

## Chapter 2

# PRICING ANALYSIS IN INTERNATIONAL INTERCONNECTED NETWORKS

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**Abstract:** The international telecommunications market is characterised by the need of operators in different countries to be interconnected. These operators enter into agreements whose principal variables are, firstly the interconnection tariff, and secondly the traffic volumes. The liberalisation of the telecommunications market has affected the dynamics of the bilateral agreements between international operators. This paper examines the interactions between fixed telephone operators in interconnected countries and analyses the effects that various settlement agreements can have in terms of the operators profitability.

**Key words:** Interconnection tariff, bargaining power, two way network, network competition.

## 1. INTRODUCTION

The changes occurring in the telephony industry in many industrialised countries, both on a legislative and technological level, have affected competitive scenarios in various national contexts. This paper examines the international telephony industry where the need of interconnection induces problems for interaction between countries which are characterised by different market contexts, legislative restrictions, and sizes on the catchment areas. These differences have a reciprocal impact in each country: changes to the macroeconomic variables in one country arising out of either the strategic choices of an individual operator or from the implementation of

economic policy involve multiplicity of effects for the operators in a country interconnected with it. In particular, the cost supported by the interconnection is established by the interconnection or access tariff, or rather the price that an operator must pay to terminate the call on the network of the operator in the destination country. The Federal Communications Commission in the United States<sup>1</sup>, in its directive on international interconnection tariffs, set the interconnection tariff values payable by U.S. operators to foreign operators for outgoing traffic from the USA so as to bar the phenomenon of “whipsawing”, that is to say, the practice of applying a relatively high access tariff adopted by foreign monopolies which, consequently, interferes with the competitive dynamics in the American market. In fact, only large operators managed to sustain the interconnection cost, meaning the small operators were excluded from the market. However, this directive was rescinded from the beginning of liberalisation of this industry in the major industrialised countries. As a result, the dynamics of bilateral agreements between international operators changed radically. The analysis carried out in this paper aims to examine the impact of the actual negotiating policies on the profitability of operators characterised by different sizes and possessing various bargaining powers.

The problems relating to the interconnection tariff negotiations have been discussed in the literature. In “two way” networks<sup>2-5</sup>, which characterise the international telecommunications market, reciprocal interconnection can distort social welfare. In fact, the interconnection tariff can be exploited as an instrument of collusion in cases where the operators offer services with a degree of differentiation so that it maintains a higher price level for the end user than would be the case in a competitive scenario. In this case, the Authority regulating this industry needs to intervene in order to maximise social welfare. Carter and Wright<sup>6</sup> examined the threat of collusion on two way networks in asymmetric conditions arising out of the fact that the incumbent operators possess the competitive advantage of brand loyalty over other competitors. The asymmetry, besides being relative to the size of operators in the same market, can be considered in terms of the size of interconnected operators belonging to different countries. The analysis of the interactions between different operators without considering the possibility of collusion, but within a competitive scenario characterised by a great deal of competition, was conducted by Madden and Savage<sup>7</sup> who developed an econometric model analysing the interaction between the pricing choices and the structure of the market. The results obtained revealed that a relationship existed between the reduction in market share of large U.S. operators and the decrease in price of international calls from foreign operators. Furthermore, the results obtained revealed the existence of a relationship between

increased competition in foreign countries and reduced price levels, not only by foreign operators but also by U.S. operators.

The actual practice of international negotiations on the rate making for the interconnection reflects Accounting Rate System (Ars) regulation based on fixing a common interconnection tariff. In reality, this negotiation practice can lead to several distortions such as the increase of the price to the end user or the reduction of the traffic volume. The Accounting Rate System was efficient when interconnection occurred between two monopolistic operators in which there was a perfect balance in the exchange of volumes of traffic and when the inflation and exchange rates were relatively constant in the two interconnected countries. However, the present international telecommunications scenario no longer reflects any of these conditions. Although liberalisation of the industry has occurred in the last decade, the ex-monopolistic operators continue to hold on to market leadership. The onset of competition has caused an unbalanced relationship between the quantities exchanged so that the larger operators are in a position of considerable bargaining power. In negotiation the larger operators, generating high quantities of outgoing traffic, can impose the tariff conditions which are most favourable to them.

The purpose of the analysis in this paper is therefore to model this negotiation practice and to test its profitability in relation to several variables, such as the gap between level of competition and the difference in the size of the catchment areas in interconnected countries. In order to model this bargaining process we use a game theoretic model<sup>8-9</sup>.

The paper is organised as follows. After this introduction, an analysis of the competitive scenario is carried out. In the third part of the paper a model is proposed for the competitive context in which operators belonging to two countries act. In the fourth part the model simulates the impact of principal key variables, and the suitability of the negotiation strategy of the interconnection charges based on the relationship between the quantities of traffic exchanged. Lastly, conclusions are elaborated in the final section.

## **2. THE COMPETITIVE SCENARIO**

In the last ten years the volume of international telephone traffic has increased to an annual average of 15%<sup>10</sup>. In 2001 international telephone calls across the world equalled 144 billions of minutes. The revenues in the international telephony industry amounted to USD 61 billions. In July 2002, worldwide 4,726 operators possessed licenses to operate on the international telephony market. It should be noted that only as long ago as 1997 there

were slightly less than 600 operators in the international telephony industry. The technological innovations and the process of liberalization of the telecommunications industry which have occurred in the major industrialized nations have contributed to this growth.

