The Impact of Electronic Information Resources in Portuguese Academic Libraries

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Libraries have an important place in the institutions of higher education. Assess the impact of these services has become a crucial issue in Librarianship and Information Science. The main aim of this paper is to show the final results of the study “The impact of electronic information resources in higher education in Portugal: a contribution to its analysis in the context of libraries” developed during 2009-2011. We implemented methods of various areas of knowledge (Statistics, Econometrics and Information Science), and we obtained an analysis of the results produced by access to electronic scientific information provided by the Portuguese electronic scientific information consortium Biblioteca do Conhecimento Online (b-on).

This article has five main objectives: i) to describe the use patterns of electronic and traditional resources in Portuguese academic libraries; ii) to estimate the value of the Portuguese electronic scientific information consortium b-on by using two alternative valuation methodologies (the value of the time saved by using this electronic resource; and the contingent valuation method to estimate how much the user is willing to pay for the service); iii) to relate the use patterns with the valuation of b-on; iv) to investigate whether the willingness to pay is influenced by a set of factors (the frequency of use, whether the user previously knew b-on or not, the type of the user, the scientific area of the user, and the institution of the user); and (v) to estimate the demand function of b-on services as function of the price and the previously mentioned factors. In order to achieve these objectives we use several regression analysis techniques – ordinary least squares Tobit model, linear probability model, Logit and Probit models.

Introduction
In the last 60 years, there has been an important increasing in libraries and documentation centers assessment processes in several countries around the world. Various indicators were designed to evaluate libraries (Poll & Boekhorst, 2007). Nowadays, the tendency is to measure the activities outcomes of the libraries services (Hernon, 2002), that is, analyze the impact that the actions of the library have on the end user, not neglecting the costs of services. Thus, the value of libraries and documentation centers can be translated by the changes that take place after the user interactions with the academic libraries services. These changes may result in new knowledge and skills that are probable to be translated into monetary values.

In a situation of economic crisis and under increasing pressure regarding the budgets is useful to calculate the ratio benefit/cost to justify to institutions tops which are the returns on investments. The quantitative and qualitative analyses are useful in the management of the libraries, to establish the best practices and improve the services. In this context, it is important to calculate the returns on investment in libraries and documentation centers of higher education in Portugal. In the last decades, the Portuguese academic libraries included the fast and easy access to digital libraries. To study this paradigm is relevant to analyze usage patterns, the degree of penetration, the ratio benefit/cost and the impact of digital library in the Portuguese academic community.

This paper shows usage patterns of traditional and digital academic libraries data, determinations of the use and value of the Biblioteca do Conhecimento Online (b-on) and the national scientific production. Nowadays the Portuguese electronic scientific information consortium (b-on – Biblioteca do Conhecimento Online) provides unlimited access to hospitals, research and academic institutions to the full texts of more than 16,750 scientific publications, via the internet, at a national level. This digital library was first planned in 1999. The OCT – Observatório das Ciências e Tecnologias – carried out an exhaustive survey of scientific journals signatures from all the Portuguese institutions to prepare for negotiations with publishers. In 2000, this digital library started giving access to an important and well known tool Web of Knowledge, from Institute Scientific Information, located in Philadelphia. This tool allowed access to titles, abstracts and citations of information and impacts of some 8,500 scientific journals, including records since 1945. Since 2005, the b-on service has made available the full texts of more than 16,750 publications. The monitoring and coordination of the
Portuguese electronic scientific information consortium b-on is secured by UMIC – Agência para a Sociedade do Conhecimento – IP. Its technical infrastructure, user support, training, relationship with publishers and other content providers is ensured by FCCN – Fundação para a Computação Científica Nacional (FCCN, 2008).

In this investigation it is assumed that the scientific and technological information provided by b-on is a good, thus it is possible to value this good in monetary terms based on the user's perspective.

