A Comparative Study of Regulation and Pricing in Mobile Communications

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Abstract

The purpose of this paper is to study the economic effects of different pricing mechanisms in the UK, France, the Netherlands and Finland. Based on game theory and bargaining theory, this paper attempts to analyze the equilibrium of the retail prices for fixed-to-mobile calls, call origination charges, mobile termination charges and the division ratio of the retail revenue between fixed and mobile operators, and then compare their levels and the welfare effects under different regimes.

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1 Introduction

While there is tremendous growth and competition in its end-user market, mobile telecommunications is indeed an industry that requires regulatory intervention. Many countries, in particular the European Union member states, regulate the rates of mobile call termination based on the rationale that each mobile operator has monopoly power over the termination of calls on its network.[1]

This paper aims to address the mobile termination rates for fixed-to-mobile calls–the charges mobile operators levy on fixed network operators for call termination. Due to its unique economic characteristic and the high level of charges, mobile termination rates have received considerable attention from regulators and academics alike. According to a study by Bomsel et al. (2003), there was an estimated transfer of €19 billion from the fixed to the mobile sector in excess termination charges over costs during 1998-2002 in the three EU countries of France, Germany, and the UK alone.

High termination rates tend to lead to high retail prices for originating calls and correspondingly lower usage rates, thus decreasing consumer welfare. Why are termination rates so high? There are possibly several factors at work. Firstly, mobile operators have a monopoly power over the termination of calls on their own networks. Oftel (now called Ofcom), the telecommunication regulatory authority in the UK, argued in 1997 that mobile operators have such a monopoly position because when someone wants to make a call to a mobile phone, the calling party has no choice but to call the network to which the called party has subscribed.[2]

Secondly, under the Calling Party Pays (CPP) principle, which is adopted throughout Europe and most other countries (an exception is the US for calls to mobiles), the caller pays for making a call. Therefore, the mobile subscribers do not choose their operator based on the cost of fixed-to-mobile calls. Consequently, there is little competitive incentive for mobile operators to reduce termination charges.[3]

Finally, the competitive effects of mobile termination charges are also adversely influenced by what Gans and King (2000) call *customer ignorance*. That is,

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[1] In 2009 the European Commission recommended that national regulatory authorities set termination rates based on the long-run incremental cost (LRIC) model, in the belief that it will improve social welfare and encourage an efficient market. See Commission Recommendation of 7 May 2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EC(2009/396/EC).

[2] See Oftel's Consultative Document "*Price of Calls to Mobile Phones*" of March 1997, paragraph 1.2.

[3] The Receiving Party Pays (RPP) principle, which applies in the US, Canada, China, and Hong Kong, avoids the overpricing problems and associated distortions of conventional CPP regimes. For the discussions of this, see Armstrong (1998, 2002), Littlechild (2006), and Lopez (2011).

fixed-to-mobile callers are not aware of which mobile network their calls terminate on,[4] and so will only consider the average fixed-to-mobile price when determining how long to talk. Consequently, each mobile operator has an incentive to overprice termination charges.

In the past decade, theoretical literature, such as Armstrong (1998), Wright (2002), and Armstrong and Wright (2009), has demonstrated that both of these factors are potential sources of inefficient pricing. However, despite the factors mentioned above, such high prices in some countries can result from the pricing system they have adopted. In particular, under the CPP principle, fixed network users pay to call mobile network users. This raises questions, such as who sets the retail price for fixed-to-mobile calls and how to determine the fixed-line origination charges and mobile termination charges, respectively.

The purpose of this paper is to study the economic effects of different pricing regimes in the Netherlands, Finland, the UK and France. Based on game theory and bargaining theory, this research attempts to analyze the equilibrium of the retail prices for fixed-to-mobile calls, origination charges, termination charges and the division ratio of the retail revenue between fixed and mobile operators, and then compare their levels and the welfare effects under different regimes.

The organization of this paper is as follows. In section 2, we characterize the different pricing systems and compares each pricing system with others to show its relative merits and drawbacks. In section 3 we conclude the paper and discuss possible extensions of the basic model.

