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Hospital patient migration: analysis using a utility index

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Introduction

Patient migration as an effect of patients being able to choose where they wish to be treated (or of following the advice of their general practitioner as an "agent") has always been a decisive factor for the financial equilibrium of private health facilities and now, since Italian Decree Law 502/92 came into force, it has also become equally decisive for public facilities.

The term "patient migration" is used to describe the fact of people residing in a particular area (e.g. a Local Health Organisation or Region) travelling to health facilities in other areas for treatment (Ministero della Sanità, 1996).

In fact it has been calculated that one patient in ten in Italy is hospitalised in Regions other than their own (Biscella 1998); this means approx. 1 000 000 transfers out of approx. 10 000 000 annual admissions (Ministero della Sanità, 2000).

The study of the mechanisms at the basis of this widespread phenomenon is even more important for healthcare planning than it is for its financial implications.

There are two kinds of transfers:

- one is caused by objective considerations linked to an actual lack in the patients' local health facilities. In this case the transfers are necessary and are caused by factors other than the patients' own preferences;
- the other is derived from subjective reasons. This takes place when patients "emigrate" either because they think they will be taken care of better in other facilities, or for various other reasons which do not necessarily imply negative judgements on the facilities linked to their own residential area (Tessier 1985).

In order to enable accurate forecasts, overcoming the uncertainty caused by the subjective nature of such evaluations and by the consumer's profiting by the freedom of choice, it is a good rule to focus one's attention on the multiple aspects of the complicated chain of provider – producer – consumer of the service. In the field of healthcare, moreover, one needs to remember that the demand for welfare is normally induced, as mentioned above, by the prescriptions of general practitioners or specialists trusted by their patients (Hodgkin 1996; Rozenberg 2001).

Much research has shown that there is a connection between the quality of hospital service and patient migration (Skinner 1977; Egunjobi 1983; Luft 1990; Phibbs 1993; Hansen 1994; Hodgkin 1996; Chernew 1998).

The quality of a service is perceived according to how its characteristics are evaluated. This takes place on a basis of individual judgements, a hospital service thus acting as a set of stimuli on which the person's evaluation is founded.

Many authors have studied the phenomenon of hospital patients migrating (Addari 1995; Degli Esposti 1996; Fabbri 1996; Ugolini 1998; and Baccarani 1998); little research, however, has left the main track of administrative data analysis to investigate directly with the deciders what motivates them to give expression to their preference and actually choose one particular facility instead of another (Skinner 1977; Egunjobi 1983; Luft 1990; Mahon 1993; Phibbs 1993; Mapelli 1993; Hodgkin 1996; Fiorentini 1997; Rozenberg 2001).

The aim of this study is to propose a statistic model for analysing the phenomenon of patient migration capable of explaining and forecasting the deciders' (patients' and general practitioners') choices and providing elements for evaluating the perceived quality of the hospital service by means of a measurement of utility.

Materials and methods

Within the sphere of studies on sanitary economics several methods have been identified for measuring utility as linked to the state of health: Standard Gamble - SG (McNeil 1978, 1981), Visual Analogue - VA (Nord 1991), Time Trade Off - TTO (Torrance 1972), Willingness to Pay - WTP (Donaldson 1993), Conjoint Analysis - CA (Ryan 1997).

A further development of CA, the technique Discrete Choice - DC, has also been used to measure utility as perceived in relation to the use of health services (Mor 1985; Rozenberg 2001). This technique has been referred to in this study.

Assumption terminology

The general structure of a DC model can be represented by a set of assumptions (Ben-Akiva 1985), which concern the decider, the alternatives, the attributes and the decisional rules:

- **Decider:** this is the specific entity (e.g. an individual, family, group of people or organisation), which makes a choice. One can ignore all the internal interactions of the group and consider only the decisions in their entirety. In order to explain the variety of the deciders' preferences it will be necessary to include their characteristics, i.e. the socio-economical variables of age, gender, education, profession, income, etc.
- **Alternatives:** these are the options open to the decider; the set of alternatives taken into consideration is called the *set of choices.* If such a set is *discrete,* i.e. it contains a limited number of alternatives, which can be listed clearly, it can be analysed with the technique we chose (DC). The preferences among the possible alternatives can be measured using the methods Ranking, Rating Scale or Discrete Choice Exercises (Green 1978). The latter method was chosen for this investigation.
- **Attributes:** these are the elements taken into account by deciders when making their decisions. An attribute is not necessarily a directly measurable quantity. The DC technique enables both the attribute itself and its logarithmic transformation to be considered, so that the most suitable one can be identified.
- **Decisional rules:** these describe the process followed by the decider to come to his/her decision. Economic theory assumes that the decider's preference for an alternative is determined by a value (called the Utility Index) and that the decider chooses the alternative, which supplies him with the highest level of utility.

The Discrete Choice technique

The Discrete Choice – DC technique makes it possible to evaluate preferences (in the specific case of the patient or doctor) with respect to some of the characteristics of a particular service.

In order to prepare the economic model we hypothesised that when the patient or his/her doctor acting as "agent" needs to select a hospital facility they evaluate the utility of the combination of attributes (see the next paragraph) according to the degree of importance they have themselves allotted to each one.

Let us consider a general decider "*i*" (doctor or patient) who needs to choose between two alternatives: the hospital belonging to the Local Health Organisation – LHO where he resides (from now on referred to as the "Origin-O") and a hospital outside the circuit of this LHO (from now on referred to as "Destination-D").

If we assume that "*i*" attributes a certain level of utility to each alternative, the choice will be the one with the highest level. More specifically speaking, "*i*" will choose "*D*" if he decides to be transferred (alternative 1), or "*O*" if he decides to stay in his own area (alternative 0).

For every "*i*" decider only one possibility (*Yi dummy)* chosen between two possible alternatives can be observed.

$$Y_i = \begin{cases} 1 \text{ if the decider "}i\text{" moves to Destination "}D\text{"} \\ 0 \text{ if the decider "}i\text{" does not move and prefers to remain in Origin "}O\text{".} \end{cases} \quad (2\text{-}1)$$

Let us assume that:
U_{i1} (A_D,C) utility for the decider "*i*" deriving from alternative 1
U_{i0} (A_O,C) utility for the decider "*i*" deriving from alternative 0

Then the decisional rule would be:

$$Y_i = \begin{cases} 1 \text{ If } U_{i1}(A_D, C_i) > U_{i0}(A_O, C_i) \\ 0 \text{ If } U_{i0}(A_O, C_i) \geq U_{i1}(A_D, C_i) \end{cases} \quad (2\text{-}2)$$

Where A_D represents the attributes characterising the destination facility "*D*", A_O – represents the attributes characterising the structure of origin "*O*", and C_i indicates the characteristics of the decider "*i*".

Since the role of our research in this context is to explain the variation in Y_i and to forecast the choices made by the deciders on the basis of the attributes considered (see next paragraph), we needed to create an economic utility model derived from the choice of each decider.

Generally speaking we can assume that the utility derived from the choice of an alternative "*J*" (*j=1* or *0)* made by the decider "*I*" (*i=1,2,...,T*) is a function of the pre-selected attributes (e.g. reputation of the facility, waiting times, distance, etc.) and of the decider's characteristics (e.g. gender, age, education, profession, income, etc.).

When one chooses between two alternatives (1,0) the key utility factor is the difference between them.

The difference relating to the decider *i*th, indicated as ΔX_i, would be:

Δx_i=(Attribute "1")-(Attribute "0")

If $\Delta X_i > 0$ the decider "*i*" will choose 1 depending on the attribute considered.
If, on the other hand, $\Delta X_i = 0$ the attribute will play no role in his/her choice.

Determining the variables and preparing the questionnaires

We used the Focus Group technique (Corrau 2000) to collect information and indications about the attributes, which can create the patient migration phenomenon and the relative levels of quantitative expression. Two groups were investigated separately:

- patients (5 males and 5 females over 18, recently discharged from Sienna hospital where they had been admitted for certain Diagnosis Related Groups – DRGs (see sampling)
- 6 general practitioners (some Siennese and some from other parts of Italy, in Sienna for training) and 4 privately employed out-patient specialists.

Each group was given an information sheet on the extension of the patient migration phenomenon in Italy and on the work programme planned. Before asking the key question it was thought advisable to prepare each group with an initial warming-up phase of approx. 15 minutes to start the participants interacting with each other, suggesting free associations on patient migration. After this initial phase came the key questions for our research:

- for the first group (patients): "What are the reasons (attributes) for a patient deciding on hospitalisation far from home?"
- for the second group (general practitioners): "What are the criteria (attributes) a doctor follows when advising a patient's admittance (in non-urgent cases) to one hospital rather than another?"

Each participant's opinions were written on a chart.

After this phase the participants were asked to determine the attributes considered most important among those emerging from the discussion.

