ISP Interconnection and Flat – Rated Internet Pricing

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Abstract

Flat – rated internet pricing is increasingly becoming the most common mode of dial - up access nowadays. However, the debate about whether ISP bound **telephone** calls should also be unmetered is still open. On the one side, consumers and ISPs complain about the high costs of telephone calls and demand unlimited local calling for a fixed monthly fee as in the U.S (or now in some European countries). On the other side, incumbent LECs complain about the investment they have to make to keep pace with ever increasing traffic and congestion without due compensation. The problem lies in the fact that, as it is always the case, both sides are probably right. This paper addresses an important issue on dial up internet access and pricing: The ISP's model of interconnection with the incumbent LEC and its implications on market prices and welfare. To that end and assuming flat – rated internet pricing, several interconnection models are studied. Among the metered models, the termination and origination models (the "benchmark" metered models), the free internet model and the end user model. Among the unmetered models: The standard CLEC – terminating American model, the FCC's newly proposed C.O.B.A.K model and the British F.R.I.A.C.O model. All arrangements are confronted with each other in terms of equilibrium ISP prices, welfare and consumer and producer surpluses generated. Within that framework the paper tries then to answer the question of whether and under what conditions unmetered telephone calling **in addition** to flat rated internet use is welfare enhancing. Conclusions and policy recommendations are drawn from the theory and some practical cases.

I. Introduction

Flat – rated internet usage is becoming the most common mode of dial - up access nowadays. It is increasingly common to see ISPs offering access plans with unlimited connection for a fixed monthly fee. Whether this is due to distortions created by regulation or simply due to market forces is not clear, the truth of the matter is that flat rated internet use is here to stay. Now, whether telephone use should or should not be metered is a different story with and open ending[1]. The key difference between these two is that since local telephone operators have the monopoly on local call origination, local call prices are normally regulated whereas internet access charges are not. The only way that consumers could have unlimited internet phone calls would be through direct government regulation because the local call market is not competitive and market forces cannot be trusted to bring call prices to zero. Since it is the regulatory authority who should be in charge of deciding whether or not unmetered telephone access will be imposed, it has to make sure first that this rate structure will be welfare enhancing.

Unmetered telephone access has long been the default method in the United States. This pricing regime faced no problems in the past because the deficits it generated could be offset by high surpluses coming from the long distance market. Since the break – up of AT&T though in 1984 and more intensely since the implementation of the Telecommunications Act in 1996, those surpluses have started to erode leaving incumbent LECs (ILECs) with important access deficits. Moreover, with the advent of flat rated internet pricing, ILECs (around the world) have started to see internet traffic increase at exponential rates but at the expense of local an long distance telephone traffic. Users are more and more substituting one for the other drastically reducing communication costs but imposing important losses on telecom operators. ILECs complain that they cannot keep pace with the ever increasing IP traffic because the current pricing regime does not remunerate capacity expansions adequately.

More recently, several European countries have imposed unmetered dial - up internet access on incumbent LECs. The pioneer in this field was OFTEL with its F.R.I.A.C.O model (flat rated internet access call origination) operative since June 2000. In France the ART introduced its offer for unlimited internet access called I.F.I (*Interconnexion Forfaitaire Ilimitée*) starting July 2000 while Germany, Spain, Italy and Belgium have followed suit[2].

Given that unlimited internet access is here to stay, this paper builds upon Wright (2001) by assuming that the ISPs do not charge internet users by minute of connection. It will be assumed that this decision is the result of price competition among ISPs. As Wright (2001) remarks, as long as the termination charge is greater than termination costs, the terminating telephone operators (CLECs / ISPs) will have the incentive to increase termination charges and reduce per minute price of connection down to zero. This way, CLECs will increase their market share and their profits at the expense of the ILECs.

Another justification for assuming flat rated internet usage could be the increasing popularity of free ISPs. These are internet providers that finance their operations either with on – line advertisement or sharing call revenues with the ILECs without charging fixed fees to consumers. These new arrangements are starting to

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[1] Normally flat – rated pricing refers to the ISP's charging method for internet use while unmetered access refers to the way telephone operators charge users for internet bound calls.

[2] See Arcome (2000) for a more detailed description

exert strong pressure on conventional ISPs to provide flat rated plans to prevent massive migration of users to free plans[3]. Lastly, this assumption will facilitate the comparative welfare analysis among models as the only per minute price will be the local call rate.

Seven ISP interconnection models will be compared in terms of welfare, consumer and producer surpluses generated. Four metered models, the origination and termination models (the "benchmark" metered models), the free internet model and the end user model. Three unmetered models: the CLEC – terminating American model, the C.O.B.A.K proposal and the F.R.I. A.C.O model. Within this framework the question this paper will try to answer will be: Assuming away any congestion or demand rationing ¿Is unmetered local calling **in addition** to flat rated internet usage welfare enhancing? ¿Under what circumstances? The paper is structured as follows: Section II lays out the basic assumptions of the models along with the calculations of consumer and producer surpluses and welfare generated. Section III conducts a comparative welfare analysis of all the models indicating which one provides the highest level of consumer and producer surpluses and aggregate welfare. Finally, it concludes giving policy recommendations mainly for developing countries where dial up internet access markets are growing rapidly.

II. Interconnection models for ISPs: Basic assumptions

Seven dial up interconnection arrangements will be studied in this paper, four metered: the termination (direct) model, the free internet model, the origination (indirect) model and the end user model. The three unmetered models will be: the CLEC – terminating American model, the FCC's C.O.B.A.K proposal and the new British F.R.I.A.C.O model. For all seven models the basic assumptions will be the same, there is one single monopolistic fixed line telecom operator that originates all ISP bound calls (The ILEC). There is also a fringe of competitive telecoms (The CLECs or OLOs in European jargon) that basically sign up ISPs to terminate internet bound calls. The CLECs do not compete with the ILEC in the call origination market. There are also ISPs that, as end customers, buy business lines from the CLECs only to receive internet calls. To further simplify the analysis, and as in Wright (2001), the terms CLECs (or OLOs) and ISPs will be used interchangeably. CLECs could well be the same ISPs "claiming to be networks" before the authorities with the sole intent of collecting terminating revenue from the ILEC.

The price of a local call *P* is regulated by the authorities but not necessarily in line with underlying costs. The rest of the prices involved in the models are freely negotiated between the parties. End users select their preferred ISPs paying a fixed monthly fee of *m* dollars per month and P per minute of local call to the ILEC. Lastly, ISPs do not charge by the minute of internet connection as already explained.

II.1. The Termination or Direct model

In this model the end user calls the ISP by making a local call originated in the ILEC's local network. The ILEC then bills the user for all ISP bound calls originated in its network but pays termination charges to the CLEC to terminate the calls. This CLEC is commonly another local telecom operator or sometimes a long distance operator that has the ISP as a customer. Being a long distance operator has the advantage that it can reach the whole country from a single point of presence (POP) but origination and transit costs can be substantially higher. Since this call involves two telecom operators

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[3] The author of this paper is himself a recent migrant to a free ISP.

