The Impact on Broadband Access to the Internet of the Dual Ownership of Telephone and Cable Networks*

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Abstract

In Portugal, the telecommunications incumbent offers broadband access to the Internet, both through digital subscriber line and cable modem. In this article, we estimate the impact on broadband access to the Internet of the structural separation of these two businesses. We use a panel of consumer level data and a discrete choice model to estimate the price elasticities of demand and the marginal costs of broadband access to the Internet. Based on these estimates, we simulate the effect on prices and social welfare of the structural separation. Our results indicate that the structural separation would lead to substantial price reductions. For broadband clients, on average, each household would save 3.37 euros per month, or 14% of the current price levels. Overall, on average, each household would save 2.73 euros per month, or 14% of the current price levels. We test the robustness of our results in terms of: **(i)** the estimates of the demand elasticities, **(ii)** the strategic behavior of the firms, and **(iii)** the market share estimates. There is no evidence of collusion.

Key Words: *Broadband, Structural Separation, Prices*

JEL Classification: L25, L51, L96

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1 Introduction

Networks for the distribution of cable television services, *Cable Networks* for short, can be used to deliver telecommunication services, such as fixed telephony, or broadband access to the Internet through cable modem. If a firm owns both the *Public Switched Telephone Network*, *PSTN*, and a cable network, it controls two local access networks, that can potentially compete against each other. This can hinder the development of competition in the telecommunications industry. As Table 1 indicates, in Denmark, Finland, Greece, Portugal and Sweden, the telecommunications incumbent owns cable networks.

[*Table* 1]

In the Unites States, the Telecommunications Act of 1996 recognized the importance of cable television networks for providing an alternative infrastructure to the local access network of the incumbent. It also recognized a potential conflict of interests. Section 302 imposed the structural separation of firms that own local telecommunications networks, and firms that own cable television networks.[1] The situation in Europe is more ambiguous. The European Commission indicated a preference for the structural separation in the Cable Directive 95/51/EC, Article 2, and the Communication 98/C 71/04. However, the legislation of the European Union, namely Directive 2002/77/CE, Article 8, imposed only legal separation. Brito and Pereira (2006) and Brito and Pereira (forthcoming) discuss the role of cable television networks and their ownership structure, in promoting competition in the local access market.

[*Table* 2]

In Portugal, the telecommunications incumbent, the holding company *Portugal Telecom*, *PT*, owns both the firm *PT Comunicações*, which operates the *PSTN*, and the firm *TV Cabo Portugal*, *CATVP*, which operates the largest cable television network. As indicted in Table 2, broadband access to the Internet was first offered in Portugal through the cable modem technology in 1999 by *CATVP*. One year later, in 2000, the Portuguese telecommunications industry was fully liberalized.[2] In 2001, the unbundling of the incumbent's local loop was mandated. As a consequence, *PT.com*, the Internet service provider of *PT*, started offering broadband access to the Internet through the asymmetric digital subscriber line technology,

[1] *Structural Separation* is the separation of a firm into several legally independent firms, with little or no cross ownership between them.

[2] In the EU countries, the telecommunications sector was a legal public monopoly for most of the twentieth century. The objective of establishing an internal market for telecommunications services led the EU to initiate the liberalization of the sector in the late 1980s. Council Resolution 93/C213/01 established the deadline of January 1st of 1998 for the liberalization of all public voice telephony services. Some countries were granted an additional transition period. In Portugal, the full liberalization occurred in 2000.

ADSL. In 2005, *PT* had a market share of 75% in broadband access to the Internet, as Table 3 shows. *Cabovisão*, the second largest cable television firm, had a market share of 15%. All the other cable television firms, *Bragatel*, *Pluricanal Leiria*, *Pluricanal Santarém*, and *TV Tel*, also offer broadband access to the Internet through cable modem, but have only local coverage. Most of the firms present in the fixed line business, such as *Oni*, *Sonaecom*, or *AR Telecom*, offer broadband access to the Internet through *ADSL*, but until 2005 gained very small market shares. As indicated in Table 1, in 2005 the penetration rate of broadband access to the Internet in Portugal was 10%.

[*Table* 3]

Portugal offers a suitable framework to evaluate the merits of the structural separation of a *PSTN* and a cable network. In this article, we use a rich panel of consumer level data, to estimate the impact on the broadband access to the Internet of the structural separation of these two businesses.[3] We estimate a series of discrete choice models, to obtain the price elasticities of demand for broadband access to the Internet. The model that fits the data better is a random effects mixed logit model, in which unobserved household characteristics are allowed to affect the price sensitivity coefficient, and the unobserved component is the same for a given household for all periods. Households are very sensitive to price variations in Internet access services. Assuming that firms play a Bertrand game, we use the demand elasticities to estimate marginal costs. Given the demand and cost estimates, we simulate the effect on prices and social welfare of the structural separation.

Our results indicate that the structural separation would lead to substantial price reductions. For broadband clients, on average, each household would save 3.37 euros per month, or 14% of the current price levels. For narrowband clients, on average, each household would save 0.53 euros per month, or 11% of the current price levels. Overall, i.e., including also families that previously did not buy access to the Internet, on average, each household would save 2.73 euros per month, or 14% of the current price levels. The price of some products could decrease by as much as 16 euros. For broadband clients, on average, the consumer surplus per household would increase by 2.56 euros per month, and the profits per household would decrease by 0.32 euros per month. Overall, on average, the consumer surplus per household would increase by 1.69 euros per month, and the profits per household would decrease by 0.37 euros per month.

We perform three exercises to test the robustness of our results. First, we simulate parameter vectors, and use them to generate alternative demand elasticities. Then, we use these demand elasticities to estimate the marginal costs. The alternative marginal cost and price change estimates do not differ much from our original estimates. Second, we

[3] Pereira and Ribeiro (2006) use similar data for the Portuguese cable television industry.

estimate the marginal costs, assuming that before the separation firms colluded on prices. If we impose no restriction, the estimates of some of the marginal costs are negative. If we impose a non-negativity restriction, the estimates of marginal costs imply lower price-cost margins, than if firms played a Bertrand game before the separation. We interpret this as evidence that firms do not collude in prices. Third, we calibrate our final model to reflect the most recent information available on market shares, as well as the entry of firms not present in our original data set. The price decreases caused by the separation become larger, due to the higher penetration of broadband.

Our methodological approach draws on the discrete choice literature, represented among others by Domencich and McFadden (1975), McFadden (1974), McFadden (1978), and McFadden (1981). In the industrial organization literature, Berry (1994), Berry, Levinsohn, and Pakes (1995), and Nevo (2001) applied discrete choice models to the analysis of market structure. Dube (2005), Ivaldi (2005), Ivaldi and Verboven (2005), Nevo (2000), and Pinkse and Slade (2004) analyzed the impact of mergers in a framework similar to ours.[4] These studies used aggregate data, with the exception of Dube (2005).

Regarding the empirical literature on broadband access to the Internet, Crandall, Sidak, and Singer (2002) used a nested-logit model to produce demand elasticity estimates. They obtained estimates of the own-price elasticities of demand for broadband access to the Internet through *ADSL* and cable modem of −1.18 and −1.22, respectively, and of the cross-price elasticity of demand for cable modem access with respect to the price of the *ADSL* of 0.60. Rappoport, Kridel, Taylor, and Alleman (2003) conducted a similar analysis for a series of models that differed in the choice set of Internet access available to households. Their estimates of the own-price elasticity of demand for narrowband access ranged from −0.17 to −0.37. The estimates of the cross-price elasticity of demand for narrowband access with respect to the prices of access to the Internet through cable modem and *ADSL* were 0.52 and 0.42, respectively; and the estimates of the cross-price elasticities of the demands for access to the Internet through cable modem and *ADSL* with respect to the price of narrowband access were 0. The estimates of the own-price elasticity of access through cable-modem and *ADSL* ranged from −0.59 to −0.9, and −1.4 to −1.5, respectively. The estimate of the cross-price elasticity of the demand for cable modem access with respect to the price of *ADSL* access was 0.77, and the estimate of the cross-price elasticity of demand for *ADSL* access with respect to the price of cable modem access was 0.62. Goolsbee (2006) obtained higher estimates of own-price elasticity of the demand for broadband access to the Internet in the range of −2.15 and −3.76. Varian (2000) reported own-price elasticities in the range of −1.3 and −3.1 from the INDEX experiment.[5]

[4] See also Baker and Bresnahan (1985) and Hausman, Leonard, and Zona (1994).

[5] For other studies about the demand for broadband access to the Internet see Duffy-Deno (2002), Flamm

The rest of the article is organized as follows. Section 2 describes the data. Section 3 presents the model. Section 4 describes the econometric implementation and presents the basic estimation results. Section 5 analyzes the impact of a structural separation, and Section 6 concludes.

