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Econometric Modelling of Spanish Very Long Distance Intenational Calling

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ECONOMETRIC MODELLING OF SPANISH VERY LONG DISTANCE INTERNATIONAL CALLING

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ABSTRACT

This study estimates a demand model for the outgoing telephone calling from Spain to a group of African and Oriental countries. The traffic to those countries is called very long distance calling because of the high tariffs applicable to all of them even when some of them are geographically not very distant. In this study a theoretical framework is used which takes into account the specific characteristics of the international long distance services and the socio-economic relationships between Spain and this group of countries.

The analysis of annual data for minutes of calling between Spain and 27 countries from 1982 to 1991, using panel data techniques, reveals a significant own-price elasticity of -1.31 and a positive reciprocal calling effect of +0.69. The estimated elasticity of the outgoing traffic to the volume of foreign tourism is +0.22. The estimated elasticities are in the range that is reported in other empirical studies. The favorite equation passes a battery of diagnostics.

RESUMEN

En este trabajo se estima un modelo para la demanda del tráfico telefónico que sale de España hacia un grupo de países de Africa y Oriente. Al tráfico hacia este grupo de países le llamamos tráfico de muy larga distancia por las altas tarifas que se les aplican, a pesar de que algunos de dichos países no están geográficamente muy distantes. En este estudio se usa un marco teórico que tiene en cuenta las características específicas del tráfico internacional y las relaciones socio-económicas entre España y los países de la muestra.

El análisis de los datos anuales de minutos de conversación entre España y un grupo de 27 países entre 1982 y 1991, usando técnicas de datos de panel, revela una elasticidad precio significativa de -1.31 y un efecto positivo de reciprocidad de la llamada de +0.69. La elasticidad estimada del tráfico con respecto al volumen de turismo es de +0.22. Todas las elasticidades estimadas están en el rango de valores obtenidos en otros trabajos empíricos. La ecuación seleccionada pasa una batería de diagnósticos.

The author is grateful to Telefónica de España for providing the telecommunication data.
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1. INTRODUCTION

The objective of this work is to develop an econometric model of the Spanish very long distance international calling. The common characteristic of the telephone traffic to the group of countries considered in this work is the very high tariffs applicable to them. In that sense, the traffic to all the selected countries can be considered very long distance international traffic even when some of them are geographically not very distant.

There exist several important reasons for studying the international telephone demand. First, its importance in terms of revenues. Second, because of the policy issues surrounding it. In fact, as in most countries, in Spain the prices are regulated by the government and subject to review. In that context, it would be very useful a better understanding of demand in order to: project future levels and usage patterns, estimate likely deficits or surpluses and examine the effects of alternative pricing policies on use, capacity, and on economic welfare. The purpose of the present paper is to contribute to such understanding, using annual data on the traffic between Spain and a group of 27 African and Oriental countries for the period 1982-1991.

The previous empirical studies in Spain about the international traffic demand have used either aggregate national data for the traffic from Spain to the rest of the world (Pérez-Amaral, 1993 and PNR & Associates, 1994), or data disaggregated by each of the 50 provinces of origin of the call (Garín and Pérez-Amaral, 1996a). There exists also a group of unpublished empirical studies, Telefónica (1992), that estimate the elasticities of the traffic from Spain to individual countries.

In this work, with regard to the disaggregation, I adopt a position in between those mentioned above. The object of the study is neither the traffic from Spain to the rest of the world (highest level of aggregation), nor the traffic from Spain to each of the different countries. In contrast, I use a panel data set consistig of 10 annual observations for a group of 27 countries. By using this type of data I estimate a single elasticity for the whole region and that could be advantageous for evaluating rate adjustments since from 1990 uniform rates have been established within the region. Furthermore, panel data offer many more degrees of freedom than time-series or cross-sectional data, and also allow to control for omitted variable bias and reduce the problem of multicollinearity, hence improving the accuracy of parameter estimates (Hsiao, 1986).

The same type of analysis developed in this study has been used by the author for modelling the telephone traffic from Spain to America (Garín, 1996). In a related paper, Garín and Pérez-Amaral (1996b), analyze a similar data set for the traffic from Spain to Europe.

Data sets of this type have been used in studies for other countries e.g.: Lago (1970), Rea and Lage (1978), Schultz and Triantis (1982), Appelbe el al. (1988), Acton and Vogelsang (1992), Appelbe et al. (1992) and Hsiao et al. (1993).

