TELEPHONE TARIFFS AND VOLUME OF TRAFFIC IN OECD COUNTRIES

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INTRODUCTION

The question of tariff policy occupies a central position in discussions on restructuring which are in progress in the telecommunications sector. Current opinion holds that the prices charged by network operators are still far from reflecting the actual cost structure. As far as the international telephone service is concerned, it has contributed for a long time to the subsidization of other services. This practice has recently been changing. The growing competition - real or potential - with which the administrative bodies have been confronted has stimulated a gradual uniformity of tariffs. The disparity in charges for international conversations which still exists between single countries has become much narrower than that for internal communications. These modifications in tariffs have had noticeable repercussions on the volume of traffic, which is increasing rapidly.

In recent years the OECD has compiled a series of data on individual member countries, for the purpose of comparison between them. The statistics currently available cover one particular year and the analyses they allow are therefore limited and can only be explorative. For our part, we have used these publications to consider the problem of estimation of the demand function for telephone services at an international level. Most of the studies carried out up to the present - which are in fact not numerous - were commissioned by network operators, especially in North America, and their publication in academic journals has been very limited. Amplification of the available statistics should facilitate analyses also to the researcher not strictly bound to these sources of information. In this article we will link the estimate of the demand for usage to a practical evaluation. We have already mentioned the fact of convergence of international tariffs. We can use the elasticity estimated with a model to establish the scope of the repercussions which total parity would have on the volume of traffic and on receipts. For this purpose we consider it useful to modify the specification commonly used, keeping in mind, for the derivation of demand, a function of production of information.

In Section 1 we briefly examine the actual situation regarding tariffs for international conversations, highlighting the differences existing between individual countries. In Section 2 we present the characteristics of the model used for adjustment. The following Section will be dedicated to the presentation and comments on the results obtained. Finally we will draw some conclusions.

1. TARIFF STRUCTURE OF OECD COUNTRIES

A recent publication of the OECD (1990) allows comparisons to be drawn regarding the level of tariffs in effect in member countries. The most significant data is set out in Table 1, showing figures calculated for 1989 on the basis of average OECD tariffs. Comparing the data for internal traffic of individual countries (local and trunk calls) with that of international traffic, it is interesting to observe that they have very little connection one with the other. In both columns countries are listed in ascending order of charges. As far as internal traffic is concerned, one sees that telephone costs in Northern countries, with the exception of Norway, are below average. Instead, at the opposite end, we find certain countries - among them some of the leading nations like Germany, Japan, Italy and even the United States - which still impose relatively high tariffs. These indices are calculated on the basis of a basket of services compatible with the characteristics of each country. All figures are derived by data expressed in dollars.

Table 1

Telephone costs of conversation (business) in OECD countries (index) 1989			
National		International	
Iceland	27	Australia	82
Netherlands	39	Canada	83
Denmark	43	United States	83
Sweden	47	New Zealand	86
Finland	64	Denmark	86
Belgium	67	France	89
Greece	74	Norway	91
New Zealand	78	United Kingdom	93
Canada	85	Finland	95
United Kingdom	95	Sweden	95
Portugal	101	Switzerland	100
Switzerland	102	Austria	101
Turkey	104	Belgium	101
Spain	109	Germany	103
France	116	Iceland	103
Australia	118	Netherlands	104
Norway	119	Portugal	105
United States	121	Japan	107
Ireland	148	Greece	109
Italy	153	Italy	115
Germany	155	Spain	116
Austria	165	Ireland	119
Japan	169	Turkey	126