2 The Regimes of Fixed to Mobile Pricing

According to OECD (2000, 2012, 2013), in some countries, fixed network operators set the retail price of a call from the fixed to a mobile network. In other countries, the mobile network operators set the retail price after an interconnection agreement is made between mobile and fixed operators. Within these two main approaches, there are a number of variations as follows.

(i) Mobile and fixed operators agree to a retail price (the regime of the Netherlands). In the Netherlands, mobile operators negotiate with fixed operators for an interconnection arrangement, which includes the retail price and the share of

[4] Gans and King (2000, p 303) also stated: "Number portability exacerbates customer ignorance. Even where a prefix may initially provide some information about the network being called, with mobile number portability those differences will diminish over time, making mobile networks indistinguishable to fixed-line customers."

revenue each party receives.

(ii) Mobile operators set their termination charges, while fixed operators determine their origination charges independently (the regime of Finland). In Finland, the price of fixed-to-mobile calls is simply the sum of origination charges and termination charges. These charges are unilaterally determined by fixed and mobile operators.

(iii) Fixed operators set the retail price of fixed-to-mobile calls (the regime of the UK). This system is in operation, for example, in Australia, Denmark, Italy, Sweden and the UK. Under this regime, the fixed network operators set the retail price for a fixed-to-mobile call after the termination rate has been formulated for calls terminating on the mobile network.

(iii) Mobile operators set the retail price of fixed network to mobile network calls (the regime of France). In contrast to the regime of the UK, in a number of countries, it is mobile operators who set the retail price for calls from the fixed network to mobile networks. This occurs, for example, in France, Taiwan and Portugal.

Different regimes of fixed-to-mobile pricing will apparently influence the equilibrium price; therefore, we will analyze the economic and welfare effects of various regimes based on game theory and bargaining theory in the following.

The Essential Case: Integrated monopoly

To obtain a feel for how the pricing regimes can affect the equilibrium outcomes, we begin by constructing a benchmark model. Suppose that there is an integrated monopoly which owns both a single fixed network and the only mobile network. Let the demand for calls made by fixed subscribers to mobile users be given by the downward sloping demand curve $D(P)$, where P is the price of a call from the fixed network to the mobile network. We can think of this price as either being a price per call or a price per second of the call. The monopoly sets this price.

Moreover, the marginal cost of originating a call on the fixed network is c , while the marginal cost of terminating a call on the mobile network is given by t. Then the profit generated by the monopolist from the fixed-to-mobile calls can be written as:

(1) $$\Pi_m = (P_m - c - t)\,D(P_m).$$

The first-order condition for profit maximization under the integrated monopoly is shown to be:

(2) $$\frac{d\Pi_m}{dP_m} = D(P_m^*) + (P_m^* - c - t)D'(P_m^*) = 0.$$

where P_m^* is the optimum price. Moreover, we assume that the second-order condition $(d^2\Pi_m / dP_m^2) < 0$ is satisfied for the integrated monopolist.

Case 1 The regime of the Netherlands

Under the system of the Netherlands, mobile operator negotiates an interconnection arrangement with the fixed operator, which includes the retail price and the share of revenue each party receives. Now, let k be the fixed operator's share of revenue and $(1-k)$ be the share of the mobile network, where $0 \le k \le 1$. Then the profit functions of the fixed operator, Π_{nl}, and the mobile operator, π_{nl}, can be represented as follows:

(3) $$\Pi_{nl} = (kP_{nl} - c)D(P_{nl}),$$

(4) $$\pi_{nl} = [(1-k)P_{nl} - t]\,D(P_{nl}).$$

According to Binmore and Harboard (2005), the Nash bargaining solution to this problem is found by maximizing the product of the profits to each operator over the status quo.[5]

(5) $$\max_{P_{nl},\,k} N = \pi_{nl} \cdot \Pi_{nl}.$$

Maximizing (5) gives a pair of first-order conditions that can be written as:

(6) $$\frac{dN}{dP_{nl}} = D(P_{nl}^*) + (P_{nl}^* - c - t)D'(P_{nl}^*) = 0,$$

(7) $$\frac{dN}{dk} = [k^*P_{nl}^* - c] - [(1-k^*)P_{nl}^* - t] = 0 \quad \text{or equivalently} \quad \Pi_{nl}^* = \pi_{nl}^*.$$

[5] We simplify the bargaining problem by assuming that the operators receive no income in the absence of an interconnection agreement, thus their status quo or disagreement payoffs will be zero.

