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# **Interconnection of Cable Networks: A Regulation Proposal for Broadband Internet Services**

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*Abstract:* In this article a brief revision of the European and Portuguese Regulatory frameworks is made, especially in terms of the interconnection of broadband internet services that are offered by cable operators. A formalization with two cable networks is presented, in order to obtain a benchmark for symmetric networks, and two scenarios: collusion and regulated market; are developed. This justifies the implementation of regulatory policies, with the establishment of caps for the interconnection tariffs, in order to assure a larger penetration rate of the broadband internet services and a bigger total welfare.

**Keywords:** Regulation, Tariffs of Interconnection, Goodwill.

**Résumé:** Cet article présente une révision brève de l'Européen et Portugais cadres Régulateurs, surtout dans les termes du interconnexions de services d'Internet haut débit qui sont offerts par les opérateurs de câble. Une formalisation avec deux réseaux de câble est présentée, afin d'obtenir un benchmark pour les réseaux symétriques, avec deux scénarios: la connivence et le marché réglé. Ceci justifie l'implémentation de politiques régulatrices, avec l'établissement de caps pour les tarifs de interconnexions, afin d'assurer un plus grand taux de pénétration des services d'Internet haut débit et un plus grand bien-être total.

**Mots clés:** Régulation, Tarifs de Interconnexions, Goodwill

## 1. INTRODUCTION

The reality of the cable television industry, in Portugal, serves as starting point for the presentation of a regulation proposal that states the development of interconnection schemes between two cable operators (incumbent, and entrant), especially in the access to the broadband internet services.

The main contribution of the present article is a formalization that considers a scenario of interconnection, which is applied to networks of cable operators, as well as, the presentation of a proposal with regulatory guidelines related to tariffs of interconnection and prices of the broadband internet services.

In this article, we aim to expand the literature about interconnection, through an application to the cable television industry (to the moment, not regulated, in a competitive way, in Portugal). Furthermore, we aim to reveal the effects of the inclusion of some asymmetry, in terms of the consumers' demand, the total welfare, and the drawing of regulatory policies.

In the second section, the European and Portuguese regulatory frameworks are reviewed. In the third section, a model is formalized with a benchmark scenario of symmetric networks, and the tariffs of bidirectional access are presented, as well as the analysis of the welfare. Afterwards, an asymmetry factor in the networks is incorporated, and two scenarios: Collusion and Regulated Market are considered. The implementation of regulatory procedures is suggested, in terms of the interconnection tariffs and the prices of the broadband internet services. Last, the conclusions are presented.

## 2. REGULATORY FRAMEWORKS

In the ambit of the European Union, the telecommunication sector has been demonstrating an enormous dynamism with the national regulatory authorities betting in the progress of the liberalization process.

According to the Package 2002, the European instances implemented an outline of re-regulation of the telecommunications sector, based on a philosophy materialized in five fundamental directives.

TABLE N.º 1

### Regulatory Framework of Telecommunications in Europe

<b>Board Directive</b> 2002/21/CE	<b>Authorization</b> (authorization of networks and services of electronic communications – Directive 2002/20/CE).
	<b>Access</b> (access and interconnection of networks of electronic communications and related resources – Directive 2002/19/CE).
	<b>Universal Service</b> (universal service and rights of the users, as regards to networks and services of electronic communications – Directive 2002/22/CE).
	<b>Privacy and Electronic Communications</b> (treatment of personal data, and protection of privacy in the sector of electronic communications – Directive 2002/58/CE).

In the plan of the Portuguese regulatory framework, this follows a set of orientations, where the independence, face to the economic and politic power, the cooperation with other European instances involved in the convergence process, and the promotion of self-regulation instruments and of co-regulation, is in consonance with the aims of the involved agents, and the different regulation authorities (ICS and ANACOM, 2002).

In this field, it must be stressed the role assumed by the ICP – ANACOM, which was instituted as independent administrative authority, that has administrative and supervision functions of the telecommunications sector. Additionally, it has several competences of administrative nature, conjugated with other related competences, namely, the development of cooperative schemes with the Government, in the definition of strategic guidelines and of the general politics of the telecommunications sector, and the supervision of the ambit of the operators' activities, including the emission of specialist reports, and the elaboration of legislative projects, in the domain of the telecommunications.

