# Asymmetric Regulation of Mobile Access Charges and Consumer Welfare with Price Regulation

Jongyong Lee, Duk Hee Lee, and Choong Young Jung

**Asymmetric regulation as applied to mobile termination rates refers to regulatory arrangements in which different mobile operators charge different termination rates, even though the services provided are essentially identical. The asymmetric regulation has been frequently used as a regulatory tool to support new entrants to a mobile market. This paper examines the economic effects of asymmetric regulation of mobile termination rates using a theoretical model and its simulation. The result shows that when there is no noticeable difference in brand loyalty between mobile operators with the high degree of substitutability between services provided by mobile operators, and the costs of new entrants are low, a reduction in the asymmetry of mobile access prices results in an enhancement of consumer welfare. These findings provide positive evidence for the argument that in certain situations asymmetric pricing of mobile access services may be counterproductive for consumer welfare.**

**Keywords: Network competition, asymmetric regulation, mobile telecommunications, mobile termination rates, consumer welfare.**

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## I. Introduction

Mobile telecom markets are capital-intensive markets that tend toward oligopolistic structures. This is due on one hand to the high entry barriers of these markets, which are related to the limited availability of frequency spectrum resources, while on the other hand to large initial investment requirements, which are offset by economies of scale. Strong network externalities enjoyed by the dominant suppliers of these markets are also a contributing factor. These special characteristics of mobile markets have a significant influence on the costs of their participants and quality of services they provide, and are ultimately a cause for the wide disparity frequently observed between incumbent operators and new entrants in market power. This is one reason why regulatory intervention is considered necessary in mobile markets to ensure effective competition.[1)]

The term “asymmetric regulation” as applied to mobile termination rates refers to regulatory arrangements in which different mobile operators charge different termination rates, even though the services provided are essentially identical. Asymmetric regulation is frequently used as a regulatory tool to support new entrants to a mobile market. Network operators, regardless of age or size would prefer to keep total control of calls originated from subscribers of a competitor’s network and finishing with their own subscribers. If a mobile operator with market power uses its position to set an unreasonably high access price for termination services, this can result in serious

1) In Korea, examples of asymmetric regulation in the mobile market include the imposition of a cap on retail rates charged by the incumbent, asymmetric pricing of access services between the incumbent and latecomers, asymmetric rules on the use of spectrum between operators assigned high-quality spectrum and those assigned spectrum of low-quality, and a differentiated implementation schedule for number portability in favor of new entrants.

  

losses in terms of social welfare and allocative efficiency. On the other hand, efforts in creating a level playing field in a mobile market through asymmetric regulation could also misfire if such regulation allows latecomers to raise their access charges excessively. Also, if operators have equal monopoly power within the termination market, asymmetric regulation is not a justifiable option. Regulators may resort to asymmetric regulation to support market entry by new entrants in certain situations, for the goal of promoting competition. However, market entry support through asymmetric regulation cannot be a fundamental solution to the problem of market power.

The potential negative consequences of asymmetrically regulating mobile termination prices have been pointed out by telecom regulators of several countries. According to the European Commission, asymmetric pricing of mobile termination services hinders improvement in productive efficiency, and forces efficient operators to subsidize inefficient operators. Inefficiencies caused by asymmetric regulation, when they trickle down to the retail market, cause a decline in end-users' welfare. Further, the European Commission opines that a regulator, by keeping in place an asymmetric pricing regime for an extended period of time, risks encouraging and assisting the entry of inefficient operators into the market. The European Commission, therefore, opted against asymmetric regulation and put in place a symmetric pricing regime in which a single access price, calculated based on the costs of an imaginary efficient operator, is applied to all operators. Meanwhile, during the transition period, member states currently having an asymmetric pricing regime are allowed to keep their regimes, as long as they are based on objective cost disparities [1]. The European Regulators Group (ERG) holds a similar view to the European Commission on asymmetric regulation. ERG's stance is that mobile termination services must be symmetrically priced, and that asymmetric pricing must be used only when justifiable reasons exist [2].

UK regulator Ofcom, meanwhile, has recently decided to recognize only objective differences in mobile access costs, such as those arising from differences in frequency bands, and excludes cost disparities resulting from differences in market share or capital costs. Ofcom announced that it plans to shift toward a symmetric pricing regime for mobile termination services, applying to all operators over the long term, citing the need to reduce the regulatory burden in the mobile market and new deregulatory measures, such as the authorization of spectrum trading and a lifting of restrictions on the types spectrum uses [3]. AGCOM, the Italian telecom regulator, also recently reached a decision to progressively move toward a single price regime for mobile termination services. During a phase-in period, a single rate of 5.4 Euro cents is planned to be applied to access services by TIM, Vodafone, and Wind starting from the year 2010. From 2012, the access price will be set to 4.5 cents for all Italian mobile operators, including the latecomer H3G [4].