Source: OECD 1990

The situation is quite different regarding international conversations in individual countries. In the first place, dispersion of the tariffs narrows considerably. It must be kept in mind that these indices take into account the average cost of each connection between two countries, based on the volume of traffic registered. It is easy to see that a large number of countries align their tariff structures to the average level. The Anglo-Saxon countries in the various Continents are clearly able to offer more advantageous services. Tariffs in Australia, Canada, the United States and New Zealand are between 15% and 20% lower than the average. At least four countries namely Italy, Ireland, Spain and Turkey - still show difficulty in adjusting to the average. Italy and Ireland have notoriously high tariffs, even on internal conversations. Spain and Turkey, on the other hand, have made serious efforts to reach an alignment of their internal tariffs, while maintaining high tariffs on external communications. A final point worthy of notice concerns the proportion of international communications in regard to the total volume of telephone traffic. The differences are most pronounced. The above-mentioned OECD publication goes from quotients clearly lower than 0.5% in the case of the United States and Japan, to quotients obviously much higher in the case of European countries: for example, in Germany figures reach 2.67%. International telephone traffic represents, therefore, a highly variable source of profit from one country to another, and consequently the possibilities of compensation between single components of the tariff structure are disparate. However, it is impossible at first sight to find any connection between the relative volume of international traffic and the tariff policy in effect.

2. THE MODEL

The specifications used for the estimate of telephone demand, with its various components - local, trunk and international - are based on certain generally accepted principles and do not present significant variations. This whole question is fully discussed in Taylor (1980), in which the results of the main empirical estimations carried out are also reported. A synthesis of the entire subject matter is furnished in a later contribution by the same author (1983). In general terms, we can confirm that the modelling of telephone demand closely follows that which is normally used for demand in general. However, certain deviations from this pattern reveal some distinctive features of the telephone service. The first element to consider is the presence of external effects. It is in fact notable how a supplementary user of a network produces benefits to existing subscribers, increasing their possibilities of contact - access externality. Also, the benefits produced by a communication are not only limited to the user who pays for the conversation - call (use) externality. In general, it is sought to take these effects into account by introducing a measurement of the size of the network. A further important element is the fact that telephone demand usually involves two components: that of access and that of usage, which should be evaluated simultaneously. In any case, a separate estimate of the latter should include a variable - the cost of access - which establishes the connection with the former. However, for empirical adjustments this element is usually omitted. A recent estimate of a model of this type, frequently quoted, is reported in Pacey (1983).

A special feature of telephone communication is that it involves the participation of two users to realise the potential of the service, and this can be considered in terms of production and exchange of information. This can happen in various forms, but here we will concentrate on two extreme cases. In the first, a telephone communication is used to transmit clearly defined information and, once the transmission has terminated, the

necessity of maintaining contact is exhausted. For example: one company supplies another with information concerning a client. At the other extreme we find those cases where the transmission of information involves a confirmation in the other direction: for example, for the verification of the identity of the caller. The interesting aspect here is that the treatment of information can to a greater or lesser extent involve some form of understanding between the two parties, outside of the communication itself. And this understanding can have certain effects on the course of the communication in both directions. Recently Larsen et al. (1991) presented an interesting modification for the specification of the demand function. They suggest taking this relationship between the parties into account through the introduction into the utility function - from which we derive the demand curve - of a variable related to information. More precisely, supposing that U(X,I) is the utility of a user, in relation to the amount of the composite good X and the information exchanged I, the following problem of optimisation can be defined:

$$\max_{(X,Q_{ij})} U(X,I)$$

with the conditions: $I = f(Q_{ij},Q_{ji})$

and $pX + qQ_{ij} = Y$

where:

Q_{ij} : communications from locality i to locality j
Q_{ji} : communications from locality j to locality i
Y : disposable income
p : price of composite good
q : cost of conversation.

