Benchmarking telecommunications in developing countries: A three-dimensional approach

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This paper reports different aspects of telecommunications development that need to be addressed when performing cross country performance assessments. The paper proposes an integrated approach in terms of theoretical background and analytical tools for benchmarking. The proposed three-dimensional benchmarking model, called ISER, consists of the assessment of ‘Information Society, sector Efficiency and Regulatory’ framework. The model is also composed of two commonly used analytical tools in the benchmarking telecommunications sector: 1) Composite Indicators (CIs) and 2) Data Envelopment Analyses (DEA). An empirical example is given for 20 developing (transition) countries in 2002 and 2007. The results are discussed in terms of policy making.

Key words: Benchmarking, three-dimensional approach (ISER), telecommunications, policy making.

INTRODUCTION

The dynamics of the telecommunications sector requires constant measurement, survey, analysis and comparison of the relevant performance features, as a way to set the starting point in the adoption and implementation of the appropriate development strategy. At the same time, it is vital to create a concrete methodological procedure that will enable continual monitoring and act as the sustainable source of guidelines for the definition, implementation and post-implimental corrections of an adequate telecommunications policy. Assessments of sector performance are important for developing and developed countries alike, for they ensure sector development both in the short and long run because telecommunications development generates substantial economy-wide positive externalities (Roller and Waverman, 2001). International Telecommunications Union (ITU, 2009) points out that, only by making international comparisons is it possible to show which policies have been more successful than others, and, for this reason, an approach based on comparative rankings may be more meaningful than one that uses absolute growth rates.

Therefore, benchmarking was promoted as a support tool for policy making. As a common tool for strategic planning, benchmarking found its way to becoming a widely used methodology for improving performance both on the micro (operators or services¹) and macro level (for cross-country performance evaluation²). The main idea behind benchmarking is simple, compare one’s self with others, and find the best practice and use it as a goalpost (benchmark) for a development strategy. However, use of benchmarking becomes problematic when it is used on items that cannot be empirically measured, tracked or managed. In other words, if there are no quantitative targets defined by policy makers, the role of benchmarking is much fuzzier (Osimo and Gareis, 2005). What makes benchmarking more complicated is the fact that, telecommunications have evolved into an area of research that consists of technical aspects, social issues, economic and business factors, and regulation demands (Lam and Shiu, 2008; Stiller, 2009). Although the technological standpoint was, for a long time, the primary standpoint, many studies from the 1980s (Gasmi and

¹For example, see Cook et al. (2004)
Recuero, 2009; Flacher and Jennequin, 2008; Varoudakis and Ressoto, 2004; Fink et al., 2003; Gutierrez, 2003; Lien and Peng, 2001) have highlighted telecommunications as an economic activity, that is subject to a regulatory system and one that has a strong impact on society. In many countries, the telecommunications regulatory reform began in 1998 or later (Lam and Shiu, 2008, 2010), which reinforced empirical studies in the field of relationships between different aspects of regulatory reform and economic performance. The information society concept also influenced contemporary policy making, creating a need to define a separate development strategy that will address digital divide issues.

A key challenge for telecommunications policy creators is to build an information society in an environment of open and “fair” markets and to do so without jeopardising the sector efficiency. If international benchmarking is adopted as a policy tool, it is important that cross-country performance evaluation should reflect the most important aspects of policy impact: the digital divide, regulatory reform and economic efficiency. Once these aspects (that is development dimensions) have been identified, the theoretical background for benchmarking can be established. However, because benchmarking relies on measuring and comparisons, the effectiveness of its use depends on the indicators and analytical tools applied. Resurgent standpoints of telecommunications development created the need for devising innovative methodological procedures and assessment indicators (Tölösi and Lajtha, 2000). There are two main sources of indicators in telecommunications defined by ITU. The first one is ‘The Indicators Handbook’, periodically published by ITU, which defines ‘Key indicators for analyzing the telecommunications/ICT sector’. The second source provides definitions, model questions and methodological notes to measure the Information Society (so called ‘The Partnership on Measuring ICT for Development’s Core ICT Indicators’). Whereas the former source gives the list of “traditional” indicators for electronic communications, the latter source attaches more importance to sector convergence and information society. Both lists can be used as a good starting point in cross-country assessments of technological and economic aspects of telecommunications. On the other hand, in policy and regulatory assessments, if there are no quantitative targets, the scope of benchmarking is limited. Regulatory framework indicators represent the least harmonised field because an indicator can sometimes be the measure of outcomes, results or impacts of regulation, whereas at other times, it is solely a measure of regulatory compliance.

