FUNCTIONAL SEPARATION AND ECONOMIES OF VERTICAL INTEGRATION IN EUROPEAN FIXED TELECOMS

Clementina Bruno

Working Paper n. 03/2012

© HERMES
Fondazione Collegio Carlo Alberto
Via Real Collegio, 30
10024 - Moncalieri (TO)
Tel: +39 011 6705000
      +390321375414

info@hermesricerche.it

http://www.hermesricerche.it

FUNCTIONAL SEPARATION AND ECONOMIES OF VERTICAL INTEGRATION IN EUROPEAN FIXED TELECOMS

Clementina Bruno,
HERMES Research Centre and Università del Piemonte Orientale, Italy
clementina.bruno@libero.it

Abstract
This work presents an empirical analysis of the economies of vertical integration in fixed telecommunications, which is an issue of large interest but rarely addressed from the empirical perspective. The dataset includes European incumbent firms and the analysis employs a method based on Data Envelopment Analysis. It allows to compute the economies of vertical integration by comparing, for each firm, the efficiency scores obtained with respect to the separated firms frontier with the efficiency scores computed with respect to the integrated firms frontier. The results show that diseconomies of vertical integration are relevant, providing an important argument in favor of separation policies. However, they reduce when the downstream output (retail lines) is split in narrow and broadband lines (i.e., by considering the quality of the downstream accesses), for firms more concentrated on broadband.

1 Introduction

During the last decades the telecom industry, as many other utilities, has been involved, in most developed and developing countries, in a privatization and liberalization process. In order to foster competition in sectors which have been operating as monopolies for a long time, many Governments and regulators have implemented unbundling (separation) policies of the incumbent firms, with the aim of separating the segment of the production chain that shows monopolistic features. Once separated from the rest of the company, the access to the bottleneck infrastructure (in general, the network) should be granted under equal conditions to the incumbent firm and to the competitors, improving (service-based) competition.

The "last mile" (the local access network), that the incumbent possesses and that the competitors need to access in order to provide their service to the final users, is what gives to the fixed telecom market monopolistic features, because it is difficult and costly to replicate. The separation of this segment is involved in a relevant debate: the European Union has considered functional separation as a solution to foster competition and grant equal and fair condition of access to the last mile to competitor firms, when mandatory access imposed on incumbents does not work effectively. Some member States have shown a positive attitude towards this opportunity (e.g. Ireland, Latvia, Poland), but the cases where functional separation has already been implemented are very limited (for a deep discussion, see Tropina et al., 2010 and Crandall et al., 2010).

UK has been the first country moving in this direction. In 2005, the negotiation between the regulator and the incumbent, British Telecom (BT), leaded to the creation of a separate BT business unit, Openreach, in charge of operating the local access network and of providing the related wholesale services either to the BT retail branch and to competitors.

Italy moved the first steps towards separation in 2002, when AGCOM, the regulator, directed Telecom Italia (TI) towards the creation of distinct retail and wholesale business units. However, the most significant change occurred in 2008, when, the powers of AGCOM were expanded: the Italian legislation conferred the regulator the power to impose functional separation. TI, then, created a separated unit, OpenAccess, following the line of Openreach[1]. At the end of 2008, AGCOM approved the measure.

Moreover, 2008 has been a crucial year also for the Swedish telecom market. The regulator, PTS, received from the Parliament the power to impose separation on the incumbent TeliaSonera. Even before the law was approved, TeliaSonera implemented functional separation by creating a wholly owned subsidiary, TeliaSonera Skanova Access, that provides access to the incumbent's network both to the competitors and to the downstream branch of the parent company.

Strong and broadly accepted theoretical reasons support functional separation as a mean to foster competition; however (and, again, in theory), such a solution could in principle generate important drawbacks, in terms of reduced incentives to investment and innovation, and in term of losses of (vertical) economies of scope. Whether or not the competition benefits offset the efficiency losses is mainly an empirical question, whose answer requires to quantify both the gains and the costs. The aim of this work is to provide a contribution with respect to the costs side:

Q: Is functional separation in fixed telecoms costly in terms of losses of economies of vertical integration?

To answer this question, a non-parametric DEA-based methodology will be applied over a sample of 14 European operators, with data over the period 2005-2010. The dataset contains cost and operational information on integrated and functionally separated firms. Two model specifications will be tested: a basic model that simply distinguishes wholesale and retail activities, and an improved model accounting for different quality of access (narrow band and broadband) provided to the final users.

The rest of the paper is organized as follows. The next section introduces the competition issues in fixed telecommunications and clarifies the *pros* and *cons* of functional separation; moreover it provides a definition of economies of vertical integration and reviews some empirical contributions addressing the problem of economies of scope in telecommunications; section 3 presents the methodology; section 4 illustrates the dataset and the variables employed in the two model specifications; section 5 discusses the results, while section 6 draws some conclusions.

---

[1] However Open Access deals directly only with TI retail division, not with the competitors, that must ask for services the wholesale division. This one and other transparency issues are discussed in Nucciarelli and Sadowsky, 2010.