In the decade 1990-2000 the opening up of a competitive regime has involved numerous countries. In 1990 only six countries in the world had been liberalized in the telecommunications industry whereas by 2002 there were 59.

In the United States the level of competition in the industry has grown exponentially in recent years. In 2003 there are over 1,800 international telephony operators in contrast to the 175 present in 1997. Globally the competitive scenario is characterised by a competitive regime in which the ex-monopolists, almost always, retain the leadership, as shown in figure 1. In particular, in Italy where there are 120 international telephony operators in various market segments, the ex monopolist Telecom Italia had about 60% of the total international telephone call minutes.

An important consequence of the wider competition has been a progressive reduction in prices. From the onset of liberalisation, the dominant operators have decreased the cost of international calls by approximately 40%<sup>11</sup>. This decrease in prices has also been made possible by technological improvements which have substantially modified the cost structure for international telephony operators, causing a significant reduction in the costs of call completion.

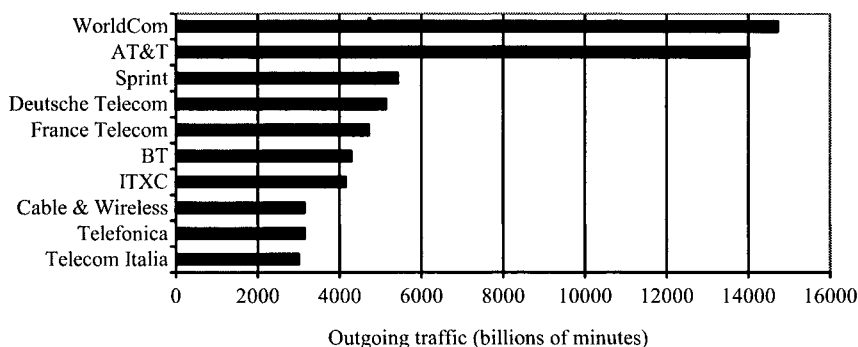


Figure 1. Top ten international carriers (source: Telegeography, 2003)

The liberalization of the industry within the individual countries has increased the strategic importance of the interconnection tariff. In 2003 the determination of the conditions of interconnection and the price for the end user represent a crucial factor in a complex competitive context such as the international telephony. In fact, in this industry the competition is not only based on attracting the national subscribers for international telephone calls, but also on the determination of the interconnection tariff for the termination of calls coming from foreign countries. The determination of the interconnection tariffs assumes greater complexity because they are fixed in a reciprocal manner by the operators of the two countries who want to connect. Therefore, the competition takes place in two stages: firstly, on a national level in order to compete for the subscribers of international telephone services, and secondly on an international level in order to make more favourable agreements with foreign operators for the termination of international calls.

In Europe, European Union legislation protects the possibility of operators negotiating “*transfrontier agreements*” between them for access and interconnection on a “*commercial basis*”, or rather, negotiations not subjected to legislative restrictions. Notwithstanding this freedom of behaviour, until 2003 the negotiating practice used by the international telephony operators had closely followed the regulations of Ars which, as already seen above, contain numerous weaknesses. In practice, Ars provides for the fixing of a common interconnection tariff. Where there is a difference in volumes of traffic exchanged, the operator in the country which generated the greater call volume compensates the operator to which it connects with a sum equal to the difference in the quantity exchanged multiplied by the value of the access tariff. This negotiation practice produces paradoxical results. The operator which generates the larger call volume is disadvantaged, probably applying lower final prices. Vice versa, the operators which fix higher final prices and produce a lower volume of traffic are in an advantageous position, collecting a higher active interconnection tariff than its partner operator.

This method of negotiation, in addition to bringing distortions, is largely bypassed through several alternative methods:

1. call-back. This is a form of re-directing the call. The call from country A to country B is first directed to country C where the call back operator interconnects the operators of the two countries, profiting on the difference in final price imposed in the different countries.
2. Collect calls. This is a service which makes the subscriber receiving the call pay for the call.
3. Refile. This is a form of commercial agreement for the delivery of traffic between two administrations via a third party where the final transit point

appears as the technical, and more importantly the commercial origin of the traffic and declares the traffic as such. In 2002, 25% of international telephone traffic was transported using the refile technique.

Besides the technique of negotiating using Ars regulations, when the quantities exchanged diverge appreciably, for example when an incumbent operator negotiates with a competitor, the method of negotiation is based on the relative contractual power possessed by the operators. In this case, the distortions generated by the traditional type of negotiation are overcome since the operator which sends the most telephone traffic is rewarded. However, it is important to analyse the limits of this negotiation method in that the dominant operator can behave anti-competitively and undermine the competitiveness of the market.

### 3. ANALYSIS OF NEGOTIATION FOR INTERCONNECTION

With the purpose of analysing competition in the international telephony industry, two different national markets of fixed telephony are considered, market A and market B, in which two competitors in each market operate, one an incumbent the other a competitor, as shown in figure 2.

Each operator is able to operate in both: in the intermediate market in which international connections take place, and in the final market, offering full service coverage. Competition between carriers therefore takes place on two levels: firstly, in the national market where the decision variable is the price to the end user, and, secondly, in the international market where the decision variable is the interconnection tariff.

