Potential users' preferences towards cardiac telemedicine services: a discrete choice experiment investigation in Sardinia

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Abstract

Background
Potential users' preferences for telemedicine services directed to cardio-vascular diseases are investigated applying a discrete choice experiment (DCE). Given the potential of telemedicine to minimize costs without reducing overall efficiency, assessing preferences for these types of services represents a priority for policy makers. This is especially true for those pathologies that absorb a relatively high quota of total health expenditure. The empirical setting is Sardinia (Italy) because of its insularity and the underdeveloped internal transport network. Telemedicine is likely to mitigate distance between healthcare providers and final users.

Methods
A survey conducted between February and May 2013 was administered to a selected Sardinian population older than 18 (potential users) through face-to-face interviews. A discrete choice experiment was implemented and four attributes (i.e. scanning mode, location, waiting list and cost) assess in what measure these influence potential users' utility by using a random parameter modeling with heterogeneity (RPH).

Results

The empirical findings, based on 2,000 interviews, highlight that potential users are not very open to the application of telemedicine services in cardiology, mostly preferring the *intromoenia* (visit at the hospital) and private system. Besides, remarkable individual heterogeneity has been found.

Conclusions
Potential users see the implementation of new technologies in healthcare with a certain caution. However, the relatively higher preferences towards services provided at their own municipality suggests that there is ground to explore further the implementation of telemedicine services through the family doctor and local pharmacy.

Keywords: cardiac telemedicine; potential users' preferences; Discrete Choice Experiment.

JEL Classification: C13; C25; I12

1. Introduction

In Italy, 10% of the total health expenditure is devoted to circulatory diseases and denotes the largest share for hospital stays and pharmaceutics spending, even if the latter had seen a consistent reduction thanks to the introduction of the "generic market" [1, 2]. Although several health indicators (e.g. life expectancy, obesity rates, doctors per capita [3]) and quality of care are still above OECD average, the country lags behind in terms of long term care and prevention given the high quota of the aging population. Although telemedicine may help in facilitating a real time connection between the patient and health care services, an appropriate investigation on needs and preferences of potential users is required.

This paper explores potential users' preferences for telemedicine and their evaluation on public policy directed to enhance cardiologic services. These objectives are pursued by applying a discrete choice experiment (DCE) to explore potential users' willingness to accept new diagnostics for heart problems. The empirical setting is the region of Sardinia (Italy). The rising incidence of cardiovascular diseases – due to unhealthy habits, obesity and an increased life expectancy- together with public sector financing constraints and costs reduction make this analysis relevant from an economic and policy perspective. Sardinia represents an interesting case study because of its insularity and underdeveloped internal transport network. In such a geographical setting, telemedicine may represent a way to mitigate distance between healthcare providers and final users.

From an empirical perspective, a preliminary random parameter with heterogeneity (RPH) will assess the impact of four attributes (i.e. scanning mode, location, waiting list and cost) and in what measure these influence potential users' utility. Besides, a cluster RPH will assess the robustness of the previous analysis and will explore the attributes that mostly affect individuals' utility within the clusters. These steps of the investigation will provide a more comprehensive picture on potential users' preferences.

2. Background

One of the key objectives of the telemedicine action plan for 2012–2020 was to exploit the full potential of Information and Communication Technology (ICT) in improving quality and modes of provision of healthcare. This aim has remained mostly unmet in many EU countries [4, 52]. The use of ICT has been widely supported by European policy makers, since it responds to the need of promoting a vision of citizen-centered health delivery systems, by increasing participation of patients in health decisions and strengthening the linkage between healthcare deliveries and end users [6]. Furthermore, the benefits of telemedicine extend to an improved efficiency and quality of healthcare, thus becoming a priority in the EU policy maker's agenda. Practitioners support an extensive use of telemedicine (e.g. promoting cooperation, information sharing, decision support and flexibility) especially for those with chronic conditions, thus improving the quality of care [2, 7].