2 Background
2.1 Telecommunications and competition

As previously mentioned, the competition issue in fixed telecommunications is related to the presence of a downstream segment (retail, involving the provision of services to the final users) which is, at least potentially, competitive, and of an upstream segment (wholesale, or more precisely, the access infrastructure, i.e. the so-called "last mile") which shows some monopolistic features.

As a first step, it is important to distinguish between two definitions of competition (see Tropina et al., 2010). It is *infrastructure based* when the competitors do not rely (at least, not relevantly) on the access infrastructure of the incumbent, because they possess their own one. It is the most powerful form of competition, but it requires long time to be implemented and strong investments on the side of the competing firms. Therefore, as a quicker solution, many Governments and regulators' efforts are directed to foster *service based* competition. In this case competitors use the incumbent firm's access network to provide their services. The level of required investment is reduced and the development of a competitive market is faster, but some drawbacks arise: for instance, the necessary regulatory effort is relevant, because the authority has to impose some forms of mandatory access (e.g. local loop unbundling, LLU) on the incumbent, in order to grant the competitors the possibility to access the last mile at fair conditions. On the regulator side, this is not a simple task: the incumbent has the incentive, and in general also the ability, to engage anticompetitive behaviors, basically in the form of price and non-price discrimination. The former consists in charging excessively high wholesale prices on competitors (thus rising their costs) or in applying predatory prices to its own retail customers, in order to drive new entrants out of the market. Many other non-price-based forms of discriminatory behavior are available for monopolists (for instance, a strategic variable in this sense is the quality of service offered to other firms); usually they are identified as non-price discrimination or sabotage.

Regulators have seen in some forms of business separation an effective way to deter and to detect such undesirable behaviors. To use the consolidate taxonomy suggested in Cave (2006), a first step is accounting separation, which requires just separate accounts for the separated branches, in order to allow the regulator to detect too high wholesale margins or too low retail profits (indicating excessive access prices applied to competitors or predatory prices in the downstream segment, respectively). If price discrimination can be effectively dealt with by implementing this solution, non-price discrimination remains an unsolved issue. More pervasive forms of separations seem necessary in this sense. Crew et al. (2004), develop a model referred to RBOCs (Regional Bell Operating Companies), firms controlling the access to local network in US. They demonstrate that the divestiture by RBOCs of their local network could be a highly powerful tool against sabotage and other monopoly issues. Moreover, it would constitute a welfare enhancing solution if economies of scope in the industry were not relevant.

The extreme option of ownership separation (the incumbent has to divest the bottleneck segment, which cannot belong to the same ownership as the rest of the firm) has been implemented in some countries for other network industry (e.g. electricity). However some authors do not consider it as a suitable option for telecoms (see Cave et al., 2006), for several reasons, among which is again highlighted the impossibility to exploit of economies of scope and coordination across the ownership boundary[2].

Functional separation is seen as an intermediate solution, effective against non-price discrimination and able to limit the disadvantages of more pervasive forms of break-up. It can itself be ranked in several degrees, ranging from the creation of a wholesale division to legal separation (separate entities under the same ownership). As discussed by Tropina et al. 2010, to provide a definition, separation occurs with respect to functions, employees and information.

In this framework, it is reasonable to question whether some of the disadvantages previously mentioned for ownership separation are likely to occur also implementing this softer option, perhaps in a weaker form. For instance, the impossibility to share production factor (which in principle could be common between stages) such as labor, or to transfer information relevant for coordination activities could produce inefficiencies in term of loss of economies of vertical integration. Moreover, the availability of the bottleneck assets for competitors at favorable conditions is, on one hand, useful to foster service-based competition; nevertheless,

---

[2] The authors highlight also the possibility of reducing the incentive to invest, the difficulty in establishing a clear and stable point of break-up, which is impossible to be moved in case of mistake, and the fact that (except the separation of AT&T), structural separation operations in telecoms have often failed.

on the other hand, it reduces the incentive of new entrants to invest in their own infrastructure, thus delaying the implementation of infrastructure-based competition, broadly recognized as superior.

It emerges that it is relevant, from a regulatory perspective, to identify the potential *pros* and *cons* of a break-up policy, even if implemented in a "soft" form such as functional separation. Moreover, it is relevant to understand the magnitude of gains and costs, which must be correctly balanced. The aim of this work is to evaluate the costs, if any, in term of losses in economies of vertical integration, of the implementation of functional separation in European Countries. If such economies did not exist or were not relevant, this would constitute an argument in favor to functional separation, as this solution would benefit consumers through improved competition (which is likely to induce lower prices), without hurting them with efficiency losses in the production of the service, which ultimately would impact negatively by raising the final tariff. If such economies were relevant, instead, they would represent a relevant cost of a separation policy, which should be implemented only if the gains in term of competition were large enough to offset those efficiency losses.

2.2 Economies of vertical integration and the telecom industry

The economies of vertical integration (EVI, henceforth) can be though as a special case of economies of scope. Following Baumol, Panzar and Willig (1982), economies of scope are said to exist if the joint production of several outputs is cheaper than the production of the same outputs by means of separated specialized firms. The measure, in the case of two distinct vertical stages (and two outputs), can be expressed as

$$EVI = \frac{C(y_u, 0) + C(0, \, y_d) - C(y_u, y_d)}{C(y_u, y_d)}$$

Where y_u indicates the output of the upstream stage, y_d indicates the output of the downstream stage and $C(.)$ represents the cost of producing a certain output vector.

