

An Exploratory Study on Factors Influencing Spectrum Pricing Strategies in Indian Telecommunication Sector

Rajendra Kumar Joshi and Lata Rani

Abstract—It is a well-known fact that India's telecommunications sector has been a growing service sector over the past three decades. It has played an integral role in accelerating the growth of the Indian economy. Spectrum is the major factor affecting the growth of telecommunications in the country and, therefore, is also seen as a multiplier for the economic growth of the Indian economy. Thus, optimal pricing of scarce economic resources like spectrum assumes paramount importance. Important factors or variables that have an impact on spectrum pricing strategies in the telecommunications sector in India and their relative impact are examined in this Paper.

Index Terms—ARPU, exploratory analysis, ITU, regulatory provisions, spectrum pricing, spectrum pricing strategies, telecommunication sector, TRAI etc.

I. INTRODUCTION

The major cause of decline in fixed line subscribers is the growth of cellular phones [1]. The growing popularity of mobile phones is due to their compact size, easy use, comfortable handling and especially their connection even when mobile. Tremendous upgradation of these cell phones (for features, speed, look and portability etc) have been very evident since their inception. The low cost of handsets and economical tariff has opened a huge market for the telecom sector in India [2], [3]. As per publicly available information, currently Indian has the second largest subscriber base in the world after China. Growth in telecommunications has a more than proportionally (multiplier) effect on the Indian economy.

NDCP-National Digital Communication Policy, 2018 of Government of India (GoI) predicted that the investment of one hundred million dollars in the Indian telecom sector would result in the rise of 1.21 Trillion dollars contribution to the Indian GDP on a cumulative basis¹. Currently the subscribers of telecom in India are about 1174 Million (with 1154 Million Wireless subscribers and 20 Million Fixed Line Subscribers) at the end of December 2020 [4].

II. OBJECTIVES OF THE STUDY

For any type of communication, spectrum becomes a scarce resource due to increasing demand and new

technology development [5]. The right price of spectrum is very important from the point of view of the country and consumers. Charging less will be a loss to the public purse and, overbilling will be detrimental to the interests of consumers.

Pricing and spectrum assignment influences the costs of telecommunications service providers (TSPs) through their network costs and service quality. These costs end up being passed on to customers (or the nation). Therefore, it is important to explore the factors that influence spectrum pricing strategies so that their impact can be properly measured and the optimal price is arrived at. Thus, the *main research objectives of the study* are: - a. to identify the relevant factors affecting the spectrum pricing strategies in the Indian telecommunication sector and b. to study the impact of factors on spectrum pricing strategies in the Indian telecommunication sector.

III. REVIEW OF LITERATURE

A spectrum sharing strategy has been advocated [including between primary users (licensed users) and clusters (unlicensed users)], to get the maximum value of spectrum [6]-[10]. Author of [11] recommends that each regulatory agency should adopt a well-organized process to manage this scarce resource along with other stakeholders. [11] further recommends a market based, multi-usage and technological neutral approach in these countries to make more efficient use of spectrum and get the best value. [12] Opines that an important step in spectrum valuation by opportunity cost approach is to analyze the proper representative of bidders which can be either a major operator in the market or an average firm. Telecom Regulatory Authority of India (TRAI) Recommendations, 2013 and 2017, have advocated the adoption of more than one approach or method of valuation by stating "Since there are no naturally competitive markets for spectrum, valuation of spectrum has to be undertaken through various alternative techniques. A market-based approach is a valuation technique where the value of an asset is calculated based on the prices of actual transactions for similar assets". Reference [13] have attempted to develop a modelling framework for spectrum pricing index by identifying generic factors influencing spectrum pricing and thereafter developed linkages and hierarchy of factors by using Interpretive Structural Modelling (ISM) and Total Interpretive Structural Modelling (TISM).

Reference [14] is a report which analyses the various spectrum auctions conducted by the Department of Telecommunication, India during 2010 to 2016 and does a relative comparison. The study provides requisite data,

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Rajendra Kumar Joshi is with the Indira Gandhi National Open University, India (e-mail: joshirk@rediffmail.com).

Lata Rani was with India University of Engineering and Management, India (e-mail: lata.mutti@uem.edu.in).