In the domain of the interconnection of networks, the ICP - ANACOM still has important interference powers. For example, the imposition of interconnection agreements, and the introduction of changes in the interconnection agreements that are celebrated between the telecommunications operators.

### 3. REGULATION OF INTERCONNECTION: MODEL

In the literature, the problem of interconnection, given its economic importance, has assumed a special role in the prosecution of competitive practices and in the drawing of regulation policies that avoid possible collusion practices, in the fixation of interconnection tariffs between the operators (Laffont and Tirole, 1994, 1996, 2000; Carter and Wright, 1994; Armstrong, 1998, 2002; and Noam, 2001, 2002).

In the work of Carter and Wright (2003), the competition model was expanded, by considering a network, with reciprocal access tariffs and retail prices in schemes of two part tariffs, and also by including an asymmetry factor in the demand.

Taking into consideration the work of Shaked and Sutton (1982), where it is considered the practice of product differentiation, as a suitable mechanism for relaxing competition, through the price, the model now presented expands the work of Carter and Wright (2003), in a different direction. Firstly, the benchmark result for symmetric networks is obtained, by considering the inexistence of horizontal differentiation of the product. Afterwards, the analysis is expanded through the incorporation of a distortion factor on the consumers' demand, which yields a certain asymmetry that is originated by the effects of the goodwill intensity (Dorfman and Steiner, 1954; Boyer, 1974; Osório and Leitão, 2001).

#### 3.1. Symmetric Networks

##### 3.1.1. Tariffs of Bidirectional Access

Taking as reference the work of Shy (2001), in the formalization now presented, two operators initially regional monopolists that offer the broadband internet services, are considered (Leitão, 2004). It is considered that  $2\eta$  consumers subscribe the service offered by the operator 1, and  $2\eta$  proceed to the subscription of the service offered by the operator 2.

Each cable operator of cable operates the broadband internet service in a certain geographic area, and also in the area operated by the other operator, making use of the services that are offered by the concurrent Internet Backbone Provider (IBP).

It is presupposed although, in each geographical area,  $\eta$  potential customers of high income that are available to spend  $\beta_H$ , in order to access the broadband internet service, and  $\eta$  potential consumers of low income that are available to pay a maximum of  $\beta_L$ .

The utility of each type of operator is obtained through the subscription of the service offered by the regional monopolist  $I$ , and it may be expressed by the following:

$$U_H = \max\{\beta_H - p_i, 0\} \quad \text{and} \quad U_L = \max\{\beta_L - p_i, 0\} \quad (1)$$

where  $p_i$  is the price of the broadband internet service that is requested by a consumer starting from the geographical area  $i$ .

Following Shy (2001), in the sense of establishing the maximum level of prices that consumers of high income are capable to support, the following presupposition is considered:

**Presupposition 1:** The consumers of high income are available to pay more for the broadband internet service, than the consumers of low income, but not more than twice. This means that  $\beta_L < \beta_H < 2\beta_L$ .

In terms of tariffs of access,  $a_{12}$  corresponds to the tariff of access that is established by the operator 2, for any connection to the broadband internet service on its IBP. We suppose this connection is requested by a subscriber located in the geographical area covered by the network of the operator 2.

In an analogous way,  $a_{21}$  corresponds to the tariff of access that is established by the operator 1, for a connection to the broadband internet service. We also consider that this connection is requested by a subscriber, located in the area of the operator 1.

The profit of each operator  $i$  (with  $i=1,2$ ), obtained by the consumers' of the broadband internet service is given by the following:

$$\Pi_1 = q_1 \left( p_1 - a_{12} \right) + q_2 a_{21}, \quad \Pi_2 = q_2 \left( p_2 - a_{21} \right) + q_1 a_{12} \quad (2)$$

Where:  $q_1$  = Number of access connections to the internet requested by subscribers of the operator 1, and  $q_2$  = Number of access connections to the internet requested by subscribers of the operator 2.