$EVI > 0$ indicates economies of vertical integration, $EVI < 0$ indicates diseconomies.

EVI in fixed telecom is not largely investigated in empirical works. In particular, to the best of our knowledge, this is the first attempt to address the question of the existence of EVI in EU incumbent operator after the implementation of separation policies.

Even if the issue of vertical economies between the wholesale and retail segments is, in general, not explicitly investigated in the empirical literature on economies of scope in telecoms, there exist some interesting contributions assessing the synergies between local and long distance (toll) services, which reflect, in principle, a similar vertical relationship. In fact, the long distance provider need to access the local network, which usually belong to the local operators. These works are mainly developed with reference to the US market in the context of the debate concerning the break-up of AT&T. Therefore, they rely on quite old dataset; moreover, the findings are controversial.

For instance, Evans and Heckman (1984) suggest a local test for natural monopoly based on the estimation of a translog cost function. The estimated parameters are used to compute the predicted value of cost for joint production of local and toll services and predicted value for disaggregated production, evaluated for different output mixes. The results show that the cost function is not subadditive, providing evidence against joint service provision.

A similar methodology is employed by Shin and Ying (1992), considering three outputs: number of access lines, local calls and toll calls. Also in this case, the evidence supports superadditivity of cost in most of the analyzed possibilities.

On the other hand, several studies provide evidence in favor of integration. For instance, Röller (1990) finds important economies of scope and cost complementarities between local and toll services by testing two models (with aggregated toll services or with a distinction in intra/interLATA), using quadratic specifications of the cost function.

Charnes et al. (1988) as well find important efficiency gains coming from joint production with respect to multi-firm production, by employing a goal programming /constrained regression model (basically a parametric frontier model) in order to test for the presence of natural monopoly features in the Bell System.

Banker et al. (1998) estimate a multiple linear equations model, where the dependent variables (different cost categories) are regressed on the same set of explanatory variables, that includes some indicators of joint

production (scope): scope lines (business, residential, public), scope calls (local or toll) and scope geography (single or multi-state). The results show a negative impact of joint production on almost all cost categories, thus including "scope calls", even if only the effect of the indicator "scope lines" is statistically significant.

Gabel and Kennet (1994) employ cost data generated by means of an optimization model to compute economies of scope between switched and non-switched (private line) service, either local and toll. They find the economies of scope between switched and non-switched services to decrease with costumers density, while stable and strong economies of scope are shown to exist between local and long-distance services within the switched branch.

Moreover, to mention some non-US based contribution, it is important to recall Fuss and Waverman's (1981) work, using data related to Canadian operators. They estimate a translog cost function and find no significant cost complementarities among the three considered outputs: local services, message toll (long distance) services and other (competitive) services. However, the signs of the computed (non-significant) values suggest the presence of complementarities between local and toll services.

Finally, evidence in favor of scope economies is provided by Bloch et al. (2001). The authors use a composite cost function estimated on Telstra (the Australian incumbent) data, from 1926 to 1991. They find that the economies of scope hypothesis hold between local and long distance calls.

As it emerges from the analysis of previous studies, there is not consistent evidence of the existence of economies of scope in fixed telecom: the results are quite controversial and sensitive to the methodology employed. Moreover, as mentioned above, the analyses rely on old datasets, while the rapid evolvement of the technology would suggest that the findings could change by employing more recent data.

3 Methodology.

In this work we employ a non-parametric method to compute EVI. It is based on Data Envelopment Analysis (DEA) and employs a two stages procedure, which will be illustrated below. The use of DEA methods to estimate economies of scope has been introduced by Färe (1986). Later, similar approaches have been used, among the others, by Arocena (2008), for electricity; Ferrier et al. (1993), for banking; Prior (1996), Fried et al. (1998), Prior and Solá (2000), Kittelsen and Magnussen (2003), concerning hospitals; Grosskopf and Yaisawarng (1990), on local public services; Kwon and Yun (2003), on cogeneration; Cummins et al. (2003), on insurance; Growitsch and Wetzel (2007), on railways.

The basic idea is to construct two different frontiers: one for integrated firms, providing both the upstream and the downstream outputs, while a second frontier is constructed for "specialized firms". In many of the above mentioned contributions, the specialized firms (providing only one of the considered outputs) are combined, i.e. summed, in order to create virtual "additive" units producing output vectors similar to those ones produced by the integrated firms; in doing so, the technology defined by summing the specialized firms does not reflect joint production; rather, it conserves the productivity characteristics of the specialized production technologies.

Let us analyze the procedure. First of all, the N units are divided in two groups: the group I of integrated (not separated) firms, and the group S of "combined" separated firms. Moreover we have:

c_n = input (cost) of firm n, $n = 1, \dots, N$
Y_n = output (vector) of firm n
$J, H = (S, I)$

Stage 1. For each firm n, we need to get the efficiency score computed with respect to its own frontier, which can be defined as:

$$E_n^j = E_n\left(c_n^J, Y_n^J\right) = Min\ \{E_n|\ (E_n c_n,\ Y_n)\epsilon\ T^J\}$$

This is computed by means of a standard DEA program, and we expect to get $E_n^J \leq 1$.