The rest of the paper is organized as follows. Section 2 presents the theoretical framework. The data is presented and analyzed in Section 3. Section 4 shows the econometric model and the estimation results. Section 5 presents a comparative analysis of the results of this and previous studies. The conclusions are summarized in Section 6.

2. THEORETICAL FRAMEWORK

In order to elaborate a telecommunications demand model it is important to have in mind the specific characteristics of this type of services. First, telecommunications consumption depends upon the interaction of at least two economic agents who jointly consume the service. Second, a telephone call is a shared service, but only one of the agents (the caller) pays for it. This is unconventional because both economic agents derive utility from the message. These specific characteristics of the telecommunications services make inappropiate the utilization of the standard consumer theory. For this reason, several studies have developed theoretical models for the telecommunications demand.

This paper is based on the model of Larson, Lehman and Weisman (1990) for long distance telephone traffic demand. The authors assume that information yields utility to individuals, not telephone calls per se. They develop their model taking into account the characteristic of joint consumption of the telecommunications services.

The model considers an economic agent with access to the telephone network. This agent derives utility from information and a composite good. Information is produced from incoming and outgoing long distance calls. Assuming that: 1) there is only a long distance traffic route with endpoints A and B and, 2) the agent is located at point A, then the agent's optimization problem is:

$$\begin{aligned} & Max \;\; U^A (X^A, I^A) \\ & s.t.\; I^A = f(Q_{AB}, Q_{BA}) \\ & p^A X^A + q^A Q_{AB} = M^A \end{aligned} \qquad (1)$$

where U^A is the utility function of the agent located at point A and the variables are:

X^A Quantity of composite good.
Q_{AB} Telephone traffic from point A to point B.
Q_{BA} Telephone traffic from point B to point A.
I^A Information produced as a function of Q_{AB} and Q_{BA}.
M^A Income
p^A Price of composite good.
q^A Price of the long distance traffic.

The Lagrangian function for (1) is:

$$L = U^A \, [X^A, f(Q_{AB}, Q_{BA})] - \lambda (M^A - p^A X^A - q^A Q_{AB}) \qquad (2)$$

where λ is the Lagrangean multiplier.
The first order conditions for (1) are:

$$U^A_{x^A} + \lambda p^A = 0 \qquad (3)$$

$$U^A_I f_{Q_{AB}} + \lambda q^A = 0 \qquad (4)$$

$$p^A X^A + q^A Q_{AB} = M^A \qquad (5)$$

where subscripts denote partial derivatives (except those of Q_{AB} and Q_{BA}).
These conditions imply:

$$\frac{U^A_x}{U^A_I f_{Q_{AB}}} = \frac{p^A}{q^A} \qquad (6)$$

meaning that the marginal rate of substitution between X^A and Q_{AB} equals the price ratio. From (6), the general form of the traffic demand equation is:

$$Q_{AB} = W(X^A, p^A, q^A, M^A, Q_{BA}) \qquad (7)$$

This equation reveals that the proper specification of a traffic demand model from A to B must include as explanatory variables, not only all the variables usually included but also the traffic generated in the reverse direction.

The traffic demand originated at point B and terminating at point A may be determined in a similar manner. The agent at B faces the optimization problem:

$$Max \quad U^B (X^B, I^B)$$

$$s.t.: I^B = g(Q_{AB}, Q_{BA})$$

$$p^B X^B + q^B Q_{AB} = M^B \qquad (8)$$

where g is the production function for information of agent B.

The maximization in (8) yields the long distance demand function

$$Q_{BA} = Z(X^B, p^B, q^B, M^B, Q_{AB}) \qquad (9)$$

Equation (7) describes agent A's demand as a function of agent B's calls, while equation (9) describes agent B's calls as a function of agent A's calls. A Nash equilibrium is attained by the simultaneous solution of equations (7) and (9). For that reason, estimation of point-to-point traffic demand requires to estimate simultaneously these two demand equations, taking explicitly into account the influence of incoming traffic on outgoing calls.

The first restriction of the maximization problem (1) is a production function where information is the output whereas incoming and outgoing traffic are the inputs. There are several hypotheses regarding the substitutability between inputs in the production of information. First, at one extreme, those inputs are considered as complementary inputs. This is the hypothesis of reciprocity of the calls. Under this hypothesis, information is only generated when there is traffic in both directions. At the other extreme is the hypothesis of the information content of the calls. In this case, any message (incoming or outgoing) generates information. The estimated sign of Q_{BA} in (7) will give us an idea of the substitutability between incoming and outgoing calls.