2 Data

The data used in this study consists of a rich micro panel. The information is based on monthly invoices, collected by *Marktest* for mainland Portugal between April 2003 to March 2004. The panel consists of around $1,200$ households surveyed each month, and renewed periodically. Over the sample period, $1,650$ households were surveyed. The panel is proportional, segmented by age, 8 education levels, 5 social classes, and 6 regions.[6] The histograms in Figure 1 describe the demographic variables in March 2004. The data for the other months is similar.

[*Figure* 1]

We classified the Internet access options into eight products, and one outside option of no Internet access. Product (1) is the outside option. Product (2) is narrowband access. Products (3)-(6) belong to *PT*; (3) is *ADSL* access, (4) and (5) are cable modem access with different speeds, and (6) is a pay-as-you-go cable modem access. Finally, (7)-(9) are products of *Cabovisão* with different speeds. An explanation is in order. In our data set only *PT* offers the dial-up service. However, in 2004, *PT* had a market share of dial-up of only 25%, whereas *IOL*, *Novis*, *Oni*, and *Nortenet* had market shares of 32%, 27%, 10%, and 5%, respectively. We had two options, either assume that *PT* controlled all of the dial-up business, or assume that *PT* controlled none of it. We chose the latter, and interpret the share of this product as the share of dial-up as a whole, and not only the share of *PT*.[7]

[*Figure* 2]

[*Figure* 3]

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and Chaudhurib (2005), Hausman, Sidak, and Singer (2001a), Hausman, Sidak, and Singer (2001b), Madden, Savage, and Coble-Neal (1999), and Madden and Simpson (1996).

[6]The stratification of the sample was based on the 2001 census data from the Portuguese National Statistics Institute. The education levels are: 1 - Illiterate or incomplete 4th grade, 2 - 4th grade, 3 - 6th grade, 4 - 9th grade, 5 - 10th, 11th or 12th grade, 6 - incomplete Bachelor's degree, 7 - Bachelor's degree, and 8 - other. The social class levels are: 1 - High, 2 - Medium/High, 3 - Medium, 4 - Medium/Low, 5 - Low. The regions are: 1 - Greater Lisbon, 2 - Greater OPorto, 3 - Northern Coast, 4 - Central Coast, 5 - Northern Interior, 6 - South.

[7]This is done also to allow the comparison of the results of section 5.1 with the results of the calibration exercise in section 5.3, in which more firms with dial-up and *ADSL* are added.

Figures 2 and 3 describe the evolution of the penetration rates and the market shares, respectively. During the period under analysis, the market share of broadband access to the Internet increased steadily, mostly at the expense of dial-up access. The penetration rates of Internet access changed little throughout the period.

The data has three limitations. First, there is little price variation. Prices do not vary geographically, and apart from minor adjustments, they do not vary over time either. This implies that the price coefficient is identified through the interaction of price and household characteristics, and from specifying other product characteristics that are not perfectly collinear with the price variable. The second limitation of the data is that households rarely change their choice of type of Internet access. Most variation in the access choices of the households over time consists of the entry and exit of subjects from the market or the panel. In addition, it is difficult to differentiate these events from sampling decisions of not to survey a given household. The third limitation of the data is that it does not include all firms active in the industry. However, as Table 2 indicates, *PT* and *Cabovisão* represented 95% of the market in 2004, and 90% in 2005.

3 Economic Model

In this section, we present the econometric model. First, we provide a brief introduction of the discrete choice models we estimate. Second, we describe the implications of these models for the welfare analysis. Third, we present the assumptions about the behavior of firms.

3.1 Demand

3.1.1 Utility of Internet Access

A household chooses among a set of alternative products of Internet access. The products differ in: **(i)** the price, **(ii)** the speed of access, **(iii)** the bandwidth, i.e., narrowband or broadband, **(iv)** the technology, i.e., *ADSL* or cable modem, and **(v)** the firm. *PT.com* and *CATVP* have national coverage. *Cabovisão* does not operate in some regions.[8] For the households of those regions we excluded the products of *Cabovisão* from their choice set. For the households of the regions where both *PT* and *Cabovisão* operate, we included the products of both firms in their choice set.[9]

[8]In Portugal, unlike other countries such as the US, there is no regulatory limit to the number of cable television firms that can operate in the same geographic area, and overbuilds are common.

[9]Within a region were both *PT* and *Cabovisão* operate, there might be sub-regions where the latter is not active. We accounted for this possibility by estimating models where product dummy variables interact

We omit time subscripts whenever possible. Household $n = 1, ..., 1650$ in period $t = 1, ..., 12$ derives from alternative $i = 1, ..., 9$ utility:

$$U_{nti}(p_{ti}, z_{nt}, x_i, \xi_n, \varsigma_n, \varepsilon_{nti}, \theta) = V_{nti}(p_{ti}, z_{nt}, x_i, \xi_n, \varsigma_n, \theta) + \varepsilon_{nti},$$

where p_i is the price of alternative i, x_i is a j dimensional vector of the other characteristics of alternative i, z_n is a k dimensional vector of household characteristics, ς_{nj} and ξ_{nk} are unobserved household components, which define the random coefficients associated with each of the variables, θ is a vector of parameters, and finally ε_{ni} is a random disturbance independent across products, households, and time, and identically distributed. We assume additionally that:

$$V_{ni}(p_i, z_n, x_i, \xi_n, \varsigma_n, \theta) := p_i \alpha(z_n, \xi_n, \gamma, \sigma_\gamma) + g(x_i, \varsigma_n, \beta, \sigma_\beta),$$

where

$$\alpha(z_n, \xi_n) := -\exp\left[\sum_{k=1}^{K} z_{nk}(\gamma_k + \sigma_{\gamma_k}\xi_{nk})\right],$$

$$g(x_i, \varsigma_n, \beta, \sigma_\beta) := \sum_{j=1}^{J} x_{ij}(\beta_j + \sigma_{\beta_j}\varsigma_{nj}),$$

$$\theta := (\gamma, \sigma_\gamma, \beta, \sigma_\beta),$$

and where $\alpha(\cdot)$ is the negative of the marginal utility of income, which depends on individual characteristics. The exponential transformation imposes the restriction that the marginal utility of income is positive. All individual characteristics are therefore identified by an interaction with a price variable. Expression $g(\cdot)$ is a linear combination that summarizes the utility component associated with all product characteristics other than price. The parameters γ and σ_γ translate the effect of individual characteristics on the marginal utility of income. The parameters β and σ_β translate the household valuation of the different product characteristics. This formulation encompasses all the models analyzed in this paper. If $\sigma_{\beta_j} = \sigma_{\gamma_k} = 0$, and ε_{ni} has an extreme value Type I distribution, one obtains the standard multinomial logit model. If one sets the joint distribution of ε_{ni} to be of the generalized extreme value family, with the required generating function, one obtains the nested logit model. If $\sigma_{\beta_j} \neq 0$ or $\sigma_{\gamma_k} \neq 0$, one obtains the mixed logit model. Note that (ς_n, ξ_n) do not depend on t. Hence, for the models that use the whole panel, these unobserved components capture the correlation over time between choices of the same household, given the limited

with region dummy variables. If in a region households chose a product of PT only because *Cabovisão* was not active, then the estimate of the coefficient of the product of the dummy variable of *Cabovisão* with the dummy variable of that region ought to be negative. However, the estimates of those coefficients were not statistically significant.

time variation in our data. For the models that use a single month of data, these terms capture only the correlation between alternatives, leading to flexible substitution patterns.

3.1.2 Choice Probabilities

Household n chooses product i if $U_{ni} > U_{nj}$, for all $j \neq i$. This occurs with probability:

$$P_i := \Pr\left[V_i - V_j + \varepsilon_i > \varepsilon_j, \text{ for all } j \neq i, j = 1, \ldots, 9\right] = \int F_i(V_i - V_1 + u, \ldots, u, \ldots, V_i - V_9 + u)du$$

where $F(\cdot)$ is the joint distribution function of $(\varepsilon_1, \ldots, \varepsilon_I)$, and $F_i(\cdot)$ is its partial derivative with respect to the i^{th} argument. If $F(\cdot)$ is an extreme value type I distribution, one obtains the standard multinomial logit expression for the choice probabilities:

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}}.$$

If V_{ni} depends on unobserved components, the choice probabilities result from the integration over these components, and one obtains the mixed logit expression for the choice probabilities:

$$P_{ni} = \int \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}} f(\varsigma_n, \xi_n) d\varsigma_n d\xi_n.$$

In models that use the whole panel, one must consider the sequence of choices made by a given household. The choices in different periods are not independent. Their dependence is modeled though the unobserved household characteristics common to all periods. The probability of observing a given sequence of choices $\mathbf{i} = (i_1, \ldots, i_T)$ of products over time is:

$$P_{n\mathbf{i}} = \int \prod_{t=1}^{T} \frac{e^{V_{ni_t t}}}{\sum_j e^{V_{njt}}} f(\varsigma_n, \xi_n) d\varsigma_n d\xi_n.$$

3.1.3 Likelihood Function

The log-likelihood functions corresponding to the multinomial logit and mixed logit models are:

$$\mathcal{L} = \sum_n \sum_i y_{ni} \ln(P_{ni}),$$

where $y_{ni} = 1$ if household n chooses product i, and zero otherwise. In this case, either one ignores the relationship between choices over time, or alternatively, one applies the model to the data of a single month.