Stage 2. For each firm n, we need also the cross-frontier efficiency score, i.e. the efficiency score each firm gets when compared to the frontier constructed with respect to the firms belonging to the other group:

$$E_n^h = E_n\left(c_n^J, Y_n^J\right) = Min\{E_n|\ (E_n c_n,\ Y_n)\epsilon\ T^H\}, \qquad H \neq J$$

This is computed by solving a super-efficiency DEA program. It allows to exclude from the frontier the unit under evaluation, i.e. the firm receives an efficiency score but does not contribute to define the shape of the production possibility set. For this reason, in this stage E_n^h is not constrained to be smaller or equal to one.

After the second stage each firms possess two efficiency score: E_n^S, computed with respect to the separated firms frontier, and E_n^I, computed with respect to the integrated firms frontier. These values allow to compute the EVI.

Starting from the definition of economies of vertical integration presented in section 2.2, and following Arocena (2008), we will get, for each one of the considered units:

$$\text{EVI} = \frac{C(y_u,0)+C(0,y_d)-C(y_u,y_d)}{C(y_u,y_d)} = \frac{E_n^S * c_n - E_n^I * c_n}{E_n^I * c_n} = \frac{E_n^S}{E_n^I} - 1. \qquad (1)$$

Where the term "$E_n^S * c_n$" represents the observed cost projected on the frontier, as it is multiplied by the efficiency score, considering the "separated" technology, while the term "$E_n^I * c_n$" represents the efficient cost of producing the same output vector by means of the "integrated" technology.

Clearly, if the (efficient) joint production is cheaper than the (efficient) separated production, economies of vertical integration occur (EVI>0). Diseconomies would result in the opposite case.

Such approach presents some relevant advantages:
- it is implemented in a non-parametric (DEA) framework, which has the desirable features of not imposing any pre-specified functional form and of being suitable for small dataset, which is actually our case.
- It employs a frontier technique, therefore no cost-minimizing behavior is assumed *a priori*; rather, the existence of inefficiency is allowed for. Following Grosskopf et al. (1992), this is an interesting feature, because it allows to compute economies and diseconomies of integration on the "pure" technology, "cleaned" from the inefficiency effect that could distort the results.
- Two separated frontiers are constructed for integrated and separated firms; in this way we do not assume that the two groups operate under the same technology; rather, the existence of two different production possibility sets is allowed for.

In Figure 1 a two inputs (x1 and x2) case is represented. It is relevant to point out that this is not the case of the two models proposed in this work. Anyway, such a representation is helpful to better understand the methodology.

The two isoquants represent all the efficient combinations of inputs allowing to produce a given level of output by means of a joint (I) or of a separate (S) production technology, respectively. Let us assume that firm A is a functionally (vertically) separated firm operating with some degree of inefficiency, as the input consumption is higher than the efficient one, represented in the point C, that lies on the (separated) frontier isoquant. The efficiency score of firm A would be $E_A^S = \frac{OC}{OA}$, which express the maximal proportional contraction that can be applied to the input and still allows to produce the given output.

If we compute E_A^I, the efficiency score of firm A with respect to the frontier I, i.e. $\frac{OB}{OA}$, we would get an higher ratio, because the segment OB is longer than the segment OC. In other words, we will have $E_A^I > E_A^S$.

This is so because the integrated production technology (bounded by the frontier I) is "internal" to the separated one, in the sense that some of the production combinations allowed by the technology S are not feasible in I. This is evident by looking at the relative position of the two frontier: S requires, for a given level of output, an always lower quantity of x1 or x2, or of both the factors. This means that it is more efficient to produce using technology S rather than technology I; in other words, diseconomies of vertical integration occur.

In fact, if we compute the values of the EVI for firm A following (1), we will get

$$\text{EVI} = \frac{E^S}{E^I} - 1 = \frac{OC}{OA} / \frac{OB}{OA} - 1 < 0 \qquad \text{as OC < OB}$$

Clearly, no *a priori* assumption is made on the relative position of the two frontiers. The case depicted in figure 1 will always lead to infer the presence of diseconomies of vertical integration (negative EVI). It can also happen the position of I and S to be inverted: this is the case of vertical economies. Moreover it is possible that the two frontiers intersect each other, and we will find, over the sample, both economies and diseconomies.
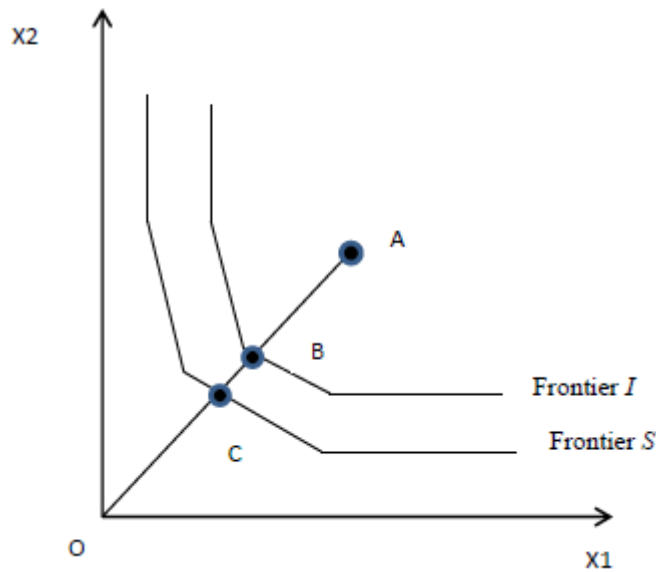