Equations (7) and (9) are the individual long distance telephone traffic demands. In order to construct the corresponding aggregate demand equations it is important to take into account the number of individual economic agents with access to the telephone network, that means, the number of main lines in the country of origin of the calls.

The utilization of point to point demand models allows to include as explanatory variables a group of variables that approximate the community of interest between the countries considered. It would be expected that the greater the community of interest between two countries, the greater the amount of telephone traffic between them. Previous models of international traffic have used market size as a proxy for the community of interest between

countries. However, community of interests may be more related to a group of variables that measure the economic and social relationships between countries. Those variables can include: tourism, foreign residents, language communality, and so on.

3. THE DATA

3.1. Type of data

In this study I examine annual telephone traffic from Spain to a group of 27 African and Oriental countries over the period 1982-1991. The data on amount of traffic (incoming and outgoing minutes of conversation) have been provided by Telefónica and are disaggregated by countries of origin or destination of the traffic. However, the data is available in greater aggregation than it would be desirable: they include all customer groups, and they do not distinguish the rating period in which the call was placed. The number of main lines in Spain during each year of the sample has also been provided by Telefónica.

The price variable used in this analysis is the price faced by customers (including taxes) of a three minutes call at the standard daytime rate schedule. With the available data it is not possible to distinguish the time of the day in which the call was placed. For that reason it has been impossible to construct a weighted average price index and the price index corresponding to the standard daytime rate schedule has been used. However this approximation can be reasonable since most of the telephone traffic to these countries is business traffic and is probably generated during business hours. Deflation of the nominal prices is based on the consumer price index (CPI) published by the Instituto Nacional de Estadística (INE).

Data corresponding to the tourism variable have been collected, also, from INE. Finally, data on volume of trade (value of imports plus exports) have been provided by the Dirección General de Aduanas.

3.2. Description of the data

This section is devoted to a brief overview of the volume of traffic between Spain and the countries of the sample. Changes in prices of this service during the sample period are, also, presented.

The 27 countries of the sample concentrate approximately 3% of the total number of minutes of outgoing international telephone traffic from Spain in 1991. Even when this percentage of the total traffic is relatively small it is important to know the behavior of the traffic with these countries for two reasons. First, prices of this service are going to decrease significatively in the near future. Second, the traffic to this group of countries is growing more quickly than with any other region.

It is worth mentioning that the volume of calling is very heterogeneously distributed between the countries of the sample. Table 1 shows a list of countries ordered by their importance as destination of the telephone traffic generated in Spain. Notice that the traffic is highly concentrated by countries of destination. Only four countries concentrate more than half (52.61%) of the traffic with the whole group.

TABLE 1
Countries of destination of traffic by participation on the traffic to the whole region

Australia	21.34	Pakistan	1.56
Japan	17.77	Indonesia	1.42
Israel	8.19	Thailand	1.28
India	5.31	Nigeria	1.18
South Korea	4.98	Lybia	1.15
Philippines	4.74	Ivory Coast	0.91
Egypt	4.53	Syria	0.89
China	4.36	Lebanon	0.75
Arabia	4.34	Cameroon	0.51
South Africa	3.53	Kenya	0.50
Taiwan	2.95	Bahrein	0.44
Senegal	2.77	Liberia	0.21
Jordan	2.17	Gabon	0.10
Iran	2.12		

Self-constructed. Data corresponding to 1991. The values are percentages of the total traffic of the whole group.

During the period of 1982-1991, the volume of traffic from Spain to this group of countries (measured in minutes of conversation) has increased substantially partly because of the decrease in real prices, the increase in the quality of communications and other factors. On average, the traffic from Spain to the considered region increases at an annual compound rate of 18.48 % over the sample period[1]. However, the rates of increase have been very heterogeneous for the different countries. Table 2 contains a list of countries ordered by the traffic increases. It is worth mentioning the very fast increase of the outgoing traffic from Spain to several countries, especially China and Australia.

1 The annual rate of increase of the telephone traffic from Spain to Europe for the same period was 13.25%. The corresponding rate of increase of the traffic to America was 16.1%.