The question is how to define a benchmarking process in telecommunications which covers all points of interest for policy makers. This paper proposes an innovative multidimensional benchmarking approach, that addresses the three key dimensions of telecommunications development 1) social, 2) economic and 3) regulatory. This approach deals both with ranking countries and benchmark determination as the two main objectives of benchmarking. The proposed three-dimensional benchmarking approach called ISER is composed of two commonly used analytical tools in the benchmarking telecommunications sector 1) Composite Indicators (CIs) and 2) Data Envelopment Analyses (DEA). The results obtained are discussed in terms of policy making in telecommunications.

MATERIALS AND METHODS

Empirical studies point to the two most common methodological approaches in benchmarking telecommunications 1) Composite Indicators (CIs) and 2) Data Envelopment Analysis (DEA). A brief review of some of the representative research studies associated with these methods is offered, and metrics for the proposed three-dimensional benchmarking in telecommunications named ISER are described.

Common tools for benchmarking in telecommunications – CIs and DEA

The index, or the composite indicator, refers to a group of indicators aggregated into a single value (Gudmundsson, 2001). There can be more than one level of indicator aggregation. In the latter case, the first level consists of indicators aggregated into composite indicators called sub-indices, and, as a result of the sub-indices aggregation (second level), the composite indicator is in fact, a composite index. There are two main domains of telecommunications characterised by index-based assessments 1) digital divide and 2) regulation (that is policy).

The idea of a composite cluster of associated technologies, along with a selection of these technologies and the indicators measuring them, was introduced by Press, who pointed out that, with a complex concept such as the Internet, “an index may be more robust than a [single] indicator in measuring a qualitative concept” (Press, 1999). Since an information society was introduced as one of the global priorities, many cross-country assessment approaches were developed with the objective to measure the digital divide. The endeavours were supported by ITU Telecommunication Development Sector (ITU-D), which ventured into the process of defining the methodology and indicators for benchmarking. As a result, several composite indices were developed. The latest, the Information and Communications Technologies development index (referred to as IDI), was published in 2009 (ITU, 2009). Many

3 Regulatory reform in telecommunications addresses the privatisation of state-owned operators, the introduction of competition, the opening of markets to foreign investment and the establishment of pro-competitive regulations (Fink et al., 2003).

4 There are various definitions of what is meant by digital divide. Organization for Economic Cooperation and Development - OECD (2001) defines it as differences between individuals, households, companies, or regions related to the access to and use of Information and Communication Technologies (ICT) (Hanafuzidah et al., 2009).

5 The name is related to the three dimensions in benchmarking: Information Society, Sector Efficiency and Reform

authors explored issues in devising indices for telecommunications assessment, including Archibugi and Coco (2005), Al-mutawkikil et al. (2009), Hanafizadeh et al. (2009). Although the indices summarise complex, multidimensional realities and allow progress tracking of countries over time, they also have many disadvantages. Selection of indicators, weights, and methods to be used in index construction which can lead to unrealistic results and simplistic policy conclusions (Nardo et al., 2008). Additionally, those studies focus on the mere ranking of countries, with less attention paid to analysing and discussing the causes and implications of the results. This paper contributes to filling this void by tackling the relationship between ITU indices (IDI), regulatory reform scores and telecommunications efficiency in transition countries.

Besides information society, the intensive regulation changes in the telecom sector during the last two decades engendered the need for alternative and meaningful indicators. The aim was to construct policy-based, rather than outcome-based, measures (Rodriguez and Rodrik, 2000). Different composite indicators (indices) were devised as policy-based measures of liberalisation, competition, privatisation, deregulation, and overall openness of telecommunications markets. OECD developed indicators of regulation in telecommunications7 (Conway and Nicoletti, 2006). EBRD developed transition indices for various sectors, including the transition index for infrastructure reform in telecommunications.8 At the end of 2008, EBRD published the results of the benchmarking study on telecommunications regulatory assessment (EBRD, 2008). Recent empirical work (from 2000 to date) has been performed by Gutierrez and Berg (2000), Matteo et al. (2001), Li and Xu (2002), Gutierrez (2003), Varoudakis and Ressoto (2004), El Khoury and Savvides (2006), Duso and Seldeslachts (2010).

