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A MODEL OF SPAIN-EUROPE TELECOMMUNICATIONS

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ABSTRACT

In this study we present a model for the outgoing telephone traffic from Spain to a group of 24 European countries. The model incorporates the specific characteristics of the international long distance service and the socio-economic relationships between Spain and this group of countries. Using annual panel data for the period 1981-1991, we estimate a significant elasticity of the minutes of outgoing traffic per line with respect to its own real price of -0.81. Other significant variables are: the volume of trade, the number of visitors from each country, the number of foreign residents and the minutes of incoming traffic. This last variable measures the so-called reciprocal calling effect which is highly significant with a positive elasticity of 0.78. Appropriate panel data techniques are used for controlling for individual specific unobservable variables and correcting for possible simultaneity between incoming and outgoing traffic. A battery of diagnostics suggest that the model is appropriate for estimation and inference.

RESUMEN

En este trabajo presentamos un modelo de la demanda del tráfico telefónico que sale de España hacia un grupo de 24 países europeos. El modelo incorpora las características específicas del servicio telefónico de larga distancia y las relaciones socio-económicas entre España y el grupo de países considerado. Utilizando un panel anual de datos para el período 1981-1991, estimamos una elasticidad significativa del número de minutos de conversación por línea con respecto a su propio precio de -0.81. Otras variables significativas son: el volumen de comercio, el número de visitantes de cada país, el número de residentes legales en España y el tráfico telefónico de entrada. Esta última variable mide el efecto de reciprocidad de las llamadas que resulta ser altamente significativo con una elasticidad positiva de 0.78. Se utilizan las técnicas apropiadas de datos de panel para controlar los efectos específicos individuales así como las variables no observables. Se corrige la posible simultaneidad entre tráfico de entrada y tráfico de salida. Una batería de diagnósticos sugiere que el modelo es apropiado para estimación e inferencia.

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1. INTRODUCTION

The aim of this work is to develop an econometric model of the demand for outgoing telephone traffic from Spain to Europe. There exist several important reasons for studying 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 periodic revisions. In this context, it would be very useful to have 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 24 European countries for the period 1981-1991.

Previous empirical studies of the international traffic demand in Spain have used either aggregate national data for the traffic from Spain to the rest of the world [Pérez-Amaral (1993), PNR & Associates (1994)], or data disaggregated by each of the 50 provinces of origin of the call (Garín and Pérez-Amaral, 1995). 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, we 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 one of the different countries (lowest). In contrast, we use a panel data set consisting of 11 annual observations for a group of 24 European countries. By using this type of data we estimate a single elasticity for the whole region and that could be advantageous for evaluating rate adjustments given that very similar rates are established within the region. Furthermore, panel data offer many more degrees of freedom than time-series or cross-section data, and allow to control for omitted variable bias and reduce the problem of multicollinearity, hence improving the accuracy of parameter estimates (Hsiao, 1986). In Garín (1996a) the demand for telephone traffic from Spain to America is analysed using an analogous panel data set.

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 et 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 contains the theoretical framework. The data are presented and analysed 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 bear 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 telecommunications services make the utilization of standard consumer theory inappropriate. For this reason, in recent years, several studies have developed a theoretical framework for 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 is assumed to derive 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:

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

where the superindex A refers to a consumer located at point A and the variables are:

- U Utility of the consumer.
- X Quantity of composite good.
- Q_{AB} Quantity of telephone traffic from point A to point B.
- Q_{BA} Quantity of telephone traffic from point B to point A.
- I Information produced as a function of Q_{AB} and Q_{BA} .
- M Income
- p Price of composite good.
- q Price of the long distance traffic.
- f Production function for information.

The Lagrangian function for (1) is:

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

where λ is the Lagrangean multiplier.

The first order conditions for (1) are:

$$U_{X^A}^A + \lambda p^A = 0 \quad (3)$$

$$U_I^A f_{Q_{AB}} + \lambda q^A = 0 \quad (4)$$

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

where subscripts denote partial derivatives (except those of Q).