(the ILEC and the CLEC) the originating operator (the ILEC) has to pay for interconnection links with the terminating operator (See Figure 1)

Figure 1: The Termination Model
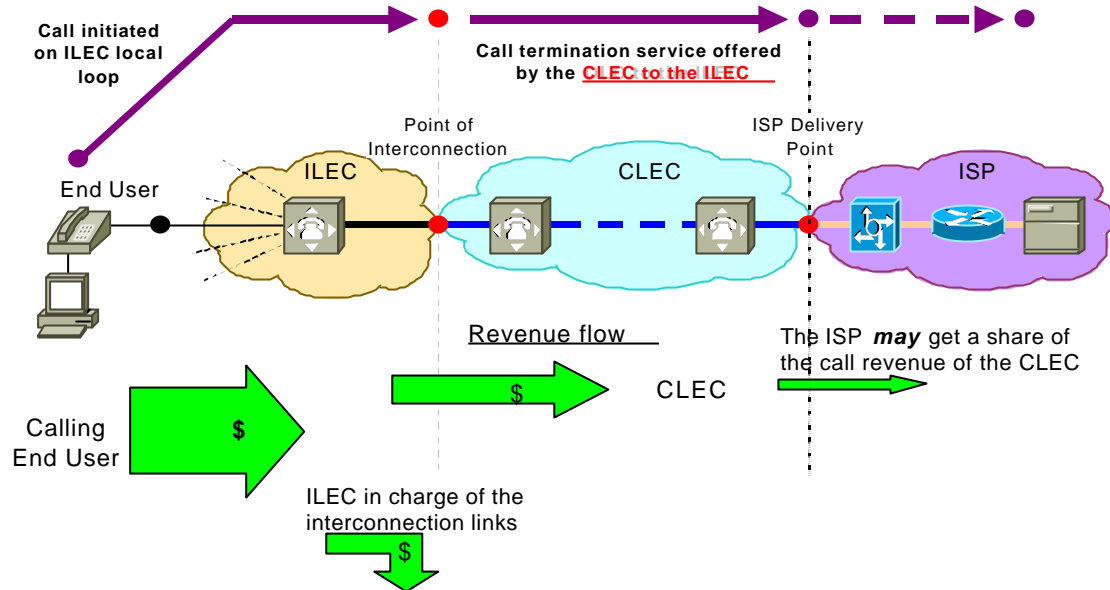
Source: Arcome (2000)

The end user is then billed by the ILEC for local calls and by the ISP for internet use (fixed monthly fee). The ISP may also get a share of the terminating revenue received by the CLEC. This is generally a free negotiation between these two operators.

Box 1: The Hotelling model of network competition

Following Laffont, Rey and Tirole (1998), Armstrong (1998), Carter and Wright (1999) and more specifically Wright (2001), internet subscribers are located uniformly along a straight line and both ISPs are located at each end of the line. Since internet use is assumed uncharged, each ISP's market share S_1 and S_2 will be given by the "indifferent subscriber" condition:

1.1 $\quad v(P_1) - m_1 - t\, S_1 = v(P_2) - m_2 - t\,(1 - S_1)$

Where v, m and t represent consumer's utility level from calls, ISP subscription fixed monthly fee and "transportation cost" respectively. P stands for the minute of local call. If $P_1 = P_2$, rearranging **1.1** leads to:

$$S_1 = \frac{1}{2} + \boldsymbol{s}\,(m_2 - m_1) \ \text{ and } \ S_2 = \frac{1}{2} + \boldsymbol{s}\,(m_1 - m_2)$$

Where; $\boldsymbol{s} = \dfrac{1}{2t}$; and $\dfrac{\partial S_i}{\partial p_i} = -\boldsymbol{s}\,\boldsymbol{q}\,q(P)$

And $\lim\limits_{P \to 0} \boldsymbol{q}\,q(P) = \boldsymbol{q}$; also $\dfrac{\partial S_i}{\partial m_i} = -\boldsymbol{s}$ $\ and\ $ $\dfrac{\partial S_i}{\partial m_j} = \boldsymbol{s}$

All interconnection arrangements are formalized using the Hotelling model of horizontal differentiation whose basic elements are summarized in Box 1. The formal analysis of the termination model is outlined in Box 2.

Box 2: The Termination (Direct) Model

In this model internet users pay P per minute of local call to the ILEC. For the sake of simplicity we will assume throughout that the minute of internet use is free. The ILEC pays a_t to the ISP to terminate each ISP bound call. Building upon Wright (2001), the profit the ILEC makes selling ISP bound calls to consumers is given by

2.1 $$\boldsymbol{p}_0^T = S_1(P - c_o - a_t)\boldsymbol{q}\,q(P) + S_2(P - c_o - a_t)\boldsymbol{q}\,q(P) - S_1\,r_1 - S_2\,r_2 - F_0$$

Where c_0, a_t, and F_0 stand for origination cost, termination access charge and fixed costs respectively. Also, the ILEC is responsible for installing and maintaining interconnection links with the CLEC incurring r_i per subscriber. Under this arrangement the ILEC collects P from the user, pays termination to the ISP (CLEC) and incurs c_0. The ISPs' profit functions are

2.2 $$\boldsymbol{p}_1 = \max_{m_1}\left\{ S_1(a_t - c_t - c_i)\boldsymbol{q}\,q(P) + S_1\,(m_1 - f_1^T) - F_1 \right\}$$

2.3 $$\boldsymbol{p}_2 = \max_{m_2}\left\{ S_2(a_t - c_t - c_i)\boldsymbol{q}\,q(P) + S_2\,(m_2 - f_2^T) - F_2 \right\}$$

ISPs collect a_t from the ILEC and incur c_t and c_i per minute of internet connection. They also incur f_i^T / month per subscriber costs that recover through the monthly fee m_i. Assuming Bertrand competition between ISPs, the F.O.Cs of **2.2** and **2.3** with respect to m_1 and m_2, yield the following

2.4 $$m_1 = f_1^T + \frac{S_1}{\boldsymbol{s}} - (a_t - c_t - c_i)\boldsymbol{q}\,q(P) \quad \text{with } \frac{\partial m_1}{\partial a_t} < 0 \ \text{ and } \ \frac{\partial S_1}{\partial a_t} > 0$$

2.5 $$m_2 = f_2^T + \frac{S_2}{\boldsymbol{s}} - (a_t - c_t - c_i)\boldsymbol{q}\,q(P) \quad \text{with } \frac{\partial m_2}{\partial a_t} < 0 \ \text{ and } \ \frac{\partial S_2}{\partial a_t} > 0$$

Assuming symmetry throughout ($f_1 = f_2$ and $r_1 = r_2$) then the ISPs' and the ILEC's profits in equilibrium are given by

2.6 $$\boldsymbol{p}_1 = \frac{S_1^2}{2\boldsymbol{s}} - F_1 = \frac{1}{4\boldsymbol{s}} - F_1 \quad and \quad \boldsymbol{p}_2 = \frac{S_2^2}{2\boldsymbol{s}} - F_2 = \frac{1}{4\boldsymbol{s}} - F_2$$

2.7 $$\boldsymbol{p}_0^T = (P - c_o - a_t)\boldsymbol{q}\,q(P) - r - F_0$$

Assuming symmetry, $S_1 = S_2 = \tfrac{1}{2}$, $m_1 = m_2$, consumer surplus is calculated as the sum of the surplus generated by calls plus the surplus generated by "closeness to preferred taste" weighted by market participation (See demonstration in Appendix I)

2.8 $$CS^T = \boldsymbol{q}\int_P^\infty q(x)dx - m + \frac{3}{8\boldsymbol{s}} = \boldsymbol{q}\int_P^\infty q(x)dx + (a_t - c_i - c_t)\boldsymbol{q}\,q(P) - \frac{1}{8\boldsymbol{s}} - f_i^T$$

And aggregate welfare,

2.9 $$W^T = \boldsymbol{q}\int_P^\infty q(x)dx - f_i^T + \frac{3}{8\boldsymbol{s}} - 2F + (P - c_0 - c_t - c_i)\boldsymbol{q}\,q(P) - r - F_0$$

Box 2 shows the ILEC's profit equation and ISPs' profit equations and first order conditions. Since the ILEC has the monopoly over the origination of local calls the price of a local call is regulated by the authorities. The ISPs on the other hand, operate in a deregulated market where they attract customers by competing on both service quality and the monthly fee m. The ILEC makes money selling local calls to internet users, incurring origination costs, paying termination charges and paying for interconnection links with the ISPs. There is also a fixed cost F_0 incurred by the ILEC but strictly related to the dial up internet service.