These indices are used for the examination of the empirical links between market openness and telecommunications sector performance. The main advantage of the index-based approach is that, it reflects the partial adoption of reform measures9 and thus gives a better insight into countries regulatory performance in relation to the appropriate benchmarks.10 The disadvantage of this approach is that, once a benchmark is attained (the regulation framework is compliant with the current legislature), the question of ranking re-emerges. Matteo et al. (2001) arrived at a similar conclusion by pointing out that, ranking a country by various policy combinations imposes a constraint on the data. Rodriguez and Rodrik (2000) also criticised the indicator of "openness" used by researchers. This paper fills this void by employing a three-dimensional benchmarking process, thus proposing that the benchmark countries are only those that combine (1) full regulatory reform (2) sector efficiency and (3) progress towards information society.

Another widely applied tool for benchmarking in telecommunications is Data Envelopment Analysis (DEA). The main idea of DEA is to extend the traditional concept of productivity or efficiency (input to output ratio) and make it suitable for performance evaluation and benchmarking within the context of multiple performance measurements (Zhu, 2003). DEA uses mathematical programming techniques and models to evaluate the performance of peer units (called Decision Making Units or DMUs) in terms of multiple inputs used and multiple outputs produced.

There are many examples of DEA applications in telecommunications. Research is being conducted both at the micro (operators, divisions) and macro (countries, regions) levels. Sueyoshi (1994) used two alternative DEA models to measure the performance of public telecommunications in the US. Majumdar (1997) examined the impact of incentive regulation on technical efficiency provided by DEA in the U.S. between 1998 and 1993. Pentzaropoulos and Giokas (2002) examined the main European public telecommunications organisations (PTOs) in terms of their operational efficiencies, using data envelopment analysis. In their study, they highlighted DEA as the most suitable technique for exploring telecommunications development and performance evaluation. Lien and Peng (2001) used three alternative DEA methods to examine the production efficiency of telecommunications in 24 OECD countries from 1980 to 2005. Azadeh et al. (2007) studied 27 developed and developing countries using DEA, principal component analysis (PCA) and numeral taxonomy (NM). Giokas and Pentzaropoulos (2008) compared and subsequently ranked 30 OECD member states according to their respective telecommunications efficiencies and went on to underscore policy implications. Lam and Shiu (2008) relied on the DEA approach to measure the productivity performance of China's telecommunications at a provincial level. Lam and Shiu (2010) used the non-parametric DEA approach to calculate the Malinquist Index, in order to measure the total factor productivity (TFP) growth in 105 countries between 1980 and 2006. They discussed the results by taking into account the existence of competition and privatisation in telecommunications.

DEA evaluates each decision-making unit (DMU) individually and detects those units, that exhibit the best practice in the sample. These best practice units constitute an exemplar (frontier) to which the remaining units in the sample are compared. There are two types of DEA models depending on the envelopment surface. The first one is called the CCR model proposed by Charnes et al. (1978), which uses constant returns to scale (CRS) surface. The other is called the BCC model, proposed by Banker et al. (1984), which uses a variable returns to scale (VRS) surface. Both types of models can be applied in an input or output orientation. A description of DEA models used in this paper is given in Appendix 1. DEA can be regarded as a benchmarking tool because the identified frontier can be understood as an empirical standard of excellence (benchmark). Benchmarking is a process of defining valid measures of performance comparison among peer DMUs, using them to determine the relative positions of the peer DMUs and ultimately, establishing a standard of excellence. Once the frontier is established, a set of new DMUs may be compared to the frontier. However, when a new DMU outperforms the identified frontier, a new frontier is generated by DEA. As a result, it is not the same benchmark (frontier) for other (new) DMUs (Cook et al., 2000).

