

Silva, Rita Filipe; Proença, Isabel; Vareda, João

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## Dynamics of broadband demand: Substitution or complementarity between fixed and mobile technologies? An application to the Portuguese case

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# DYNAMICS OF BROADBAND DEMAND: SUBSTITUTION OR COMPLEMENTARITY BETWEEN FIXED AND MOBILE TECHNOLOGIES? AN APPLICATION TO THE PORTUGUESE CASE\*

WORKING VERSION

RITA FILIPE SILVA †, ISABEL PROENÇA‡, JOÃO VAREDA±

## ABSTRACT

The development of the broadband market is a key aspect of the economic and social growth of a country. However, despite the importance and the development of broadband market in Portugal in recent years, especially with the explosion of the number of mobile broadband accesses, the studies for the Portuguese case are rare.

The present paper seeks to contribute to the discussion about the definition of the broadband market in Portugal, specifically studying the demand for broadband Internet and measuring the determinants that explain the use of each of the technologies available to provide broadband access, with emphasis on the differences between fixed and mobile accesses. Demand broadband functions were estimated using nested logit and multinomial discrete choice model. The primary source of information was ANACOM's Electronic Communications Services Consumption Survey, complemented with price information regarding the offers available in the market.

The estimations obtained for the elasticities point out the probable existence of substitution between ADSL and cable and between these fixed broadband technologies and the mobile broadband. However, the inverse relation is not statistically significant, the demand for mobile broadband isn't constrained by the price of ADSL or of cable, which may reveal the existence of asymmetric substitution between fixed and mobile broadband accesses. These results have implications in the definition of the broadband market in Portugal which will be discussed.

**Keywords** Broadband, Market Definition, Demand, Regulation, Fixed-Mobile Substitution.

**JEL Classifications** L51 L96

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\* The opinions expressed in this article reflect only the authors' views and do not bind the institutions to which they are affiliated.

† ANACOM, Avenida José Malhoa, n.º12, 1099 - 017 Lisboa, Portugal; E-mail: [rita.silva@anacom.pt](mailto:rita.silva@anacom.pt).

‡ ISEG, School of Economics and Management, and CEMAPRE, Technical University of Lisbon; Rua do Quelhas 6, 1200-781 Lisboa, Portugal; E-mail: [isabelp@iseg.utl.pt](mailto:isabelp@iseg.utl.pt).

± AdC, Avenida de Berna, n.º 19, 7.º, 1050-037 Lisboa, Portugal. E-mail: [joao.vareda@concorrencia.pt](mailto:joao.vareda@concorrencia.pt).

## **1. INTRODUCTION**

Broadband (BB) is a critical element of economic progress: drives growth, stimulates innovation and creates new fields of economic activity. In developed economies Internet represents about 10% of GDP. The BB market is enormous and its impact on social welfare is revolutionary: the amount of information available is massive, BB accelerates the diffusion of information and reduces transaction costs through electronic commerce, reducing delivery costs and thus making available a wide variety of services from entertainment services to e-learning and e-health.

The relevance of BB for the economic and social development is one of the motivations of this paper, thus it is important to study the characteristics that influence demand and Internet access in Portugal.

In the European Union (EU) electronic communications regulatory framework, BB market definition has been warmly discussed, namely if shall include cable and, in a more recent debate, mobile broadband (MBB). This last discuss was initiated by the Austrian regulator (RTR), which concluded that fixed broadband (FBB) and MBB access services shall constitute the same market. This conclusion was made through an empirical analysis of the market and by conducting a “small but significant non-transitory increase in price” (SSNIP) test that using elasticities based on a survey, indicated the existence of substitutability between MBB and FBB services. In line with this approach is other goal of this paper: contribute to the discussion about BB market definition and substitutability between fixed and mobile accesses in Portugal, using a similar methodology to calculate the SSNIP test and assess about BB market definition. With this aim we will use discrete demand models and analyze the individual characteristics of consumers that explain the access to different BB technologies, identifying usage patterns. Then, we will analyze the competitive pressure which MBB exerts on FBB, to assess whether MBB shall be included in the same market. With this objective we will estimate own and cross elasticities for MBB and FBB technologies for the Portuguese market.

The Portuguese market is particularly interesting to study this question as the MBB penetration rate more than tripled in the past five years and is higher than the FBB rate of penetration (32.9 accesses per 100 inhabitants compared with 22.6 for MBB).

Finally, this paper aims to contribute to the debate about the substitution between fixed and mobile access technologies, as there are few specific studies about BB demand, particularly in Portugal.

## **2. BROADBAND MARKET IN PORTUGAL**

The analysis of the number of accesses using different technologies shows that all types of access continue to show an upward trend in 2012, with the exception of ADSL. The higher increase is in MBB penetration rate, but FBB accesses continue to grow, which may indicate complementary. Portugal is in a good position in the EU penetration rate ranking in what matters MBB accesses through cards (11<sup>th</sup> position in the EU in 2012, above the EU average). This tendency was significantly influenced by the dissemination and development of the

program “e-initiatives”<sup>2</sup>, which allowed, under certain conditions of eligibility of the users, the provision of computers with Internet MBB connection under favourable terms.

Table 1 – BB penetration rates (%)

|   | 2008 | 2009 | 2010 | 2011 | 2012 | var. (p.p)<br>2012/2011 |
|---|------|------|------|------|------|-------------------------|
| <b>Fixed Broadband Accesses</b>         | 15,9 | 18,0 | 20,0 | 21,2 | 22,6 | 1,4                     |
| ADSL Accesses                           | 9,4  | 10,3 | 10,5 | 10,4 | 10,2 | -0,2                    |
| Cable modem Accesses                    | 6,3  | 7,2  | 8,1  | 8,5  | 9,0  | 0,5                     |
| Optical Fibre and other types of access | 0,2  | 0,5  | 1,4  | 2,2  | 3,4  | 1,2                     |
| <b>Mobile Broadband Accesses</b>        | 10,9 | 20,4 | 24,1 | 27,7 | 32,9 | 5,2                     |
| MBB using cards/active modems           | 8,3  | 11,3 | 12,0 | 10,7 | 9,3  | -1,4                    |

Source: ANACOM, Situation of Communications.

Another important aspect of BB market in Portugal is the expansion of offers in bundles, including triple-play or quadruple play: in 2012, 44.3% of the households have a triple or quadruple-play offer. Specifically regarding triple-play, Portugal occupied in 2012 the fourth position in the EU ranking.

From the point of view of the consumer there is a need: access and use BB Internet services. Therefore, in principle is indifferent the technology or network in which these services will be provided. More than the specific technology, for the end user is important the features that each type of access allows (e.g. speed, quality, coverage, mobility).

In what matters FBB, cable and ADSL exhibit very similar features from the point of view of end users (permanent access, speed and equivalent quality), so these technologies satisfy similar needs. Based on these similarities and considering other factors which indicated the existence of substitutability between ADSL and cable access, ANACOM, in the last BB market access analysis (i2009) maintained the position that, from the point of view of demand and supply, ADSL and cable access services are substitutes and belong to the same retail market.

On the other hand, as shown in the table 2, the differences in terms of cost and access speeds between the FBB and MBB have been strengthening.

Table 2 – Difference of average prices and download speeds between FBB and MBB

|     |                                 | Average Price (€) |      |      | Average Download speed (Mbps) |      |      | Price/Mbps |      |      |
|-----|---------------------------------|-------------------|------|------|-------------------------------|------|------|------------|------|------|
|     |                                 | 2010              | 2011 | 2012 | 2010                          | 2011 | 2012 | 2010       | 2011 | 2012 |
| FBB | ADSL (stand-alone)              | 26.6              | 25.8 | 25.2 | 9.5                           | 9.0  | 9.2  | 2.8        | 2.9  | 2.7  |
|     | Fiber (includ. fixed telephone) | 40.0              | *    | *    | 76.7                          | *    | *    | 0.5        | *    | *    |
|     | Cabo (stand-alone)              | 34.3              | 35.9 | *    | 17.6                          | 25.0 | *    | 1.9        | 1.4  | *    |
| MBB | Cards/Modem                     | 27.8              | 26.0 | 23.0 | 7.8                           | 8.8  | 30.0 | 3.6        | 3.0  | 0.8  |
|     | Mobile Phone Internet           | 10.3              | 10.3 | 11.6 | 4.1                           | 4.1  | 18.0 | 2.5        | 2.5  | 0.6  |

\* No existing stand-alone offer

Source: Situation of Communications ANACOM 2010, 2011, 2012

<sup>2</sup> Program active from end 2007 until 2010.

Additionally it turns out that the majority of FBB offers supports triple-play offers that include (in addition to fixed telephone) television and access to streaming, which MBB does not allow. The main advantage of MBB is its inherent mobility, which permits the use of the service anywhere with a unique contract.

We resumed some qualitative arguments that seem to support the existence of substitutability between MBB and FBB. Thus, it is clearly relevant to continue this discussion in empirical terms by estimating discrete choice models for the BB demand in Portugal.

### **3. LITERATURE REVIEW**

#### **3.1. REGULATORY FRAMEWORK FOR ELECTRONIC COMMUNICATIONS IN THE EU**

According to the EU regulatory framework for electronic communications, the national regulatory authorities of each Member State must review periodically the markets that are subject to *ex ante* regulation. In the 2007 Recommendation, the European Commission (COM) defined the relevant markets candidates to the imposition of *ex ante* regulation, which includes the wholesale market of network infrastructure access (market 4) and broadband access (market 5). These are the wholesale markets that are more directly related to the BB service available at the retail level and, therefore, the obligations imposed on these markets seek to eliminate existing competition problems in the BB retail market.

If a company has significant market power (SMP) in a market, regulators must apply *ex ante* remedies to prevent anti-competitive practices and abuse of dominant position and promote competition. Before analyzing the potential existence of SMP it shall be define the relevant market. The COM has created guidelines for the SMP assessment, which follow EU competition law, defining the relevant markets as the intersection of the size of the product and geographic markets.

For the product relevant market the aim is to identify all products and services sufficiently substitutable or interchangeable. Products or services with a limited substitutability are not part of the same market. Products are part of the same relevant market if the behaviour of producers and suppliers is subject to the same kind of competitive pressures, particularly in terms of prices.

The methods used for assessing the existence of substitutability on the demand side include the application of the hypothetical monopolist (HM) test. There are several versions of this test, but the COM defined it as examining whether a non-transitory increase of 5-10% will be profitable for the HM in the relevant market. The smallest set of services to which this price increase can be sustained is the relevant market.

The COM indicates that the responses of consumers and businesses to the hypothetical price increase will help determine if there are substitute products and, if applicable, the limits of the relevant market. That is, if the cross elasticity between two products is high, we can in principle conclude that consumers perceive these products as close substitutes.

One of the objectives of this thesis is precisely to look at the demand-side substitutability BB retail access, estimating the price elasticities for the various BB types of access.

Market definition of BB retail and wholesale broadband markets has generated attention and even controversy in the regulatory environment. It is noteworthy the notification to the COM of BB wholesale access market by OFCOM, ANACOM and other regulators. These regulators concluded that accesses using cable networks and using copper networks (xDSL) constitute the same market when there wasn't wholesale broadband access offer supported in cable networks. There wasn't, therefore, a direct and effective substitutability at the wholesale level between these networks.

In this context it shall be considered the existence of significant indirect constraints, which was exactly the argument used by the regulators: the HM of ADSL access could not raise the prices of wholesale bitstream profitably by 5-10%, since, on certain conditions, this would increase the retail prices of the ADSL offer, which would make customer switching from ADSL other technologies which maintained the prices. If the retail substitution is strong enough, the increase in the wholesale price will not be profitable since the accesses given through another retail network cease to be supplied also at the wholesale level. The retail elasticity of demand is thus crucial not only for the definition of retail markets but also for the definition of BB wholesale market. The COM, which considers that the indirect constraints should only be considered when assessing SMP and not on market definition, ask the regulators to demonstrate the retail elasticities of demand to validate the existence of indirect constraints.

BB market analysis obtained even more controversy in 2009 with the notification of this market by RTR. By examining the BB retail access market, RTR concluded that FBB and MBB constitute the same market, taking into account, *inter alia*, that MBB accesses represent a significant share of the total market and observed a massive growth; that about 25 % of MBB accesses were used in a complementary way with fixed networks accesses; data revealed that there was a growing number of end users who have switched FBB access by MBB; the SSNIP test, made through the use of questionnaire carried out to end users, indicated the existence of substitutability between MBB and FBB.

In Portugal, ANACOM concluded in the last market analysis that there was no demand-side substitutability for most users and that supply-side substitutability was not relevant, concluding that MBB and FBB do not constitute the same relevant market. The defined BB product retail access market in Portugal includes BB access services through xDSL, cable modem and fiber optic provided to residential and non-residential clients.

### **3.2. BROADBAND DEMAND STUDIES**

One of the motivations of this paper is to contribute to the discussion on the demand for BB, since there are few specific studies on this subject and, above all, there is lack of studies on the substitution between the MBB and FBB.

