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ASSESSING THE PERFORMANCE OF TELECOMMUNICATION INDUSTRY IN INDIA: A DATA ENVELOPMENT ANALYSIS

ABSTRACT

Rapid growth of telecommunications in India has been creating opportunities for many players from Asia, Europe and other parts of world. Relative assessment of efficiencies can be used to enhance productivity and competitiveness. In this study an attempt is made to evaluate competitiveness of the telecom industry in India focusing on the efficiency. Input oriented data envelopment analysis is used to measure the relative technical and scale efficiencies of 10 service providers. Further, using output oriented model, the efficiency analysis is extended to 23 service circle areas. From the analysis performed on service providers the technically and scale efficient firms were identified. Technical and scale efficiency were assessed at circle level also. The findings confirm some assumptions and hint at several competitiveness implications for leadership in firms and government.

Key Words: performance measurement, efficiency, productivity, industrial competitiveness, benchmarking, telecommunication industry growth

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INTRODUCTION: RAPID GROWTH OF TELECOM SERVICES IN INDIA AND THE DILEMMA

Rapid diffusion of information and communication technologies (ICT) in Asia is creating massive opportunities for players across the world. China and now India are fast emerging as growth engines due to their vast markets. Japan and Korea, already very advanced ICT countries, are moving to next levels such as ubiquitous network. Smaller countries such as Singapore and Taiwan are surpassing diffusion levels in emerging segments such as broadband beyond many developed countries in the West. Rapid diffusion of mobile telephony has taken India to top rank in terms of new additions. Such a growing market is creating opportunities for capable international players such as Nokia, Samsung and Vodafone across the industry value system.

From policy perspective, such explosive growth creates several competitiveness dilemmas, if it creates huge imbalances. Competitiveness research got a major boost since Porter (1990) introduced the diamond model. He tried to explain competitiveness of a specific industry in a country. Cost competitiveness becomes a necessity in situation of hyper-competition, a reality in many emerging countries, and demands increasing productivity. Cho and Moon have extended the diamond model in several ways to evolve theory of competitiveness (for details see Cho, Moon and Kim, 2008) and have discussed the linkage between productivity and competitiveness (Cho and Moon, 2005). Competitiveness of India was quite low and progress has been quite slow due to several issues across levels: country, industry and firm (Momaya, 2001). Several imbalances are surfacing in India and efficient operations are necessary to take telecom to masses in a low income large country. First dilemma is about the digital divide. While urban diffusion of wireless has seen explosive growth to take India to first rank in terms of monthly additions, it has rapidly widened the adverse rural-urban divide thus threatening digital and economic divide. While India has achieved some of the low ARPU in the world, sustainability of that is questionable in light of very high import content and rising prices of inputs including energy. One of the biggest barriers to rural diffusion has been found to be high cost of telecom, which is not affordable to rural populations with meager incomes. Similarly, rapidly worsening trade balances need to be addressed, if the current pace of growth is to be sustained.

More challenging dilemma may be on international trade and technological imbalances. The trade competitiveness index in telecom, a good proxy for international

competitiveness has worsened from -0.71 in 2000 to -0.91 for India (Table 1), a position very close to the worst (-1) any country can get. Data are not available, but situation on technological factors does not seem any better despite large number of talented people capable of activities from R&D and design to engineering and manufacturing. Some of the countries in East Asia have best positions (Table 1) and have sustained growth. These can be partly attributed to massive technovation capabilities firms in such countries developed. For instance, 16 core technologies and 39 very capable electrical machinery firms (e.g. Canon, NEC, Sharp and Toshiba) were identified by Kondo et al. (2007) to explain the resonant mobile innovation-led development trajectory of ICT. While some players in India have started building technological capabilities in telecom, most service players have still not investing adequately in technological innovation that can give sustainable competitive advantages. Hence, it may be less relevant to talk about technological imbalances in near future, but efficiency in several fronts is very essential.

Key objective of the paper is to explore use of data envelopment analysis to measure competitiveness of an industry. In context of telecom in this paper, the measurement is done at firm level and circle level focusing on efficiency. Findings from such analysis can help draw implication for leadership in companies and the government.