In this way the main factors concerning the demand (deciders) and the supply (hospital services) emerged, i.e. those connected to the perception of quality and to the decisional process being studied (activation or non-activation of the patient mobility phenomenon):

- demographic factors (such as gender and age);
- socio-economic factors (education, profession, income). It can be intuited that high income levels can facilitate transfers, since, besides treatment costs, the indirect expenses (travel, family members' board and lodging, night nurse, etc.) also play a strong role;
- type (urgent, planned) and causes of admission (seriousness, complexity);
- factors linked to the hospital network's structure, which can be evaluated in terms of presence or absence of the service on the spot, and of the distance between home and hospital. It was agreed to measure this distance in travelling time;
- quality of the facility (judgement of the capability of the hospital facility to solve the health problems in question);
- waiting times for admission;
- communication and co-operation between the hospital and the patient's GP.

The two groups were then asked to suggest the possible levels of expression for each attribute. The information thus obtained was used to prepare two questionnaires: one for the patients and one for the GPs. They were designed to collect general data needed for the use of the "DC" technique (gender, age, education, income, type of admission, etc.) and information on reputation, distance, waiting times, co-operation (for the doctor) on the "Origin" and "Destination" hospitals. (These coincide where patients residing in a Local Health Organisation area are admitted to the hospital belonging to that area or referring to it.) The first section of each questionnaire was aimed at establishing the logic behind the patient's/doctor's choice (*Why did you decide to enter this hospital? Who advised you to enter this hospital? What weight did the reputation of this facility, the waiting time, the* *distance from your home have in your decision to be admitted here? According to your opinion, what is a hospital's good reputation based on? etc.).* The questionnaire for the doctors covers the activity of the previous 30 days and is divided into two sections: the first for the most recent recovery they prescribed for a patient residing in Sienna and admitted to Sienna hospital; the second for their latest patient residing in Sienna and sent to a hospital outside the province of Sienna. The two questionnaires were then perfected by a pilot study covering ten doctors and ten patients.

Samples and methods

Since it was not possible to define which population the investigation on the patients should be referred to, we followed the fundamental indications given in the literature for a statistical study of this kind (Champion 1970; D'Ascani 1987; Bailey 1995) and decided to acquire at least 100 questionnaires correctly filled in by patients and 30 by doctors. The criteria for selecting patients for the study were:

- a random sample of adult patients admitted to Sienna Hospital in March 2001;
- In order to describe the seriousness and complexity of the cases and render them more homogenous the DRG system, as adopted by all Italian hospitals (Bonoldi 1998), was used. The DRGs to be examined were identified on the basis of the following criteria:
  - The DRGs were selected from those with many documented cases (normal recovery in public hospitals);
  - Above all DRGs where recovery could be postponed for a medium or long period were considered, since DRGs of emergency cases do not normally allow the patient any choice. In order to allow comparisons, a few typical, urgent case DRGs were included (DRGs 127 and 87);
  - Relative importance (in the sample there must be DRGs of various degrees of relative importance); in fact, for some authors this importance is a variable positively correlated to the migration level (Fabbri 1996);
  - Low Coefficient of Variation – CV (DRGs with little variation in the inter-group average stay in hospital, i.e. more homogeneous than the others). The average hospitalisation CV measures the relative inter-group dispersion and can thus be used to compare the relative dispersions of two or more DRG distributions. It is known that each DRG represents cases of hospitalised patients with a similar consumption of resources (days in hospital); therefore, DRGs with $CV < 1$ are considered homogeneous, whereas a $CV \geq 1$ expresses an excessive dispersion, higher than the group's mean hospital stay. The CV of the length of the stay is influenced by the homogeneity of the cases and by the efficiency of the facility where they are being treated. While it can be hypothesised that in-house efficiency does not change, the seriousness can or cannot change whether or not a selection of pathologies exists. A low CV should be proof of a scarce selection, whether active or passive;
  - Pathologies not belonging to very high specialities (treatment supply not monopolised);
  - Inclusion of both surgical and medical pathologies.
- The departments with more frequent admissions due to the above-described DRGs were identified first of all and the investigation was performed there (Table 1).

The survey on the patients was carried out in the Sienna Hospital within 20 days, from 8th March to 1st April, 2001. 151 questionnaires were distributed personally to the patients. The doctors were surveyed by mailing the questionnaires to 50 GPs operating in the Sien-

Table 1. Selection criteria and characteristics of the sample of patients studied

Diagnosis Related Group – DRG		Criteria					Departments							Cases studied		
		Frequency	Relative weight	Possib. of deferment	Variation Coefficients	Non monopolised treatment	General surgery	General medicine	Obstetrics	Gynaecology	Orthopaedics	Urology	Haematology	Male	Female	Total
87	Pulmonary oedema and respiratory failure		1.263	X		X		X						2	3	5
127	Heart failure and shock.	X	1.260	X		X		X						0	7	7
134	Hypertension	X	0.775	X	X	X		X						1	3	4
162	Operations for inguinal and femoral hernia in people over 17, w/o complications	X	0.75	X	X	X	X							2	3	5
167	Appendectomy with uncomplicated main diagnosis, w/o complications	X	0.68	X	X	X	X							4	1	5
206	Liver diseases except malignant neoplasm, cirrhosis, alcoholic hepatitis w/o complications	X	0.80	X		X		X						4	3	7
209	Major operations on the articulations, arms and legs		3.31	X							X			7	11	18
243	Medical disorders of the back	X	0.770	X	X	X		X						2	2	4
245	Bone diseases and specific arthropathies, w/o complications	X	0.759	X	X	X		X						5	2	7
294	Diabetes in people over 35	X	1.008	X	X	X		X						1	3	4
324	Urinary calculosis, w/o complications	X	0.53	X	X	X	X					X		1	4	5
359	Operations on the womb and adnexa, not for malignant neoplasm and w/o complications	X	1.043	X	X	X	X			X				0	9	9
373	Vaginal birth with diagnosed risk of complications	X	0.64	X	X	X			X					0	11	11
391	Normal birth	X	0.20	X	X	X			X					0	9	9
473	Acute leukaemia w/o operation in people over 17		6.82										X	1	2	3
Total														30	73	103

na Commune. Our surveyors then visited each patient and doctor personally to collect the filled-out questionnaires, helping to complete the forms in case of doubt.

Factorial analysis

In the questionnaires given to the patients and doctors the set of input variables which can create patient migration, such as "Reputation of the hospital" (HOSPREP), "Reputation of the department" (DEPTREP), "Reputation of the Chief Physician" (CHIEFREP), "Distance from home" (DIST), "Short waiting list" (SHORTLIST), "Doctor's advice" (DOCADV), "Direct acquaintance of a doctor at the hospital/dept." (DIRKNOW), "Direct co-operation with the hospital/dept." (DIRCOOP), etc. Factorial analysis was used to reduce the number of these variables. Factorial Analysis (FA) is a statistical technique for investigating the correlation between the variables/items being considered with regard to a certain phenomenon. FA also identifies any factors explaining such correlation (Royce 1963, Morizet-Mahoudeaux 1983). The SPSS software automatically performed *the analysis of the main components* (Hotelling 1933) and the *Scree Test* (Cattell 1978), identifying three factors, which were named I, II and III. It was seen that these factors were not correlated to each other and were therefore independent. Then the values of these factors were calculated automatically using the method *Direct Oblimin* (Gorsuch 1983) and the *Varimax* normalisation (Kaiser 1958). The correlation values were estimated in terms of factorial correlations (between the variables and the factors) and factorial configuration (weights applied to the variables) (Kline 1997). At this point it was necessary to determine the factor and optimum reading scale for weighing up the single variables. Where the doctors' survey is concerned, as already mentioned, the minimum amount of 100 cases, considered as optimum (Kline 1997) could not be achieved. However, in agreement with a substantial amount of literature, we believe that an item, which reaches the value of 0.2 at least, independently of its positive or negative sign, can be considered as sufficiently correlated to a factor (Cattell 1978; Bailey 1995; Kline 1997; Comrey 1995).

Structuring of the model

The DC model we hypothesised is intended to investigate the reasons behind patient migration on a basis of the differences between the utility values of the attributes of the "Destination" hospital and those of the "Origin" hospital. The Focus Groups, Pilot Studies (and the first data processing phases later on) directed us to those attributes and characteristics of the deciders, which could be adopted in the final structure of the DC model, and to the relating levels of expression (Table 2). When the relationship between the variables is not linear, or when the independent variable is not of the quantitative kind (Dominick 1985; Kazmier 1986), as happened for some cases we took into consideration, we can apply multiple linear regression models, such as the Linear Probability Model – LPM, and multiple logistics regression models such as Logit and Probit, used by Discrete Choice. Analysis with these models offers the advantage of being useful for forecasting and estimating too, instead of only verifying the significance of the relationships existing between the variables. As we have already mentioned, where the relationship between the variables is not linear, it is, in any case, possible to transform the function which expresses this non-linearity into a linear function using a logarithm.