Within the studies that estimate the magnitude of the elasticities of demand for various types of Internet access, the majority conclude that the price of DSL is restricted by the cable and that the two services have a high probability of being part of the same relevant market.

Some limitations can be found in these studies. Firstly, they are static, so they do not allow analyzing switching costs. On the other hand, generally these studies do not analyze if the FBB is restricted by MBB, question which

has becoming increasingly important with the increase of MBB penetration rate, which is one of the aims of this paper. A third set of problems is related to the available data. The majority of the databases used in these papers are not representative of the markets, don't consider all the offers available in the market or use aggregated data.

A summary of the literature review can be found in the appendix (Table 12). It follows a review of the most relevant studies for the analysis of the problems of this paper.

The main reference of this paper is the study of Cardona *et al* (2009) about the demand for residential Internet access in Austria. Mobile connections are included and were estimated various nested logit models in order to derive conclusions about the BB market analysis. The data used is a RTR questionnaire of 2006, made solely for this purpose. This survey covers 4029 households and has information about the type of Internet connection, monthly expenses, age, education and household size. The database was divided into two sub-samples: one for areas where there are 4 types of technology (DSL, cable, mobile and narrowband) and one for areas where only narrowband and DSL are available. The results indicate that Internet demand in Austria is elastic for DSL, cable and mobile in areas where there are several types of BB access and that the different BB access technologies are close substitutes and restrict each other. Applying a SSNIP test for defining the market, an increase of 5-10% of the competitive price is not profitable for the hypothetical monopolist with regard to DSL, so the cable should be included in the relevant market. The authors also conclude that the magnitude of substitution between retail DSL and cable is sufficiently large so (by considering the existence of indirect constraints) both products are part of the same wholesale market. As the MBB penetration rate was very low in 2006, it was not specifically investigated whether DSL and cable together are restricted by the MBB.

Ida and Kuroda (2006), in an application for Japan, use conditional logit model and nested logit model to calculate the own price elasticities and conclude that the market for ADSL is independent of the others, since the demand for ADSL is inelastic and lower than the elasticity of demand for cable and fibre. As the BB Japanese market is dominated by the ADSL, the authors divide the market into three categories: high, medium and low speed. It appears that the ADSL of high and low speeds is highly elastic (9.1 and 10.6), so there is direct competition between high-speed ADSL and fibre (FTTH) and between low-speed ADSL and narrowband.

Pereira and Ribeiro (2006) provide an econometric analysis for the Portuguese market. This article aimed to measure the impact on BB access and in terms of welfare of the structural separation between the cable and copper networks, as on that time, Portugal Telecom (PT) owned PT Communications (copper network - xDSL) and PT Multimedia (cable network). These authors estimate several discrete choice models to obtain the elasticities of BB demand in Portugal. They concluded that households are very sensitive to price changes in the access to Internet services. More specifically, the BB demand is more elastic than the demand for narrowband. They also conclude that both are substitutes by calculating cross elasticities.

The report from Hauge *et al* (2009) commissioned by ANACOM and ANATEL, aims to examine the adoption, use and impact of MBB in Portugal and Brazil, comparing the factors which determined the adoption of the FBB. The conclusion is that the use is similar among users of MBB and FBB, suggesting that these services are substitutes from the point of view of consumers. Using as a basis only the analysis of the individual

characteristics of the respondents (the authors do not analyze price or elasticities), they conclude that the MBB and FBB are reasonable substitutes for consumers.

Demand for access Internet residential customers in the United States is estimated by Crandall *et al* (2002) using nested logit discrete choice models. They conclude that DSL and cable demand is elastic and that the cross-elasticity of the cable relative to the price of ADSL is 0.591. The authors consider this as evidence that DSL and cable belong to the same market, without, however, undergone a SSNIP test.

Rappoport *et al* (2003) conducted a similar analysis, which differs only in the Internet choices available for households. The outcome was that DSL demand is elastic and cable demand inelastic. The demand cross-elasticity for cable with respect to the DSL price is 0.618, so they conclude that DSL and cable belong to the same market.

#### 4. ECONOMETRIC AND THEORETICAL MODEL

An innovation in demand analysis literature is the use of discrete choice models to analyze the access demand under the assumption that consumer choice is qualitative. Perl (1978) was the first to apply discrete choice models for analyzing telecommunications access demand, followed by the use of logit and probit discrete choice models. The emergence of nested logit models, which make partially flexible the hypothesis of independence of irrelevant alternatives (IIA) of the conditional logit models, was particularly important.

##### 4.1. MULTINOMIAL REGRESSION MODELS

The multinomial regression models are models where the dependent variable defines several mutually exclusive categories. The probability that the outcome for individual  $i$  is the alternative  $j$ , conditional on regressors  $x_i$  is:

$$(1) P_{ij} = \Pr(y_i = j) = F_j(x_i \beta_j), \text{ sendo } j = 1, \dots, J \text{ para cada decisor } i = 1, \dots, I.$$

In discrete choice models the consumer behaviour is based on the theory of Random Utility. Econometrically these models can be interpreted in terms of random utility maximization (RUM models). In these models is attributed a utility  $U_{ij}$  to each alternative  $j = 1, \dots, J$  for each  $i = 1, \dots, I$  decision-maker. The decision-maker will choose the alternative with higher utility, *i.e.*, will choose alternative  $j$  if and only if  $U_{ij} > U_{ik}, \forall j \neq k$ .

The utility, which is only known by the decision-maker, is determined by a large number of features and alternatives. As we have information only about some of the factors determining the utility of choosing a type of access, the utility has a deterministic part  $V_{ij}$  and a stochastic part  $\varepsilon_{ij}$  (not observed):

$$(2) U_{ij} = V_{ij} + \varepsilon_{ij}$$

The likelihood  $P_{ij}$  of a consumer  $i$  choosing alternative  $j$  is equal to the probability of  $U_{ij}$  being not inferior to all  $U_{ik}$ , with  $k \neq j$ . Being  $y_i \in \{1 \dots J\}$  the alternative that the decision maker  $i$  chooses, its probability of choice is:

$$(3) P_{ij} = \Pr(y_i = j) = \Pr(\varepsilon_{ik} - \varepsilon_{ij} \leq V_{ij} - V_{ik}, \forall k = 1, \dots, J: k \neq j)$$



Given the specification of the deterministic part of the utility function  $(V_{i1}, \dots, V_{ij})$ , this probability depends on the assumptions about the distribution of the stochastic error terms  $\varepsilon_{i1}, \dots, \varepsilon_{ij}$ , which lead to several discrete choice models with different  $F_j(\cdot)$  specifications in equation (1), being the most prominent examples for the case study logit, multinomial logit, conditional and nested logit.

In the event that  $\varepsilon_{ij}$  follows a distribution of Type I extreme value, the probability  $P_{ij}$  has the following general specification:

$$(4) \quad P_{ij} = \frac{e^{V_{ij}}}{\sum_{k=1}^J e^{V_{ik}}}$$

Where, for the multinomial logit models we have:

$$(5) \quad V_{ij} = x_i \beta_j$$

And for the conditional logit (CL):

$$(6) \quad V_{ij} = z_{ij} \gamma$$

Representing  $z_{ij}$  the regressors specific to alternative  $j$  and  $x_i$  the regressors specific to individual  $i$ .

#### 4.2. NESTED LOGIT MODELS

The nested logit models allow relaxing the IIA assumption and are ideal to use when a decision can be made in stages and according to a clear hierarchical tree structure. In this case, it is found that there is independence between the different alternative nests of a tree, when the alternatives of the same nest can be correlated. Another advantage is that, in general, these models are consistent with utility maximization.

The set of choices is partitioned into  $M$  subsets (nests)  $B_m, m = 1, \dots, M$ , where each nest may have several alternatives. The individual chooses the nest first and then the alternative  $j$  of that nest.

In this context, it is relevant to know the probability of an individual choosing the nest  $m$  and the alternative  $j$ ,

$$(7) \quad P_{i,mj} = P_{im} * P_{ij|m}$$

For each nest  $m=1, \dots, M$  the joint distribution of the error term has an additional parameter  $\tau_m$  which represents the measure of mutual correlation of the error term between all alternatives of that nest. The model will be compatible with RUM models if  $\tau_m$  is positive and less or equal to 1.

Note that  $\tau_m = \sqrt{1 - \rho_m}$ , with  $\rho_m$  representing the correlation coefficient. Thus, it is an inverse measure of correlation, thus is called in the literature as dissimilarity parameter. The nested logit specification results of the hypothesis of the joint distribution of the errors being of generalized extreme value. When  $\tau_m = 1, \forall m = 1, \dots, M$ , we obtained the special case of the model defined in (6).

The estimation of the parameters of these models is made resorting to maximizing its likelihood function.

## 5. DATA AND DESCRIPTIVE STATISTICS

A major problem of estimating Internet demand is the rapid technological change of the market. Given the short life cycle of these services, time series for estimating the BB demand are unavailable. This is one of the reasons for choosing a cross-section model instead of a time series model. On the other hand, the micro-databases have the advantage of having a greater quality of information which allows analyzing how the individual characteristics affect BB access.

Another limitation faced by the Internet demand researchers is the lack of data, especially about prices, speed and volume. This is a common problem in the applications for the Portuguese case<sup>3</sup>. As a consequence, researches have to use imperfect estimation approaches to determine marginal effects and BB price-demand elasticities.

The more recent cross-section databases about residential Internet in Portugal are the Survey on the use of information technology by the families of the Institute of National Statistics (INE), the ANACOM's Electronic Communications Services Consumption Survey (ICSCE)<sup>4</sup>, the National Index of Customer Satisfaction of the Portuguese Institute of Quality and the Marktest Communications Barometer. None of these databases has information on BB expenditures and download speed, with the exception of the Marktest Barometer. As the access to the individual data of the latter data base was not granted<sup>5</sup>, it was chosen the more recent and rich database, the ICSCE 2009<sup>6</sup>, which has information regarding the specific characteristics of the respondents and of their Internet access choice.

For the prices we defined a proxy that corresponds to the price of the offer which is closer to the characteristics of the type of Internet access chosen by the household (identified in the questionnaire). Thus, the primary source of our paper was completed with the information from providers pricing plans<sup>7</sup>. For each of the individuals of the ICSCE 2009 database was imputed a price corresponding to the household choice of access, analyzing which was the offer in 2009 (moment of inquiry) which fits the characteristics of the technology chosen<sup>8</sup>. This approach required an enormous workload and took a long time but allowed a good approximation of the relevant price data, enabling to have econometric estimations with an explanatory variable essential to the demand, the price.

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<sup>3</sup> As identified in the studies of Pereira and Ribeiro (2006) and Hauge *et al* (2009).

<sup>4</sup> The last edition of this annual survey was 2009.

<sup>5</sup> It was given access only to aggregate data of previous years. Moreover, the rate of non-response to the questions about expenditures and speed is particularly high, with a non-response rate on the mobile Internet expenditure in June 2010 of about 16.8% for mobile and 34.9% for fixed Internet. The rate of non-response to the question about download speed is even higher: 50.2% in December 2010. Thus, even if we had access to the Barometer data, we still have the problem of the quality of information.

<sup>6</sup> ICSCE 2009 has 3106 observations obtained through personal interviews conducted to individuals with 15 years or older, selected by the quota method of NUTS II region, gender, age, education and occupation.

<sup>7</sup> Public information from the providers, collected by ANACOM.

<sup>8</sup> For FBB we have the following variables: type of technology (ADSL, cable, fibre and others), operator, type of tariff, region, date of contract and type of bundle. For MBB: download speed, operator, type of technology, type of tariff, contract date and use of MBB "e-initiatives" program. Therefore, we have quite a realistic approximation of the real price and a significant variability of prices. For individuals who indicated that they had adhered to "e-initiatives" program, it was considered the price of the respective initiative, which is known. These prices are significantly lower than the market prices. For example, for the adherents of "e-opportunities" the price is €15 and for the "e-school" the price varies in 3 levels, where, for example, for a student with a low income the monthly price was €5.

Given the substantial differences between the MBB access via mobile phones and cards/modems and the low penetration of the use of MBB using smartphones in 2009, it was not considered that, in that period, MBB via mobile phones is a FBB substitute. Therefore, in the estimations we only considered the MBB access through cards and as such we removed from the database the 25 observations of MBB through mobile phones.

A caveat shall be made regarding the imputation of the price when the service is provided in a bundle. The methodology followed was to consider, for each type of bundle, the percentage of the price that is related to FBB, considering the stand-alone offer of that specific provider.

Based on this approach it was possible to have large price variability, which is relatively close to average expenditures values obtained in the Marktest Barometer<sup>9</sup>. Table 3 presents the price and speed of download of our database.