In this model the ISPs have two sources of income: the termination charges they collect from the ILEC for every minute of call terminated in their networks and the monthly fees they collect from internet users. They also incur per minute termination and internet costs and per customer fixed costs. ISPs maximize profits with respect to the monthly fee m and the F.O.Cs are given by equations **2.4** and **2.5**. The optimal monthly fees are increasing in both per customer and per minute costs but decreasing in the termination charge. As Wright (2001) points out, ISPs have the incentive to increase market shares (and profits) by lowering the monthly fee *m* as they increase the termination charge a_t. To see this apply the envelope theorem to **2.2** or **2.3**,

$$\frac{\partial \boldsymbol{p}_i^*}{\partial a_t} = \boldsymbol{q} \, q(P) \, S_i^* > 0 \quad \text{and} \quad \frac{\partial (\boldsymbol{p}_0^* + \boldsymbol{p}_1^* + \boldsymbol{p}_2^* + CS^*)}{\partial a_t} = -\boldsymbol{q} \, q(P) + \boldsymbol{q} \, q(P) = 0$$

Raising a_t is a welfare neutral move though since the fall in the ILEC's profits is exactly offset by the increase in the ISPs' profits plus the increase in consumer surplus. In sum, increasing a_t leaves welfare unchanged (equation **2.9**) but increases consumer surplus (equation **2.8**) and ISPs' profits (equations **2.6**) at the expense of the ILEC's profits (equation **2.7**).

II.2 The U.S Reciprocal Compensation Problem

The Telecommunications Act of 1996[4] required all LECs "*to establish reciprocal compensation arrangements for the transport and termination of telecommunications*". Later in the Local Competition Order (1996), the FCC made this provision apply only to the transport and termination of "local telecommunications traffic" but made no distinctions between local voice traffic and internet bound traffic (circuit switched versus packet switched traffic). This meant that two interconnected carriers that exchanged local switched traffic had to pay equal termination charges to each other regardless of the nature of the call. This is a convenient way of dealing with interconnection costs when traffic is balanced but creates a distortion whenever traffic is unbalanced. An extreme example of this distortion is ISP bound traffic that is one way by definition and is aggravated when there are flat rated local calls.

In the U.S today ILECs do not collect any call revenue from internet users but they have to pay termination charges to ISPs (or CLECs to be more precise) to terminate ISP bound calls originated in their networks. Obviously, CLECs have taken advantage of this distortion to sign up ISPs as customers only to collect termination revenue. As long as termination charges more than offset termination costs, CLECs stand only to profit from this situation. To remedy this problem, The FCC has proposed[5] a bill and keep arrangement between carriers to prevent this arbitrage opportunity (See Box 3 for the details of the model).

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[4] Section 251 (b) (5) of the Telecommunications Act of 1996
[5] De Graba (2000) calls this arrangement C.O.B.A.K, "Central Office Bill and Keep"

Box 3: The U. S. Reciprocal Compensation Problem

Under this arrangement the ILEC charges P = 0 (unmetered local calls) but it pays termination of a_t per minute to the ISP incurring c_0 to originate local calls. The ILEC is also in charge of interconnection links (r_i per user) and its profit is given by:

3.1 $$\boldsymbol{p}_0^{US} = -S_1(c_o + a_t)\boldsymbol{q} - S_2(c_o + a_t)\boldsymbol{q} - S_1\,r_1 - S_2\,r_2 - F_0 < 0$$

Where c_0, a_t, and F_0 stand for origination cost, termination access charge and fixed costs respectively. Under this arrangement the ILEC pays termination to the ISP (CLEC) and incurs c_0. The ISPs' profit functions are

3.2 $$\boldsymbol{p}_1 = \max_{m_1}\left\{ S_1(a_t - c_t - c_i)\boldsymbol{q} + S_1\,(m_1 - f_1^T) - F_1 \right\}$$

3.3 $$\boldsymbol{p}_2 = \max_{m_2}\left\{ S_2(a_t - c_t - c_i)\boldsymbol{q} + S_2\,(m_2 - f_2^T) - F_2 \right\}$$

Assuming Bertrand competition between ISPs, the F.O.Cs of **3.2** and **3.3** with respect to m_1, and m_2, yield the following

3.4 $$m_1 = f_1^T + \frac{S_1}{\boldsymbol{s}} - (a_t - c_i - c_t)\boldsymbol{q}$$

3.5 $$m_2 = f_2^T + \frac{S_2}{\boldsymbol{s}} - (a_t - c_i - c_t)\boldsymbol{q}$$

Again, if symmetry prevails ($f_1 = f_2$ and $r_1 = r_2$), then the ISPs' and the ILEC's profits in equilibrium are given by

3.6 $$\boldsymbol{p}_1 = \frac{S_1^2}{2\boldsymbol{s}} - F_1 = \frac{1}{4\boldsymbol{s}} - F_1 \quad and \quad \boldsymbol{p}_2 = \frac{S_2^2}{2\boldsymbol{s}} - F_2 = \frac{1}{4\boldsymbol{s}} - F_2$$

3.7 $$\boldsymbol{p}_0^{US} = -(c_o + a_t)\boldsymbol{q} - r - F_0 < 0$$

Under DeGraba's C.O.B.A.K proposal ($a_t = 0$), the ILEC's new profit equation is

3.8 $$\boldsymbol{p}_0^{COBAK} = -c_0\,\boldsymbol{q} - r - F_0 < 0$$

Again and assuming symmetry, aggregate consumer surplus is given by:

3.9 $$CS^{US} = \boldsymbol{q}\int_0^\infty q(x)dx - f_i^T - \frac{1}{8\boldsymbol{s}} + (a_t - c_t - c_i)\boldsymbol{q}$$

3.10 $$CS^{COBAK} = \boldsymbol{q}\int_0^\infty q(x)dx - f_i^T - \frac{1}{8\boldsymbol{s}} - (c_t + c_i)\boldsymbol{q}$$ and aggregate welfare is

3.11 $$W^{US} = \boldsymbol{q}\int_0^\infty q(x)dx - f_i^T + \frac{3}{8\boldsymbol{s}} - 2F - (c_0 + c_i + c_t)\boldsymbol{q} - r - F_0 = W^{COBAK}$$

Box 3 shows the ILEC profit equation **3.1** with only costs and no revenues collected from the internet user or the ISP. The ILEC incurs origination costs and pays termination charges to the ISP and charges final users zero per minute of local call. At the same time it is in charge of interconnection links with the CLEC because this one is another telecommunications carrier that terminates internet bound calls. It can be clearly seen that this arrangement is a "money losing machine" for the ILEC (equation **3.7**) whose loss is partially mitigated by the C.O.B.A.K proposal (equation **3.8**) that only eliminates the obligation to pay termination charges to the CLEC.

Internet users and ISPs are the big beneficiaries of this arrangement. ISPs collect termination charges for all ISP bound calls and as long as these revenues are higher than costs, ISPs will pass this surplus on to final users through lower monthly fees (equations **3.4** and **3.5**) increasing market shares and profits. (Again, apply the envelope theorem to **3.2** and **3.3** to see that increasing a_t raises each ISP's profits by q S_i^6).

Furthermore, equation **3.9** shows that consumer surplus is higher the higher are termination charges and this is because equilibrium monthly fees are lower. The C.O.B.A.K proposal though reduces consumer surplus as it eliminates the source of the reduction in the monthly fees, the termination charges collected by the CLECs. Also aggregate welfare remains unchanged with the introduction of C.O.B.A.K as termination charges are a transfer from the ILEC to the final user through lower monthly fees.

To conclude, it is clear from the analysis that in the U.S model it is the ILEC that finances consumer surplus and ISPs' profits by incurring big losses. ISPs and CLECs share this gain as they pass on to consumers some of the increases in profits coming from termination revenues. The C.O.B.A.K proposal cuts losses for the ILECs and reduces ISPs' profits but reduces consumer surplus by the same amount leaving welfare unchanged (check equation **3.11**).

II.3 The Free Internet Model

An increasingly popular way of internet connection is the free internet model. In its dial up version the user pays only the price of a local call without any monthly fee. In this model ISPs do not sign up customers as there is no contractual relationship between them. Each user connects to the ISP he / she wants every time they need to access the Web only by calling the ISP's geographic number and paying the local calls consumed to the ILEC. At the same time however, each ISP shares with the ILEC the call revenue generated by all calls bound for each ISP. In practice this revenue sharing consists of the payment of a termination charge per minute of call that the ILEC makes to each CLEC (ISP) for every ISP bound call (See Table 1 on Appendix 1 for an example of revenue sharing in Europe).