This makes it possible to apply coefficient estimation methods (Ordinary Least Squares) for the LPM and Log Likelihood for models Logit and Probit. The LPM model's parameters

Table 2. Factors studied determining the choice of hospital

Attributes	Levels
Considered in the preparation of the patients' model:	Excellent, Good, Medium, Poor[a]
Reputation of the hospital facility (Rep)	Up to 1, 7, 14, 21, 28, 42, 56, 70, 84 and beyond (days)
Waiting times (Times)	8, 24, 38, 53, 68, 83, 106, 136, 166[c] (minutes)
Distance (Dist)	1 = Male, 2 = Female
Gender[b]	
Considered in the preparation of the doctors' model:	Excellent, Good, Medium, Poor[a]
Reputation of the hospital facility (Rep)	Up to 1, 7, 14, 21, 28, 42, 56, 70, 84 and beyond (days)
Waiting times (Times)	8, 24, 38, 53, 68, 83, 106, 136, 166[c] (minutes)
Distance (Dist)	Constant, Sufficient, Sporadic, None[a]
Co-operation (Co-op)	

[a] In the statistical processing these levels were categorised as follows: ("Excellent, Good = 1", "Medium, Poor = 0") and ("Constant, Sufficient = 1", "Sporadic, None = 0").
[b] It was seen that other characteristics of the patient (age, income, profession, level of education) initially included in the model did not improve it, probably because of the criterion adopted for selecting the sample.
[c] Average values considered as representative of the intervals proposed (e.g. 8 = from 1 to 15 minutes, 24 = from 16 a 30 minutes; ... 166 = from 151 to 180 minutes, the rare excess values were also considered in this last level.

are linear and when the explanatory variables vary there is no guarantee that the probability (in our case the migration) will be included between 0 and 1.

For this reason it is preferable to substitute this linear probability model, or back it up, with statistic models such as Probit and Logit which, not having linear parameters, allow measurement of the relationship between the dependent variable (expressed in terms of probability) and a set of independent variables, and whose interval of probability always lies between 0 and 1 (Aldrich 1984; Griffiths 1993).

The fact that the relationship between the probability that Y will assume value 1 (he/she migrates) and every explanatory variable X_i (reputation of the facility, waiting times, distance, co-operation) is non-linear means that the effect of X_i on the probability of $Pr(Y=1)$ is less evident than in the linear probability model. Therefore, in the model we adopted the utility the deciders "*i*" perceived of migrating from "O" to "D" is described (estimated) by the following linear functions U (.):

$$\Delta U_i = \beta_0 + \beta_1 C_i + \beta_2 \Delta\text{Rep} + \beta_3 \Delta\text{Temp} + \beta_4 \Delta\text{Dist} + e_i \quad \text{(Patients' model)} \tag{2-3}$$

$$\Delta U_i = a_0 + a_1 \Delta\text{Rep} + a_2 \Delta\text{Temp} + a_3 \Delta\text{Dist} + a_4 \Delta\text{Coll} + e_i \quad \text{(Doctors' model)} \tag{2-4}$$

where:

- ΔUi indicates the difference between the level of utility the decider "*i*" attributes to "D" and "O";
- ΔRep, ΔTimes, ΔDist and ΔCo-op refer, respectively, to the difference in level of reputation, waiting times, distance/travelling times in minutes and that of the co-operation between the GP and the hospital facility where the patient is admitted. The natural logarithm Ln of the variable distance "*Dist*" was considered in the statistic processing;
- the parameters β_0 and a_0 are the constant terms or intercepts of the regression and give the estimated value of ΔU_i when the independent variables ΔRep, ΔTimes, ΔDist and ΔCo-op (for the GP) = 0;
- C_i indicates the characteristics of the decider "*i*" and refers to his/her parameter with β_1;
- The parameters β_k $(k=2,3,4)$, a_w $(w=1,2,3,4)$ measure the variation of ΔU_i for every unit variation of the independent variable when the other independent variables are kept con-

stant; the parameters β and a are coefficients of the partial regression, since they correspond to the partial derivative of ΔU_i with respect to the independent variable;

- Finally, e_i represents the imponderable factors in the utility function of the decider "i".

During the course of the processing phases on the basis of the interactions encountered amongst the variables for the estimation of the ΔUi utility index the following equations were found to be the best:

$$\Delta U_i = \beta_0 + \beta_1 \text{Sesso} + \beta_2 \Delta \text{Rep} + \beta_3 \Delta \text{Temp} + \beta_4 \Delta \text{Dist} + \beta_5 \Delta \text{Dist}^2 + \\ + \beta_6 (\Delta \text{Dist} * \Delta \text{Rep}) + e_i \quad \text{(Patients)} \qquad (2\text{-}5)$$

$$\Delta U_i = a_0 + a_1 \Delta \text{Rep} + a_2 \Delta \text{Temp} + a_3 \Delta \text{Dist} + a_4 (\Delta \text{Dist} \times \Delta \text{Rep}) + \\ + a_5 \Delta \text{Coll} + a_6 (\Delta \text{Rep} \times \Delta \text{Dist}^2) + e_i \quad \text{(Doctors)} \qquad (2\text{-}6)$$

The marginal effects of each independent variable on the probability $P(Y=1)$ in the Probit and Logit models are identified with the mark β_k, a_w, which determines the direction of each effect, which tends to grow as β_k, a_w increases, while the relative size varies together with the variation of the independent variable ΔX_i. The data were processed with statistics software SAS version 6.00 and SPSS version 10.

Results and considerations

Table 2 as mentioned in the "Materials and Methods" (Structuring of the model), contains the attributes and deciders' characteristics (factors determining the choice of hospital), and the relating levels of expression adopted according to the results of the Focus Groups and pilot studies. The following tables and figures refer to the outcomes of the sample investigations performed on hospitalised patients and GPs.

Of the 151 questionnaires distributed to the patients, 27 (17.9%) were refused; 17 patients (11.3%) were discharged straight after the distribution and were, therefore, non longer available; in 4 cases (2.7%) the name and address were not filled in and so they were not included in the processing. 103 questionnaires (68.2%) were completely filled in and processed; (Table 1) refers to these.

Of the 50 questionnaires sent to the doctors 30 (60%) were sent back correctly completed, while in 20 cases (40%) there was no co-operation. 8 of the 30 doctors who co-operated (26.6%) had sent all their patients needing hospitalisation to different hospitals than those belonging to their LHO in the 30 days prior to the interview. 8 (26.6%) turned to both local facilities and other structures, while the remaining 14 (46.6%) had patients hospitalised within their own LHO. In all, the 30 doctors co-operating prescribed 38 admissions in the thirty days preceding the interview. The following results refer to these cases. From an examination of Table 3 one can see that the patients felt that all the attributes included in the study were important (reputation 80.6%, waiting times 64%, distance 55.4%). On the other hand it was clear that the doctors were insensitive to the distance from the patient's home to the hospital prescribed (reputation 81%, waiting times 73.7%, distance 31.6%, co-operation 86.8%). In general, distance seems to be the least important attribute amongst those considered, for both patients and doctors. Reputation and (for the doctors) co-operation appear to be the most important attributes.

Table 4 analyses the motives supplied by those interviewed for their deciding on admission to Sienna Hospital, whether the patients belonged to Sienna LHO no. 7 (not migrating) or not (migrating).

Table 3. Judgement of the importance of the variables considered

Attributes	Patients' judgement (n=103)				Doctors' judgement (n=38)			
	Unimport.	Not very Important.	Import.	Very Import.	Unimport.	Not very Important.	Import.	Very Import.
Reputation	10.7%	8.7%	49.5%	31.1%	5.3%	13.2%	36.8%	44.7%
Waiting times	23.3%	12.6%	31.1%	33%	5.3%	21.1%	52.6%	21.1%
Distance	26.2%	18.5%	28.2%	27.2%	47.4%	21.1%	15.8%	15.8%
Co-operation	–	–	–	–	5.3%	7.9%	34.2%	52.6%

Table 4. Percentage distribution of the Deciders according to the criteria adopted for their choice of hospital for admittance

Criteria for choice and/or migration	Patients (n=103)		Doctors (n=38 patients)	
	No migration	Migration	No migration	Migration
Hospital's reputation (HOSPREP)	19.4	8.7	0	0
Department's reputation (DEPTREP)	20.4	6.8	30	26.7
Chief physician's reputation (HEADREP)	12.6	9.7	0	0
Nearness to own home (DIST)	33	9.7	0	0
Short waiting list (SHORTLIST)	3.9	1.9	3.3	6.7
Doctor's advice (DOCADV)	11.7	11.7	–	–
Direct acquaintance with a hosp./dept. doctor. (DIRACQ)	14.6	16.5	6.7	10
Direct co-operation with the hospital/departm. (CO-OP)	–	–	6,7	10

It is noticeable that the doctors and patients use different criteria when making their decisions: while reputation, especially that of the department for the recovery, is important for both categories, the distance of the hospital is important only for the patients and does not affect the doctor, and the waiting times influence the doctor, and also the patient, but much less.