In a geographical setting, where reduced mobility and access to healthcare providers – due to distance to major urban centers and the lack of, or costly transportation - represent a major barrier to healthcare, telemedicine may help to ease the remoteness constraints, reducing travel costs and disadvantages, such as mobility problems and the scarce availability of specialty healthcare providers [8-10]. Furthermore, telemedicine may represent a possible solution for an uneven distribution of healthcare specialists; this is particularly true in those sectors, such as cardiology, where an increased demand – due to the increased number of elderly people that has caused a higher incidence of chronic diseases – has not been offset with an adequate supply of healthcare specialists [11].

Systematic reviews have found consensus on the effectiveness of telemedicine devices in patients with chronic heart failure and coronary heart disease [12-16]. The benefits of telemedicine in cardiology include reduced mortality and number of hospital admissions, rationalized costs and improved practitioners' decision making [7].

The implementation of information technologies in healthcare has been explored from diverse perspectives that take into account users preferences in the case of adopting Electronic Health Record [17, 18]. The economic literature provides a vast range of techniques to elicit consumer preferences. DCE applications are becoming popular in policy evaluation and many studies consider these tools as the most appropriate method in health services evaluation [19]. The elicited preferences techniques are generally applied to provide policy makers with useful directions in the decision process and for assessing the benefits provided by a specific healthcare scheme.

This methodology provides researchers the opportunity to collect comparable data, to understand individual trade-offs and identify benefits from services characteristics and at the same time provide a consumers' utility function [20, 21]. Some studies adopt this method to study innovative health technologies and non-market goods [19, 20] but also to elicit chronic pain patients' treatment preferences [22], hospital preferences and insured preferences for health system attributes [23]. By using a DCE, services and policies are described by their attributes. Respondents are asked what they would prefer amongst a basket of goods/services [24]. Specifically, a DCE includes several scenarios (or alternatives), as combinations of a set of the selected attributes and associated levels, and respondents are asked to choose the most preferred options. The importance of each attribute can be estimated through models which handle observed and unobserved heterogeneity [25]. Moreover, DCE applications for policy analysis allows one to estimate how choice probabilities vary with changes in attributes or attribute levels.

3. The empirical investigation

3.1 The study context

The empirical application focuses on Sardinia (Italy), where the healthcare integrates the public National Healthcare Service (NHS) and private health services. Public healthcare is mainly supplied at the major urban centers (Cagliari and Sassari), with emergency and cardiologic rehabilitation

units [26]. However, there is still a scarce availability of highly specialized cardiovascular healthcare and often users travel to the mainland for specific treatments. Hence, the Regional Plans of Prevention (PRP) 2010-2012 promote programs aimed at the prevention of cardiovascular diseases by raising awareness about risks related to incorrect lifestyle and involving medical and voluntary associations [27].

In Sardinia, healthcare expenditure is 9.8% of regional GDP. Healthcare expenditure in 2014 was equal to €3.23 billion (1,944 euro per capita), far above the national average and the similar Southern regions [28].

The island has one of the lowest inter-regional mobility index of 0.29, that is the ratio between the inflow and outflow rates, compared to an average of 0.43 in the south and 1.42 in the centre-north [29]. This index takes values larger than 1 when the Regional Healthcare System (RHS) is a net importer of patients from other RHS. The insularity condition represents an obstacle for patient mobility who has to rely on more expensive air and sea transport. Furthermore, an underdeveloped regional transport infrastructure limits public transport usage, preventing intra-regional mobility. In 2014, the percentage of people using public transport amounted to 15.3% [28].

3.2 The survey

The questionnaire contains three main sections: Section I, *The Health Expenditure* - within a 5-point Likert Scale from 1=complete disagreement to 5=complete agreement, respondents were asked to provide their view on several public policies aimed at reducing healthcare costs. Section II, DCE (*Analysis of Preferences on Cardiology telemedicine)*, contains 22 cards presented to the respondents to assess their preferences on Scenario B with respect to Scenario A (the status quo). This choice structure helped respondents to distinguish the most currently used health service, as a combination of the previous described levels, from the alternatives proposed under new policy scenarios that enhance telemedicine services. Section III, *interviewee's profile* - where socio-

economic and demographic information such as gender, year of birth, employment status, marital status, income class, as well as whether they belong to the health sector were gathered.