¹<https://economictimes.indiatimes.com/news/economy/indicators/100-billion-investment-in-telecom-to-add-1-2-trillion-to-indias-gdp-report/articleshow/66973009.cms?from=mdr>

analysis and reasons for success or failure of each auction. [15] Disentangles and quantifies major factors that differently contribute to the spectrum value. [16] Brings out that flexible use licenses are more valuable than the licenses that prescribe certain uses. also states that policy uncertainty depresses the license value. Reference [17] proposed a model of Artificial Neural Network (ANN), a non-parametric model against the parametric models that need a higher background of statistics. [18] Compares the auction strategies adopted in different countries and suggest approach for 'value for money'. International Telecommunications Union (ITU) , 2016 report titled ""Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fee schedules"" states that license renewal fees set by regulators may often be based on technical and business modeling of spectrum value and should provide some indication of market value. [19] Recommends that while estimating the price of the spectrum based on benchmarking, necessary adjustment with respect to technical, social and economic factor be done to cater the changes. Reference [20] states that the current assignment and allocation of spectrum is unlikely to be at market equilibrium, for the simple reason that economic factors have only had a very indirect impact (if any) on past allocation and assignment decision. [20] further states that radio spectrum as a natural resource is practically useful and limited over its whole width, but in some parts its limitation increases, i.e. it is relatively limited.

The review of the literature brings out that spectrum pricing and related strategies present a complex and challenging set of practical and theoretical issues. There is no one-size-fits-all approach to assessing spectrum price for sale to TSPs. The factors influencing the valuation of these methods are though not same but many factors are common.

In addition, factors need to be reviewed regularly (including need of addition/deletion) because of the dynamic nature of the technology and economic aspects. It is generally agreed to use a number of valuation methods, and to consider the value indications concluded by each in certain predetermined weights in order to provide an estimate for the final value. This weighted average price plays a vital role, since the reserve price is calculated by TRAI/DoT according to this. The reserve price is the reference price under which the sale cannot be made.

IV. RESEARCH METHODOLOGY

This paper is primarily a descriptive study, but an exploratory analysis of variables impacting spectrum pricing strategies has also been undertaken. This blended approach was adopted to predict their influence on spectrum pricing strategies in the telecom sector in India. The data was compiled using a well written questionnaire. Sample size of 300 considered to be appropriate by the Cochran's formula and Nunnally method.

Prior to conducting Exploratory Factor Analysis (EFA), the reliability test, sphericity test and sample adequacy tests were performed. Factor identification was conducted against the EFA using the SPSS 19 program through the Principal Component Analysis (PCA) for factor extraction. Factors with a Eigen value of more than 1 were selected. The

component matrix and Varimax rotation were also adopted. Their names (Identified Factors) were decided on the basis of literature review and auction details held over the past 20 years. Details of the auction are available on websites, books and magazines, and from government and regulatory agencies, etc. The names of the factors were validated after discussion with experts from industry, regulators and academics, etc. The reliability of the identified factors was further tested by verifying their Cronbach's alpha value.

A. Questionnaire Development

From the thorough insights of the review of literature, the initial 51 items questionnaire was developed. All items impacting spectrum pricing were reviewed following a thorough investigation and discussions with TSP executives, officials of TRAI/Department of Telecommunications (DoT) and academicians. A pilot study was conducted and, according to the reliability tests, the final questionnaire containing 43 items was finalized. Cronbach's alpha score which was calculated at 0.607 with 51 items in the initial questionnaire was improved to 0.925 after dropping 8 items in the Final Questionnaire of 43 items. Experts' opinions were again sought before the final instrument was prepared. Since the spectrum pricing is quite uncommon to a common man thus he data have been collected from the selected persons which interalia include executives/ ex-executives from TSPs, Officials from TRAI & DoT dealing with spectrum pricing, employees/ex-employees from private telecom consulting firms and research scholars etc. Factor analysis was used in the analysis of factors affecting spectrum pricing strategies.

The statistical tests and criteria have been used to explore/validate the relative importance of factors. The data was attempted from a sample of 400 respondents who are the main stakeholders in spectrum pricing. And convenience sampling was used as the study is an exploratory research plan, as convenience sampling is best suited to exploratory research.