The utility of a generic consumer subscribing to the  $j$ -th operator is given by<sup>6</sup>:

$$U = w_j^A + \theta_j^A + v_0^A \quad (1)$$

where:

$w_j^A$  is the utility deriving from carried out calls;

$\theta_j^A$  represents the additional benefit derived from the connection with operator  $j$ ;

$v_0^A$  is the constant fixed surplus caused by the use of the interconnection service.

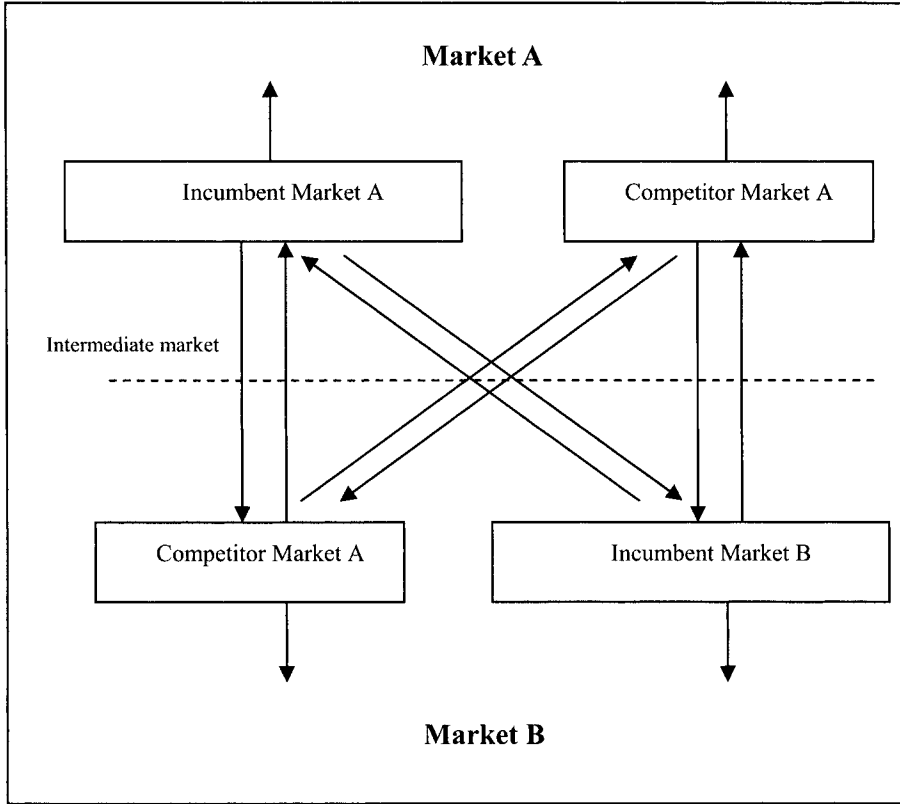


Figure 2. Competitive Scenario

Since the subscribers are assumed uniformly distributed with value  $x$ , on the classic Hotelling<sup>12</sup> segment of unitary length and the carriers are localised on the segment of length  $1+\beta^A$ , where  $\beta^A$  represents the degree of asymmetry in terms of brand loyalty, we obtain:

$$\theta_1^A = \frac{\beta^A}{2\sigma^A} + \frac{1-x}{2\sigma^A} \text{ and } \theta_2^A = \frac{x}{2\sigma^A} \quad (2)$$

the variable  $\beta^A$  can vary between 0 and 1. When it is equal to 0 the operators have the same brand loyalty and the market shares are only influenced by prices. When it is equal to 1, the incumbent operator has a strong competitive advantage since it possesses maximum brand loyalty. The variable  $\sigma^A$  represents the degree of substitutability between operators; when  $\sigma^A$  is moving to 1, the switching cost of the subscriber is annulled. The

function of net surplus of the subscriber belonging to the  $j$ -th operator is given by:

$$w_j^A = u(q_j^A) - p_j^A q_j^A (p_j^A) \quad (3)$$

A subscriber localised on the Hotelling<sup>12</sup> segment at point  $x$  will choose one of the two carriers indifferently if his utility is the same:

$$w_1^A + \frac{\beta^A}{2\sigma^A} + \frac{1-x}{2\sigma^A} = w_2^A + \frac{x}{2\sigma^A} \quad (4)$$

By solving  $x$ , the following shares for market A are obtained:

$$S_1^A = \frac{1+\beta^A}{2} + \sigma^A (w_1^A - w_2^A)$$

$$S_2^A = \frac{1-\beta^A}{2} + \sigma^A (w_2^A - w_1^A) \quad (5)$$

The same considerations are valid for market B.

In order to set up carrier profit functions, the following negotiation hypotheses are assumed:

1. the incumbent in market A draws up an interconnection agreement with the incumbent in market B, while the competitor in market A does the same with the competitor in market B.
2. the incumbent in market A draws up an interconnection agreement with the competitor in market B, while the competitor in market A does the same with the incumbent in market B.