Figure 1

4 Data, variables and models.

The dataset is composed of observations over 14 European incumbent operators in fixed telecommunications and contains financial and operational information retrieved from the companies' annual reports. We have chosen to restrict the analysis to the incumbent firms because they are the companies involved in separation operations. Moreover, usually non-incumbent operators do not possess the access network, not producing the relative wholesale output; therefore their output vectors are not completely comparable with the incumbents' ones.

Most of these companies operate in both the fixed and the mobile markets, but we have chosen to focus on the fixed branch operations, because it is the market concerned with the separation issues illustrated above. Therefore we did not include in the sample the remaining 13 EU incumbent as they do not provide separate accounting (cost) information for the fixed segment. Moreover, for the included companies, such information is not available over the whole period. As a result, the sample contains a total of 62 observations.

The financial years from 2005 to 2010 are included. For each company, we collected the data starting from 2005 or 2006, i.e. from the year of the first application of the IFRS accounting standards. This should ensure higher longitudinal (among different financial periods) and cross-company comparability of the collected data. Moreover, we focus on the operation in the home country. The reason is that some of the companies in

the sample are controlled or participated by other ones which are as well included in the dataset, and which consolidate the former in the group accounts. The exclusion of the operations in foreign countries avoids the problem of attributing the same costs and outputs twice, to the controlled and to the controlling company.

The group of separated units is composed of three firms: Telecom Italia, British Telecom and TeliaSonera. In all these cases, the separated wholesale entities still belong to the parent company (division) or to its group (subsidiary). Therefore, the separated firms technology is estimated through units that produce both the upstream and the downstream output, but with the awareness that they operate under functional separation restrictions. In relation to this point, this work differs from other contributions employing similar methodologies: in most cases, the "separate" technology is estimated by means of "virtual" firms constructed combining (summing the data of) observations related to completely specialized independent units. In this work, instead, the separated units are real, rather than "virtual", firms. This fact could be considered an advantage, as here it make sense to estimate the EVI (as "potential" EVI lost as a consequence of functional separation) also over this segment of the sample.

The group of integrated units is composed by the observations related to the remaining firms (49 observation).

Table 1 contains a list of the firms included in the sample, with the indication of the country of origin.

Table 1 – Companies and countries

COMPANY	COUNTRY
Separated firms group:	
Telecom Italia	Italy
TeliaSonera	Sweden
British Telecom	UK
Integrate firms group:	
Telefónica	Spain
France Telecom	France
Deutsche Telekom	Germany
OTE	Greece
TEO	Lithuania
Belgacom	Belgium
Eirecom	Ireland
Polish Telecom	Poland
Telekom Austria	Austria
Portugal Telecom	Portugal
KPN	Netherlands

The methodology illustrated in the previous section is implemented in two slightly different models.

Model 1. It is a one input – two outputs model. The unique input is the total operational cost, composed as the sum of material and services expenditure, labor cost and depreciations. The cost is expressed in constant 2005 prices. Moreover, in order to correct for the difference in the prices level among the considered countries, the total value is converted using the Purchase Power Parity (provided by EUROSTAT). In principle, such a problem could be more effectively dealt with by using "physical", rather than monetary, measures of input (number of employees, network length, etc.); however the small dimension of the sample, especially in relation to the separated firms group, suggest to implement a model as parsimonious as possible; therefore the inputs have been condensed in a single variable. Moreover, the necessary information on physical production factors is not available for all the companies, therefore the choice of including such variables would have caused a further reduction in the number of observations. Finally, reasoning in term of "cost" is consistent with the traditional definition of economies of scope.

The two outputs must reflect the upstream and the downstream operations. The most relevant indicator available for all the firms is the number of access lines. Therefore the two considered output measures are:
- The total number of wholesale accesses (provided to other operators by means of local loop unbundling, wholesale line rental, etc.)
- The total number of retail accesses provided to the final customers.

As in Arocena (2008), the observations are pooled, i.e. each observation is treated as an independent unit in order to construct an inter-temporal best practice frontier, as explained in Tulkens and Vanden Eeckaut (1995). This procedure also allows to operate with a sufficient number of observations.

The DEA programs are run under the CRS assumption. This assumption ensure that, once an inefficient unit is projected on the frontier, we have net out all the possible sources of inefficiency, namely technical and scale inefficiency, thus we are able to detect pure scope effects. Moreover, it allows to avoid problems in dealing with the super-efficiency estimates, as the super-efficiency program could in some cases have no solution if VRS were assumed.