Table 1: Trends in Trade Competitiveness Index for Select Countries in Telecom Equipments

Year / Country / Union	1990	2000	2003	2004	2005
European Union (25)		-0.03	-0.08	-0.08	-0.07
United States	-0.39	-0.37	-0.51	-0.52	-0.55
extra-EU (25) imports		-0.08	-0.16	-0.20	-0.17
Hong Kong	0.04	-0.03	0.02	0.04	0.05
China	0.02	0.22	0.40	0.47	0.53
Japan	0.83	0.39	0.41	0.38	0.30
Korea, Republic of	0.64	0.42	0.66	0.70	0.70
India	-0.70	-0.71	-0.86	-0.90	-0.91

Source**:** Mittal et al., 2009; Based on trade data obtained from WTO. Note: Trade competitiveness index (TCI) = Exports-Imports/(Exports+Imports)

THE NEED FOR COMPETITIVENESS AND PERFORMANCE MEASUREMENT

Emerging countries face some common dilemma and can benefit from competitiveness and performance measurement to think more clearly about enhancing

them. India is fast emerging to become the most populous country with the largest number of youth. The country has potential and should enhance competitiveness rapidly to meet rising basic needs of masses: water, food, housing and now ICT. However the current pace in competitiveness journey is far below the potential for several reasons (Momaya, 2001). For instance, it has improved the country competitiveness rank from 33 in 2001 to 28 in 2009 as per National Competitiveness Research Report (IPS, 2009); too slow considering youth phase. In that report, growing population was considered the fundamental social, economic and environmental problem, as capabilities to educate and transform the youth are not improving fast. Industries such as telecom must contribute to enhance competitiveness of country, but the glimpse given in the Table 1 hints at the need for major improvements and measurement.

Effectiveness and efficiency are becoming of paramount importance for competitiveness and are of very high relevance to sustain India's telecom revolution. With open market policies India has adopted, competition in several segments of telecom is reaching levels close to hyper-competitive. For instance, best growth examples of telecom industry like China, Japan, Korea have often 2-3 players (often less if segmentation is carefully viewed), but 6 major players are already competing in India and many more are waiting to get licenses. In such hyper-competitive environment in a developing country, firms will have to achieve best efficiency positions on several competitiveness factors. While in the short-run the cost competitiveness factors drive customer growth, high dissatisfaction as reflected in higher churn will demand rapid enhancement on service quality (e.g. Seth et al., 2008), innovative solutions capability, new product development capability; many of these can demand technological competitiveness (Mittal et al., 2009).

An attempt is made in this research to make sense of competitiveness opportunities and challenges for telecom firms in India with focus on performance measurement and benchmarking. Measurement has been given high importance in emerging approaches to competitiveness (Cho, Moon and Kim, 2008). Factual perspectives on growth, market shares in different mobile technologies and market distribution among circles are given as background. The methodology giving rational for selection of right tool is discussed. Key findings from the analysis are reported to draw policy implications.

INDUSTRY OVERVIEW

The telecom services sector in India has witnessed tremendous growth in recent times. The total subscriber base (both wireless and wireline) of telecom sector in India crossed 600 million mark with 621.28 million subscribers as on 31st March 2010. Telecommunications network in India is the fastest growing network in the world and currently the second largest in terms of size and also in usage. Indian telecom industry has come a long way after the National Telecom Policy (NTP) was announced in 1994 to open up the private partnership in basic and cellular services*. The Telecom Regulatory Authority of India (TRAI) was constituted in 1997 as an independent regulator with an objective to regulate and encourage healthy competition in this sector. Later in 1999, NTP was implemented with a focus on creating an environment to enable continued attraction of investment in the sector and allow creation of communication infrastructure by leveraging on technological development.

These positive steps from the government side have led to rapid growth of this industry. The total revenue of telecom service sector has gone up from Rs. 867.19 billions in 2005-06 to Rs. 1053.18 billions in 2006-07. The teledensity has increased from 0.08 percent in 1994 to 52.74 percent in March 2010. The wireless market has reached 584.32 million subscribers as against 184.92 million on June 2007. On the other hand, the wireline services subscriber base has decreased from 37.06 million at the end of December 2009 to 36.96 millions at the end of March 2010, bringing down the wireline teledensity to 3.14 from 3.16 in December 09. The total wireless subscriber base over last six years is shown in Figure 1.

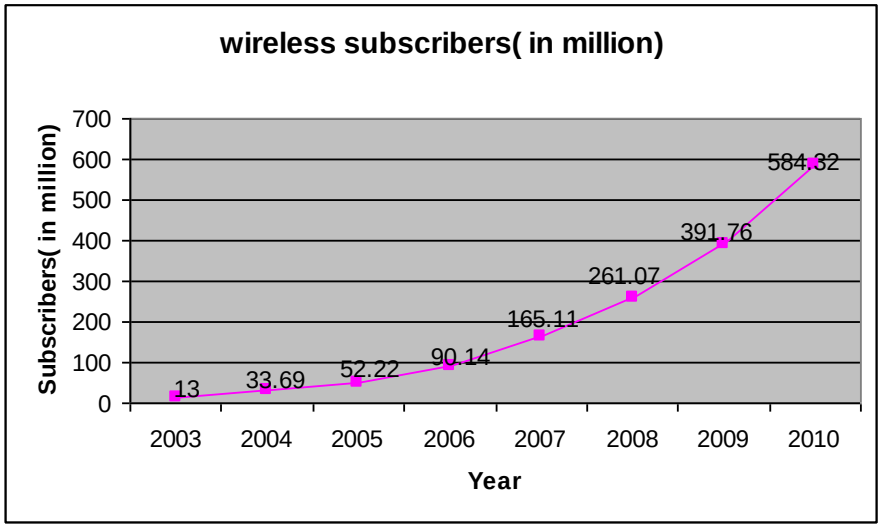
As we can see in the Figure 1, the wireless subscriber base has been increasing at a growing rate in the recent years. The wireless technologies that are currently in use are known as Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA). GSM technology dominates the Indian market with 81.9% percent of the share on March 2010. The list of all the Wireless service providers along with their licensed service areas is given in the following Table 2.