Two cable operators interact in a game, which embraces the development of two successive phases:

- **Phase 1:** Fixation of the tariffs of access:  $a_{12}$  and  $a_{21}$ ;

- **Phase 2:** Simultaneous establishment of the prices of the broadband internet services,  $p_1$  and  $p_2$ , taking the tariffs of access as given.

Each operator  $i$  is only affected by the tariff of access that is established by the concurrent cable operator. The utility functions of the consumers (see (1)) imply that:

$$q_i = \begin{cases} 2\eta, & \text{if } p_i \leq \beta_L \\ \eta, & \text{if } \beta_L \leq p_i \leq \beta_H \\ 0, & \text{if } p_i > \beta_H \end{cases} \quad (3)$$

Taking into consideration the equations presented at (2) and (3), the profit of the operator  $i$  is given by the following:

$$\Pi_i = \begin{cases} 2\eta(\beta_L - a_{ij}) + q_j a_{ji}, & \text{if } p_i = \beta_L \\ \eta(\beta_H - a_{ij}) + q_j a_{ji}, & \text{if } p_i = \beta_H \\ q_j a_{ji}, & \text{if } p_i > \beta_H \end{cases} \quad (4)$$

In the phase 2, each cable operator  $i$  takes the tariffs of access as given, and he chooses the correspondent price of the broadband internet service, in order to assure the profit maximization. The distribution of prices of the broadband internet is represented in the following way:

$$p_i = \begin{cases} \beta_L, & \text{if } a_{ij} \leq 2\beta_L - \beta_H; \\ \beta_H, & \text{if } 2\beta_L - \beta_H \leq a_{ij} \leq \beta_H; \\ a_{ij}, & \text{if } a_{ij} > \beta_H \end{cases} \quad (5)$$

The pricing strategies that are expressed through the expressions presented at (5), aim the profit maximization for the cable operator  $i$ . This fact is justifiable through the direct comparison between the profit levels that are expressed at (4), where it is observed that the establishment of  $p_i = \beta_L$  provides a higher level of profit, than when it is established at

the level  $p_i = \beta_H$ , since  $2\eta(\beta_L - a_{ij}^{\rightarrow}) \geq \eta(\beta_H - a_{ij}^{\rightarrow})$ , in the case that  $2\beta_L - \beta_H \geq a_{ij}^{\rightarrow}$ .

The profit obtained by the cable operator  $i$  ( $\Pi_i'$ ), through the tariffs of access that are established by the operator  $i$ , is equal to:

$$\Pi_i' = a_{ji}^{\rightarrow} q_j; \text{ where: } i, j = 1, 2; \text{ and } i \neq j. \quad (6)$$

and by incorporating (3), that profit is expressed in the following way:

$$\Pi_i' = \begin{cases} 2\eta(2\beta_L - \beta_H) & \text{if } a_{ji}^{\rightarrow} \leq 2\beta_L - \beta_H \\ \eta\beta_H & \text{if } 2\beta_L - \beta_H \leq a_{ji}^{\rightarrow} \leq \beta_H \end{cases} \quad (7)$$

The operator  $i$  will choose a low value for the tariff of access,  $a_{ji}^{\rightarrow} = 2\beta_L - \beta_H$ , in detriment of a high value for the tariff of access,  $a_{ji}^{\rightarrow} = \beta_H$ , if  $2\eta(2\beta_L - \beta_H) \geq \eta\beta_H$ , and when  $\beta_H \leq (4/3)\beta_L$ .

From the previous, it results the following proposition:

**Proposition 1:** In a equilibrium balance of a perfect sub-game, the tariff of access that is established by the operator  $i$  over an access to a broadband internet service originated in  $j$  is given by the following:

$$a_{ji}^{\rightarrow} = \begin{cases} 2\beta_L - \beta_H, & \text{if } \beta_H \leq (4/3)\beta_L \\ \beta_H, & \text{if } \beta_H > (4/3)\beta_L \end{cases} \quad (8)$$

For the determination of the profit of each cable operator, and by using the pricing strategy for tariffs of access enunciated in (8), we substitute the obtained revenue in (4), through the use of the tariffs of access given in (7), and of the equilibrium price given in (5).