**Methodology**

**Survey design**

Portuguese academic libraries users are a large population to study. However, nowadays, all the elements in this population use the Internet and electronic mail on a regular basis. For this reason we decided to send our questionnaire to all academic users in all the public Portuguese higher education institutions (universities and polytechnic institutes) instead of sending it only to a sample of the population. The questionnaire was sent using the users’ mail lists in the various institutions (with the help of the library directors). For a population familiar with electronic services the e-survey is the easiest way to get responses. The questionnaire included questions to characterize the respondent (name of the institution, type of user, user’s scientific area), questions to characterize the respondent’s pattern of use of library services (type of library use – traditional, digital or both; knowledge of the b-on service; type of information resources use; type of search engine use; place where the user accesses library e-resources) and two questions related to the respondent’s valuation of the electronic scientific information consortium b-on (number of hours saved by using the electronic scientific information consortium b-on and maximum willingness to pay (WTP) to continue to access this electronic service).

**Time saved evaluation**

Some researchers argue that the time valuation is a method that libraries often use to determine their value (Griffiths & King, 1996; Koenig, 1992) Troll argues that users do not have enough time and this fact induces users to increase the use of electronic academic resources for research, learning and teaching (Troll, 2001). The time saved on using electronic resources has a very positive impact on their abilities to do their work (Brown et al., 2007). Chung assumes the time saved to calculate the value of the benefit realized through the use of Physiques and Chemistry resources (Chung, 2007).

**Contingent valuation method**

The contingent valuation method (CVM) has been increasingly applied to cultural resources (Noonan, 2003) and thus it is a natural candidate to estimate the monetary value of library services. In fact, in the last decade, some authors have used the contingent valuation method for monetary valuations of libraries services (Aabo, 2005; Barron et al., 2005; BritishLibrary, 2004; Elliott et al., 2007; Hider, 2008; Holt & Elliott, 2003; Holt et al., 1999; McDermott, 2002; Morris et al., 2002) e.g. of public libraries (Harless & Allen, 1999), academic libraries (Chung, 2007) and special libraries.

In this study we consider the contingent valuation method (CVM) based on the willingness to pay, WTP, to value in monetary terms the electronic scientific information consortium b-on, available in Portuguese academic libraries.

**Sample**

In this study, the Portuguese academic population was stratified by type of user (professor, PhD student/researcher, graduate students, undergraduate students and others, such as library staff and anyone else who works at the university) for the various areas of knowledge (Physiques and Chemistry Sciences, Humanities and Social Science, Earth and Planetary Science and Life and Health Sciences, Engineering, Mathematics and Computer Sciences) from different institutions of higher education in Portugal (ISCTE – University Institute of Lisbon, University of Azores, University of Algarve, University of Aveiro, University of Beira Interior, Catholic University of Portugal, University of Coimbra, University of Évora, University of Lisbon, University of Madeira, University of Minho, New University of Lisbon, University of Porto, University of Trás-os-Montes and Alto Douro and various Polytechnics Institutes).

During four months we obtained 1930 valid responses. The sample collected is representative of the population and it is possible to extrapolate conclusions. The statistical inference determines parameters of the study population, which we estimated from the sample. In the analysis of qualitative variables we used contingency tables. Data analysis were carried out comparisons of means, including ANOVA, and regression analysis that included regression models when the dependent variable is binary - linear probability model (MPL), Logit and Probit models, and regression models when the dependent variable is continuous - multiple linear regression model and Tobit model.
Analysis of the results

Use patterns of electronic and traditional library services

Users

In the last decade, many research studies have investigated how people use electronic resources in the academic community. Most of this literature reveals use patterns of the information searching behavior (Haglund & Olsson, 2008; Kerins et al., 2004; Malliari et al., 2009; Martell, 2007; Pors, 2008; Tenopir, 2003; Tenopir & Read, 2000).

As mentioned above, our e-survey included several questions with the purpose of giving us a picture of the current use patterns of electronic services in the Portuguese universities libraries. In particular, we are interested in the comparison between different types of users. We considered five groups of users: professor, PhD students/researchers, master’s students, undergraduate students and others. In order to characterize the use patterns, we analyzed the data with descriptive statistics (frequency tables and graphics).

The most relevant results obtained for the use patterns of digital information of academic libraries, by type of user are as follows (Melo & Pires, 2011a):

The population of the higher education shows relatively high levels of concurrent use of traditional and digital libraries to support their teaching, research and learning. As recognized in international studies on the informational behavior, it seems that the different patterns of behavior are based on professional information needs of the user (Pors, 2008).