Table 3 – Descriptive statistics of the price and download speed of the database

|                                | Average | Standard deviation | Minimum | Maximum |
|--------------------------------|---------|--------------------|---------|---------|
| <b>Prices in euros (month)</b> |         |                    |         |         |
| ADSL                           | 26,5    | 12,1               | 8,1     | 52,5    |
| Cable                          | 22,1    | 10,6               | 9,2     | 65      |
| Optic Fiber                    | 27,5    | 9,7                | 16,4    | 44,9    |
| MBB (Cards)                    | 27,5    | 11,4               | 4,2     | 49,9    |
| <b>Download speeds (Mbps)</b>  |         |                    |         |         |
| ADSL                           | 15,5    | 5,0                | 3,6     | 27,3    |
| Cable                          | 7,0     | 6,9                | 3,5     | 24,0    |
| Optic Fiber                    | 14,3    | 7,3                | 6,8     | 30,0    |
| MBB (Cards)                    | 4,0     | 2,0                | 1,0     | 12,0    |

The estimation of nested logit models imply that each individual has a price for all internet options, even those not chosen, which raises the question of how to determine the price of these alternatives. We applied a methodology similar to the used by Cardona *et al* (2009), using the prices of the offers in 2009.

The price of not having Internet is zero<sup>10</sup>. For individuals who have ADSL it was used information available for the offers in December 2009. We defined 3 average prices<sup>11</sup> that correspond to a low, medium and high level of use. Individuals who do not have Internet or that have narrowband are assigned to the low usage profile. Individuals who have cable, fibre and MBB are allocated to the offer which has the closest price to the chosen option (ADSL).

For cable and fibre we also defined 3 average prices corresponding to a low, medium and high level of use, considering, as for ADSL, the closest price to the chosen option (cable or fibre).

For MBB the methodology is similar, but we defined 5 levels of use, corresponding to the 5 different offers in terms of download speeds offered by all MBB operators in 2009. Table 13 in Appendix shows the prices obtained using this methodology.

<sup>9</sup> In June 2010 the average expenditure was €20.58 for mobile internet and €22.88 for fixed Internet.

<sup>10</sup> Was also set a price for narrowband, but since the information available about this type of access is scarce and there are no differences between user profiles, was considered the average price in 2009 (€18.94 for 56 kbps/s).

<sup>11</sup> The average prices for each technology are obtained by weighting the price of each operator by its market share.

The following table presents the descriptive statistics of the database used in the estimations and in Table 14 in the appendix it can be found the definition of the variables used.

Table 4 – Descriptive statistics of the individual variables

|   | No BB<br>(1743) | ADSL<br>(391) | Cable<br>(514) | Optic<br>Fiber<br>(49) | Other<br>FBB (66) | MBB<br>Cards<br>(257) | MBB and<br>FBB (61) |
|---|-----------------|---------------|----------------|------------------------|-------------------|-----------------------|---------------------|
| Age (average)                               | 52,6            | 36,5          | 37             | 31,7                   | 43,4              | 31,4                  | 32,6                |
| Gender: Female                              | 55%             | 52%           | 52%            | 51%                    | 48%               | 54%                   | 51%                 |
| Dimension of the household                  | 2,6             | 3,5           | 3,3            | 3,5                    | 3,7               | 3,2                   | 3,5                 |
| Desktops (average number)                   | 0,2             | 0,8           | 0,8            | 0,5                    | 0,7               | 0,4                   | 0,9                 |
| Laptops (average number)                    | 0,2             | 0,9           | 0,9            | 1,2                    | 0,9               | 1,1                   | 1,6                 |
| PDA's/Palmtops (average number)             | 0,0             | 0,0           | 0,0            | 0,1                    | 0,0               | 0,1                   | 0,1                 |
| Televisions (average number)                | 1,9             | 2,7           | 2,8            | 2,5                    | 2,2               | 2,5                   | 3,1                 |
| Game consoles (average number)              | 0,0             | 0,2           | 0,2            | 0,4                    | 0,1               | 0,2                   | 0,4                 |
| Income level A                              | 0,4%            | 1%            | 3%             | 2%                     | 0%                | 2%                    | 0%                  |
| Income level B                              | 4,4%            | 23%           | 24%            | 29%                    | 15%               | 24%                   | 36%                 |
| Income level C                              | 11,5%           | 29%           | 25%            | 24%                    | 20%               | 17%                   | 26%                 |
| Income level D                              | 64,4%           | 35%           | 35%            | 27%                    | 52%               | 39%                   | 31%                 |
| Income level E                              | 19,2%           | 12%           | 12%            | 18%                    | 14%               | 17%                   | 7%                  |
| Employed                                    | 43%             | 68%           | 65%            | 57%                    | 68%               | 64%                   | 72%                 |
| Student                                     | 3%              | 14%           | 15%            | 27%                    | 6%                | 22%                   | 21%                 |
| Unemployed                                  | 8%              | 7%            | 6%             | 6%                     | 3%                | 9%                    | 5%                  |
| Retired                                     | 33%             | 6%            | 7%             | 4%                     | 15%               | 2%                    | 0%                  |
| Other types of inactivity                   | 14%             | 5%            | 7%             | 6%                     | 8%                | 2%                    | 2%                  |
| Education: Cannot read                      | 6,0%            | 1%            | 0%             | 2%                     | 0%                | 0%                    | 0%                  |
| Education: Can read without education       | 11,0%           | 1%            | 1%             | 0%                     | 5%                | 0%                    | 0%                  |
| Education: 9 years of education             | 73,0%           | 55%           | 56%            | 53%                    | 74%               | 53%                   | 38%                 |
| Education: 12 years education (high school) | 7,0%            | 29%           | 27%            | 22%                    | 17%               | 29%                   | 34%                 |
| Education: university degree                | 3,0%            | 14%           | 16%            | 22%                    | 5%                | 18%                   | 28%                 |
| Region: North                               | 27,0%           | 20%           | 17%            | 29%                    | 24%               | 28%                   | 11%                 |
| Region: Center                              | 16,0%           | 18%           | 13%            | 14%                    | 5%                | 11%                   | 23%                 |
| Region: Lisbon                              | 15,0%           | 16%           | 28%            | 29%                    | 20%               | 16%                   | 30%                 |
| Region: Alentejo                            | 11,0%           | 17%           | 4%             | 0%                     | 9%                | 18%                   | 10%                 |
| Region: Algarve                             | 11,0%           | 11%           | 5%             | 10%                    | 6%                | 15%                   | 8%                  |
| Region: Azores Islands                      | 9,0%            | 12%           | 12%            | 8%                     | 27%               | 5%                    | 11%                 |
| Region: Madeira Islands                     | 10,0%           | 7%            | 20%            | 10%                    | 9%                | 7%                    | 7%                  |
| Nr Inhabitants: Below 2 000                 | 52%             | 45%           | 29%            | 29%                    | 50%               | 51%                   | 38%                 |
| Nr Inhabitants: Between 2 000 and 4 999     | 9%              | 11%           | 10%            | 16%                    | 12%               | 13%                   | 21%                 |
| Nr Inhabitants: Between 5 000 and 9 999     | 7%              | 13%           | 8%             | 6%                     | 14%               | 9%                    | 2%                  |
| Nr Inhabitants: Between 10 000 and 99 999   | 20%             | 20%           | 29%            | 20%                    | 9%                | 20%                   | 28%                 |
| Nr Inhabitants: More than 100 000           | 11%             | 12%           | 24%            | 29%                    | 15%               | 7%                    | 11%                 |

## 6. ESTIMATION RESULTS

The deterministic part of the utility of consumer  $i$  to choose alternative  $j$  ( $V_{ij}$ ), is a linear function of the characteristics of consumer<sup>12</sup> ( $x_i$ ) and of the product ( $z_{ij}$ )<sup>13</sup>:

$$(8) \quad V_{ij} = x_i\beta_j + z_{ij}\gamma$$

In order to explain the probability of an individual choosing a particular BB alternative access<sup>14</sup> several binary, multinomial and nested logit models were estimated<sup>15</sup>. The output of the estimated models is presented in Tables 15 to 22 in Appendix. The restricted models were obtained by testing the joint nullity of the parameters, considering a 10% level of significance.

The multinomial models presented the more interesting results, which will be discussed in the following section. We will also present some conclusions about the nested logit.

### 6.1. MULTINOMIAL REGRESSION MODELS

Multinomial models are an extension of the models used to represent the binary choice between more than two mutually exclusive options. The dependent variable is a dummy variable representing the alternatives for choosing Internet. The explanatory variables are the variables with individual features identified in Table 13 and the prices of each type of BB access<sup>16</sup>. The dependent variable of the multinomial Model A is a discrete variable that assumes the values 1, 2, 3 and 4 representing the access options No BB (1), FBB (2) MBB (3) , FBB and MBB (4). The goodness of fit of the model is high (adjusted  $R^2$  of about 48.1%) and the base variable (omitted) the MBB access. Tables 5 and 6 show the average marginal effects<sup>17</sup> on the probability of choosing FBB and MBB, respectively.

The average marginal effect on the probability of having FBB (Table 5<sup>18</sup>) indicate that, on average, when the price of FBB increases one euro, the probability of having FBB reduces by 2.0 percentage points (p.p.), whereas when the MBB price increases one euro, this probability increases by 2.5 p.p.

In terms of individual features, marginal effects also have the expected sign of variation. On the other hand, individuals living in places with more than 5000 inhabitants have a higher probability of having FBB than those living in smaller places. As expected, having desktops and laptops increases the likelihood of having FBB. Having one more desktop increases in 20.5 p.p. the probability of having FBB and having one laptop has an impact of 9.2 p.p.

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<sup>12</sup> Within the consumer characteristics is included the age, education, gender, household size, presence of children and elderly in the household, employment situation, income level, region, size of the local, use of Internet outside the home of the household and existence of desktops, laptops, pdas, TVs and game devices.

<sup>13</sup> Price of the Internet access.

<sup>14</sup> Thus, the dependent variables in these models indicate the presence/absence of a particular type of access and not a given quantity. For this reason, the results indicate the likelihood of having a type of access, not the variation in quantity. This feature of the models has implications in the interpretation of the marginal effects and elasticities.

<sup>15</sup> All estimations were obtained using STATA-11.

<sup>16</sup> Prices attributed to each type of access, according to the methodology defined in Chapter 5.

<sup>17</sup> Which show the likelihood of the household, on average, choosing an option of access related to the base alternative, depending on the variation of one unit of a given variable.

<sup>18</sup> All marginal effects were statistically significant at 5% except Madeira Islands (10%).

Table 9 – Multinomial Model A – Average marginal effects on the probability of choosing FBB

|                          |  |           |        |               |                      |           |  |
|--------------------------|--|-----------|--------|---------------|----------------------|-----------|--|
| Average marginal effects |  |           |        | Number of obs |                      | = 3081    |  |
| Model VCE                | : OIM                                      |           |        |               |                      |           |  |
| Expression               | : Pr(chosen50==BLF), predict(outcome(BLF)) |           |        |               |                      |           |  |
| -----                    |  |           |        |               |                      |           |  |
|                          | Delta-method                               |           |        |               |                      |           |  |
|                          | dy/dx                                      | Std. Err. | z      | P> z          | [95% Conf. Interval] |           |  |
| -----                    |  |           |        |               |                      |           |  |
| preoblf                  | -.0195731                                  | .0013381  | -14.63 | 0.000         | -.0221958            | -.0169504 |  |
| preoblm                  | .0251091                                   | .0015654  | 16.04  | 0.000         | .022041              | .0281772  |  |
| idade2                   | -.0000118                                  | 5.40e-06  | -2.19  | 0.029         | -.0000224            | -1.23e-06 |  |
| rendb                    | .054148                                    | .0211904  | 2.56   | 0.011         | .0126155             | .0956804  |  |
| rendc                    | .0453199                                   | .0169326  | 2.68   | 0.007         | .0121325             | .0785072  |  |
| crian_agreg              | -.0425418                                  | .0146177  | -2.91  | 0.004         | -.0711919            | -.0138917 |  |
| agreg                    | .0246741                                   | .0066725  | 3.70   | 0.000         | .0115963             | .0377519  |  |
| desktops                 | .2047373                                   | .0101119  | 20.25  | 0.000         | .1849184             | .2245563  |  |
| laptops                  | .0917069                                   | .0091684  | 10.00  | 0.000         | .0737372             | .1096766  |  |
| tv                       | .0133374                                   | .0060755  | 2.20   | 0.028         | .0014297             | .0252451  |  |
| ensinosecund             | .035925                                    | .0180735  | 1.99   | 0.047         | .0005015             | .0713485  |  |
| 5000-9999                | .0790677                                   | .0243547  | 3.25   | 0.001         | .0313333             | .1268021  |  |
| 10000-99999              | .0580506                                   | .0161474  | 3.60   | 0.000         | .0264023             | .0896988  |  |
| mais_100000              | .0858588                                   | .0206682  | 4.15   | 0.000         | .0453498             | .1263678  |  |
| norte                    | -.0807441                                  | .0169807  | -4.76  | 0.000         | -.1140257            | -.0474626 |  |
| alentejo                 | -.0951681                                  | .0224813  | -4.23  | 0.000         | -.1392306            | -.0511057 |  |
| algarve                  | -.0524076                                  | .0221775  | -2.36  | 0.018         | -.0958748            | -.0089405 |  |
| ramadeira                | .0398885                                   | .0238638  | 1.67   | 0.095         | -.0068838            | .0866607  |  |
| internetfora             | -.0578509                                  | .0159555  | -3.63  | 0.000         | -.0891231            | -.0265787 |  |

If the base option is MBB access (Table 6), on average, when the weighted FBB price increases in one euro, the probability of having MBB increases by 1.4 p.p., while when the MBB price increases one euro this probability decreases by 1 p.p. These results already indicate that the own elasticity of MBB related to other options in terms of access is negative and that the cross-elasticity is positive. On the other hand, individuals who have higher levels of education are more likely to have MBB.