Table 5 carries the results of the factorial analysis (analysis of the main components, Scree Test, Direct Oblimin, Kaiser Varimax normalisation) of the relations between the variables listed in the previous table corresponding to the patients interviewed. The correlations between the variables and their linking factors are thus determined.

Where the doctors' model is concerned no statistics were calculated since the variances of the items (HOSPREP, CHIEFREP, DIST) equal zero; moreover, the sample is not large enough for this analysis to achieve any statistical significance.

One can see that the average of all the items lies between 0.22 and 0.34, and the standard deviation between 0.42 and 0.47, except for item SHORTLIST with an average of 0.05 and standard deviation of 0.24. These results show that the above variables are almost equally important as reasons for migration, while the "Waiting Times" variable differs from the others.

The items over 0.2, considered the significance threshold, are shown in bold. It can be seen that:

- the first factor is significant for items HOSPREP ($r=0.74$), DIRKNOW, ($r=0.71$), DEPTREP ($r=0.48$) and DIST ($r=-0.25$); this suggests that a hospital's reputation is linked to the fact that when doctors working in a particular department are known directly, they attract patients even from far-off areas.

Table 5. Results of the factorial analysis (analysis of main components, Scree Test, Direct Oblimin, Kaiser Normalisation) on the observations reported by the 103 patients interviewed

	Item		Factorial Correlations			Factorial Configuration		
	Average	S.D.	Factor I	Factor II	Factor III	Scale I	Scale II	Scale III
HOSPREP	0.28	0.45	0.736	0.042	−0.014	0.547	0.020	−0.090
DIRACQ	0.31	0.47	0.712	0.044	0.121	0.516	0.019	0.022
DIST	0.34	0.48	−0.245	0.737	−0.211	−0.170	0.593	−0.160
SHORTLIST	0.05	0.24	0.095	0.586	0.094	0.054	0.461	0.058
DOCADV	0.23	0.42	−0.172	−0.583	−0.157	−0.105	−0.455	−0.098
HEADREP	0.22	0.42	−0.138	−0.0003	0.865	−0.186	−0.108	0.718
DEPTREP	0.27	0.45	0.479	0.196	0.662	0.290	0.131	0.484
Total variation percentage explained			21.45	17.93	16.14			
Kaiser Meyer Olkin Test			TKMO=0.458					
Barlett Test		$\chi^2=35.49$	DF=21	P<0.025				

Table 6. What does a hospital's "good reputation" mean for patients? (values per cent)

Reputation Indicators	Patients (n=103)	Doctors (n=38)
No judgement	1.0	0.0
Presence of valid and well-known specialists	53.4	44.7
Availability of sophisticated, modern equipment	11.7	2.6
Large number of cases treated	4.9	10.5
Recovery rates	7.8	21.1
Percentage of satisfied patients	10.7	13.2
Percentage of patients of other regions/provinces	1.0	0.0
Polite, willing staff	7.8	2.6
Modern facility	1.9	5.3

- the second factor is significant for items DIST ($r=0.74$), SHORTLIST ($r=0.59$), DOCADV ($r=-0.58$) and DEPTREP ($r=0.20$); this factor suggests that where there is no advice from doctor lack of co-operation? "do-it-yourself" patients?) the distance and short waiting times come to the fore; i.e. accessibility conditions the patient's choice;
- the third factor is significant for items CHIEFREP ($r=0.87$), DEPTREP ($r=0.66$) and DIST ($r=-0.21$); this factor shows that the reputation of a department is founded on that of its chief physician and both attract patients from afar.

The same table shows the loads of each item according to its actual contribution to a particular scale. According to the Kaiser Meyer Olkin test (KMO) the sample is sufficient (KMO index=0.458). The correspondence (i.e. how far the data foreseen by the model correspond to those actually measured) evaluated by the Barlett test (*$\chi^2=35.49$ with 21 degrees of freedom-DF and $p<0.025$*) was significant. The table contains the percentages of the explained variance attributable to the single factors; it would obviously be best to identify all the factors so as to explain the variance totally. It is not normally considered advisable to go so far ahead with the investigation. Justifying the 55.52% of the variance with only a few factors (Factor I=21.45%, Factor II=17.93%, Factor III=16.14%) is a result we can consider more than satisfying (Kline 1997) and we decided not to proceed further. Table 6 shows the significance of a hospital's reputation (the main selection criterion according to the results) for the 103 patients and 30 doctors interviewed.

It is noticeable that the highest percentages are generally expressed by the *presence of excellent, well-known specialists* (53.4% for the patients and 44.7% for the doctors). Then come:

- for the patients, the technical equipment (11.7%), the satisfaction reported by acquaintances and relations (10.7%) and the courtesy, availability and willingness of the staff (7.8%);
- for the doctors, clinical efficacy (21.1%), the amount of pathologies treated (10.5%), the satisfaction reported by previous patients (13.2%).

Table 7 shows the results obtained using the DC technique.

Among the decider's various characteristics only gender was seen to be important, although it was not statistically significant, as we shall see. Age, income, profession and education, initially included in the model as explanatory variables, were then removed because they brought no improvement and do not clarify the variation in Y_i.

- age: most of the patients interviewed were more than 75 years old;
- income: the majority stated they had a low annual income of less than 10000000 Lit.;
- profession: given their age, the patients were retired;
- education: most were blue-collar workers and housewives.

For conciseness the table only contains the results obtained by logistic regression (model Logit – main effects) since both models, Logit and Probit, have proved, also in our investigation, to correspond to each other where the interpretation of the results is concerned (Liao 1994). Several authors have found that it is possible to obtain approximately the coefficients of the Probit model starting with the values obtained with Logit, dividing the parameters estimated calculated by the factor 1.814 according to Aldrich (1984) or by the factor 1.6 according to Amemiya (1981).

From a first reading of Table 7 emerges a very high significance for both models (patients $p[X^2(6) > 13.232] = 0.0001$ or doctors $p[\chi^2(6) > 34.406] = 0.008$): i.e. the Likelihood Ratio shows that at least one coefficient relating to the independent variables is other than zero. Therefore, the models explain the variability of the phenomenon studied. An analysis of the table shows that:

- the intercept in both models has a negative sign (*Patients: –7.48, $t = 2.24$, $p < 0.13$; Doctors: –1.86, $t = 6.72$, $p < 0.01$*); this means that, when all the characteristics of the two facilities Origin and Destination are the same, the decider is not willing to move away from his own area.
- The "gender" parameter in the patients' model was negative (*+6.08, $t = 2.39$, $p < 0.12$*); although the "gender" variable has a low significance level, its inclusion is justified by the improvement it brings to the model's adaptation.
- The ΔRep parameter was positive in both models (*Patients 6.79, $t = 3.81$, $p < 0.05$; Doctors 6.51, $t = 0.93$, $p < 0.33$*); when the level of reputation of the Destination facility grows with respect to the Origin, the utility for the decider also grows, and with it the probability of migration.
- The ΔTimes parameter was negative in both models (*Patients –0.03, $t = 0.39$, $p < 0.53$; Doctors –0.37, $t = -7.11$, $p < 0.007$*); this shows that the increase in the waiting times of a nearby facility with respect to the one further away increases the utility and consequent probability of migration.
- The ΔDist parameter is, paradoxically, positive in both models (*Patients 0.15, $t = 3.88$, $p < 0.049$; Doctors 0.31, $t = 8.91$, $p < 0.003$*). Logically speaking, one would expect a negative sign: if the distance increases, the probability of migration should be less. It seems that distance has an effect on reputation (the patient who has no faith in his local hospital prefers to go to a distant one which he presumably knows less about).