TABLE 2
Destination countries by annual rate of increase in minutes of conversation from Spain

China	81.31	Indonesia	16.65
Australia	38.87	Egypt	16.26
Pakistan	31.94	South Africa	15.89
Jordan	29.57	Cameroon	14.71
Thailand	29.04	Ivory Coast	11.01
Japan	25.76	Liberia	9.96
India	24.08	Lybia	9.96
South Korea	23.96	Nigeria	9.54
Taiwan	22.69	Arabia	3.05
Kenya	22.16	Lebanon	1.66
Senegal	21.66	Syria	0.01
Israel	19.92	Iran	-1.24
Bahrein	18.25	Gabon	-1.76
Philippines	16.88		

Self-constructed. Period 1982-1991. The values are percentages.

In order to analyze the reciprocity of the telephone traffic between Spain and the countries of the sample, the ratio outgoing to incoming traffic based on the data of the last year of the sample is constructed. Table 3 shows the evolution of that ratio for the most important countries in terms of destination of traffic.

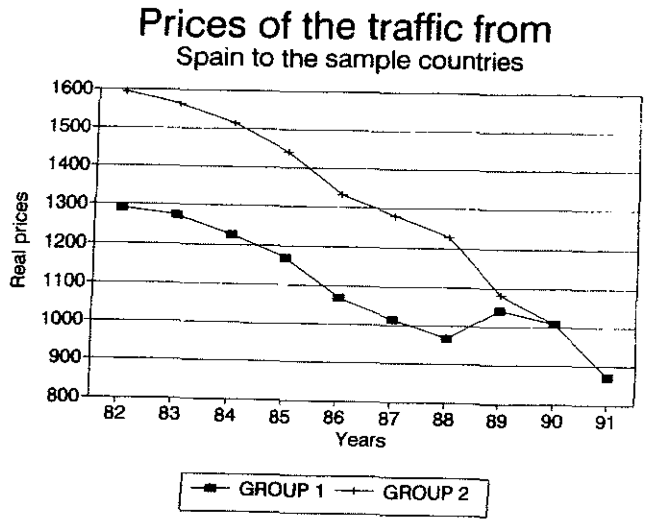
TABLE 3
Outgoing minutes / incoming minutes

YEAR	AUSTRALIA	JAPAN	ISRAEL
1982	0.41	1.09	1.17
1983	0.42	1.20	1.51
1984	0.22	1.11	1.85
1985	0.45	0.97	1.09
1986	0.39	0.90	1.17
1987	0.51	0.90	0.94
1988	0.60	0.93	0.93
1989	0.63	1.03	0.98
1990	1.31	0.86	1.19
1991	2.47	0.74	1.11

Self-constructed. Traffic measured in minutes of conversation.

The prices of this service have been decreasing substantially in nominal and real terms over the sample period. From 1982 to 1989 the countries of the sample were assigned to two different groups or tariffication areas. In the first group (Arabia, Bahrein, Israel, Iran, Jordan, Lebanon, Syria, Egypt, Liberia, and Lybia) prices in real terms have decreased by 32.61% between 1982 and 1991. For the second group of countries (China, South Korea, Philippines, India, Indonesia, Japan, Pakistan, Thailand, Taiwan, Cameroon, Ivory Coast, Gabon, Kenya, Nigeria, Senegal, South Africa and Australia) the decrease in real prices has been 48.38%. Figure 1 shows this evolution.

FIGURE 1



4. MODEL SPECIFICATION AND EMPIRICAL RESULTS

The empirical model has been constructed using the theoretical framework shown in Section 2 and taking into account a group of previous empirical studies such as Lago (1970), Yatrakis (1972) and Rea and Lage (1978). All these authors were pionners in the study of international telecommunications demand and their works are summarized in Taylor (1994).

By using a double-logarithmic form, the model is as follows:

$$\ln OUTLIN_{it}^{A} = \alpha_i + \beta_1 \ln INLIN_{it}^{A} + \beta_2 \ln PR_{it}^{A} + \beta_3 \ln TRADE_{it}^{A} + \beta_4 \ln TOUR_{it}^{A} + u_{it}^{A} \qquad (10)$$

$$\ln OUTLIN_{it}^{B} = \delta_i + \gamma_1 \ln INLIN_{it}^{B} + \gamma_2 \ln PR_{it}^{B} + \gamma_3 \ln TRADE_{it}^{B} + \gamma_4 \ln TOUR_{it}^{B} + u_{it}^{B} \qquad (11)$$

where the variables in equations (10) and (11) are:

