pi_i}{\alpha_i}\frac{\partial \alpha_i}{\partial F_i} + \alpha_i \left(\sum_{j=1}^{n} \frac{\partial \alpha_j}{\partial F_i} P_{ij} + 1 \right).$$

In a symmetric Nash equilibrium we have $\alpha_i = 1/n$, $\partial \alpha_i/\partial F_i = -(n-1)\sigma$, and for all $j \neq i$, $\partial \alpha_j/\partial F_i = \sigma$ and $P_{ij} = P_{ii}$. Solving the first-order condition for π_i we obtain

$$\pi_i = \frac{1}{(n-1)\, n^2 \sigma}. \tag{1}$$

These profits do not depend on Q, i.e. we have a full waterbed effect. As for linear tariffs, consider the first-order condition for maximizing profits with respect to the call price p_i:

$$0 = \frac{\partial \pi_i}{\partial p_i} = \frac{\pi_i}{\alpha_i}\frac{\partial \alpha_i}{\partial p_i} + \alpha_i \left(\sum_{j=1}^{n} \frac{\partial \alpha_j}{\partial p_i} P_{ij} + \sum_{j=1}^{n} \alpha_j \frac{\partial P_{ij}}{\partial p_i} \right).$$

In a symmetric Nash equilibrium, we have $p_i = p^*$ and $q_i = q^*$ for all $i = 1, \ldots, n$, and thus $\partial \alpha_i/\partial p_i = -(n-1)\sigma q^*$ and $\partial \alpha_j/\partial p_i = \sigma q^*$, with

$$\pi_i = \frac{1 - \eta^* L^*}{(n-1)\, n^2 \sigma}, \tag{2}$$

where $L^* = (p^* - c - (n-1)m/n)/p^*$ is the Lerner index for the equilibrium call price and η^* the corresponding price elasticity of demand. Combining both expressions for profits shows that even in our more general framework under two-part tariffs the call price continues equal to average cost, i.e. $L^* = 0$ or $p^* = c+(n-1)m/n$, i.e. does not depend on Q at all. On the other hand, we now need to determine $\partial p^*/\partial Q$ for linear tariffs, for which we combine (2) with the symmetric equilibrium profits $\pi_i = (P^* - f + Q)/n$, $P^* = (p^* - c)q^*$, to obtain

$$\frac{dp^*}{dQ} = -\frac{(n-1)\, n}{(n-1)\, n\, (P^*)' + (\eta^* L^*/\sigma)'},$$

where apostrophes denote derivatives with respect to p^*. Since p^* is below the monopoly price $(P^*)'$ is strictly positive, and the denominator is positive unless the demand elasticity decreases very strongly as the call price increases. The following assumption, common in the economic literature, provides a simple sufficient condition for $(\eta^* L^*)' > 0$.

Assumption 1. The price elasticity of demand $\eta(\cdot)$ is non-decreasing.

Under this assumption, we conclude that under linear tariffs higher Q feeds through to lower call prices, $dp^*/dQ < 0$. Finally,

[3] Armstrong (2002) discusses a model of perfect competition in two-part tariffs. It exhibits a full waterbed effect due to the type of tariff, not due to the type of competition.

[4] This demand specification encapsulates both the generalized Hotelling model of Hoernig (2014) and the logit model $\alpha_i = \exp(w_i)/\sum_{j=1}^{n} \exp(w_j)$. We can allow for the more general specification $\alpha_i = D_i(w)$, but in this case σ is no longer constant. Expression (3) remains the same, but is harder to sign.