The addition of a supplementary restriction concerning the classic formulation is to be noted. This can be considered a production function of information, with the volumes of the communications being considered as inputs. Resolving this programme, the demand function can be derived as:

$$Q_{ij} = g(X,p,q,Y,Q_{ji})$$

Similar reasoning applies to communications in the opposite direction. The special feature of this specification consists of the presence, in the single user function, of the communications which he receives in the opposite direction. A more detailed justification for a choice of this type is furnished by the authors (ibid., pp. 301-305), where the two above mentioned hypotheses are described as: the first - hypothesis of information content (when, once information has been transmitted, a reply is of no use), and the second - the hypothesis of reciprocity (when a return call is considered necessary). The validity of one of these hypotheses rather than the other should influence the sign of the parameter associated with the indicator of the volume of return communications. In the first case it would be negative; in the second positive. Probably both these hypotheses, or some intermediate form, could be valid under different conditions. Only an empirical estimation can indicate which of the two prevails. The estimations put forward by the above mentioned study, and also those we will present later, give clear preference to the second hypothesis. In the present context, bearing in mind that we are interested in evaluating the explicit impact of a reconciliation of tariffs between different countries, this specification seems particularly promising. It seems logical to presume that the effect

generated by the modification of tariff structures would have repercussions in various countries. The formulation adopted up to now would not identify these.

A simultaneous consideration of the flow in both directions is necessary to adjust this function. The model we refer to can be characterised in the following manner:

$$Q_{ij} = a_1 + b_1 Q_{ji} + c_1 q_{ij} + d_1 Y_i + e_1 M_{ij} + u_{ij} \qquad c_1 < 0,\ d_1, e_1 > 0$$

Q_{ij} : communications from country i to country j, measured in erlang. Data of 1987 issued by ITU, General Plan for the Development of the Interregional Telecommunication Network, Geneva, 1988. This data has been partly modified to eliminate transit traffic in various centres. Moreover, not all the data concerning single connections is available. The total number of observations,which should be 552 corresponding to a square matrix of dimension 24, without the elements on the diagonal, is reduced to 424.

Q_{ji} : communications from country j to country i, measured in erlang, id.

q_{ij} : cost of a conversation of three minutes from i to j, in $ 1989, from OECD, Communication Outlook, 1990.

Y_i : national disposable income pro capita in $ 1987, from UN, National Accounts Statistics, 1990.

M_{ij} : dimension of the communications network between i and j estimated on the basis of the product of the subscribers in i and j, 1987, from ITU,Yearbook of Statistics, 1988.

a_1, b_1, c_1, d_1, e_1 : parameters to be estimated.

All the variables are in logarithmic form; u_{ij} is a stochastic error. The second equation is similarly defined.

Unfortunately it has not been possible to reconcile the data on costs of conversations with that referring to the other variables. Our estimates therefore are still of a provisional nature and serve as an initial examination of this subject. Two stages least squares have been used for the adjustment. The data has been subdivided into two samples, to avoid using the same values for the flow in each direction. To estimate the effects of price modification we will use the reduced form to this model:

$$Q_{ij} = a^* + c_1^* q_{ij} + c_2^* q_{ji} + d_1^* Y_i + d_2^* Y_j + e^* M_{ij}$$

The coefficients c_1^* e c_2^* measure the direct and indirect effects of conversation charges.

3. EMPIRICAL RESULTS

Considering the variability resulting from the structural factors which can apply in each individual country, certain supplementary variables have been taken into account. These can act as a corrective. In particular, the effect of the distance between the two countries is evaluated, also the linguistic affinity existing between them, their proximity, and the time zones which separate them. None of them showed significant effects.

Considering that a test ($\chi^2 = 6.665$, df = 5, p = 0.247) has verified that there are no significant differences between the coefficients of the two estimated equations, we have repeated the estimate placing restrictions of equality on the parameters.

Table 2

Regression results		
	Structural Form	Reduced Form
Dependent variable	Flow I-J	Flow I-J
N of obs	212	
R-BAR**2	0.912	
Constant	-2.62	-9.68
	(-5.84)	
Dimension I-J	0.19	0.72
	(5.33)	
Tariff I-J	-0.58	-1.25
	(-5.29)	
Income I	0.11	0.23
	(3.83)	
Tariff J-I		-0.91
Income J		0.17
Flow J-I	0.73	
	(14.48)	

In Table 2 the results of these estimations are set out. They are limited to the values for one equation only. (Student's t are given in parenthesis). In general, it can be said that the estimates are satisfactory and most of the parameters reliable. The size of the coefficients of the inverse connections is analogous with the estimate of Larson et al., which does not necessarily represent a positive element, in view of the different context in which our analyses are conducted. It will be necessary to await further verification of this specification before being able to estimate which elements may affect the results and to formulate a more reliable judgement. The result would seem to confirm the prevalence of the hypothesis of reciprocity.

