

# Ownership Structure of Cable Networks and Competition in Local Access\*

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## Abstract

In this paper, we discuss the role of cable television networks and their ownership structure in promoting competition in the local access market. First, we show that the dual ownership of a local telephone network and a cable network, compared with separate ownership, may increase or decrease incentives to invest in upgrading the cable television network. Second, we argue that separate ownership of the two networks is important to promote competition in local access.

**Key Words:** *Cable Networks, Local Access, Competition*

**JEL Classification:** L43, L96

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# 1 Introduction

A cable television network can be upgraded to offer telecommunication services and can therefore compete with a public switched telephone network. In this paper, we discuss the role of cable television networks and their ownership structure in promoting competition in local access. Our objective is twofold. First, we investigate how the dual ownership of a telephone and a cable television network, compared with separate ownership, affects incentives to invest in upgrading the cable network.<sup>1</sup> We measure the incentives to upgrade the cable network by the resulting incremental profit and show with a simple model, that there is no definite relationship between the incentives to upgrade and the ownership structure of the networks. Second, we argue that separate ownership of the two networks is important to promote competition in local access. We use our model to compare the equilibrium prices under the two ownership structures. Even if a firm that owns both networks upgrades its cable network, it should behave like a multiproduct monopolist and it is unlikely that any meaningful competition between the two networks will emerge. Only an independently owned cable television firm will use its upgraded cable network to compete with the telecommunications incumbent.

To our knowledge, competition between cable television networks and public switched telephone networks has not been explicitly addressed in the literature. However, our article relates to the literature on the relative advantages of the various forms of entry in the telecommunications industry and the literature on intermodal competition. Regarding the first literature strand, Faulhaber (2003) analyzes regulatory initiatives to open segments of the telecommunications market to competition and mentions cable networks as a viable alternative to the incumbents' local access telecommunications network. Bourreau & Dogan (2004, 2005), using a dynamic model of technology adoption, study the incentives of an entrant to lease the incumbent's local loops and compete "service-based", or to build a more efficient infrastructure and compete "facility-based". They show that the incumbent can delay the entrant's adoption of new superior technology, by setting low rental prices for the local loops. Dessein (2004) considers competition between two established horizontally differentiated networks and shows how customer heterogeneity affects nonlinear pricing strategies. Regarding intermodal competition, Loomis & Swann (2005) develop and estimate a model of local competition. They find that there is substantial competition between incumbents and entrants using wireless and high-speed services.<sup>2</sup> Finally, note that although we use a model of a multi-product monopolist, our setting

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<sup>1</sup>*Separate Ownership* means that there is no meaningful overlap between the shareholders of the individual companies. *Dual Ownership* means that the companies are largely held by the same shareholders.

<sup>2</sup>For a discussion of optimal pricing with intermodal competition, see Braeutigam (1979).

has several nonstandard features, such as scope and coordination economies.

The remainder of the paper is organized as follows. Section 2 presents the policy debate related to the ownership structure of cable networks. Section 3 presents the model and section 4 characterizes the equilibria. The analysis is conducted in section 5 and section 6 concludes. All proofs are in the Appendix A.

## 2 Policy Debate

In this section we give an overview of the policy debates surrounding the ownership structure of cable television networks. First, we discuss the importance of facilities based entry in promoting competition in local access. Second, we discuss the importance of cable television networks in promoting facilities-based entry. Third, we discuss the impact of the ownership structure on the incentives to upgrade the cable television network and on competition in local access.

### 2.1 Facilities Based Entry and Competition in Local Access

In the *US*, the Telecommunications Act of 1996 promoted the entry of new firms into the local access market by two means in addition to own facilities entry: (i) the resale of the incumbent's services and (ii) the unbundling of the incumbent's local loop.<sup>3</sup> This was a new and promising paradigm. The removal of high entry barriers to the local access market, associated with scale, density and scope economies, would give entrants time to develop their customer base and to build their own infrastructures.<sup>4</sup> The *EU* experienced a similar process of liberalization.

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<sup>3</sup>*Local Access* is the origination and termination of calls on local networks. In *Own Facilities* entry, new firms build their own local loop, switches, etc. This form of entry makes new firms independent of the incumbent's network, but requires time and large investments. In *Resale* entry, new firms buy the incumbent's services at a lower price than that charged by the incumbent to its clients and the new firms resell these services to their own clients. This form of entry is fast and cheap. However, the arbitrage between the wholesale and the retail prices is the only profit opportunity. Entry through *Local Loop Unbundling* is a hybrid between the first and second forms of entry. New firms lease unbundled elements of the incumbent's local loop, and combine them with their own infrastructure.

<sup>4</sup>The basic local telephone infrastructure consists of poles, conduits and underground plants. To a large extent, this infrastructure is invariant to the number of circuits provided. In addition, the cost of this infrastructure constitutes more than a third of the total cost of the local basic telephone network. High capacity transport is also subject to significant economies of scale. A more dense and even distribution of customers allows the construction of a more efficient transport network.

Entry through resale and local loop unbundling rely on the *Open Network Principle*, according to which, all telecommunications firms should have access to the basic public telephone network, under the principles of: **(i)** non-discrimination, **(ii)** transparency and **(iii)** cost orientation.<sup>5</sup>

The open network principle is part of the legislation of many countries, e.g., the Access Directive 2002/19/EC. However, it is hard to enforce. The incumbent can resort to obstruction tactics which are hard to detect or to prosecute. In addition, even if prosecution is feasible, due process takes time. In the 1974 antitrust suit against *AT&T*, the *Antitrust Division* of the *Department of Justice* of the *US* asked for the divestiture of *AT&T*, on the basis of the argument that the sectorial regulator, the *Federal Communications Commission*, would not be able to stop *AT&T* from charging excessive prices and providing inferior quality for its rivals' access to the local networks (Noll & Owen (1988)).<sup>6</sup> In other words, the request for divestiture was based on the argument that the *Federal Communications Commission* would not be able to enforce the open network provision. The process concluded 1984 with the break-up of *AT&T*.<sup>7</sup>

Aside from leaving entrants dependent on the incumbent's infrastructures, the two alternative forms of entry constrain the entrants' marketing options. In particular, resale does not allow entrants much scope for product differentiation or innovation.

### Figure 1

Either due to the incumbent's obstruction, or due to its intrinsic limitations, resale and the unbundling of the local loop have, so far, produced very modest results both in the *US* and the *EU*. As Figure 1 illustrates, incumbents continue to dominate local access after six years of liberalization in the *EU*. After all, it seems that these two forms of entry are no substitutes, even temporary, for facilities based entry.

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<sup>5</sup>The existence of common costs makes the implementation of cost orientation hard. The legal battles in the *US*, around the *Telpak* tariff in the 60s, the *ENFIA* tariff in the 70s and the Telecommunications Act in the 90s, illustrate these difficulties (Temin (2000)). See Hausman (2000) for a discussion of cost orientation.

<sup>6</sup>The suit alleged monopolization of the long-distance, local and equipment markets.

<sup>7</sup>Aside from an enforceability problem, the open network provision also seems to have a legitimacy problem. In a recent judgement regarding *VERIZON v. TRINKO* (540 U. S. \_ (2004)) the *US* Supreme Court stated the following. "The 1996 Act is in an important respect much more ambitious than the antitrust laws. It attempts to eliminate the monopolies enjoyed by the inheritors of *AT&T*'s local franchises. (...) Section 2 of the Sherman Act, by contrast, seeks merely to prevent unlawful monopolization. It would be a serious mistake to conflate the two goals. The Sherman Act is indeed the 'Magna Carta of free enterprise', (...) but it does not give judges carte blanche to insist that a monopolist alter its way of doing business whenever some other approach might yield greater competition."