Table 7. Comparison of the estimators (Logit – Main Effects of the two models)

Estimation of	Patients	Doctors
Intercept	−7.4847	−1.862
Standard Error	4.9964	0.719
T-ratio	2.24	6.715
Significance	0.1341	0.010
Gender	6.0845	–
Standard Error	3.9349	
T-ratio	2.39	
Significance	0.1220	
Rep	6.7933	6.516
Standard Error	3.4864	6.746
T-ratio	3.81	0.933
Significance	0.0514	0.334
Times	−0.0318	−0.369
Standard Error	0.0512	0.140
T-ratio	0.39	6.960
Significance	0.5340	0.008
Dist(*)	0.1519	0.305
Standard Error	0.0770	0.102
T-ratio	3.88	8.908
Significance	0.0486	0.003
Dist*Dist	0.0011	–
Standard Error	0.0005	
T-ratio	4.83	
Significance	0.0280	
Rep*Dist	0.0435	−0.209
Standard Error	0.0454	0.295
T-ratio	0.92	0.499
Significance	0.3372	0.480
Co-op	–	−5.339
Standard Error		2.597
T-ratio		4.227
Significance		0.040
Rep*Dist2	–	0.0003
Standard Error		0.003
T-ratio		0.007
Significance		0.932
−2LLR	13.232	34.406
DF	6	6
Overall significance	$p < 0.0001$	0.008

* Was considered the natural logarithm of the distance Ln (Dist) in the regression analysis

- All the squares of the various attributes were examined and only the square of the distance in the patients' model was found to be significant and to improve the model (*0.0011, $t = 4.83$, $p < 0.03$*);
- The par ameter of the ΔCoop variable has a negative sign (*-5.34, $t = 0.0001$,n.s.*), a condition which leads one to think that there is little communication and co-operation between the doctor and the hospitals, both of Origin and of Destination. It is likely that the negative sign is determined above all by the poor co-operation between the GP and the local hospital, which encourages patient migration.
- In our endeavours to improve the model, we examined the square effects of the various attributes: only the distance square of the patients' model was significant, with an improvement of (*0.0011, $t = 4.83$, $p < 0.03$*); it was thus included in Table 6;.
- If we associate the Distance (or square distance for the doctors' model) to the reputation, we get a positive sign for the parameter (*Patients 0.041, $t = 0.92$, $p < 0.34$; Doctors 0.0003, $t = 0.007$, $p < 0.93$*);
- We interpret this datum in the sense that when the level of reputation increases, there is an increase in the probability of migration independently of the fact that the hospital is far from home. The negative sign obtained for the Rep * Dist parameter with the doctors' model is not so easy to interpret.

Figure 1, structured fundamentally with the application of the DC models described above (see Appendix) illustrates the dynamics resulting from increases or reductions of some variables (waiting times, reputation, reputation associated with distance, co-operation). It can be seen that:

- a reduction of the waiting times in favour of the hospital of Destination causes an increase in the probability of migration, both of "do-it-yourself" patients (A) and of patients sent by their GP (a);
- the interaction of Reputation and Distance improves the significance of the values, as explained above, but it does not alter the behaviour profile already noted for Reputation alone;
- the lower the level of co-operation between GP and local hospital, the greater the tendency to hospitalise patients in distant facilities;
- there are different profiles in the curves referring to the decisional models of both patients and doctors.

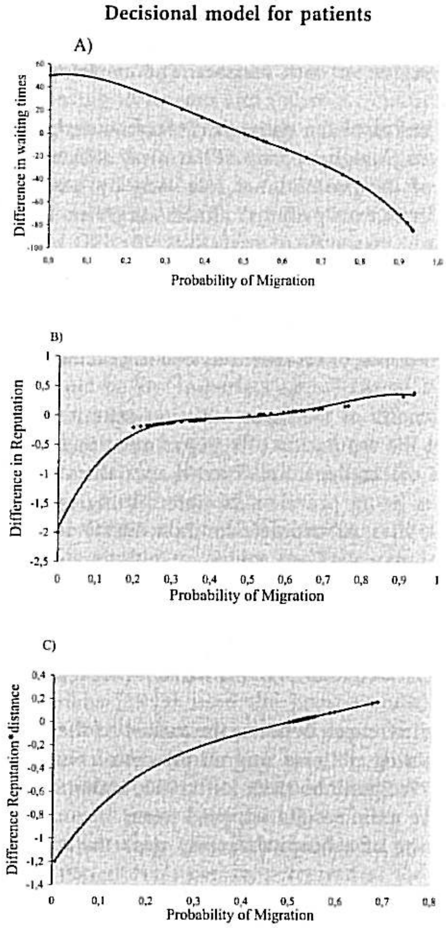
Conclusions

This study was aimed at finding a statistical model capable of explaining (and forecasting) patients' and GPs' choices of hospitals for admission.

By means of Focus Groups and interviews conducted on samples of GPs and patients we discovered the main principles determining their choice of hospital for treatment:

- the reputation of the hospital, waiting times and distance were the most important factors for the patients;
- co-operation with the hospital, its reputation and the waiting times were the most important for the doctors.

Logically, doctors and patients seem to use different decisional criteria: while reputation, especially that of the department for admission, is important for both categories, the distance from home is important only for the patients and does not affect the doctors' judgement; waiting times affect the doctor's choice but are not nearly so important for of the patient.



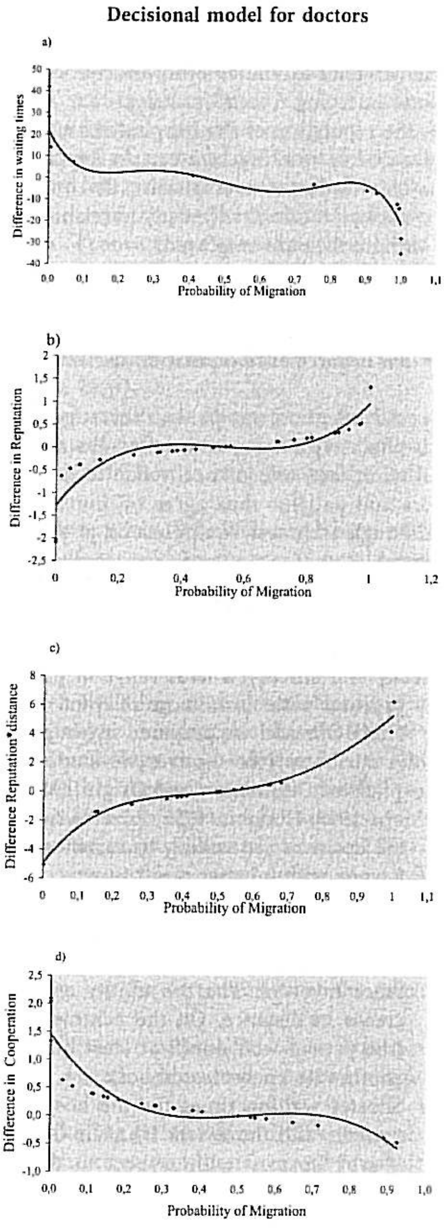


Fig. 1. Influence of some variables (Difference in utility between hospitals of Origin and Destination) on the probability of hospital patinets "migrating" (Discrete Choice – Logit models)

The asymmetry existing between the information possessed by doctors and patients is the most natural explanation of this phenomenon: e.g. whether it is advisable to solving the clinical problem as soon as possible or how long the waiting times are for other hospitals. Mahon (1993) has observed that most GPs are well informed about the hospital waiting times in their area, while the information is not normally readily available for patients. We shall come back to this subject later.

Using Factorial Analysis on the patients' answers, we investigated the links between the above-mentioned decisional criteria. This technique proved it could clarify the nature of the variables examined and we determined the weights for each variable. The main indications emerging from this analysis are:

- the reputation of the hospital chosen is often linked to the patient's direct knowledge of a doctor working in a certain department, even though he may be far away (Factor I). This leads us to emphasise the importance of the promotional role held by hospital doctors' activities (mostly freelance) in different out-patients' clinics/surgeries from where they are employed;
- when the GP does not advise a department/hospital for admission (and only then) the importance of ease of access (first distance and second a short waiting list) emerges (Factor II);
- the department's reputation derives mainly from that of its chief physician. (Factor III).

Special attention was paid to investigating the genesis of the main selection criterion, the hospital's reputation, and the results showed that the reputation of a department or hospital is, in fact, unequivocally due to the presence of excellent, well-known specialists. Doctors and patients thus agree on human resources being prevalent in determining quality. Although technical equipment is also important, it is subordinate for how utility is perceived.

In creating the reputation of a hospital/department, humanity and relationships were decisive for the patients (e.g. satisfaction reported by acquaintances and relations, polite, kind and willing staff), while the doctors considered "objective" knowledge (clinical efficiency and efficacy, a wide range of pathologies treated) but also the satisfaction reported by previous patients as more relevant.

The DC model we prepared investigated the differences between the values of the variables-attributes (the motives we studied determining patients migration) concerning the hospitals of Destination and Origin. (Skinner 1977; Egunjobi 1983; Luft 1990; Mahon 1993; Phibbs 1993; Hodgkin 1996; Rozenberg 2001). The main results achieved were:

- the deciders are willing to sacrifice the benefits of a hospital facility near their home for one with a better reputation;
- when the level of the Destination hospital's reputation increases with respect to the hospital of Origin, the utility for the decider, and consequently the probability of migrating, also increases, and the latter pursues the good reputation independently of the distance involved. The probability of the patient migrating does not lessen with the increase in distance. On the contrary, a paradoxical "effect of reputation" was observed (the patient who does not trust his own hospital of reference prefers to be admitted to another he knows less about).
- Shorter waiting times for the hospital of Destination mean that both "do-it-yourself" patients and those sent by their GPs will probably migrate. Long waiting times in the nearby hospital with respect to the distant one naturally increase the probability of transfer. Shorter waiting times locally can limit hospital patients' migration, so it is excellent that the strategic aims of the Italian National Health Programme 2002/2004 include "adapting the waiting times and ease of access to the consumers' requirements" (Ministero della Salute, 2002).
- The lower the level of co-operation is between the GP and the hospital of reference, the greater the tendency to admit patients to distant hospitals. Co-operation and communication are, therefore, important for motivating a GP to send a patient to a particular hospital and, once more, this study has highlighted the insufficiency in this field.
- Various different profiles can be seen in the curves referring to the decisional models of the patients and doctors.