From the previous statements the equilibrium level of profit that is obtained by each operator is expressed by the following:

$$\Pi_i = \begin{cases} 2\eta\beta_L, & \text{if } \beta_H \leq (4/3)\beta_L \\ \eta\beta_H, & \text{if } \beta_H > (4/3)\beta_L \end{cases} \quad (9)$$

### 3.1.2. Levels of total welfare

The total welfare is defined through the sum of the utilities that are obtained by the consumers, and of the profit levels obtained by the operators. In formal terms, we have that:

$$W = 2\eta U_H + 2\eta U_L + \Pi_1 + \Pi_2 \quad (10)$$

Considering (9) the total welfare is expressed in different forms according to what is enunciated in the following Table:

TABLE N.º 2

#### Total Welfare, by parameter of valorisation

Parameters of valorisation	Total Welfare (W)
$\beta_H \leq (4/3)\beta_L$	$W = 2\eta(\beta_L + \beta_H)$
$\beta_H > (4/3)\beta_L$	$W = 2\eta(\beta_H)$

In the previous Table is considered the inexistence of production costs. From this, it results that the tariffs of access are, merely, transfers between the two cable operators. This way, the total welfare should equal the gross utility obtained by the consumers, that is, the utility obtained before processing the prices' reduction.

The presupposition which states that  $\beta_H < 2\beta_L$ , and the results presented in the previous Table, allow the definition of the following proposition:

**Proposition 2:** The fixation of low tariffs of access, that is,  $a_{ji} = 2\beta_L - \beta_H$ , allows to obtain a higher level of total welfare, than the establishment of high tariffs of access. In this sense, a market failure is observed, when the parameters of valorisation satisfy the condition  $\beta_H > (4/3)\beta_L$  (that is to say, when there is a high valorisation on the part of the consumers of high income). In this interval, the tariffs of access exceed the levels that are considered socially optimal. Therefore, the optimal regulatory action, in social terms, implies that the regulatory agency imposes a cap for the tariffs of access tariffs, at the level of  $\bar{a} = 2\beta_L - \beta_H$ , because just with this procedure it is guaranteed the access to the broadband internet services, from the part of the subscribers of low income.

The presupposition which considers that  $\beta_H < 2\beta_L$  and the results presented in the Table N.º 2 imply that the inclusion of the totality of the consumers provides a higher total welfare. To induce the operators to the fixation of the price  $p_i = \beta_L$ , instead of  $p_i = \beta_H$  (see (5)), it is necessary that the tariffs of access don't exceed the following:  $a_{ji} = 2\beta_L - \beta_H$ .

On the contrary, when  $\beta_H > (4/3)\beta_L$  (see (8)) this implies that the operators establish high tariffs of access, which are considered non optimal, in social terms, given the economic rationale that was, previously, presented.

## 3.2. Asymmetric Networks

### 3.2.1. Tariffs of Bidirectional Access

For modelling a scenario of asymmetric networks, we consider, as starting point, the formalization presented in Carter and Wright (1999, 2003). Firstly, it is considered that a consumer of the broadband internet service will prefer to subscribe the service offered in the network 1 that is owned by the incumbent, in detriment of the network 2, which is operated by the entrant, since:

$$v(p_1, S_1, \theta_1, m) > v(p_2, S_2, \theta_2, m) \quad (11)$$

Where:  $p_i$  is price of the broadband internet service;  $S_i$  is the dimension of the network of operator  $i$ ;  $\theta_i$  are the additional benefits for

belonging to the network  $i$ ;  $m$  is the net income; and  $i = 1, 2$ . corresponds to the networks of the cable operators.

The exercise of the preference depends on the dimension of the network ( $S_i$ ), of the prices of the internet service ( $p_i$ ) and of the differentiating characteristics of the network ( $\theta_i$ ).

For specifying the parameter relative to the horizontal differentiation ( $\theta_i$ ), a Hotelling formalization is used (Tirole, 1988).

As in the works of Carter and Wright (1999, 2003) and Laffont *et al.* (1998), it is presupposed that the distinction established between the two cable operators is unidimensional. Therefore, it is considered that, the operators are located in opposite extremes of the unitary interval and that the respective consumers are distributed along that same interval. The benefits for the customer of the type  $x \in [0,1]$ , for belonging to the network 2, they are proportional to  $x$  and may be expressed in the following way:

$$\theta_2(x) = \alpha x \quad (12)$$

Where:  $\alpha$  = Degree of importance of the competition not originated through the price.