"In the end, unbundling is an unnatural act for a vertically integrated provider. (...) Realistically, a goal of perfect interconnection, or the complete absence of discriminatory treatment of affiliated and unaffiliated partners, is unattainable. The embedded local networks we have today were optimized for exclusive use by a monopoly carrier, not for wholesale supply of unbundled elements or other networks", Woroch (2002), pg. 709.<sup>8</sup>

A more benign interpretation of the current situation in the telecommunications markets is that entry takes more time than what was initially anticipated. Geroski (1992) reports that for a wide range of industries, it takes entrants considerable time to accumulate a small market share. Given the complexity of the telecommunications industry, a slow entry process should come as no surprise.

## 2.2 Cable Networks and Competition in Local Access

Regarding the feasibility of facilities based entry in promoting competition in local access, there is a clear dichotomy between the residential and the non-residential markets.<sup>9</sup> Deploying a local access network for non-residential clients might not be a problem. Building a fixed wireless access for a large corporate client, or building a fiber-optic ring for a commercial business district, might be profitable investments.<sup>10</sup> However, the situation for most residential clients is different. Unless the network is used to provide other services, it might not be profitable to build. In this respect cable television networks can play an important role.

### *Table 1*

Among the various alternatives that provide local access to consumers, cable television networks have three special characteristics that allow them to compete in the short run with the public switched telephone network. The first special characteristic of cable networks is that

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<sup>8</sup>Crandall (2002) reports evidence that the building of their infrastructure was fundamental for the success of the firms that entered into the local access market following the enactment of the Telecommunications Act. Faulhaber (2003) predicts the failure of the current local loop unbundling model.

<sup>9</sup>*Non-Residential* and *Residential* customers have different demand characteristics. Businesses often require high-capacity connections for data or the provision of private branch exchange trunks.

<sup>10</sup>The fiber ring technology exhibits high fixed costs, and negligible marginal costs. The high fixed costs limit the applicability of the technology: (i) to large business customers, or (ii) to areas with extremely high population densities, like multi-unit residential buildings in urban areas. On the optimal pricing strategies for utilities with large customers who have attractive service options, see Einhorn (1987).

they can be upgraded to offer telecommunications services. Cable television networks were originally designed to broadcast information, i.e., to deliver a one-way signal.<sup>11</sup> However, they can be upgraded as fiber optics increases bandwidth, digitalization increases the quality and the range of services, bidirectional amplifiers allow carriage of a return signal and switches enable circuit-switching. An upgraded cable television network can offer a complete range of interactive services, such as fixed telephony, broadband access to the Internet through cable modem and video on demand. The second special characteristic of cable networks is that upgrading an existing network to carry a return signal is faster and cheaper than deploying a new telecommunications network. Woroch (1998) puts the cost per household of upgrading the cable telephony in the range of \$400-\$900 and estimates a pay back period of 6 years. See Hatfield Associates (1997) for other estimates.<sup>12</sup> The third special characteristic of cable networks, illustrated in Table 1, is that in many countries, the cable infrastructure already deployed offers good coverage.<sup>13</sup>

**The Case of the United Kingdom** The example of the *UK* is revealing of the importance of cable television networks in promoting competition in local access. After seven years of legal duopoly, 1984-1991, *Mercury*, the rival of *British Telecom*, gained a 1% market share of voice services. *Mercury* resold lucrative services, but did not invest in access lines. In 1991, with the publication of the 1990 Telecommunications Policy Review, the Duopoly Review, cable television firms were allowed to offer fixed telephony services.<sup>14</sup> Cable telephony rapidly over-

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<sup>11</sup>Cable television originated in the *US* in 1948 in order to enhance poor reception of over-the-air television signals in mountainous or geographically remote areas. Community antennas were built on high points and homes were connected to the antenna towers to receive the broadcast signals.

<sup>12</sup>The cost of enabling the supply of telephony services varies depending on the state of the existing cable network. The traditional tree-and-branch architecture of cable networks is incompatible with telephony because cascading chains of amplifiers in the distribution network make two-way communication impossible. Such networks therefore have to be extensively overhauled. A recently built cable network may have replaced the coaxial cable in portions of the network with fiber optics in order to enhance cable quality, improve reliability and increase capacity. In addition, it may have adopted a star and ring architecture which is more conducive to two-way communications. A cable network built with a hybrid fiber coaxial cable network architecture, capable of supporting two-way communication, would need only minor additional upgrades. In the *UK*, firms followed a different technological approach by deploying networks in which a separate coaxial cable and copper wire pair were intertwined to form a single cable.

<sup>13</sup>"Homes Passed" is the expression used by the industry to designate homes covered by a network.

<sup>14</sup>Cable operators were allowed to offer their own telephony services instead of merely reselling those of *British Telecom* or *Mercury*. In particular, they were allowed to deploy their own switches and to interconnect freely with other operators of adjacent cable franchises.

took subscription television. Now there are more cable telephone subscribers than television subscribers. In the third quarter of 2003, *NTL Home* had 2,809,500 customers, of which 864,600 were broadband customers, 1,294,800 were digital television customers, 2,489,800 were telephony customers and 55,100, i.e. 19.6%, took all three services. In the same period, *Telewest* had 329,336 broadband customers, 911,191 digital television customers and 1,588,358 telephony customers. In 1992, *British Telecom* had a revenue market share of 99.2% for *UK* geographic calls. In the second quarter of 2003, *NTL* and *Telewest* had a dual, a revenue market share of 13.4% for *UK* geographic calls and of 19.7% for residential calls, whereas *British Telecom* had respectively, 65.7 and 70.6%.<sup>15</sup> These numbers are remarkable since cable networks only pass around half of the households in the *UK*.

**Other Cases** The *US* provides a less compelling case for the importance of cable television networks in promoting competition in local access.<sup>16</sup> In 2003, cable television firms supplied 2.5 million residential telephony lines, whereas there were 73.783 million basic cable customers and 102.900 million passed homes.<sup>17</sup> *Comcast Cable Communications* and *Cox Communications* were the largest providers with 63% and 31% market shares of cable telephony, respectively. In Germany, none of the firms that bought parts of *Deutsche Telekom*'s cable television network have showed any interest in offering telephony services so far.<sup>18</sup>

There are other alternative technologies that give local access to consumers, like the *Wireless Local Loop*,<sup>19</sup> or the combination of *Powerline Communications*<sup>20</sup> and *Voice over the Internet*

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<sup>15</sup>The data on *NTL* is from the firm's "Quarterly Report", the data on *Telewest* is from *ECCA*'s "Web Site" and the data on market shares is from *OFCOM*'s "Market Information".

<sup>16</sup>See Chandler et al. (2002) for a discussion on the inhibiting factors.

<sup>17</sup>According to the *National Cable & Telecommunications Association*.

<sup>18</sup>The German market has several idiosyncrasies. First, the sales pitch of digitalization has been premium programing, and increased channel choice. However, analogue, free-to-air, multichannel television, a substitute for cable television, is ubiquitous. This hinders the penetration of cable television. Second, the cable network is organized into four tiers, which do not necessarily belong to the same party, even in a given geographical area. This reduces the firms' incentives to invest in upgrading their cable networks for telephony.