Model 2 follows almost entirely model 1, except for the fact that the retail output is split in narrow band and broadband accesses. The underlying idea is that not all the retail lines present the same quality in terms of customer utility. Moreover, telecom companies receive pressure from the regulatory side to increase the penetration of the broadband. Finally, it is likely that the higher quality of the broadband output is reflected in higher resource consumption. Summing up, the variables appearing in model 2 are:
- total cost, as defined in model 1, as input;
- total wholesale accesses (which in principle could as well be divided in narrow and broadband; unfortunately, the information is not available for all the firms. Moreover, the number of observations is not sufficient to deal with one more dimension);
- "low-quality" retail accesses: narrow band lines provided to the final customers (e.g. traditional PSTN lines)
- "high-quality" retail accesses: broadband lines provided to final customers (e.g. DSL lines).

The two proposed models are very similar, anyway it is interesting to undertake both the approaches in order to understand whether or not accounting for qualitative difference in the provided services has an impact on the final results.

Table 2 provides some descriptive statistics of the variables. It emerges a relevant variability that depends mainly on the different size of the analyzed firms.

Table 2. Descriptive statistics

	Mean	St.Dev.	Min.	Max.
Tot. cost (euro millions)	6335	5971	250	20340
Wholesale accesses (thousands)	3646	4560	35	16221
Retail accesses (thousands)	14132	13203	689	44800
Broadband retail accesses (thousands)	3149	3079	102	12100
Narrowband retail accesses (thousands)	10983	10398	477	37900

5 Results

From the application of the described methodology, it is possible to get, as an "intermediate" result, the efficiency scores of the observed units. As table 3 shows, on average, the efficiency scores are slightly higher for the separated firms group in both the models. As we are analyzing the efficiency measures computed, for each unit (observation), with respect to its own frontier, we still cannot say whether the firms in group *S* are more efficient than firms in group *I*. This result just means that, on average, the separated units lie closer to the frontier, while the integrated ones are more dispersed.

Table 3. Average efficiency scores and average by year.

	MODEL 1		MODEL 2	
	Separated	Integrated	Separated	Integrated
mean	80,06	75,94	85,11	81,23
2005	-	69,40	-	77,17
2006	63,85	70,54	66,40	74,77
2007	69,78	71,19	73,80	75,03
2008	77,99	78,63	83,88	84,10
2009	86,07	79,11	91,82	85,52
2010	93,79	87,27	99,64	90,80

Moreover, dealing with observations related to different years allows to highlight a trend: the efficiency scores are, on average, increasing over the considered time period. The tendency is confirmed either by model 1 and model 2 (except for year 2005 in model 2, in relation to group *I*) and suggests the presence of a technological improvement, which seems to be faster and more evident for group *S*. By examining the individual efficiency scores, not reported in the table[3], it emerges that this trend holds for all the separated firms, while the integrated ones do not show such a clear tendency.

Let us turn to the examination of the estimated economies of vertical integration, summarized in table 4 (the EVI are reported for each firm as average over the available period).

Table 4. Average EVI by firm

FIRMS	EVI M1	EVI M2
Separated firms		
Telecom Italia	-0,27	-0,20
TeliaSonera	-0,28	-0,28
British Telecom	-0,47	-0,45
Integrated firms		
Telefonica	-0,19	-0,17
France Telecom	-0,26	-0,25
Deutsche Telecom	-0,24	-0,20
OTE	-0,24	-0,25
TEO	-0,19	-0,05
Belgacom	-0,19	-0,21
Eirecom	-0,29	-0,25
Polish Telecom	-0,20	-0,18
Telekom Austria	-0,19	-0,10
Portugal Telecom	-0,19	-0,21
KPN	-0,36	-0,35
mean	-0,25	-0,21

Quite surprisingly, at least from a theoretical perspective, negative EVI (diseconomies) result from both the models and present, on average, relevant values (more than 20%). This result should be interpreted, for integrated firms, as an higher cost sustained because of joint provision of wholesale and retail services; for

---

[3] Available upon request

the *S* group, instead, the EVI indicator expresses the savings firms achieve by operating under functional separation. Putting it differently, separated firms are able to produce more efficiently. It is relevant to point out that these losses and savings do not apply to the observed cost level of the firms: it is the effect that vertical integration or disintegration would induce on the units if they operated efficiently, i.e. on the frontier.

The EVI indicators estimated by means of model 1 are quite stable (20-30%), with the exception of British Telecom that presents higher values. The stability is maintained also when we consider the value of the indicator computed for single observations (not reported in the table).

By looking at the results of model 2, it emerges an higher variability in the EVI indicator, which is on average lower in terms of absolute value; in other words, diseconomies of integration still prevail, but they are smaller and less stable across firms. Only two companies, Belgacom and Portugal Telecom, present higher diseconomies[4]. Paying attention to the composition of the output, it emerges that the increase in the EVI indicator across models is higher the more the firms are concentrated on the broadband service: the correlation coefficient between the increase in EVI across models and the percentage of broadband access provided is about 80%, meaning that when the broadband output becomes more important, the two frontiers get closer. Basically, it appears that on average separated firms operate by far more efficiently than the integrated ones, but they become relatively less good once more advanced services must be supplied.

Summing up, from the empirical analysis, the following points emerge:

1) Separated firms increase their efficiency level over time more (and more quickly) than integrated firm do.