These conditions imply:

$$\frac{U_X^A}{U_I^A f_{Q_{AB}}} = \frac{p^A}{q^A} \quad (6)$$

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:

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

This equation reveals that the specification of a traffic demand model from A to B must include as explanatory variables, not only the variables usually included but also the amount of 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:

$$\begin{aligned} \text{Max } U^B(X^B, I^B) \\ \text{s.t. } I^B = g(Q_{AB}, Q_{BA}) \\ p^B X^B + q^B Q_{AB} = M^B \end{aligned} \quad (8)$$

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

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

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

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 is, 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 (Rohlfs, 1974). 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 on 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 include: tourism, foreign residents, language communality, and so on.

3. THE DATA

3.1. Type of data

In this study we examine annual telephone traffic from Spain to 24 European countries over the period 1981-1991. We measure the amount of traffic by the number of minutes of conversation between a given country and Spain. The data have been provided by Telefónica. They are disaggregated by countries of origin or destination of the traffic. However, the data are available in greater aggregation than would be desirable: they include all customer groups, and do not distinguish the rating period during which the call was placed.

The number of main lines in Spain has also been provided by Telefónica. The price variable used in this analysis is the price faced by customers of a three-minute call at the standard daytime rate schedule. Deflation is based on the consumer price index (CPI), published by the Instituto Nacional de Estadística (INE).

Socioeconomic data corresponding to other explanatory variables (tourists and residents) have also been obtained from INE. The volume of trade between countries has been constructed adding the values of imports plus exports provided by the Dirección General de Aduanas, and deflating them with the CPI.

3.2. Description of the data

This section gives a brief overview of the volume of traffic between Spain and Europe and its evolution. Changes in prices of this service during the sample period are also presented.

The 24 countries of the sample concentrate approximately 82% of the total number of minutes of outgoing international telephone traffic from Spain in 1991. However, the minutes of calling are very heterogeneously distributed between the countries of the sample. Table 1 shows a list of countries by their importance as destination of the traffic generated from Spain. Notice that the traffic is highly concentrated by countries of destination. France, Germany and United Kingdom concentrate 60.63% of the traffic from Spain to Europe in 1991.

TABLE 1
European countries by minutes of outgoing traffic from Spain in 1991

France	23.89 %	Norway	0.97 %
Germany	18.79 %	Finland	0.65 %
United Kingdom	17.95 %	Greece	0.43 %
Italy	9.45 %	Poland	0.31 %
Netherlands	5.52 %	Yugoslavia	0.26 %
Switzerland	5.47 %	Turkey	0.25 %
Portugal	4.79 %	Czechoslovakia	0.22 %
Belgium	4.57 %	Hungary	0.15 %
Sweden	2.38 %	Bulgaria	0.07 %
Denmark	1.39 %	Iceland	0.07 %
Ireland	1.27 %	Cyprus	0.05 %
Austria	1.07 %	Malta	0.02 %

Self-constructed with data from Telefónica. Percentage of outgoing minutes to each country over the total number of minutes to Europe.

During the period 1981-1991, the volume of traffic from Spain to Europe (measured in minutes of conversation) has increased substantially partly because of the decrease in real prices, and other factors that we analyse in this paper. On average, the traffic from Spain to Europe increases at an annual compound rate of 13.25% over the sample period. Table 2 contains a list of countries ordered by their annual rates of increase of traffic.

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

Bulgaria	35.85 %	Italy	17.81 %
Cyprus	31.53 %	Portugal	16.23 %
Turkey	30.75 %	Austria	16.05 %
Poland	29.79 %	Sweden	15.29 %
Iceland	26.89 %	United Kingdom	14.67 %
Finland	25.56 %	Denmark	13.95 %
Czechoslovakia	25.44 %	Netherlands	13.73 %
Malta	23.22 %	Belgium	12.61 %
Ireland	22.06 %	Germany	12.47 %
Hungary	21.94 %	France	11.31 %
Norway	21.25 %	Greece	11.08 %
Yugoslavia	20.71 %	Switzerland	10.48 %

Note: period 1981-91, self elaborated with data from Telefónica.