This latest discovery, already emerging with the comment to Table 4 and Figure 1, is a function of the asymmetry in information, which justifies the GP's role of agent.

It can be hypothesised that the differences between these profiles increase or decrease according to the era and the social/cultural contexts, and that they become less substantial where information is readily available and the patient trusts in his doctor.

In fact, for a GP to become an Agent, a foundation of mutual trust should be there: he acts on behalf and in the interest of the patient and interprets his needs, taking his place in choosing the health care providers necessary for satisfying them. The decisional incidence of the GP's role is decisive in all phases of the process of converting the need for health into a request for treatment and in the choice of the quality and substance of the health services capable of satisfying the request (Rozenberg 2001). On the other hand, besides being the patient's intermediary for the request, the GP normally takes part in actually producing health care, so he may be conditioned by factors of an economic-professional nature. For this reason he could be an "imperfect agent" (Rossi 1994; Brenna 1999).

Correcting the lack of access to information, which conditions the patient's freedom of choice, or developing the role of the GP as an agent and his trustful relationship with the patient are two potential alternatives for future strategic action to be taken by the Italian National Health Service.

The Italian National Health Programme 2002/2004 appears to be indicative here, since, besides aiming to reduce the time required for diagnosis and treatment, it provides for monitoring of the relative data and their sharing via a computer system dedicated to structures and professional people (hospitals, LHCs, regional councils, central administrational bodies, doctors). However, this system is not meant to be directly accessible by citizens/patients (Ministero della Salute, 2002).

Phibbs (1993) used the Logit Conditional model, inserting control variables (quality, prices for services and road distance between hospitals) to demonstrate that the choice of a hospital depends on how long the treatment of the pathology can be deferred.

For our research we considered above all DRGs with a medium and high possibility of deferment; those cases with possibility of deferment zero (emergencies, accident victims) do not normally allow any choice and are directed to the nearest hospital (Hansen 1994).

A patient with cancer, perceived as the most worrying problem, is intuitively more willing to move to distant facilities (naturally where there is no clinical emergency) than a patient needing selective interventions for solving other pathologies.

There is no doubt that more analytical studies on patient migration in relation to specific pathologies could lead to more useful indications on the determinants of the migration flows.

The fact that, in the absence of other input, and also for pathologies where treatment can be postponed, patients in general tend to apply for admission to the nearest hospital has been ascertained (Chernew 1998).

Hansen (1994) found that patients residing on the border between different hospital consumer areas considered the technical quality of the treatment, comfort and humanity, previous experiences (Gooding 1996) and easy access (e.g. public transport) to be most important when selecting a hospital.

Payment terms or insurance constitute another well-known determinant, which we did not study since they do not affect the Italian National Health Service (Chernew 1998).

The possibility of making choices without having to worry about the financial side is in itself a sign of the quality of our health system.

The programme for the hospital networks proposes to eliminate the less quantifiable financial conditioning deriving from the distance of the hospital.

However, it is becoming clearer and clearer that emphasising the patients' freedom of choice, keeping up the network and developing the quality of the assistance (e.g. through competitive mechanisms) are goals reconcilable only with the availability of substantial financial means and the capability of attentive evaluation.

Where there is the same level of coverage, and patients have received objective information about it (e.g. post-hospitalisation mortality with specific causes, availability of advanced technology), the technical quality of the treatment provided appears to be the main determinant for patients transferring and, therefore, the main thing the hospitals are asked for (Hodgkin 1996; Chernew 1998).

We leave our observations on this determinant to other studies, including our own (Nante 1999; Nante 2000a; Nante 2000b; Nante 2001).

The model we created enables calculation of a "utility index". On the one side the utility index can help the patient to make the right choice and, on the other, it is actually a perceived quality evaluator. In fact, this instrument transcends the function of the techniques for measuring the consumer's satisfaction *a posteriori* (Nante 2002; Pellegrino 2002), which are useful for management, and assumes an important planning role. The model enables:

- the identification of the possible transfers of a patient/group of patients, while improving the weak spots;
- the establishment, on a simulation basis, of the features that a hospital/department already existing, or being built, should have in order to overcome competition in the vicinity.

We believe this second use could be even more helpful than the first.

To give an example, Table 8 compares two hospitals: one of Origin "O" and one of Destination "D"; in both there is an identical level of reputation 0 (1(D)-1(o)=0), but different waiting lists (5(D)-10(O)=-5 days) and a different distance from the patient's home (20(D)-6(O)=14 minutes) in "O" with respect to "D".

The result is a utility level (index) of approx. -0,817 equal to a likelihood of 0,31, for (male) patients to migrate towards the Destination hospital.

The example given in Table 8, with vector of the explanatory variables [1 0 -5 14], compares 2 hospitals; however, it is possible to hypothesise uses for improving a single hospital, starting from the actual data and, on the basis of viable planning choices, simulate the changes these factors would cause in that hospital.

Furthermore, one can obtain the marginal effects of each single independent variable on the probability (PrY=1), as shown in Table 8; if the if the ΔTime (Difference in waiting times) increases by one unit, the probability diminishes by approx. 0.01, while, if ΔDist (Difference between the distances) increases by one unit, the probability grows by approx. 0.03. Finally, if the increase in ΔDist is accompanied by an increase in ΔRep (Difference in reputation), we will obtain a probability increase of approx. 0.01.

Table 8. Results obtained with the patients' Logit using simulation

Coefficients	β_0	β_1	β_2	β_3	β_4	β_5	β_6	Utility Index	Prob.
Patients' Logit model estimators	−7.48	6.08	6.79	−0.03	0.15	0.001	0.043		
Hypothesised vector of the explanatory variables (ΔX_i)	1	1 (Maschi)	0	−5	2.6391**	6.965	0		
Results	−7.45	6.08	0	0.15	0.396	0.007	0	−0.82	0.31
Marginal effects		*	*	−0.01	0.03	0.0002	0.01		

* The marginal effects of the categorised variables are not calculated (Liao Tim 1994); ** Ln (14) = 2.6391

Our study was limited by the fact that we began with real decisions already taken (hospitalisations in course or over) and went back to the characteristics, as perceived by the decider (doctor or patient), which motivated their choice.

This represents an inverted route with respect to the traditional DC path, which starts with a predefined set of characteristics and asks the subject to imagine which choices he would make on that basis. This led us to analyse a limited number of possible observations (levels of the variables studied in different combinations) for each subject, while with the traditional approach many hypothetical scenarios can be proposed to the subjects being interviewed. However, the methodology we adopted achieves more realistic results.

The importance of our research does not lie so much in our having discovered new reasons for patient migration, the determinants of which have been known for some time (Hansen 1994; Hodgkin 1996; Chernew 1998), as in the fact that we have attributed specific decisional weights to them and have identified forecasting models based on the values taken on step by step by the determinants.

In the near future we propose to apply these weights to actual data and situations in order to see how the model presented here works in practice.

There is another possible interesting development of our findings, i.e. the application of the game theory to the strategic interaction (competition?) between the Local Health Companies or Hospitals. The function we found to measure the utilities is used to discover which is the best strategy (improving the reputation, reducing the waiting times, reducing the distances between the hospital facilities and their potential consumers) to adopt in order to achieve the equilibrium of the game, i.e. the equilibrium which provides the maximum utility for the players-competitors.

Summary

The aim of this study is to determine a statistical model capable of explaining (and forecasting) the choices of patients and their doctors (GPs) regarding hospitals for admission:

Using focus groups and interviews carried out on samples of patients and doctors (GPs), we found that the main determinants for the choices of a place for treatment made by the above deciders are:

- for the patients – **reputation** of the hospital, **waiting times** and **distance** (most important determinants for the patients;
- for the doctors – **co-operation** with the hospital, its **reputation** and the **waiting times.**

By performing a factorial analysis on the replies given by a sample of patients we investigated the connections between the decisional criteria shown above and their relative weights. By means of a Discrete Choice model (a development of the Conjoint Analysis technique) we investigated the differences between the value of the variables-attributes (the above-mentioned motivations determining patient migration) we studied in the hospitals of Destination and Origin, observing that:

- the deciders are willing to sacrifice the benefits of a hospital facility near home for one with a better **reputation;**
- as the level of **reputation** of the Destination hospital grows with respect to the one of Origin, the decider's utility also grows and with it the probability of migration. The deciders follow a good **reputation,** independently of **how far away** the hospital is. The probability of the patient migrating does not diminish as the distance involved increases;

- an improvement in the waiting times in favour of the Destination hospital causes an increase in the probability of migration on the part of both "do-it-yourself" patients and of those sent by their GPs. Long waiting times in the nearby facility with respect to the distant one increase, rather obviously, the probability of the patient migrating. The reduction in the waiting times can limit this migration.
- The less co-operation there is between the GP and the reference hospital, the greater is the tendency to admit patients to far-off facilities.
- Different profiles can be seen in the curves referring to the patients' and doctors' decisional models.

