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Dynamic performance analysis of U.S. wireline telecommunication companies

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ABSTRACT

Assessing the changes over time in the efficiency of firms participating in competitive markets has always been a major concern to researchers and experts alike. With respect to the US wireline telecommunications sector, recent changes in unbundling regulations, as well as intermodal competition and mergers, have just increased uncertainty in a sector still marked by the Telecommunications Act of 1996. Although Data Envelopment Analysis (DEA) has become a methodology commonly used in many efficiency assessment applications, in the telecommunications context there is a need to implement an approach that takes into account carry-over activities between consecutive years; because of a wide customer base, financial long-term planning and investments in network elements and facilities are crucial for Local Exchange Carriers (LECs) to succeed. To that end, a Dynamic DEA application is formulated in this paper to evaluate the Incumbent LECs' (ILECs) performance from 1997 to 2007. Finally, a regression analysis has been carried out to establish the impact of competition and regulatory schemes upon carriers' efficiency. The results show that local competition has worsened efficiency, whereas neither intermodal competition nor incentive regulation has such a clear influence.

1. Introduction

Many authors have pointed out that productivity efficiency can be considered as a key element for obtaining greater operating revenues and improved market position in competitive markets (Pentzaropoulos & Giokas, 2002; Tsai, Chen, & Tzeng, 2006). The telecommunications sector has been one of the most competitive industries since the liberalization of the market in 1996. Competitiveness requires operating efficiency. From among the different efficiency assessment methods, Data Envelopment Analysis (DEA) is the one that has been most commonly applied in a wide range of industries, due to its versatility.

DEA is a well-known non-parametric method that estimates the relative efficiency of similar Decision Making Units (DMUs) (see, for example, Cooper, Seiford, & Tone, 2006; Cooper, Seiford, & Zhu, 2011; Thanassoulis, 2001; Zhu, 2002). DEA evaluates the DMUs' observed inputs and outputs, in order to determine which DMUs make up the efficient frontier, and provides efficiency estimations for all units. Best-practices units are identified and become the reference sets for the

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less efficient DMUs. In the case of inefficient DMUs, DEA identifies the reduction in inputs or increase in outputs (with respect to the observed values) that these units have to carry out in order to reach the efficient frontier.

There are a number of DEA applications to the telecommunications sector in the literature. Thus, Lien and Peng (2001) examined the production efficiency of telecommunications in 24 OECD countries from 1980 to 1995, by applying DEA to every year separately. In their study, total revenue is chosen as the output measure and three inputs are considered, namely the number of telephone lines, the number of employees and the total amount of investment. With respect to the use of investment as an input, capital expenditure and total assets are included as alternatives. Pentzaropoulos and Giokas (2002) studied the situation of the European telecommunications market by comparing the DEA efficiency of the main European operators. One of their conclusions is that operational efficiency can be achieved by organizations with large and small revenues alike. Similar results were presented by Tsai et al. (2006) in their comparative analysis for global telecommunication companies. More recently, Sadjadi and Omrani (2010) estimated the efficiency of telecommunication companies in Iran by implementing a bootstrapped robust DEA model.

The statutory framework for the U.S. communications policy is based on the Telecommunications Act of 1996, and is aimed at opening the local and long distance telephone markets, which were previously being operated as monopolies, to competition, by removing barriers to entry for new incumbents. In other words, Competitive Local Exchange Carriers (CLECs) could gain access to unbundled network elements in order to provide telecommunication services. The influence of this deregulatory environment on the efficiency of Incumbent Local Exchange Carriers (ILECs) from 1988 to 2000 was investigated to some extent by Resende (2008) via DEA. Sastry (2009) also used DEA to study the links between these major changes in competition and the performance attributes of telecommunications providers, focusing on service quality.

There are a number of DEA models that have been developed to cope with changes in time. Thus, Charnes, Clark, Cooper, and Golany (1984) presented a Window-analysis (WA) approach that takes into account data from several years when assessing efficiency. This WA approach was used in Yang and Chang (2009) to measure telecommunication firms' efficiencies in Taiwan over the period 2001 to 2005.

An alternative approach is the Malquimst Productivity Index (MPI) that allows analysis of the productivity change of a certain industry over time (Färe, Grosskopf, Lindgren, & Roos, 1992). In addition, the MPI allows decomposing this productivity change into an efficiency change between adjacent periods of time (relative to the efficient frontier of each period) and an efficient frontier shift (a.k.a. technological change). In the literature there are some studies regarding productivity growth in telecommunications industry. Thus, Uri (2000) calculated the performance changes and shifts in technology of 19 LECs for the period 1988 to 1998 and concluded that growth was due mainly to technological innovation rather than improvements in relative efficiency. In contrast, more recent evidence (Seo, Featherstone, Weisman, and Gao 2010) shows that ILECs underperformed over the period 1996 to 2005 in terms of average productivity growth.

More recently, Sung (2012) also applied a MPI approach to evaluate the total factor productivity (TFP) of ILECs and estimated the effects of regulatory schemes and competitive pressure on the slowdown in productivity growth of ILECs by means of a TFP-level regression analysis. It was found that intermodal competition and incentive regulation have induced a positive technical change but have worsened the ILECs' performance. Other attempts have been made with the purpose of estimating technological progress in the U.S. wireless services industry (Banker, Cao, Menon, & Natarajan 2010), which were motivated by the expanding market share of mobile telecom firms.

Nevertheless, despite the MPI approach being able to evaluate the change effect, MPI only measures distance to the efficient frontier in single periods of time (or at most between adjacent periods of time) and does not consider the carry-over activities between consecutive periods of time. In most industries with economies of scale, such as the telecommunications sector, long-term planning and investments in network infrastructure and technology are critical to gain better positions in the market. In fact, the entry barriers in telephone markets, that the Telecommunications Act of 1996 was intended to remove, are related to the huge amounts of money that new firms had to invest in network elements to be able to compete with the ILECs. Some authors (Ai & Sappington, 2002; Jung, Gayle, & Lehman 2008) have included infrastructure from previous periods as an explanatory variable in their dynamic data panel models. This lagged investment influences the network modernization in future periods. Cambini and Jiang (2009) have thus considered the influence of investment on competition.

In order to take into account the connecting activities along multiple periods, the Dynamic DEA approach was proposed (Tone & Tsutsui, 2010). In this paper, Dynamic DEA is used to assess the performance of wireline telecommunications firms from 1997 to 2007, and afterwards a regression is carried out to evaluate the effects of local competition, unbundling regulation, intermodal competition, incentive regulation, and mergers upon the carriers' efficiency. The paper is divided into six sections. Section 2 reviews the current state of the industry in the U.S. In Section 3 the Dynamic DEA methodology is described. The description of the data used is presented in Section 4 with the discussion of the results Section 5. Finally, conclusions are drawn in Section 6.

2. Background

This section addresses the features of the U.S. telecommunication sector and the issues that have arisen in the last years. Specifically, the current state of the unbundling deregulation, the recent trends in telecommunications usage leading to intermodal competition and the influence of price-cap regulation are reviewed. Therefore, the evaluation of the