So, the profit function of the  $j$ -th operator in the market A interconnected with  $i$ -th operator in market B ( $i = 1, 2$ ; 1 is referred to market incumbent and 2 to market competitor) is given by:

$$\pi_j^A = (p_j^A - c_j^A - t_j^{Ap}) q_j^A S_j^A N + (t_j^{Aa} - c_j^A) q_i^B S_i^B M \quad (6)$$

Similarly, the profit function of the  $i$ -th operator in market B interconnected with  $j$ -th operator in market A is given by:

$$\pi_i^B = (p_i^B - c_i^B - t_i^{Bp}) q_i^B S_i^B M + (t_i^{Ba} - c_i^B) q_j^A S_j^A N \quad (7)$$



where:

$p_j^A$  is the price of one minute of a telephone call starting from A and ending in B carried out by the end user in market A subscribing to operator j;

$p_i^B$  is the price of one minute of a telephone call starting from B and ending in A carried out by the end user in market B subscribing to operator i;

$c_j^A$  is both the originating and termination cost of one minute of telephone traffic towards B of operator j in market A;

$c_i^B$  is both the originating and termination cost of one minute of telephone traffic towards A of operator i in market B;

$t_j^{Ap}$  is the interconnection tariff paid by operator j in market A to the operator i in market B to terminate one minute of a telephone call in market B (passive interconnection tariff of operator j);

$t_i^{Bp}$  is the interconnection tariff paid by operator i in market B to the operator j in market A to terminate one minute of a telephone call in market A (passive interconnection tariff of operator i);

$t_j^{Aa}$  is the interconnection tariff received by operator j in market A for one minute of a telephone call coming from market B paid by the operator i (active interconnection tariff of operator j);

$t_i^{Ba}$  is the interconnection tariff received by operator i in market B for one minute of a telephone call coming from market A paid by the operator j (active interconnection tariff of operator i);

$q_j^A$  is the quantity of calls made by a subscriber of the j-th operator and directed to market B ( $q_j^A = a - bp_j^A$ );

$q_i^B$  is the quantity of calls made by a subscriber of the i-th operator and directed to market A ( $q_i^B = r - sp_i^B$ );

$S_j^A$  is the market share of operator j in market A in terms of percentage of subscribers;

$S_i^B$  is the market share of operator i in market B in terms of percentage of subscribers;

N and M are the number of subscribers belonging respectively to market A and market B who make international telephone calls.

The focus of this paper is the analysis of competition in international telecommunications industry, showing the importance of operators bargain power. So, we overcome the hypothesis of a common interconnection tariff stated in literature<sup>13</sup> and we consider that the interconnection tariff is negotiated depending on carriers bargaining power. Therefore, we assume that the operators compete on price in the final market ( $p_j^A$  and  $p_i^B$  are the decision variables of the model), whilst they may negotiate the interconnection tariff using their own bargaining power based on the quantity of the telephone traffic exchanged. In this way, interconnection tariff is fixed as a function of exchanged traffic volumes. Therefore, the passive interconnection tariff of j-th operator in market A is given by:

$$t_j^{Ap} = K \frac{q_i^B MS_i^B}{q_j^A NS_j^A} t_j^{Aa} \quad (8)$$

whereas the passive interconnection tariff of  $i$ -th operator in market B is given by:

$$t_i^{Bp} = \frac{1}{K} \frac{q_j^A NS_j^A}{q_i^B MS_i^B} t_i^{Ba} \quad (9)$$

where  $K$  represents a multiplication factor of the quantity. Notice that the passive interconnection charge for the operator  $j$  in market A is equal to the active interconnection tariff for the operator  $i$  in market B, and vice versa ( $t_i^{Ba} = t_j^{Ap}$  and  $t_j^{Bp} = t_i^{Aa}$ ).

When the quantity exchanged is equivalent,  $K=1$  and the interconnection tariff is common in that the passive tariff coincides with the active one. When there is considerable asymmetry between the quantity of traffic exchanged, the operator sending the most traffic claims a higher active tariff than the related passive tariff. According to this negotiation methodology, the greater the gap between the volumes of traffic exchanged, the greater the gap between the active and passive tariffs. This negotiating method is, therefore, efficacious when an appreciable difference exists between the volumes of traffic exchanged, but on the other hand when the quantity exchanged does not vary much, applying a contractual method which does not raise the size of the gap is better. In fact, when the gap between the exchanged traffic volumes is low, the observed carrier behavior is to fix asymmetric interconnection tariff only on the imbalance. Since the analysis is based on the hypothesis of asymmetrical conditions for several variables regarding the interconnected countries, the negotiating method based on the relationship between the quantities exchanged proved to be the most efficacious.

On the basis of the above assumptions, the final price is simultaneously fixed by the two operators solving the two systems (one for each market) of first order conditions of the profit functions:

$$\left\{ \begin{array}{l} \frac{\partial \pi_1^A}{\partial p_1^A} = 0 \\ \frac{\partial \pi_2^A}{\partial p_2^A} = 0 \end{array} \right. \quad \text{for market A} \quad \left\{ \begin{array}{l} \frac{\partial \pi_1^B}{\partial p_1^B} = 0 \\ \frac{\partial \pi_2^B}{\partial p_2^B} = 0 \end{array} \right. \quad \text{for market B} \quad (10)$$

The maximization process (10) is shown in the appendix. The solutions of previous system are obtained through a software for advanced mathematics (Maple 9).

#### 4. SIMULATION RESULTS

In order to analyse the impact of a settlement agreement based on the exchanged traffic volumes, for simulation purposes on carrier profitability, we consider the following key variables:

- the level of competition in each country, represented by the degree of asymmetry and of substitutability between operators;
- the size of the catchment area.

The competitive scenario can not only be influenced by the prices applied by individual operators, but also by the brand loyalty possessed by the incumbent compared to that possessed by the competitor which leads to asymmetry in the market share and a greater switching cost for the subscriber.