The undergraduate students are the group that use more frequently the library facilities (traditional libraries) and search the publications on the shelves. These groups use moderately the reference services (online catalog and library staff).

The undergraduate and postgraduate students showed a greater ignorance of Biblioteca do Conhecimento Online (b-on) services.

Professors and PhD students/researchers use the "hybrid" library in good proportion.

Academic libraries staff use very frequently scientific technological information on Open Access to respond to library users requests. This pattern is not surprising since many of these professionals participate on Open Access initiatives to create and maintain institutional archives and repositories. Librarians and information managers of higher education have worked hard in promoting the use of Open Access scientific and technological information. However, our results show that full text magazines have double use, in relation to Open Access information in Portuguese academic community. Librarians must continue work in the creation of repositories and their disseminations to minimize costs. On the other hand, it is essential establish news criteria, to this type of information, in order to get more quality and credible such like the scientific information acquired by purchase. Nowadays, in several countries and in Portugal the governmental entities have evaluated the knowledge production in function of the paid journals. These criteria reflect the results of the study, which is, paid journals are more used.

Google is the starting point for many searches on the Internet. In the academic community, many users have reported starting their research with Google to find content that they know already exists, for example, a particular website that connects to full-text books, professional associations, (academic or non-academic) or government institutions (McMartin et al., 2008). This behavior is a common standard of research (Smith et al., 2003) and suggests that Google has become a reliable tool, as already identified in previous studies (Manduca & Fox, 2006; Pors, 2006). McMartin et al. (2008) emphasize that the links between educational digital libraries and search engines create a set of synergies conducive to easy access to the contents of digital libraries and provide greater quality of information accessed on the Web. The results from this investigation show that pattern behaviour is similar in the Portuguese academic community. Google is a fundamental tool to start any search for scientific and technological information on the WWW. Concerning this evidence it is important to build links between educational digital libraries and search engines to create a set of synergies that facilitate easy and fast access to the content of the digital libraries via Internet.

Scientific areas

Data analyses also show the use of digital resources pattern by area of science (Melo, 2012). It is clear that the academic community with access to e-resources, has a faster and greater access to global scientific research. Currently people have rapid access to a huge amount of quality scientific information, therefore to know the use pattern of information in the academic environment, by scientific area is especially important. In the present study, we considered various groups of scientific areas base on the Web of Knowledge categories (Thomson - Reuters).

The results show that users of the Engineering and Humanities and Social Science are the ones who use more the buildings of the university libraries. There is a decreasing occupation of libraries, respectively, by persons of Mathematics and Computer Sciences, Physiques and Chemistry Sciences, Earth and Planetary Science and Life and Health Science. This evidence may occur because certain users of specific scientific areas work harder in laboratories and out side of the university, therefore, a significant fraction of these groups does not use the library
facilities to get the information available in academic libraries.

On the other hand, data show that the best way to find scientific information for these groups is using the hybrid library (books, journals and digital resources). The use of digital library is a very significant feature in the users of Physiques and Chemistry Sciences, Earth and Planetary Science, Life and Health Science areas. They use scientific information in various supports – textual, numerical and images.

Users of the Humanities and Social Science manifest less use to the e-resources. Probably they feel more difficulty in "handling" an interface computer, less appreciation for the digital resources and a special interest for printed documents (books and journals on paper).

In all scientific areas considered the use of e-resources, provide by academic libraries, have a moderate level of remote access, except for Earth and Planetary Science. These areas reveal that this information is used every day of the week and anytime.

The study also shows that people from all scientific areas, except for the Social Humanities and Social Science, access to information in the campus of the institution with their own laptop. This trend may be a highlight because the Portuguese government has made many investments, over the past five years, providing wireless network at the campi universities and financial support to purchase laptops for young people. The library catalog is a major secondary source of information to find the location of a publication in a library. Humanities and Social Science users are the ones who use most this resource. In all other areas the level of use is poor. It is urgent to promote the use of this useful resource.

The group of Life and Health Science shows a moderate level of use of digital sources is Open Access. In the other areas the access to scientific information in Open Access is minor.

Google is the main starting point for the research of scientific and technological information on the WWW in the Portuguese academic population for the various scientific areas.