2) Separated firms are able to operate more efficiently than integrated ones: by comparing the two frontiers, it emerges that the separated production technology is superior over the whole sample in model 1, and over most of the sample in model 2. This suggests that the technology does not present synergies of joint production, rather, separating wholesale and retail branches seems to induce efficiency gains. However, the superior efficiency of the separated technology can have other sources than "pure" economies of vertical integration. For instance, it is possible that the *S* group companies, in implementing functional separation, have also re-organized their way to operate, by solving congestion problems or eliminating other latent sources of inefficiency; this could easily be the case since these incumbent firms have enjoyed some degrees of discretion in the re-organization process.

   Finally, it is possible that the implementation of functional separation, by encouraging new entries, or, at least, by generating the expectation of new entries in the future, provides an incentive to the incumbent firms to improve their performance: higher competitive pressure (or, at least, a threat in this sense) often leads the firms in the market to operate more carefully on the cost side.

3) The magnitude of diseconomies decreases when, on the output side, a distinction is made between narrow and broadband accesses, and firms concentrate more on the latter service. This fact suggests that, although separation remains, at least on average, the most efficient way to operate, when advanced services such as broadband assume more weight in terms of output mix, the separated firms loose part of their relative advantage. A possible explanation is that the provision of advanced services (and, probably, this is especially the case in the starting phases) requires to share production factors and, perhaps more relevantly, information flows across vertically related stage. When "Chinese walls" are built between subsequent segments, this task becomes harder, generating efficiency reductions.

The general idea emerging from the analysis strongly support functional separation policies: not only they foster competition, but they also induce improvements, rather than losses, in terms of economies of scope. Clearly, this analysis does not consider another major possible drawback of separation, namely the possibility that new entrants delay investments on their own network and thus the implementation of infrastructure based competition. Anyway, if the efficiency gains coming from separation actually depended only on the presence of "pure" diseconomies of scope characterizing the technology, the interest in providing incentive for new entrants to undertake such investments would be questionable. In fact, it would lead to a

---

[4] By looking to the EVI value for single observations, the variability is even higher, with a few cases (4 observation) where the sign changes (small economies: around 2%).

market composed of many vertically integrated operators, whose performance would suffer of inefficiencies due to negative EVI. Rather, it could be the case to consider the opportunity to further foster service-based competition and to promote separation as a best practice solution.

6 Conclusions

Functional separation in fixed telecommunication is now involved in a relevant academic and non-academic debate. The aim of implementing such a policy is to foster service-based competition, which would ultimately benefit consumers through lower prices. However, some potential drawbacks have been pointed out: a major one is related to the possible losses in production efficiency due to the inability to exploit economies of scope. This work is aimed to check whether the implementation of functional separation in some European Countries has been costly in terms of economies of vertical integration.

The empirical analysis is performed by means of a DEA-based methodology allowing to estimate the value of EVI by computing and comparing, for each firm, two efficiency scores, evaluated with respect to the separated and to the integrated technology frontiers, respectively.

Two models have been implemented: a basic model that simply distinguishes wholesale and retail outputs, and an improved model that considers different quality levels in the downstream output, treating narrow band and broadband accesses as distinct variables.

The findings show that separation is not costly from an efficiency perspective; rather, diseconomies of vertical integration emerge from both the models (more that 20%, on average). This fact can be related to the technological features characterizing the industry (we would have detected "pure" diseconomies), but can also depend on other reasons. For instance, the companies, in implementing functional separation, could have undertaken a sort of organizational restructuring helpful in improving performance by eliminating latent inefficiency sources, not necessarily related to the vertical structure of the firm. Moreover, it is likely that the increased competitive pressure following separation (or the incumbents' expectations in this sense) acts as an incentive leading to improve the efficiency level.

Whatever the cause ("pure" vertical diseconomies, re-organization, competitive pressure, or a mix of these factors), it emerges that separation positively affects incumbent performance, sustaining the arguments in favor of the implementation of such a policy choice.

However, if model 1 is completely consistent with these results, model 2 presents more variability in the estimated EVI indicators. The level of diseconomies is (on average) lower than in model 1, and the difference is more evident for the units more concentrated on the provision of the broadband output. This means that, although on average separate production is superior, its relative advantage is reduced when firms focus on more advanced services. It could be related to the fact that the provision (or, at least, the implementation) of advanced services requires production factors or, more likely, information to flow freely across subsequent operational stages; separation limits these possibilities of "circulation", and this fact could act reducing the separation advantages. Therefore, if increasing broadband penetration is a regulatory priority, than more caution should be taken in implementing separation policies.

However, it is worthwhile to point out that, from a policy perspective, our results should be taken cautiously, considering the limited dimension of the sample, especially in relation to the group of the separated firms. Moreover, no environmental factors have been included in the analysis: European incumbent firms operate in similar, but not identical, environments, and accounting for such factors could constitute an interesting development for future research.

REFERENCES

Arocena, P. (2008) "Cost and quality gains from diversification and vertical integration in the electricity industry: a DEA approach". *Energy economics*, 30, pp.39-58.

Banker, R.D., Chang, H.H., Majumdar, S.K. (1998). "Economies of scope in the U.S. telecommunications industry". *Information economics and policy,* 10, pp.253-272.

Baumol, W.J., Panzar, J.C., Willig, R.D. (1982). "Contestable markets and the theory of industry structure". *Harcourt Brace Jovanovich,* New York.