In the case  $\alpha = 0$ , the differential of prices assumes a special importance and the operator that establishes lower prices, it will win all the market.

This way, the operator intends to increase progressively  $\alpha$  in the sense of establishing a higher price than the rival operator without facing the risk of getting a reduction on its market share.

In the present formalization, in order to allow the existence of asymmetry between the networks, is added one extra factor  $\beta$  that measures the benefits for belonging to the network 1 in a such way that:

$$\theta_1(x) = \alpha(1-x) + \alpha\beta \quad (13)$$

The parameter  $\beta$  results from the accumulated preferences of the consumers, which, for its turn, are originated from the long term advertising (Nerlove and Arrow, 1962).

This parameter represents the loyalty of the consumers and it results from the allocation of the goodwill advertising that contributes to the edification of entry barriers, and to the increase of the limit-price (Boyer, 1974).

In this context, it is considered a simple formalization, where the demand for the broadband internet service is dependent of the stock of accumulated goodwill, which is affected according to the levels of investment in advertising along the phases of the life cycle of the enterprise (Osório and Leitão, 2001).

For simplifying the current analysis, and since we consider that the spatial distribution of the operators is unidimensional, we derive the following presupposition:

**Presupposition 2:** The degree of asymmetry degree between the networks ( $\beta$ ) assumes values between 0 and 1. If  $\beta = 0$ , then the networks are symmetric. For its turn, if  $\beta = 1$ , with identical prices, then we admit that the consumers of the type  $x = 1$  will prefer to subscribe the broadband internet service that is offered in the network 1.

For a consumer of the type  $\bar{x}$  it will be indifferent to opt among the two networks in the case of verifying the following:

$$v(p_1, S_1, \beta, \bar{x}, m) = v(p_2, S_2, \beta, \bar{x}, m) \quad (14)$$

For example, in the simplest case, when  $x$  is distributed, uniformly, in  $[0, 1]$ , the market share of the network 1 ( $S_1$ ) is given by  $S_1 = \bar{x}$ . The additional specification depends of the fact of being possible, or not, to provide mechanisms of interconnection between the two networks.

### 3.2.2. Interconnection with asymmetry

By assuming a uniform distribution of  $x$ , the market share of the network is equal to:

$$S(p_1, p_2) = \begin{cases} 0, & \text{if } \bar{x} < 0 \\ 1, & \text{if } \bar{x} > 1 \\ \bar{x}, & \text{in the contrary case.} \end{cases} \quad (15)$$

Solving (14) in order to  $\bar{x}$ , the following is obtained:

$$\begin{aligned} v(p_1, S_1, \beta, \bar{x}, m) &= v(p_2, S_2, \beta, \bar{x}, m) \Leftrightarrow \\ \Leftrightarrow \bar{x} &= (1/2) + (\beta/2) + (\varphi(p_1) - \varphi(p_2))/(2\alpha) \end{aligned} \quad (16)$$

From the analysis of the result obtained in (16) it is straightforward that:

(i) If the degree of asymmetry between the networks (expressed by the goodwill intensity) is equal to 0 (that is, if  $\beta = 0$ ), and if the networks

establish identical prices ( $p_1 = p_2$ ), then each network will reach, exactly, half of the market, that is,  $\bar{x} = (1/2)$ ;

(ii) If the degree of asymmetry expresses an effective loyalty in relation to a certain brand (that is, if  $\beta > 0$ ), that is, a more inelastic final demand, then the network  $I$  (the incumbent one) will reach a market share bigger than 50%;

(iii) If the degree of importance of the competition not originated through the price ( $\alpha$ ) assume extreme values that tend to  $\infty$ , then the network  $I$  will obtain a market share bigger than 50%, which is expressed by:

$$\bar{x} = (1/2) + (\beta/2) \text{ (with } \beta > 0 \text{)}.$$

### 3.2.3. Levels of Total Welfare

In the determination of the total profits, the following presuppositions are considered:

**Presupposition 3:** Given the valorisation attributed by the consumers to the accumulated brand image by the incumbent, and the importance of the competition not originated through the price, the network  $I$  reaches a market share that is equal to:  $\bar{x} = (1/2) + (\beta/2)$ .