For models that use the whole panel, the log-likelihood function is:

$$\mathcal{L} = \sum_n \sum_{\mathbf{i}} s_{n\mathbf{i}} \ln(P_{n\mathbf{i}}),$$

where the summation is over all possible sequences of choices, and $s_{n\mathbf{i}} = \prod_{t=1}^{T} y_{ni_t t}$, i.e., $s_{n\mathbf{i}} = 1$ if household n had a sequence of choices given by $\mathbf{i}$, and 0 otherwise.

3.1.4 Price Elasticities of Demand

Denote by ε_{nij}, the elasticity of demand of product i with respect to price of product j for household n:

$$\varepsilon_{nij} := \frac{\partial P_{ni}}{\partial p_j}\frac{p_j}{P_{ni}}.$$

In the multinomial logit model, the partial derivative is:

$$\frac{\partial P_{ni}}{\partial p_j} = \begin{cases} \alpha_n P_{ni}(1-P_{ni}) & \text{if } i=j \\ -\alpha_n P_{ni}P_{nj} & \text{otherwise} \end{cases}$$

implying the following elasticities:

$$\varepsilon_{nij} = \begin{cases} \alpha_n p_i(1-P_{ni}) & \text{if } i=j \\ -\alpha_n p_j P_{nj} & \text{otherwise} \end{cases}$$

In the mixed logit model the partial derivative is:

$$\frac{\partial P_{ni}}{\partial p_j} = \begin{cases} \int \alpha_n(\xi)\tilde{P}_{ni}(\varsigma,\xi)(1-\tilde{P}_{ni}(\varsigma,\xi))f(\varsigma,\xi)d\varsigma d\xi & \text{if } i=j \\ \int -\alpha_n(\xi)P_{ni}(\varsigma,\xi)P_{nj}(\varsigma,\xi)f(\varsigma,\xi)d\varsigma d\xi & \text{otherwise,} \end{cases}$$

where $\tilde{P}_{ni}(\varsigma,\xi) = \frac{e^{V_{ni}(\varsigma,\xi)}}{\sum_j e^{V_{nj}(\varsigma,\xi)}}$. The elasticities are obtained using the expression used above.

We computed the demand elasticities of subsets of products with the formula:

$$\varepsilon_{ab} = \left[\sum_{i\in a}\sum_{j\in b}\frac{\partial P_{ni}}{\partial p_j}\right]\frac{\sum_{j\in b} w_j p_j}{\sum_{i\in a} P_{ni}},$$

where a and b are disjoint subsets of products, and $w_j := \frac{P_{nj}}{\sum_{k\in b} P_{nk}}$.

3.1.5 Consumer Welfare Variation

Denote by $V^{'}_{nj}$ and $V^{''}_{nj}$, the utility levels before and after the structural separation, respectively. The structural separation implies two types of changes. First, prices change, which requires computing the market equilibrium after the separation. Second, the characteristics of the products change, i.e., x_i and z_n change. We assume that the number of products offered does not change.

The generalized extreme value model, of which the multinomial and the nested logit models are particular cases, provides a convenient computational formula for the exact consumers' surplus, up to a constant, associated with a policy that changes the attributes of the products in the market. Such expression, known as the "log sum" formula, is:

$$\Delta CS_n = \frac{1}{\alpha}\left[\ln H\left(e^{V^{''}_{n1}},\ldots,e^{V^{''}_{nJ}}\right) - \ln H\left(e^{V^{'}_{n1}},\ldots,e^{V^{'}_{nJ}}\right)\right], \tag{1}$$

where $H(\cdot)$ is the generating function of the generalized extreme value distribution.[10]

This formula is valid only when the indirect utility function is linear in income, i.e., when prices changes have no income effects, which is the case assumed here.

For the mixed logit model, the integration of (1) with respect to the unobserved household characteristics provides an approximation of the change in the aggregate consumer surplus.

3.2 Supply

3.2.1 Price Equilibrium

The profit function of firm i is:

$$\Pi_i = \sum_{j=1}^{J} \delta_{ij} \pi_j,$$

where $\pi_j := p_j Q_j(\mathbf{p}) - C_j(Q_j(\mathbf{p}))$ is the profit in market j, $\delta_{ij} = 1$ if firm i sells product j, and $\delta_{ij} = 0$ otherwise. We assume that firms choose prices and play a static non-cooperative game, i.e., a Bertrand game.[11] The Nash equilibrium of the game is characterized by the following set of first order conditions:[12]

$$\sum_{i=1}^{I} \delta_{ik} \frac{\partial \Pi_i}{\partial p_k} = \sum_{i=1}^{I} \delta_{ik} \left[\delta_{ik} Q_k + \sum_{j=1}^{J} \delta_{ij} \frac{\partial Q_j}{\partial p_k} \left(p_j - \frac{\partial C_j}{\partial p_j} \right) \right] = Q_k + \sum_{j=1}^{J} \gamma_{kj} \frac{\partial Q_j}{\partial p_k} (p_j - c_j),$$

where $c_j := \frac{\partial C_j}{\partial p_j}$, and $\gamma_{kj} = 1$ if products j and k are sold by the same firm, and $\gamma_{kj} = 0$ otherwise.

Let matrices Γ and Φ consist of the elements $\Gamma_{ij} = \gamma_{ij}$ and $\Phi_{ij} = \frac{\partial Q_j}{\partial p_i}$, respectively. Matrix Γ represents the market structure, and matrix Φ consists of the demand estimates. Denote by $A \circ B$ the element by element product of matrices A and B, i.e., the Hadamard product. The system that defines the equilibrium can be written as:

$$\mathbf{Q} + (\Gamma \circ \Phi)(\mathbf{p} - \mathbf{c}) = 0. \tag{2}$$

Initially there are three firms: **(i)** a firm that offers dial-up services, the *Dial-Up* firm, **(ii)** *CATVP*, and **(iii)** *Cabovisão*. The dial-up firm controls one product, *CATVP* controls

[10]This expression was developed by Domencich and McFadden (1975), and McFadden (1974) for the multinomial logit model, and by McFadden (1978) and McFadden (1981) for the nested logit model. Small and Rosen (1981) elaborate on the connection between the above measures of welfare and standard measures of consumer surplus. For the logit model: $H(x_1, \ldots, x_J) = \sum_{j=1}^{J} x_j$.

[11]Internet access through cable modem is unregulated. In addition, the retail broadband access offer of *PT.com*, which is based on the *ADSL* wholesale offer of *PTC*, is also unregulated.

[12]We assume that a Nash equilibrium exists. Caplin and Nalebuff (1991) proved existence in a general discrete choice model, with single product firms. Anderson and de Palma (1992) proved existence for the nested logit model with symmetric multiproduct firms.

four products, and *Cabovisão* controls the remaining three. Thus:

$$\Gamma = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

In the course of the analysis, we will assume two alternative forms for the matrix Γ, associated with the cases of: **(i)** structural separation, and **(ii)** perfect collusion before the separation.

3.2.2 Profit Variation

Denote by $(\mathbf{Q}', \mathbf{p}')$ and $(\mathbf{Q}'', \mathbf{p}'')$ the levels of output and prices before and after the structural separation, respectively. Taking a first-order approximation of the cost function of product j around the current level of output, the profit function is:

$$\pi_j(\mathbf{Q}, \mathbf{p}) = p_j Q_j - C_j(Q_j) \simeq p_j Q_j - C_j(Q_j') - c_j(Q_j - Q_j').$$

The profit variation for product j is then:

$$\Delta\pi_j = \pi_j(\mathbf{Q}'', \mathbf{p}'') - \pi_j(\mathbf{Q}', \mathbf{p}') \simeq p_j'' Q_j'' - p_j' Q_j' - c_j(Q_j'' - Q_j') = (p_j'' - c_j)Q_j'' - (p_j' - c_j)Q_j'.$$

4 Econometric Implementation

4.1 Basic Estimation Results

We estimated five models by maximum likelihood.[13] Table 4 presents the results.