As on 31st March 2010, the total subscriber base of 584.32 million comprises of 393.45 million urban subscribers and 190.88 Million rural subscribers. The subscriber base of different wireless operators along with their rural subscriber base is given in Table 3. It may be seen that the rural connections account for 32.67 percent share of the total

*Prior to this, in 1992, sector was opened for value added services such as email, radio paging etc.

telecom market in India. This indicates an immense scope for further expansion of the subscriber base in rural India. It is also important to note that in this market, Bharti and Vodafone have got the maximum presence with their market shares 25.20 percent and 19.28 percent respectively. However when we look at the total rural and urban market in Table 3, we find that Bharti Group emerges as the dominant player with 21.84 percent market share. The considerable gap between the first and second position is notable and in fact we find two players competing for the second position - Reliance with 17.53 percent and Vodafone (Known as Hutchison prior to takeover by Vodafone) with 17.26 percent share in the total market. After this, BSNL, Tata and Idea Group are coming as strong contenders for the third position with their market shares ranging between 10 to 12 percent. Share of rest of the firms is insignificant in comparison to the top seven players.

Figure 1: Trend in Wireless Telecom Subscribers in India



Source: The Indian Telecom Services Performance Indicators Report Jan- March 2010, Telecom Regulatory Authority of India.

The GSM subscriber base in the country has reached 478.68 million in the in March 2010. Table 4 enumerates subscriber base along with the share of different players in this market.

Table 2: List of Wireless Service Providers and their Service Areas

Service Provider	Area for which licensed with number
Bharti	All India
IDEA (Including Spice)	All India
Tata Teleservices	All India
Vodafone	All India
BSNL	All India (except Delhi & Mumbai)
Reliance communications	All India (except Assam & NE)
Etisalat	AP, Delhi, Gujarat, Karnataka, Kerala, Maharashtra, Punjab, Rajasthan & UP(E)
Unitech	AP, Karnataka, TN (incl. Chennai), Kerala, UP(W), UP(E), Bihar & Orissa
Aircel Group	AP, TN, Karnataka, Assam, Bihar, Chennai, Delhi, HP, J&K, Kerala, Kolkata, MH, Mumbai, NE, Orissa, UP(E), UP(W) & WB
MTNL	Delhi & Mumbai
Videocon	Haryana & TN (incl Chennai)
S Tel	HP, Bihar & Orissa
Reliance Telecom	Kolkata, MP, WB, HP, Bihar, OR, Assam & NE
Sistema Shyam Telelink	Kolkata, TN (incl. Chennai), Karnataka, Kerala, Rajasthan, Haryana, Maharashtra, Mumbai, Delhi, Bihar & WB
Loop Telecom Private Ltd	Mumbai
HFCL	Punjab

Source: The Indian Telecom Services Performance Indicators Report Jan-March 2010 Telecom Regulatory Authority of India.

Table 3: Subscriber Base of Wireless Operators

Service Provider	Subscribers as on Mar-10 (in millions)	Market Share (%)	Rural Subscribers (in millions)	Rural subscribers (%)	Rural Market Share (%)
Bharti	127.62	21.84	48.09	37.69%	25.20%
Reliance	102.42	17.53	21.25	20.74%	11.13%
BSNL	69.45	11.89	25.26	36.37%	13.23%
Vodafone	100.86	17.26	36.79	36.48%	19.28%
Tata	65.94	11.28	13.45	20.40%	7.05%
IDEA	63.82	10.92	29.82	46.72%	15.62%
Aircel/Dishnet	36.86	6.31	14.00	37.98%	7.34%
S Tel	1.01	0.17	0.27	26.85%	0.14%
MTNL	5.09	0.87	-	-	-
Sistema	3.78	0.65	0.54	14.29%	0.28%
HFCL	0.33	0.06	0.001	0.34%	0.00%
Unitech	4.26	0.73	1.40	32.77%	0.73%
Loop	2.84	0.49	-	-	-
Etisalat	0.0004	0.00	-	-	-
Videocon	0.03	0.01	-	-	-
Total	584.32	100	190.88	32.67%	100%

Source: The Indian Telecom Services Performance Indicators Report Jan-March 2010, Telecom Regulatory Authority of India.