The US Federal Communications Commission (FCC) expressed the view that while symmetric pricing of access services can encourage operators requesting interconnection to use more efficient technologies to reduce their costs, asymmetric regulation can provide certain operators with opportunities for making undue profits and thereby undermine the public interest [5]. There are also quite a few academic studies calling into question the benefits of asymmetric access price regulations. Valletti for instance, argued that setting different access prices according to the operator leads to distributive and productive inefficiencies and distorts competition, ultimately hurting the welfare of users. Asymmetric regulation, he points out, can also have the undesirable effect of promoting reliance on government protection on the part of operators authorized to set a higher access rate, cutting the incentive for innovation and investment [6].

Four European countries in which an asymmetric pricing regime was previously in place have already abandoned it in favor of a symmetric regime; namely, Sweden, Denmark, Poland, and Portugal [7]. Interestingly, a study measuring changes in competition indicators and consumer welfare indicators in these four European countries, between the date at which asymmetric pricing was repealed and the year 2007, found that the indicators improved over this period much more significantly for the second and third largest mobile operators than the largest one.[2] The main implication of the quoted research is not that asymmetric price regulation for a limited period of time is acceptable, but that lifting asymmetric price regulation apparently provides incentives for the supposed beneficiaries to boost their productivity. Any prolonged use of asymmetric regulation of mobile access charges is therefore bound to create inefficiencies. Hence, it is important for regulators to limit the use of asymmetric pricing to cases in which social benefits exceed the social costs resulting from it. It is also desirable to adopt different regulatory approaches for different stages of the market. Additional markups on mobile access rates could be allowed on a temporary basis, for example, during an early growth stage, and not when the market is in a maturity phase [10]. Asymmetric regulation of mobile access rates, meanwhile, is an effective strategy when

2) Indicators used to measure changes in the competition situation within the mobile market include market share and earnings margin before interest, taxes, depreciation, and amortization, and indicators explaining consumer benefits are minutes of use and voice revenue per minute, a popular proxy indicator for retail call prices. The data used in this study, related to access price disparities and price brackets, were taken from the 2008 mobile access pricing statistics published by Ovum, and the rest of the data is from Global Wireless Matrix 4Q 07 released by Merrill Lynch, in April 2008 [8], [9].

the incumbent brand loyalty is high, and the degree of substitutability between offered services is low so that the switching cost is significantly high and market share is not affected by an entrant's price [11]. Whether or not to opt for asymmetric regulation of mobile access rates is therefore a question that depends on multiple factors affecting a mobile market, and must be decided according to the specific market environment within a country at a given time.

In the literature, prior studies about network competition are classified into symmetric and asymmetric network models in terms of network size. The former mainly focuses on the mature market and symmetric unregulated networks. In [12]-[14], it is shown that higher termination charges become an instrument of collusion in order to increase retail prices under symmetric networks and linear retail prices. This research also indicates the possibility of an anti-competitive problem in the entry market because the dominant operator can squeeze the entrant or deter entry by increasing termination charges. Cherdron [15] and Gabrielsen and Vagstad [16] emphasize that firms can increase their profits by setting the access charge higher than the true cost of access through a model assuming two symmetric networks, two-part tariffs, calling clubs, and termination-based price discrimination. In addition, Cambini and Valletti (2003) introduce a quality parameter into a symmetric network model to illustrate that operators agree on above-cost access charges to avoid competing excessively against each other over investment [17]. Meanwhile, according to Dessein, termination charges may not be a collusive tool when operators compete in nonlinear pricing under symmetric networks [18]. Gans and King [19] and Calzada and Valletti [20] propose that access charges of symmetric networks maximizing network profit can be below cost without entry threats.

The models about asymmetric networks generally assume an unbalanced market share resulting from the difference of entry time. Armstrong considers a model where the dominant firm's retail tariff is controlled using non-reciprocal termination charges [21]. In addition, Dewenter and Haucap examine termination regulations under asymmetric mobile networks when consumer ignorance regarding access charges exists, but do not consider on-net calls [22]. Hoernig, however, presents that a differential between on-net and off-net prices has a significant influence on the competition of asymmetric telecommunications networks when the utility of receiving calls exists [23]. It is worth considering the curious result that the free market termination prices may be negatively associated to the market share of the operator due to a free-ride effect, which is at odds to conventional industrial organization analysis. This effect was noticed by Gans and King [24] and Wright [25]. Asymmetric regulated access pricing can increase this problem.