[*Table* 4]

Model 1 is a stacked logit model, i.e., a model where the same household in different periods is considered a different household. This model, presented for comparison purposes, ignores the correlation of the choices of a household over time. As a consequence, the estimated standard deviations are artificially low. We also estimated twelve monthly logit models. The results showed that the estimates are very stable across periods, and are very close to those of Model 1. This reflects the fact that households do not change their choice of provider over the period in our sample.

[*Table* 5]

[13]Integration, when necessary, was performed numerically by the Gaussian-Hermite quadrature, except in the models that required more than one integral, in which case integration was done by simulation. All procedures were coded in MATLAB.

Model 2 is a logit model, where product dummies are allowed to evolve over time. Table 5 presents the estimates of the coefficients of these additional dummy variables. The evolution of the estimates reflects the evolution of market shares, which was very small over the period of our sample. The estimates of most of these coefficients are not statistically significant.

We also estimated a nested logit model with three nests: one for no Internet access, one for *PT*, and one for *Cabovisão*. The substitution pattern had to be constrained to be compatible with random utility maximization, in which case the estimates became very close to those of Models 1 and 2. This nested logit model is therefore omitted.

As it is well know, the multinomial logit model has the property of *independence of irrelevant alternatives*, IIA. We performed three types of tests to determine if the data complied with the IIA property, and the direction of any eventual departure from this property. First, we performed Hausman-McFadden type of tests (Hausman and McFadden (1984)) for Model 1, using different subgroups of the choices, and performing the test for each period. The tests were implemented in their Lagrange Multiplier version as described in McFadden (1987). The null hypothesis that the data complies with the IIA property was rejected in the vast majority of cases. Second, we performed Lagrange Multiplier tests with the nested logit model as the alternative, also described in McFadden (1987). The null hypothesis was not rejected in most cases. This suggests that the failure previously detected should be corrected with models other than those of the nested logit class. Third, we performed Lagrange Multiplier specification tests for the multinomial logit against mixture models described in McFadden and Train (2000). The null hypothesis was rejected when the mixture was associated with the parameters γ, that translate the the effect of individual characteristics on the marginal utility of income $\alpha(\cdot)$.

Given the results of these tests, we estimated several mixed logit models. Models with mixture components associated with the variables education, social class and age produced essentially the same results as models with a mixture component only on the constant term. Besides, for some periods, the former models are not statistically significantly better than the latter models. Thus, we present and discuss only the more parsimonious models with a mixture component in the constant term.

Model 3 is a mixed logit model, where unobserved household characteristics are allowed to affect the sensitivity of price. The mixing distribution is a normal distribution. This formulation allows a flexible substitution pattern between products. However, the correlation between observations of a single household is still ignored. The same household in two different periods is considered a different household. We also ran an alternative version of this model, where the parameters were estimated on a monthly basis. The estimates of the coefficients of the model remained stable across periods.

Model 4 is a random effects mixed logit model, where the unobserved component is the same for a given household for all periods. The decrease in the log-likelihood is noticeable. This translates the fact that households change Internet provider very infrequently, and therefore the choices of the households are highly correlated over time.

Model 5 is similar to Model 4, except that it has some extra random components. The elasticities implied by this models are very close to those of Model 4.

Given the previous discussion, we select Model 4 to conduct our analysis.[14]

The households' price sensitivity is decreasing in the education level, the social class, and the age until the late 40's, and increasing in the age afterwards.[15] The price sensitivity also seems to be higher in the northeast, and smaller in the south. The median of the distribution of the marginal utility of income, α, is 1.47. This value does not have a specific metric since the variance in these models is not identified The estimates of the coefficients of product characteristics reflect the consumers' valuation of these attributes relative to no access. For instance, the negative coefficient -0.79 of *Cabovisão* translates into a negative median premium of $0.54 = \frac{0.79}{1.47}$ euros for the products of this firm.

4.2 Price Elasticities of Demand

Table 6 presents the average of the elasticities, ε_{nij}, over all households, using the parameter estimates of Model 4. The results indicate that the demands for the products considered are elastic with respect to price.

$[Table\ 6]$

$[Table\ 7]$

$[Table\ 8]$

The uncertainty about the parameter estimates of the consumer choice model reflects into the demand elasticity estimates. To assess the effect of this uncertainty, we simulated $1,000$ parameter vectors from a multivariate normal distribution with a mean and variance-covariance matrix given by the parameter estimates of Model 4. For each simulated vector, we computed the matrix of the demand elasticities and its Frobenius norm. The matrices presented in Tables 7 and 8 correspond to the matrices with the norm in percentile 1 and

[14]Doing all the analysis with model 4 or 5 yields essentially the same results. Model 4 has computational advantages in terms of speed since numerical integration was used in all calculation were it was required.

[15]Recall from footnote 4 that in *Marktest*'s coding, lower values for the social class variable indicate a higher social class. Social class is presumably a proxy for income level.

99, respectively. The variation in the average elasticities across Tables 6, 7, and 8 is small.[16]

[*Table* 9]

[*Table* 10]

Tables 9 and 10 report the price elasticities of demand of subsets of products. The results suggest that: **(i)** the demand for broadband access is more elastic than the demand for narrowband access, **(ii)** broadband and narrowband access are substitutes, and **(iii)** the demand for broadband access is less sensitive to the price of narrowband access, than the demand for narrowband access to the price of broadband access.

5 Analysis

5.1 Structural Separation assuming Nash ex-ante

The separation of the *ADSL* and cable modem businesses of *PT* would result in a market with four firms: **(i)** a firm with the dial-up business, **(ii)** a firm with the *ADSL* business of *PT*, **(iii)** a firm with the cable modem business of *PT*, and **(iv)** *Cabovisão*, which would maintain its products. The structural separation consists of a change from matrix Γ to matrix Γ', given by:

$$\Gamma' = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

We impose two assumptions on marginal costs. The first assumption is that marginal costs are constant. The second assumption is that marginal costs depend only on firm characteristics and type of product, such as dial-up, cable modem, *ADSL*, and pay as you go. This implies that marginal costs are the same for all cable products within a firm. We made these two assumptions on marginal costs due to data limitations. On section 6, we comment the likely impact of these assumptions on our results.

[*Table* 11]

Given the elasticities of Table 6, we solved system (2) numerically with respect to $\mathbf{c}$. We obtained estimates of marginal costs, $\hat{\mathbf{c}}$, which are presented in Table 11. Then, given the value of these estimates, and replacing Γ with Γ', we solved system (2) with respect to

[16] Alternatively, one could estimate the marginal costs for each of the simulated vectors, and compute the distribution of marginal costs implied by the distribution of the parameter estimates. This would, however, be computationally burdensome, and would provide information qualitatively similar to ours.

prices, to estimate the price of each product after the separation. The results are presented in Table 12.

[$Table$ 12]

After the separation, the prices of broadband products decrease on average 2.58 euros, i.e., decrease 12% of their current levels. The price of narrowband decreases on average 0.32 euros, i.e., decrease 06% of their current levels. Overall, prices decrease on average 0.99 euros, i.e., decrease 10% of their current levels. The largest reductions occur for cable modem products (5) and (9), for which prices decrease by as much as 11 euros. Product (7) may experience a mild price increase.

[$Table$ 13]

Table 13 reports the impact on welfare of the separation. After the separation, for broadband, on average, the consumer surplus per household increases by 0.81 euros per month, the profits per household decrease by 0.00 euros per month, and the social welfare per household increases by 0.81 euros per month. For narrowband, on average, the consumer surplus per household increases by 0.64 euros per month, the profits per household decrease by 0.08 euros per month, and the social welfare increases by 0.56 euros per month. Overall, i.e., including also families that previously did not buy access to the Internet, on average, the consumer surplus per household increases by 0.51 euros per month, the profits per household decrease by 0.08 euros per month, and the social welfare per households increases by 0.43 euros per month. The apparent discrepancy between the magnitude of the average price decrease and the magnitude of the increase in consumer surplus is explained by the fact that the price variation captures only the welfare effect of the marginal consumer, whereas the consumer surplus also captures the welfare effect of the submarginal consumers, including those that currently do not but access to the Internet.

We repeated the previous exercises for the elasticities of Tables 7 and 8. In Table 11 we report the respective marginal cost estimates, and in Table 12 we report the prices after the separation. The new results about the price variations caused by a structural separation do not differ much from those based on the elasticities of Table 6. In the case of the elasticities of Table 7, i.e., the matrix of elasticities with the norm in percentile 1, prices decrease on average 0.95 euros, or, 9.7% of their current levels. In the case of the elasticities of Table 8, i.e., the matrix of elasticities with the norm in percentile 99, prices decrease on average 2.17 euros, or, 22.5% of their current levels. Table 13 reports the associated consumer surplus and profit changes caused by the separation.