Bharti with 127.62 million subscriber base remains the largest GSM mobile operator followed by Vodafone and Idea and BSNL with subscriber base of 100.86 million, 63.82

million and 63.31 million respectively. The subscriber base of Bharti, BSNL, Vodafone and Idea is around 75% of the total GSM subscriber base. Private operators contribute 86.88% subscribers and public sector operators (BSNL & MTNL) contribute only 14.22% subscribers in the GSM segment.

Table 4: Subscriber Base of GSM Operators

GSM Group	Subscribers (millions)	Share (%)
Bharti	127.62	26.66%
Vodafone	100.86	21.07%
IDEA	63.82	13.33%
BSNL	63.31	13.22%
Reliance	46.37	9.69%
Aircel / Dishnet	36.86	7.70%
Tata	26.91	5.62%
MTNL	4.78	1.00%
Unitech	4.26	0.89%
Loop	2.84	0.59%
S Tel	1.01	0.21%
Videocon	0.03	0.01%
Total	478.68	100.00

Source: The Indian Telecom Services Performance Indicators Report Jan-March 2010, Telecom Regulatory Authority of India.

Table 5: Subscriber Base of CDMA Operators

Service Provider	Subscribers (millions)	Share (%)
Reliance	56.05	53.06%
Tata	39.03	36.95%
BSNL	6.14	5.82%
MTNL	0.31	0.29%
HFCL	0.33	0.31%
Sistema	3.78	3.57%
Total	105.64	100

Source: The Indian Telecom Services Performance Indicators Report Jan-March 2010, Telecom Regulatory Authority of India

The CDMA subscriber base has reached 105.64 million in March 2010. Its distribution among the service providers is presented in Table 5. Reliance remains the largest CDMA mobile operator followed by Tata Teleservices and BSNL with subscriber base of 56.05 million, 39.03 million and 6.14 million respectively. It is notable that the respective share of MTNL, HFCL and Sistema in the total market is less than 4 percent. The top three players account for 96 percent of the total subscriber base in this market.

Circle-wise subscriber base

The Country is divided into 23 service areas consisting of 19 telecom circle service areas and 4 metro service areas for providing Cellular Mobile Telephone Service (CMTS). The market share distribution among Metros & Circles A to C is given below:

Table 6: Market Distribution among the Circles

Circles	Service Areas	No. of Subscribers (in millions)	Market Share (in %age)	% age Growth in 2010
Metros	Delhi, Mumbai, Chennai and Calcutta	124.86	21.37	8.10
Circles 'A'	Maharashtra, Gujarat, Andra Pradesh, Kanrataka and Tamil Nadu.	158.62	27.15	10.70
Circles 'B'	Kerala, Punjab, Haryana, Utar Pradesh (West and East), Rajasthn, Madya Pradesh, West Bengal and Andaman & Nicobar	223.99	38.33	23.94
Circles 'C'	Himachal Pradesh, Bihar, Orissa, Assam, North East and Jammu & Kashmir	76.85	13.15	21.13

Source: The Indian Telecom Services Performance Indicators Report Jan-Mar 2010, Telecom Regulatory Authority of India

Glance at the Table 6 hints at emerging patterns. It may be seen that Circles B have registered the maximum growth and are also the largest group in terms of number of subscribers with 23.94 % share. Another important finding is that the metro group has exhibited the least growth which indicates saturation in the metro cities. So far as the operators are concerned, in Delhi, there are four GSM mobile phone service providers viz., Airtel, Vodafone, MTNL and IDEA; and Reliance and Tata Indicom in the CDMA segment. In Mumbai Vodafone, Airtel and MTNL are the main players in GSM. Reliance and Tata Indicom are the CDMA providers in Mumbai. Aircel, Airtel, Vodafone and BSNL are providing GSM service in Chennai and Reliance and Tata Indicom are in the CDMA segment. In Kolkata, Airtel, Hutch, BSNL and Reliable Internet, Vodafone, Reliance and Tata are the key players. Main players in circle A are Airtel, Hutch, Aircel, Spice, BSNL and IDEA. In Circle B, Airtel, Hutch, Idea, BSNL, Aircel and Dishnet are the main players. In Circle C, Airtel, Reliance, Escorts, BSNL and Hutch are the main providers.

Increased competition in telecommunications has created a need for performance measurement and enhancement. Apart from understanding the consumer behaviour and distinguishing their product from other competitors, higher productivity and efficiency levels are indispensable for these firms to operate successfully in the long run. This study focuses on the efficiency aspect which is core component of productivity and attempts to

analyze the efficiency of telecom industry in India. In the current study, efficiency analysis is conducted initially on the telecom operators and later on the telecom circles. The objective behind this exercise is to find the most efficient telecom operator(s) in the industry along with insights about how far below other players are lying on the efficiency frontier. Similarly the circle-wise exercise will throw insights in terms of which most profitable circle(s) and how other circles are placed on this parameter. To conduct this relative efficiency analysis exercise, Data Envelopment Analysis is used.