$OUTLIN^{A}_{it}$	Number of minutes of outgoing international telephone traffic per line from Spain to country i in year t.
α_i	Non observable individual characteristics of the traffic from Spain to country i.
$INLIN^{A}_{it}$	Number of minutes of international incoming telephone traffic per line from country i in year t.
PR^{A}_{it}	Real price of a 3 minutes international call from Spain to country i in year t.
$TRADE_{it}^{A}$	Volume of trade (imports + exports) between Spain and country i in year t.
$TOUR^{A}_{it}$	Number of tourists in Spain from country i in year t.
u^{A}_{it}	Random error term.
$OUTLIN^{B}_{it}$	Number of minutes of international telephone traffic per line from each country to Spain in year t.
δ_i	Non observable characteristics of the traffic from each country to Spain.
$INLIN^{B}_{it}$	Number of minutes of international incoming telephone traffic per line from Spain to country i in year t.
PR^{B}_{it}	Real price of a 3 minutes international call from country i to Spain in year t.
$TRADE_{it}^{B}$	Volume of trade between Spain and country i in year t.
$TOUR^{B}_{it}$	Number of tourists from Spain in country i in year t.
u^{B}_{it}	Random error term.

i = 1, ..., 27 countries; t = 1982, ..., 1991 years; number of observations = 270.

Equation (10) is the demand for outgoing traffic from Spain to the considered countries, and equation (11) is the demand for traffic from the group of African and Oriental countries to Spain. Given the availability of data it has been impossible to estimate the second equation [equation (11)] of the simultaneous equations model. For that reason, we have concentrated in the first equation [equation (10)] where the traffic demand from A to B is formulated.

The dependent variable which is used in this study is the average traffic per line from Spain to the countries of the sample. The explanatory variables are: the average incoming traffic per line (by country of origin of the call), the real price of the service, the volume of trade between countries and the number of tourists in Spain by countries of origin. By using the number of lines in the denominator of the dependent variable I am imposing the restriction that the elasticity of the amount of international traffic to the number of lines is one. This constraint is tested in the Appendix and is not rejected by the data.

An important issue in panel data analysis is how best to control for unobserved individual heterogeneity to avoid biasing the coefficient estimates of included explanatory variables and improve the efficiency of parameter estimates. Therefore, I experiment with various ways to model route specific effects. Table 4 shows the coefficient estimates obtained under different assumptions on individual heterogeneity.

TABLE 4
Log of number of minutes of outgoing international telephone traffic per line

EXPLANATORY VARIABLES	(1) OLS	(2) WITHIN GROUPS	(3) GLS	(4) ORTHOGONAL DEVIATIONS	(5) ORTHOG. DEVIAT. with I.V.
ln INLIN	0.41 (17.08)	0.49 (13.08)	0.45 (14.80)	0.71 (9.48)	0.69 (12.40)
ln PR	-1.21 (-9.43)	-1.09 (-8.72)	-1.17 (-10.29)	-0.66 (-3.75)	-0.69 (-4.70)
ln TRADE	0.08 (5.25)	0.09 (2.12)	0.09 (3.49)	-0.02 (-0.44)	-----
ln TOUR	0.34 (15.36)	0.19 (3.06)	0.29 (7.94)	0.11 (1.45)	0.12 (1.74)
R^2	0.90	0.94	0.93	-----	-----
Wald test of joint significance	-----	-----	-----	423.70 DF = 4	456.69 DF = 3
Standard error of regression	0.37	0.29	0.31	0.30	0.29
M1 M2	----- -----	8.174 4.006	----- -----	8.696 7.238	8.950 7.458
Instruments	-----	-----	-----	-----	ln INLIN(-1)

Note: t-ratios in parentheses. M1 and M2, are respectively first and second order autocorrelation tests. DF: degrees of freedom. Hausman test for fixed versus random effects: 5.76 (critical value: 13.3).

The results in column (1), corresponding to ordinary least squares, restrict all the coefficients to be the same for all the traffic routes. The OLS model assumes that the traffic to all the countries of the sample react in the same manner to a change in the values of the explanatory variables and that the non-observable characteristics are the same for all the traffic routes and constant in the temporal dimension. However, the implicit assumption of constant intercept and slope coefficients may not always hold for the different countries.