Value of the time saved by using b-on

The monetary value of the Biblioteca do Conhecimento Online (b-on) is important in the context of the information provided by universities to the academic population of Portugal. To assess the value of electronic sources we used two different methods: valuing the time gained by the user of the b-on services, and determine the maximum amount that each type of user is willing to pay for this non-material good.

The academic members do not have enough time to spend in the learning activities, research and teaching. This leads to an increasing use of digital resources. We considered the average wages of professor and financial support for students for hours to determine the value of the time saved by using scientific information electronic resources by each type of user per month and per year. The idea is that each hour saved in accessing journals can be used in some other activity (for instance, writing papers, working on the PhD or masters theses or preparing classes), thus we can value each hour by the value that it would have in these alternative uses. Adding up the value of the time saved for all the groups, we obtained an estimate of the benefits of the Portuguese electronic scientific information consortium, b-on. Using this estimate we calculated the benefit–cost ratio for this resource, obtaining a ratio 2.54:1 based on the estimated benefits of time saved by using the e-resource (Melo & Pires, 2011a).

Willingness to pay for the b-on services

In this study we consider the contingent valuation method (CVM) based on the willingness to pay, WTP, to value in monetary terms the electronic scientific information consortium b-on, available in Portuguese academic libraries. In this research we considered a hypothetical scenario and the academic users were requested to answer to the following question: ‘Suppose that the Portuguese electronic scientific information consortium b-on stopped its services. However you may continue having access to this service by paying a monthly fee, with values ranging from 5 to 50 Euros. How much are you willing to pay per month to continue having access to the scientific information consortium b-on?’

The range (€5 to €50) proposed in this study was based in data from the FCCN (2008).

Harless and Allen (1999) argue that ‘in contingent valuation studies, it is common to have some participants who, at least initially, refuse to answer or respond that their maximum WTP is zero as a protest response’. To solve this problem we decided to analyze the data in two different manners. In the first approach we considered all the users including those who do not want to pay anything for this service. This approach will underestimate the true total willingness to pay as some zeros are just protest answers and thus do not really mean that the user does not give any value to the service. In the second approach we excluded all the users who declared having a zero WTP and consider the frequency distribution among the positive WTP values. This approach overestimates the total WTP since some zeros might be truthful, that is, some users might not give any value to the service. By using these two approaches we are able to obtain a lower bound and an upper bound estimates for the users WTP.

Using the average willingness to pay per group and the number of people in each group in the population excluding the “Other” user categories (see Table 1) we estimated the
value of the benefit–cost ratio. When one includes null values (1930 answers), the ratio is equal to 1.91:1 while when null values are excluded (1157 answers) the ratio is equal to 3.32:1 (Melo & Pires, 2011a).

Table 1. Frequency of maximum willingness to pay (WTP) to continue to access Portuguese electronic scientific information consortium b-on. The hypothetical scenario considers that the user needs to pay a monthly tax with values ranging from 5 to 50 Euros

<table>
<thead>
<tr>
<th>User</th>
<th>Accepting null value (Euros for month)</th>
<th>Not accepting null value (Euros for month)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Professors (%)</td>
<td>3.6</td>
<td>2.4</td>
</tr>
</tbody>
</table>

The results showed that the services of the national consortium of scientific and technological information b-on, accessible in the institutions of higher education in Portugal, on the whole, are valued higher of its cost by the end-user perspective.

Data analysis of the relationship of the b-on value, respectively, the value of time saved and the total use of digital resources show that in monetary terms the value of b-on is higher for groups of users with greater use percentage of e-resources and greater knowledge of the existence of b-on.

Factors that influence the amount a user is willing to pay for the b-on services

In the second part of the study we identified the factors that influence the amount a user is willing to pay for the b-on services and to understand the factors that explain whether an individual is willing or not willing to pay a certain amount to access b-on. In the first case we want to explain the amount a user is willing to pay (a quantitative variable). In the second case we want to explain whether an individual is willing or not willing to pay a certain amount (a qualitative variable that can either be ‘yes’ or ‘no’). Regression analysis is particularly well suited to achieve our two objectives. In fact, regression analysis can be applied when we want to study whether a set of independent (or explanatory) variables help to explain the behaviour of a dependent (or explained) variable, which is precisely our case.