RESEARCH METHODOLOGY

Data Envelopment Analysis (DEA) is a linear programming-based technique that can be used to evaluate the efficiency of a set of comparable economic entities such as firms, departments, individuals, processes etc. It emanated from the continued research interest in the problem of measuring the productive efficiency of an industry. Farell (1957) defined the term 'technical efficiency' as a firm's success in producing maximum output. Assuming constant returns to scale (CRS), Charnes, Cooper and Rhodes (1978) formulated it as a linear programming problem which could be used for multiple outputs and inputs. Considering its restrictive nature, Banker, Charnes and Cooper (1984), developed the variable returns to scale (VRS) model. This model helps to decompose the CRS technical efficiency into technical efficiency and scale efficiency components which allow investigating scale effects also. This decomposition shows the sources of inefficiency whether it is caused by inefficient use of resources or by disadvantageous conditions or both. Technical efficiency shows the ability of a firm to produce maximum output that is attainable. Whereas, scale efficiency presents insights on firm's returns to scale indicating whether a firm is operating at increasing, decreasing or optimal scale. Increasing returns to scale hold when a small increase in the input X results in considerable increase in the average productivity. Therefore a firm experiencing increasing returns can benefit from further expansion. Constant returns to scale means that an increase in input X leaves the average productivity unchanged. This situation makes a firm scale efficient. Decreasing returns to scale means an increase in input X leads to a decline in average productivity.

DEA's desirable characteristics make it preferable to other performance measurement techniques such as traditional ratio analysis and stochastic frontier analysis. First, being non-parametric in nature, DEA does not require the specification of an *a priori*, well-

defined functional form for the particular production process being analysed. Second, DEA permits the simultaneous incorporation of more than one input and output by assigning appropriate weights. Hence, it has been used widely in various areas such as banking (Oliveira and Tabak, 2005; Chen et al., 2005), hospitals (Staat, 2006), automotive components industry (Saranga, 2009), internet companies (Serrano-Cinca et al., 2005), vendor evaluation (Talluri et al., 2006), football teams (Garcia-Sanchez, 2007), university libraries (Reichmann and Reichmann, 2006), paper mills (Hua et al., 2007), higher education (Bougnol and Dula, 2006) traffic safety (Odeck, 2006) cement firms (Sharma, 2008), banks (Sharma and Gupta, 2010), SME sector (Sharma and Sharma, 2010) and for analyzing the Inter-country R&D performance (Sharma and Thomas, 2007) etc†. The formulation of the Variable Returns to Scale (VRS) DEA, used in this study is as below.

$$\min_{\theta,\lambda} \theta_m$$

such that

$$Y\lambda \geq Y_m$$
$$X\lambda \leq \theta X_m$$
$$\sum_{n=1}^{N} \lambda_n = 1$$

$\lambda \geq 0$; θ_m unrestricted.

θ is the dual variable corresponding to the equality constraint that normalizes the weighted sum of inputs of the primal problem.

λ is the dual variable corresponding to the other inequality constraints of the primal. It acts as a weight for the firms.

n stands for the number of DMUs, n = 1, 2, …., N.

m stands for the m^{th} Decision Making Unit (DMU).

X stands for the matrix of inputs. Y stands for the matrix of outputs.

The constraint $\sum_{n=1}^{N} \lambda_n = 1$ is termed a convexity constraint, and was introduced by Banker et al. (1984). To study the relative efficiency of the wireless service providers in the telecom industry in India, capital employed is taken as the input variable and the number of subscribers and total value of output are taken as output variables. An input oriented DEA model is used for this analysis assuming that company management would aim at minimization of inputs subject to attaining the desired output levels due to dmand side

† For an overview of the methodological developments in DEA, the reader is referred to Cook and Seiford (2009).

constraints. For the circle-wise study, number of subscribers has been taken as input and revenue generated has been considered as output variable. For this analysis, output oriented model is used under the assumption that in each circle, the revenue has to be maximized for a given level of subscribers. Study uses data for the year 2006 that is drawn from reports by Telephone Regulatory Authority of India and the Capitaline Plus online database developed and maintained by Capital Market Publishers India Pvt. Limited.

EMPIRICAL FINDINGS AND IMPLICATIONS

Using BCC DEA model, technical efficiency and the scale efficiency measures for 10 service providers and 23 area circles for the year 2006 are computed. Results for the service providers are presented in Table 7 and Figure 2.