In order to illustrate the reciprocity of the international traffic between countries we construct the ratio between outgoing and incoming minutes of traffic and show its value for the most important countries in terms of traffic (Table 3). It is worth mentioning that in the routes Spain-Germany, Spain-France and Spain-Switzerland, Spain receives more traffic than it generates. This fact is not very surprising since a three-minutes call from Spain to each of these

countries is more expensive than in the reverse direction¹. However, the relationship with Italy is the opposite².

TABLE 3
Outgoing minutes / incoming minutes of telephone traffic from/to Spain

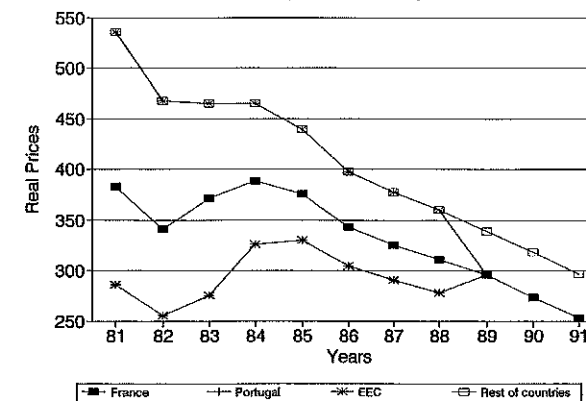
YEAR	GERMANY	FRANCE	UK	ITALY	SWITZERLAND
1981	0.743	0.735	0.994	1.072	0.693
1982	0.811	0.686	1.050	1.042	0.669
1983	0.802	0.714	1.063	1.049	0.690
1984	0.808	0.739	1.071	1.036	0.641
1985	0.812	0.750	1.077	1.026	0.605
1986	0.816	0.761	1.081	1.019	0.577
1987	0.843	0.796	1.175	1.035	0.572
1988	0.893	0.812	1.236	1.064	0.586
1989	0.933	0.856	1.282	1.083	0.596
1990	0.925	0.887	1.363	1.107	0.572
1991	0.921	0.894	1.261	1.035	0.581

Self-constructed. The volume of traffic measured in minutes of conversation.

Figure 1 shows the evolution of prices of outgoing traffic during the period 1981-1991 for the different areas.

FIGURE 1

Prices of telephone traffic from Spain to Europe



According to OECD data (December 1990) the average cost, in 1990 US\$, of a peak-rate three-minute call were the following: from Spain to Germany and France: 3.34, from Spain to Switzerland: 3.92. From Germany to Spain: 2.12. From France to Spain: 2.06. From Switzerland to Spain: 3.00.

The average cost, in 1990 US\$, of a peak-rate three-minute call from Spain to UK and Italy is 3.34. The same call from UK to Spain costs 1.94, and from Italy to Spain 3.45.

As we show in Figure 1, at the beginning of the sample period there were 3 different areas of tariffication: Portugal, France and Rest of European countries. However, after march 1989 the areas of tariffication are: EEC and Rest of Europe. The average real cost of a 3-minute telephone call from Spain to Portugal, has decreased by 11.57% during the sample period. In the same period, the average cost of a telephone call from Spain to France has decreased by 33.86%. The prices of traffic from Spain to the EEC (except France and Portugal) have decreased by 52.82%. Finally, the price decrease for the traffic to the rest of Europe has been 44.69%.

4. MODEL SPECIFICATION AND EMPIRICAL RESULTS

The empirical model has been constructed using the theoretical framework of Section 2 and taking into account previous empirical studies such as Lago (1970), Rea and Lage (1978), Appelbe et al. (1988) and Acton and Vogelsang (1992). These works are summarized in Taylor (1994). Using a double-logarithmic form, the model will be as follows:

$$\ln OUTLIN_{it}^A = \alpha_i + \beta_1 \ln PR_{it}^A + \beta_2 \ln INLIN_{it}^A + \beta_3 \ln TRADE_{it}^A + \beta_4 \ln TOUR_{it}^A + \beta_5 \ln RES_{it}^A + u_{it}^A \quad (11)$$

where \ln stands for natural logarithms and the variables in equation (11) are:

$OUTLIN_{it}^A$	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 .
PR_{it}^A	Real price of a 3 minutes international call from Spain to country i in year t .
$INLIN_{it}^A$	Number of minutes of international incoming telephone traffic per line from country i to Spain in year t .
$TRADE_{it}^A$	Value of imports plus exports between Spain and country i in year t , deflated by the CPI.
$TOUR_{it}^A$	Number of tourists in Spain from country i in year t .
RES_{it}^A	Number of legal foreign residents in Spain from country i in year t .
u_{it}^A	Random error term.

$$\ln OUTLIN_{it}^B = \delta_i + \gamma_1 \ln PR_{it}^B + \gamma_2 \ln INLIN_{it}^B + \gamma_3 \ln TRADE_{it}^B + \gamma_4 \ln TOUR_{it}^B + \gamma_5 \ln RES_{it}^B + u_{it}^B \quad (12)$$

the variables in equation (12) are:

$OUTLIN_{it}^B$	Number of minutes of outgoing international telephone traffic per line from each one of the European countries to Spain in year t .
δ_i	Non observable individual characteristics of the traffic from country i to Spain.
PR_{it}^B	Real price of a 3 minutes international call from country i to Spain in year t .
$INLIN_{it}^B$	Number of minutes of international incoming telephone traffic per line from Spain to country i in year t .
$TRADE_{it}^B$	Value of imports plus exports between country i and Spain in year t , deflated by the CPI.
$TOUR_{it}^B$	Number of tourists from Spain in country i in year t .
RES_{it}^B	Number of legal foreign residents from Spain in country i in year t .
u_{it}^B	Random error term.

$i = 1, \dots, 24$ European countries; $t = 1981, \dots, 1991$ years; number of observations = 264.

Equation (11) is the outgoing traffic demand from Spain to the considered countries, and equation (12) is the demand of traffic from the group of European countries to Spain.

Given the availability of data it has been impossible to estimate the second equation [equation (12)] of the simultaneous equations model. For that reason, we have concentrated in the first equation [eq.(11)] that refers to outgoing traffic from Spain.

The dependent variable which is used in this study is the average traffic per line from Spain to Europe. The explanatory variables are: the real price of the service, the average incoming traffic per line (according to the country of origin of the traffic), the volume of trade between Spain and the considered countries, the volume of tourism and the number of legal foreign residents 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 of the model 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, we experiment with various ways to model route specific effects. Table 4 shows the coefficient estimates obtained under different assumptions about individual heterogeneity.

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

Method of Estimation Regressors	(1) OLS	(2) WITHIN	(3) GLS	(4) FIRST DIFFERENCES	(5) ORTHO. DEV. WITH I.V.
CONSTANT	-2.49 (-3.48)	-	-2.36 (-3.92)	-	-
ln PR	-0.29 (-3.83)	-0.39 (-5.20)	-0.38 (-6.75)	-0.63 (-8.13)	-0.32 (-3.63)(-3.04)
ln INLIN	0.79 (27.91)	0.71 (22.59)	0.73 (25.42)	0.47 (13.66)	0.78 (17.43)(9.87)
ln TRADE	0.12 (4.32)	0.08 (2.56)	0.09 (3.18)	0.07 (2.13)	0.09 (2.88)(3.34)
ln TOUR	0.09 (4.21)	0.13 (3.41)	0.11 (3.88)	0.16 (4.44)	0.11 (2.78)(1.34)
ln RES	0.01 (0.52)	0.08 (3.62)	0.07 (3.25)	0.05 (3.12)	0.04 (1.93)(1.29)
Adjusted R ² Signif. slope coef. Degrees of freedom	0.99 -	0.91 -	0.96 -	425 5	2283.03 5
Serial correlation M1 M2	- -	- -	- -	1.01 0.99	9.26 6.24
Signif. Individual Dummies	-	F _{3,435} = 27.21	-	-	-
Standard Error Regr.	0.24	0.13	0.14	0.08	0.12

Note: t-ratios in parentheses. M1 and M2, are respectively first and second order autocorrelation tests. DF: number of degrees of freedom. In column (5) the second set of t statistics in column 5 are robust to heteroskedasticity across traffic routes.

The results in column (1), correspond to ordinary least squares, and restrict the coefficients to be the same for all the traffic routes. However, the implicit assumption of constant intercept and slope coefficients may not always hold for the different countries.