5.2 Structural Separation assuming Collusion ex-ante

In section 5.1, we assumed that before the structural separation, firms played a Bertrand game. But firms could have played a game that led to either more or less competitive outcomes, than those implied by a Bertrand game. Since we have no cost data, we cannot explore the first possibility. Regarding the second possibility, we estimate the marginal costs assuming that before the separation firms played a cooperative game. More specifically, we assume that before the separation, firms maximized jointly their profits. Matrix Γ is now:

$$\Gamma = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

We maintain the assumption that after the separation firms play a Bertrand game.

If we impose no restriction, the estimates of marginal costs of products (2) and (6) are large and negative. If we impose a non-negativity restriction, the marginal cost estimates are higher than those obtained assuming that firms play a Bertrand game before the separation. This implies that the firms have lower price-cost margins if they collude, than if they play a Bertrand game. In addition, the price decreases following a separation are smaller. We interpret these results as implying that the data does not support the hypothesis that firms collude perfectly on prices.

5.3 Calibration of the Market Shares

The most recent observations from our data set are from 2004:1. Since the market has been changing very fast, our data set does not reflect the current market shares. Besides, some of the firms that currently provide *ADSL* and dial-up services are not present in our data set. We believe that the bias in the sample is independent of the characteristics of the households; the bias reflects mostly the diffusion process in the adoption of broadband, and the data collection decisions of *Marktest*. If this is true, then only the coefficients that reflect directly market shares, i.e., the coefficients of the product dummy variables, were estimated inconsistently. One can, therefore, obtain consistent estimates for these coefficients by a calibration process that adjusts them, so that the model's predicted market shares match actual market shares.[17]

Partition the vector of coefficients, θ, into (θ_1, θ_2), where θ_1 represents the coefficients associated with product dummy variables, and θ_2 represents all the remaining coefficients.

[17] There are several alternative techniques to correct the bias of some of the coefficients of the model. See, e.g., Manski and McFadden (1981), in particular chapters 1 and 2. The first method that appeared in the econometrics literature addressing this issue was the WESML estimator of Manski and Lerman (1977).

Let s_i represent the correct market share for product i, and $\hat{\theta}_2$ the estimated value of θ_2. The calibrated value of θ_1, denoted by $\tilde{\theta}_1$, is defined by:

$$\tilde{\theta}_1 := \arg\min_{\theta_1} \sum_{i=1}^{I} \left(s_i - \frac{1}{N} \sum_{n=1}^{N} P_{ni}(\theta_1, \hat{\theta}_2) \right)^2$$

It is possible to add new products not present in the initial sample, provided that one can compute P_{ni}. All that is required is that one: **(i)** knows the value of the exogenous variables that characterize these products, and, **(ii)** includes new product dummy variables. Then, one is left with stipulating a price for the dial-up and *ADSL* products not present in the sample. We set the prices of these new products equal to those of *PT*.[18]

[*Table* 14]

[*Table* 15]

[*Table* 16]

The elasticities that result from the calibration exercise are reported in Table 14, where we introduced six new products for four additional firms. Tables 15 and 16 present elasticities by aggregate products. In general, the own and cross price elasticities of products (2) to (9) increase.

[*Table* 17]

Table 17 presents the marginal cost estimates for the calibrated model. In general, the marginal cost estimates of products (2) to (9) increase.

[*Table* 18]

Table 18 presents the prices after separation for the calibrated model. After the separation, the prices of broadband products decrease on average 3.37 euros, i.e., decrease 14% of their current levels. The prices of narrowband decrease on average 0.53 euros, i.e., decrease 11% of their current levels. Overall, prices decrease on average 2.73 euros, i.e., decrease 14% of their current levels. The largest reductions occur again for cable modem products (5) and (9), for which prices decrease by as much as 16 euros. Product (7) may experience a price increase. The price decreases are now larger, due to the higher penetration of broadband.

[*Table* 19]

Table 19 presents the surplus variations for the calibrated model. After the separation, for broadband, on average, the consumer surplus per household increases by 2.56 euros per month, the profits per household decrease by 0.32 euros per month, and the social

[18] In reality, prices differ little, if at all.

welfare per household increases by 2.24 euros per month. For narrowband, on average, the consumer surplus per household increases by 2.12 euros per month, the profits per household decrease by 0.05 euros per month, and the social welfare increases by 2.07 euros per month. Overall, i.e., including also households that previously did not buy access to the Internet, on average, the consumer surplus per household increases by 1.69 euros per month, the profits per household decrease by 0.37 euros per month, and the social welfare per households increases by 1.32 euros per month.

6 Concluding Remarks

In this article, we evaluated the impact on broadband access to the Internet of the structural separation of the telephone and the cable networks of the Portuguese telecommunications' incumbent. We used consumer level data and a discrete choice model to estimate the price elasticities of demand and marginal costs for broadband access to the Internet. Given these estimates, we simulated the effects on prices and welfare of the structural separation. Our results suggest that the increase in competition, caused by the structural separation, may lead to substantial price decreases, as well as to consumer welfare increases.

We assumed that marginal costs are constant.[19] This assumption is acceptable if the structural separation does not result in large shifts in consumer shares across firms, and a large expansion in the size of the market. In other words, this assumption is acceptable to measure the short-run impact of the structural separation. Otherwise, our estimates of price changes underestimate the impact of the structural separation. In addition, if the firms in the industry face moral hazard agency problems, such as those analyzed by Gagnepain and Pereira (forthcoming), the increase in competitive pressure unleashed by the structural separation, could induce firms to increase their cost reducing efforts, and thereby lead to lower marginal costs.

To be sure, the analysis conducted in this article gives an incomplete assessment of the impact of the structural separation of a telephone network and a cable network. First, we ignored the costs of the divestiture process. Second, we focused on broadband access to the Internet. A structural separation would impact other markets, such as fixed telephony and subscription television. The cable television firm of the incumbent could offer fixed telephony over its network. Or, the fixed telephony firm of the incumbent could offer subscription television over its network. Third, we ignored the impact of emerging technologies, such as the wireless local loop and powerline communications, that can allow the deployment of

[19] Ribeiro and Pereira (2006) found evidence of scope economies between cable television and cable modem services, and of increasing returns to scale for the cable modem service.

alternative local access networks. These technologies are promising. However, it is unlikely that they will have a large impact in the near future.

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7 Tables

Table 1: Industry Indicators on October 2005

	Penetration Rate BB	DSL's Share	Incumbent Share	Incumbent has Cable Modem	Penetration Rate PCs
South Korea	25.5				
Netherland	22.5	60	43		77
Denmark	21.8	63	60	yes	70
Finland	18.7	79	67	yes	52
Sweden	18.5	65	36	yes	80
Japan	16.4				
USA	14.5				
UK	13.5	72	25		62
EU	11	80	50		
Portugal	9.9	57	78	yes	34
Spain	9.3				49
Italy	10	94	70		47
Ireland	4.3	76	59	yes	47
Greece	0.8	98	74		33

Source: Authors

Table 2: Chronology of the Portuguese Telecommunications Industry

1981	creation of sectorial regulator, ICP-ANACOM
1987	beginning of digitalization of the PSTN
1992	beginning of Cable Tv in Madeira and Aç ores
1994	group PT formed
	beginning of Cable Tv in mainland Portugal through CATVP
1996	Cabovisão starts operations
1997	basic Telecommunications Law
1998	full liberalization of the telecommunications industry in the EU
	CATVP offers Cable Tv through digital satelite
1999	Law 458/99 of the scope of Universal Service
	full digitalization of PSTN
	broadband access to Internet through Cable Modem
2000	full liberalization of the telecommunications industry in Portugal
	introduction of carrier pre-selection
2001	introduction of number portability
	local loop unbundling
2003	implementation of the 99 Revision

Source: Authors

Table 3: Market Shares

	2003	2004	2005
Group PT	78	80	75
Cabovisão	16	15	15
Others	4	5	10
ADSL	38	42	50
Cable Modem	62	58	50