In our study (Melo & Pires, 2011b), the explanatory variables of the willingness to pay (WTP) to access b-on are the frequency of use, whether the user knew previously b-on or not, the type of the user, the scientific area of the user, and the institution of the user. To explain the probability of the user being willing to pay a certain amount to access b-on we use the same set of variables and the access price as explanatory variables. It should be noted that all our explanatory variables, except the frequency of use, are qualitative variables. The variable previous knowledge of b-on is a dichotomous qualitative variable (yes or no). To include dichotomous variable in the regression we have to transform it in a binary variable (dichotomous variable) that takes the value 1 when the answer is «yes» and takes the value 0 when the answer is «no». The variable type of user is a categorical variable with five categories (professors, researchers PhD students, master students, undergraduate students and others). The variable scientific area of the user has six categories (Life and Health Science, Physiques and Chemistry Science, Humanities and social Science, Earth and Planetary Science, Mathematics and Computer Science and Engineering). Finally, the variable institution is divided in the following categories: University of Algarve, University of Aveiro, University of Coimbra, University of Évora, University of Lisbon, New University of Lisbon, University of Oporto, Technical University of Lisbon, University of Coimbra, Other Universities and Polytechnic Institutes.

The dependent variable is continuous in the data analysis of the factors that influence the maximum amount a person is willing to pay for b-on services. In this case, we used, respectively, the multiple linear regression model and the Tobit model.

The study of the factors that influence the likelihood of the user is willing to pay a certain amount to b-on services the dependent variable is binary. For this analysis we used linear probability models, the Logit and Probit. It is important to note that the interpretation of the coefficients in the regression models Tobit, Logit and Probit is not simple, as in linear regression. This happens because the dependent variable is a nonlinear function of the explanatory variables. To solve this problem, instead of analyzing the values of regression coefficients, we observed the average marginal effects.

Comparing the maximum values that a user is willing to pay for access to scientific b-on information service: the amount increases with the frequency of e-resources use, is superior to a reader of Life and Health Science, Physiques and Chemistry Sciences, Social Sciences and Humanities than for other scientific areas, is higher for users who knew previously the b-on services, and is lower for people from University of Lisbon.

The three regression models used to identify the factors that influence the likelihood of a user be willing to pay a certain amount to access b-on services (linear probability models, Logit and Probit) all have as dependent variable the binary variable that is equal to 1 when the user is willing to pay a certain amount to access b-on and equal to 0 when the user is not willing to pay a certain amount to access b-on. The reason that we used the binary variable is that the dependent variable is a dichotomous (i.e., yes or no) variable. Regression analysis is particularly well suited to achieve this type of dependent variable, as well as to our objectives. In fact, regression analysis can be applied when we want to predict whether a set of independent (or explanatory) variables help to explain the behaviour of a dependent (or explained) variable, which is precisely our case.
model, Logit and Probit) show similar results. The following explanatory variables are statistically significant: the price of access to b-on, the frequency of use digital library, the user is professor or belong to the category "Other", the user is from Life and Health Sciences or Earth and Planetary Science. It was found that the Logit model is the one that best fits the data obtained (Melo & Pires, 2011b).

The hypotheses studied and supported by the obtained results are as follows:

The maximum willingness to pay to access the Biblioteca do Conhecimento Online (b-on) increases with the frequency of use;

The maximum willingness to pay to use b-on services varies with the type of user:

It is higher for people who more often access to information as a resource for production new scientific knowledge;

The users who use the digital library services more frequently present a higher probability of paying to access b-on;

Among the various types of users, the Professor category is the one that shows higher probability of buying the b-on services;

The results reflect the fact that information is an experience good, since the users who already knew b-on, and hence who have less uncertainty regarding its value, are willing to pay more than the users who did not know b-on; and,

The results are according to economic theory, since the demand for b-on services is decreasing with its price and the users who use b-on more often are willing to pay more to have access to the b-on services (Melo & Pires, 2011b).

Finally, using data at the institutional level, we studied the relationship of the use and monetary value of Biblioteca do Conhecimento Online (b-on) with the scientific production.