One way to address the problems resulting from constraining the intercept and slope coefficients to be equal for the different cross sections is by allowing the intercepts to vary. The estimates in columns (2) to (5) correspond to the assumption that the slopes are equal across traffic routes, but allows for each route to have its own unique intercept. Models of this type are widely used when working with panel data since they represent a simple and reasonable alternative to the assumption that all the parameters take on the same values for all individuals and for all periods (Hsiao, 1986). The results in columns (2) and (3) differ in the assumption concerning the non-observable individual effects. In (2), the individual effects are treated as fixed (fixed effects model), whereas in (3) they are considered random and form part of the error term

(error components model). Under the fixed effects assumption, the within groups estimator is the best unbiased estimator, while under the random effects hypothesis the most efficient unbiased estimator is the generalized least squares estimator, provided that the specific random effects are uncorrelated with the explanatory variables. When this is not the case, the generalized least squares estimator (GLS) becomes inconsistent, and one must resort to an estimator which both eliminates the permanent effects and permits consistent estimation of the coefficients of the other regressors.

A way of detecting correlation between individual effects and regressors is the Hausman test, which measures the distance between the estimations of the fixed effects and random effects models. The difference should be small if the individual effects are uncorrelated with the explanatory variables. A large difference, however, would suggest correlation between errors and regressors and the GLS would be inconsistent. In the present case, the chi-square statistic for the Hausman test is 5.76, which is insignificant when compared with the critical value of χ^2_4 =13.3. In this case, even when the Hausman test suggests to select the random effects model, there exists an additional problem which is the simultaneity between incoming and outgoing traffic. That makes necessary to use instrumental variables for the incoming traffic. The results of column (4) belongs to that case where the instrumental variable used for the INLIN variable is its own value lagged one year.

In column (4) all the variables appear in an orthogonal deviations transformation (Arellano and Bover, 1995). That transformation means that we substract from each observation the standardized mean of the future values of that variable for the considered country. By using orthogonal deviations we are eliminating the specific characteristics of each country and that allows us to estimate consistently the coefficients of the rest of the variables. At the same time, in order to avoid the possible bias in the estimated coefficients, instrumental variables are used to control for the simultaneity between OUTLIN and INLIN. The results of column (4) show that the TRADE variable, which was significant in columns (1), (2), and (3), is not significant anymore. For that reason this variable is eliminated of the specification and the results are shown in column (5) of Table 4.

After selecting specification (5), I interpret the estimated coefficients. Because of the double-logarithmic funcional form of the model, the estimated coefficients are directly elasticities. However, these are impact elasticities and they are only measuring the first effect on the outgoing traffic of a given change in the explanatory variables. Those values are ignoring the effects that any change in the explanatory variables will have on the volume of outgoing traffic through the simultaneous change of the volume of incoming traffic.

Incoming minutes of conversation per line turn out significant, with a coefficient of +0.69. This supports the hypothesis of incomplete substitutability between calls in each direction and suggests the existence of a positive reciprocal calling effect.

The other relevant variable when explaining the outgoing telephone traffic from Spain to these countries is the volume of tourism. The estimated impact elasticity is +0.12.

In order to obtain the total effect of a change in any of the explanatory variables it is necessary to construct the reduced form equation corresponding to equations (10) and (11). The reduced form of our model of simultaneous equations will be:

$$\ln OUTLIN_{it}^{A} = \alpha_i + \beta_1 [\delta_i + \gamma_1 \ln INLIN_{it}^{B} + \gamma_2 \ln PR_{it}^{B} + \gamma_3 \ln TRADE_{it}^{B} + \gamma_4 \ln TOUR_{it}^{B} + u_{it}^{B}] + \beta_2 \ln PR_{it}^{A} + \beta_3 \ln TRADE_{it}^{A} + \beta_4 \ln TOUR_{it}^{A} + u_{it}^{A} \quad (12)$$

Given that the traffic received in Spain with origin in the group of African and Oriental countries is equal to the outgoing traffic from that group of countries to Spain, in equation (12) we may substitute $INLIN^B$ by $OUTLIN^A$ and the new equation for the reduced form will be:

$$\ln OUTLIN_{it}^{A} = \alpha_i + \beta_1 [\delta_i + \gamma_1 \ln OUTLIN_{it}^{A} + \gamma_2 \ln PR_{it}^{B} + \gamma_3 \ln TRADE_{it}^{B} + \gamma_4 \ln TOUR_{it}^{B} + u_{it}^{B}] + \beta_2 \ln PR_{it}^{A} + \beta_3 \ln TRADE_{it}^{A} + \beta_4 \ln TOUR_{it}^{A} + u_{it}^{A} \quad (13)$$

From equation (13), in order to obtain the total effect of a change in price on the volume of outgoing traffic we can proceed in the following way:

$$\frac{\partial \ln OUTLIN_{it}^{A}}{\partial \ln PR_{it}^{A}} = \frac{\beta_2}{1 - \beta_1 \gamma_1} \quad (14)$$

Assuming that the reciprocal calling effect is equivalent in both directions $(\beta_1 = \gamma_1)$ we obtain for our data an own-price total effect of -1.31.