Table 6 - Multinomial Model A – Average marginal effects on the probability of choosing MBB

|  |  |              |           |                      |       |                      |
|--|--|--------------|-----------|----------------------|-------|----------------------|
| Average marginal effects                               |  |              |           | Number of obs = 3081 |       |                      |
| Model VCE : OIM  |  |              |           |                      |       |                      |
| Expression : Pr(chosen50==BLM) , predict(outcome(BLM)) |  |              |           |                      |       |                      |
| -----  |  |              |           |                      |       |                      |
|  |  | Delta-method |           |                      |       |                      |
|  |  | dy/dx        | Std. Err. | z                    | P> z  | [95% Conf. Interval] |
| -----  |  |              |           |                      |       |                      |
| preoblf  |  | .0142844     | .0008676  | 16.47                | 0.000 | .012584 .0159847     |
| preoblm  |  | -.0101039    | .0007836  | -12.89               | 0.000 | -.0116398 -.008568   |
| idade2   |  | -.0000286    | 4.49e-06  | -6.38                | 0.000 | -.0000374 -.0000198  |
| rendc  |  | -.0245032    | .0119743  | -2.05                | 0.041 | -.0479724 -.0010339  |
| agreg  |  | -.014712     | .004592   | -3.20                | 0.001 | -.0237121 -.0057119  |
| desktops   |  | -.0132022    | .0075393  | -1.75                | 0.080 | -.0279789 .0015745   |
| laptops  |  | .0489952     | .0054471  | 8.99                 | 0.000 | .0383191 .0596713    |
| ensinosecund   |  | .0283824     | .0111324  | 2.55                 | 0.011 | .0065632 .0502015    |
| ens_superior   |  | .0294913     | .0142458  | 2.07                 | 0.038 | .0015701 .0574125    |
| mais_100000  |  | -.0518348    | .016954   | -3.06                | 0.002 | -.085064 -.0186056   |
| norte  |  | .0184099     | .0107438  | 1.71                 | 0.087 | -.0026475 .0394673   |
| alentejo   |  | .0356332     | .0130264  | 2.74                 | 0.006 | .0101019 .0611644    |
| algarve  |  | .0434331     | .0131542  | 3.30                 | 0.001 | .0176514 .0692148    |
| raaores  |  | -.037046     | .0193073  | -1.92                | 0.055 | -.0748875 .0007955   |
| ramadeira  |  | -.0564304    | .0184963  | -3.05                | 0.002 | -.0926825 -.0201782  |
| internetfora   |  | -.0456438    | .0105624  | -4.32                | 0.000 | -.0663458 -.0249418  |

Model A allows to conclude that, on average, the demand for FBB and MBB (compared to the alternatives) is elastic (elasticities between -2.55 and -4.14) and cross-elasticities are positive, which indicates substitutability between the MBB and FBB - Table 7.

Table 7 – Own and Cross- Elasticities of FBB and MBB (Multinomial Model A)

| $\epsilon_{ij}$  | Model A |       |
|------------------|---------|-------|
|                  | FBB     | MBB   |
| <b>FBB Price</b> | -2.55   | 5.97  |
| <b>MBB Price</b> | 3.36    | -4.14 |

In order to analyze how each of the FBB technologies restricts the MBB demand and infer about the substitutability among FBB technologies, we estimated multinomial regression models with the FBB disaggregated by technology (ADSL, Cable and fiber<sup>19</sup>) – Model B.

In Model B the dependent variable is the dummy: No BB (1) ADSL (2) Cable (3) MBB (4), MBB and FBB (5)<sup>20</sup>. The results of this model for MBB as a base option are shown in table 16. We conclude that the probability of choosing ADSL alternative compared with the other options increases on average 1.5 and 0.2 p.p. when the price, of respectively, the cable and MBB increases in one euro – Table 8<sup>21</sup>. When the ADSL price increases in 1 euro, *ceteris paribus*, the probability of choosing the ADSL alternative compared to the others decreases 0.8 p.p. on average. The probability of having ADSL (compared to the other technologies) is reduced in 23 p.p. if the individual is from Madeira Islands and in 4.2 p.p if is from the North. However, an individual from Azores Islands is 7.2 p.p. more likely to choose ADSL than the other technologies.

Table 8 – Model B: Average Marginal Effects in the probability of choosing ADSL

|  |              |           |       |                 |                      |           |
|--|--------------|-----------|-------|-----------------|----------------------|-----------|
| Average marginal effects                               |              |           |       | Number of obs = |                      | 2965      |
| Model VCE : OIM  |              |           |       |                 |                      |           |
| Expression : Pr(chosen9==ADSL), predict(outcome(ADSL)) |              |           |       |                 |                      |           |
| -----  |              |           |       |                 |                      |           |
|  | Delta-method |           |       |                 |                      |           |
|  | dy/dx        | Std. Err. | z     | P> z            | [95% Conf. Interval] |           |
| -----  |              |           |       |                 |                      |           |
| preoadsl   | -.0079146    | .0011714  | -6.76 | 0.000           | -.0102105            | -.0056186 |
| preocabo   | .0146737     | .0010621  | 13.82 | 0.000           | .012592              | .0167554  |
| preoblm  | .002386      | .0011881  | 2.01  | 0.045           | .0000572             | .0047147  |
| rendb  | .0425577     | .0196115  | 2.17  | 0.030           | .0041198             | .0809956  |
| rendc  | .0585935     | .0173655  | 3.37  | 0.001           | .0245578             | .0926293  |
| crian_agreg  | -.037247     | .0117532  | -3.17 | 0.002           | -.0602828            | -.0142112 |
| agreg  | .0235969     | .0055898  | 4.22  | 0.000           | .012641              | .0345527  |
| desktops   | .1211272     | .0087612  | 13.83 | 0.000           | .1039556             | .1382988  |
| laptops  | .0268826     | .0067512  | 3.98  | 0.000           | .0136505             | .0401147  |
| pdas   | .0759932     | .0282159  | 2.69  | 0.007           | .020691              | .1312953  |
| ensinosecund   | .0325044     | .0138467  | 2.35  | 0.019           | .0053655             | .0596434  |
| 5000_9999  | .0428427     | .0179959  | 2.38  | 0.017           | .0075715             | .0781139  |
| norte  | -.0420006    | .0130904  | -3.21 | 0.001           | -.0676573            | -.0163439 |
| raaores  | .0715462     | .0183711  | 3.89  | 0.000           | .0355395             | .1075528  |
| ramadeira  | -.2285629    | .0246848  | -9.26 | 0.000           | -.2769442            | -.1801815 |
| internetfora   | -.0359137    | .0129144  | -2.78 | 0.005           | -.0612256            | -.0106019 |

<sup>19</sup> In these estimations were removed the observations corresponding to the respondents who indicated other FBB access or which don't know the FBB technology chosen. Therefore, in these estimates the number of observations is smaller than for the model A. In model A the FBB options were aggregated, so it was important to include all households with FBB, which is not the case in Model B.

<sup>20</sup> We also estimated models including optic fiber, but the results for this technology were not statistically significant, therefore these 49 observations were excluded.

<sup>21</sup> All marginal effects are significant at 5%.

In Table 9<sup>22</sup>, the probability of respondents choosing the cable alternative increases on average 2.0 p.p. when the ADSL price increases in one euro and 0.2 p.p. with an equal variation of the MBB price. When the cable price increases 1 euro, as expected, the probability of choosing the alternative cable compared to the other alternatives decreases by 2.8 p.p.

Table 9 - Model G: Average Marginal Effects compared to the cable choice

|  |  |              |           |                      |       |                      |
|--|--|--------------|-----------|----------------------|-------|----------------------|
| Average marginal effects                               |  |              |           | Number of obs = 2965 |       |                      |
| Model VCE : OIM  |  |              |           |                      |       |                      |
| Expression : Pr(chosen9==cabo), predict(outcome(cabo)) |  |              |           |                      |       |                      |
| -----  |  |              |           |                      |       |                      |
|  |  | Delta-method |           |                      |       |                      |
|  |  | dy/dx        | Std. Err. | z                    | P> z  | [95% Conf. Interval] |
| -----  |  |              |           |                      |       |                      |
| preoadsl   |  | .0207        | .0011463  | 18.06                | 0.000 | .0184534 .0229466    |
| preocabo   |  | -.0284617    | .0010141  | -28.07               | 0.000 | -.0304493 -.0264741  |
| preobl   |  | .0024017     | .0010514  | 2.28                 | 0.022 | .0003411 .0044624    |
| rendd  |  | -.0275654    | .0129709  | -2.13                | 0.034 | -.0529879 -.0021429  |
| desktops   |  | .0449245     | .0078132  | 5.75                 | 0.000 | .029611 .060238      |
| laptops  |  | .0187262     | .0060658  | 3.09                 | 0.002 | .0068375 .0306149    |
| pdas   |  | -.174092     | .0537923  | -3.24                | 0.001 | -.2795229 -.0686611  |
| tv   |  | .0130684     | .0041205  | 3.17                 | 0.002 | .0049925 .0211444    |
| 10000-99999  |  | .0524456     | .011349   | 4.62                 | 0.000 | .030202 .0746892     |
| mais_100000  |  | .0485978     | .0144009  | 3.37                 | 0.001 | .0203726 .0768231    |
| raaiores   |  | -.1029624    | .0149667  | -6.88                | 0.000 | -.1322966 -.0736283  |
| ramadeira  |  | .2801097     | .0193706  | 14.46                | 0.000 | .2421441 .3180754    |

In what matters the marginal effects on the probability of choosing MBB (Table 10<sup>23</sup>), if the price of ADSL or cable increases in one euro, the likelihood of having MBB compared with the alternatives increases 0.7 p.p. on average. If the MBB price increases in the same amount, the likelihood of choosing that option reduces 0.7 p.p. on average. Moreover, individuals who have higher levels of education are more likely to have MBB (compared to the alternatives).

Table 10 – Model B: Average Marginal Effects compared to the MBB choice

|                          |   |           |       |                      |                      |           |
|--------------------------|---|-----------|-------|----------------------|----------------------|-----------|
| Average marginal effects |   |           |       | Number of obs = 2965 |                      |           |
| Model VCE                | : OIM                                     |           |       |                      |                      |           |
| Expression               | : Pr(chosen9==BLM), predict(outcome(BLM)) |           |       |                      |                      |           |
|                          | -----                                     |           |       |                      |                      |           |
|                          | Delta-method                              |           |       |                      |                      |           |
|                          | dy/dx                                     | Std. Err. | z     | P> z                 | [95% Conf. Interval] |           |
|                          | -----                                     |           |       |                      |                      |           |
| preoadsl                 | .0077205                                  | .000911   | 8.48  | 0.000                | .005935              | .009506   |
| preocabo                 | .0065177                                  | .0007355  | 8.86  | 0.000                | .0050761             | .0079593  |
| preoblm                  | -.007203                                  | .0007623  | -9.45 | 0.000                | -.0086971            | -.005709  |
| idade2                   | -.0000293                                 | 4.82e-06  | -6.08 | 0.000                | -.0000387            | -.0000198 |
| rendc                    | -.030272                                  | .0150122  | -2.02 | 0.044                | -.0596954            | -.0008486 |
| agreg                    | -.0137482                                 | .0048945  | -2.81 | 0.005                | -.0233413            | -.0041551 |
| desktops                 | -.0223758                                 | .0076203  | -2.94 | 0.003                | -.0373113            | -.0074403 |
| laptops                  | .0427444                                  | .0056925  | 7.51  | 0.000                | .0315873             | .0539014  |
| pdas                     | .0606512                                  | .0193705  | 3.13  | 0.002                | .0226858             | .0986166  |
| ensinosecund             | .0263594                                  | .0118509  | 2.22  | 0.026                | .0031322             | .0495867  |
| ens_superior             | .0308219                                  | .015129   | 2.04  | 0.042                | .0011697             | .0604741  |
| mais_100000              | -.04859                                   | .0170442  | -2.85 | 0.004                | -.0819961            | -.0151839 |
| ramadeira                | -.0567345                                 | .0181135  | -3.13 | 0.002                | -.0922364            | -.0212326 |
| internetfora             | -.0490398                                 | .0111377  | -4.40 | 0.000                | -.0708692            | -.0272103 |

<sup>22</sup> All marginal effects are significant at 5%.