When it comes to asymmetric network models, we can also regroup some of them into asymmetric and symmetric regulation approach about access charges. First, in an asymmetric approach advocating asymmetric termination rates, De Bijl and Peitz [26] provide significant contributions on regulatory policies regarding access and retail prices in a variety of market environments. In particular, they show that under a situation where operators compete in two-part tariffs, an asymmetric access markup only for the entrant increases consumer surplus and the entrant's profits in an infant market. They also confirm the results with the help of simulation methods. In subsequent work, Peitz addresses a model analyzing the effect of asymmetric access price regulation using two-part tariffs and termination-based price discrimination. He states that while the asymmetric access charge regulation has a positive side for the entrant to quickly penetrate the market it can increase the dangers of inefficient entry and cream-skimming [27], [28]. In addition, Cricelli and others [11], Kocsis [29], Geoffron and Wang [30], and Kim and Park [31] insist that asymmetric access price regulation may be a useful policy to promote competition in the market providing that first-mover advantages, such as brand loyalty, and calling club effects are significant. Second, regarding a symmetric approach supporting reciprocal or symmetric termination rates, Littlechild [32] and Valletti [6] strongly state that mobile access charges should be symmetric in that all mobile networks, regardless of their network size, have monopoly power in the termination market, and the policy of supporting entry through access markup for the entrant may distort competition. Armstrong also shows that a reciprocal termination charge is optimal if the incumbent is regulated under heterogeneous demand [33]. Based on reciprocal access charges, Cater and Wright present a model of vertical differentiation, in which the incumbent offers a superior service to the entrant [34].

This paper considers the effect of asymmetric termination rates on consumer welfare. To this effect, we build a theoretical model based on the models regarding competing interconnected networks proposed in [13] and perform numerical evaluations within this model. Our study extends the benchmark models by taking into account brand loyalty as a parameter that effects competition as in [14]. We primarily focus on the assumption that a new entrant faces a peculiar problem when the retail price of an incumbent is regulated. This approach, in particular, reflects the actual situation of mobile telecommunications markets in Korea, in which only the incumbent's retail price is controlled and mobile termination rates of operators are asymmetrically regulated. We also consider the degree of substitutability between services provided by operators and the costs of new entrants as important factors determining the effectiveness of asymmetric access price regulation in our model.

The rest of this paper is organized as follows. In section II, we develop a theoretical two-firm model in which the retail price of one of the firms is fixed. In section III, we assess the influence of asymmetric regulation of mobile termination rates on consumer welfare using simulations on our developed static model. Finally, in section IV, we derive implications from the research results and introduce a direction for future study.

## II. Model

Let us consider a linear city of length 1. Consumers are distributed uniformly along the interval [0, 1]. Let us suppose that there are two mobile operators, an incumbent and a new entrant, which we will call "operator A" and "operator B" respectively, and that operator A is located at point 0 and operator B at point 1, in a manner reflecting horizontal product differentiation. We assume that the operator cannot differentiate charges by destination. Also, we define $p_A$ and $p_B$ as the price per subscriber of each operator, and $v_A$ and $v_B$ as the brand loyalty of each operator. If we call the unit transportation cost or unit cost of movement $t$ as a parameter representing the degree of substitutability between services, the welfare function of consumer $x$ can be expressed as[3)]

If subscribed to operator A,

$$Ux = v_A - p_A - tx. \quad (1)$$

If subscribed to operator B,

$$Ux = v_B - p_B - t(1-x). \quad (2)$$

Let us now suppose that each consumer makes only one call, and that neither of the operators charges a subscription fee. There are two types of calls that a subscriber of operator A can make: on-net calls and off-net calls. When the share of subscribers for each operator can be expressed as $q_A$ and $q_B$, respectively, the demand functions for each operator are

$$q_A = \frac{1}{2} + \frac{p_B - p_A + \Delta v}{2t}, \quad (3a)$$

$$q_B = \frac{1}{2} + \frac{p_A - p_B - \Delta v}{2t} = 1 - q_A. \quad (3b)$$

Here, we have written $\Delta v = v_A - v_B$ for the difference in brand loyalty between the operators. This difference represents a gap in the objective quality perceived by consumers toward each operator as a measure of vertical differentiation.

We assume that $r_A$ and $r_B$ denoting mobile termination rates of each operator are regulated, and $\Delta r = r_A - r_B$ is the size of the mobile access charge asymmetry. If the regulator reduces the asymmetry of mobile access rates, this results in the reduction of the rate disparity between operators A and B. As $\Delta r$ is a negative value ($\Delta r < 0$), the reduction of the rate disparity results in the increase of $\Delta r$.