Box 4 illustrates the mathematics of this model. The ILEC sells minutes of local calls to internet users incurring origination costs and paying termination charges to the terminating CLEC (ISP). At the same time, the ILEC has to install and maintain interconnection links with the terminating CLEC, costs that are assumed proportional to the number of users (equation **4.1**).

On the ISP side the only source of income that internet providers have is the termination revenue collected from local calls, there is no fixed monthly fee here. Since the only source of income is the per minute termination charge, this revenue has to

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[6] Of course, in equilibrium ISPs' profits remain unchanged as market shares stay constant

cover all costs (variable and fixed). Sometimes on line advertisement is used to help finance costs here we assume this to be an unimportant source of the company's income.

Box 4. The Free Internet Model

Internet users pay the ILEC only local calls. The latter shares call revenue with CLECs / ISPs to terminate ISP bound calls in their networks. The ILEC pays for interconnection links. Therefore the profit the ILEC makes selling ISP bound calls to customers is given by:

4.1 $\quad \boldsymbol{p}_0^F = S_1(P - c_o - a_t)\, \boldsymbol{q}\, q(P) + S_2(P - c_o - a_t)\, \boldsymbol{q}\, q(P) - S_1\, r_1 - S_2\, r_2 - F_0$

Where c_0, a_t, and F_0 stand for origination cost, termination access charge and fixed costs respectively. Under this arrangement the ILEC collects P from the user, pays termination to the ISP (CLEC) and incurs c_0. The ISPs do not collect fixed monthly fees from users. For a fixed termination charge and with free entry into the internet market ISPs' profits will be driven down to zero

4.2 $\quad \boldsymbol{p}_1 = S_1(a_t - c_t - c_i)\, \boldsymbol{q}\, q(P) - F_1 = 0$

4.3 $\quad \boldsymbol{p}_2 = S_2(a_t - c_t - c_i)\, \boldsymbol{q}\, q(P) - F_2 = 0$

If Bertrand competition prevails, the equilibrium termination charge a_t will be given by

4.4 $\quad a_t = c_t + c_i$

The resulting profit levels for the ISPs will be $\boldsymbol{p}_1 = - F_1$ and $\boldsymbol{p}_2 = - F_2$ that ISPs normally can finance with on - line advertisement. If, on the other hand, average cost competition and pricing prevail, and symmetry is assumed, the average termination charge will be given by

4.5 $\quad a_t = c_t + c_i + \dfrac{2F}{\boldsymbol{q}\, q(P)} > c_t + c_i$

The ILEC's profits will be

4.6 $\quad \boldsymbol{p}_0^F = (P - c_o - a_t)\, \boldsymbol{q}\, q(P) - r - F_0$

Replacing the value of a_t above in **4.6**

4.7 $\quad \boldsymbol{p}_0^F = (P - c_o - c_t - c_i)\, \boldsymbol{q}\, q(P) - 2F - r - F_0$

And aggregate consumer surplus is

4.8 $\quad CS^F = \boldsymbol{q} \displaystyle\int_P^\infty q(x)\,dx + \dfrac{3}{8\boldsymbol{s}}$ And aggregate welfare will be given by,

4.9 $\quad W^F = \boldsymbol{q} \displaystyle\int_P^\infty q(x)\,dx + \dfrac{3}{8\boldsymbol{s}} + (P - c_o - c_t - c_i)\, \boldsymbol{q}\, q(P) - 2F - r - F_0$

If there is average cost and price competition among ISPs, the optimal termination charge will be given by equation **4.5**. Notice that this charge is increasing in the ISPs' fixed costs F. As long as these costs are important, the more ISPs there are in the market the higher will have to be the termination charge and the lower will be the ILEC's profits. Moreover and contrary to the termination and U.S models, here termination charges do not affect consumer surplus as this depends solely on the price of the minute of local call (regulated by the government). The termination charge does affect the ILEC's profits and the ISPs' profits. However, welfare remains constant as it depends solely on the price level that is regulated by the government.

II.4. The Origination or Indirect Model

In this model it is the receiving or terminating network that is in charge of collecting the call from the originating network (See Figure 2). Internet users make ISP bound calls using the ILEC's local network by dialing the ISP's (generally non geographic) number and pay these local calls to the terminating operator (the CLEC in this case). This one collects call payments, pays the ILEC origination charges and incurs termination and internet connection costs. Now it is the CLEC who is responsible for the call, the call belongs to the CLEC. This one is also is responsible for installing and maintaining interconnection links with the originating operator (the ILEC).

Figure 2: Origination (Indirect) Model
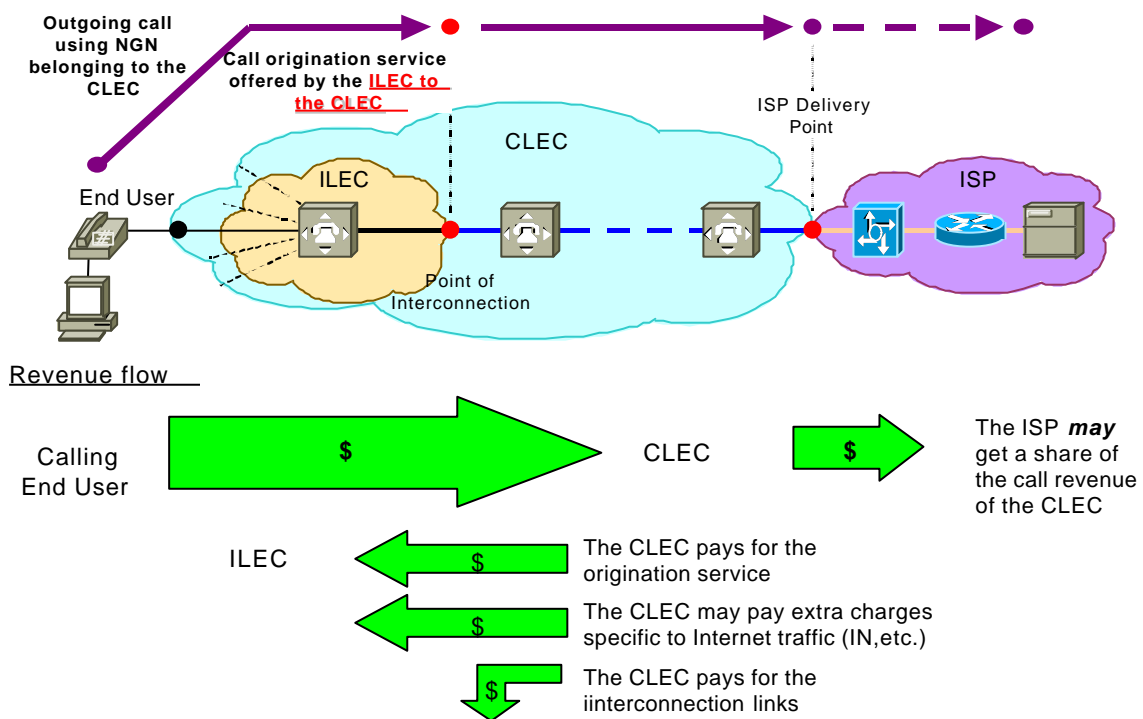
Source: Arcome (2000)

Notice that now ISPs can compete also on call prices as they are now responsible for collecting call payments (like in the long distance market). Box 5 shows all the variables and equations involved in the model. Equation **5.1** shows the ILEC's profit function with revenues from origination charges and interconnection links. These are provided by the ILEC but leased to the ISPs on a monthly basis and proportional to the number of users. The costs incurred by the ILEC are origination per minute costs c_0 and the costs of fixed interconnection links r_i that are recovered from the origination charge a_0 and the monthly fixed fee f_i respectively.