Note that equation (6) is identical to equation (2). Hence, the fixed-to-mobile price under the regime of the Netherlands is equal to the monopoly price. That is,

(8) $$P_{nl}^{*} = P_{m}^{*}.$$

Case 2 The regime of Finland

Now, consider the system of Finland. In this regime, the fixed operator determines its origination charges, S_{fl}, and the mobile operator sets its termination charges, R_{fl}, independently and simultaneously. The profit of the operators then becomes

(9) $$\Pi_{fl} = (S_{fl} - c)\, D(P_{fl}),$$

(10) $$\pi_{fl} = (R_{fl} - t)\, D(P_{fl}).$$

In addition, the fixed-to-mobile price under the regime of Finland, P_{fl}, is simply the sum of S_{fl} with R_{fl}. That is,

(11) $$P_{fl} = S_{fl} + R_{fl}.$$

The problem for the fixed operator is thus to choose S_{fl} to maximize Π_{fl}, and the first-order condition is:

(12) $$\frac{d\Pi_{fl}}{dS_{fl}} = D(P_{fl}^{*}) + (S_{fl}^{*} - c)\, D'(P_{fl}^{*}) = 0 .$$

Similarly, the first-order condition for the mobile operator is:

(13) $$\frac{d\pi_{fl}}{dR_{fl}} = D(P_{fl}^{*}) + (R_{fl}^{*} - t)\, D'(P_{fl}^{*}) = 0 .$$

Recalling that $P_{fl}^{*} = S_{fl}^{*} + R_{fl}^{*}$, we can sum (12) and (13) and rearrange to read:

(14) $$2D(P_{fl}^{*}) + (P_{fl}^{*} - c - t)\, D'(P_{fl}^{*}) = 0.$$

In order to compare P_{fl}^* in (14) with the monopoly price P_m^* in (2), evaluating the derivative in (2) at P_{fl}^* yields:

(15) $$\frac{d\Pi_m}{dP_m}\Big|_{P_m=P_{fl}^*} = D(P_{fl}^*)+(P_{fl}^*-c-t)D'(P_{fl}^*) = -D(P_{fl}^*) < 0,$$

where the second equality follows from (14).

The assumption of $(d^2\Pi_m / dP_m^2)<0$ coupled with (15) and (8) enables us to assert the following result,

(16) $$P_{fl}^* > P_{nl}^* = P_m^*.$$

Case 3 The regime of the United Kingdom

In the UK, the retail price is set by the fixed network operator after a commercially negotiated interconnection arrangement is reached with the mobile operator. To analyze the UK's system, let us consider a game with the following stages. In the first stage, the fixed operator negotiates fixed-to-mobile termination charges with the mobile operator. It is assumed that the termination charges set in the first stage are irreversible and cannot be adjusted in the second stage. Then, in the second stage, the fixed operator sets the retail price of fixed-to-mobile calls.

This is a two-stage game, and is generally solved backwards. Therefore, at the second stage, the fixed operator will choose P_{uk} to maximize its profit,

(17) $$\Pi_{uk} = (P_{uk}-R_{uk}-c)D(P_{uk}).$$

The first-order condition is given by

(18) $$D(P_{uk})+(P_{uk}-R_{uk}-c)D'(P_{uk})=0.$$

Moving to the first stage of the game, we use the Nash bargaining solution, which implies the maximization of

(19) $$\begin{aligned}\max_{R_{uk}} \quad N &= \pi_{uk}\cdot\Pi_{uk} \\ &= [(R_{uk}-t)D(P_{uk})]\cdot[(P_{uk}-R_{uk}-c)D(P_{uk})].\end{aligned}$$

where $[(R_{uk}-t)D(P_{uk})]$ is the profit of the mobile operator under the regime of the

UK.