<sup>19</sup>The *Wireless Local Loop* is a set of technologies that connect subscribers to the public switched telephone network using radio signals as a substitute for copper for all or part of the connection between the subscriber and the switch. It includes cordless access systems, proprietary fixed radio access and fixed cellular systems.

<sup>20</sup>The *Digital PowerLine* uses the existing electricity infrastructure to transmit low frequency signals at 50 to 60Hz and higher frequency signals above 1MHz. The lower frequency signals carry power, while the higher frequency signals can transmit data at a rate of 1Mbps. A conditioning unit filters those separate signals, sends electricity to the outlets in the home and data signals to a service unit. The service unit provides multiple channels for data, voice, etc. Base station servers at local electricity substations connect to the Internet via

*Protocol*.<sup>21</sup> However, these alternatives are only starting to be deployed.

### 2.3 Ownership Structure, Incentives to Invest and Competition

The US Telecommunications Act of 1996 recognized the importance of the cable television networks for providing an alternative infrastructure to the incumbent's local access network. It also recognized a potential conflict of interests. Section 302 of the 1996 Act imposes structural separation between firms that own local telecommunications networks and firms that own cable television networks.<sup>22</sup>

The legislation of the *European Community*, reflecting the political equilibrium between numerous parties, is ambiguous. Article 2 of the Cable Directive 95/51/EC, required firms that simultaneously offer telecommunications and cable television networks to put in place accounting separation between the two activities. However, it indicated a preference for the full structural separation of firms offering telecommunications and cable television networks.<sup>23</sup> In 1998, after the Review of the measures taken in response to Directive 95/51/EC, the *Commission* concluded that accounting separation was insufficient to increase competition in the industry. In Communication 98/C 71/04, the *Commission* recommended that telecommunications and cable television activities should be legally separate, but added that the structural separation was preferable. Article 8 of Directive 2002/77/CE, however, imposed only legal separation.<sup>24</sup> Several European countries followed a more assertive approach, either forbidding fiber or broadband coaxial cable. The system is similar to a neighborhood local area network.

<sup>21</sup>*Circuit-Switched* telephone networks establish a dedicated circuit between two end points for the duration of a call to avoid latency, i.e., delays, in the transmission of data. However, latency control comes at the expense of wasted bandwidth. Although there are many periods during a telephone conversation where no data is transferred, a full 64-Kbps stream, on digital networks, is still required for the entire call. In *Packet-Switched* networks, instead of dedicated connections, network resources are shared and used only when data is sent or received in quick bursts. Using compression algorithms, telephone calls can be delivered at rates as low as 8 Kbps in a packet format, offering even more bandwidth efficiency.

<sup>22</sup>*Legal Separation* means that firms are different legal entities according to the principles of corporate law. *Structural Separation* means that firms are legally separate and in addition there is no meaningful cross-ownership between them.

<sup>23</sup>*Accounting Separation* of the activities of a dominant firm makes finance fluxes more transparent and helps to detect and avoid abusive practices by the dominant firm regarding, e.g., price setting. *Legal Separation* of firms makes assets and costs more transparent. However, accounting and legal separation do not solve the fundamental conflict of interests. Two legally separate firms may be controlled by a third firm, with majority positions on both firms. The third firm will effectively control the assets of other two firms.

<sup>24</sup>Preambles cannot be relied on as such. However, they provide useful insights into the rationale of the Directives. Paragraph 11 of the preamble of Directive 99/64/EC which was amended by Directive 2002/77/CE

ownership by the telecommunications incumbent of cable television networks or forcing the telecommunications incumbent to divest, totally or partially, its participation in the ownership of cable television networks.<sup>25</sup>

The basis for the *Commission's* preference for structural separation is the argument that a firm that owns both networks has no incentive to upgrade the cable network. A cable network endowed with bidirectionality can compete with the telephone network, in relation to both telephony services and broadband access to the Internet. It is unlikely that investment in the cable network will generate additional net revenues as it will merely redirect revenues. An independently owned cable television firm does not have the same conflict of interests. Telecommunications services attract new clients. Paragraph 10 of the preamble of Directive 99/64/EC states that:

“Where Member States have granted a special or exclusive right to build and operate cable TV networks, to a telecommunications organization in the same geographic area where it is dominant on the market for services using telecommunications infrastructure, that telecommunications organization has no incentive to upgrade both its public narrowband telecommunications network and its broadband cable TV network to an integrated broadband communications network (‘full-service network’) capable of delivering voice, data and images at high bandwidth. In other words, such an organization is placed in a situation whereby it has a conflict of interests, because any substantial improvement in either its telecommunications network or

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states that: “In order to achieve this transparency, it is necessary that the networks be operated by separate legal entities which may, however, in principle be jointly owned. The requirement of legal separation would therefore be complied with if the cable TV operations of a telecommunications organization were transferred to a fully owned subsidiary of the telecommunications organization.”

<sup>25</sup>In the *UK*, *Belgium* and *Spain*, the dominant firm offering telecommunication services was prohibited from offering cable television services. *Holland* took several measures to limit the dual ownership of the telecommunications and cable television networks by the telecommunications incumbent and to separate structurally the two activities. In 1997, *KPN*, the Dutch incumbent, was forced by the government to reduce from 100% to 20% its participation in the cable firm *Casema*. In the remaining countries, the pressure exerted by the *Sectorial Regulators*, *Antitrust Authorities* combined with some financial difficulties has lead incumbents to divest their participations in firms that own cable networks. In December 1999, *Swisscom*, *Siemens Schweiz*, and *Veba* sold group *Cablecom* to *NTL*. In July 2002, following pressure from the *European Commission*, *Deutsche Telekom* divided its cable television firm, *Kabel Deutschland*, into nine regional firms which it has been progressively selling (Press Note of the Commission: IP/00637). In May 2002, the merger of *Telia* and *Sonera*, the telecommunications incumbents of *Sweden* and *Finland*, respectively, was approved by the *Commission*, subject to the condition, inter alia, that *Telia* divest its cable television network.

its cable TV network may lead to a loss of business for the other network. It would be desirable in those circumstances to separate the ownership of the two networks into two distinct companies since the joint ownership of the networks will lead those organizations to delay the emergence of new advanced communications services and will thus restrict technical progress at the expense of the users, (...).”

The OECD holds a similar position (OECD (1998)).

Similar to the *Commission* we favor structural separation. However, we disagree with the *Commission*’s motivations for structural separation for two reasons. The first reason is that there is no simple relationship between ownership structure and incentives to upgrade a cable network. Dual ownership may, or may not, reduce incentives to upgrade the cable network. The *self-cannibalization effect* may reduce the incentives of a firm that owns both networks to upgrade the cable network. However, there are other factors that can mitigate, or even overcome, the impact of this effect and give a firm that owns both networks more incentives to upgrade the cable network than an independently owned cable firm. Some of these reasons are: **(i)** coordination economies in the joint operation of the two networks, **(ii)** differences in costs of upgrading the cable network between the two types of firms, **(iii)** regulatory uncertainty, **(iv)** regulatory arbitrage and **(v)** attraction of new customers when networks are non-overlapping. As seen in subsection 2.2, the example of Germany shows that structural separation is no guarantee that the cable network will be upgraded and used to provide telecommunication services.