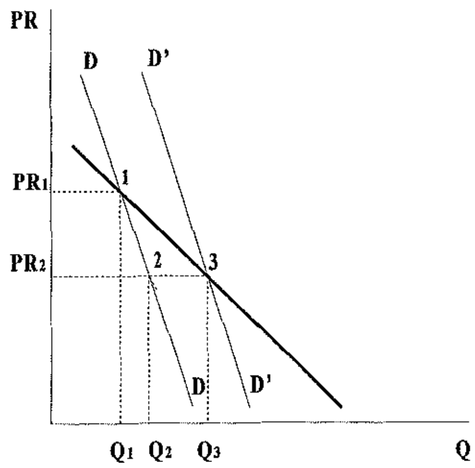
The total effect on the outgoing traffic of a change in the volume of tourism can be obtained in a similar manner:

$$\frac{\partial \ln OUTLIN_{it}^{A}}{\partial \ln TOUR_{it}^{A}} = \frac{\beta_4}{1 - \beta_1 \gamma_1} \quad (15)$$

and the estimated total effect in our case will be +0.22.

Figure 2 shows the difference between the two values of the price elasticity just mentioned. DD is the representation of equation (10) and shows the demand curve for the outgoing traffic from Spain to the considered countries. This curve has been constructed for a given amount of incoming traffic, $INLIN = INLIN_1$. When the real price of this service decreases from PR_1 to PR_2, the quantity demanded will increase from Q_1 to Q_2. That movement is the impact effect of a change in prices and its estimated value in this work is -0.69. However, when prices decrease the INLIN variable will increase ($INLIN = INLIN_2$) and the new demand curve will be D'D'. With D'D' and PR_2 the quantity demanded will be Q . The effective demand curve will pass through points 1 and 3 of the picture. The price elasticity estimated for this effective demand curve has been -1.31.

FIGURE 2



The estimates of this study can be considered long run elasticities and the equation should be considered a long run equation, which might justify the existence of serial correlation in the errors. The modelling of the short run dynamics would probably require quarterly data which are currently unavailable. The Appendix contains a battery of diagnostics of the selected equation. These diagnostics consist of tests for omitted variables and stability of the coefficients across traffic routes. These diagnostics suggest that the equation is adequate for estimation, inference and forecasting.

5. COMPARATIVE ANALYSIS OF THE RESULTS

In order to compare the results of this and previous studies, it is important to have in mind the differences between the different countries, periods of time and the types of data. Table 5 summarizes the results of this study and previous empirical works.

For the case of Spain, there exist previous studies referred to the international traffic with the rest of the world as a whole. These studies estimate price elasticities of -0.42 (Pérez-Amaral, 1993) and -0.77 (Garín and Pérez-Amaral, 1996). There also exists an study of the traffic from Spain to Africa and Asia (Telefónica, 1992) which found a price elasticity of -1.15 which is close to the elasticity estimated in this work.

TABLE 5
Price elasticities of international telephone traffic.

STUDY	DEPENDENT VARIABLE	PRICE ELASTICITY	INCOME ELASTICITY	TYPE OF DATA
TELEFONICA (1992)	N. of minutes Spain - Africa and Asia	-1.15	-	T.S. monthly 1981-1991
PEREZ-AMARAL (1993)	N. of meter counts Spain (residential)	-0.42 (-0.19)	2.46 (0.30)	T.S. quarterly 1980-1991
GARIN AND PEREZ-AMARAL (1996a)	Revenue of outgoing traffic from Spain	-0.77 (0.08)	0.63 (0.09)	Panel annual: 1985-1989 50 provinces
GARIN (1996)	Minutes of outgoing traffic from Spain to America	-0.53 / -0.65 (0.08) / -	-	Panel annual: 1981-1991 19 countries
GARIN AND PEREZ-AMARAL (1996b)	Minutes of outgoing traffic from Spain to Europe	-0.32 / -0.81 (0.08) / -	-	Panel annual: 1981-1991 24 countries
GARIN (present study)	Minutes of outgoing traffic from Spain to Asia and Africa	-0.69 / -1.31 (0.06) / -	-	Panel annual: 1982-1991 27 countries

Note: Standard deviations in parentheses. A dash refers to a corresponding value not specified in the study. T.S.: Time Series. When there are two values in the same line, the first one is short run and the second long run elasticity.