3.3 The discrete choice experiment

In the DCE application, services are described by four attributes and four or five levels (Table 1) that help to understand potential users' preferences for telemedicine services. Hence, the set of attributes and levels were selected on the basis of the geographical context which, as previously highlighted, presents high mobility costs.

TABLE 1 HERE

The first attribute includes five levels related to the preferences towards possible "***scanning mode"*** within the traditional as well as telemedicine services directed to circulatory diseases (e.g. electrocardiogram, doppler, holter, anticoagulant monitoring and treatments). The second attribute takes into account the "***location"*** where potential users can obtain telemedicine services. The levels were identified taking into account generic location where the services are currently supplied (e.g. abroad, mainland, province, region) but also at their own municipality where telemedicine services can be supplied by the family doctor or at the local pharmacy. Besides, these levels can be also regarded as a proxy of travel costs. A further attribute includes four levels related to the "***waiting list"*** identified according to the Italian survey of the health services waiting list [30]. The last attribute is expressed in monetary terms and represents the ***"cost"*** of a visit identified from the standard costs charged in the NHS and in the private system, and hence for potential telemedicine services, respectively [31]).

The scenarios were developed using a Hyper Greco-Latin (HGL) matrix [32] that in this case produced 22 congruent combinations based on the defined attributes and levels. The choice sets were generated automatically using SPSS. Each choice card contains two alternatives: an invariant option (Scenario A), containing the *status quo*, that remains the same in all the 22 cards, and an alternative option (Scenario B). The invariant option describes the most common consultation

system with average costs and characteristics. On the whole, the various scenarios describe different hypotheses about the fruition of telemedicine cardiology services. Table 2 provides an example of a given choice card.

TABLE 2 HERE

3.4 The sample and data description

A survey targeting the Sardinian population, who can be regarded as potential users, was conducted between February and May 2013. The target group was chosen on the basis of the general Sardinian population older than 18 years old and consists of a target of a minimum number of 1,900 observations, considering a 99% confidence level and a 3% interval error. The survey was conducted with face to face interviews by a group of trained students to randomly selected potential users. The interviewers had to select individuals within selected age segments (18-28 years old; 29-39 years old; 40-50 years old; 51-65 years old and >65 years old) and gender characteristics. These quotas were based on the distribution of residents in Sardinian as calculated on data retrieved from Italian National Institute of Statistics demographic data [33]. In this manner, it is possible to obtain a representative sample of potential users of telemedicine services. The trained interviewers had to randomly collect data on individuals according to these quotas and with a stratification by municipality (with a particular focus on the Centre and North of Sardinia).

Overall, 2,000 valid questionnaires were collected. A rather balanced gender proportion of the population has been obtained: 54.3% are female and 45.7% are male. The age distribution follows the sampling design, with the highest quota belonging to 51-65 years old; the median and the average equal to approximately 47 years. The income distribution is a mirror of the actual Sardinian economic conditions since 65% of the sample declared to own an annual income between 10 and 30 thousand euros. The great quota of the sample (64.5%) stated to have one or two children. A quota of 11.2% declared to have an income related to the health service sector.

4. Empirical results

This section presents the main findings from the empirical applications. In this paper, a random parameter logit with observed heterogeneity (RPH) is estimated in Nlogit 4.0, by applying a simulated maximum likelihood using Halton draws with 500 replications. The model assumes possible heterogeneity of individual preferences that may vary according to individual socio-economic characteristics (i.e. age, education, income). Besides, a two-step cluster analysis (TSC) is implemented to gather individuals in orthogonal groups to discriminate them according to their evaluation on public policy directed to enhance telemedicine. On this basis, a cluster RPH is applied to further assess the robustness of the findings from the previous RPH modeling and to explore the attributes that mostly affect individuals' utility within the clusters.