The second and more important reason for which we disagree with the *Commission* is that we think that the emphasis on the impact of the ownership structure on the incentives to upgrade the cable network is misplaced. We believe that the impact of the ownership structure in establishing competition in local access is far more relevant. Even if a firm that owns both networks upgrades its cable network, it will have no incentive to make the cable network compete with the telecommunications network. Only an independently owned cable television firm will use the cable network to compete with the telecommunications firm.<sup>26</sup>

### 3 The Model

Since this is a policy oriented paper, we have developed a stylized model to make the analysis transparent. In section 6 we discuss several extensions.

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<sup>26</sup>Structural separation with the purpose of promoting competition in the local access raises legitimacy problems similar to those discussed in footnote 7, regarding the open network principle.

There are two networks: **(i)** a public switched telephone network, *PSTN* and **(ii)** a cable network, *CN*. The *PSTN* belongs to the *Telecommunications Company* and provides fixed telephony services, denoted by  $f$ . The *CN* belongs to the *Cable Company* and provides subscription television services, denoted by  $t$ . If endowed with bidirectionality, the *CN* can also provide fixed telephony services bundled with subscription television, denoted by  $b$ . We index the products with subscript  $j = f, t, b$ . In subsection 6.2, we allow the cable company to offer fixed telephony services in a bundle as well as separately, i.e. we allow the cable company to practice mixed bundling. There are two possible ownership structures for these companies: **(i)** separate ownership and **(ii)** dual ownership, through a  *Holding Company*. Denote by  $i$ , the independently owned cable company and denote by  $h$  the cable company owned by the holding company. We index the two types of cable companies with superscript  $k = i, h$ .

The game has two stages, which unfold as follows under both ownership structures. In stage 1, the cable company decides whether to upgrade the *CN*. In stage 2, both companies choose prices simultaneously.

### 3.1 Firms

Upgrading the *CN* involves a fixed cost,  $\varphi > 0$ , independently of the ownership structure of the cable company. Marginal production costs are constant for the three products. Denote by  $c_f$ , the marginal cost of telephony services. For subscription television and for the bundle, we distinguish between the marginal cost of an independently owned cable company and a cable company owned by the holding company. Denote by  $c_j^k$ ,  $j = t, b$ ,  $k = i, h$ , the marginal cost of product  $j$ , produced by cable company  $k$ .

We assume that there are *Coordination Economies* in the dual ownership of the two networks. Coordination economies stem from the cable company integrating its network with the telephone network, e.g., sharing resources, if it is owned by the holding company.<sup>27</sup> This means that a cable company will have lower marginal costs if it is owned by the holding company, than if it is owned independently. More specifically: **(i)**  $c_t^h := c_t^i - \delta_t$  and **(ii)**  $c_b^h := c_b^i - \delta_b$ . Parameter  $\delta_t$  on  $[0, c_t^i)$ , captures coordination economies with respect to cable television services and parameter  $\delta_b$  on  $[0, c_b^i)$  captures coordination economies with respect to the bundle.

We assume that there are *Economies of Scope* in the joint provision of subscription television

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<sup>27</sup>There is a duplication of resources between the two networks, e.g., the local loops, switches, or backbone networks. If such resources are managed jointly, they can be used more efficiently. Besides, if both networks are digitalized then, bandwidth considerations aside, either network can carry the two types of traffic. This allows the optimization of the traffic flow over the two networks.

services and fixed telephony services over the *CN*. Scope economies stem from joint marginal costs of offering multiple services over the same network.<sup>28</sup> This means that on the *CN*, the production cost of the bundle is no larger than the sum of the production costs of subscription television services and telephony services. More specifically:  $c_b^k := c_f + c_t^k - \gamma$ , where parameter  $\gamma$  on  $[0, c_f + c_t^h - \delta_b)$  captures scope economies. Table 2 summarizes the cost structure.

*Table 2*

We assume that the holding company behaves like a multiproduct monopolist and that firms do not engage in price discrimination, i.e., firms charge all consumers the same price for identical services. The relevance of this assumption is discussed in footnote 35.

### 3.2 Consumers

There is a continuum of consumers, whose measure we normalize to 1. All consumers have access to both networks. Consumers come in two types, indexed by  $\tau = 1, 2$ , which differ only on how they value the bundle. Denote by  $v_f$  and  $v_t$ , the consumers' valuation for fixed telephony services and for subscription television services, respectively; and denote by  $v_b^\tau := v_f + v_t + \theta^\tau$ , the valuation of type  $\tau$  consumers for the bundle, where  $\theta^\tau$  is a parameter on  $\Re$  that measures the marginal valuation for the bundle. *Type 1* consumers, a proportion  $\beta$  on  $(0, 1]$ , have a high valuation for the bundle and *type 2* consumers, a proportion  $1 - \beta$ , have a low valuation for the bundle, i.e.,  $\theta^2 < \theta^1$ . The high valuation for the bundle of type 1 consumers is due to the convenience of interacting with a single firm, i.e., signing one contract, paying one monthly bill, calling one maintenance service, etc.<sup>29</sup> The low valuation of the bundle by type 2 consumers is due to some sort of consumer inertia, that makes them reluctant to sign on for a new service. We assume that when consumers are indifferent as to whether or not to buy the bundle, they choose the former.

To close the model we make the following assumptions on the values of the parameters. Let: **(i)**  $c_f < v_f$ , **(ii)**  $c_t^i < v_t$  and **(iii)**  $\theta^2 < -(v_f - c_f) - (v_t - c_t^k) - \gamma < 0 \leq \theta^1$ ,  $k = i, h$ .

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<sup>28</sup>According to Cluny (1995) for a multiple services operator, about 10% of its operating costs are incremental to subscription television, 20% to telephony and 70% or more are non-attributable common costs. See also Woroch (1997) for a description of the technological advances that allow scope economies between video and voice services.

<sup>29</sup>Cooper (2003) provides evidence that following the introduction of new advanced services, cable television firms were able to raise their fees by more than the increase in capital expenditures required to make these services available.

Assumptions (i)-(iii) and the assumptions on the cost structure imply that:  $v_b^2 < c_b^h < c_b^i < v_b^1$ .

We abstract from possible network effects since, typically, the *PSTN* has interconnection obligations.

## 4 Characterization of Equilibrium

In this section, we characterize the game's equilibria which we solve by working backwards for the two alternative ownership structures.

### 4.1 Stage 2: The Price Game

In this subsection, we characterize the equilibrium prices under the two ownership structures and for the cases in which the *CN* was, and was not, upgraded.

#### 4.1.1 Non-Upgraded *CN*

Denote by  $p_j$ , the price of product  $j = f, t, b$ . When the *CN* is not upgraded, the price equilibrium is simple and is the same under both ownership structures. The telecommunications and the cable companies are monopolists and charge their monopoly prices.<sup>30</sup> We present this observation in the next Remark for future reference.

**Remark 1:** *In equilibrium, if the *CN* was not upgraded, then the telecommunications and the cable companies charge, respectively: (i)  $p_f = v_f$  and (ii)  $p_t = v_t$ .* ■

To simplify notation, we define the monopoly profit margins for telephony and cable television as  $\mu_f := v_f - c_f$  and  $\mu_t^k := v_t - c_t^k$ ,  $k = i, h$ .

Using Remark 1, the equilibrium profits of the telecommunications and the type  $k$  cable television companies when the *CN* was not upgraded are, respectively,  $\mu_f$  and  $\mu_t^k$ ,  $k = i, h$ .