With regard to the second variable, in the international telephone scenario considerable asymmetry exists between the catchment areas. As shown in figure 3, in 2003 almost 80% of the international telephone traffic is generated in Europe and North America.

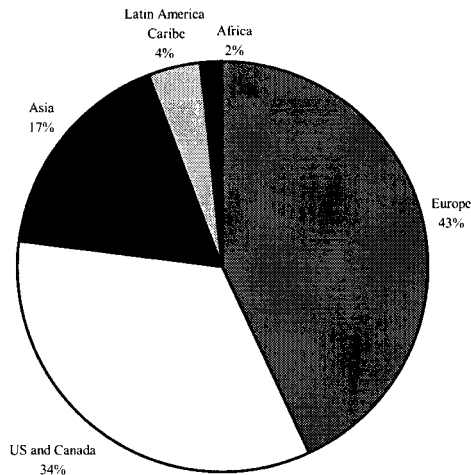


Figure 3. International traffic volume by the country of origin (source: Telegeography, 2003)

The simulations applied to the relative sizes of the operators are reported in tables 1 and 2. In particular, in table 1, the starting situation is characterised by the market B incumbent (1B) having strong market power ( $\beta^B = 1$ ). The existence of a strong brand loyalty induces both the highest price level of the incumbent and the lowest for the competitor; moreover the total traffic volume produced by the incumbent ( $Q_1^B = q_1^B S_1^B M$ ) is greater than the volume produced by the competitor  $Q_2^B$ . This is due to the prevalence of the market share effect with respect to price impact. It is interesting to note that the greater the reduction in brand loyalty the greater the total traffic volume produced  $Q$ . Such increase is composed by two opposite effects: the first one is related to the reduction in traffic volume produced by the incumbent although the price reduction, whereas the second one is related to an increase in traffic volume produced by the competitor although the price increase, as shown in columns  $\Delta Q_1^B$  and  $\Delta Q_2^B$ . This means that the brand loyalty effect is prevalent with respect to price impact. Now it is interesting to analyse the impact of variations in the competitive scenario in term of profits. So, it is necessary to consider the interconnection tariff representing a high share of revenue and cost. The bargaining power gap between incumbent and competitor induces to consider the two different negotiation hypotheses defined above. The obtained results can be summarised in table 2.

Table 1. Optimal values of prices, calls and market shares related to  $\beta^B$ 

$\beta^B$	$P_1^B$	$P_2^B$	$S_1^B$	$Q_1^B$	$\Delta Q_1^B$	$Q_2^B$	$\Delta Q_2^B$	Q
1	2.22	1.02	0.88	4903 (84%)		952 (16%)		5855
0.8	2.19	1.33	0.81	4577 (77%)	-7%	1361 (13%)	+43%	5938
0.6	2.16	1.57	0.74	4219 (70%)	-8%	1770 (30%)	+30%	5989
0.4	2.11	1.75	0.66	3834 (64%)	-9%	2183 (36%)	+23%	6017
0.2	2.06	1.88	0.58	3431 (57%)	-11%	2600 (43%)	+19%	6031
0	1.98	1.98	0.50	3018 (50%)	-12%	3018 (50%)	+16%	6036

(Notice that price are in €/min. and quantities are in millions of minutes)

Table 2. Carriers profits variations with respect to  $\beta^B$ 

$\beta^B$	Negotiation hypothesis 1				Negotiation hypothesis 2			
	$\pi_1^A$	$\pi_2^A$	$\pi_1^B$	$\pi_2^B$	$\pi_1^A$	$\pi_2^A$	$\pi_1^B$	$\pi_2^B$
1	54525	56110	102924	462	68675	43030	104512	-2179
0.8	55481	53171	94321	10991	64943	44129	95654	9144
0.6	56459	51453	84801	21617	62842	45251	85992	20197
0.4	57457	50187	74654	32447	60786	46358	75705	31296
0.2	58326	48784	64107	43824	60138	47406	65023	42227

(Notice that profits are €x1000)

The reduction of the brand loyalty  $\beta^B$  has an impact in terms of profits in market B, as shown in figures 4 and 5. Notice that, in both negotiating hypothesis, the profits made by the incumbent is decreasing, since a reduction in the quantity of outgoing traffic occurs, which in turn causes a worsening in the negotiating position of the passive tariff. In particular, the incumbent in market B finds an advantage in negotiating the interconnection with the competitor in market A due to better bargaining power.

On the contrary (figure 5), in both negotiating hypotheses the profits of the competitor in market B increase because of the raise of its market share and the consequent improvement in its bargaining power. Figures 4 and 5 show that for the incumbent it will be better to bargain with the competitor since it increases the strength ratio that defines the passive tariff; the same consideration is true for the competitor. Such effect is greater than that arising from the low traffic volume deriving from the interconnection with the competitor (instead of the incumbent), so involving a high level of profits.