Table 3

Increments predicted by the model, in traffic and income (in percent)		
Countries	Traffic	Income
Australia	61	61
Austria	17	11
Belgium	23	10
Canada	28	26
Germany	32	24
Denmark	31	22
Spain	64	13
France	22	12
Finland	32	6
United Kingdom	28	12
Greece	40	12
Netherlands	26	23
Italy	82	14
Ireland	72	15
Iceland	114	14
Japan	18	5
Luxembourg	26	21
Norway	28	9
Portugal	31	10
Sweden	21	21
Switzerland	23	14
Turkey	186	22
United States	40	33
Totals	36	19

Our price elasticity comes out greater - if only by a small margin - than that estimated in the above-mentioned study by Larson. This fact is quite reliable, given the diverse segments of the market which are referred to in the two analyses. The elasticity is greater in international conversations, which supports the expectations formulated by Taylor (1983). Contrary to his indications, however, our estimates are somewhat inelastic, as a result of the presence of the variable concerning the return flow.
Comparison with the results of other studies is not always easy. The range of the estimates is quite considerable. One goes from a minimum of -0.25 in Pacey to a maximum of -1.7 in a study by Rea and Lage (1978). In the first instance, it must be remembered that the study concerns trunk communications; in the second, the estimates present a notable volatility on the various periods used for the adjustment, even if the authors offer justifications for this phenomenon. A study by Lago (1970), admittedly rather outdated, indicates an elasticity of -1.25, which corresponds to the parameter of our reduced form. And here, according to us, lies the real problem. Our estimate is more or less reliable - the question concerns the choice of the specification. The one most commonly used is a reduced form according to the perspective used in this study. When

we proceed to the evaluation of the direct effects of price modifications, we reach a conclusion similar to that which would have been obtained were we to have used Lago's formulation. However, we should also bear in mind the indirect effects which are not included in his model, and consequently the impact will be greater.

The parameter regarding income is to be considered as unsatisfactory. The absence of a distinction between private and business communications probably has a negative influence on this. Also Pacey, in her study on trunk communications in the United States, arrives at evaluations which show that income has only a slight influence. However, we do not share her optimism, in that the conclusion implicit in these results would lead one to expect limited evolution of telecommunications when there is a continuation of economic growth. This point is worthy of further consideration, if the statistical base could be extended over several periods.

Table 4

Predicted traffic: classification of countries		
	High Increment	Low Increment
Direct Increment	Spain, Greece, Italy, Ireland, Iceland, Turkey	Belgium, Finland, UK, Japan, Norway, Portugal
Indirect Increment	Australia, USA	Austria, Canada, Germany, Denmark, France, Netherlands, Luxembourg, Sweden, Switzerland

The interesting problem now consists of determining how far the tariff policies of single countries have come towards convergence on the international market, and what impact a complete alignment of tariffs would have in terms of volume of communications and income. Here we are concerned only with an evaluation of comparative static without considering the possible trajectories which could bring about such a convergence. Our hypothesis is relatively simple: supposing that, in the case of a difference in tariff between a communication in one direction and a communication in the other, the higher tariff were to be reduced to the level of the lower. Our calculations show how the global impact of these modifications remains - when all factors are considered - rather limited, as can be seen from Table 3. The increment is 36% regarding the intensity of traffic at peak hour, and reduces to 19% if one considers the volume of receipts. This latter figure is given purely for indicatory reasons. These are calculated on the supposition that the volume of conversations in minutes is proportional to the value in erlang. This presupposes that the average duration of the conversations, and the amount of peak hour traffic in respect of the daily total, are the same in all cases. This hypothesis is somewhat restrictive in such a context.