4.1 The random parameter with heterogeneity

The first model provides the results obtained for the all sample (Table 3).

TABLE 3 HERE

The pseudo R-squared value is one of the indicators of goodness of fit of the model. A pseudo R-squared values in the range of 0.20 to 0.40 can be translated as a standard R-squared value of between 0.70 and 0.90 for the equivalent linear model [32]. In this case, the pseudo R-squared value is 0.22 and hence can be regarded as good fit of the model [32].

Notably, the choice levels denote statistically significant coefficients with the only exception for the location of the cardiologic visit in Italy (i.e. *mainland*). A negative utility is detected for a visit with the family doctor as well as for the intermediation of a pharmacy. As far as the first attribute is concerned (***scanning mode***), the utility for potential users is higher for *intramoenia* services, private health services and NHS, respectively. Regarding ***location***, *municipality* is the most preferred one, followed by *province* and hence the *region*; individuals' utility decreases with a visit *abroad*. As expected, the longer the waiting list the less the utility. The cost of visit is included as a non-random parameter in the utility function, as in this kind of model it is common to keep the coefficient on

price as non-random [34]; the coefficient is statistically significant and negative as expected. The *intercept* presents a statistically significant coefficient at the 1% level and has a negative sign, which implies that respondents derive higher utility when choosing an alternative scenario with respect to the *status quo*.

As a further output, the derived standard deviation of parameter distribution is presented. These are calculated over each of the number draws and relate to the dispersion around the mean of the parameter. A not statistically significant coefficient indicates that the dispersion around the mean is statistically equal to zero. This suggests that all information about the respondents' preferences towards these variables is captured in the estimated mean. The null hypothesis cannot be accepted in the case of a visit through the NHS, *intramoenia* and the family doctor, implying a dispersion, and hence heterogeneity in the preferences of the sample. Hence, different individuals have their own preferences that differ from the mean estimated for the sample population.

4.2 The cluster analysis

The presence of heterogeneity is further investigated by adopting a two-step cluster (TSC) analysis, in order to identify groups with common characteristics and statistically different from the other clusters. The log-likelihood is used as a distance measure where continuous variables are assumed to be characterized by a normal distribution, while categorical variables are assumed to be characterized by a multinomial distribution and the variables are independent of each other. The Bayesian information criterion (BIC) is employed to determine the number of clusters [35].

The TSC identifies two distinct clusters that reflect their perceptions on a public policy directed to implement a sharing of information on their health, that is in line with telemedicine. As previously stated, the first section of the questionnaire contained a set of items and socio-economic variables that are included in the statistical specification as follows: introduction of new diagnostic approaches, introduction of new technologies, creation of a national database of medical records, greater sharing of medical records and evaluation of the waiting time for having a visit; the dummy

gender (1=female; 0=male) and the total expenditure per capita in cardiology health services are included as evaluation fields.

The silhouette measure of cohesion and separation is rather fair. The ratio of cluster sizes presents a value well below two (1.16) that implies that no cluster is more than two times larger than any other clusters. From the predictor importance, it emerges that the most important policy is the introduction of new diagnostic approaches followed by the introduction of new technologies (full results can be provided upon request). From Figure 1, Cluster 2 (*Highly favour towards telemedicine*) comprises of 348 respondents who evaluated the waiting time for a visit as rather short and is characterized mainly by female. This group tends to spend relatively more in cardiology health services, that is a little more than 50 euros against the global median of 30 euros. Cluster 1 (*Less favour towards telemedicine*) includes 299 respondents who evaluated the waiting time for a visit as fair, and is mainly characterized by males and individuals who spent a relatively lower amount in cardiology health services, that is around 44 euros but still more than the value of the global median.

FIGURE 1 HERE

4.3 Modelling the cluster random parameter with heterogeneity

Based on the TSC analysis, a further cluster RPH is carried out. Table A1 in the appendix provides the results obtained when considering Cluster 2 (*Highly favour towards telemedicine*).