Let us now define revenues for operator $i$ as $p_i q_i + r_i(1-q_i)q_i$, and costs as $2c_i q_i + r_j(1-q_i)q_i$. Here, $c_i$ stands for marginal costs incurred in the origination and termination segment. In this case, the profit function of mobile operator $i$ is given as

$$\begin{aligned}\pi_i &= [p_i - 2c_i + (r_i - r_j)(1-q_i)]q_i \\ &= \frac{1}{4t^2}[(2t+r_i-r_j)p_i-(r_i-r_j)p_j+(r_i-r_j)(t-v_i+v_j)-4tc_i] \\ &\quad \times (t + p_j - p_i + v_i - v_j). \end{aligned} \quad (4)$$

In Korea's case, the regulator adopts not only asymmetric mobile access charge regulations based on long-run incremental costs but also an asymmetric mobile retail pricing regime. Therefore, cost-based regulation is imposed on the incumbent holding significant market power (SMP) in terms of market share over 50%, and its retail price is subject to prior approval by the government.[4)] However, the entrants can freely set their retail price. To reflect this situation, let us now assume that the regulated retail price of operator A is $\overline{p_A}$. As this regulated price is a factor influencing the profit maximization price for operator B, we formulate the profit maximization problem for the latter as

$$\begin{aligned}\max_{p_B} \ \pi_B &= [p_B - 2c_B + (r_B - r_A)(1-q_B)]q_B \\ &= \frac{1}{4t^2}[(2t-\Delta r)p_B+\Delta r\overline{p_A} -\Delta r(t+\Delta v)-4tc_B] \\ &\quad \times (t + \overline{p_A} - p_B - \Delta v), \end{aligned} \quad (5)$$

where $\Delta r = r_A - r_B (\Delta r < 0)$, $\Delta v = v_A - v_B$.

The equilibrium price satisfying the above profit maximization equation and the equilibrium market shares of operators A and B would then be

$$\overline{p_B} = \frac{t-\Delta r}{2t-\Delta r}(\overline{p_A} - \Delta v) + \frac{t(t+2c_B)}{2t-\Delta r}, \quad (6a)$$

$$\overline{q_A} = \frac{1}{2(2t-\Delta r)}[3t + \Delta v - \Delta r - \overline{p_A} + 2c_B], \quad (6b)$$

$$\overline{q_B} = \frac{1}{2(2t-\Delta r)}[t - \Delta v - \Delta r + \overline{p_A} - 2c_B]. \quad (6c)$$

3) Laffont, Ray, and Tirole expressed substitutability between services (σ) as $\sigma = 1/2t$, which means that the cost of movement and substitutability between services have an inverse relationship with each other [13].

4) For a more detailed explanation about Korean mobile retail price regulation, see [35], [36].

In (6a), $\overline{p_{\text{B}}}$ is a function of $\Delta r$, as a change in the value of $\Delta r$ causes the value of $\overline{p_{\text{B}}}$ to also change. Hence, if we differentiate (6a) with respect to $\Delta r$, after simplification this will give (7)

$$\frac{d\overline{p_{\text{B}}}}{d\Delta r}=\frac{t(t+\Delta v+2c_{\text{B}}-\overline{p_{\text{A}}})}{(2t-\Delta r)^2}. \tag{7}$$

It is shown in (7) that operator B will try and make up for a decline in its regulated access price asymmetry (an increase in $\Delta r$) by either raising its retail price if substitutability is low and/or brand loyalty is high ($t+\Delta v+2c_{\text{B}}>\overline{p_{\text{A}}}$) or lowering its retail price if substitutability is high and/or brand loyalty is low ($t+\Delta v+2c_{\text{B}}<\overline{p_{\text{A}}}$). Whilst access price asymmetries are high ($\Delta r$ is a big negative), operator B has an incentive to keep its market share low so as to gain more from high levels of interconnection traffic per subscriber (since a high proportion of its traffic will be off-net). This can be seen from (5). If the asymmetry is reduced (an increase in $\Delta r$), this incentive is reduced and so operator B will seek a higher market share. It can do this by lowering its price only if substitutability is high and/or brand loyalty is low. Otherwise, lowering prices has less impact on market shares and so serves less purpose (whilst losing revenue). In other words, when operator B suffers a reduction in access price asymmetry, it has less incentive to secure subscribers (because it has less incoming revenue from each subscriber), and so if substitutability is low and/or brand loyalty is high, it will increase prices.

Now, to determine how a change in the degree of asymmetry in mobile access prices charged by operators A and B affects consumer welfare, let us write the following consumer welfare function as

$$\begin{aligned}CS&=\int_0^{q_{\text{A}}}(v_{\text{A}}-\overline{p_{\text{A}}}-tx)dx+\int_{q_{\text{A}}}^{1}(v_{\text{B}}-\overline{p_{\text{B}}}-t(1-x))dx\\&=v_{\text{B}}-\overline{p_{\text{B}}}(\Delta r)-\frac{1}{2}t+\frac{t}{4(2t-\Delta r)^2}(3t+\Delta v-\Delta r-\overline{p_{\text{A}}}+2c_{\text{B}})^2.\end{aligned} \tag{8}$$