Source: Authors

Table 4: Demand Model Estimates I

Variable	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
const	-0.602**	-0.600*	1.305***	1.435***	1.653**
	-2.225	-1.676	3.270	4.265	2.327
educ	-2.349***	-2.342	-4.501***	-2.051***	-2.440***
	-10.091	-0.811	-13.630	-6.877	-3.562
class	2.997***	2.986***	6.156***	1.719***	2.089
	6.354	4.137	4.273	3.566	1.409
age	-5.065***	-5.054***	-8.618***	-3.450***	-3.290**
	-10.962	-11.903	-8.225	-6.564	-2.182
max(age-48,0)	9.288***	9.265***	16.991***	8.191***	8.280***
	11.560	6.316	9.355	8.593	9.037
northeast	0.564***	0.558***	0.790***	0.698***	0.583***
	10.138	3.081	9.490	9.232	3.374
south	0.234***	0.229	0.137	-0.115	-0.029
	3.332	1.414	1.580	-0.788	-0.203
dialup	0.683***	0.681	1.154***	6.774***	7.063***
	6.216	0.623	8.900	15.881	12.794
adsl	-1.093***	-1.684	-0.849***	5.957***	6.327***
	-8.270	-1.298	-5.522	12.938	10.236
cable	-1.292***	-1.330	-0.821***	5.157***	5.621***
	-14.070	-1.298	-7.009	12.183	10.196
cv	-0.593***	-0.593***	-0.567***	-0.790***	-0.701***
	-9.979	-2.630	-8.692	-4.149	-3.605
payg	-1.181***	-1.182	-0.940***	-3.408***	-3.529***
	-12.344	-1.133	-8.874	-12.080	-9.476
fast	0.665***	0.670	0.397***	1.418***	1.188***
	8.854	1.411	5.422	6.900	5.790
std_const			1.749***	0.943***	1.788***
			11.463	22.485	18.583
std_educ					0.672***
					8.887
std_class					0.057
					0.215
std_age					0.570**
					2.366
std_max(age-48,0)					0.161
					0.219-α 25%
-α 25%	0.040	0.040	0.059	0.781	0.625
-α median	0.076	0.076	0.208	1.296	1.138
-α 75%	0.139	0.139	0.718	2.174	2.073Logl
Logl	12984	12966	12759	7742	7347
Pseudo R2	0.5216	0.5223	0.5299	0.7148	0.7293
N	12352	12352	12352	12352	12352

(1) - Stacked multinomial logit; (2) - Stacked multinomial logit; (3) - Stacked mixed logit; (4) Random effects mixed logit; ***, **, and * indicate significance at 1%, 5% and 10% levels respectively. t-stats are presented in smaller font size below the corresponding coefficient

Table 5: Demand Models Estimates II - Model (2)

Month	dialup	adsl	cable
m2	0.048	0.273	0.157
	0.190	0.674	0.739
m3	0.075	0.302	0.211
	0.309	0.741	1.034
m4	0.099	0.466	0.101
	0.343	0.503	0.389
m5	0.081	0.575	0.089
	0.191	0.220	0.153
m6	0.035	0.609	0.128
	0.202	0.326	0.499
m7	-0.006	0.682	-0.019
	-0.004	0.155	-0.005
m8	-0.021	0.670	-0.039
	-0.008	0.163	-0.005
m9	-0.025	0.710	-0.069
	-0.019	0.353	-0.020
m10	-0.002	0.843 *	0.039
	-0.006	1.738	0.060
m11	-0.094	0.886 **	0.066
	-0.311	1.978	0.133
m12	-0.192	0.767	-0.114
	-0.429	0.175	-0.184

Table 6: Estimated Elasticities - I

ε_{ij}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	s_i
(1)	0.000	0.493 *	0.005	0.013	0.003	0.044	0.007	0.008	0.001	0.618
(2)	0.000	-1.364	0.056	0.127	0.037	0.127 *	0.066	0.084	0.009	0.269
(3)	0.000	0.324	-4.037 **	0.388 *	0.356	0.041	0.184 **	0.373	0.107	0.016
(4)	0.000	0.564 **	0.303 **	-3.644 **	0.237	0.067	0.178 *	0.302	0.088	0.022
(5)	0.000	0.200	0.420 ***	0.341 *	-3.716 **	0.039	0.161 *	0.320	0.101	0.014
(6)	0.000	1.160 ***	0.083	0.166	0.067	-2.479 ***	0.086	0.109	0.013	0.027
(7)	0.000	0.566 **	0.296 **	0.365 *	0.232	0.068	-3.833 ***	0.372	0.084	0.012
(8)	0.000	0.444 *	0.330 ***	0.352 *	0.249	0.047	0.208 ***	-3.809 **	0.084	0.018
(9)	0.000	0.277	0.381 ***	0.424 ***	0.293	0.023	0.198 ***	0.361	-4.759 *	0.003

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV)

The elasticity values correspond to the average over households.

”***”, ”**”, and ”*” mean that the estimate is significantly different from 0 at 1%, 5% and 10% confidence levels, respectively. The null hypothesis is -1 for diagonal elements, and 0 for off-diagonal elements.

Table 7: Estimated Elasticities - II

ε_{ij}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	s_i
(1)	0.000	0.427 *	0.008	0.015	0.006	0.048	0.009	0.010	0.001	0.621
(2)	0.000	-1.283	0.065	0.114	0.044	0.119 *	0.065	0.079	0.013	0.250
(3)	0.000	0.288	-3.461	0.274 *	0.273	0.041	0.144 **	0.265	0.094	0.019
(4)	0.000	0.469 *	0.254 **	-3.154 *	0.192	0.065	0.143 **	0.223	0.082	0.023
(5)	0.000	0.180	0.330 ***	0.238 *	-3.127 *	0.041 *	0.125 *	0.225	0.087	0.018
(6)	0.000	0.899 ***	0.093	0.144	0.075	-2.108 **	0.082	0.099	0.016	0.031
(7)	0.000	0.468 *	0.251 **	0.264 *	0.190	0.065	-3.260 **	0.274	0.079	0.014
(8)	0.000	0.381	0.274 ***	0.253 *	0.200	0.046	0.166 ***	-3.318 *	0.077	0.019
(9)	0.000	0.255	0.304 ***	0.298 ***	0.221	0.024	0.155 ***	0.256	-4.089	0.005

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV)

The elasticity values correspond to the average over households.

”***”, ”**”, and ”*” mean that the estimate is significantly different from 0 at 1%, 5% and 10% confidence levels, respectively.

The null hypothesis is -1 for diagonal elements, and 0 for off-diagonal elements.

Table 8: Estimated Elasticities - III

ε_{ij}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	s_i
(1)	0.000	0.542 *	0.004	0.014	0.002	0.050	0.007	0.008	0.000	0.613
(2)	0.000	-1.485	0.055	0.158	0.031	0.154 *	0.079	0.094	0.008	0.270
(3)	0.000	0.348	-4.678 **	0.533 *	0.401	0.046	0.246 **	0.491	0.112	0.015
(4)	0.000	0.630 *	0.362 **	-4.103 **	0.255	0.080	0.236 *	0.390	0.088	0.026
(5)	0.000	0.204	0.527 ***	0.469 *	-4.357 **	0.043	0.215 *	0.427	0.110	0.013
(6)	0.000	1.343 ***	0.085	0.212	0.058	-2.792 ***	0.106	0.126	0.011	0.029
(7)	0.000	0.636 *	0.352 **	0.498 *	0.247	0.082	-4.397 ***	0.483	0.084	0.013
(8)	0.000	0.490	0.396 **	0.478 *	0.271	0.055	0.277 ***	-4.347 **	0.084	0.019
(9)	0.000	0.298	0.466 ***	0.573 ***	0.333	0.025	0.260 ***	0.466	-5.592 *	0.003

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV)

The elasticity values correspond to the average over households.

”***”, ”**”, and ”*” mean that the estimate is significantly different from 0 at 1%, 5% and 10% confidence levels, respectively.

The null hypothesis is -1 for diagonal elements, and 0 for off-diagonal elements.

Table 9: Estimated Elasticities - IV

ε_{ij}	No access	Narrowband	Broadband	s_i
No access	0.000	0.412	0.135	0.618
Narrowband	0.000	-1.156	0.876	0.269
Broadband	0.000	0.503	-2.836	0.113

Table 10: Estimated Elasticities - V

ε_{ij}	No access	Narrowband	ADSL	Cable	s_i
No access	0.000	0.412	0.003	0.124	0.618
Narrowband	0.000	-1.156	0.070	0.772	0.269
ADSL	0.000	0.206	-3.196	1.236	0.016
Cable	0.000	0.550	0.298	-3.130	0.097

Table 11: Marginal Cost Estimates

Product	p	Nash ex-ante		
		Elast I	Elast II	Elast III
(1)				
(2)	5.0	0.7	0.3	1.0
(3)	29.4	15.2	13.2	16.4
(4)	19.8	11.4	10.0	12.0
(5)	35.0	11.4	10.0	12.0
(6)	6.2	3.0	2.3	3.4
(7)	19.5	14.1	12.4	15.0
(8)	24.0	14.1	12.4	15.0
(9)	35.5	14.1	12.4	15.0

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV)

Table 12: Marginal Costs and Prices after Structural Separation assuming Nash ex-ante