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<sup>30</sup>We assumed that a holding company that owns a non-upgraded network does not market the bundle for two reasons. First, it seems unlikely that two legally separated firms could offer consumers the benefits described above, i.e., a unique contract, assistance and payment. Second, by definition, there are no scope economies if each service is provided over a different network. Hence, bundling the services or selling them separately is exactly the same as far as consumer valuation and marginal costs are concerned.

### 4.1.2 Upgraded *CN* with Dual Ownership

The assumption that the holding company behaves like a multiproduct monopolist implies that it maximizes dual profits. Again the price equilibrium is simple.

**Remark 2:** *In equilibrium, under dual ownership, if the *CN* was upgraded, then the holding company charges: (i)  $p_f = v_f$ , (ii)  $p_t = v_t$  and (iii)  $p_b = v_b^1$ . ■*

The intuition of Remark 2 is straightforward. The holding company faces a trade-off. It can sell the bundle to type 1 consumers through the cable company. Alternatively, it can sell telephony services and subscription television services separately through both networks to these consumers. Given that there are economies of scope in the supply of the bundle and that type 1 consumers have a higher valuation for the bundle, it is more profitable to sell the bundle than to sell both services separately:  $v_b^1 - c_b^h = \mu_f + \mu_t^h + \theta^1 + \gamma + \delta_b > \mu_f + \mu_t^h$ . The holding company is a monopolist with respect to the three services and sets prices accordingly. Monopoly prices allow the holding company not only to sell telephony and subscription television services to type 2 consumers, extracting all their surplus, but also to induce type 1 consumers to pay more for the bundle.

Using Remark 2, the equilibrium profits of the holding company when the *CN* was upgraded are:

$$\Pi^m = (1 - \beta)(\mu_f + \mu_t^h) + \beta(v_b^1 - c_b^h)$$

### 4.1.3 Upgraded *CN* with Separate Ownership

In this case, there exists no equilibrium in which the firms play pure pricing strategies with respect to all products. First, note that the cable company has a dominant strategy of charging the monopoly price for subscription television services,  $p_t = v_t$ .<sup>31</sup> At this price, the cable company sells subscription television services to type 2 consumers. Second, note that the cable company has no equilibrium pure strategy for the price of the bundle and the telecommunications company has no equilibrium pure strategy for the price of telephony

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<sup>31</sup>Given that there are economies of scope and type 1 consumers value the bundle, the cable company would like to induce these consumers to buy the bundle. Thus, the cable company would never charge less than  $p_b - p_f - \theta^1$  for subscription television services. This means that it will only sell subscription television services to type 2 consumers. However, since the cable company has monopoly power over these consumers, it charges the highest possible price of  $v_t$ .

services.<sup>32</sup> In subsection 5.3, we discuss how to modify the model so that all price equilibria are in pure strategies.

Next we construct the supports of the price distributions of telephony services and the bundle.<sup>33</sup> The telecommunications company may decide to sell only to consumers with a low valuation for the bundle, whose proportion is  $1 - \beta$ , at price  $v_f$ . Alternatively, the telecommunications company may charge a price lower than  $v_f$ , to try to undercut the cable company and also sell to consumers with a high valuation for the bundle. Let  $l_f$  be the lowest price the telecommunications company is willing to charge to sell to all consumers, i.e.,

$$(l_f - c_f) \equiv (1 - \beta)\mu_f,$$

from which we obtain:

$$l_f = c_f + (1 - \beta)\mu_f.$$

Value  $l_f$  is decreasing in the proportion of consumers that have a high valuation for the bundle,  $\beta$ , and increasing in the monopoly profit margin for telephony services,  $\mu_f$ . A larger  $\beta$  implies a smaller opportunity cost of charging a price lower than  $v_f$  to also sell to consumers with a high valuation for the bundle; a larger  $\mu_f$  implies a larger opportunity cost of charging a price lower than  $v_f$ .

The cable company can sell subscription television services separately to consumers with a high valuation for the bundle, whose proportion is  $\beta$ , at price  $v_t$ . Alternatively, the cable company can sell the bundle to these consumers. Denote by  $l_b$  the lowest price the cable company is willing to charge for the bundle, i.e.,

$$\beta(l_b - c_b^i) \equiv \beta\mu_t^i,$$

from which we obtain:

$$l_b = c_b^i + \mu_t^i.$$

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<sup>32</sup>Any price for telephony services,  $p_f$ , on  $[c_f, v_f]$  can be undercut by the cable company by setting  $p_b = v_t + p_f + \theta^1$ . This is profitable for the cable company if and only if  $(v_t + p_f + \theta^1 - c_b^i)\beta + \mu_t^i(1 - \beta) > \mu_t^i$ . As this is equivalent to  $p_f - c_f > -(\theta^1 + \gamma)$ , which is always true, any price for telephony services will be undercut by the cable company. As for the bundle, any price  $p_b$  on  $[c_b^i, v_b^1]$  can be undercut by the telecommunications company by setting  $p_f < p_b - v_t - \theta^1$ . Such a price is profitable for the telecommunications company if and only if  $(p_f - c_f) > \mu_f(1 - \beta)$ , or equivalently, if and only if  $p_f > c_f + \mu_f(1 - \beta)$ . Hence, undercutting is profitable if the interval  $(c_f + \mu_f(1 - \beta), p_b - v_t - \theta^1)$  is non-empty. This happens if  $p_b > v_b^1 - \mu_f\beta$ . For  $p_b \leq v_b^1 - \mu_f\beta$  the telecommunications company prefers to set  $p_f = v_f$  rather than trying to sell to the type 1 consumers. But for  $p_f = v_f$  the cable company prefers to set  $p_b = v_t + v_f + \theta^1 = v_b^1$ . As  $v_b^1 > v_b^1 - \mu_f\beta$ , the telecommunications company would then undercut this price.

<sup>33</sup>See Varian (1980) or Narasimhan (1988) for the details on the method we use.

Value  $l_b$  is decreasing in the cable company's monopoly profit margin for subscription television services,  $\mu_t^i$ . A larger  $\mu_t^i$  implies a larger opportunity cost of selling the bundle to consumers with a high valuation for the bundle.

The cable company sells the bundle to type 1 consumers, if

$$p_b \leq p_f + p_t + \theta^1. \quad (1)$$

As we argued at the beginning of this subsection,  $p_t = v_t$ . Replacing  $p_j$  by  $l_j$ ,  $j = f, b$ , (1) becomes  $l_b \leq l_f + v_t + \theta^1$ . Thus, if the cable company charges  $l_f + v_t + \theta^1$  for the bundle with probability 1, it sells the bundle to type 1 consumers and earns:

$$\underline{\pi}_b^d = (l_f + \theta^1 + v_t - c_b^i)\beta = [(\theta^1 + \gamma) + (1 - \beta)\mu_f + \mu_t^i] \beta.$$

Since

$$l_b - l_f - v_t - \theta^1 = -(\theta^1 + \gamma) - (1 - \beta)\mu_f < 0,$$

this possibility is always feasible.