<sup>23</sup> All marginal effects are significant at 5%.



The analysis of the own elasticities (Table 11) demonstrates that the probability demand for ADSL and cable BLM is elastic. Moreover, the demand of the latter technology is highly elastic: a variation of 1% of the price of the cable causes a reduction of 11.62% of the probability of its demand. On the other hand, the ADSL demand is restricted by the cost of the cable and cable demand is also constrained by the cost of ADSL, but at a higher intensity. There is thus evidence of substitutability between the two technologies, which confirms the results obtained from the analysis of the BB retail market in Portugal.

MBB demand is restricted by the price of ADSL and cable, but we couldn't verify if the ADSL and cable are constrained by the MBB price, since the estimated elasticities are not statistically significant. There is, however, evidence of substitutability, because the marginal effects analysis showed that when the MBB price increases in of 1 euro the demand for ADSL and cable increases by about 0.2 p.p.<sup>24</sup>.

Table 11 – Average own and cross elasticities of ADSL, cable and MBB (Model G)

| $\epsilon_{ij}$ | ADSL  | Cable  | MBB   |
|-----------------|-------|--------|-------|
| ADSL price      | -1.09 | 7.68   | 3.78  |
| Cable price     | 4.34  | -11.62 | 3.15  |
| MBB price       | 0.01* | 0.42*  | -3.45 |

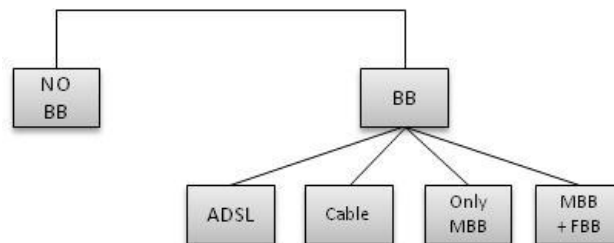
All elasticities are significative at 1% except:

\* Elasticity non significative at 10%

These estimations results are particularly interesting. Firstly, there is evidence of symmetrical substitution between ADSL services and cable. By other side, when the price of cable or of ADSL increases, the MBB demand increases, but when the MBB price increases it is not necessary true that the cable and ADSL demand increases. And this takes us to a second conclusion: there is asymmetric substitutability of demand between MBB and the fixed technologies ADSL and cable, *i.e.*, the substitution between fixed and mobile technologies occurs only in the sense of fixed to mobile. In this regard, it will be important to consider that users who value mobility can hardly accept that a FBB offer is a substitute of the MBB.

## 6.2. NESTED LOGIT MODELS

Several nested logit models were estimated (Models C, D and E), which relax the hypothesis IIA of the conditional models. The nested Model C has the following decision tree:



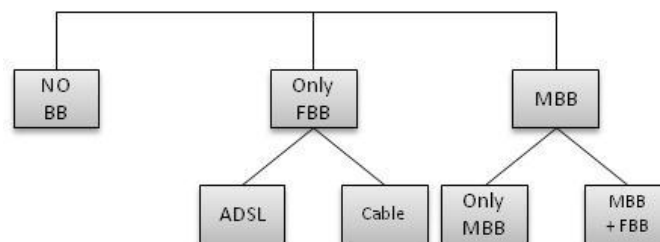
The omitted variable (base) of the model C is BB. The estimation results are shown in Table 17 in the Annex. For this model the price variable is statistically significant, but has no economic reading, since the coefficient sign is

<sup>24</sup> Although this effect is very small is statistically significant at 5%.

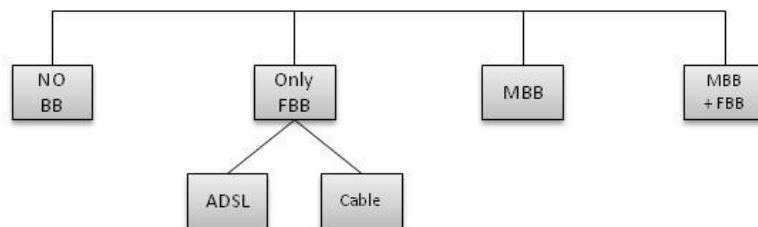
positive, that is, a price increase causes an increase in conditional probability of access alternatives demand, for each of these alternatives. Through the LR test for  $\tau_m$ , calculated for the hypothesis of all  $\tau_m$  being equal to one, it was concluded that using a CL model was not suitable. The model C is not compatible with a maximizing utility model, as the BB parameter of dissimilarity does not meet the compatibility conditions.

Marginal effects for the price of each access alternative were calculated using the method of calculating the average marginal effects for the nested logit models proposed by Cameron, A. C. & P. Trivedi K. (2010). None of the marginal effects is significant (Tables 18-20 in the appendix) and therefore we couldn't calculate the elasticities.

We also estimated model nested logit D, which has the following tree:



The estimation results (Only FBB base) are presented in Table 21 in the Appendix. For this model the variable price is not statistically significant, although this model is consistent with RUM. Finally, we estimated model E with the following decision tree:



The estimation results are shown in Table 22. In this model the sign of the coefficient of the price variable is consistent with the economic theory (negative), but this variable is not significant, so the marginal effects and elasticities are not significant. Model E is compatible with the assumptions of RUM models.

Through the analysis of nested logit models, we concluded that the price variable doesn't explain the demand based on the three decision trees used. There is evidence that, for the decision trees defined, other explanatory variables are more important than the price to discriminate the choice among the alternatives within each nest. It should be stressed that the variables which characterize the household have the expected sign and confirm the conclusions already obtained for the models previously estimated.

The nested models do not allow drawing the same conclusions regarding the price as the multinomial models. One reason which may explain this is that the price information is not good enough to discriminate between alternatives within each nest, but good enough for more flexible models, such as the multinomial models.

## 7. SSNIP TEST AND IMPLICATIONS FOR MARKET ANALYSIS

For market analysis, market definition serves to identify all sources of relevant competition that influence the conditions under which a good is supplied by the companies. The standard test for defining the relevant market is the HM test. In practice, the HM test is implemented using a set of quantitative and qualitative considerations or data about the demand behaviour. Empirically, the substitution behaviour of the retail demand can be determined with the help of the elasticity of retail demand, which indicates the percentage of change in the quantity demanded in response to a percentage change in the price.

To determine to what extent the existence of substitution is sufficient to limit the HM in its policy of setting prices, the elasticity of demand should be compared with the critical elasticity, the elasticity from which a given increase in the price is no longer profitable for the HM. The critical elasticity can be calculated as follows (for a linear demand):

$$\varepsilon_k = \frac{1}{m + t}$$

Where  $m$  is the initial margin, *i.e.*:

$$m = \frac{p_0 - c}{p_0}$$

And  $t$  is the percentage increase in the price (usually 5 or 10%), *i.e.*:

$$t = \frac{p_1 - p_0}{p_0}$$

If the actual elasticity is below the critical value the relevant market shall include the next best substitute. If it is above the critical value, the product (or product set) represents the relevant market.

In Portugal, in the last market analysis conducted by ANACOM was concluded that the BB access retail market consists of BB access services via xDSL, cable and optic fiber provided to residential and non-residential clients. The BB market defined by ANACOM is our starting point, so, if the HM test reveals that the HM cannot impose a non-transitory increase of 5-10% in a profitable way, to this relevant market must be added the closest substitute (MBB).

There isn't publicly available information about the  $m$  in Portugal, therefore we considered the percentage calculated by RTR for the Austrian market, *i.e.*,  $m$  is estimated to be about 60%-80%<sup>25</sup>. Consequently, the critical elasticity is between 1.1 and 1.5. As the estimated elasticities of our models are above this critical value, we can conclude that according to estimations, the current BB retail product market access should be extended to include the next best substitute, MBB.

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<sup>25</sup> The Austrian regulator considered that variable costs are an adequate approximation of marginal costs.

It is important to note, however, that the role of regulators in BB market is primarily at the level of the wholesale markets and aims to eliminate the problems identified in the retail market. The definition of the wholesale market does not differ conceptually from the definition at the retail level (HM test is used in both cases) and the definition of the retail market should even be the starting point for the definition of related wholesale markets. However, the definition at the wholesale level involves other issues that are mostly related to the possibility of direct substitution at the wholesale level, which are outside the scope of this paper. Nevertheless, there is also a need to consider sources of direct substitution at the wholesale level which are related to the substitution at the retail market.

Thus, at the wholesale level in addition to the potential direct substitution of the current wholesale services supported in copper networks by other wholesale services in cable or mobile networks, it must be also considered the indirect constraints in the wholesale market caused by the existence of substitutability at the retail level<sup>26</sup>. It is precisely in the study of indirect constraints that the estimations of substitution obtained might be relevant since they are important references in the impact of the retail market in the definition of the wholesale market.

In this regard and assuming that there is no direct substitution at the wholesale level, it can be considered the approach of Schwarz (2007), considering the assumptions that one unit of wholesale input is used to produce one unit of the good in retail and that the retail market is competitive. Therefore the relationship between the elasticity of demand in the retail and wholesale market is:

$$\varepsilon_W = \frac{w}{p} \varepsilon_R$$

Where  $\varepsilon_W$  is elasticity at the wholesale level and  $\varepsilon_R$  the elasticity at the retail level,  $w$  the wholesale price and  $p$  the retail price.

As we estimated the retail elasticity and there is information available on the percentage of the wholesale costs in the price of retail<sup>27</sup>, is possible to estimate the wholesale elasticity caused indirectly by the existing substitution in the retail market<sup>28</sup>, which assumes values between 3.5 and 4.3.

Thus, as the estimated elasticities for retail and the retail market are above the critical value calculated, the relevant market might include the next best substitute. Accordingly, it seems appropriate to incorporate in the same access market FBB and MBB services.

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<sup>26</sup> This because a price increase at the wholesale level also results, under certain conditions, in an increase of the price at the retail level, motivating consumers to switch to other products that are not made with the same inputs and whose prices were not increased.

<sup>27</sup> According to the analysis of BB market performed by ANACOM in 2009, the percentage of wholesale costs with the bitstream offer varies between 60% and 70% of the retail price.

<sup>28</sup> Assuming that there are no sources of direct substitution at the wholesale level.

## 8. CONCLUSIONS AND FURTHER RESEARCH STEPS

Aiming to study the demand for Internet, we estimated several multinomial and nested logit models, using information of the ICSC questionnaire, complemented with information of the price offers in the market.

These estimations identify the individual variables that influence the decision of consumers in terms of choice of access to Internet service and capture the demographic and socio-economic characteristics of BB demand.

It was confirmed an expected economic result: an increase of the price of a BB technology results in the decrease, in probabilistic terms, of the demand of such technologies. The estimated own price elasticities are all negative, so all BB access services BL are normal goods.

The empirical results also show that when the size of the household increases, its propensity to have MBB decreases. Furthermore, when the age of the respondent increases, the propensity to have BB reduces. The gender and the variables related to the condition towards work are not statistically significant, revealing to have little influence on the choice of internet access.

The estimated models permit calculating MBB and FBB own price elasticities, revealing that the demand for all technologies is elastic. By technology, the less elastic demand is for ADSL, a result already found by Ida & Kuroda (2006).

In the model that aggregates all FBB technologies, the demand for MBB is restricted by the FBB weighted price (elasticity of 5.97). But when analyzing the demand for each type of FBB technology the conclusions are slightly different.

Through the estimation of a multinomial discrete choice model for each FBB technology (ADSL and cable) and MBB was possible to reach conclusions particularly relevant for the substitution between fixed and mobile accesses. Firstly, there is evidence of symmetrical substitution between ADSL services and cable, with cross elasticities of, respectively, 4.34 and 7.68. These results support the BB market analysis in Portugal (ADSL and cable are in the same BB retail market), since both have the same features, identical speed, coverage and prices. By other side, when the price of ADSL or cable increases, the MBB demand increases (elasticities, respectively, of 3.78 and 3.15), but when the MBB price increases is not certain that the demand for cable and ADSL increases, as the estimation of these cross-elasticities is not statistically significant. That is, the substitution between fixed and mobile technologies occurs only in one direction, which leads us to a second conclusion: there is asymmetric substitutability of demand between the MBB and ADSL and cable fixed technologies. Users of ADSL and cable can replace Internet services by MBB in response to an increase in the price of ADSL or cable, but it is not necessarily true that users of the MBB service replace ADSL or cable in the case of a MBB price increase.

Economic theory tells us that the asymmetry in demand substitution can occur for many reasons, from the existence of potential price discrimination to the existence of asymmetric preferences in consumption. And as already stated, the distinctive MBB characteristics can lead to asymmetric preferences, due to its inherent mobility.

The next step was to carry out a SSNIP test based on estimated elasticities considering as the starting point the market that integrates ADSL and cable services. The test used is a simple test that follows the methodology established by RTR to analyse BB market in 2009, by calculating a critical value. It was found that the estimated

elasticities for the retail market are above the critical value calculated. This test reveals that the HM cannot impose a profitable non-transitory increase in price. Therefore, the current BB relevant market should be extended to include the next best substitute, MBB.