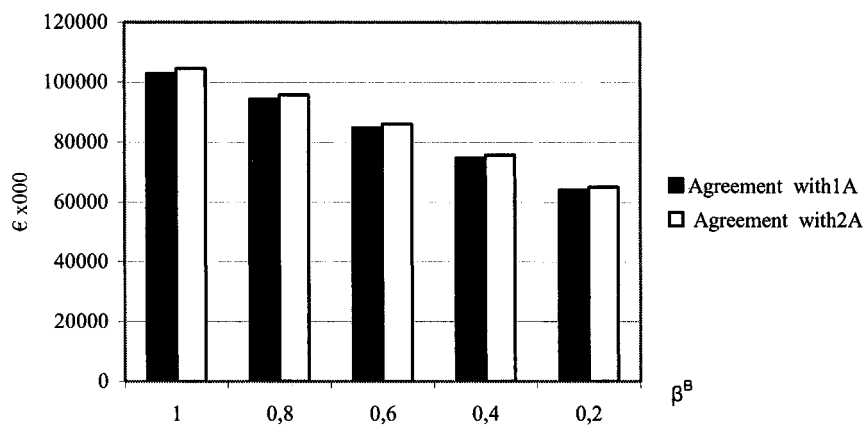


Figure 4. Incumbent profits variations in market B with respect to  $\beta^B$

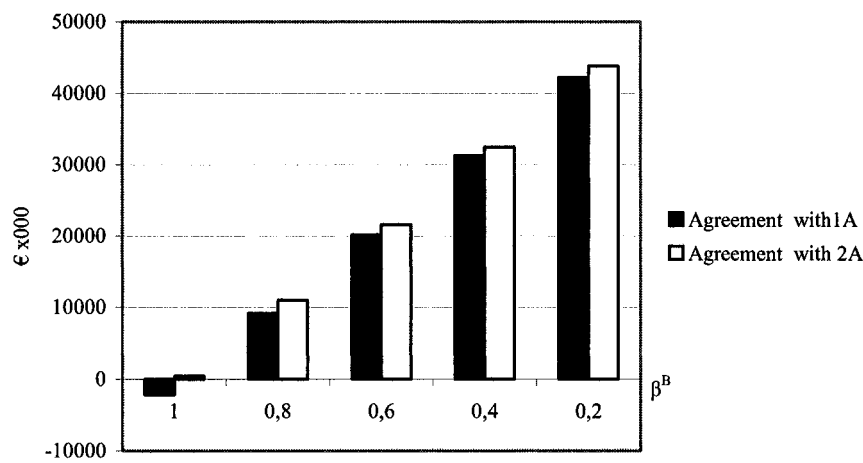


Figure 5. Competitor profits variations in market B with respect to  $\beta^B$

Now we analyse the impact of a reduction of brand loyalty in market B on carriers profits in market A. With the reduction of  $\beta^B$ , the first hypothesis of negotiation results a progressive growth of profit. Moreover, the second hypothesis of negotiation is always better for both market A carriers, obtaining a high level of profits, as shown in figures 6 and 7. Such advantage is declining with respect of reduction of  $\beta^B$  since the difference in bargaining power between the incumbent and the competitor in market B become negligible.

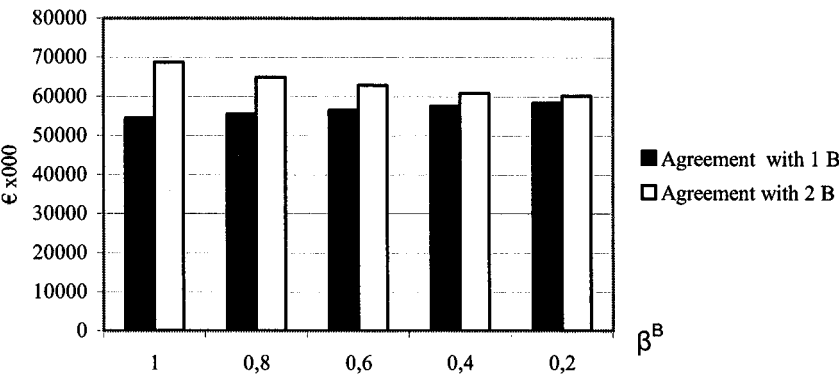


Figure 6. Incumbent profits variations in market A with respect to  $\beta^B$

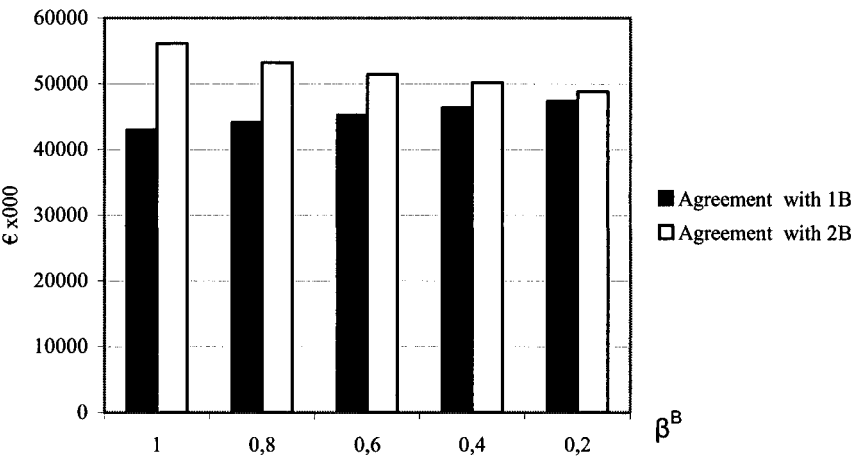


Figure 7. Competitor profits variations in market A with respect to  $\beta^B$

Table 3. Profits variations with respect to market B catchment area

Market B size	Negotiation hypothesis 1				Negotiation hypothesis 2			
	$\pi_1^A$	$\pi_2^A$	$\pi_1^B$	$\pi_2^B$	$\pi_1^A$	$\pi_2^A$	$\pi_1^B$	$\pi_2^B$
N=200000 subscribers	58756	48783	58756	48783	59644	47888	59644	47888
1.25*N	56942	47202	75284	62580	58159	45805	76457	61579
1.50*N	54724	45276	92103	76645	56466	43272	93687	75460
1.75*N	52255	43052	96055	79893	54407	40399	97024	78424
2*N	49082	40360	127175	106003	52183	36792	129390	104092

Analysis of the catchment area is carried out by assuming an increase in the size of market B, *ceteris paribus*, as we can observe in table 3.