The fact that assumptions about the functional relationship between inputs and output are not required can be seen as one of the main advantages of the DEA method. Zheng et al. (2003) pointed out that, the main disadvantage of the DEA approach was that, it did not provide statistical tests for the estimated production function. DEA is good at estimating the "relative" efficiency of a DMU, but it converges very slowly to the "absolute" efficiency. In other words, it can tell you how well you are doing compared to your peers but not compared to a "theoretical maximum." In addition, its main disadvantage is that, the computed inefficiency scores are very sensitive to measurement errors, either in the

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7 The so called ETCR indicators covering energy, transport and communication over the 1975-2003 period in 21 OECD countries
8 For methodology and data, see http://www.ebrd.com/pages/research/analysis/forecasts.shtml
9 Rather than simply assigning C for competition or M for Monopoly when assessing liberalisation. For example, the World Bank gives the score of 1 for monopoly, 3 for competition and 2 for partial competition without clear explanation of partial competition. These limitations are also discussed by Gutierrez (2003).
10 Benchmarks are very common and can be found in ex ante and ex post regulation. Both regulations mostly address competition. Ex ante regulation is an anticipatory intervention and sector specific, while the ex post regulation is the application of the competition law and addresses specific allegations of anti-competitive behaviour or market abuse.
11 In an output orientation model, efficiency is measured from the perspective of producing the maximum of output with the same amount of inputs.
output or input variables (Soderbom and Teal, 2003). The use of panel data can reduce this problem, admittedly at the cost of imposing assumptions about the evolution of the level efficiencies over time, but it can at the same time complicate benchmark assumptions (Los and Timmer, 2005). To reduce the potential effect of DEA’s disadvantages on the results, all unnecessary imputation of missing data was avoided. Another disadvantage that has a bearing on benchmarking is that, DEA does not provide ranking for DMUs found to be efficient (with efficiency scores of 1.00). This paper proposes that, countries that are found to be efficient be ranked according to other assessment dimensions.

A three-dimensional approach for benchmarking - ISER methodology

This approach follows the idea that only multidimensional, cross-country performance evaluation can be used as a support tool for policy making in telecommunications. Therefore, a three-dimensional benchmarking combining assessments of information society, regulatory reform and economic efficiency is proposed. It is also proposed that, only a country that is successful in all three dimensions can be regarded as a benchmark country.

The benchmarking metrics applied to each dimension were: (1) Information and Communications Development Index (IDI) for information society, (2) efficiency obtained by DEA for sector economic efficiency (denoted by E), and (3) EBRD index scores for regulatory framework (denoted by R). The three-dimensional benchmarking model is named ISER. The research sample of this study was 20 developing countries regarded as transition countries by EBRD (EBRD, 2008). Although the transition process ended for some countries in the sample (Kito, 2007), they were included in the analysis because they can serve as potential benchmarks for countries still in transition. A time cut analysis was performed for the years 2002 and 2007.

In this study, IDI was used as a measure of the availability of information and communications technologies for society, in other words, the social aspects of telecommunications development. The EBRD transition index was used for the infrastructure reform in telecommunications. This index reflects a country’s progress in the commercialisation and regulation of telecommunications; because the infrastructure owned by an incumbent operator comes first in planning but last in actual deregulation and liberalisation, this index is a good measure of the regulation aspect. For efficiency calculation, Excel implementations of DEA envelopment output models with CRS and VRS were used, as introduced in Zhu (2003). It is seen by some authors (Lam and Shiu, 2008; Lien and Peng, 2001) that the assumption of CRS is appropriate, only when all DMUs operate on an optimal scale, and in imperfectly competitive markets, VRS specification can give better results. In this study, both output-oriented methods (DEA with VRS and DEA with CRS) were used because the general assessment of telecommunications market conditions is complicated by the strong regional disparities between transition countries.