Box 5: The Origination (Indirect) Model

Now the user pays the call to the ISP / CLEC and this one pays origination to the ILEC. The CLECs now pay for the costs of interconnection links through monthly fees f_i. The profit the ILEC makes selling ISP bound calls to customers is given by:

5.1 $\quad p_0^0 = S_1(a_o - c_o)\,\mathbf{q}\,q(P_1) + S_2(a_o - c_o)\,\mathbf{q}\,q(P_2) + S_1\,(f_1 - r_1) + S_2\,(f_2 - r_2) - F_0$

Where c_0, a_o, and F_0 stand for origination cost, origination access charge and fixed costs respectively. The ISPs now maximize profits with respect to both *m* and call price *P*.

5.2. $\quad p_1 = \underset{P_1, m_1}{max}\left\{ S_1(P_1 - a_o - c_t - c_i)\,\mathbf{q}\,q(P_1) + S_1\,(m_1 - f_1^0) - F_1 \right\}$

5.3 $\quad p_2 = \underset{P_2, m_2}{max}\left\{ S_2(P_2 - a_o - c_t - c_i)\,\mathbf{q}\,q(P_2) + S_2\,(m_2 - f_2^0) - F_2 \right\}$

Where $f_i^0 = f_i^T + f_i$. ISPs have to pay for both the cost of interconnection links with the ILEC (f_i) and per customer costs f_i^T, both adding up to f_i^0. Assuming Bertrand competition between ISPs, the F.O.Cs of 5.2 and 5.3 with respect to p_1, m_1 p_2 and m_2, yield the following

5.4 $\quad m_1 = f_1^0 + \dfrac{S_1}{\mathbf{s}} \;\; and \;\; P_1 = a_o + c_t + c_i = P_0$

5.5 $\quad m_2 = f_2^0 + \dfrac{S_2}{\mathbf{s}} \;\; and \;\; P_2 = a_o + c_t + c_i = P_0$

From **5.1** and **5.4** and **5.5**, the ILEC's profits are therefore given by

5.6 $\quad p_0^0 = (P_0 - c_t - c_o - c_i)\,\mathbf{q}\,q(P_0) + (f_i - r) - F_0$

5.7 $\quad p_1 = \dfrac{S_1^2}{2\mathbf{s}} - F_1 = \dfrac{1}{4\mathbf{s}} - F_1 \;\;\; and \;\;\; p_2 = \dfrac{S_2^2}{2\mathbf{s}} - F_2 = \dfrac{1}{4\mathbf{s}} - F_2$

Aggregate consumer surplus is now

5.8 $\quad CS^0 = \mathbf{q}\displaystyle\int_{P_0}^{\infty} q(x)dx - m + \dfrac{3}{8\mathbf{s}} = \mathbf{q}\displaystyle\int_{P_0}^{\infty} q(x)dx - \dfrac{1}{8\mathbf{s}} - f_i^0$

Aggregate welfare is given by

5.9 $\quad W^0 = \mathbf{q}\displaystyle\int_{P_0}^{\infty} q(x)dx - f_i^T + \dfrac{3}{8\mathbf{s}} - 2F + (P_0 - c_o - c_t - c_i)\,\mathbf{q}\,q(P) - r - F_0$

Equations **5.2** and **5.3** represent the ISPs profit maximization functions with revenue coming from each minute of local call P and monthly fixed fees m both collected from users. Again, and unlike in the other cases, in this model ISPs compete on both call price P and monthly fees m. Costs come from the origination charge a_0, termination and internet connection costs (c_t and c_i respectively), overhead F costs and monthly per user f_i^0 costs. These are the sum of the customer service costs f_i^T (connection and billing costs) and the monthly fee f_i charged by the ILEC to install and maintain interconnection links with the ISP. In sum, ISPs incur higher fixed per customer costs than in the termination (direct) models because here they have to pay for interconnection links with the ILEC. This increase is reflected in higher optimal monthly fees they charge to their customers (See equations **5.4** and **5.5)**.

In this particular case and unlike in the other models, the optimal call price P charged by ISPs is equal to marginal call plus internet costs. This is because now ISPs are responsible for call payments and can now offer lower call prices to customers thus increasing market shares and profits. This model works exactly like the long distance call model. Users make long distance calls and pay them to the long distance operator and this in turn pays call origination and termination charges to the ILEC.

Finally, in this model the access charge is a cost for the ISP since it is this one that has to pay it to the ILEC to be able collect calls. Consequently it comes as no surprise that now the origination charge a_0 negatively affects consumer surplus (through a higher P) but now increasing welfare since P is lower due to competition in the call market. Contrary to the termination model, origination access charges affect negatively ISPs' profits and consumer surplus but competition in the call market increases welfare through lower call prices.

II.5. The End User Model

In this model ISPs are not telecommunications carriers but end users just as any other telephone user. ISPs buy business lines from the ILEC and receive calls originated in the ILEC's local network connecting the caller with internet. Since this model generally operates in countries where there is no competition in the telecommunications market, here there is no CLEC in between the ISP and the ILEC. ISPs are customers of the ILEC.

This model has two important differences with the standard indirect or direct models though: the price of the minute of connection is generally lower than the standard local call rate[7]. The second difference with the standard models is that the ILEC keeps the entirety of the value of the call price. This is, the ISPs receive no variable revenues as the whole call price goes to the ILEC. There is no revenue sharing here. Therefore ISPs have to finance their operations only through the monthly fee they charge their customers.

Box 6 illustrates the variables involved in the model. It will be assumed throughout that the End User rate is exactly the same as standard local call rate P. Equation **6.1** shows the ILEC's profit equation with revenues coming from internet bound calls and the leasing of lines to ISPs. The ILEC incurs both origination and termination costs because in this model there is no terminating operator (or CLEC). It also has to install and maintain lines that leases to the ISPs in exchange for a monthly payment f_i.

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[7] This is the case in Argentina where 0610 rates are lower than the local call rate to make internet access more affordable to low income users.

Box 6. The End User Model

In this model the ISP is an end user just like any other telephone user. It has to rent lines from the ILEC and does not collect any revenue from calls, just monthly fees from the internet users that it subscribes. There are no terminating operators involved in this model. The profit the ILEC makes selling ISP bound calls to users and leasing lines to ISPs is given by:

6.1
$$\boldsymbol{p}_0^{EU} = S_1(P - c_o - c_t)\boldsymbol{q}\,q(P) + S_2(P - c_o - c_t)\boldsymbol{q}\,q(P) + $$
$$+ S_1(f_1 - r_1) + S_2(f_2 - r_2) - F_0$$

Where c_0, c_t, and F_0 stand for origination cost, termination cost and fixed costs respectively. Under this arrangement the ILEC collects P from the user, delivers the call to the ISP point of interconnection incurring c_0 and c_t. Their ISPs' profit functions are

6.2
$$\boldsymbol{p}_1 = \max_{m_1}\left\{-S_1\,c_i\,\boldsymbol{q}\,q(P) + S_1(m_1 - f_1^0) - F_1\right\}$$

6.3
$$\boldsymbol{p}_2 = \max_{m_2}\left\{-S_2\,c_i\,\boldsymbol{q}\,q(P) + S_2(m_2 - f_2^0) - F_2\right\}$$

The F.O.Cs of **6,2** and **6.3** with respect to m_1 and m_2 lead to

6.4
$$m_1 = f_1^0 + \frac{S_1}{\boldsymbol{s}} + \boldsymbol{q}\,q(P)c_i \quad and \quad m_2 = f_2^0 + \frac{S_2}{\boldsymbol{s}} + \boldsymbol{q}\,q(P)c_i$$

With symmetry, ISPs profits are

6.5
$$\boldsymbol{p}_1 = \frac{S_1^2}{2\boldsymbol{s}} - F_1 = \frac{1}{4\boldsymbol{s}} - F_1 \quad and \quad \boldsymbol{p}_2 = \frac{S_2^2}{2\boldsymbol{s}} - F_2 = \frac{1}{4\boldsymbol{s}} - F_2$$

The ILEC's profit in equilibrium is then given by

6.6
$$\boldsymbol{p}_0^{EU} = (P - c_o - c_t)\,\boldsymbol{q}\,q(P) + (f_i - r) - F_0$$

And aggregate consumer surplus

6.7
$$CS^{EU} = \boldsymbol{q}\int_P^\infty q(x)dx - m + \frac{3}{8\boldsymbol{s}} = \boldsymbol{q}\int_P^\infty q(x)dx - f_i^0 - \boldsymbol{q}\,q(P)c_i - \frac{1}{8\boldsymbol{s}}$$

And aggregate welfare

6.8.
$$W^{EU} = \boldsymbol{q}\int_P^\infty q(x)dx - f_i^T + \frac{3}{8\boldsymbol{s}} - 2F + (P - c_o - c_t - c_i)\boldsymbol{q}\,q(P) - r - F_0$$

Equations **6.2** and **6.3** represent the ISPs' profit maximization functions. ISPs do not collect any revenue from calls just monthly fees m from their internet users. They also incur per minute internet connection costs c_i and fixed monthly charges $f_i^0 = f_i + f_i^T$ as in the previous origination model that they recover from monthly fees m.