The obtained results show how both carriers in market A are not favoured by interconnection with countries having larger catchment areas because of the imbalance in the relationship between the quantity of traffic transmitted. All the same, it is better for both carriers to conclude interconnection agreements with the competitor in the other country. Results show that both carriers in market B obtain an increased profit from the growth of their catchment area. The growth in the number of subscribers increases the quantity of outgoing traffic and improves the negotiating conditions of the interconnection. Furthermore, both carriers prefer to negotiate with the competitor in market A as it allows them to make a greater profit because it improves the ratio between the quantities exchanged.

All the simulations show that for both incumbent and competitor it is always best to negotiate the interconnection conditions with smaller carriers.

To complete the analysis it is worthwhile to compare the impact on profitability caused by difference in the degree of asymmetry of interconnected markets and those differences derived from variation in the market B catchment area.

As table 4 and 5 show, the effects produced by variation in the catchment area on the profits of market A carriers are greater compared to those stemming from the degree of market asymmetry. When market A incumbent negotiates with market B incumbent, it suffers a decrease in profit when the degree of market B asymmetry increases. Moreover, such profit loss of market A incumbent is greater when the market B catchment area increases.

In the case in which the market A incumbent negotiates with the competitor in market B, its profit grows when the degree of market B asymmetry rises, because it obtains the better contractual conditions. On the contrary, it obtains a profit decrease with an increase in the market B catchment area because of the worsening of the ratio between the exchanged traffic. The situation of the market A competitor is analogous.

Table 4. Incumbent profits variations in market A

Negotiation with market B incumbent		Negotiation with market B competitor	
$\beta$	N	$\beta$	N
-1.5%	-3.0%	+1.1%	-2.4%
-3.2%	-6.9%	+4.5%	-5.3%
-4.9%	-11.1%	+8.0%	-8.8%
-6.5%	-16.5%	+14.2%	-12.5%



Table 5. Competitor profits variations in market A

Negotiation with market B incumbent		Negotiation with market B competitor	
$\beta$	N	$\beta$	N
+2.9%	-3.2%	-2.2%	-4.3%
+5.5%	-7.2%	-4.5%	-9.6%
+9.0%	-11.7%	-6.9%	-15.6%
+15.0%	-17.3%	-9.2%	-23.2%

The variations in terms of profitability compared to the carriers in market B are shown in table 6, in which the second negotiating hypothesis has been omitted since it does not present any relevant differences compared to the first.

The market B incumbent obtains increased profits in both cases and by negotiating with all carriers in market A. Moreover, its profit increases most in the case in which its catchment area increases. The competitor in market B, negotiating with either carrier, experiences a reduction in profit when the competitive scenario changes, since its passive interconnection tariff increases on the reduction in its size. Vice versa, its profits rise when its catchment area increases since the bargaining power with the market A partner carriers grows.

The results of the simulation demonstrate the relative sizes of the catchment areas produce more incisive effects on profitability of all interconnected carriers compared to those generated by changes in the competitive scenario caused by changes in the degree of asymmetry between carriers. In particular, for the carriers with the smallest catchment area, the increase in the size of the catchment area in the country with which they are interconnected, produces a considerable deterioration in their negotiating position through the imbalance in the bargaining power between partner carriers.

Table 6. Carriers profits variations in market B

Negotiation between market B incumbent and market A incumbent		Negotiation between market B competitor and market A competitor	
$\beta$	N	$\beta$	N
+16.4%	+28.1%	-25.9%	+28.1%
+32.3%	+56.8%	-50.7%	+57.1%
+47.1%	+63.5%	-74.9%	+63.7%
+60.6%	+116.4%	-98.9%	+117.3%

## 5. CONCLUSIONS

In recent years the increased competitive pressure developed in the major industrialised countries has impacted on the international telephone traffic agreements. When, internationally, a monopolistic regime operated, the common interconnection tariff was determined according to bilateral agreements between carriers in different countries. From the beginning of liberalisation, the interconnection tariff experienced a radical decrease and, at the same time, became an important strategic leverage in the choice of foreign carrier.

Furthermore, the liberalisation has allowed interaction between carriers of different dimensions, consequently resulting in changes in the bargaining power. Large carriers in the negotiating situation hold considerable contractual power because of the greater telephone traffic generated. The aim of the analysis in this paper is to determine the advantages of adopting the negotiating typology based on the quantities of traffic exchanged compared to the level of competition and in relation to the relative sizes of the carriers. The advantage of adopting such a contractual typology can, therefore, depend on the composition and the dimension of the market with which interconnection is desired. The analysis carried out revealed how the size of the catchment area of the interconnected country's market causes a more incisive effect on the carrier's profitability. In particular, the increased size of the market in one country causes an improvement in its negotiating conditions and so on the profitability of the carriers in that country, while it has a negative effect on the interconnected carriers having a small catchment area, that suffer a worsening of their negotiating strength and of their profits as a result.