To measure the efficiency of the telecommunications sector, data on sector outputs and inputs were chosen. Similar to Sueyoshi (1994), Lien and Peng (2001), Giokas and Pentzaropoulos (2008), Lam and Shiu (2008), total telecommunication services revenue (measured in millions of US dollars) was the output measure, while the three inputs taken into consideration were as follows: (1) total number of subscribers measured in thousands, (2) total full-time staff employed measured in thousands, and (3) annual telecommunication investment measured in millions of US dollars). Total telecommunications revenues for the year and the average annual telecommunications investment were expressed in US dollars, using the average annual exchange rate for US$ for a given year and country. Thus, any potential inflation factors were eliminated from our study. All the data were taken from the Yearbook of Statistics-Telecommunications Services Chronological time Series 1998 to 2007 by the International Telecommunications Union (ITU, 2008). The missing data were obtained from other sources (e.g., OECD, World Bank and National Statistical Offices. If they could not be obtained from other sources, the missing data were estimated by simple extrapolation (that is, assuming constant changes in the figures between the years). This study only allowed two or at most, three missing data for an input or output variable.

RESULTS

Here, the ISER benchmarking results of telecommunications in developing (that is, transition) countries are presented. Benchmarking scores for each dimension are summarised in Table 1. Progress, regress or no change of dimensions and country rankings are also reported in Table 1 (denoted by ‘+’, ‘−’ and ‘0’ respectively). Due to the fact that, the efficiency scores show relative efficiency (among peer DMUs), IS and R scores are normalised using the distance to reference country method (reference country here is a country with the highest score for a given year). The efficiency presented in the table is the result obtained by DEA with CRS, although the table would not have been much different, had DEA been used with VRS because they exhibit a high level of correlation (Pearson and Spearman rank correlation coefficients are above 0.80 for both years).

In the last three columns of Table 1, an illustration (emoticons) is given for each case of value and rank “changes combinations”. The emoticons are assigned as shown in Table 2. Although all countries show progress regarding regulation in telecommunications in social and economic terms of development, both progress and regress are evident, which can also be seen in Figure 1. The spider diagrams for 2002 and 2007 are similar, implying that none of the country rankings for the three dimensions changed. However, as shown in Table 1 (in columns change and rank changes), changes in absolute values are not always followed by the rank moving up. Only four countries (see the last three columns of Table 1) showed both growth in performance scores and rank improvements namely Estonia, Hungary, Lithuania and Moldavia. Uzbekistan is the country with the lowest performance because it showed no improvements either in absolute values or in ratings. The values in the

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12 detailed description and data on IDI can be found in ITU (2009).
13 because the data for IDI are available for these years.
14 The sum of the main telephone lines in operation, mobile subscribers and internet subscribers.
15 A detailed description on indicators used in DEA as inputs and outputs can be found at: http://www.itu.int/ITU-D/ict/material/IndDef_e_v2007.pdf, (March, 2010).
16 For example, in the case of full staff employees we used the World Bank data on Mobile and fixed-line subscribers per employee as the second dimension and if the PMCC (Pearson product-moment correlation coefficient) between dimensions was higher than 0.95 we predicted the future value along a linear trend using the existing values.
Table 1. ISER benchmarking results of 20 developing countries in 2002 and 2007.