It should however be mentioned that the inclusion of one technology in the BB market results not only from SSNIP test analysis and from the calculation of elasticity. To draw robust conclusions for market definition we must also conclude that the features of the different technologies allow satisfying the pattern of use of the majority of the end users. It is evident that the fixed and mobile accesses have differences, namely the mobility provided by the MBB and the better quality of FBB, so it is always necessary to complement this analysis. If it is true that the differences between MBB and FBB have been narrowing, it is also relevant to consider that it is increasingly common to have Internet offered in a bundle, including television, which makes the substitution between MBB and FBB less intense (due to the reduced capacity of mobile networks to provide TV service).

It should also be mentioned that the results might be less robust due to lack of databases with information about the price. The constraint of having limited information about the characteristics of price plans, speed and volume is a common characteristic of all the studies about this topic. Thus, a next step in research, if possible, would be to repeat this exercise with a database which has the richness of the survey used (ICSCE) but with more information about the type of access, including prices and download speeds.

Other research step it will be to apply this method to a more recent database, in order to analyse the use of more recent technologies and tendencies, as the widespread of Internet in smartphones and of optic fibre. The estimation results can also be more robust if there are more observations with BB access, particularly with multiple types of access, which would allow the analysis of consumption patterns. Additionally, having more BB observations will permit to obtain statistically significant results with nested logit models, allowing to use more powerful econometric models and compatible with utility maximization.

We also estimated the wholesale elasticity caused by the indirect substitution in the existing retail market. A next step of research will be to examine in more detail this substitutability.

In summary, this paper presents some new aspects that contribute to the discussion of the dynamics of Internet demand in Portugal. Firstly, we built a database for the Internet access with information about prices. Despite the limitations of the assumptions inherent in the imputation of prices, is the first known application for the Portuguese market that analyzes the demand for Internet access through a micro-database representative of the Portuguese population. Secondly, it was possible to conclude about the marginal effects of individual explanatory variables and calculate demand price elasticities. The third innovation was conducting a HM test by using the estimated values of the elasticities, concluding that there is empirical evidence that the relevant BB market in Portugal might include MBB in the coming years or, at least, that effective substitutability between MBB and FBB services should continue to be analyzed in detail.

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## APPENDIX

Table 12 – Resume of Literature Review

| Study (Country)  | Method and Data   | Own Demand Elasticities   | Cross Elasticities   | Conclusions  |
|--|---|---|--|--|
| <b>Cardona et al (2009)</b><br><b>(Austria)</b>          | - <i>Nested logit</i><br>- Consumers Survey<br>RTR (2825 observations)      | 4 technologies: Demand of DSL, cable and mobile elastic (between -2.61 and -2.48)<br>Two technologies: DSL (-0.97) and narrowband (-0.77) inelastic | 4 technologies: Between 0,183 and 0,402                                  | The different technologies are close BB substitutes                                |
| <b>Pereira &amp; Ribeiro (2006)</b><br><b>(Portugal)</b> | - <i>Mixed logit</i><br>- Panel Marktest (1200 households)                  | BB elastic (-2,836)<br>Narrowband lelastic (-1,156)<br>DSL: -3,196<br>Cable: -3,130   | BB Demand /narrowband price: 0,503<br>Demand narrowband /BB price: 0,876 | BB and narrowband are substitutes  |
| <b>Ida &amp; Kuroda (2006)</b><br><b>(Japão)</b>         | - Conditional and <i>nested logit</i><br>- Surveys Web (< 800 observations) | ADSL inelastic (-0,846)<br>Cable (-3,150) and fiber (-2,5) elastic  | Not estimated  | ADSL market is independent from cable and fiber                                    |
| <b>Hauge et al (2009)</b><br><b>(Portugal)</b>           | - Multinomial Model<br>- ICSCE 2008 and BB Survey 2006                      | Not estimated   | Not estimated  | Substitution between MBB and FBB (analysis of the individual features)             |
| <b>Crandall et al (2002)</b><br><b>(USA)</b>             | - <i>Nested logit</i><br>- Survey: 3 500 observations                       | DSL elastic (-1,184)<br>Cable: -1,220   | Demand cable/ price DSL: 0,591<br>Demand DSL/ price cable: 0,415         | DSL and cable in the same market (without conducting a SSNIP test)                 |
| <b>Rappoport et al (2003)</b><br><b>(USA)</b>            | - <i>Nested logit</i><br>- 20 000 random households                         | DSL elastica (-1,462)<br>Cable inelastic (-0,587)   | Demand cable/price DSL: 0,618  | DSL and cable substitutes and in the same market (without conducting a SSNIP test) |
| <b>Goel et al (2007)</b><br><b>(OECD Countries)</b>      | - <i>log-linear</i><br>- Data from OECD and World Bank                      | Internet: between -0.6 and -0.7   | Not estimated  | Demand Internet inelastic  |



Table 13 – Usage patterns

|             |                 | Price (€)       | Speed (Mbps)    | Household with access   |
|-------------|-----------------|-----------------|-----------------|---|
| ADSL        | Low Usage       | 21,37           | 3,47            | Without Internet and narrowband; Cable, MBB and optic fiber: offer closer to price  |
|             | Average Usage   | 26,88           | 8,28            | Cable, MBB and optic fiber: offer closer to the price   |
|             | High Usage      | 38,69           | 24              | Cable, MBB and optic fiber: offer closer to the price   |
| Cable       | Low Usage       | Mainland: 26,73 | Mainland: 8,39  | Without access and narrowband; ADSL, MBB and optic fiber: offer closer to the price   |
|             |                 | Azores: 16,57   | Azores: 5,19    |   |
|             |                 | Madeira: 35,18  | Madeira: 6,8    |   |
|             | Average Usage   | Mainland: 37,12 | Mainland: 18,38 | ADSL, MBB and optic fiber: offer closer to the price  |
|             |                 | Azores: 22,47   | Azores: 10,39   |   |
|             |                 | Madeira: 43,49  | Madeira: 13,59  |   |
|             | High Usage      | Mainland: 59,24 | Mainland: 29,97 | ADSL, MBB and optic fiber: offer closer to the price  |
|             |                 | Azores: 33,12   | Azores: 20,39   |   |
|             |                 | Madeira: 153,98 | Madeira: 20,39  |   |
| Optic Fiber | Low Usage       | 20,54           | 28,84           | Without Internet and narrowband; ADSL, Cable and MBB: offer closer to the price   |
|             |                 | Madeira: 19,81  | Madeira: 23,46  |   |
|             | Average Usage   | 24,21           | 63,46           | ADSL, cable and MBB: offer closer to the price  |
|             |                 | Madeira: 33,28  | Madeira: 50     |   |
|             | High Usage      | 37,13           | 126,91          | ADSL, cable and MBB: offer closer to the price  |
| MBB (Cards) | Very Low Usage  | 22,80           | 2               | Without Internet (and doesn't pretend to have in the next 12 months) and narrowband; ADSL, Cable and optic fiber: offer       |
|             |                 |                 |                 | Without Internet (but pretend to have in the next 12 months) and narrowband; ADSL, Cable and optic fiber: offer closer to the |
|             | Low Usage       | 30,33           | 3,6             |   |
|             | Average Usage   | 36,67           | 5               | ADSL, cable and optic fiber: offer closer to the price  |
|             | High Usage      | 45,53           | 7,2             | ADSL, cable and optic fiber: offer closer to the price  |
|             | Very High Usage | 49,90           | 21,6            | ADSL, cable and optic fiber: offer closer to the price  |

Table 14 – Description of the variables of the models

|  | Variável      | Description  |
|--|---------------|--|
| <b>Type of access</b>                        | BLM           | MBB Access = 1, otherwise = 0                                  |
|  | BLF           | FBB Access = 1, Otherwise = 0                                  |
|  | Chosen50      | No Internet = 1, FBB = 2, MBB = 3, MBB and FBB = 4             |
|  | Chosen9       | No Internet = 1, ADSL = 2, Cable = 3, MBB = 4, MBB and FBB = 5 |
| <b>Price</b>                                 | preobl m      | Price of MBB Access  |
|  | preobl f      | Price of FBB Access  |
|  | preoadsl      | Price of ADSL Access   |
|  | preocabo      | Price of Cable Access  |
| <b>Region</b>                                | norte         | North Region = 1, Any other region = 0                         |
|  | centro        | Center Region = 1, Any other region = 0                        |
|  | alentejo      | Alentejo Region = 1, Any other region = 0                      |
|  | algarve       | Algarve Region = 1, Any other region = 0                       |
|  | raaores       | Azores Islands = 1, Any other region = 0                       |
|  | ramadeira     | Madeira Islands = 1, Any other region = 0                      |
| <b>Size of the place of living</b>           | 2000-4999     | Place with 2 000 - 4 999 inhabitants = 1, Otherwise = 0        |
|  | 5000-9999     | Place with 5 000 - 9 999 inhabitants = 1, Otherwise = 0        |
|  | 10000-99999   | Place with 10 000 - 99 999 inhabitants = 1, Otherwise = 0      |
|  | mais_100000   | Place with more than 100 000 inhabitants = 1, Otherwise = 0    |
| <b>School level</b>                          | ensinosecund  | High school completed = 1, otherwise = 0                       |
|  | ens__superior | Graduation completed = 1, otherwise = 0                        |
| <b>Gender</b>                                | mulher        | Female = 1, Male = 0   |
| <b>Bundle</b>                                | cabaz         | Internet included in a bundle = 1, otherwise = 0               |
| <b>Household</b>                             | agreg         | Household dimension (number)                                   |
|  | crian_agreg   | Children in the household = 1, otherwise = 0                   |
|  | idosos_agreg  | Elderly in the household = 1, otherwise = 0                    |
| <b>Existence of devices in the household</b> | desktops      | Number of desktops in the household                            |
|  | laptops       | Number of laptops in the household                             |
|  | pdas          | Number of pdas and palmtops in the household                   |
|  | tv            | Number of televisions in the household                         |
|  | consolas      | Number of game consoles in the household                       |
| <b>Employment</b>                            | trabalhador   | Employed = 1, otherwise = 0                                    |
|  | desempregados | Unemployed = 1, otherwise = 0                                  |
|  | reformados    | Retired = 1, otherwise = 0                                     |
|  | outros_inact  | Other type of inactivity = 1, otherwise = 0                    |
| <b>Age</b>                                   | idade         | Number of years of the respondent                              |
|  | idade2        | Square of the number of years of the respondent                |
| <b>Income</b>                                | renda         | Income level A (higher) = 1 , other levels = 0                 |
|  | rendb         | Income level B = 1 , other levels = 0                          |
|  | rendc         | Income level C = 1 , other levels = 0                          |
|  | rendd         | Income level D = 1 , other levels = 0                          |
| <b>Internet</b>                              | internetfora  | Internet usage outside household = 1, otherwise = 0            |

Table 15 – Model A – Restrictive Multinomial Model

|                                 |               |   |         |
|---------------------------------|---------------|---|---------|
| Multinomial logistic regression | Number of obs | = | 3081    |
|                                 | LR chi2(69)   | = | 2829.44 |
|                                 | Prob > chi2   | = | 0.0000  |
| Log likelihood = -1583.3547     | Pseudo R2     | = | 0.4719  |

|   | chosen50     | Coef.     | Std. Err. | z      | P> z  | [95% Conf. Interval]   |
|---|--------------|-----------|-----------|--------|-------|------------------------|
| 1 | preoblfb     | -.2303647 | .0209366  | -11.00 | 0.000 | -.2713997    -.1893297 |
|   | preoblm      | .1036708  | .0181694  | 5.71   | 0.000 | .0680593    .1392822   |
|   | idade2       | .0007922  | .0000959  | 8.26   | 0.000 | .0006043    .0009801   |
|   | rendb        | -.7669286 | .2996099  | -2.56  | 0.010 | -1.354153    -.1797041 |
|   | rendc        | .2571364  | .2636635  | 0.98   | 0.329 | -.2596346    .7739074  |
|   | crian_agreg  | .0627118  | .2102714  | 0.30   | 0.766 | -.3494125    .4748361  |
|   | _agreg       | .2449894  | .1001054  | 2.45   | 0.014 | .0487864    .4411924   |
|   | desktops     | -1.055754 | .1906674  | -5.54  | 0.000 | -1.429455    -.6820528 |
|   | laptops      | -1.857715 | .1444555  | -12.86 | 0.000 | -2.140842    -1.574587 |
|   | tv           | -.0229222 | .0915231  | -0.25  | 0.802 | -.2023042    .1564598  |
|   | consolas     | -.2354337 | .2349238  | -1.00  | 0.316 | -.695876    .2250086   |
|   | ensinosecund | -.9407381 | .25521    | -3.69  | 0.000 | -1.44094    -.4405358  |
|   | ens_superior | -1.041035 | .3410389  | -3.05  | 0.002 | -1.709458    -.3726107 |
|   | 2000-4999    | -.546445  | .2956448  | -1.85  | 0.065 | -1.125898    .0330081  |
|   | 5000-9999    | -.562749  | .3246088  | -1.62  | 0.105 | -1.162971    .1094726  |
|   | 10000-99999  | -.0637771 | .2350176  | -0.27  | 0.786 | -.5244032    .396849   |
|   | mais_100000  | .8035663  | .3678072  | 2.18   | 0.029 | .0826775    1.524455   |
|   | _norte       | .2172369  | .2379826  | 0.91   | 0.361 | -.2492004    .6836743  |
|   | alentejo     | -.2329151 | .2976467  | -0.78  | 0.434 | -.816292    .3504619   |
|   | algarve      | -.6338544 | .289925   | -2.19  | 0.029 | -1.202097    -.0656118 |
|   | raaeros      | .9390777  | .4147154  | 2.26   | 0.024 | .1262506    1.751905   |
|   | ramadeira    | 1.100449  | .3973393  | 2.77   | 0.006 | .3216778    1.879219   |
|   | internetfora | 1.369597  | .2410688  | 5.68   | 0.000 | .897111    1.842083    |
|   | _cons        | 4.806494  | .4903432  | 9.80   | 0.000 | 3.845439    5.76755    |