Appendix

When the random variable is discrete, such as Y_i in equation (2-1), we can obtain all the possible values with their respective probabilities by means of a probability density function, which is the basis of a DC statistical model:

(P_i) shall be the probability that the ith decider chooses alternative 1 (he transfers) and (1-P_i) the probability of his choosing alternative 0 (he does not transfer).

In this case the probability density function of Y_i is:

$$g(y_i) = p_i^{y_i}(1-p_i)^{1-y_i};\ y_i = 1,0$$

Therefore, the probability that the decider "i" transfers is:

$$g(1) = p[y_i = 1] = p_i$$

On the other hand, the probability that the same decider "i" does not transfer is:

$$g(0) = p[y_i = 0] = 1 - p_i$$

The mean and variance of the discrete probability distribution of a discrete casual variable Y_i are respectively:

$$E[y_i] = p_i$$

$$Var[y_i] = p_i(1-p_i)$$

The probability distribution of Y_i is, therefore, completely determined by P_i which expresses both the probability of choosing alternative 1, and the expected value of Y_i.

The random utility model

Since the random utility function is not known with certainty (Aldrich 1984), it is expressed as the sum of an observable component and an idiosyncratic component (random errors):

$$U_{ij} = \bar{U}_{ij} + \varepsilon_{ij}$$

where U_{ij} is the random utility of alternative *"J"* *(j=1 o 0)* chosen by the decider *"I"* *(i=1,2,...,T)*.

If we wish to express utility U_{ij} as a function of the attributes (Rep, Time, Dist, Co-op) of the alternative preferred and of the decider's characteristics (Gender, Age, Education, Income, Profession), we can write the systematic component, which represents the indirect utility, as

$$\bar{U}_{ij} = A_{ij}\beta + C_i a_j \qquad (2)$$

where,

A_{ij} is the vector of the attributes of the alternative "*J*" of the decider "*I*" (A_{ij} = Rep, Time, Dist, Co-op);

C_i is the vector of the characteristics of the decider "*I*" (C_i = Gender, Age, Education, Income, Profession);

β, a_j are vectors of the known parameters.

Combining (1) with (2) we obtain:

$$U_{ij} = A_{ij}\beta + C_i a_j + \varepsilon_{ij} \tag{3}$$

assuming that the errors are independent for each decider and alternative and that they are distributed normally with a mean of zero and a variance of $\sigma_j^2 2$; $(j = 0, 1)$. These hypotheses imply that the utility a decider attributes to an alternative is not correlated with the utility attributed by another decider.

Since we are not sure of being able to find out which alternative will be chosen, but we can foresee the probability of one of the possible alternatives being chosen, specifically, we represent the probability of the decider "*i*" choosing each alternative as:

$$p_i = p_r[y_i = 1] = p_r[U_{i1} \rangle U_{i0}]$$
$$1 - p_i = p_r[y_i = 0] = p_r[U_{i1} \leq U_{i0}]$$

Given the random utility model in equation (3) we can write:

$$p_i = p_r(U_{i1} \rangle U_{i0})$$
$$p_i = p_r(\bar{U}_{i1} + \varepsilon_{i1} \rangle \bar{U}_{i0} + \varepsilon_{i0})$$
$$p_i = p_r(\varepsilon_{i0} - \varepsilon_{i1} \langle \bar{U}_{i1} - \bar{U}_{i0}) \tag{4}$$

On this basis we can identify a DC statistical model by substituting (3) with (4) and specifying the distribution of the probabilities of the difference in the random utility errors, $\varepsilon_{i0} - \varepsilon_{i1}$.

First of all, let "I_i" be the utility index representing the difference of utility in the systematic component in the right-hand part of equation (4):

$$I_i = \bar{U}_{i1} - \bar{U}_{i0} = (A_{i1} - A_{i0})\beta + C_i(a_1 - a_0) \tag{5}$$

$$I_i = [(A_{i1} - A_{i0})C_i]\begin{bmatrix} \beta \\ a_1 - a_0 \end{bmatrix}$$

$$I_i = X_i \eta \tag{6}$$

We point out that, if the parameters (a_1, a_0), were originally equal, the different characteristics of the individual would not then contribute to the difference in utility. Therefore, the utility index "I_i" is the difference between the systematic component of alternative (1) and that of alternative (0); the bigger "I_i" is, the bigger the systematic component of the alternative (1) is with respect to (0). Consequently, the higher "I_i" is, the higher the probability that alternative (1) will be preferred to (0).

By substituting (4) with (6) we obtain:

$$p_i = p_r[\varepsilon_{i0} - \varepsilon_{i1} \leq X_i \eta] = p_r[e_i \leq X_i \eta] \tag{7}$$

Equation (7) highlights the fact that the probability that alternative 1 will be chosen is the probability that the difference in the random errors e_i will be less than or equal to the utility index.

Given that the errors ε_{ij} are independent random variables, with a mean of zero and variance σ_j^2, their difference is $e_i \sim N(0, \sigma^2 = \sigma_0^2 + \sigma_1^2)$:

$$p_i = p_r[e_i \leq X_i \eta]$$
$$p_i = p_r\left[\frac{e_i}{\sigma} \leq \frac{X_i \eta}{\sigma}\right] \tag{8}$$
$$p_i = p_r[\kappa_i \leq X_i \beta]$$

where

$$\kappa_i = \frac{e_i}{\sigma}, \quad \beta = \frac{\eta}{\sigma}$$

The random variable κ_i is distributed normally with a mean of zero and a variance of one: *N (0, 1)*.

The probability that the random variable κ_i is "less than" or "equal to", is provided by the cumulative distribution function of the random variable. Consequently, the probability that alternative 1 will be chosen is:

$$p_{i1} = p_r[\kappa_i \leq X_i\beta] = \phi(X_i \beta)$$

where
$\phi(X_i \beta)$ is the value of the cumulative distribution function of the standardised variable and is calculated by means of the following formula, called the "Probit Model":

$$p_i = \phi(X_i \beta) = \phi(I_i) \tag{9}$$

where ϕ (.) is the cumulative distribution function of the standardised random variable.

Generally we can write:

$$\phi(I_i] = \phi X_i\beta = \int_{-\infty}^{X_i\beta} 2\pi^{-\frac{1}{2}} \cdot e^{-\frac{\kappa^2}{2}} \cdot d\kappa \tag{10}$$

When the random errors e_i assume a logistic instead of a standardised normal distribution, another formula called the "Logit Model" and its expression is:

$$\phi(I_i) = \frac{1}{1 + e^{-1}}$$

In order to measure the marginal effect of every independent variable on the probability *P (Y=1)*, in the models of the Probit e Logit type, we can apply the following formulas respectively in which the sign β_i determines the direction of such effect, which tends to grow as β_i increases, while the relative size varies together with the variation of the exogenous variable X_i.

$$\frac{\partial P(Y=1)}{\partial X_i} = \frac{1}{\sqrt{2\pi}} \cdot e^{-\frac{I^2}{I^2}} \cdot \beta_i \equiv \phi(I)\beta_i \tag{11}$$
$$\frac{\partial P(Y=1)}{\partial X_i} = \frac{e^I}{1 + e^I} \cdot \frac{1}{1 + e^I} \cdot \beta_i \tag{12}$$

These considerations lead us to formula (13) in which the relationship between the probability *P (Y=1)* and the variation in X_i will be visible.

$$\frac{\partial P(Y=1)}{\partial X_i} = \frac{e^{\beta_i(X_{1i} - X_{0i})}}{1 + e^{\beta_i(X_{1i} - X_{0i})}} \tag{13}$$