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<td>Albania</td>
<td>0.43</td>
<td>0.90</td>
<td>0.75</td>
<td>0.46</td>
<td>0.81</td>
<td>0.83</td>
<td>+ - +</td>
<td>+ - 0</td>
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<td>Armenia</td>
<td>0.45</td>
<td>0.39</td>
<td>0.58</td>
<td>0.52</td>
<td>0.32</td>
<td>0.67</td>
<td>+ - +</td>
<td>0 - 0</td>
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<tr>
<td>Azerbaijan</td>
<td>0.38</td>
<td>0.28</td>
<td>0.25</td>
<td>0.45</td>
<td>0.37</td>
<td>0.42</td>
<td>+ + +</td>
<td>+ + -</td>
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<td>Belarus</td>
<td>0.61</td>
<td>0.52</td>
<td>0.75</td>
<td>0.73</td>
<td>0.50</td>
<td>0.92</td>
<td>+ - +</td>
<td>0 0 +</td>
<td>☺ ☺ /neutralface ☺ ☺ /neutralface</td>
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<td>Bosnia and Herzegovina</td>
<td>0.52</td>
<td>0.55</td>
<td>0.58</td>
<td>0.59</td>
<td>0.62</td>
<td>0.58</td>
<td>+ + 0</td>
<td>+ + -</td>
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<tr>
<td>Bulgaria</td>
<td>0.57</td>
<td>0.28</td>
<td>0.50</td>
<td>0.63</td>
<td>0.19</td>
<td>0.50</td>
<td>+ - 0</td>
<td>- - -</td>
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<td>0.71</td>
<td>0.93</td>
<td>0.83</td>
<td>0.78</td>
<td>0.92</td>
<td>0.92</td>
<td>+ - +</td>
<td>- - 0</td>
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</tr>
<tr>
<td>Estonia</td>
<td>0.88</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>+ + +</td>
<td>0 0 0</td>
<td>☺ ☺ ☺ /neutralface ☺ ☺ ☺ /neutralface</td>
</tr>
<tr>
<td>FYR Macedonia</td>
<td>0.59</td>
<td>1.00</td>
<td>0.58</td>
<td>0.57</td>
<td>0.76</td>
<td>0.83</td>
<td>- - +</td>
<td>- - +</td>
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<tr>
<td>Hungary</td>
<td>0.78</td>
<td>1.00</td>
<td>1.00</td>
<td>0.87</td>
<td>1.00</td>
<td>1.00</td>
<td>+ + +</td>
<td>0 0 0</td>
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<tr>
<td>Kyrgyzstan</td>
<td>0.44</td>
<td>0.37</td>
<td>0.58</td>
<td>0.44</td>
<td>0.38</td>
<td>0.75</td>
<td>- + +</td>
<td>- + +</td>
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</tr>
<tr>
<td>Lithuania</td>
<td>0.71</td>
<td>0.62</td>
<td>0.83</td>
<td>0.89</td>
<td>0.79</td>
<td>0.92</td>
<td>+ + +</td>
<td>+ 0 0</td>
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<td>Moldova</td>
<td>0.48</td>
<td>0.27</td>
<td>0.58</td>
<td>0.55</td>
<td>0.39</td>
<td>0.75</td>
<td>+ + +</td>
<td>0 + +</td>
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<tr>
<td>Mongolia</td>
<td>0.44</td>
<td>0.77</td>
<td>0.67</td>
<td>0.45</td>
<td>0.42</td>
<td>0.67</td>
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<td>Poland</td>
<td>0.75</td>
<td>0.91</td>
<td>1.00</td>
<td>0.83</td>
<td>0.77</td>
<td>1.00</td>
<td>+ - 0</td>
<td>0 - 0</td>
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<tr>
<td>Romania</td>
<td>0.55</td>
<td>0.68</td>
<td>0.75</td>
<td>0.70</td>
<td>0.58</td>
<td>0.83</td>
<td>+ - +</td>
<td>+ - 0</td>
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<tr>
<td>Slovak Republic</td>
<td>0.79</td>
<td>0.65</td>
<td>0.83</td>
<td>0.83</td>
<td>0.89</td>
<td>0.92</td>
<td>+ + +</td>
<td>- + 0</td>
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<tr>
<td>Slovenia</td>
<td>1.00</td>
<td>0.85</td>
<td>0.75</td>
<td>0.98</td>
<td>0.94</td>
<td>0.75</td>
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<td>0.56</td>
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<td>0.58</td>
<td>0.64</td>
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<td>0.67</td>
<td>+ - +</td>
<td>+ - 0</td>
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<td>Uzbekistan</td>
<td>0.39</td>
<td>0.39</td>
<td>0.50</td>
<td>0.34</td>
<td>0.30</td>
<td>0.50</td>
<td>- - 0</td>
<td>- - -</td>
<td>☺ ☺ /neutralface ☺ ☺ /neutralface</td>
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</table>

Table 2. Emoticons showing changes in countries scores and rank.

<table>
<thead>
<tr>
<th>Rank/Value</th>
<th>+</th>
<th>0</th>
<th>-</th>
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<tr>
<td>+</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>0</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
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<tr>
<td>-</td>
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</table>

correlation matrix (Table 3) between the performance scores can lead to the conclusion that, countries with a better regulatory framework also perform better in terms of information society and sector efficiency and vice versa.

However, this conclusion should be taken with caution due to the rather small sample and time cut analysis. Estonia is among the top ten countries in the world that increased their IS values most between 2002 and 2007 (ITU, 2009). This country also remained efficient and had the highest score for regulatory reform. Based on two criteria, highest rank and progress in all three dimensions, this country can be seen as a triple benchmark. Hungary is also a country that can be seen as a triple benchmark. It retained the highest score for regulatory reform and efficiency along with progress towards information society. Therefore, their performance should be a goal of other countries.