Product	Today	After Separation											
		Elast I				Elast II				Elast III			
	p	c	p	Δp	$\frac{p-c}{p}$	c	p	Δp	$\frac{p-c}{p}$	c	p	Δp	$\frac{p-c}{p}$
(1)													
(2)	5.0	0.7	4.7	-0.3	0.86	0.3	4.1	-0.9	0.93	1.0	5.1	0.1	0.80
(3)	29.4	15.2	24.4	-5.0	0.38	13.2	24.5	-4.9	0.46	16.4	24.1	-5.3	0.32
(4)	19.8	11.4	18.9	-0.8	0.40	10.0	18.6	-1.2	0.46	12.0	19.6	-0.2	0.39
(5)	35.0	11.4	24.2	-10.8	0.53	10.0	25.7	-9.3	0.61	12.0	20.3	-14.7	0.41
(6)	6.2	3.0	6.0	-0.2	0.49	2.3	4.8	-1.4	0.52	3.4	9.6	3.4	0.65
(7)	19.5	14.1	21.1	1.6	0.33	12.4	20.8	1.3	0.40	15.0	21.2	1.7	0.29
(8)	24.0	14.1	22.7	-1.3	0.38	12.4	22.6	-1.4	0.45	15.0	22.5	-1.6	0.33
(9)	35.5	14.1	25.5	-10.0	0.45	12.4	26.8	-8.7	0.54	15.0	24.9	-10.6	0.40

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV)

Table 13: Changes in Consumer Welfare and Profits

Population		$\Delta p^{\dagger}$	$\frac{\Delta p}{p}$	$\Delta CS^{\ddagger}$	Δ profit ‡
All	Elast I	-0.99	-0.10	0.51	-0.08
All	Elast II	-1.56	-0.15	0.64	-0.27
All	Elast III	-0.50	-0.05	0.54	-0.09
Broadband	Elast I	-2.58	-0.12	0.81	-0.00
Broadband	Elast II	-2.94	-0.14	0.97	-0.26
Broadband	Elast III	-1.80	-0.09	0.92	-0.02
Narrowband	Elast I	-0.32	-0.06	0.64	-0.08
Narrowband	Elast II	-0.85	-0.17	0.80	-0.01
Narrowband	Elast III	0.07	0.01	0.71	-0.08

† Average; ‡ per household/month

Table 14: Estimated Elasticities - I (calibrated)

ε_{ij}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	s_i
(1)	0.00	0.06	0.06	0.06	0.01	0.11	0.03	0.05	0.00	0.06	0.05	0.02	0.03	0.01	0.01	0.658
(2)	0.00	-2.95 **	0.60	0.43	0.06	0.28	0.18	0.39	0.01	0.14 **	0.12 **	0.04 **	0.06 **	0.08	0.06	0.022
(3)	0.00	0.03	-4.46 *	0.57	0.34	0.07	0.22	0.80	0.09	0.03	0.03	0.01	0.01	0.29***	0.21***	0.092
(4)	0.00	0.07	1.81 **	-5.39***	0.23	0.16	0.27	0.77	0.07	0.07	0.06	0.02	0.03	0.25 **	0.19 **	0.036
(5)	0.00	0.01	1.99***	0.40	-5.67***	0.05	0.16	0.56	0.08	0.01	0.01	0.00	0.01	0.28***	0.20***	0.017
(6)	0.00	0.13 **	0.83	0.52	0.09	-3.00 **	0.21	0.46	0.01	0.13 **	0.12 **	0.04 **	0.06 **	0.12	0.09	0.040
(7)	0.00	0.07	1.78 **	0.65	0.23	0.15	-5.79***	0.95	0.07	0.07	0.06	0.02	0.03	0.25 **	0.18 **	0.015
(8)	0.00	0.05	1.87***	0.56	0.24	0.10	0.28 *	-5.20 **	0.07	0.05	0.04	0.01	0.02	0.26***	0.19***	0.040
(9)	0.00	0.02	1.99***	0.51 *	0.30	0.03	0.20	0.70	-6.41***	0.02	0.01	0.00	0.01	0.28***	0.20***	0.003
(10)	0.00	0.14 **	0.60	0.43	0.06	0.28	0.18	0.39	0.01	-2.95 **	0.12 **	0.04 **	0.06 **	0.08	0.06	0.022
(11)	0.00	0.14 **	0.60	0.43	0.06	0.28	0.18	0.39	0.01	0.14 **	-2.97 **	0.04 **	0.06 **	0.08	0.06	0.019
(12)	0.00	0.14 **	0.60	0.43	0.06	0.28	0.18	0.39	0.01	0.14 **	0.12 **	-3.05***	0.06 **	0.08	0.06	0.006
(13)	0.00	0.14 **	0.60	0.43	0.06	0.28	0.18	0.39	0.01	0.14 **	0.12 **	0.04 **	-3.03 **	0.08	0.06	0.009
(14)	0.00	0.03	2.06***	0.57	0.34	0.07	0.22	0.80	0.09	0.03	0.03	0.01	0.01	-6.24***	0.21***	0.013
(15)	0.00	0.03	2.06***	0.57	0.34	0.07	0.22	0.80	0.09	0.03	0.03	0.01	0.01	0.29***	-6.31***	0.009

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT);

(7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV); (10) - Dial-up (Novis); (11) - Dial-up (IOL); (12) - Dial-up (ONI);

(13) - Dial-up (OTH); (14) - ADSL (NOVIS); (15) - ADSL (ONI)

The elasticity values correspond to the average over households.

"***", "**", and "*" mean that the estimate is significantly different from 0 at 1%, 5% and 10% confidence levels, respectively.

The null hypothesis is -1 for diagonal elements, and 0 for off-diagonal elements.

Table 15: Estimated Elasticities - IV (calibrated)

ε_{ij}	No access	Narrowband	Broadband	s_i
No access	0.000	0.190	0.492	0.666
Narrowband	0.000	-2.231	2.819	0.077
Broadband	0.000	0.180	-2.122	0.257

Table 16: Estimated Elasticities - V (calibrated)

ε_{ij}	No access	Narrowband	ADSL	Cable	s_i
No access	0.000	0.190	0.046	0.374	0.666
Narrowband	0.000	-2.231	0.578	1.939	0.077
ADSL	0.000	0.071	-3.335	1.731	0.107
Cable	0.000	0.257	1.863	-3.882	0.150

Table 17: Marginal Cost Estimates (calibrated)

Product	p	Nash ex-ante Calib
(1)		
(2)	5.0	2.1
(3)	29.4	17.6
(4)	19.8	12.1
(5)	35.0	12.1
(6)	6.2	2.6
(7)	19.5	18.0
(8)	24.0	18.0
(9)	35.5	18.0
(10)	5.0	3.1
(11)	5.0	3.2
(12)	5.0	3.2
(13)	5.0	3.2
(14)	29.4	24.1
(15)	29.4	24.2

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV); (10) - Dial-up (Novis); (11) - Dial-up (IOL); (12) - Dial-up (ONI); (13) - Dial-up (OTH); (14) - ADSL (Novis); (15) - ADSL (ONI)

Table 18: Marginal Costs and Prices after Structural Separation assuming Nash ex-ante (calibrated)

Product	Today	After Separation Calib			
	p	c	p	Δp	$\frac{p-c}{p}$
(1)					
(2)	5.0	2.1	3.7	-1.3	0.44
(3)	29.4	17.6	23.8	-5.6	0.26
(4)	19.8	12.1	18.0	-1.8	0.33
(5)	35.0	12.1	19.2	-15.8	0.37
(6)	6.2	2.6	5.6	-0.6	0.53
(7)	19.5	18.0	22.3	2.8	0.19
(8)	24.0	18.0	23.3	-0.8	0.23
(9)	35.5	18.0	25.6	-9.9	0.30
(10)	5.0	3.1	4.7	-0.3	0.33
(11)	5.0	3.2	4.8	-0.2	0.33
(12)	5.0	3.2	5.0	-0.0	0.35
(13)	5.0	3.2	4.9	-0.1	0.35
(14)	29.4	24.1	29.4	0.0	0.18
(15)	29.4	24.2	29.4	0.0	0.18

(1) - No access; (2) - Dial-up (PT); (3) - ADSL (PT); (4) - Cable V1 (PT); (5) - Cable V2 (PT); (6) - Cable, pay as you go (PT); (7) - Cable V1 (CV); (8) - Cable V2 (CV); (9) - Cable V3 (CV); (10) - Dial-up (Novis); (11) - Dial-up (IOL); (12) - Dial-up (ONI); (13) - Dial-up (OTH)

Table 19: Changes in Consumer Welfare and Profits (calibrated)

Population		$\Delta p^{\dagger}$	$\frac{\Delta p}{p}^{\dagger}$	$\Delta CS^{\ddagger}$	Δ profit ††
All	Calib	-2.73	-0.14	1.69	-0.37
Broadband	Calib	-3.37	-0.14	2.56	-0.32
Narrowband	Calib	-0.53	-0.11	2.12	-0.05
No access	Calib	0.00	0.00	1.36	0.00