There also exist two previous studies of the international telephone traffic from Spain which use a similar theoretical model and panel data techniques. One of those studies, Garín and Pérez-Amaral (1996b), is about the telephone traffic with Europe. The other study, Garín (1996), is a model for the telephone traffic with America. The short run price elasticities are -0.32 and -0.53 respectively. The different estimated price elasticities of the Spanish international traffic for the different regions agree with the expectations we had. In fact, one would expect that the lower the prices, the lower the price elasticity. And that is what happens. The region subject to the lowest prices is Europe, followed by America and, finally, the group of countries considered in this paper. And the absolute values of the price elasticities follow the same ranking (Europe: -0.32, America: -0.53, African & Oriental countries: -0.69). However, if we compare the total effect on the volume of outgoing traffic of a change in price taking into account the simultaneous change of the volume of incoming traffic we find a different ranking. The traffic with the group of African & Oriental countries is, again, the most sensitive to price changes (-1.31). However, when measuring the total effect, the traffic with Europe is more elastic than the traffic to America (-0.81 vs. -0.65). This result may be explained because the reciprocal calling effect is larger for the case of Europe than for the traffic to America.

6. CONCLUSIONS

Demand functions for outgoing international telephone traffic from Spain to a group of African and Oriental countries are estimated using a cross-section/time series data set corresponding to 27 countries for the period 1982-1991.

Using the log of the number of minutes per line of outgoing traffic as the dependent variable, I estimate a total own-price elasticity of -1.31. This means that in the present moment, when there is a tendency to decrease tariffs, a reduction of the tariffs would imply an increase of the revenues of the operating company.

Another result is the existence of a "reciprocal calling effect" with an estimated value of 0.69. Other relevant factor when explaining the outgoing traffic from Spain to this group of countries is the number of foreign tourists in Spain. This variable presents an elasticity of 0.22.

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APPENDIX

Diagnosis of the model

Once column 5 in Table 4 has been selected as the preferred specification and estimation technique, a battery of diagnostics is performed in order to explore the validity of the assumptions which have been used as the basis of the estimation.

Omitted variables tests

Here I present the results of Wald's tests of omitted variables in order to test if there are some variables which have not been included in the model and whose inclusion could be justified from a theoretical point of view. This is the case for the following variables:

GDP_{it} Gross Domestic Product of Spain. Being this a measure of the level of economic activity of the country, a positive sign for this coefficient would be expected.

LIN_{it} Number of lines in Spain during each year. It is used to test the constraint that the lines have a coefficient of one, imposed in the estimation.

Table 6 shows the results derived from Wald's tests.

TABLE 6

Omitted variables tests.

VARIABLE	COEFFICIENT	t-RATIO
ln GDP	- 0.11	-0.21
ln LIN	-0.19	-0.48

In this table, it is observed that ln GDP is insignificant. On the other hand, the insignificance of ln LIN suggests the validity of the constraint of the unit value of the lines coefficient.

Test of stability across routes

To implement this diagnostic I divide the sample and compare the estimated coefficients in the different subsamples with those estimated using the whole sample. In this case, we have alternatively considered two groups. Group 1 contains all the countries with the exception of

Australia and Japan, therefore eliminating 40% of the total traffic to this region. Group 2 contains the 15 most important routes in terms of minutes of traffic.

TABLE 8

Stability across routes.

VARIABLES	TOTAL	GROUP 1	GROUP 2
ln INCLIN	0.69 (12.40)	0.71 (12.29)	0.68 (8.57)
ln PR	-0.69 (-4.70)	-0.53 (-3.44)	-0.85 (-3.34)
ln TOUR	0.12 (1.74)	0.09 (1.15)	0.13 (1.12)

Note: t-ratios in parentheses.

In Table 8, one can see that the estimated coefficients for Groups 1 and 2 are very similar to the ones estimated for the whole sample.