Maximizing (19) gives a first-order condition as follows:

(20) $$(P_{uk} - R_{uk} - c) - \alpha (R_{uk} - t) = 0,$$

where $\alpha \equiv (1 + \partial P_{uk} / \partial R_{uk}) > 1$. In addition, $(\partial P_{uk} / \partial R_{uk}) > 0$ is the fixed operator's reaction to mobile termination rates changes. Rearranging (20) slightly, we have:

(21) $$R_{uk} = \frac{1}{1+\alpha} (P_{uk} - c + \alpha t)$$

Substituting (21) back into (18), we obtain:

(22) $$\lambda D(P_{uk}^*) + (P_{uk}^* - c - t) D'(P_{uk}^*) = 0,$$

where $\lambda \equiv 1 + (1/\alpha)$, and $1 < \lambda < 2$.

Now, evaluating the derivative in (2) at P_{uk}^* yields:

(23) $$\frac{d\Pi_m}{dP_m} |_{P_m = P_{uk}^*} = D(P_{uk}^*) + (P_{uk}^* - c - t) D'(P_{uk}^*) = (1-\lambda) D(P_{uk}^*) < 0,$$

where the second equality follows from (22).

The assumption of $(d^2\Pi_m / dP_m^2) < 0$ coupled with (23) and (16) enables us to assert the following result:

(24) $$P_{fl}^* > P_{uk}^* > P_{nl}^* = P_m^*.$$

Case 4 The regime of France

In France, it is the mobile operator, instead of the fixed operator, which sets the retail price for fixed-to-mobile calls. The profit of the operators then becomes:

(25) $$\Pi_{fr} = (S_{fr} - c) D(P_{fr}),$$

(26) $$\pi_{fr} = (P_{fr} - S_{fr} - t) D(P_{fr}).$$

The structure of the game is that the fixed operator bargains with the mobile operator over origination charges, S_{fr}, at the first stage. Then, the mobile operator sets a retail price, P_{fr}, at the second stage unilaterally. Because the game structure is similar to the regime of the UK, therefore, we can get the following equilibrium condition immediately:

(27) $$\theta D(P_{fr}) + (P_{fr} - c - t) D'(P_{fr}) = 0$$

where $\theta \equiv 1 + (1/\beta)$, and $1 < \theta < 2$. In addition, $\beta \equiv (1 + \partial P_{uk} / \partial S_{uk}) > 1$, where $(\partial P_{uk} / \partial S_{uk}) > 0$ is the mobile operator's reaction to fixed-line origination rates changes.

Analogously to (24), one can show that:

(28) $$P_{fl}^{*} > (P_{fr}^{*} \gtrless P_{uk}^{*}) > P_{nl}^{*} = P_{m}^{*}.$$

3 Conclusion

A comparison of the general economic effects of the fixed-to-mobile pricing under the different regimes is showed in this paper. In particular, there are two main conclusions concerned with the price of fixed-to-mobile calls and traffic. First of all, $P_{fl}^{*} > (P_{fr}^{*} \sim P_{uk}^{*}) > P_{nl}^{*} = P_{m}^{*}$. Secondly, $D(P_{fl}^{*}) < (D(P_{fr}^{*}) \sim D(P_{uk}^{*})) < D(P_{nl}^{*}) = D(P_{m}^{*})$.

In fact, the models developed above are based on wisdom from various theories of industrial organization. For example, the regime of the Netherlands reflects the theory of bilateral monopoly; the regime of Finland is based on the theory of Cournot's copper-zinc competition; and the regimes of the UK and France are applications of double marginalization.

The price level under the regime of the Finland is the highest, the UK and France are in the middle, and the Netherlands induces the lowest price level. However, all prices are equal to or greater than the price level of an integrated monopoly. That is, improper regimes will result in higher than monopoly prices for fixed-to-mobile calls. Therefore, to improve consumer welfare and encourage an efficient market, the mobile industry needs to be regulated.

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