Bloch, H., Madden, G., Savage, S.J. (2001). "Economies of scale and scope in Australian telecommunications". *Review of industrial organization*, 18, pp. 219-227.

Cave, M., Correa, L., Crocioni, P., (2006). "Regulating for non-price discrimination. The case of UK fixed telecoms". Online at:
http://web.si.umich.edu/tprc/papers/2006/526/non-price2.pdf

Cave, M. (2006). "Six degrees of separation. Operational separation as a remedy in European telecommunications regulation". *MPRA paper no. 3572.*
online at http://mpra.ub.uni-muenchen.de/3572/

Charnes, A., Cooper, W.W., Sueyoshi, T. (1988). "A goal programming/constrained regression review of the Bell system breakup". *Management Science,* vol. 34, n.1, pp. 1-26

Crandall, R.W., Eisenach, J.A., Litan, R.E. (2010). "Vertical separation of telecommunication networks: evidence from five countries". *Federal Communication law journal,* vol.62, n.3, pp. 493-539

Crew, M.A., Kleindorfer, P.R., Sumpter, J. (2004). "Bringing competition to telecommunications by divesting the RBOCs" in *Obtaining the best from regulation and competition*, Kluwer Academic Publishers, pp.21-40

Cummins, J.D., Weiss, M.A., Zi, H. (2003). "Economies of scope in financial services: A DEA bootstrapping Analysis of the US insurance industry". Available at http://irm.wharton.upenn.edu/F03-Cummins.pdf

Evans, D.S., Heckman, J.J. (1984). "A test for subadditivity of the cost function with an application to the Bell system". *The American economic review,* vol.74, no.4, pp. 615-623.

Evans, D.S., Heckman, J.J. (1986). "A test for subadditivity of the cost function with an application to the Bell system - erratum". *The American economic review,* vol.76, no.4, pp. 856-858.

Evans, D.S., Heckman, J.J. (1988). "Natural monopoly and the Bell system: response to Charnes, Cooper and Sueyoshi". *Management science,* vol.34, no.1, pp-27-38.

Färe, R. (1986). "Addition and efficiency". *Quarterly journal of economics,* 51, pp. 861-865.

Ferrier, G.D., Grosskopf, S., Hayes, K.J., Yaisawarng, S. (1993). "Economies of diversification in the banking industry". *Journal of monetary economics,* 31, pp. 229-249.

Fried, H.O., Schmidt, S.S., Yaisawarng, S. (1998). "Productive, scale and scope efficiencies in U.S. hospital-based nursing homes". *INFOR,* 36, 3. pp. 103-119.

Fuss, M., Waverman, L. (1981). "Regulation and the multiproduct firm: the case of telecommunications in Canada". In *Studies in public regulation,* ed. By G. Fromm, Cambridge: MIT Press, 277-313.

Gabel, D., Kennet, D. M. (1994). "Economies of scope in the local telephone exchange market". *Journal of regulatory economics,* 6, pp. 381-398.

Grosskopf, S., Yaisawarng, S. (1990). Economies of scope in the provision of local public services. *National tax journal,* 43, 1, pp. 61-74

Grosskopf, S., Hayes, K., Yaisawarng, S. (1992) "Measuring economies of diversification: a frontier approach". *Journal of business & economic statistics,* vol.10, n.4, pp. 453-459.

Growitsch, C., Wetzel, H. (2007) "Testing for economies of scope in European Railways: an efficiency analysis". *University of Luneburg, working paper series in economics,* n.72.

Kittelsen, S.AC., Magnussen, J. (2003). "Economies of scope in Norwegian hospital production – a DEA analysis". Available at:
http://www.med.uio.no/helsam/forskning/nettverk/hero/publikasjoner/skriftserie/2003/HERO2003_8.pdf

Kwon, O.S., Yun, W.C. (2003). "Measuring economies of scope for cogeneration systems in Korea, a non-parametric approach. *Energy economics,* 25, pp. 331-338

Penrose, E. (1959). "The theory of the growth of the firm". *Oxford: Basil Blackwell*

Prior, D. (1996). "Technical efficiency and scope economies in hospitals". *Applied economics*, 78, pp. 1295 - 1301

Prior, D., Solà M. (2000). "Technical efficiency and economies of diversification in health care". *Health care management science,* 3, pp. 299-307.

Röller, L.-H. (1990). "Proper quadratic cost functions with an application to the Bell System". *The review of economics and statistics,* vol. 72, no.2, pp. 202-210

Sappington, D.E.M. (2002). "Price regulation and incentives" in *Handbook of telecommunication economics (EdS)* M. Cave, S. Majumdar, and I. Vogelsang, North Holland, Amsterdam pp. 225-93.

Shin, R.T., Ying, J.S. (1992). "Unnatural monopolies in local telephone". *The RAND journal of economics,* vol. 23, no.2, pp. 171- 183

Tropina, T., Whalley, J., Curwen, P. (2010). " Functional separation within the European Union: debates and challenges". *Telematics and informatics, 27,* pp. 231-241.

Tulkens, H., Vanden Eeckaut, P. (1995). "Non-parametric efficiency, progress and regress   measures for panel data,methodological aspects". *European Journal of Operational Research*, 80, pp.474–499.