If the telecommunications company charges  $v_f$  with probability 1, it sells telephony services to type 2 consumers and earns:

$$\underline{\pi}_f^d = (1 - \beta)\mu_f.$$

**Remark 3:** *In equilibrium, under separate ownership, if the CN was upgraded, then: (i) the cable company charges for subscription television  $p_t = v_t$  and (ii) the cable company plays a mixed strategy with respect to the price of the bundle whose support is  $[l_f + \theta^1 + v_t, v_b^1]$  and the telecommunications company plays a mixed strategy with respect to the price of telephony services whose support is  $[l_f, v_f]$ . ■*

The intuition of Remark 3 is clear. The telecommunications and the cable companies compete for type 1 consumers. For the telecommunications company, charging a price lower than  $v_f$  entails both an expected marginal benefit, associated with more sales to type 1 consumers and a marginal loss, due to a smaller per consumer profit on type 2 consumers. Similarly, for the cable company, charging a price lower than  $v_b^1$  for the bundle also entails an expected marginal benefit, associated with more sales of the bundle to type 1 consumers and a marginal cost, associated with less sales of subscription television services to type 1 consumers. Given that there are scope economies in the supply of the bundle and that type 1 consumers have a

high marginal valuation for the bundle, the opportunity cost of charging lower prices for the bundle is smaller for the cable television company, than the opportunity cost of charging lower prices for telephony services for the telecommunications company:  $l_b - l_f - \theta^1 - v_t < 0$ . As a consequence, on average, the cable company succeeds in undercutting the telecommunications company and sells the bundle to type 1 consumers, earning  $\underline{\pi}_b^d = (l_f + \theta^1 + v_t - c_b^i)\beta$ . The telecommunications company charges  $p_f = v_f$  with positive probability. Price  $p_f = v_f$  can be interpreted as its regular price and lower prices can be viewed as discounts to attract type 1 consumers. In the Appendix A we present the equilibrium cumulative price distributions for the bundle and telephony services.

When the *CN* was upgraded, using Remark 3, the expected equilibrium profit of the telecommunications company is:

$$\Pi_f^d = (1 - \beta)\mu_f,$$

and the equilibrium profits of the independently owned cable company resulting from the sale of the bundle and of subscription television services are:

$$\Pi_t^d + \Pi_b^d = (1 - \beta)\mu_t^i + [(\theta^1 + \gamma) + (1 - \beta)\mu_f + \mu_t^i]\beta.$$

## 4.2 Stage 1: The Investment Decision

In this subsection, we characterize the firms' equilibrium investment decisions under the two ownership structures.

The incremental profit of upgrading the *CN* for the holding company is:

$$\Delta^{HC} := \Pi^m - \mu_f = \beta\theta^1 + \beta\gamma + \beta\delta_b - \varphi.$$

The incremental benefit has three parts: first, the *Bundle Value effect*,  $\beta\theta^1$ , second, the *Scope Economies effect*,  $\beta\gamma$  and third, the *Coordination Economies effect*,  $\beta\delta_b$ .

The incremental profit of upgrading the *CN* for the independently owned cable company is:

$$\Delta^{CC} := \Pi_t^d + \Pi_b^d - \mu_t^k = \beta\theta^1 + \beta\gamma + \beta(1 - \beta)\mu_f - \varphi$$

The incremental benefit has again three parts: first, the *Bundle Value effect*,  $\beta\theta^1$ , second, the *Scope Economies effect*,  $\beta\gamma$  and third, the *Business Stealing effect*,  $\beta(1 - \beta)\mu_f$ . Since  $l_f = c_f + (1 - \beta)\mu_f$  is the lowest price the telecommunications company is willing to charge,  $l_f - c_f = (1 - \beta)\mu_f$ , is the minimum profit margin that it can earn with type 1 consumers. By introducing the bundle and successfully undercutting the telecommunications company, the

cable company can steal this profit margin,  $(1 - \beta)\mu_f$ , times the measure of type 1 consumers,  $\beta$ .<sup>34</sup>

## 5 Analysis

In this section, we discuss, first the impact of the ownership structure on the firms' incentives to upgrade the *CN* and second the impact of the ownership structure on competition.

### 5.1 Ownership Structure and Incentives to Upgrade the *CN*

Next, we show that the holding company may, or may not, have more incentives than the independently owned cable company to upgrade the *CN*. Note that:  $\Delta^{HC} - \Delta^{CC} = \beta[\delta_b - (1 - \beta)\mu_f]$ .

**Proposition 1:** (i) *If either  $\delta_b > \mu_f$ , or,  $\delta_b < \mu_f$  and  $\beta$  is on  $\left(1 - \frac{\delta_b}{\mu_f}, 1\right]$ , then the holding company has more incentives than the independently owned cable company to upgrade the *CN*. (ii) *If  $\delta_b < \mu_f$  and  $\beta$  is on  $\left(0, 1 - \frac{\delta_b}{\mu_f}\right)$ , then the independently owned cable company has more incentives than the holding company to upgrade the *CN*. ■**

As referred to above, the investment in the upgrade of the cable network generates four effects. Two of the effects are common to both the holding company and the independently owned cable company. Both firms will benefit from consumers valuing the bundle and also from economies of scope. In addition, the holding company will benefit from coordination economies with respect to the bundle and the independently owned cable company will benefit from stealing business from the telecommunications company. The balance between the latter effects determines which type of firm has more incentives to upgrade. In addition, the net effect is potentially ambiguous.

There are a three limit cases of interest. First, if all consumers have a high valuation for the bundle,  $\beta = 1$ , then the telecommunications company will have no captive consumers and will be prepared to price at marginal cost,  $l_f = c_f$ . This implies that the telecommunications company,

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<sup>34</sup>Our assumption that firms do not price discriminate plays a crucial role here. First note that it is unlikely that firms could identify the two types of consumers. However, if firms could set different prices for different types of consumers, the telecommunications company would be willing to lower its price for type 1 consumers until  $p_f = c_f$ . The cable company would then undercut this price, selling to all type 1 consumers at  $p_b = v_t + \theta^1 + c_f$ . The *Business Stealing effect* would then be zero as the telecommunications company makes no profit.

on average, has zero profits,  $\pi_f^d = (1 - \beta)\mu_f = 0$  and therefore the business stealing effect is null. Consequently, the holding company has more incentives than the independently owned cable company to upgrade the *CN*. Second, the profit margin for telephony services may be zero,  $\mu_f = 0$ , if either: **(i)**  $p_f$  is regulated, or **(ii)** the existence of an attractive outside option, such as mobile telephony, pushes  $v_f$  down. In either case, although the telecommunications company has captive consumers, the business stealing effect is again null and the holding company has more incentives than the independently owned cable company to upgrade the *CN*. Third, in the absence of coordination economies for the bundle,  $\delta_b = 0$ , the independently owned cable company has more incentives than the dually owned cable company to upgrade the *CN*.<sup>35</sup>

## 5.2 Ownership Structure and Price Levels

In this subsection, we argue that dual ownership of the two networks leads to higher equilibrium prices than separate ownership.

**Remark 4:** *If the CN is upgraded, then the prices of telephony services and the bundle are lower under separate ownership than under dual ownership.* ■

Remark 4 follows trivially from Remarks 2 and 3. The holding company should look out for the interests of both firms as a whole. This means behaving like a multiproduct monopolist and setting monopoly prices. Under separate ownership, the telecommunications company and the cable company compete for consumers that value the bundle. Consequently, the prices of telephony services and the bundle fall from their monopoly levels. Regardless of which ownership structure generates more incentives to upgrade the *CN*, separate ownership is important to promote competition in the local access.