Optimal monthly fees are given by **6.4**. Since ISPs receive no variable revenues fixed fees m have to cover the variable loss $q\ q(P)\ c_i$ incurred to connect the user to internet. There are no origination or termination charges in this model and consumer surplus depends negatively on the price of a minute of call, the per user fixed costs and per minute internet connection costs.

II.6. Wholesaling originating capacity: The F.R.I.A.C.O model

Since June 2000, British Telecom started offering origination services to terminating operators based on capacity[8]. The idea was to permit ISPs that competed with BT to offer unlimited internet use to their customers for a fixed monthly fee. To that purpose BT now sells originating capacity to CLECs and charges them a fixed fee per circuit or per Mb of requested capacity. This model has been dubbed F.R.I.A.C.O or Flat Rated Internet Access Call Origination and allows users to have untimed internet connection.

The F.R.I.A.C.O model is an indirect model as it is the ISP (or CLEC) who charges the end user a fixed fee per month for internet connection and pays British Telecom a call origination fee based on contracted capacity. Also in this model it is the ILEC (BT) that is in charge of interconnection links but charges the CLEC for installation and maintenance on a per user basis.

Box 7 illustrates the mathematics of this model. Since this is a flat rated model users consume until they are satiated. The ILEC's profit function (**7.1**) shows the costs and revenues involved. The ILEC incurs per minute origination costs c_0 and per customer (per line) costs r_i.

F.R.I.A.C.O is a cost based model, then the optimal monthly fee f_i that the ILEC has to charge ISPs will be given by equating **7.1** to zero. Equation **7.2** shows the optimal value of f_i. This value has to cover both per customer r_i and overhead F_0 costs and make up for the per minute loss the ILEC incurs in originating each call (- $c_0\ q$).

The buyers of originating capacity though (ISPs) pay the optimal f_i per line to the ILEC but also have to cover per customer service costs f_i^T both adding up to f_i^0. ISPs incur per minute costs, c_t and c_i respectively, per customer f_i^0 costs and overhead F costs. ISPs maximize profits by differentiating both **7.3** and **7.4** with respect to m_1 and m_2 leading to **7.5**. The optimal m will help ISPs cover per minute per customer and overhead costs. However and similarly to the origination model, ISPs' profits are negatively affected by the fixed access charge f_i. To see this apply the envelope theorem to **7.3** and **7.4** with respect to f_i to see that equilibrium profits fall by the market share S_i.

As expected, consumer surplus is negatively related to the F.R.I.A.C.O origination charge f_i as this is part of the fixed fee the ISP charges the internet user. Also since by definition the ILEC's profit is zero, aggregate welfare will be given by the sum of consumer surplus plus ISPs' profits (equation **7.9**).

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[8] See OFTEL (2000)

Box 7. Britain's FRIACO Model

In this model the ILEC wholesales originating capacity to CLECs / ISPs charging a fixed flat monthly charge based on requested capacity, in turn ISPs sell flat rated internet use to end users charging them a fixed monthly rate. The ILEC's profits are now

7.1 $\quad \boldsymbol{p}_0^{FR} = -S_1\, c_o\, \boldsymbol{q} - S_2\, c_o\, \boldsymbol{q} + S_1\,(f_1 - r_1) + S_2\,(f_2 - r_2) - F_0$

Where F_o is a fixed cost but incremental to the FRIACO function. Assuming symmetry throughout, no congestion or demand rationing, and that the Regulator sets the origination flat rated charge f_i so that the ILEC breaks even, then:

7.2 $\quad \boldsymbol{p}_0^{FR} = [(f_i - r_i) - c_o\, \boldsymbol{q}] - F_0 = 0 \quad$ therefore, $\quad f_i = r_i + F_o + c_o \boldsymbol{q}$

The ISPs' profit functions now are

7.3 $\quad \boldsymbol{p}_1 = \underset{m_1}{max}\left\{ -S_1\,(c_t + c_i)\,\boldsymbol{q} + S_1\,(m_1 - f_1^0) - F_1 \right\}$

7.4 $\quad \boldsymbol{p}_2 = \underset{m_2}{max}\left\{ -S_2\,(c_t + c_i)\,\boldsymbol{q} + S_2\,(m_2 - f_2^0) - F_2 \right\}$

Where $f_i^0 = f_i^T + f_i$. Assuming Bertrand competition between ISPs, the F.O.Cs of **7.3** and **7.4** with respect to m_1 and m_2, yield the following

7.5 $\quad m_1 = f_1^0 + \dfrac{S_1}{\boldsymbol{s}} + (c_i + c_t)\,\boldsymbol{q} \quad$ and $\quad m_2 = f_2^0 + \dfrac{S_2}{\boldsymbol{s}} + (c_i + c_t)\,\boldsymbol{q}$

Now, the monthly fixed charges m_i have to make up for the per minute loss $(c_i + c_t)$ ISPs incur in terminating calls and connecting users to internet. Replacing **7.2** in **7.5** we get

7.6 $\quad m_i = r_i + f_i^T + F_o + \dfrac{S_1}{\boldsymbol{s}} + (c_i + c_t + c_o)\,\boldsymbol{q} \quad$ and ISPs profits are now

7.7 $\quad \boldsymbol{p}_1 = \dfrac{S_1^2}{2\boldsymbol{s}} - F_1 = \dfrac{1}{4\boldsymbol{s}} - F_1 \quad and \quad \boldsymbol{p}_2 = \dfrac{S_2^2}{2\boldsymbol{s}} - F_2 = \dfrac{1}{4\boldsymbol{s}} - F_2$

7.8 $\quad CS^{FR} = \boldsymbol{q}\displaystyle\int_0^{\infty} q(x)dx - [\, f_i^T + f_i + \boldsymbol{q}\,(c_i + c_t)\,] - \dfrac{1}{8\boldsymbol{s}}$

And aggregate welfare is given by

7.9 $\quad W^{FR} = \boldsymbol{q}\displaystyle\int_0^{\infty} q(x)dx - [\, f_i^T + f_i + \boldsymbol{q}\,(c_i + c_t)\,] + \dfrac{3}{8\boldsymbol{s}} - 2F$

III. Comparative welfare analysis

In this section all metered and unmetered models are confronted with each other in terms of welfare, consumer and producer surpluses generated. The methodology followed is the one indicated in the introduction, namely there is one monopolistic telecom operator (the ILEC) that provides call origination services to ISPs or CLECs. The ILEC and the ISPs will be subject to the different pricing arrangements studied so far, the termination model, the free internet model, the U.S and C.O.B.A.K models, the origination model, the end user and the F.R.I.A.C.O models. The first results of the comparison are given by *Lemma 1*.