The differences between individual countries are, however, much more marked, especially in countries with high tariffs, such as Turkey, Iceland, Italy and Spain. For a

better overview of the situation resulting from delayed tariff adjustment in single countries, we have classified each one, as set out in the last Table. In this, two criteria must be taken into account: the scope of the modifications generated and their direct or indirect character. The first group consists of countries such as Turkey, Iceland, Ireland, Italy and, to a lesser extent, Spain and Greece, which still today impose tariffs that are noticeably higher than in other countries. Most of these countries are in the Mediterranean area. One country, however, which is excluded from this group is Portugal. The modifications which a tariff adjustment would produce on the volume of their communications is significant. However, it is necessary to keep in mind that these modifications of volume would be compensated by those resulting from the reduction of charges. In this case the effects would be indirect and modifications cannot be expected at the level of receipts.
Unfortunately this would not be an argument to put forward in an attempt to convince them to adjust their policy. The second group consists only of Australia and the United States. They are able to capitalize on the policy of reduced tariffs currently in force. The changes would be significant and, what is most important, could be completely reflected on the receipts. A third category of countries is represented by those which would also benefit from indirect increments, although these would not reach significant levels. The situation in some of these countries: for example, Germany, Denmark and Holland, is very close to that of the United States. A final group completes the picture: those countries which impose only slightly higher tariffs than average, and for this reason their situation would not change significantly.

These figures refer to the global situation of individual countries. If one considers the effects on single connections between one country and another, the picture further alters. We will try to summarize the most interesting aspects, on the basis of certain obvious criteria. Even limited changes in tariff can have noticeable repercussions among countries with a heavy volume of traffic. In this regard, we can cite the case of contacts between the United Kingdom and Germany. For this reason, tariff adjustment between the leading Central and Northern European nations, where differences currently exist, will have important consequences. If the tariff adjustment is very consistent, the effect is also clearly visible, even if the actual flow is not at a particularly high level. This is the case, for example, in communications between Canada and Italy. If the two effects were cumulative, the variations would be striking. Telephone traffic from Switzerland to Italy would increase by 43%, if the latter were to reduce its tariffs to the level of the former.

We return now to the fact that the statistics for conversation charges which we have used do not refer to the same period as the other variables. With the double-logarithmic form of the specification used, there should not be any disadvantage in this, if the evolution during the two years which separate the data has followed a similar pattern in all the countries. However, it is more likely that there has been a gradual convergence of countries with higher tariffs towards the others. Therefore one can make a final affirmation that the impact of a realignment of tariff structure should not have visible effects on the volume of telephone traffic, and even more so on receipts, in the area of the more developed countries. This is a consequence of the level of estimated elasticity and the fact that, in general, the tariffs are by now quite close.

CONCLUSIONS

In this study we have been able to present an estimate of a demand function for the use of international telephone services. It does not claim to reach a conclusive valuation. The chief weakness lies in the chronological disparity in the measurement of telephone tariffs in respect of the other variables. Also, in these cross-section analyses, structural components are present, the results of which cannot be kept sufficiently under control. One must wait for a chronological series of a particular duration, before being able to formulate the necessary adjustments. However, bearing in mind these limits, our analysis allows an evaluation of the dimension of the parameters in play. In particular, it seems that one can safely assume that the demand for services is not sufficiently elastic to stimulate substantial reductions in countries where tariff adjustments are delayed. The specification used, which introduces the effect of indirect communications in the valuations, brings a new element into account. This should generate a transfer of the benefits of eventual reductions to countries which first made the effort to reach an adjustment. In this case the main beneficiary would be the United States. The conclusion which should be drawn by each individual country is, therefore, not without a certain paradox. It should place itself ahead of the other countries. The effect on the volume of communication would be more or less guaranteed. The other countries would be forced to react and the benefits generated indirectly would gradually mature.

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