DISCUSSION

Performance assessment of the telecommunications sector can be addressed relatively and absolutely. In terms of benchmarking, a country shows progress not by merely showing higher values for performance indicators but also when it is better than others (that is, showing rank improvements). Therefore, two important questions emerge from the obtained results. The first one addresses the position of each country relative to the others, and the second one concerns the determination of benchmark countries. Both questions are discussed from the perspective of policy makers.

Countries showing progress both in absolute values and rankings can be seen as countries with effective telecommunications policies. Results showed that, the less developed countries such as Moldavia can be as successful as European Union members (Estonia, Hungary and Lithuania). The relationship between development in telecommunications and the overall economic development is not always evident (El Khoury and Savvides, 2006). In addition, according to many studies, there is no clear relationship between different dimensions of telecommunications development (Rodriguez and Rodrik, 2000; Bernstein and Sappington, 2000; Fink

\[17\] In our study, retaining 1.00 score for efficiency and 4.00 for regulatory reform can also be seen as progress.
et al., 2003; Flacher and Jennequin, 2008; Vaezi and Bimar, 2009). In other words, a country may show progress in one dimension (that is, regulatory reform), but it does not necessarily imply better performance in other dimensions (that is, economic efficiency), which is also evident in this study.

For instance, FYR Macedonia shows relatively high regulatory reform scores in both of the years observed (reform score grew from 2.33 to 3.33 in absolute values), but its efficiency and digital divide scores decreased, which suggests that the changes in the regulatory framework were not followed by improvements in sector performance and digital divide (relative to the other countries analysed). The absence of reform effects has also been discussed by other authors. Flacher and Jennequin (2008) examined the efficiency of regulation policy in the telecommunications sector and came to the conclusion that, not all implemented policies were necessarily efficient. The results obtained by Fink et al. (2003) implied that, the gain from policy reform depended on the government’s commitment to the reform process, and that sometimes, the reform regulations were not implemented in practice. Yomralioglu et al. (2009) addressed the policy impact on spatial information system implementation in a particular transition country (Turkey) and pointed to the importance of cooperation between different government institutions of interest. Vaezi and Bimar (2009) also discussed this problem from the e-readiness perspective. The implication for policy makers is that, regulatory measures need a certain redefining or monitoring process to ensure their positive effect on performance.

The other example is Azerbaijan, a so called “early transition” country, which showed improvements in all dimensions with the exception of relative rank regarding regulatory reform. The overall progress is evident for Azerbaijan, but its regulatory reform is “slower” than in other countries due to the rank moving down. Some authors recognise this kind of result as “latecomer’s advantage”. Lam and Shiu (2008) explained it as a possibility for transition economies (that are late comers in telecommunications development) to deploy the latest technologies to develop their nation’s wide telecommunications networks. They also pointed out that, late comers can even “leapfrog” some developed countries in sector performance, which is mostly related to the investments in wireless or mobile systems local loops and to passing investments exclusively in fixed lines (Jha and Majumdar, 1999). In addition, sector efficiency can be the result of the efficient use of negligible capital inputs, but it is in fact realised in command markets with low availability of services for users (Kumar and Russel, 2002). Therefore, even without a regulatory framework that fosters competition and market openness, performance improvements are achievable. In the case of one dimension assessments based on aggregate values, performance improvements may “mask” this type of conclusion. For policy makers, it is important to recognise the latecomers’ advantage and turn it into a comparative advantage.

Another question of interest for policy makers is in reference to benchmark countries. The criteria for identifying benchmark countries adopted in this study

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**Table 3.** Correlation matrix between dimensions in ISER benchmarking.

<table>
<thead>
<tr>
<th></th>
<th>IS</th>
<th>E</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2002</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>0.616</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>0.734</td>
<td>0.756</td>
<td>1</td>
</tr>
<tr>
<td><strong>2007</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>0.741</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>0.694</td>
<td>0.773</td>
<td>1</td>
</tr>
</tbody>
</table>

---

*Figure 1. ISER benchmarking results in 20 developing countries in 2002 and 2007.*
reflect both static and dynamic standards of excellence. According to these criteria, Estonia and Hungary can be seen as benchmark countries. However, policy makers can also consider the countries that are not highly ranked but are showing progress in all three dimensions. From that point of view, Lithuania and Moldavia can be considered as potential benchmarks. Therefore, policy makers can first create a group of potential benchmarks and then decide on the most suitable one by including more criteria.