In (8), for an increase in the value of $\Delta r$ to result in improvement in consumer welfare, the condition $dCS/d\Delta r>0$ must be met. To reformulate (8) in a manner that shows the effect of a change in the value of $\Delta r$ on consumer welfare, one can differentiate it with respect to $\Delta r$ by taking (7) into consideration. The new equation resulting from differentiation and after simplification is

$$\frac{dCS}{d\Delta r}=\frac{t(t+\Delta v+2c_{\text{B}}-\overline{p_{\text{A}}})(t+\Delta v+2c_{\text{B}}-\overline{p_{\text{A}}}-(2t-\Delta r))}{2(2t-\Delta r)^3}. \tag{9}$$

From (9), we are now able to derive the following three lemmas:

**Lemma 1.** If $t+\Delta v+2c_{\text{B}}<\overline{p_{\text{A}}}$, then $\frac{dCS}{d\Delta r}>0$.

*Proof.* In (9), if the first term of the right-hand side of the equation has a negative value, the condition $t+\Delta v+2c_B<\overline{p_A}$ being met, then the second term $t+\Delta v+2c_B-\overline{p_A}-(2t-\Delta r)$ will also have a negative value $(2t-\Delta r>0)$ because of $t\ge 0$ and $\Delta r<0$; hence $\frac{dCS}{d\Delta r}>0$. □

Lemma 1 indicates that under a situation in which retail rates charged by an incumbent (operator A) are kept through regulatory actions, both operator B's cost level and the gap in brand loyalty between A and B are low, whilst the degree of substitutability between services is high. Under this condition, responding to the shortfall in termination revenue caused by a reduced difference in mobile access rates, operator B desires to decrease its retail rates to win over A's subscribers. Therefore, an increase in the value of $\Delta r$, as it leads to a decrease in the value of $\overline{p_{\text{B}}}$, has a direct effect of enhancing the welfare of subscribers of operator B. In a situation where a high degree of substitutability exists, this can also induce subscribers of operator A switching over to operator B. The resulting growth of its subscriber base will then allow operator B to appreciate greater network effects. On the other hand, the customers of operator A, paying higher prices for the same services, will see their welfare further diminish due to the shrinking subscriber base. Finally, a reduction in the asymmetry of access prices will have an overall positive effect on consumer welfare, as the enhancement in the welfare of operator B's subscribers largely exceeds the decline in the welfare of operator A's subscribers.

**Lemma 2.** If $t+\Delta v+2c_{\text{B}}>\overline{p_{\text{A}}}$ and the degree of substitutability between services is low, then $\frac{dCS}{d\Delta r}<0$.

*Proof.* In (9), if the first term of the right side of the equation has a positive value, the condition $t+\Delta v+2c_{\text{B}}>\overline{p_{\text{A}}}$ being met, and the second term has a negative value $(2t-\Delta r>0)$, the condition $t+\Delta v+2c_{\text{B}}-\overline{p_{\text{A}}}<(2t-\Delta r)$ being also met, then $\frac{dCS}{d\Delta r}<0$. □

Lemma 2 corresponds to a situation in which there is a high level of brand loyalty towards the incumbent, while the degree of substitutability between services is rather low. In such a situation, an increase in the value of $\Delta r$ also raises the value of $\overline{p_{\text{B}}}$, resulting in a decline in the welfare of consumers subscribed to operator B. Subscribers to operator B, however, cannot easily switch to operator A, or vice versa, subscribers to operator A to operator B, due to the low degree of substitutability. Under such a scenario, reducing the asymmetry of inter-carrier access prices can only worsen the welfare of subscribers of operator B.

**Lemma 3.** If $t+\Delta v+2c_{\mathrm{B}}>\overline{p_{\mathrm{A}}}$, and the degree of substitutability between services is high, then $\frac{dCS}{d\Delta r}>0$.

*Proof.* In (9), if the first term of the right side of the equation has a positive value, the condition $t+\Delta v+2c_{\mathrm{B}}>\overline{p_{\mathrm{A}}}$ being met, and the condition $t+\Delta v+2c_{\mathrm{B}}-\overline{p_{\mathrm{A}}}>(2t-\Delta r)$ is further satisfied, then the second term will also have a positive value $(2t-\Delta r>0)$; hence, $\frac{dCS}{d\Delta r}>0$. □

Lemma 3 holds for a situation in which an increase in the value of $\Delta r$ results in a increase in the value of $\overline{p_{\mathrm{B}}}$, thereby also increasing substitutability between services. This condition encourages subscribers of operator B to switch over to operator A. The subscriber churn, while it will cause the welfare of subscribers of operator B to decline, will enhance the welfare of subscribers of operator A. As the increase in the welfare of subscribers of operator A is significantly greater than the decrease in the welfare of subscribers of operator B, this situation results in the enhancement of the overall consumer welfare.