This perspective of the behavior of a holding company could be criticized on the grounds that perfect coordination among legally separate, dually owned firms, may be hard to achieve. It is difficult to align perfectly the incentive schemes of the members of legally separate firms. Furthermore, price coordination among legally separated firms has to be done carefully, to avoid breaching competition law. However, casual empiricism suggests that some level of coordination

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<sup>35</sup>As a monopolist, the holding company could suffer from productive inefficiency, due to a slack in cost control. This means that it could have higher production costs than the independently owned cable company:  $\delta_b < 0$ ,  $\delta_t < 0$ . Alternatively, there could be a loss of coordination in operating two networks:  $\delta_b < 0$ . In either case, the holding company would have less incentives to upgrade the *CN* than the independently owned cable company.

among dually owned, legally separated firms is possible.<sup>36</sup> In addition, typically this level of coordination will be enough to ensure that these firms do not compete among themselves and enable them to promote their common interests. Simple joint profit maximization may be an exaggeration, but assuming independent profit maximization by the telecommunications and cable firms would be even more inappropriate. Joint profit maximization is a simple way of capturing the idea that some coordination within the holding company is possible.

## 6 Concluding Remarks

In this paper we discussed the role of cable television networks and their ownership structure in promoting competition in the local access market. We showed that there is no simple relationship between the ownership structure and the incentives to upgrade the cable television network. We also argued that separate ownership of the two networks is important to promote competition in local access. To make the results transparent, we conducted the analysis with a very simple model. In the remainder of this section, we discuss several generalizations of the model in section 3.

### 6.1 Other Reasons

In this subsection, we discuss four additional reasons that might increase or decrease the firms' incentives to upgrade the *CN*.

First, if the holding company has easier access to financing than the independently owned cable company, perhaps because it is a larger firm, or because it has been in the market for longer, then it could bear a lower cost for upgrading the *CN*. In this case, the holding company could have, trivially, a larger incentive to upgrade the *CN* than the independently owned cable company.

Second, the holding company owns two potentially competing local access networks. This may put the holding company under pressure from the sectorial regulator or the legislator, to sell one of the networks, possibly the cable network. If the risk that the holding company is forced to sell the cable network increases significantly once the *CN* is upgraded, then the holding company has no incentive to upgrade the *CN*, independently of other technological or strategic considerations.

Third, there is typically some regulatory asymmetry between the *PSTN* and the *CN*. The

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<sup>36</sup>See Parker and Roeller (1997) for evidence that cross-ownership affects the firms' pricing behavior.

*PSTN* is subject to the open network provision, whereas the *CN* is not. For instance, broadband access to the Internet through *DSL* is regulated, whereas broadband access to the Internet through *Cable Modem* is not.<sup>37</sup> Evading regulatory obligations could be a motive for the holding company to upgrade the cable network.

Fourth, there is evidence of consumer substitution from fixed to mobile telephony (Barros and Cadima (2000), Rodini et al. (2004)). In several countries, like Denmark, Portugal or Sweden, the penetration rate of fixed telephony has been falling, while the penetration rate of mobile telephony continues to rise. This implies that, potentially, there is a segment of consumers that do not buy telephony services from the incumbent telecommunications company, but buy subscription television services and might buy the bundle. The cable company will be a monopolist with respect to these consumers, independently of the ownership structure. However, in the absence of price discrimination, these consumers are more valuable to the holding company than to an independently owned cable company. The reason is that the holding company will be able to charge them monopoly prices, while the cable company has to take into account the fact that it faces competition with respect to type 1 consumers.

## 6.2 Mixed Bundling

Next, we discuss the implications of allowing the independently owned cable company to offer telephony services, both in a bundle and separately, i.e., to practice mixed bundling. We show that if mixed bundling is allowed, it is still true that either of the two ownership structures can generate the largest incentives to invest in upgrading the *CN*.

Assume that consumers view telephony services offered through the *PSTN* and *CN* as perfect substitutes. Denote by  $c_b^i + \gamma_{mb}$  the unit cost of producing subscription television and telephony services separately on the *CN*, where  $\gamma_{mb}$  on  $(0, \gamma)$  is a parameter that measures the diseconomies of producing these two services separately instead of in a bundle. We assume that the cost of producing the bundle is lower than the cost of producing the two services separately through the cable network and that the latter is lower than the cost of producing the two services through different networks:  $c_b^i < c_b^i + \gamma_{mb} < c_b^i + \gamma = c_f + c_t^i$ . Producing subscription television and telephony services separately on the same network involves *Economies of Scope*, but of smaller magnitude than those of producing both services in a bundle. This is a reasonable assumption given that, if both services are produced separately, there will be a duplication of some of the activities required to produce the services.<sup>38</sup> Denote by  $p_\phi$ , the price of fixed

<sup>37</sup>See Sidak et al. (2002) for a discussion of this particular asymmetry.

<sup>38</sup>We assume that when the *CN* is upgraded, the holding company uses both networks to supply type 2

telephony services provided through the *CN*.

The next Remark describes the new price equilibrium.

**Remark 5:** *In equilibrium, under separate ownership, if the CN was upgraded and there is mixed bundling, then the telecommunications and the cable companies charge: (i)  $p_f = c_f$ , (ii)  $p_t = v_t$ , (iii)  $p_b = c_f + v_t + \theta^1$  and (iv)  $p_\phi = c_f - \varepsilon$ , with  $\varepsilon \rightarrow 0^+$ . ■*

Using Remark 5, the equilibrium profits of the independently owned cable company if the *CN* was upgraded and there is mixed bundling, are:

$$\Pi_{mb}^d = \mu_t^i + \gamma + \beta\theta^1 - (1 - \beta)\gamma_{mb} - \varphi.$$

Practicing mixed bundling is more profitable for the independently owned cable company than selling telephony services only in the bundle if, and only if, the profits obtained from selling fixed telephony separately above marginal cost to type 2 consumers is larger than the *Business Stealing effect*:  $(1 - \beta)(\gamma - \gamma_{mb}) > (1 - \beta)\mu_f\beta$ .

With mixed bundling, the incremental profit of upgrading the *CN* for the independently owned cable company is:

$$\Delta^{CC} = \beta\theta^1 + \gamma - (1 - \beta)\gamma_{mb} - \varphi.$$

The expression of the incremental benefit differs in three respects relative to the expression of subsection 3.2. First, the *Business Stealing effect*,  $\beta(1 - \beta)\mu_f$ , vanishes because the telecommunications company now prices at marginal cost. Second, all type 2 consumers are supplied through the same network, which allows to extension to all consumers of the *Economies of Scope effect*,  $\gamma$ . Third, type 2 consumers that purchase separately subscription television and telephony services through the *CN* are supplied at a higher cost than type 1 consumers,  $(1 - \beta)\gamma_{mb}$ .

Recalling the value  $\Delta^{HC}$  from subsection 3.2, the difference in the incentives to upgrade the *CN* between the holding company and the independently owned cable company is:

$$\Delta^{HC} - \Delta^{CC} = \beta\delta_b - (1 - \beta)(\gamma - \gamma_{mb})$$

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consumers. This allows the holding company to exploit fully *Coordination Economies*, but at the expense of not exploiting fully *Economies of Scope*. In a previous version of this article we considered the possibility that after upgrading the *CN*, the holding company shut down at least part of the *PSTN* and used mainly the *CN* to provide both services, even to consumers that do not purchase the bundle. This allowed the holding company to exploit fully *Economies of Scope*, but at the expense of forgoing at least part of the *Coordination Economies*. Again, it was unclear which ownership structure generates the largest incentives to upgrade the *CN*.