**Presupposition 4:** Considering a scenario that contemplates the celebration of an interconnection agreement with the fixation of reciprocal tariffs of interconnection:  $a_{ij} = a_{ji} = 2\beta_L - \beta_H$ , the valorisation attributed to the incumbent network  $I$  allows to setting a higher price ( $p_1 = \beta_H$ ). For its turn, the entrant network opts to establish a lower price ( $p_2 = \beta_L$ ), in order to increase its market share.

In the situation of asymmetric networks, the profit function of the network  $I$  is now expressed by the following:

$$\Pi_1 = q_1 \left( p_1 - a_{12} \right) + q_2 a_{21} \Leftrightarrow \Pi_1 = 2\lambda(\beta_H - \beta_L) + (1 - \lambda)(2\beta_L - \beta_H)$$

$$\text{where: } \lambda = \eta + (\beta/2).$$

(17)

In the same situation, the profit function of the network 2 corresponds to the following:

$$\Pi_2 = q_2 \left( p_2 - a_{21} \right) + q_1 a_{12} \Leftrightarrow \Pi_2 = (1 - \lambda)(\beta_H - \beta_L) + \lambda(2\beta_L - \beta_H)$$

Where:  $\lambda = \eta + (\beta / 2)$ .

(18)

The sum of the total profits of the operators is equal to:

$$\Pi_1 + \Pi_2 = \lambda(\beta_H - \beta_L) + \beta_L$$
(19)

and the total welfare (W) is expressed by the following:

$$W = 2\eta U_H + 2\eta U_L + \Pi_1 + \Pi_2 \Leftrightarrow W = (2\eta + \lambda)(\beta_H - \beta_L) + \beta_L$$
(20)

Comparing with the benchmark result for symmetric networks that was, previously, presented in Table N.º 2, when  $\beta_H \leq (4/3)\beta_L$ , the following Lemma may be derived:

**Lemma 1:** With the inclusion of a degree of asymmetry in the demand, through the product differentiation originated by the accumulated stock of goodwill owned by the incumbent, the total welfare is dependent of the valorisation attributed by the consumers (expressed by  $\lambda$ ), and of the disposition to pay, from the part of the consumers of high income ( $\beta_H$ ). Taking into consideration that  $\lambda = \eta + \beta / 2$ , the bigger the weight of the accumulated preferences of the consumers, for belonging to the incumbent network 1, the bigger will be the disposition to pay, from the part of the consumers of high income and, by consequence, the bigger will be the total welfare.

### 3.3. Scenarios

#### 3.3.1. Scenario 1: Collusion

Considering now a scenario of asymmetric networks where the operators, in the celebration of the interconnection agreement, decide to collude. This way, we consider the following:

**Presupposition 5:** In the fixation of reciprocal interconnection tariffs:  $a_{ij} = a_{ji} = \beta_H$ , the incumbent network 1 establishes a higher price ( $p_1 = \beta_H$ ), given the high valorisation attributed to its broadband internet

service. For its turn, the entrant network 2 establishes a lower price ( $p_2 = \beta_L$ ), given its reduced accumulated stock of goodwill.

In the collusive scenario, the profit function of the network 1 is given by the following:

$$\begin{aligned} \Pi_1 &= (\eta + \beta/2)(\beta_H - \beta_H) + (1 - \eta - \beta/2)(\beta_H) \Leftrightarrow \Pi_1 = (1 - \lambda)(\beta_H) \\ \text{Where: } \lambda &= \eta + (\beta/2). \end{aligned} \quad (21)$$

The profit function of the network 2 is given by the following:

$$\begin{aligned} \Pi_2 &= (1 - \eta - \beta/2)(\beta_H - \beta_H) + (\eta + \beta/2)(\beta_H) \Leftrightarrow \Pi_2 = \lambda(\beta_H) \\ \text{Where: } \lambda &= \eta + (\beta/2). \end{aligned} \quad (22)$$