In addition, the results obtained from the simulation concerning the level of competition and the size of catchment area converge towards a particular contractual solution. All the simulations show how size (that is, both the number of subscribers and the volume of traffic transmitted) gives carriers greater negotiating power so that large carriers benefit from negotiating with small carriers since the bargaining power is greater. On the contrary, for small carriers it is advantageous to negotiate with carriers of the same size. When a contractual methodology based on telephone traffic exchanged is applied, a strategy of polarisation is only advantageous for small sized carriers. Since both the carriers of the market prefer to make interconnection agreements with a competitor carrier in the other country, it triggers a process of negotiation which is inevitably unsatisfactory to someone.

A possible solution is that the larger carriers offer the smaller carriers some form of compensation for the profit loss, a solution already proposed by Wright<sup>13</sup> for multilateral negotiations.

The contractual typology based on the relationship between the quantities of exchanged telephone traffic, even though it eliminates the distortion of social welfare caused by traditional negotiating methodologies, only brings about improved efficiency if the smaller carriers are offered some form of incentive.

## References

1. FCC, *IB Docket 96/261 In the Matter of International Settlement Rates* (1997).
2. M. Armstrong, Network interconnection in telecommunications, *Economic Journal*, **108**, 545-564 (1998).
3. J-J. Laffont, P. Rey and J. Tirole, Network competition: I Overview and nondiscriminatory pricing, *Rand Journal of Economics*, **29** (1), 1-37 (1998).
4. J-J. Laffont, P. Rey and J. Tirole, Network competition: II Discriminatory pricing, *Rand Journal of Economics*, **29** (1), 38-56 (1998).
5. L. Cricelli, M. Gastaldi and N. Levialdi, Vertical Integration in International Telecommunication System, *Review of Industrial Organization*, **14** (3), 337-353 (1999).
6. M. Carter and J. Wright, Interconnection in network industries, *Review of Industrial Organization*, **14**, 1-25 (1999).
7. G. Madden and S.J. Savage, Market structure, competition and pricing in United States international telephone markets, *Review of Economics and Statistics*, **82** (2), 291-296 (2000).
8. J. Tirole, *The Theory of Industrial Organization*, (MIT Press, Cambridge- Massachusetts, 1988).
9. R. Gibbons, *Game Theory of Applied Economists*, (Princeton University press, Princeton- New Jersey, 1992).
10. Telegeography, *Country Traffic Statistic*, (2003).
11. Agcom, *Relazione Annuale sull'Attività Svolta e sui Programmi di Lavoro-2003*, (2003).
12. H. Hotelling, Stability in Competition, *Economic Journal* **39**, 41-57 (1929).
13. J. Wright, International Telecommunications, Settlement Rates, and the FCC, *Journal of Regulatory Economics*, **15** (3), 267-292 (1999).

## Appendix

Proof of proposition (10)

Substituting the demand function and the tariff expression (8) in the profit function (6), we obtain:

$$\pi_1^A = \left( p_1^A - c_1^A - \frac{K(r - sp_1^B)MS_1^B t_1^{Aa}}{(a - bp_1^A)NS_1^A} \right) \left( (a - bp_1^A)S_1^A N + (t_1^{Aa} - c_1^A)(r - sp_1^B)S_1^B M \right)$$

$$\pi_2^A = \left( p_2^A - c_2^A - \frac{K(r - sp_2^B)MS_2^B t_2^{Aa}}{(a - bp_2^A)NS_2^A} \right) (a - bp_2^A)S_2^A N + (t_2^{Aa} - c_2^A)(r - sp_2^B)S_2^B M$$

the maximization process is given by:

$$\frac{\partial \pi_1^A}{\partial p_1^A} = \left\{ 1 - \frac{b(r - sp_1^B)MKS_1^B t_1^{Aa}}{(a - bp_1^A)^2 NS_1^A} + \frac{\sigma(-a + 2bp_1^A)(r - sp_1^B)MKS_1^B t_1^{Aa}}{(a - bp_1^A)NS_1^{A^2}} \right\} (a - bp_1^A)NS_1^A + \left\{ p_1^A - c_1^A - \frac{(r - sp_1^B)MKS_1^B t_1^{Aa}}{(a - bp_1^A)NS_1^A} \right\} \{ N\sigma(a - bp_1^A)(-a + 2bp_1^A) - bNS_1^A \} = 0$$

$$\frac{\partial \pi_2^A}{\partial p_2^A} = \left\{ 1 - \frac{b(r - sp_2^B)MKS_2^B t_2^{Aa}}{(a - bp_2^A)^2 NS_2^A} + \frac{\sigma(-a + 2bp_2^A)(r - sp_2^B)MKS_2^B t_2^{Aa}}{(a - bp_2^A)NS_2^{A^2}} \right\} (a - bp_2^A)NS_2^A + \left\{ p_2^A - c_2^A - \frac{(r - sp_2^B)MKS_2^B t_2^{Aa}}{(a - bp_2^A)NS_2^A} \right\} \{ N\sigma(a - bp_2^A)(-a + 2bp_2^A) - bNS_2^B \} = 0$$

Analogous solutions can be derived for market B.

The solution of the system (available from authors on request) is obtained using a software for advanced mathematics (Maple 9).



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