Interestingly, robust results are obtained in terms of signs, statistically significant coefficients and in most of the cases coefficients magnitude. Overall, the results from the cluster RPH confirm that potential users obtain higher utility from *intramoenia* services and when the location of the health services is located in the municipality and province, respectively. Cost and waiting time negatively influence respondents' utility. All these findings are further validated when considering Cluster 1 (*Less favour towards telemedicine*) as reported in Appendix A (Table A.2). Nevertheless, from Table 3 (Cluster 2), less heterogeneity exists amongst individuals' preferences with the only exception for

having a cardiology visit abroad and at the NHS. Moreover, higher heterogeneity emerges for the Cluster 1 specification, especially for having a cardiology visit through *intramoenia* and at a pharmacy, as well as in the mainland and abroad.

5. Conclusions

This paper employed a DCE to capture and measure potential users' preferences towards a public policy directed to implement telemedicine cardiology services. The research was done in Sardinia (Italy) characterized by insularity and a rather limited limit inter and intra-regional patient mobility.

The empirical findings highlighted that potential users increase their utility by having a visit through *intramoenia* services, but would mostly prefer a visit in their municipality of residence. This suggests that telemedicine could be a good policy decision to meet potential users' preferences. However, some caution needs to be used as a negative utility is perceived when using alternative services provided by pharmacies and the family doctor. These findings contrast with other empirical surveys [36] that detect preferences towards general telemedicine services within the United States adult population that favor the use of such services through their own doctor. The explanation could lie in the level of service specialization proposed that, as for the present analysis is rather specialized and respondents may feel safer relying upon qualified personnel. As expected, costs and waiting time reduce respondents' utility, in line with the literature [18, 37]. For example, this is supported by prior research in telemedicine for dermatology [37]: patients were willing to pay more to shorten waiting times.

The analysis showed the importance of considering individual heterogeneity when a policy or service is evaluated. In this respect, two clusters were identified: those less favorable towards telemedicine and those highly favorable towards telemedicine. Potential users, who evaluated the average waiting time for a visit as fair, mostly male and individuals who spent a relatively lower amount in cardiology health services, were clustered in the first group. The second group, mostly female, included those who evaluated the waiting time for a visit as short. This group denoted a

relatively higher expenditure for cardiology health services. Respondents revealed caution towards telemedicine services that may be explained by an overall lack of awareness because of its limited diffusion, other than a common concern towards new technologies.

Cost and waiting time are confirmed to negatively influence respondents' utility. As expected, the minimization of time allocation and expenditure in health services are of primary importance for individuals.

Although the case study application was focused on a specific island, this paper offers important policy implications. A DCE represents a powerful tool to assess preferences of heterogeneous groups. Moreover, the potential role of telemedicine in increasing patients' utility by reducing costs and waiting times brings to the forth the need for increasing individual awareness on the beneficial effects of telemedicine services. This represents a priority especially in those remote and insular areas where distance represents an obstacle for the fruition of healthcare services. Indeed, telemedicine may contribute to improve patients' accessibility, reducing transport costs and waiting times, facilitating communication between patients and healthcare suppliers and guaranteeing a homogeneous geographical distribution of healthcare services.

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Table 1: Attributes and levels employed in the DCE

Attributes	**Levels**	**Description**
Scanning mode	NHS (Status quo)	Visit run at the hospital; this is one of the scanning modes that can be used in Italy as an alternative to the private system.
	Intramoenia	This is one of the scanning modes that can be used in Italy as an alternative to the private and public system, within the hospital.
	Private	This is one of the scanning modes that can be used in Italy as an alternative to the public system.
	Family doctor (telemedicine)	This is an telemedicine screening mode that can be developed within the NHS
	Pharmacy (telemedicine)	This level represents a screening mode that has not yet been developed on a large scale in Italy and Sardinia.
Location	Municipality	
	Province of residence (Status quo)	
	Region of residence	
	Mainland (Italy)	
	Abroad	
Waiting time (expressed in minutes)	0 days	The visit is made in the same day.
	2 days	This is considered as an intermediate waiting time for a cardiology visit.
	3 days	This is an average waiting time in Italy for a cardiology visit.
	4 days (Status quo)	The average waiting time in Sardinia for a cardiology visit in the NHS.
Cost of the visit (expressed in euros).	40 euros (Status quo)	Average cost paid to the NHS for a standard cardiology visit.
	62 euros	Average cost for a standard cardiology visit.
	90 euros	Intermediate cost for a standard cardiology visit from the private healthcare.
	120 euros	Maximum cost for a standard cardiology visit in the private healthcare.