If we look at the CRS results, we find that Bharti Airtel, Vodafone and Aircel are coming out to be technically efficient as these three are lying on the CRS frontier with efficiency score as one. However, when this assumption is relaxed and CRS technical efficiency is broken into VRS technical efficiency and scale efficiency as product of them, BSNL came out to be technical efficient. Such a finding implies that the inefficiency shown by BSNL under CRS, as a matter of fact, is attributable to scale inefficiency as reflected by its less than one scale efficiency score i.e. 0.60. Another important observation about BSNL is that under VRS framework, it is exhibiting decreasing returns to scale. This infers that it can attain scale efficiency by bringing down its size of operation or should focus on cost cutting methods. For HFCL, VRSTE came out to be 0.64 indicating 36 percent loss of efficiency in input utilisation. This also indicates that same amount of revenue and the level of subscribers can be technically sustained with 64 percent of the capital employed. This firm can gain from the further expansion of operations as it exhibited increasing returns to scale. Further, we find that in case of IDEA, the extent of inefficiency comes out to be 40 percent indicating massive scope for more efficient utilisation of capital invested. IDEA on the other hand has to either bring down the size of operations or use cost cutting measures to achieve scale efficiency. It is important to note here that MTNL and Reliance and Tata Tele are showing more than 40 percent inefficiency. The most dismal performance is reported by Tata Tele as its technical efficiency score comes out to be 0.22 only. Therefore its low level of efficiency can be attributed to low market share on one hand and high level of investment on the other hand. The increasing returns to scale indicated by our analysis suggest that these

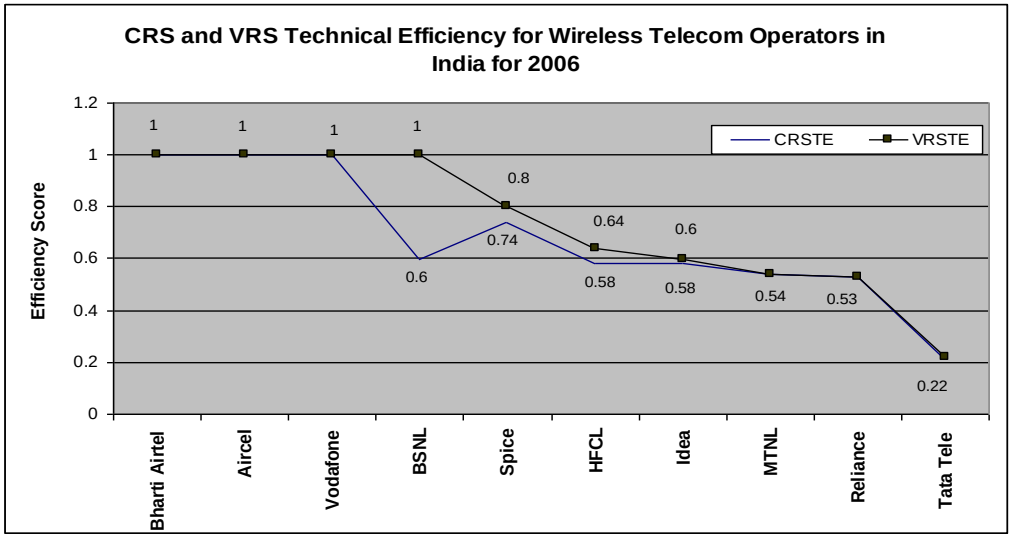
companies should scale up their size of operation and the vice-versa. Results for the circle wise efficiency analysis are presented in Table 8 and Figure 3.

Table 7: Efficiency Measures for different Service Providers

DMU	CRSTE	VRSTE	Scale Efficiency	Economies of Scale
Bharti Airtel	1	1	1	CRS
Vodafone	1	1	1	CRS
Aircel	1	1	1	CRS
BSNL	0.6	1	0.6	DRS
Spice	0.74	0.8	0.93	IRS
HFCL	0.58	0.64	0.90	IRS
IDEA	0.58	0.6	0.97	DRS
MTNL	0.54	0.54	1	CRS
Reliance Communication Ltd	0.53	0.53	1	CRS
Tata Teleservices	0.21	0.22	1	CRS
Geometric Mean	0.68	0.73	0.94	

CRSTE: Constant Returns to Scale Technical Efficiency; VRSTE: Variable Returns to Scale Technical Efficiency; IRS: Increasing Returns to Scale; CRS: Constant Returns to Scale; DRS: Decreasing Returns to Scale

Figure 2: Technical Efficiency Frontier



As we can see from the Table 8, Delhi is the only circle coming on the CRS and VRS frontier with technical and scale efficiency score as one. Hence, it can be inferred that from the given level of subscribers maximum revenue is generated in Delhi. Apart from Delhi, Himachal and North East also came out to be the technically efficient circles within the VRS framework. In the entire group 14 circles viz., Mumbai, Chennai, Kolkatta,