From lemmas 1, 2, and 3, we can now derive a new proposition:

**Proposition 1.** A reduction of asymmetry in mobile access prices may lead to an enhancement of the overall consumer welfare derived from mobile services

(a) if there is no difference of brand loyalty between an incumbent and a new entrant $(\Delta v_{\mathrm{A}}=\Delta v_{\mathrm{B}})$, and the new entrant has low costs; and/or

(b) if the degree of substitutability between services is sufficiently high compared to the difference in mobile termination rates, even if there is a difference of brand loyalty between the incumbent and new entrant, and the new entrant's costs are not lower than the incumbent's.

*Proof.* Proposition 1(a) can be easily induced from lemma 1, and proposition 1(b) from lemma 3. □

The implication of proposition 1 is that in a situation where the costs of the latecomer have been sufficiently brought down by economies of scale and an improvement in productive efficiency, and the brand loyalty gap between the two operators has clearly been removed, a reduction in the asymmetry of inter-carrier access pricing can positively affect consumer welfare. Also, even in a situation where a new entrant's costs are high and the brand loyalty gap between the two operators is still sizeable, if the degree of substitutability between services is sufficiently high, a reduction in the asymmetry of access pricing can nevertheless lead to an enhancement of overall consumer welfare.

## III. Simulations

Whether it is desirable at a societal level to reduce disparity in mobile access prices is a question that ultimately depends on whether it leads to an enhancement of economic welfare. In what follows, we examine how a gradual reduction of disparity in access prices affects consumer welfare through simulations. The conditions and parameters for this estimation are as follows:

**Condition 1.** We assume that there had been a difference in marginal costs between the incumbent and the new entrant during the initial period after the latter had entered the market, but this difference has now been almost completely erased with the market reaching the mature phase. Mobile access prices have been in steady decline in most countries around the world.[5] Therefore, if access prices are set based on actual costs, this means that the costs of operator B are also decreasing steadily. Meanwhile, marginal costs are also influenced by the extent to which an operator invests in network facilities. Therefore, if a new entrant does not try as hard as the incumbent to cut costs or does not invest in networks as much as the incumbent, its marginal costs will never be smaller than the incumbent's. To determine the effect of a change in the cost of operator B ($c_{\mathrm{B}}$), we assume two different cost levels, 2 and 3, for explanatory convenience.

**Condition 2.** The introduction of mobile number portability, however, has greatly eroded mobile users' loyalty toward a specific carrier. Also, as the mobile market has now entered its mature phase, the difference in brand loyalty between operators is currently negligible. To measure the sensitivity of results to the difference in brand loyalty, $\Delta v$, it is set alternately to 0 and 0.5 representing that there is no difference and there is significant difference in brand loyalty of the operators, respectively.

**Condition 3.** The retail price charged by operator A to its customers is set by the regulator, and operator B sets its own retail price in relation to the price of operator A. Here, we assume two different retail prices for operator A: 5 and 10, satisfying $t+\Delta v+2c_{\mathrm{B}}>\overline{p_{\mathrm{A}}}$ and $t+\Delta v+2c_{\mathrm{B}}<\overline{p_{\mathrm{A}}}$, respectively.

5) Mobile termination rates are in a steady decline in Europe, with the average rates standing at €12.65 in October 2005, €11.01 in October 2006, and €9.67 in October 2007 [37].

**Condition 4.** The cost of movement, $t$, explains the degree of substitutability between services provided by operators A and B. The lower the cost of movement is, the higher the degree of substitutability between services. Substitutability tends to heighten in a mature market, as competition between mobile carriers intensifies. To measure how the changing degrees of substitutability between services provided by the two mobile operators affect the results of analysis, we alternately assigned values of 0.1 and 0.5 to $t$. This is because if $t < 0.1$, then market share of A and B is reversed, and if $t > 0.5$, then there is no change in market share between the operators.

By successively substituting the values in conditions 1, 2, 3, and 4 into (9), we obtained four types of simulation graphs, as shown in Fig. 1. Table 1 shows key results of our simulation.

Figures 1(a) and 1(b) simulate the conditions corresponding to lemma 1. As the value of $\Delta r$ increases gradually, the value of $dCS / d\Delta r$ increases commensurately. When the value of $\Delta r$ grows close to 0, the increase in the value of $dCS / d\Delta r$ becomes particularly sharp. Figure 1(a) indicates the sensitivity with regard to changes in consumer-perceived difference in brand loyalty under a constant condition of $t = 0.1$, $c_B = 3$, and $\overline{p_A} = 10.$ The graph shows that the smaller the perceived brand loyalty difference ($\Delta v$=0), the greater the enhancement in consumer welfare resulting from a reduction of asymmetry in mobile access prices.

