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## Benchmarking and effects of reforms in the fixed telecommunications industry: A DDF approach

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### ABSTRACT

Our article proposes an application of the Directional Distance Function (DDF) approach to the fixed telecommunication field. In particular, we present an efficiency evaluation of European fixed telecom operators, where the DDF tool allows for asymmetric treatment of outputs characterized by a different degree of desirability: broadband lines (a market still in expansion, related to a welfare-improving service) and narrow band lines (an almost saturated market, corresponding to a “minimal” TLC service in developed countries). Finally, by means of a second stage regression, we investigate the effect on technical efficiency of set of variables representing the competitive environment, the ownership structure and the degree of vertical separation. Our results show that the assumptions embedded in the DDF model influence relevantly the technical efficiency estimates, where important potential bias can arise if the duality of outputs is ignored, with a subsequent relevant impact also on the second stage results. These findings highlight the relevance of choosing benchmarking models consistent with the features of the analysed technology and show that the DDF approach is a flexible tool able to accommodate even complex output structures.

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## 1. Introduction

The telecommunication sector is an industry that has achieved a leading role in the economy during the last decades, due to its potential impact in terms of welfare and development. For instance, [Röller and Waverman \(2001\)](#) found evidence of significant positive effects of telecommunications development on the economic growth at national level. For this reason, one major focus of policy makers is to sustain and foster the service diffusion ([Symeou and Pollitt \(2014\)](#), provide a valuable policy evaluation which also accounts for inter-platform complementarity and substitution).

At the same time, policy makers and regulators are also concerned that the service is provided at sustainable and, possibly, optimal economic conditions for the final users. To this aim, the European fixed telecom (TLC) sector has been involved, during the last years, in major reforms, aimed at fostering competition, reducing market concentration and, ultimately, providing consumers a cheaper and more effective service.

Moreover, the intense technological progress in recent years fostered the supply of very advanced connection services, such as the broadband, which are now assuming a key role in the industry thanks to their wide potential expansion. At the

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same time, traditional connection services have to be supplied in order to guarantee the general access to TLC that is recognized, with some differences across countries, as minimal connection standard. Indeed, as underlined by [Grove and Baumann \(2012\)](#), the complexity and the interconnection between categories of services provided by TLC firms are rising and the potential coexistence of multiple lines of business, dramatically different in terms of technological characteristics, profitability and degree of market maturity, represents an important issue.

Given those preconditions, we decide to revisit the representation of the production process of fixed TLC firms in a way more representative of the real market situation as well as more consistent with firms' strategies. The starting point is the idea that a complete portfolio of TLC services has to be produced by each firm, but usually the operators prefer to focus their attention on "growing" products. Nevertheless, those services sometimes rely on the same infrastructure or platform than less advanced services, and the basic customer profile using low speed connections is a crucial starting point to promote broadband and high speed packages. Moreover, low profile connections correspond to a specific social service to be provided in order to guarantee all citizens' minimum communication needs, in many cases recognised by law or regulation. In fact, the European Directive 2002/22/EC ([European Parliament and Council, 2002](#)), on universal service and users' rights, explicitly stated that "A fundamental requirement of universal service is to provide users on request with a connection to the public telephone network at a fixed location, at an affordable price. The requirement is limited to a single narrowband network connection, the provision of which may be restricted by Member States to the end-user's primary location/residence [...] Connections to the public telephone network at a fixed location should be capable of supporting speech and data communications at rates sufficient for access to online services such as those provided via the public Internet". This legislative reference (in force over most of the period covered by our data) was later amended by the Directive 2009/136/EC ([European Parliament and Council, 2009](#)), which, although not directly referring to narrowband lines, restates the basic concepts already appeared in the former document, i.e. "The requirement is for the provision of local, national and international telephone calls, facsimile communications and data services" where "Data connections to the public communications network at a fixed location should be capable of supporting data communications at rates sufficient for access to online services such as those provided via the public Internet."

That situation creates a sort of internal dualism across business lines, within each TLC provider. On the one hand, high speed connections and broadband emerge as the most promising activities, characterised by an intense increasing demand. On the other hand, more traditional connection services represent the most static and mature part of the business, with very limited or null possibilities of business expansion.

The aim of this work is highlighting the influence of such internal dualism in comparing performances of TLC firms by adopting a non-parametric DEA model based on the concept of directional distance functions. This approach, able to discriminate among outputs with different degree of desirability, has been developed within the environmental literature in order to internalise "bad" outputs, such as pollution. Nevertheless, its applications have been successfully extended to different benchmarking frameworks where the outputs provided have different level of desirability, or in general when output quality issues have to be accounted for. Such considerations may be especially relevant from a policy perspective since frontier methods are often employed for regulatory purposes, mainly in the case of natural monopolies such as network industries. The application of more flexible models, able to account for quality differentials in outputs, can improve the accuracy and the power of the regulators' activity, or, at least, can allow more consistent benchmarking processes by considering particular technological features.

Moreover, in such frameworks, employing models able to better capture output differentials can be relevant when efficiency analysis is employed as a tool for evaluating particular policy reforms.

We believe that the fixed TLC sector can be a suitable candidate for an empirical application in this sense: not only the industry is characterized by two kinds of outputs of different quality, but we must also remember that the recent reforms that have characterised the industry raise interest on the evaluation of their effects on firm's performance.

In this vein, we propose a non-parametric application of DDF to European incumbent firms, operating in the fixed telecom industry, followed by a second stage analysis performed by using the most recent results in terms of bootstrapping theory, applied to non-radial distance functions. In fact, the adoption of truncated regression models to explain technical efficiency results from a DDF framework is a relatively new procedure, based on the results by [Simar, Vanhems, and Wilson \(2012\)](#). In particular, we analyse how some variables of interest, such as vertical separation, ownership and competition, influence performances, depending on the specific efficiency model adopted.

Our results show that the assumptions embedded in the DDF model influence relevantly the technical efficiency estimates and that important potential bias can arise if the duality of outputs is ignored, with a subsequent relevant impact on the second stage phase.

The remainder of the paper is organized as follows. [Section 2](#) illustrates the motivation of this work, provides a literature review and describes the theoretical model. [Section 3](#) presents the dataset used, while [Section 4](#) illustrates our results and, finally, some policy implications and general considerations conclude the work.

## 2. Motivation, theoretical background and model

### 2.1. Benchmarking with complex output structure: the case of fixed telecommunications

Frontier methods (either econometric, such as SFA – stochastic frontier analysis – or based on linear programming, such as DEA – data envelopment analysis) have shown, in the last decades, to be suitable for several purposes: from an *internal* or

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