One way to address the problems that arise from constraining the intercept and slope coefficients to be equal for the different cross sections is 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 having its own intercept. 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 (GLS), provided that the specific random effects are uncorrelated with the explanatory variables. When this is not the case, GLS is inconsistent, and one must resort to an estimator which both eliminates the permanent effects and permits consistent estimation of the coefficients.

A way of detecting correlation between individual effects and regressors is the Hausman test, which measures the distance between the within and GLS estimations. 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 2.1, which is insignificant when compared with the critical value of $\chi^2_5 = 11.1$. Then, in this case, and in absence of other problems, the GLS estimator would be the most efficient unbiased estimator. However, in our case, there exists simultaneity between incoming and outgoing traffic and we correct it instrumenting the incoming traffic.

The differences between columns (2) and (4) of Table 4 are due to the different methods used for controlling for the non-observable effects. In (2), the specific effects are eliminated by subtracting from each observation the temporal average corresponding to that specific route, whereas in (4) they are eliminated by taking first differences.

The estimators of (2), (3) and (4) are consistent only when the regressors are strictly exogenous. In our case, the number of lines (which appears in the denominator of the dependent variable and incoming traffic) can be safely considered exogenous, since it is essentially determined by the volume of local and national long distance traffic. The price is, also, an exogenous variable because it is a regulated price and does not depend on demand. The variables tourism, trade and foreign residents can also be considered exogenous variables. However, in

order to control for the possible simultaneity between outgoing and incoming traffic we estimate the model using the lagged value of $\ln \text{INLIN}$ as instrumental variable. The estimates are presented in column (5) in which we use an orthogonal deviations transformation of the variables where constants are removed by subtracting from each observation the standardized mean of the observations corresponding to future periods (see Arellano and Bover, 1989).

In column (5) two values for the t-statistics are presented in parentheses. The first one is not robust to heteroskedasticity and the second one is robust to heteroskedasticity across traffic routes. In this case we prefer the non-robust t-statistics due to the small number of cross section units, which renders the correction inappropriate.

After selecting specification (5) we comment the results in terms of elasticities. Because of the double logarithmic functional form, 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.

The first effect of a change in the own-price on the volume of outgoing international traffic from Spain to Europe is -0.32 and highly significant.

Incoming minutes of conversation per line turn out significant, with a coefficient of +0.78. This supports the hypothesis of incomplete substitutability between calls in each direction and suggests the existence of a positive reciprocal calling effect.

Other relevant variables when explaining the outgoing telephone traffic from Spain to Europe are: the number of foreign residents in Spain, the volume of trade and the volume of tourism. The estimated impact elasticities are +0.04, +0.09 and +0.11, respectively.

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 (11) and (12). The reduced form of our model of simultaneous equations will be:

$$\begin{aligned} \ln OUTLIN_u^A &= \alpha_i + \beta_1 \ln PR_u^A + \beta_2 [\delta_i + \gamma_1 \ln PR_u^B \\ &+ \gamma_2 \ln INLIN_u^B + \gamma_3 \ln TRADE_u^B + \gamma_4 \ln TOUR_u^B \\ &+ \gamma_5 \ln RES_u^B + u_u^B] + \beta_3 \ln TRADE_u^A + \\ &\beta_4 \ln TOUR_u^A + \beta_5 \ln RES_u^A + u_u^A \end{aligned} \quad (15)$$

Given that the traffic received in Spain with origin in each European country is equal to the outgoing traffic from that European country to Spain, we may substitute $INLIN^B$ by $OUTLIN^A$ in equation (15) and obtain that the total effect of a change in price on the volume of outgoing traffic is:

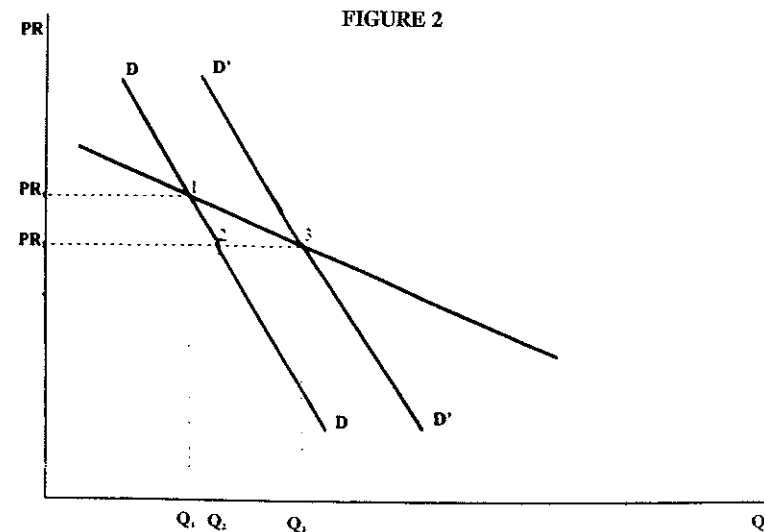
$$\frac{\partial \ln OUTLIN_u^A}{\partial \ln PR_u^A} = \frac{\beta_1}{1 - \beta_2 \gamma_2} \quad (16)$$

Assuming that the reciprocal calling effect is symmetrical in both directions ($\beta_2 = \gamma_2$) we obtain a total effect of -0.81.

The total effect on the outgoing traffic of a change in the rest of the explanatory variables can be obtained in a similar manner. The results will be:

- Total effect of a change in the number of residents: +0.05.
- Total effect of a change in the volume of tourism: +0.18.
- Total effect of a change in the volume of trade: +0.15.

Graphically, the difference between the two values of the price elasticity are explained in Figure 2.



DD is the representation of equation (11) and shows the demand curve for the outgoing traffic from Spain to Europe. 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 elasticity is -0.32. 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_3 . The effective demand curve will pass through the points 1 and 3 of the picture. The price elasticity estimated for this effective demand curve is -0.81.

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.

5. COMPARATIVE ANALYSIS OF THE RESULTS

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

TABLE 5
Price elasticities of international telephone traffic.

STUDY	DEPENDENT VARIABLE	PRICE ELASTICITY	INCOME ELASTICITY	TYPE OF DATA
REA AND LAGE (1978)	N. of outgoing calls U.S.A.	-1.72 (0.26)	2.66 (0.27)	Panel annual: 1964-1974 37 countries
SCHULTZ AND TRIANTIS (1982)	N. of outgoing calls U.S.A.	-0.42	1.99, 3.12 (1.42), (1.91)	Panel quarterly: 1978-1982 7 countries
BEWLEY AND FIEBIG (1988)	N. of calls and minutes from Australia	-0.49 (0.13)	---	T.S.: quarterly 1976-1983
CURIEN AND GENSOLLEN (1989)	N. of minutes France	-0.82 (0.08)	---	Panel annual 1976-1980 25 countries
APPELBE et al. (1988)	N. of minutes Canada - U.S.A.	-0.43, -0.49	0.61, 0.74 (3.18), (2.41)	Panel quarterly: 10 routes
ACTON AND VOGELSANG (1992)	N. of minutes U.S.A. - Europe	-0.36 (0.09)	1.39 (0.17)	Panel annual: 1979-1986 17 countries.
TELEFONICA (1992)	N. of minutes Spain-Europe (EEC)	-0.32	0.81	T.S. monthly 1981-1991
TELEFONICA (1992)	N. of minutes Spain-Europe (no-EEC)	-0.56	1.46	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 (1995)	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 (present study)	Minutes of outgoing traffic from Spain to Europe	-0.32 / -0.81* (0.09) / ----	----	Panel annual: 1981-1991 24 countries

Note: Standard deviations in parentheses. A dash indicates a value not specified in the study. T.S.: Time Series. *We show two different values of the price elasticity: the first one corresponds to the impact effect, and the second is the total effect.

For the case of Spain, there exist previous studies of the international telephone traffic with the rest of the world as a whole. These studies obtain price elasticities of -0.42 (Pérez-

Amaral, 1993 for residential traffic only) and -0.77 (Garín and Pérez-Amaral, 1995). In the present study, we find a first effect of a change in price on the outgoing traffic from Spain to Europe of -0.32, which is lower than previous estimates for the traffic from Spain to America (-0.53 in Garín, 1996a). However, the total effect over the outgoing telephone traffic from Spain to Europe of a change in price is larger than the obtained in Garín, (1996a) for the traffic from Spain to America (-0.81 vs. -0.65). Price elasticities of the traffic from Spain to Europe are estimated in Telefónica (1992). In that study, the estimated price elasticity for the traffic from Spain to the EEC countries is -0.32 and the corresponding value for the traffic from Spain to the rest of European countries is -0.56. It is important to notice that the values found in Telefónica (1992) are very close to the values that we have called impact elasticities obtained in the present work.