The b-on use was considered as a function of the number of downloads made by each institution, in 2007. The University of Aveiro stood out with greater amount of downloads per professor followed by the University of Minho, Algarve and Porto. In 2007, the professor of University of Aveiro showed the best scientific production (i.e., more published articles by professor) (Melo, 2012).

**Conclusions**

This study presents some limitations. We report some solutions to problems in future studies.

The dimension of sample by scientific areas was the following: 20.50% Physiques and Chemistry Sciences, Mathematics and Computer Science, 21.30% Humanities and Social Science, 5.4% of Earth and Planetary Science, 26.00% Life and Health Science, and 26.80% Engineering. This sample is representative of the Portuguese academic population. However, we note that it is possible exist a bias in this composition in relation to the scientific areas and the various Portuguese higher education institutions. It was evident throughout the data collection a higher number of responses of the Faculties of Science and Engineering at the University of Porto.

This seems to influence the results of the use of library facilities by the Engineering group. For example the Faculty of Engineering library is excellent, large, modern, and equipped with a lot of computers and an outstanding background and updated bibliography. In further investigations it will be important control the sample size on the proportion of the number of responses obtained in the various institutions.

The e-survey of the academic users was conducted as an online questionnaire. This process offers a quick return, a control of the responses and a standardized set of information. Despite these advantages, there is a bias in the selection of data associated with this research method. Maybe people who work more with electronic information services reveal a greater willingness to respond to e-surveys. To minimize this problem it is suggested that in future research data collection will be by questionnaire conducted simultaneously in two different supports - digital and printed on paper.

The conclusions from the study of the maximum amount that a user is willing to pay (WTP) to Biblioteca do Conhecimento Online services (b-on) will lead to consider the following important factors to study in future research:

Age - The academic population presents a wide age range, it will be important to analyze the variation of the maximum willingness to pay for the electronic information services in function of the age.

Gender - During the last decades a growing number of people attending the female gender has appeared in the academic community. In this context, we advise not only gender studies in relation to variable WTP but also in relation to variables using the traditional and digital libraries and the production of scientific articles.

Household income - This variable is considered in most economic studies and becomes very useful in the estimation of the demand function of the Biblioteca do Conhecimento Online (b-on) services.

Number of scientific publications produced by the respondent - The study related the use and value of b-on with the production of scientific and technological knowledge can be improved with the inclusion of questions, about the scientific production of the respondent, in the questionnaire, for example the number of scientific articles published (either in international journals or in...
Portuguese regular journals) and eventually to the intensity of b-on use. If these variables are included it will be possible to have relations between the WTP with the individually publication of the users (and not only at institutional level).

Other limitation of this study is the calculation to identify the value of benefits, in monetary terms, of Biblioteca do Conhecimento Online. This measure does not include the category "Other" (consisting mainly of library staff and administrative staff of academic institutions) in Portuguese academic population. But more remarkable this issue is that the determination of this value only pondered the so-called "use value" (value given by people who do not use this material as well). Assuming that Biblioteca do Conhecimento Online (b-on) is involved in scientific and technological production of the country this information service may be of value to non-users.

It is also useful to carry out questionnaires to people who do not use scientific information of b-on services and estimate the "non-use value." The society in general benefits of scientific and technological capacity, which will intervene directly in the development of the several areas, such as, health, education, quality of products and services, ie, in the overall improvement of citizens’ life quality. The B-on value to society is probably much greater than the value for the readers of b-on. If the b-on has a positive impact on the production of scientific knowledge, the society wins major benefits of B-on. As a result, the monetary valuation of users is only one component of the total B-on. A more complete study should include the estimated value of the "non-use value" B-on.

It is important to study the changes that have occurred in users who use the digital scientific information resources available in academic libraries is still one other way possible. It is helpful to measure the behavior changed of teachers, researchers and students of the Portuguese academic community.

Other point of view will be to research current practices of teaching, learning and knowledge production using scientific information on the Internet. Understanding how the people of this particular community use of digital information. Understanding what skills they have or not to find information on the World Wide Web environment Understand the feelings that people have about the digital scientific information paradigm by gender and age.

These elements provide clues for future work about the impact of electronic information sources on the population of Higher Education in Portugal.

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