Table 2: Example of choice card

CARD 6	Alternative A	Alternative B
Screening mode	National health system (NHS)	Private doctor
Location	Province of residence	Municipality
Waiting time	4 days	0 days
Cost	40 euro	40 euro
Preferred option	☐	☐

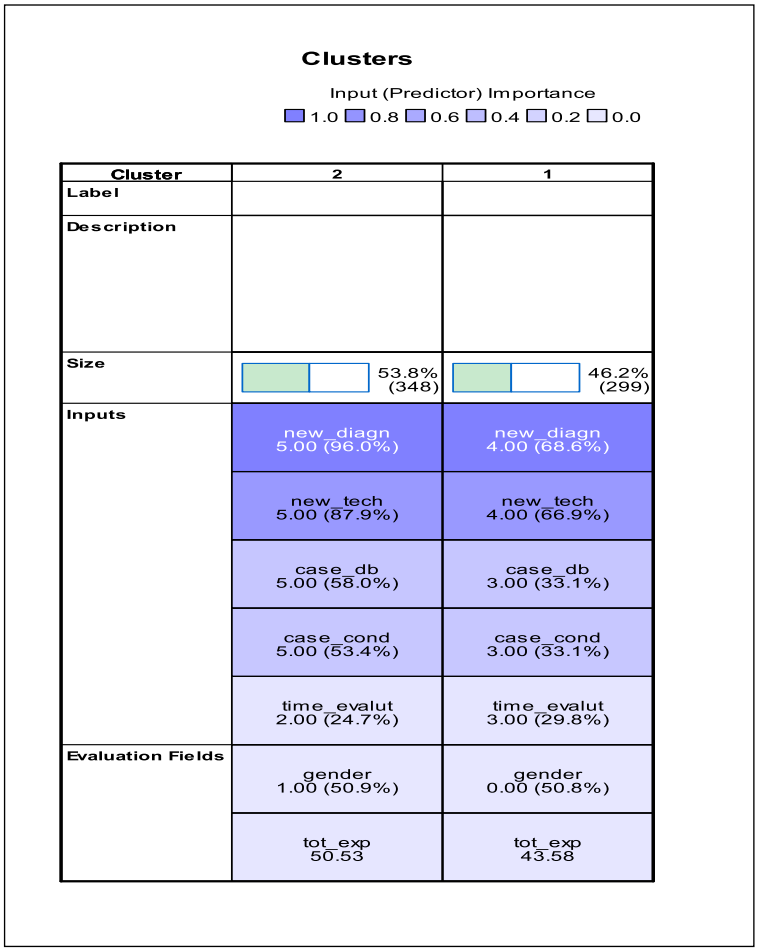
Table 3: Results for all potential users

Attribute level	Coefficient	Standard Error	Z
NHS	0.39872***	0.07985	4.99
Intramoenia	0.52520***	0.07167	7.33
Pharmacy	-0.75996***	0.06931	-10.96
Private	0.43060***	0.03433	12.54
Family doctor	-0.83651***	0.19259	-4.34
Province	1.48538***	0.08841	16.80
Italy	-0.32526**	0.16481	-1.97
Region	0.77021***	0.10859	7.09
Municipality	1.91928***	0.09787	19.61
Abroad	-0.56344***	0.10662	-5.28
Waiting time	-0.20844***	0.01825	-11.42
Nonrandom parameters in utility functions			
Cost	-0.03178***	0.00097	-32.80
Asc	-0.74293***	0.11984	-6.20
Random parameters distributions			
NsNHS	0.47212***	0.12696	3.72
Ns*Intramoenia*	0.89449***	0.17857	5.01
NsPharmacy	0.37613	0.31322	1.20
NsPrivate	0.01152	0.08837	0.13
NsFamily Doctor	1.31241***	0.43811	3.00
NsProvince	0.05897	0.08255	0.71
NsItaly	1.53946***	0.27017	5.70