Lemma 1: *Assuming the origination access charge a_0 in line with origination costs c_0, of the metered models, the origination and the free internet models provide a higher level of welfare than both the termination model and the end user models. All the unmetered models yield the same level of welfare*

Proof: Differentiating the welfare function **2.9** with respect to P

$$\frac{\partial W}{\partial P} = (P - c_0 - c_t - c_i)\, \boldsymbol{q}\, q\,'(P) \begin{cases} < 0 \ \ if \ \ P > c_0 + c_i + c_t \\ > 0 \ \ if \ \ P < c_0 + c_i + c_t \end{cases}$$

In either case, competition in the origination model will drive P (up or down) to marginal cost maximizing welfare then $W^0 > W^{EU} = W^T$. Also by comparing **4.9** with **2.9** it follows that $W^F = W^T + f_i^T$ then, $W^F > W^T = W^{EU}$. Lastly, by subtracting **7.9** from **3.11** it follows that

$$W^{US} - W^{FRIACO} = -\boldsymbol{q} c_0 - r - F_0 + f_i = W^{COBAK} - W^{FRIACO}$$

But by the definition of FRIACO **(7.2)** $f_i = \boldsymbol{q} c_0 + r + F_0$ therefore,

$$W^{US} = W^{FRIACO} = W^{COBAK}$$

Q.E.D

The explanation of the first part of *Lemma 1* is simple, by checking equations **2.9**, **5.9** and **6.8**, one can easily see that the welfare functions of the termination, the origination and the end user models look exactly the same except for the internet call price. In the termination model and the end user models the call price *P* is set by the government while in the origination model the competition between ISPs to attract internet calls will drive P either up or down to marginal cost maximizing welfare. The free internet model scores better that the termination model because it charges the same per call price but the ISP does not have to incur per user monthly costs f_T such as billing and servicing. All the unmetered models yield the same level of welfare because welfare depends ultimately on the call price and this is equal to zero in all unmetered models. The high level of consumer surplus in both the American and C.O.B.A.K models is exactly offset by the increase in the ILEC's profit in the F.R.I.A.C.O model. This one neutralizes the ILEC's loss incurred in both American models by reducing consumer surplus by exactly the same amount leaving welfare unchanged.

On the consumer side subtracting **2.8** from **5.8** one obtains:

$$CS^0 - CS^T = \boldsymbol{q} \int_{P_0}^{P} q(x)dx - (a_t - c_i - c_t)\boldsymbol{q}\,q(P) - f_i$$

The difference in consumer surplus levels will be given by the difference in call price (equal to marginal cost in the origination model) and the difference in monthly fees (lower in the termination model). Monthly fees are lower in the termination model because of two factors: on the on hand the ISP does not have to pay for interconnection costs with the ILEC and because it collects termination revenue that it uses to lower the monthly fee to end users. The final answer will also depend on whether the call price P in the termination model is set higher or lower than marginal cost and on the access charges a_0 and a_t.

The difference in consumer surplus between the end user model and the origination is obtained subtracting **6.7** from **5.8.** It can be seen that the difference will be positive as long as $P > P_0 = c_0 + c_i + c_t$

$$CS^0 - CS^{EU} = \boldsymbol{q} \int_{P_0}^{P} q(x)dx + c_i\boldsymbol{q}\,q(P) > 0$$

As regards the free internet model, this mechanism will definitely provide higher aggregate welfare than the termination model (as *Lemma 1* shows) the difference lies in the monthly per user cost f_T (billing, servicing) not incurred by the ISP in the free internet model. Surprisingly, it is not so clear that the free internet model will provide higher consumer surplus than either the origination or the termination models. Subtracting **2.8** and **5.8** from **4.8** we get respectively,

$$CS^F - CS^T = \frac{1}{2\boldsymbol{s}} + f_i^T - (a_t - c_i - c_t)\boldsymbol{q}\,q(P) \text{ and,}$$

$$CS^F - CS^0 = \boldsymbol{q} \int_{P}^{P_0} q(x)dx + \frac{1}{2\boldsymbol{s}} + f_i^T + f_i$$

The difference lies in the fact that optimal monthly fees in the termination models (equations **2.4** and **2.5**) could be zero depending on the choice of the termination access charge a_t. With a sufficiently high a_t, fixed monthly fees could drop to zero and the termination model would provide the same level of consumer surplus the free internet model does. The difference between the origination and the free internet models will lie in the difference between call prices and the monthly fee (zero in the free internet model).

Now let us compare all the unmetered models. *Lemma 1* shows that all flat rated models provide the same level of aggregate welfare. The explanation for this is quite simple: comparing the U.S model (equation **3.11**) with the C.O.B.A.K proposal leaves no doubt. The sole difference between them is the termination charge a_t that is (as it was already demonstrated) simply a transfer from the ILEC to the ISP and from this one to the user through lower monthly fees. Welfare remains unchanged therefore both models provide the same level of aggregate welfare.

On the consumer surplus side the C.O.B.A.K proposal scores worse because it reduces the ability of ISPs to collect termination revenue to reduce monthly fees. Subtracting **3.9** from **3.10** one obtains

$$CS^{COBAK} - CS^{US} = -a_t \, \boldsymbol{q} < 0 \qquad \text{then} \qquad CS^{COBAK} < CS^{US}$$

The comparison of the F.R.I.A.C.O model with its American counterparts is not so easily grasped. In both the C.O.B.A.K and U.S models the ILEC takes big losses that are offset by higher ISPs' profits and higher consumer surplus from lower monthly fees. In the F.R.I.A.C.O model however, the ILEC breaks even by definition but ISPs' profits and more importantly, consumer surplus are lower. In other words, F.R.I.A.C.O shifts losses from the ILEC to ISPs and consumers leaving aggregate welfare unchanged in all three models. Welfare remains unchanged because the increase in ILEC's profits (from negative to zero) in F.R.I.A.C.O is exactly offset by the fall in ISPs' profits and consumer surplus (check optimal monthly fees **3.4** and **3.5** under U.S and C.O.B.A.K to see that they are lower than their British counterparts **7.5**). Subtracting **7.8** from both **3.9** and **3.10** one gets

$$CS^{US} - CS^{FRIACO} = a_t \boldsymbol{q} + f_i > 0 \qquad \text{and} \qquad CS^{COBAK} - CS^{FRIACO} = f_i > 0$$

In sum, both American models provide unambiguously higher consumer surplus and exactly the same level of aggregate welfare than the British model. *Lemma 2* compares metered with unmetered models.

Lemma 2: *If call price is equal to marginal (call plus internet) costs ($P = c_0 + c_t + c_i$), any metered model will yield an unambiguously higher level of welfare than any unmetered model.*

Proof: From *Lemma 1*, $W^{COBAK} = W^{US} = W^{FRIACO}$, subtracting **3.11** from **2.9** or **3.11** from **6.8** one obtains

$$W^T - W^{US} = W^{EU} - W^{COBAK} = \boldsymbol{q} \left\{ \int_P^0 q(x)dx + Pq(P) + (c_0 + c_t + c_i)\left[1 - q(P)\right] \right\}$$

Replacing P by $c_0 + c_t + c_i$ in the expression above one obtains

$$W^T - W^{US} = W^0 - W^{COBAK} = \boldsymbol{q} \left\{ \int_{c_0 + c_t + c_i}^0 q(x)dx + (c_0 + c_t + c_i) \right\} > 0$$

Subtracting **3.11** from **4.9** and replacing P by $c_0 + c_t + c_i$

$$W^F - W^{US} = \boldsymbol{q} \left\{ \int_P^0 q(x)dx + Pq(P) + (c_0 + c_t + c_i)\left[1 - q(P)\right] \right\} + f_i^T \text{ then,}$$

$$W^F - W^{US} = \boldsymbol{q} \left\{ \int_{c_0 + c_t + c_i}^0 q(x)dx + (c_0 + c_t + c_i) \right\} + f_i^T > 0 \qquad \text{Q.E.D}$$

Lemma 2 shows that for call price equal to marginal call and internet costs both benchmark metered models (origination and termination), the end user and the free internet model will provide a higher level of welfare than any unmetered model. It is interesting to remark though that the only model that can achieve that result with minimal regulation is the origination model. By setting the origination charge a_0 in line with origination cost c_0, the regulator can make sure that competition between ISPs will drive call prices to marginal (call + internet) cost achieving the efficient solution. Therefore, and under these conditions, *the origination model will always provide greater welfare than any unmetered model.*