Acton and Vogelsang (1992) estimate price elasticities for the traffic between the U.S.A. and a group of 17 European countries by using panel data techniques. In this case the authors estimate a value of -0.36. Appelbe et al. (1988) use panel data for the Canada-U.S.A. telephone traffic. In this case the estimated price elasticity is between -0.43 and -0.49.

6. CONCLUSIONS

Demand functions for outgoing international telephone traffic from Spain to Europe are estimated using panel data corresponding to 24 European countries for the period 1981-1991. For the case of Spain this is the first time that a data set of this type is used.

Using the log of the number of outgoing minutes per line as the dependent variable, we estimate a total own-price elasticity of -0.81. This means that at the present moment, when there is a tendency to approximate the tariffs to costs, a reduction of the tariffs would imply a decrease of the revenues of the operating company for two reasons: first, the negative sign of the elasticity means that a decrease of the tariffs would imply an increase of the volume of outgoing traffic and consequently the operating company will increase its payments for the use of the international networks. Second, the estimated coefficient being less than one (in absolute value), means that a decrease in tariffs will increase the traffic in a smaller proportion. Then, the operating company may not have incentives to decrease tariffs, except that bypass is becoming an extended practice.

Another result is the existence of a "reciprocal calling effect" with an estimated value of +0.78. This result supports the intuition that "calls generate calls". Another relevant factor for explaining the outgoing traffic from Spain to Europe is the volume of trade between Spain and the different countries. This variable is used as a proxy for the community of interests between

countries and presents an elasticity of 0.15. The volume of tourism is also significant for explaining the outgoing traffic to Europe with an elasticity of 0.18.

This work belongs to a set of studies that model the international telephone traffic from Spain. This is implemented by modeling groups of homogeneous countries. At this moment, there exists a model for the traffic to America (Garín, 1996a) and the present work on the traffic to Europe. The work for the Middle and Far East countries is in Garín (1996b). The absolute values of the estimated price-elasticities (first impacts) are in the range that we would expect.

Should the data permit, it would be appropriate to model the international telephone traffic disaggregating by types of customers (residential, business and public telephones) and by time of the day.

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APPENDIX: Diagnosis of the model

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

1. Restriction of unit coefficient of the variable $\ln \text{LIN}$. The coefficient of this variable has been restricted to be one in the model of Table 4. A Wald test consisting in performing a t-test on the coefficient of the variable $\ln \text{LIN}$ as an additional regressor to the model gives a value of 0.93, which is insignificant and suggests that the data do not reject the restriction.

2. Stability of coefficients across routes. For this we compare in Table 6 the coefficients of the whole sample, with those of Subsample 1 in which we exclude the three largest countries: France, Germany and the UK, that represent 60% of the total traffic and with the coefficients of Subsample 2 in which we exclude the six smallest countries: Malta, Cyprus, Iceland, Bulgaria, Hungary and Czechoslovakia.

TABLE 6
Stability across routes.

VARIABLES	Whole sample	Subsample 1	Subsample 2
$\ln \text{PR}$	-0.32 (-3.63)	-0.32 (-2.11)	-0.28 (-3.25)
$\ln \text{INLIN}$	0.78 (17.43)	0.78 (8.86)	0.94 (16.41)
$\ln \text{TRADE}$	0.09 (2.88)	0.09 (3.33)	0.11 (2.77)
$\ln \text{TOUR}$	0.11 (2.78)	0.11 (0.08)	-0.13 (-2.05)
$\ln \text{RES}$	0.04 (1.93)	0.04 (0.25)	0.06 (2.91)

Note: t-statistics in parentheses.

The estimates above suggest that the coefficients are reasonably stable across routes, except possibly the one of tourism.