Karnatka, Gujarat, Punjab, J&K, AP, Maharashtra, Haryana, Assam, MP, Orissa and UP (West) have their technical efficiency score between 0.91 and 0.61. On the other hand, Rajasthan, Bihar, West Bengal, UP (East), Tamilnadu and Kerala, these 6 circles are having efficiency scores less than 60 percent indicating tremendous scope for further revenue generation. Low efficiency levels indicate that per subscriber revenue is not optimised. Therefore there is need to improve the quality of service (Seth et al., 2008) apart from providing more value added services, incentive schemes and lowering down of call charges. This will lead to more usage of the service by the existing customers and hence will in turn maximise the revenue. The entire area of all the circles reported 70 percent efficiency level. An interesting finding has been that except Delhi all circles are exhibiting increasing returns to scale. This indicates scope for further expansion in terms of more subscribers in these circles.

Figure 3: Variation in Technical Efficiency across Telecom Circles

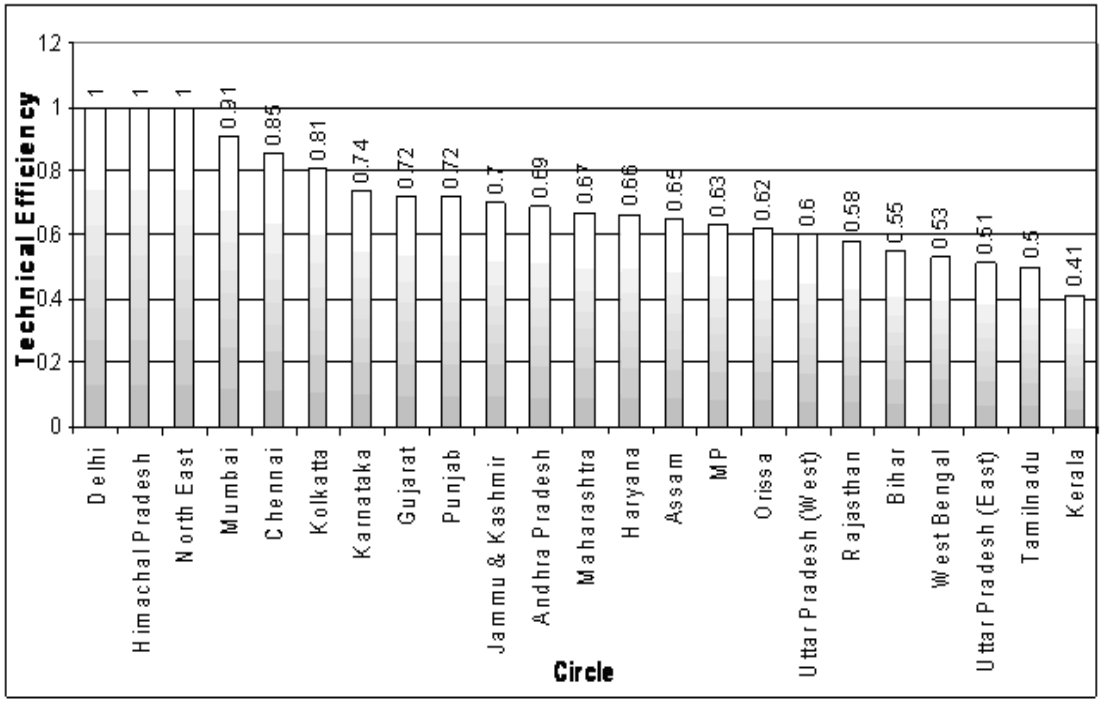


Table 8: Technical efficiencies in different circles in India

Circle	CRSTE	VRSTE	Scale Efficiency	Economies of Scale
Circles with VRSTE as 1				
Delhi	1	1	1	CRS
Himachal Pradesh	0.6	1	0.6	IRS
North East	0.36	1	0.36	IRS
Circles with VRSTE between 0.91 and 0.60				
Mumbai	0.91	0.91	0.99	IRS
Chennai	0.78	0.85	0.91	IRS
Kolkatta	0.71	0.81	0.89	IRS
Karnataka	0.72	0.74	0.98	IRS
Gujarat	0.7	0.72	0.98	IRS
Punjab	0.69	0.72	0.96	IRS
Jammu & Kashmir	0.36	0.7	0.52	IRS
Andhra Pradesh	0.67	0.69	0.97	IRS
Maharashtra	0.65	0.67	0.97	IRS
Haryana	0.52	0.66	0.78	IRS
Assam	0.4	0.65	0.62	IRS
MP	0.55	0.63	0.86	IRS
Orissa	0.44	0.62	0.7	IRS
Uttar Pradesh (West)	0.54	0.6	0.9	IRS
Circles with VRSTE below 0.60				
Rajasthan	0.5	0.58	0.87	IRS
Bihar	0.46	0.55	0.84	IRS
West Bengal	0.41	0.53	0.78	IRS
Uttar Pradesh (East)	0.46	0.51	0.91	IRS
Tamilnadu	0.47	0.50	0.93	IRS
Kerala	0.34	0.41	0.84	IRS
Geometric Mean	0.58	0.7	0.83	