Lemma 1 shows that for $P > c_0 + c_t + c_i$ the welfare function is convex in P, therefore there will be a certain value of $P = P^* > c_0 + c_t + c_i$ where the metered models will provide the same level of welfare as the unmetered models. From *Lemma 2*,

$$W^T - W^{US} = q \left\{ \int_{P*}^{0} q(x)dx + P^* q(P^*) + (c_0 + c_t + c_i)\left[1 - q(P^*)\right] \right\} = 0$$

The expression between curly brackets represents the difference between deadweight loss (the two first terms) and the change in costs as a result form the fall in consumption (the two last terms) as P goes from zero to P*. Switching to a metered regime will be welfare enhancing as long as the fall in consumption and costs (as $P \to$ P*) more than offsets the increase in deadweight loss. For P equal to marginal (call plus internet) cost metering is better than not metering, for P = P* it is the same and for P > P* not metering yields and unambiguously higher level of welfare than metering. Since P is regulated by the authorities, the final result of the comparison will depend on the level of call price P. In the origination model though is clear that as P tends to marginal cost due to competition, metering will provide higher welfare than any unmetered model.

For the free internet model, the equation above becomes zero for even higher values of P than in the previous case. This is because the absence of the fixed monthly fee in the free internet model shifts the balance away from the unmetered models and towards the metered one. P* for the free internet model will be higher than for either benchmark metered model.

$$W^F - W^{US} = q \left\{ \int_{P}^{0} q(x)dx + Pq(P) + (c_0 + c_t + c_i)\left[1 - q(P)\right] \right\} + f_i^T$$

Also notice that as long as P remains above marginal (call plus internet) cost, the expression above will always be positive regardless of the value of θ. For a hypothetical model with users indexed by θs (intensity of use), the free internet model will always yield a higher level of welfare than any unmetered models for heavy users (high θ) or for light users (low θ).

The comparison appears more relevant using consumer surplus as consumers are finally the ones with the ability to choose between different kinds of models. Subtracting **3.9** from **2.8** then,

$$CS^T - CS^{US} = \boldsymbol{q} \left\{ \int_P^0 q(x)dx - (a_t - c_t - c_i)[1 - q(P)] \right\} < 0 \quad iff \quad a_t > c_t + c_i$$

Clearly, the US model will provide higher consumer surplus than the benchmark termination model for any level of θ provided the termination charge lies above marginal termination and internet costs. The difference with C.O.B.A.K however is not so clear cut, subtracting **3.10** from **2.8**

$$CS^T - CS^{COBAK} = \boldsymbol{q} \left\{ \int_P^0 q(x)dx + a_t\, q(P) + (c_t + c_i)[1 - q(P)] \right\}$$

As long as $a_t > c_t + c_i$ the expression above will fall as P increases, then for a sufficiently high level of P the C.O.B.A.K model will yield a higher level of consumer surplus than de termination model. Likewise, there will be a sufficiently low level of P where the termination model will be more advantageous for the final user then the C.O.B.A.K model. This of course is because in the termination model the ISP collects termination revenue that it passes on to consumers through lower monthly fees.

$$CS^T - CS^{FRIACO} = \boldsymbol{q} \left\{ \int_P^0 q(x)dx + a_t\, q(P) + (c_t + c_i)[1 - q(P)] \right\} + f_i^{FR}$$

Lastly, the difference with the F.R.I.A.C.O is even more advantageous for the termination model because in addition to the same reason given above (i.e the ability to collect termination revenue), the British model charges higher fixed fees to help finance interconnection links with the ILEC.

The comparisons between the origination and the unmetered models yields very similar conclusions: the result will depend on the difference in call prices and in monthly fees and consequently on access charges.

4. Conclusions and Policy Recommendations

This paper tried to find an answer to the question of whether (or under what conditions) unmetered local calls, in addition to flat - rated internet pricing, yielded higher levels of welfare than metered local calls. Unexpectedly, the answer is not simple but it depends on rather few factors. Firstly, it depends on the interconnection model between the ISP and the ILEC chosen by them or by the authorities. There are interconnection models that benefit relatively more the consumers than the companies (i.e both American models). These provide high levels of consumer surplus but entail substantial losses for the ILECs. The standard American model does not provide the adequate incentives to invest in internet origination services. It creates distortions that induce entry into the termination segment of the market only to exploit the difference between termination charges and termination costs. The C.O.B.A.K proposal however mitigates this distortion as it eliminates the source of the problem but increasing ISP's monthly fees thus reducing consumer surplus.

The rest of the models shift the burden away from the ILEC and onto the ISPs and consumers. The metered models allow the ILEC to charge by the minute of telephone connection with ISPs and the indirect models (origination, end user and

F.R.I.A.C.O) allow ILECs to recoup investment in interconnection links with ISPs (actually CLECs). Hence these models are more in line with long term investment incentives than either American version of the termination model. However it is clear that even for the same levels of welfare, consumer surplus is unambiguously higher in both the standard American model and the C.O.B.A.K proposal.

Secondly, the answer depends crucially on the local (or internet) call rate P. Lemma 2 showed that if P is close to marginal call plus internet cost, any metered model will yield a higher level of welfare than any unmetered model. This is because with a sufficiently low P, metered models generate a small deadweight loss to consumers that is more than offset by the reduction in call plus internet per minute costs causing aggregate welfare to rise. Also, the origination model scored better that the rest because it can achieve the optimal solution with minimal regulation: just set the origination charge in line with origination cost and let competition take its course. On the other hand, above a certain value of P greater than marginal cost, the reduction in consumption generates a fall in consumer surplus and a deadweight loss that starts to outweigh the advantages of overall per minute costs and unmetered models score better.

In sum, the final answer to the question posed above appears to depend crucially on the level of P that the government sets. As a general policy recommendation the following can be said. If flat - rated internet pricing is the rule in the dial up internet market and local (or rather internet) call rates are kept low (i.e close to marginal cost), do not push for unmetered telephone calling, let the market do its job. Unmetered internet calls will eventually come as a result of competition either from "above", i.e. DSL or other broadband access technology such as CATV, or from "below", i.e. free internet models that are appealing to more and more people these days. Incumbent ISPs will, sooner or later, have to resort to reducing local call rates to prevent more migration to free ISPs or broadband technologies.

Appendix

Aggregate consumer surplus is the sum of surplus from calls and the surplus from consumer location along the "taste line" then, assuming symmetry throughout, for the termination model we have

$$CS^T = S\boldsymbol{q}\int_P^\infty q(x)dx + (1-S)\boldsymbol{q}\int_P^\infty q(x)dx - Sm - (1-S)m + \int_0^S \frac{1-x}{2\boldsymbol{s}}dx + \int_S^1 \frac{x}{2\boldsymbol{s}}dx$$

$$CS^T = \boldsymbol{q}\int_P^\infty q(x)dx - m + \frac{3}{8\boldsymbol{s}} = \boldsymbol{q}\int_P^\infty q(x)dx - \frac{1}{8\boldsymbol{s}} - f_i^T$$

Similarly for the rest of the models

Table 1: Revenue Sharing in Europe (peak hour)

Country	Type of interconnection	Share for the ILEC	Share for the CLEC	Share for the ISP
Germany	Indirect	50% ↔ 80%	50% - IC ; 20% - IC	
Belgium	Direct	69% - IC	31%	≈ 10-12%
Danmark	Indirect	29%	71% - IC	N / A
Spain	Direct	57% - IC	43%	
France	Direct	84% - IC	16%	
	Indirect	72%	28% - IC	
Italy	Direct	42% - IC	58%	
	Indirect local transit	63%	37% - IC	
Netherlands	Direct	83% - IC	17%	
Average	**Direct**	**67% - IC**	**33%**	
	Indirect	**57%**	**43% - IC**	

Source: Arcome (2000), IC stands for the interconnection costs or costs of leasing of links

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