References

Addari P, Nante N, Giannuzzi P, Ngoyi Ngongo K, De Bedin C, Mara E (1995) Studio della mobilità sanitaria relativa al bacino di utenza del policlinico senese. Atti Sez. Toscana S.It.I.; VII: 51–59
Aldrich JH, Nelson FD (1984) Linear Probability, Logit, and Probit models. SAGE; 45
Baccarani C (1998) La qualità delle prestazioni e la libera scelta dell'utente. In Economia e direzione delle aziende sanitarie, Achard PO (ed), Fontana, Roma: RIREA, Quaderno di ricerca no. 8
Bailey KD (1995) Metodi della ricerca sociale. Il Mulino, Bologna
Ben-Akiva M, Lerman SR (1985) Discrete choice analysis: Theory and application to travel demand. MIT Press, Cambridge
Biscella M, Deponti F (1998) Il Nord attira i malati in trasferta. Il Sole 24 ore, 23 Feb.
Bonoldi P (1998), Sistema DRG e finanziamento degli Ospedali: un'opportunità per programmare la qualità dell'assistenza. Centro Scientifico Editore, Turin
Brenna A (1999) Manuale di economia sanitaria per una gestione razionale delle risorse; CIS Editore, Milan
Cattell RB (1978) The scientific use of Factor Analysis. Plenum, New York
Champion, Dean J (1970) Basic statistics for social research. Scaranton PA: Chandler
Chernew M, Scanlon D, Hayward R (1998) Insurance type and choice of hospital for coronary artery bypass graft surgery. Health Services Research; 33:447–466
Comrey LA (1995) Introduzione all'analisi fattoriale. Zanichelli, Bologna
Corrau S (2000) Il focus group, Franco Angeli, Milano
D'Ascani G, Candida-De Matteo G (1987) La conjoint analysis fornisce al progettista di hardware/software le specifiche informazioni di mercato richieste nella fase creativa dell'innovazione. In Innovazione tecnologica, discipline economiche e organizzative e indirizzi di ricerca, Pagliarani G, Gottardi G (eds), Atti workshop Bressanone, 3–4 ottobre; Padova
Degli Esposti G, Rimondi M, Virgilio G, Ugolini C (1996) Matrici di mobilità per DRG's: analisi descrittiva ed applicazioni per la programmazione e le politiche sanitarie regionali. Management ed Economia Sanitaria (MECOSAN); 19: 53–62
Dominick S (1985) Statistica ed econometria, Collana Schaum teoria e problemi, ETAS Libri
Donaldson C (1993) Theory and practice of willingness to pay for health care. Health Economic Research Unit Discussion Paper No. 01/93. Aberdeen: University of Aberdeen
Egunjobi L (1983) Factors influencing choice of hospitals: a case study of the northern part of Oyo State, Nigeria, Social Science & Medicine, vol 17, Issue 9, pp 585–589
Fabbri D, Fiorentini G (1996) Mobilità e consumo sanitario: metodi per la valutazione di benessere. Management ed Economia Sanitaria (MECOSAN); 19: 37–52
Fiorentini G, Rebba V, Daniele F (1997) La regolamentazione della qualità delle prestazioni ospedaliere mediante tariffe: un'analisi dei sistemi di pagamento prospettico. In Economia della Sanità, Petretto A (ed), il Mulino, Bologna 201–219
Gooding SK (1996) The relative importance of information sources in consumers' choice of hospitals. Journal of Ambulatory Care Marketing, vol 6, Issue 1, pp 99–108
Gorsuch RL (1983) Factor Analysis, 2nd edn, Erlbaum, Hillsdale
Green P, Srinivasan V (1978), Conjoint analysis in consumer research. Issues and outlook. Journal of Consumer Research, vol 5: 103–123
Griffiths WE, Carter Hill R, Judge GG (1993) Learning and practising econometrics. John Wiley & Sons: 736–760
Hansen TB (1994) What factors affect choice of hospital in cases of trauma? A study of conditions in the county of Ringkøbing, Ugeskrift for Laeger, vol 156, Issue 5, January 31, pp 652–655
Hodgkin D (1996) Specialized service offerings and patients' choice of hospital: the case of cardiac catheterization. In Journal of Health Economics, vol 15, Issue 3, pp 305–332
Hotelling H (1933) Analysis of a complex of statistical variables into principal components, Journal of Educational Psychology, 24, pp. 417–441
Kaiser HF (1958) The varimax criterion for analytic rotation in factor analysis, Psychometrika, 23, pp. 187–200
Kazmier LJ (1986) Statistica aziendale, Schaum Teoria e Problemi Series, ETAS Libri
Kline P (1997) Guida facile all'analisi fattoriale, Astrolabio-Ubaldini Editore, Rome
Liao Tim F (1994) Interpreting probability models Logit, Probit, and other generalized linear models. SAGE, 101
Luft HS, Garnick DW, Mark DH, Peltzman DJ, Phibbs CS, Lichtenberg E, McPhee SJ (1990) Does quality influence choice of hospital?, JAMA, the Journal of the American Medical Association, vol 263, Issue 21, pp 2899–2906

Mahon A, Whitehouse C, Wilkin D, Nocon A (1993) Factors that influence general practitioners' choice of hospital when referring patients for elective surgery. The British Journal of General Practice: the Journal of the Royal College of General Practitioners, vol 43, Issue 372, pp 272–276
Mapelli V (1993) Libertà di scelta ed equità nel sistema sanitario italiano: un'indagine campionaria. In Economia Sanitaria, France G, Attanasio E, Milan (eds): Giufrè A: 345–361
McNeil B, Weichselbaum R, Pauker S (1978) Fallacy of five year survival in lung cancer. The New England Journal of Medicine; 299: 1397–1401
McNeil B, Weichselbaum R, Stephen G, Pauker S (1981) Speech and survival. The New England Journal of Medicine; 305: 982–987
Ministero della Sanità (1996) Relazione sullo stato sanitario del Paese. Servizio Studi e Documentazione
Ministero della Sanità (2000) Relazione sullo stato sanitario del Paese. Servizio Studi e Documentazione
Ministero della Salute (2002) Schema di Piano Sanitario Nazionale 2002–2004, Servizio Studi e Documentazione
Mor V, Wachtel TJ, Kidder D (1985) Patient predictors of hospice choice. Hospital versus home care programs, Medical Care, vol 23, Issue 9, pp 1115–1119
Morizet-Mahoudeaux P, Dubuisson B (1983) Analysis of the criteria of choice of hospital materials and technologies, International Journal of Bio-Medical Computing, vol 14, Issue 1, pp 53–63
Nante N, Moirano F, Giusti E, Galanti C, Giuliano G, Taddei M, Marenco C, Savioli V, Isoardi MA, La Ferlita G, Autieri G, Addari P (1999) Mortalità intraospedaliera DRG specifica in alcuni nosocomi italiani, Organizzazione Sanitaria, XXIII, 4, pp 78–91
Nante N, De Marco MF, Balzi D, Addari P, Buiatti E (2000a) Prediction of mortality for congestive heart failure patients: results from different wards of an Italian teaching hospital, European Journal of Epidemiology, XVI, pp 1017–1021
Nante N, Siliquini E, Morgagni S, Moirano F, Renga G (2000b) In-hospital mortality DRG related in Piemonte, Italy. J Prev Med Hyg 41:91–99
Nante N, Brandini S, Autieri G, Isoardi MA, Piazza A, Furfaro V, Panella M, Di Stanislao F (2001) Uno strumento per la valutazione del processo assistenziale ospedaliero: la qualità redazionale della cartella clinica, Difesa Sociale, 5, 143–155
Nante N, Fattorini A, Groth N, D'Ostuni R, Quercioli C, Moirano F (2002), Qualità assistenziale percepita dai ricoverati in ospedale: messa a punto di uno strumento valutativo, Annuale d'Igiene XIV, 51–72
Nord E (1991) The validity of a visual analogue scale in determining social utility weight for health states. International Journal of Health Planning and Management; 6: 234–242
Pellegrino P, Groth N, Cento G, Beodogni C, Moirano F, Nante N (2002), Esperienze di analisi partecipata della qualità in un'azienda ospedaliera, Annali d'Igiene XIV, 37–50
Phibbs CS, Mark DH, Luft HS, Peltzman-Rennie DJ, Garnick DW, Lichtenberg E, McPhee SJ (1993) Choice of hospital for delivery: a comparison of high-risk and low-risk women, Health Services Research, vol 28, issue 2, pp 201–222
Rossi G (1994) Mercato e non mercato in sanità: l'efficienza dei sistemi sanitari e la razionalizzazione dei consumi delle risorse, Edizioni Copinfax, Siena
Royce JR (1963) Factors as theoretical constructs in Jackson DN, Messick S (eds), Problems in Human Assessment, McGraw-Hill, New York
Rozenberg S, Ham H (2001) Effect of physician's opinion on patients' choice of treatment, European Journal of Obstetrics, Gynecology, and Reproductive Biology, vol 96, issue 2, pp 215–217
Ryan M, Hughes J (1997) Using conjoint analysis to assess women's preferences for miscarriage management. Health Economics vol 6: 261–273
Skinner TJ, Price BS, Scott DW, Gorry GA (1977) Factors affecting the choice of hospital-based ambulatory care by the urban poor, American Journal of Public Health, vol 67, issue 5, pp 439–445
Tessier G, Contandriopoulos AP, Dionne G (1985) Patient mobility for elective surgical interventions, Social Science & Medicine, vol 20, Issue 12, pp 1307–1312
Torrance G, Thomas W, Sackett D (1972) A utility maximization model for evaluation of health care programs. Health Service Research, 7: 118–133
Ugolini C, Fabbri D (1998) Mobilità sanitaria ed indici di entropia. Management ed Economia Sanitaria (MECOSAN); 26: 9–24

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