Let us draw key implications of the study for strategists in industry, government and academia. The findings give clues to strategic decision makers for effectiveness and efficiency. Players with low efficiency should think about strategic initiatives to enhance it. They can simulate the results by taking alternate measures of efficiency (e.g. capital expenditure or operating expenditure per subscriber) or effectiveness (e.g. number of new products or services developed per billion rupees invested in technology development). Efficient players should think about next stages of growth, differentiation through capabilities on relevant dimensions such as quality, design, technology or internationalization. Rapid international market growth is becoming essential for leading players, as they should try to partly balance very adverse trade competitiveness situation (details in Table 1) that "extreme out sourcing" models initiated by players such as Bharti. They should consider strategic options for rapid scale-up in innovation or technological competitiveness.

Policy makers and regulators should consider competitiveness and not just diffusion of services for sustainable growth. For that competitiveness of industry on factors such as manufacturing, international trade, innovation, technology as well as overall employment and productivity should be considered. Academia and researchers should undertake more detailed studies that incorporate other factors of competitiveness such as total factor productivity, technological and manufacturing, value creation and capture. Emerging tools of strategy planning for national competitiveness such as "Term-Priority Matrix," can be explored to evolve specific implications for stakeholders such as bureaucrats, corporate leaders. For such studies, quality data need to found or evolved, at times using proxies.

DISCUSSION AND CONCLUDING REMARKS

Leveraging the value creation potential of the vast and growing ICT industry demands strategy and competitiveness. Telecommunications is one of the fastest growing industries in the world due to its capacity to offer communication, entertainment, information, and services. Telecom in India has tremendous potential to grow in future. With the increasing intensity of internationalisation in India, the telecom firms are facing huge competition. Therefore it is crucial for the firms to enhance efficiency and productivity levels to remain competitive in the long run. In this paper, an attempt was made to examine the efficiency in the telecom industry in India by applying Data Envelopment Analysis (DEA) to different service providers first and then to the area circles. From the results, Bharti Airtel, Vodafone Aircel and BSNL came out to be the most efficient service providers. Another important but surprising insight is that MTNL, Reliance and Tata Teleservices have shown the lowest efficiency levels. Therefore there is tremendous scope for improvement in resource utilisation in these firms. These results have significant managerial implications for the inefficient firms since they come to know how far they are lagging behind the efficient players. The best performers in their technology domain can be taken as the benchmarks to improve the efficiency levels. Findings for the analysis performed on circles showed that Delhi, Himachal Pradesh and North East are the circles with maximum efficiency levels, whereas Rajasthan, Bihar, West Bengal, Uttar Pradesh (East), Tamilnadu and Kerala reported lowest efficiency levels.

Vast differences in efficiencies among different players and states hit at enormous potential to improve. Growth in India is being driven by fierce competition among firms, many of them focusing narrowly on services as an easy option. Considering, very slow

employment growth and economic development at the base of the pyramid (BOP) and questionable overall contribution of telecom to that, there is an urgent need for better approaches to measure competitiveness of firms, particularly capital efficiency. Firms with narrow focus on specific service (e.g. wireless for Hutch, now taken over by Vodafone) or smaller part of the industry value system (e.g. Bharti with narrowing focus on customer front through innovative model of outsourcing most of operations, including core network) can have better efficiency in the short run. However, the picture can be quite different, if other factors are incorporated into the productivity model.

From a strategic perspective, the telecom growth engine in India may not sustain for long, if several fundamental imbalances and barriers to competitiveness (e.g. Mittal et al., 2009) are not addressed. Our longitudinal research indicates that despite liberalization and globalization for decades, the competitiveness diamond of telecom industry (see Momaya, 2001: 107) has not improved much and the result become visible on fronts such as international trade (Table 1) and technology. Statistical analyses of globalization inequality indices (GIIs) (Kim, 2006) show that benefits from globalization are unequally distributed over countries and India faces massive challenges ahead in telecom. Findings of from our ongoing research hint at much rapid scale-up in capabilities at firm as well as country level. Several telecom firms in India have high capital efficiency, at least within India. Creating and delivering high value to customers in India and internationally may demand different and higher capabilities. Leadership in government and firms should address the critical issues such as trade, technology and ultimately imbalances such as digital divide that are reaching alarming levels in India. Considering the stage India is and as per the Nine-Factor Model (e.g. Cho and Moon, 2005), human factors, particularly politicians and bureaucrats, have very vital role to play for competitiveness. Productivity as well as competitiveness of telecom industry, including equipments, products and systems is very important and needs considerable further research.

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