Meanwhile, Fig. 1(b) indicates the sensitivity with regard to changes in the degree of service substitutability under a constant condition of $\Delta v = 0, c_B = 3$, and $\overline{p_A} = 10.$ The graph shows that the higher the degree of service substitutability ($t$=0.1), the greater the enhancement in consumer welfare resulting from a reduction of asymmetry in mobile access prices. The implication of this result is that the higher the degree of substitutability between services, the more symmetric should be the pricing of access services.

Figure 1(c) measures the sensitivity to cost changes under a constant condition of $\Delta v = 0, t = 0.1$, and $\overline{p_A} = 10.$ The graph indicates that the lower the costs of operator B ($c_B$=2), the greater the enhancement in consumer welfare resulting from a reduction of asymmetry in mobile access prices. It is therefore socially beneficial to reduce disparity in mobile termination charges by bringing the rate of operator B in line with its changing cost levels.

Finally, Fig. 1(d) assumes $\Delta v = 0, c_B = 3$, and $\overline{p_A} = 5$, describing the situations in lemmas 2 and 3; in other words, $t + \Delta v + 2c_B > \overline{p_A}$ . In this case, the degree of substitutability between services and the degree of difference in mobile access prices between mobile operators ($\Delta r$) determine consumer welfare effects that are brought about by a change in access

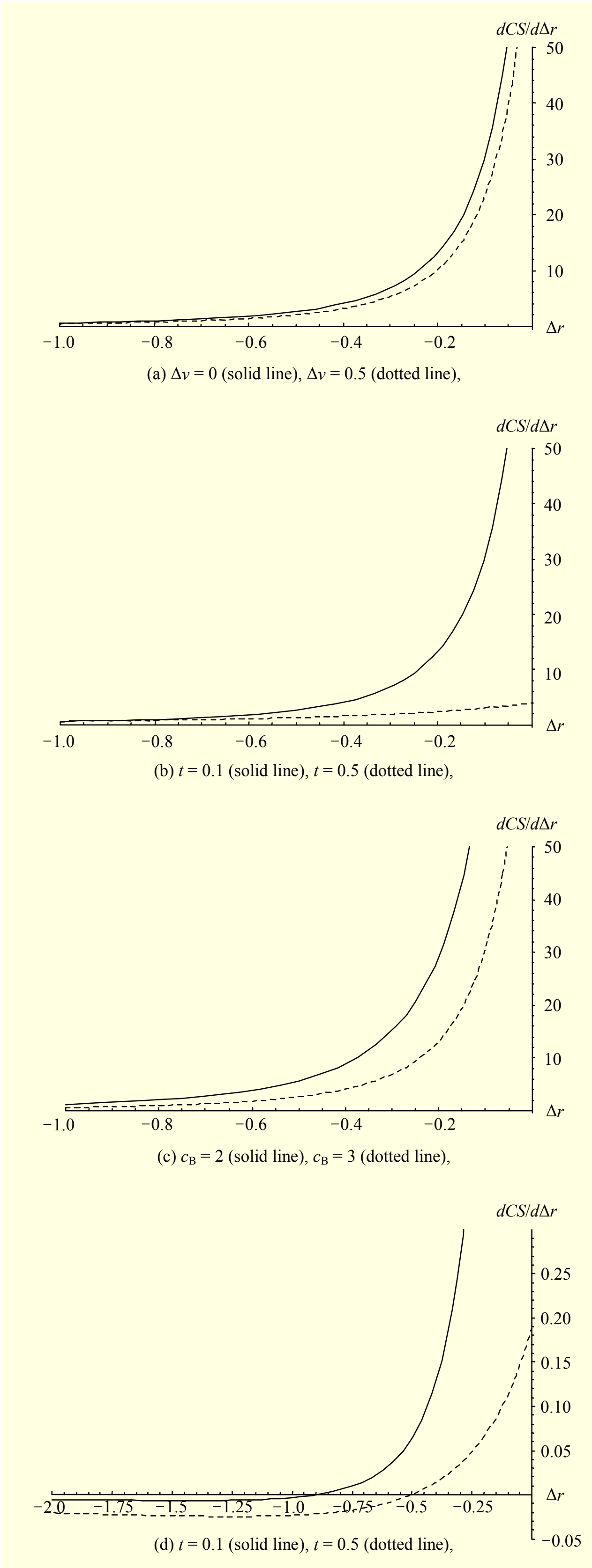


Fig. 1. Changes in consumer welfare from a reduction of mobile access pricing asymmetry.