† Average amongst all with internet access; ‡ per household/month (includes households with no access); †† per household/month amongst all with internet access

8 Figures

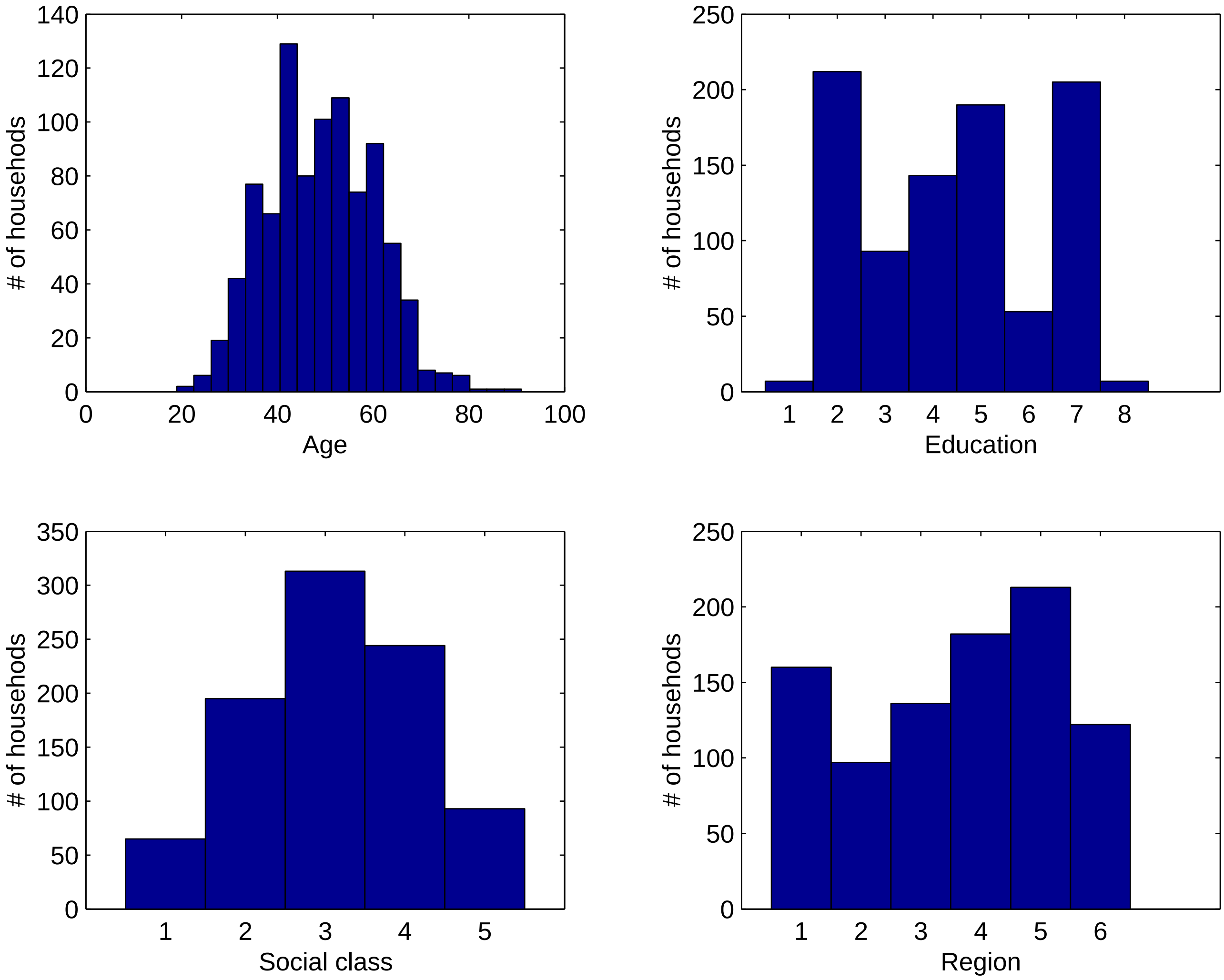

Figure 1: Histograms of demographic variables

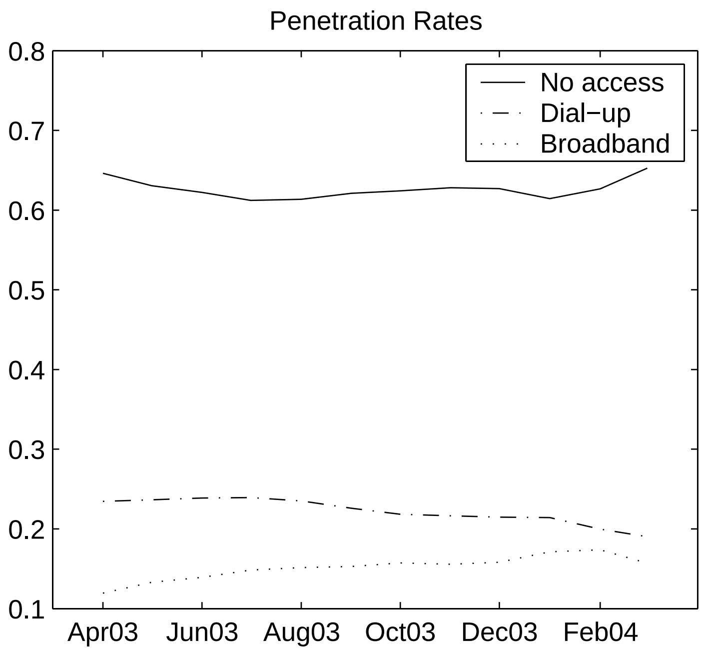

Figure 2: Penetration Rates

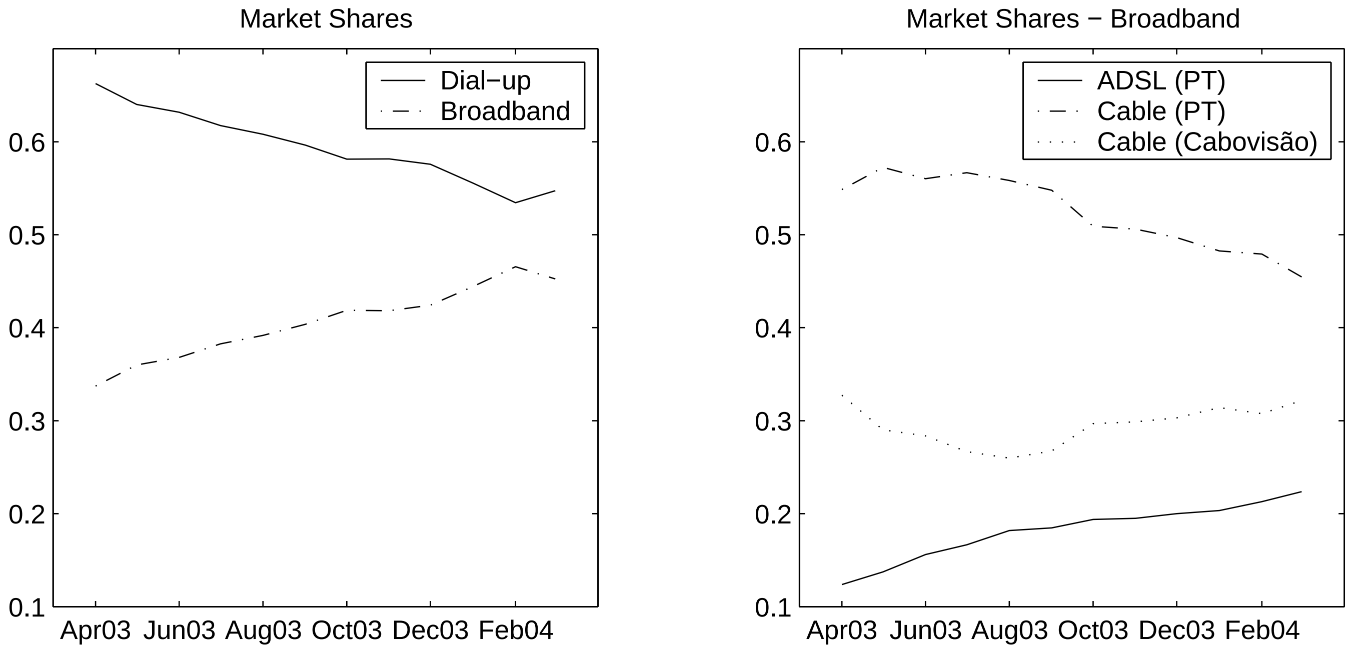

Figure 3: Market shares