The expression above can be positive or negative, depending on the relative strength of the *Coordination Economies effect*,  $\beta\delta_b$ , which benefits the holding company and the *Economies of Scope effect*,  $(1 - \beta)(\gamma - \gamma_{mb})$ , which benefits the independently owned cable company when selling telephony services separately to type 2 consumers. This implies that if mixed bundling is allowed, it is still true that either of the two ownership structures can generate the largest incentives to invest in upgrading the *CN*.

Finally, in the case mixed bundling is less profitable than only selling telephony services in the bundle, there is a prisoners' dilemma type of commitment problem. The independently owned cable company would like to commit itself not to sell telephony services separately, as this ultimately decreases its profits. However, it may not be able to credibly commit to do so. If the telecommunications company sets a price above marginal cost, it is profitable for the cable company to undercut it and sell fixed telephony to type 2 consumers. Circumstances like product differentiation or the existence of residential and non-residential consumer segments, which we ignored, would give additional incentives to the independently owned cable company to offer cable telephony outside the bundle.

### 6.3 Heterogeneous Type 1 Consumers

Next we discuss the implications of allowing type 1 consumers to be heterogeneous with respect to their valuation of the bundle,  $\theta^1$ . The main consequence of this modification is that all price equilibria are in pure strategies. Consider the model of section 3, except that the valuation of the bundle of type 1 consumers,  $\theta^1$ , is uniformly distributed on  $[0, \Theta]$ , with  $0 < \Theta < +\infty$ .

Now the cable company faces a downward sloping demand curve for the bundle. As a consequence, in Remark 2 the cable company charges a price lower than the consumers' larger valuation of the bundle,  $v_f + v_t + \Theta$ , which implies that consumer surplus will be positive. Besides, when the *CN* is upgraded under separate ownership the price equilibrium is in pure strategies. Otherwise, this article's results continue to hold qualitatively. In particular, a version of Proposition 1 and Remark 4 continue to hold. Note, however, that the model with heterogeneous type 1 consumers involves a considerable expository cost, because the price best response functions are kinked. See Brito and Pereira (2004) for the details.

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# A Appendix

In the appendix we prove the results in the main text. The proofs of Remarks 1, 2, 4, and 5 are obvious, and therefore omitted.

**Remark 3:** Denote by  $G_i(\cdot)$  the cumulative distribution of the prices charged for product  $i$ . Ignoring ties, the expected profit of the telecommunications company when it charges  $p_f \leq v_f$  is:

$$\pi_f^d(p) = (p - c_f)\{1 - \beta + \beta[1 - G_b(p + p_t + \theta^1)]\}.$$

Similarly, the expected profit of the cable company with respect to the bundle when it charges  $p_b \leq v_b^1$  is:

$$\pi_b^d(p) = (p - c_b^i)\beta[1 - G_f(p - p_t - \theta^1)].$$

Equating for the two firms the expressions of the expected profits,  $\pi_j^d(\cdot)$ , to the expressions of the equilibrium expected profits,  $\underline{\pi}_j^d$ ,  $j = f, b$ , the equilibrium price distributions can be characterized as follows:

$$G_b(p) = \begin{cases} 0 & \text{if } p < l_f + \theta^1 + v_t, \\ 1 - \left(\frac{1 - \beta}{\beta}\right) \left(\frac{v_b^1 - p}{p - v_t - \theta^1 - c_f}\right) & \text{if } l_f + \theta^1 + v_t \leq p < v_b^1, \\ 1 & \text{if } v_b^1 \leq p. \end{cases}$$

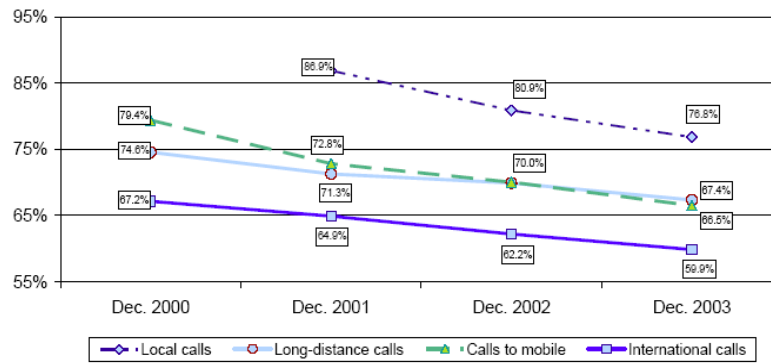
$$G_f(p) = \begin{cases} 0 & \text{if } p < l_f, \\ 1 - \frac{(\theta^1 + \gamma) + (1 - \beta)\mu_f + \mu_t^i}{p + v_t + \theta^1 - c_b^i} & \text{if } l_f \leq p < v_f, \\ 1 & \text{if } v_f \leq p. \end{cases}$$

■

**Proposition 1:** (i) A given ownership structure provides more incentives than the alternative ownership structure, if and only if, it generates an incremental profit for upgrading the CN no smaller than the alternative ownership structure. Therefore, the holding company has more incentives than the independently owned cable company to upgrade the CN if and only if  $\Delta^{HC} - \Delta^{CC} = \beta[\delta_b - (1 - \beta)\mu_f] \geq 0$ . As  $0 < \beta \leq 1$ ,  $\Delta^{HC} - \Delta^{CC} \geq 0 \Leftrightarrow \delta_b \geq (1 - \beta)\mu_f$ .

Note that  $\delta_b \geq \mu_f$  implies that  $\delta_b \geq (1 - \beta)\mu_f$ . Also, if  $\beta$  is on  $\left(1 - \frac{\delta_b}{\mu_f}, 1\right]$ , then  $(1 - \beta)\mu_f$  is on  $(0, \delta_b]$  meaning that  $(1 - \beta)\mu_f \leq \delta_b$ . (ii) Equally obvious. ■

## B Figures



EU15 Incumbents' Revenue Market Share on Voice Telephony (Source: European Telecoms Regulation and Markets, 2004)

	<b>Fixed Access</b>	<b>Homes Passed</b>
<b>Austria</b>	<i>48,8</i>	<i>53</i>
<b>Belgium</b>	<i>50,1</i>	<i>100</i>
<b>Denmark</b>	<i>71,5</i>	<i>70</i>
<b>Finland</b>	<i>67,0</i>	<i>63</i>
<b>France</b>	<i>67,6</i>	<i>32</i>
<b>Germany</b>	<i>63,5</i>	<i>86</i>
<b>Ireland</b>	<i>48,5</i>	<i>50</i>
<b>Luxembourg</b>	<i>78,6</i>	<i>100</i>
<b>Netherlands</b>	<i>64,7</i>	<i>94</i>
<b>Portugal</b>	<i>43,5</i>	<i>47</i>
<b>Sweden</b>	<i>75,5</i>	<i>65</i>
<b>UK</b>	<i>58,9</i>	<i>51</i>

Source: OECD (2003).

Table 1: Fixed Access Lines and Homes Passed in the EU per 100 Inhabitants

## C Tables

	<b>Fixed Telephony</b>	<b>Cable</b>	<b>Bundle</b>
<b>Independent Cable</b>	–	$c_t^i$	$c_b^i = c_f + c_t^i - \gamma$
<b>Holding</b>	$c_f$	$c_t^h = c_t^i - \delta_t$	$c_b^h = c_f + c_t^i - \gamma - \delta_t - \delta_b$

Table 2: Unit Costs under both Ownership Structures