The sum of the total profits obtained by the operators is the following:

$$\Pi_1 + \Pi_2 = \beta_H \quad (23)$$

and the total welfare comes equal to:

$$W = 2\eta U_H + 2\eta U_L + \Pi_1 + \Pi_2 \Leftrightarrow W = \beta_H \quad (24)$$

Comparing with the result obtained in (20), in the collusive scenario, we consider the following:

**Lemma 2:** The fixation of higher tariffs of access  $\left(a_{ij} = a_{ji} = \beta_H\right)$  harms the total welfare. Furthermore, it makes the total welfare completely dependent of the disposition to pay of the consumers of high income, which results in a non-socially desirable situation of total exclusion of the consumers with low income, in what concerns the access to broadband internet.

### 3.3.2. Scenario 2: Regulated Market

The arguments previously presented make necessary to design a scenario of regulated market, with the aim of disseminate the access to broadband internet services, trough the cable network. This is also a good

example of a possible expansion of the ambit of the denominated universal service of telecommunications. For this effect, it is considered the following presupposition:

**Presupposition 6:** The regulatory agency imposes that the tariffs of interconnection don't exceed the level expressed by:  $a_{ij}^{\rightarrow} = a_{ji}^{\rightarrow} = 2\beta_L - \beta_H$ ; and that the prices of the broadband internet service are equal, that is:  $p_1 = p_2 = \beta_L$ . This aims to increase the dissemination of broadband internet service, from the part of all types of consumers (that is, low and high income).

In the situation of regulated market, the profit function of the network 1 is expressed by the following:

$$\begin{aligned} \Pi_1 &= \lambda(\beta_H - \beta_L) + (1 - \lambda)(2\beta_L - \beta_H) \\ \text{Where: } \lambda &= \eta + (\beta / 2). \end{aligned} \quad (25)$$

In the same situation, the profit function of the network 2 is given by:

$$\Pi_2 = (1 - \lambda)(\beta_H - \beta_L) + \lambda(2\beta_L - \beta_H) \quad (26)$$

Now, the sum of the total profits is given by the following:

$$\Pi_1 + \Pi_2 = \beta_L \quad (27)$$

and the total welfare is expressed by:

$$W = 2\eta(\beta_H - \beta_L) + \beta_L \quad (28)$$

In a scenario of asymmetric networks, and comparing with the level of total welfare, obtained at (20), we are able to state that the regulatory action should establish caps for the tariffs of interconnection  $\left( a_{ij}^{\rightarrow} = a_{ji}^{\rightarrow} = 2\beta_L - \beta_H \right)$ , since this procedure guarantees the maximization of the total welfare.

In what concerns to the regulation of prices, and incorporating the Presupposition 3, which expresses the asymmetry induced on demand through the accumulated stock of goodwill, we stress the fact that the regulatory agency should let the market to operate, in a free way.



#### 4. CONCLUSIONS

The inclusion of a distortion factor on the demand for services provided by the incumbent operator, through the incorporation of the effect associated with the goodwill intensity, results in a larger total welfare (see (20)). Nevertheless, this is conditioned by the valorisation attributed by the consumers, as well as, by the weight of the preferences revealed by the subscribers, of high income, in what concerns the incumbent network. These preferences are originated through the goodwill, which contributes to a largest disposition to pay for the services, from the part of the consumers. The incumbent develops mechanisms of horizontal differentiation, in order to relax the competition through the price, and to reach a bigger market share.

The regulation should promote the celebration of interconnection agreements, by establishing caps for the tariffs of interconnection, and by avoiding potential situations of collusion, in order to eliminate the possible exploitation of joint monopoly power, from the part of vertically integrated firms. As regards to the fixation of prices of access to the broadband internet service, through cable network, the market should be adjusted, in a free way. This will assure, on the one hand, the inclusion of the subscribers of high income, and on the other hand, the maximization of the total welfare. In this sense, it is fundamental to revitalize the philosophies of pro-competitive regulatory actions, in order to assure the interconnection between the networks, and to expand the ambit of the universal service of telecommunications, through the addition of a strategic item for the economic growth of the nations, that is, the universal access to the broadband internet services.

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