Table 1. Summary of simulation results.

| Conditions | Sensitivity | Constant value | Effects of reduction in asymmetric termination charge regulation |
|---|---|---|---|
| $t+\Delta v+2c_{\mathrm{B}}<\overline{p_{\mathrm{A}}}$ | $\Delta v=0$ or $0.5$ | $t=0.1, c_{\mathrm{B}}=3, \overline{p_{\mathrm{A}}}=10$ | The smaller the incumbent brand loyalty, the greater increase of consumer welfare. |
| | $t=0.1$ or $0.5$ | $\Delta v=0, c_{\mathrm{B}}=3, \overline{p_{\mathrm{A}}}=10$ | The higher the degree of substitutability (the lower *t*), the greater increase of consumer welfare. |
| | $C_{\mathrm{B}}=2$ or $3$ | $\Delta v=0, t=3, \overline{p_{\mathrm{A}}}=10$ | The lower the costs of operator B, the greater increase of consumer welfare. |
| $t+\Delta v+2c_{\mathrm{B}}>\overline{p_{\mathrm{A}}}$ | $t=0.1$ or $0.5$ | $\Delta v=0.1, c_{\mathrm{B}}=3, \overline{p_{\mathrm{A}}}=5$ | The higher the degree substitutability, the earlier and greater increase of consumer welfare. |

price disparity. In a situation where the degree of substitutability is high, for example, $t$=0.1, and if $\Delta r$ is greater than –0.9, a reduction in the asymmetry of mobile access service pricing can result in a particularly large enhancement of consumer welfare. This implies that a reduced differential in mobile access prices causes the prices of B to increase, inciting B's subscribers to switch over to A. Thus, an increase in the welfare of the subscribers of operator A, caused by an expanded subscriber base, will largely exceed the decline in the welfare of subscribers of operator B, resulting in an enhancement of overall consumer welfare. However, where the substitutability is low, for example, $t$=0.5, and if $\Delta r$ is greater than –0.5, a reduction in mobile access pricing asymmetry will increase consumer welfare. This is because, in a situation where the degree of substitutability between services is moderate, a reduced difference in mobile access prices causes B's prices to rise, which would only result in diminished welfare for B's subscribers.

Having theoretically examined the situation where there is (a) no noticeable difference in brand loyalty towards operators who supply services with a high degree of substitutability along with (b) low costs for entering the market, it has been shown that a reduction in the asymmetry of mobile access pricing results in an enhancement of consumer welfare. This result shows that asymmetric access prices are not desirable in certain cases. This is consistent with the view of De Bijl and Peitz who suggested that though an asymmetric access price regulation is desirable in an infant market it distorts competition and reduces consumer surplus in a mature market [26]. This result can also be applied to the different access charges of fixed and mobile.

## IV. Conclusion

Telecom regulators have long adopted interventionist approaches to mobile markets in order to narrow disparities in market power between incumbents and new entrants. In an attempt to correct a competitive imbalance such as a gap in access costs resulting from differences in spectrum quality and number of subscribers between SMP operators and competitors, they have, for instance, frequently opted for asymmetric regulation in access service pricing. Aside from reflecting the cost differences between operators in access rates, asymmetric pricing is also aimed at boosting the market position of new entrants.

Today, however, as most mobile markets around the world are entering a phase of maturity after years of brisk growth, this is rapidly lowering the costs of mobile operators and narrowing the market share gap between large and small operators. In other words, both cost-related and non-cost-related factors that are used to serve as the rationale for asymmetric regulation of access prices are no longer valid in today's mobile markets. In a situation where new entrants of a mobile market are able to acquire the minimum number of subscribers necessary to ensure the viability of their operations and secure a stable source of revenue, policies aimed at creating an equitable competition environment like differentiated access pricing may be counterproductive.

This study assessed the economic effects of the asymmetric regulation of mobile termination rates through a theoretical model and its simulation using a different approach to prior works. We found that when a new entrant's costs are low, and the degree of substitutability between services is high, a reduction in the asymmetry of mobile termination charges can lead to an enhancement of consumer welfare. The results of this study, providing evidence in support of the view that symmetric access rates are more beneficial to the interests of consumers than asymmetric rates, can be used as a reference for improving related regulations. While this study may help draw attention to the fact that the principal goal of economic regulations is to counter monopoly power in mobile termination markets, when actual competition is either infeasible or not sufficiently strong, it can also encourage regulators to explore policy options that are more appropriate for this goal.

In most developed countries, however, whilst access charges of all operators are generally regulated, there is no retail price regulation of any mobile operators since it is supposed that network competition is sufficient to constrain market power by the incumbent. Therefore, we acknowledge that the applicability of our model may be limited to countries where mobile access charges are asymmetrically regulated for both large and small networks, and retail prices are also regulated for the larger incumbent network. Meanwhile, we did not address an empirical estimation of the effects of asymmetric access pricing on retail markets. In further work, we will analyze the relationship between mobile termination rates and mobile retail rates using actual data for an empirical approach. This paper could possibly be extended to cover a situation where retail prices of the incumbent are unregulated.

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