In the core of the proposed approach is the separate analysis of different development dimensions but with overall assessment of the telecommunications sector. This approach covers a variety of development aspects but gives clear policy implications of the results. For more details on assessment results, policy makers can continue with a multi level decomposition of performance measures, such as (1) information society and regulatory reform indices decomposed into their sub indices and (2) slack-based DEA efficiency analysis, pointing to changes in inputs and outputs to catch up with benchmarks.

Conclusion

The convergence of telecommunications leads to the convergence of exploration in this sector, especially from the standpoint of development policy. Policy makers are expected to thoroughly examine and appraise the sector’s performance. The social, economic and regulatory dimensions of assessment stand out, as the three most important dimensions within the domain of telecommunications policy.

Furthermore, in the current circumstances of growing competitiveness, the issue of harmonising with the countries that stand as examples of good practice is an additional imperative (for example, compliance with the EU legislation on member countries). Benchmarking, in itself, focuses on assessing, comparing and identifying the best practice. A successful application of benchmarking telecommunications depends on a multitude of factors ranging from the selection of the appropriate assessment indicators to the incorporation of the results into policy decisions. This paper proposes a three-dimensional benchmarking model, ISER, which consists of the assessments of information society, sector efficiency and regulatory framework together with combining the two common analytical tools for benchmarking telecommunications (CIs and DEA).

The advantage of the proposed approach lies in the fact that, it provides a comprehensive estimate of the sector’s performance and facilitates the determination of the sector’s position within an elaborate system composed of numerous indicators, relating to the telecommunications sector. Moreover, the model presented, lends robustness to the process of analysis in the sense that, it reduces the influence of a possible erroneous assessment that may arise from the application of a single (one-dimensional) benchmarking analysis. The shortcoming of the model is the duplication and overlapping of the influences of certain indicators, as well as the ‘limited’ possibility of ascertaining the causality, that is, the sector’s unfavourable positioning. Therefore, future studies and further development of the model should be centred on the improvement of analytical tools to be used in a more detailed analysis of the sector’s performance in relation to the established benchmark countries and the redefinition of the set of indicators for regulatory reform assessment.

REFERENCES


APPENDIX 1: Data envelopment analysis – description of DEA models

If we consider there are \( j = 1, 2, \ldots, n \) countries (DMU \( j \)) using \( m \) inputs \( x_{ij} (i = 1, 2, \ldots, m) \) to produce \( s \) outputs \( y_{rj} (r = 1, 2, \ldots, s) \), the output-oriented CRS envelopment model can be expressed as

\[
\max \Phi + \varepsilon \left( \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \right)
\]

Subject to

\[
\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io} \quad i = 1, 2, \ldots, m;
\]

\[
\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{ro} \quad r = 1, 2, \ldots, s;
\]

\[
\lambda_j \geq 0 \quad j = 1, 2, \ldots, n
\]

where \( \Phi \) is the radial efficiency factor showing the proportional increase in output levels of DMU \( j \); \( \lambda_i \) is the intensity factor showing the contribution of DMU \( j \) in the derivation of the efficiency of DMU under evaluation; \( s_i^- \) and \( s_r^+ \) are slack variables accounting for extra savings in input \( i \) and extra gains in output \( r \); \( \varepsilon \) is a very small positive number used as a lower bound to input/output weights; the aforestated model imposes CRS. If the condition (2) is added, VRS is imposed.

\[
\sum_{j=1}^{n} \lambda_j = 1
\]

A sequence of LP problems needs to be solved, one for each DMU \( j = 1 \ldots n \), to assess their efficiency. If \( \Phi = 1 \) then the DMU under evaluation is a frontier point. That is, there are no other DMUs that are operating more efficiently than this DMU. Otherwise, if \( \Phi > 1 \) then the DMU under evaluation is inefficient. That is, this DMU can either increase its output levels or decrease its input levels.