|   |              |            |          |        |       |            |            |
|---|--------------|------------|----------|--------|-------|------------|------------|
| 2 | preobl       | -0.3469281 | .0221296 | -15.68 | 0.000 | -0.3903013 | -0.3035548 |
|   | preobl       | .2993829   | .0212569 | 14.08  | 0.000 | .2577202   | .3410457   |
|   | idade2       | .0004523   | .0000954 | 4.74   | 0.000 | .0002653   | .0006394   |
|   | rendb        | -.0572861  | .261281  | -0.22  | 0.826 | -.5693876  | .4548153   |
|   | rendc        | .6495508   | .2517038 | 2.58   | 0.010 | .1562203   | 1.142881   |
|   | crian_agreg  | -.3089041  | .2012943 | -1.53  | 0.125 | -.7034337  | .0856255   |
|   | agreg        | .3797196   | .098198  | 3.87   | 0.000 | .1872551   | .572184    |
|   | desktops     | 1.208241   | .1796085 | 6.73   | 0.000 | .8562148   | 1.560267   |
|   | laptops      | -.4342946  | .1211833 | -3.58  | 0.000 | -.6718094  | -.1967797  |
|   | tv           | .1223159   | .0877724 | 1.39   | 0.163 | -.0497149  | .2943466   |
|   | consolas     | .1096567   | .2078172 | 0.53   | 0.598 | -.2976575  | .516971    |
|   | ensinosecund | -.3329246  | .2366718 | -1.41  | 0.160 | -.7967928  | .1309436   |
|   | ens_superior | -.3507056  | .2983528 | -1.18  | 0.240 | -.9354664  | .2340552   |
|   | 2000-4999    | -.1351797  | .2867841 | -0.47  | 0.637 | -.6972661  | .4269068   |
|   | 5000-9999    | .1932579   | .3110146 | 0.62   | 0.534 | -.4163196  | .8028354   |
|   | 10000-99999  | .4900218   | .2273264 | 2.16   | 0.031 | .0444703   | .9355734   |
|   | mais_100000  | 1.331124   | .3521611 | 3.78   | 0.000 | .6409007   | 2.021347   |
|   | norte        | -.7078158  | .23402   | -3.02  | 0.002 | -1.166487  | -.2491452  |
|   | alentejo     | -1.08516   | .2841144 | -3.82  | 0.000 | -1.642014  | -.5283059  |
|   | algarve      | -1.018284  | .2878316 | -3.54  | 0.000 | -1.582424  | -.4541447  |
|   | raaocres     | .6367445   | .3957594 | 1.61   | 0.108 | -.1389298  | 1.412419   |
|   | ramadeira    | 1.190961   | .3891348 | 3.06   | 0.002 | .4282706   | 1.953651   |
|   | internetfora | .5315391   | .225702  | 2.36   | 0.019 | .0891714   | .9739068   |
|   | _cons        | .3583963   | .4746523 | 0.76   | 0.450 | -.5719051  | 1.288698   |

3 | (base outcome)



|             |              |  |                |          |        |       |           |           |
|-------------|--------------|--|----------------|----------|--------|-------|-----------|-----------|
| -----+----- |              |  |                |          |        |       |           |           |
| 2           | preoadsl     |  | -.207962       | .0226195 | -9.19  | 0.000 | -.2522953 | -.1636286 |
|             | preocabo     |  | .0425403       | .0118322 | 3.60   | 0.000 | .0193495  | .065731   |
|             | preoblm      |  | .1388696       | .0193394 | 7.18   | 0.000 | .1009652  | .1767741  |
|             | idade2       |  | .000411        | .0001015 | 4.05   | 0.000 | .000212   | .00061    |
|             | rendb        |  | .1383051       | .3386657 | 0.41   | 0.683 | -.5254676 | .8020778  |
|             | rendc        |  | .9866928       | .3258725 | 3.03   | 0.002 | .3479944  | 1.625391  |
|             | rendd        |  | .1775039       | .277639  | 0.64   | 0.523 | -.3666585 | .7216663  |
|             |              |  |                |          |        |       |           |           |
|             | crian_agreg  |  | -.4609318      | .215259  | -2.14  | 0.032 | -.8828317 | -.0390319 |
|             | agreg        |  | .4426993       | .1074775 | 4.12   | 0.000 | .2320472  | .6533513  |
|             | desktops     |  | 1.417031       | .1902334 | 7.45   | 0.000 | 1.04418   | 1.789882  |
|             | laptops      |  | -.4718544      | .1302589 | -3.62  | 0.000 | -.7271571 | -.2165517 |
|             | pdas         |  | -.2091558      | .3815805 | -0.55  | 0.584 | -.9570397 | .5387282  |
|             | tvcs         |  | -.030092       | .0920903 | -0.33  | 0.744 | -.2105858 | .1504017  |
|             | consolas     |  | .1753112       | .220701  | 0.79   | 0.427 | -.2572547 | .6078771  |
|             | ensinosecund |  | -.1254936      | .2532573 | -0.50  | 0.620 | -.6218689 | .3708816  |
|             | ens_superior |  | -.3404604      | .3283798 | -1.04  | 0.300 | -.9840729 | .3031522  |
|             | 2000-4999    |  | -.3556809      | .2997104 | -1.19  | 0.235 | -.9431024 | .2317406  |
|             | 5000-9999    |  | .1222715       | .3319068 | 0.37   | 0.713 | -.5282538 | .7727969  |
|             | 10000-99999  |  | .0584497       | .2509192 | 0.23   | 0.816 | -.4333429 | .5502423  |
|             | mais_100000  |  | 1.015026       | .369771  | 2.75   | 0.006 | .2902885  | 1.739764  |
|             | norte        |  | -.3904372      | .2269366 | -1.72  | 0.085 | -.8352249 | .0543504  |
|             | raaores      |  | 1.010221       | .3967429 | 2.55   | 0.011 | .2326196  | 1.787823  |
|             | ramadeira    |  | -1.319832      | .4319579 | -3.06  | 0.002 | -2.166454 | -.4732103 |
|             | internetfora |  | .4404931       | .2420029 | 1.82   | 0.069 | -.0338239 | .9148101  |
|             | _cons        |  | -1.684627      | .5496859 | -3.06  | 0.002 | -2.761992 | -.6072629 |
| -----+----- |              |  |                |          |        |       |           |           |
| 3           | preoadsl     |  | .1663274       | .0292597 | 5.68   | 0.000 | .1089794  | .2236754  |
|             | preocabo     |  | -.5271334      | .0326626 | -16.14 | 0.000 | -.5911509 | -.4631158 |
|             | preoblm      |  | .155336        | .0224554 | 6.92   | 0.000 | .1113242  | .1993479  |
|             | idade2       |  | .0005029       | .0001096 | 4.59   | 0.000 | .0002881  | .0007177  |
|             | rendb        |  | -.1873717      | .3600925 | -0.52  | 0.603 | -.89314   | .5183966  |
|             | rendc        |  | .2654358       | .3542626 | 0.75   | 0.454 | -.4289061 | .9597777  |
|             | rendd        |  | -.5054898      | .299209  | -1.69  | 0.091 | -1.091929 | .0809491  |
|             | crian_agreg  |  | -.1802287      | .2391726 | -0.75  | 0.451 | -.6489984 | .288541   |
|             | agreg        |  | .2118335       | .1161255 | 1.82   | 0.068 | -.0157684 | .4394354  |
|             | desktops     |  | .8017872       | .2043873 | 3.92   | 0.000 | .4011954  | 1.202379  |
|             | laptops      |  | -.5275912      | .1415585 | -3.73  | 0.000 | -.8050408 | -.2501417 |
|             | pdas         |  | -3.570086      | .9581123 | -3.73  | 0.000 | -5.447951 | -1.69222  |
|             | tvcs         |  | .2037479       | .0995872 | 2.05   | 0.041 | .0085604  | .3989353  |
|             | consolas     |  | .0418557       | .2475111 | 0.17   | 0.866 | -.4432571 | .5269684  |
|             | ensinosecund |  | -.6309095      | .2860314 | -2.21  | 0.027 | -1.191521 | -.0702983 |
|             | ens_superior |  | -.7040345      | .3572815 | -1.97  | 0.049 | -1.404293 | -.0037756 |
|             | 2000-4999    |  | .075048        | .3413792 | 0.22   | 0.826 | -.5940429 | .7441388  |
|             | 5000-9999    |  | .0327915       | .3933717 | 0.08   | 0.934 | -.7382029 | .8037859  |
|             | 10000-99999  |  | .8799472       | .2704146 | 3.25   | 0.001 | .3499443  | 1.40995   |
|             | mais_100000  |  | 1.450524       | .3784164 | 3.83   | 0.000 | .7088411  | 2.192206  |
|             | norte        |  | -.054096       | .2635613 | -0.21  | 0.837 | -.5706666 | .4624747  |
|             | raaores      |  | -1.211085      | .4315193 | -2.81  | 0.005 | -2.056847 | -.3653223 |
|             | ramadeira    |  | 5.158735       | .5149943 | 10.02  | 0.000 | 4.149365  | 6.168105  |
|             | internetfora |  | .8625762       | .2652645 | 3.25   | 0.001 | .3426673  | 1.382485  |
|             | _cons        |  | 4.839246       | .7110201 | 6.81   | 0.000 | 3.445672  | 6.23282   |
| -----+----- |              |  |                |          |        |       |           |           |
| 4           |              |  | (base outcome) |          |        |       |           |           |
| -----+----- |              |  |                |          |        |       |           |           |
|             |              |  |                |          |        |       |           |           |
| -----+----- |              |  |                |          |        |       |           |           |
| 5           | preoadsl     |  | -.0141724      | .03553   | -0.40  | 0.690 | -.0838099 | .0554652  |
|             | preocabo     |  | -.0149666      | .0271979 | -0.55  | 0.582 | -.0682734 | .0383403  |
|             | preoblm      |  | -.0232107      | .0244493 | -0.95  | 0.342 | -.0711305 | .0247091  |
|             | idade2       |  | .0000673       | .0002041 | 0.33   | 0.742 | -.0003328 | .0004674  |
|             | rendb        |  | 1.061703       | .699456  | 1.52   | 0.129 | -.309206  | 2.432611  |
|             | rendc        |  | 1.966287       | .6963642 | 2.82   | 0.005 | .6014381  | 3.331136  |
|             | rendd        |  | 1.266603       | .655697  | 1.93   | 0.053 | -.0185395 | 2.551745  |
|             | crian_agreg  |  | .0139299       | .3752865 | 0.04   | 0.970 | -.7216182 | .749478   |
|             | agreg        |  | -.0486859      | .1905137 | -0.26  | 0.798 | -.4220858 | .324714   |
|             | desktops     |  | 1.686823       | .2869763 | 5.88   | 0.000 | 1.12436   | 2.249287  |