NsRegion	0.31561	0.19726	1.60
NsMunicipality	0.03739	0.09068	0.41
NsAbroad	0.13978	0.16878	0.83
NsWaiting time	0.02113	0.01791	1.18
McFadden Pseudo R^2			0.27
R^2			0.22

***, **, * ==> Significance at 1%, 5%, 10% level.

Figure 1. Two-step cluster output



Appendix

Table A1: Results for potential users highly favour towards telemedicine

Attribute level	Coefficient	Standard Error	Z
Nhs	0.39255***	0.09872	3.98
Intramoenia	0.56067***	0.07299	7.68
Pharmacy	-0.75080***	0.06672	-11.25
Private	0.38506***	0.08357	4.61
Family doctor	-0.54214***	0.08280	-6.55
Province	1.48901***	0.09405	15.83
Italy	0.13604	0.11777	1.16
Region	0.82956***	0.10591	7.83
Municipality	1.92881***	0.10330	18.67
Abroad	-0.54459***	0.11514	-4.73
Waiting time	-0.20062***	0.01816	-11.05
Nonrandom parameters in utility functions			
Cost	-0.03052***	0.00119	-25.59
Asc	-0.72182***	0.13963	-5.17
Random parameters distributions			
NsNHS	0.40106*	0.24319	1.65
Ns*Intramoenia*	0.04686	0.48985	0.10
NsPharmacy	0.03674	0.64430	0.06
NsPrivate	0.14118	0.19367	0.73
NsFamily Doctor	0.08501	0.53906	0.16
NsProvince	0.02690	0.12110	0.22
NsItaly	0.26233	0.35587	0.74
NsRegion	0.14086	0.43370	0.32
NsMunicipality	0.05148	0.29439	0.17
NsAbroad	0.42124**	0.20472	2.06
NsWaiting time	0.01255	0.02091	0.60
McFadden Pseudo R^2			0.27
R^2			0.27

***, **, * ==> Significance at 1%, 5%, 10% level.

Table A2: Results for potential users less favour towards telemedicine

Attribute level	Coefficient	Standard Error	z
NHS	0.42860***	0.08551	5.01
Intramoenia	0.57649***	0.07355	7.84
Pharmacy	-0.73441***	0.07306	-10.05
Private	0.38691***	0.04684	8.26
Base	-0.58253***	0.09109	-6.40
Province	1.45854***	0.09212	15.83
Italy	-0.03270	0.15954	-0.20
Region	0.82209***	0.10951	7.51
Municipality	1.92289***	0.10082	19.07
Abroad	-0.70811***	0.13898	-5.09
Waiting Time	-0.20041***	0.01893	-10.59
Nonrandom parameters in utility functions			
Cost	-0.03008***	0.00099	-30.37
Asc	-0.72603***	0.12493	-5.81
Random parameters distributions			
NsNHS	0.21582	0.19756	1.09
Ns*Intramoenia*	0.62198**	0.27917	2.23
NsPharmacy	0.49525**	0.25077	1.97
NsPrivate	0.02527	0.26748	0.09
NsFamily Doctor	0.17428	0.29353	0.59
NsProvince	0.09353	0.09645	0.97
NsItaly	0.91927**	0.37322	2.46
NsRegion	0.06419	0.21189	0.30
NsMunicipality	0.22508**	0.09900	2.27
NsAbroad	0.78889***	0.18181	4.34
NsWaiting time	0.00924	0.01829	0.51
McFadden Pseudo R^2			0.28
R^2			0.28

***, **, * ==> Significance at 1%, 5%, 10% level.