Dependent variable: 1: No BB, 2: ADSL; 3: Cable; 4: MBB; 5: MBB and FBB

Tree:

|     |           |           |          |        |       |           |           |
|-----|-----------|-----------|----------|--------|-------|-----------|-----------|
| NBL |           |           |          |        |       |           |           |
|     | idade     | .0421638  | .0036736 | 11.48  | 0.000 | .0349637  | .049364   |
|     | norte     | 1.246499  | .174658  | 7.14   | 0.000 | .904176   | 1.588823  |
|     | centro    | .692542   | .1930097 | 3.59   | 0.000 | .31425    | 1.070834  |
|     | alentejo  | .7420155  | .213736  | 3.47   | 0.001 | .3231007  | 1.16093   |
|     | algarve   | .5699618  | .2116283 | 2.69   | 0.007 | .155177   | .9847457  |
|     | ramadeira | .4977904  | .2045211 | 2.43   | 0.015 | .0969364  | .8986444  |
|     | raaores   | .6815366  | .2178998 | 3.13   | 0.002 | .2544608  | 1.108612  |
|     | desktops  | -2.247494 | .1164073 | -19.31 | 0.000 | -2.475648 | -2.01934  |
|     | laptops   | -1.662203 | .1017911 | -16.33 | 0.000 | -1.86171  | -1.462696 |
|     | agreg     | -.0243136 | .0497945 | -0.49  | 0.625 | -.121909  | .0732817  |
|     | rendb     | -1.081958 | .2040176 | -5.30  | 0.000 | -1.481825 | -.6820908 |
|     | rendc     | -.5852596 | .1734619 | -3.37  | 0.001 | -.9252386 | -.2452807 |
|     | rendd     | -.1233527 | .1461204 | -0.84  | 0.399 | -.4097434 | .163038   |

|                            |  |           |          |           |        |               |           |
|----------------------------|--|-----------|----------|-----------|--------|---------------|-----------|
| BL                         |  | (base)    |          |           |        |               |           |
| alternativa equations      |  |           |          |           |        |               |           |
| alternativa1               |  | (base)    |          |           |        |               |           |
| _cons                      |  |           |          |           |        |               |           |
| alternativa2               |  |           |          |           |        |               |           |
| _cons                      |  | -.8848955 | .3153491 | -2.81     | 0.005  | -1.502968     | -.2668226 |
| alternativa3               |  |           |          |           |        |               |           |
| _cons                      |  | -1.042047 | .3272907 | -3.18     | 0.001  | -1.683525     | -.4005694 |
| alternativa4               |  |           |          |           |        |               |           |
| _cons                      |  | -.7746265 | .3065521 | -2.53     | 0.012  | -1.375458     | -.1737954 |
| alternativa5               |  |           |          |           |        |               |           |
| _cons                      |  | -1.396313 | .3681997 | -3.79     | 0.000  | -2.117971     | -.6746551 |
| dissimilarity parameters   |  |           |          |           |        |               |           |
| typez                      |  |           |          |           |        |               |           |
| /NBL_tau                   |  | 1         | .        |           |        | .             | .         |
| /BL_tau                    |  | -.2840016 | .0563923 |           |        | -.3945284     | -.1734748 |
| LR test for IIA (tau = 1): |  |           |          |           |        |               |           |
|                            |  |           |          | chi2(1) = | 369.67 | Prob > chi2 = | 0.0000    |

Table 18 – Marginal effects of price for ADSL (alternative=ADSL) - Model C

| alternativa |  | Summary of dpdadsl |           |       |
|-------------|--|--------------------|-----------|-------|
|             |  | Mean               | Std. Dev. | Freq. |
| 1           |  | -.0019115          | .00170335 | 2965  |
| 2           |  | -.01243078         | .01192935 | 2965  |
| 3           |  | .00804164          | .00765202 | 2965  |
| 4           |  | .00518459          | .00587961 | 2965  |
| 5           |  | .00111609          | .00161965 | 2965  |
| Total       |  | 6.836e-09          | .00991847 | 14825 |

Dependent variable- 1: No BB, 2: ADSL; 3: Cable; 4: MBB; 5: MBB and FBB

Table 19 – Marginal effects of price for cable (alternative=cable) – Model C

| alternativa |  | Summary of dpdcabo |           |       |
|-------------|--|--------------------|-----------|-------|
|             |  | Mean               | Std. Dev. | Freq. |
| 1           |  | -.00375946         | .00296353 | 2965  |
| 2           |  | -.00439345         | .00638019 | 2965  |
| 3           |  | -.00383882         | .00552312 | 2965  |
| 4           |  | .00968418          | .00923681 | 2965  |
| 5           |  | .0023077           | .0027996  | 2965  |
| Total       |  | 2.844e-08          | .00800494 | 14825 |

Dependent variable- 1: No BB, 2: ADSL; 3: Cable; 4: MBB; 5: MBB and FBB

|             |  | Summary of dpdblm |           |       |
|-------------|--|-------------------|-----------|-------|
| alternativa |  | Mean              | Std. Dev. | Freq. |
| 1           |  | -.00482574        | .00360025 | 2965  |
| 2           |  | .00079525         | .00197074 | 2965  |
| 3           |  | .00065639         | .00195803 | 2965  |
| 4           |  | .00031599         | .00161364 | 2965  |
| 5           |  | .0030582          | .00383684 | 2965  |
| Total       |  | 1.577e-08         | .00378946 | 14825 |

Table 21 – Model *Nested Logit D*

| typeR | N    |     | alternativa | N     | k    |
|-------|------|-----|-------------|-------|------|
| NBL   | 2965 | --- | 1           | 2965  | 1743 |
| SOBLF | 5930 | --- | 2           | 2965  | 391  |
|       |      | +-  | 3           | 2965  | 514  |
| BLM   | 5930 | --- | 4           | 2965  | 257  |
|       |      | +-  | 5           | 2965  | 60   |
|       |      |     | total       | 14825 | 2965 |

```
Alternative variable: alternativa      Alts per case: min =      5
                                       avg =      5.0
                                       max =      5
                                       Wald chi2(27) =    966.66
Log likelihood =   -2243.583          Prob > chi2      =    0.0000
```

| trans1      | Coef.    | Std. Err. | z    | P> z  | [95% Conf. Interval] |
|-------------|----------|-----------|------|-------|----------------------|
| alternativa |          |           |      |       |                      |
| preo        | .0058576 | .0067446  | 0.87 | 0.385 | -.0073616 .0190768   |

|     |           |  |           |          |        |       |           |           |
|-----|-----------|--|-----------|----------|--------|-------|-----------|-----------|
| NBL | idade     |  | .0353593  | .0038268 | 9.24   | 0.000 | .0278588  | .0428597  |
|     | norte     |  | 1.311753  | .1825152 | 7.19   | 0.000 | .9540293  | 1.669476  |
|     | centro    |  | .6834469  | .1990759 | 3.43   | 0.001 | .2932653  | 1.073628  |
|     | alentejo  |  | .8888251  | .2252422 | 3.95   | 0.000 | .4473584  | 1.330292  |
|     | algarve   |  | .7660627  | .226287  | 3.39   | 0.001 | .3225484  | 1.209577  |
|     | ramadeira |  | .2669332  | .2073854 | 1.29   | 0.198 | -.1395348 | .6734011  |
|     | raaões    |  | .6092004  | .2239021 | 2.72   | 0.007 | .1703603  | 1.04804   |
|     | desktops  |  | -2.425882 | .1203978 | -20.15 | 0.000 | -2.661857 | -2.189906 |
|     | laptops   |  | -1.538886 | .1044325 | -14.74 | 0.000 | -1.74357  | -1.334202 |
|     | agreg     |  | -.0658448 | .0522235 | -1.26  | 0.207 | -.1682011 | .0365115  |
|     | rendb     |  | -1.130714 | .2116706 | -5.34  | 0.000 | -1.545581 | -.7158476 |
|     | rendc     |  | -.7113371 | .1810973 | -3.93  | 0.000 | -1.066281 | -.3563929 |
|     | rendd     |  | -.1056597 | .1556792 | -0.68  | 0.497 | -.4107852 | -.1994659 |

|       |  |        |
|-------|--|--------|
| SOBLF |  | (base) |
|-------|--|--------|



|                            |           |           |           |           |        |               |           |           |
|----------------------------|-----------|-----------|-----------|-----------|--------|---------------|-----------|-----------|
| -----+-----                |           |           |           |           |        |               |           |           |
| BLM                        | idade     |           | -.0291655 | .0054213  | -5.38  | 0.000         | -.0397911 | -.0185399 |
|                            | norte     |           | .5004495  | .2149394  | 2.33   | 0.020         | .0791761  | .9217229  |
|                            | centro    |           | .2013176  | .2429463  | 0.83   | 0.407         | -.2748485 | .6774836  |
|                            | alentejo  |           | .8712979  | .2406894  | 3.62   | 0.000         | .3995552  | 1.343041  |
|                            | algarve   |           | .8971889  | .2585431  | 3.47   | 0.001         | .3904538  | 1.403924  |
|                            | ramadeira |           | -.5418279 | .2856522  | -1.90  | 0.058         | -1.101696 | .0180401  |
|                            | raaores   |           | -.3423758 | .3010639  | -1.14  | 0.255         | -.9324502 | .2476987  |
|                            | desktops  |           | -.8271898 | .1313618  | -6.30  | 0.000         | -1.084654 | -.5697253 |
|                            | laptops   |           | .4712549  | .0893298  | 5.28   | 0.000         | .2961717  | .6463381  |
|                            | agreg     |           | -.1828878 | .0667102  | -2.74  | 0.006         | -.3136373 | -.0521383 |
|                            | rendb     |           | -.0729732 | .2275206  | -0.32  | 0.748         | -.5189055 | .3729591  |
|                            | rendc     |           | -.4833413 | .2313641  | -2.09  | 0.037         | -.9368067 | -.029876  |
|                            | rendd     |           | -.0148734 | .2047269  | -0.07  | 0.942         | -.4161308 | .386384   |
| -----+-----                |           |           |           |           |        |               |           |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| alternativa equations      |           |           |           |           |        |               |           |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| alternativa1               |           |           |           |           |        |               |           |           |
| _cons                      |           | (base)    |           |           |        |               |           |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| alternativa2               |           |           |           |           |        |               |           |           |
| _cons                      |           | -.9790752 | .3291108  | -2.97     | 0.003  | -1.624121     | -.3340299 |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| alternativa3               |           |           |           |           |        |               |           |           |
| _cons                      |           | -.9991688 | .3392878  | -2.94     | 0.003  | -1.664161     | -.3341769 |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| alternativa4               |           |           |           |           |        |               |           |           |
| _cons                      |           | -.5168672 | .411281   | -1.26     | 0.209  | -1.322963     | .2892288  |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| alternativa5               |           |           |           |           |        |               |           |           |
| _cons                      |           | -.611184  | .4606895  | -1.33     | 0.185  | -1.514119     | .2917508  |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| dissimilarity parameters   |           |           |           |           |        |               |           |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| typeR                      |           |           |           |           |        |               |           |           |
| /NBL_tau                   |           | .9179802  | 102829.5  |           |        | -201541.1     | 201543    |           |
| /SOBLF_tau                 |           | -.0260559 | .0301401  |           |        | -.0851294     | .0330176  |           |
| /BLM_tau                   |           | -.0478548 | .0568389  |           |        | -.1592569     | .0635474  |           |
| -----+-----                |           |           |           |           |        |               |           |           |
| LR test for IIA (tau = 1): |           |           |           | chi2(3) = | 305.29 | Prob > chi2 = | 0.0000    |           |
| -----+-----                |           |           |           |           |        |               |           |           |

Table 22 –Model *Nested Logit E* (Base Only FBB)

|             |      |     |             |       |      |
|-------------|------|-----|-------------|-------|------|
| Tree:       |      |     |             |       |      |
| types       | N    |     | alternativa | N     | k    |
| -----+----- |      |     |             |       |      |
| NBL         | 2965 | --- | 1           | 2965  | 1743 |
| SoBLF       | 5930 | --- | 2           | 2965  | 391  |
|             |      | +-  | 3           | 2965  | 514  |
| BLM         | 2965 | --- | 4           | 2965  | 257  |
| BLMeBLF     | 2965 | --- | 5           | 2965  | 60   |
| -----+----- |      |     |             |       |      |
| total       |      |     |             | 14825 | 2965 |

```
RUM-consistent nested logit regression      Number of obs   =    14825
Case variable: id                          Number of cases  =     2965
```

alternativa equations

|              |  |           |          |       |       |           |           |
|--------------|--|-----------|----------|-------|-------|-----------|-----------|
| alternativa1 |  |           |          |       |       |           |           |
| _cons        |  | (base)    |          |       |       |           |           |
| alternativa2 |  |           |          |       |       |           |           |
| _cons        |  | -1.422476 | .2890154 | -4.92 | 0.000 | -1.988936 | -.8560167 |
| alternativa3 |  |           |          |       |       |           |           |
| _cons        |  | -1.388794 | .2988362 | -4.65 | 0.000 | -1.974502 | -.803086  |
| alternativa4 |  |           |          |       |       |           |           |
| _cons        |  | -1.173827 | .3852161 | -3.05 | 0.002 | -1.928837 | -.4188176 |
| alternativa5 |  |           |          |       |       |           |           |
| _cons        |  | -4.793085 | .8273848 | -5.79 | 0.000 | -6.414729 | -3.17144  |

dissimilarity parameters

|              |  |          |          |  |           |          |  |
|--------------|--|----------|----------|--|-----------|----------|--|
| types        |  |          |          |  |           |          |  |
| /NBL_tau     |  | 1        | 340206.8 |  | -666792.1 | 666794.1 |  |
| /SoBLF_tau   |  | .0416693 | .026765  |  | -.0107892 | .0941277 |  |
| /BLM_tau     |  | 1        | 434711   |  | -852017   | 852019   |  |
| /BLMeBLF_tau |  | 1        | 382857.1 |  | -750385   | 750387   |  |

LR test for IIA (tau = 1):                      chi2(4) =    270.21    Prob > chi2 = 0.0000