B. Data Collection and Preparation

TABLE I: MEASURE OF SAMPLING ADEQUACY AND TEST OF CHI-SQUARE SPHERICITY

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.7944
Bartlett's Test of Sphericity	Approx. Chi-Square	1410.385
	df	406
	Sig.	.000

Data was received from 352 respondents at that point. 309 data were considered to be useable (other than incomplete data, duplicate data and outliers). The skewness and kurtoses were conducted to check whether the sample has been drawn from normally distributed population. The value of the skewness and kurtosis was calculated as -0.255 and 0.436 which is within the range of -1 to + 1. Further, in order to fulfill the objectives, factor analysis has been used. In order to check the adequacy of the sample size, KMO and the Bartlett test table were undertaken to check the sphericity of the data and the adequacy of the sample size. From the table, it is clear that the sample taken was adequate for factorial

analysis and that there was sufficient correlation among these factors which is significant at 95% confidence level.

V. ANALYSIS AND FINDINGS

The results clearly indicated that Spectrum Demand and Competition, Regulatory Provisions, Spectrum Availability, Cost, Auction and Reserve Price Rules, Spectrum efficiency and Revenue (Potential Revenue) are the key influencers affecting spectrum pricing strategies in the telecommunications sector of India. Details of these factors and their impacts are dealt with in the following paragraphs: -

Factor 1 Spectrum Demand and Competition

The first factor that influences spectrum pricing is 'Spectrum Demand and Competition', which includes the 10 items, i.e. Service Providers influence, Other Players' influence, Demographic Profile of the country, Population Density, Tele Density, Volume and growth Rate of Voice traffic, Volume of Data traffic, Growth rate of data Traffic, Income Level and Income Distribution and Competition in the Sector etc. The above variables within this factor have a positive factor loading of 0.874 and above, total variance of 22.57% and Cronbach's Alpha Score of 0.856.

Factor 2 Regulatory Provisions

The second factor that influences the spectrum pricing is 'Regulatory Provisions', which includes the 08 items i.e. Restrictions imposed for its salability in the open market, Licensing framework, Coverage obligations rules, Infrastructure sharing rules, Ease of doing the business etc, the Rules of protection of the public against electromagnetic waves, the limitation of and protection against interference and rules and regulatory framework with regards to anti-competitive behavior of the operators and predatory pricing etc. The above variables within this factor have a positive factor loading of 0.944 and above, total variance of 18.81 % and Cronbach's Alpha Score of 0.889.

Factor 3 Spectrum Availability

The third factor that influences the spectrum pricing is 'Spectrum Availability', which includes 6 Items i.e. restrictions imposed for its usage i.e. cap on the maximum number of users per cellular firm that can be provided and restriction with respect to technology that can be deployed (2G/3G/4G) etc (technology neutrality), restrictions imposed for maximum quantity of spectrum (cap), Reservation of licenses for next/subsequent auction(s), block size of spectrum offered, Open access rules and influence of the Regulator and Government on quantity made available etc. The above variables within this factor have a positive factor loading of 0.812 and above, total variance of 12.12 % and Cronbach's Alpha Score of 0.991.

Factor 4 Cost (Present and Expected)

The fourth factor which influences the spectrum pricing is 'Cost', which includes 6 Items i.e. Interest rate, Core network cost, Network maintenance cost, Interconnection Usage charges, Site rental cost and Various non-operating costs etc. The above variables within this factor have a positive factor loading of 0.655 and above, total variance of 10.28 % and

Cronbach's Alpha Score of 0.905.

Factor 5 Auction and Reserve Price Rules

The Fifth factor which influences the spectrum pricing is 'Auction and Reserve Price Rules' which includes 4 Items i.e. Type of Auction and Auction Rules, level of reserve price, Auction deposit amount and terms of payment (down payment size, number of years etc). The above variables within this factor have a positive factor loading of 0.959 and above, total variance of 9.69 % and Cronbach's Alpha Score of 0.995.

Factor 6 Spectrum Efficiency

The Sixth factor which influences the spectrum pricing is 'Spectrum efficiency' which includes 5 Items i.e. Efficiency of the bandwidth, Distance of the spectrum from the ground, Block size of spectrum offered, fragmentation of spectrum and harmonization of spectrum etc. The above variables within this factor have a positive factor loading of 0.937 and above, total variance of 8.61 % and Cronbach's Alpha Score of 0.998.

Factor 7 Revenue and Potential Revenue

The Seventh factor which influences the spectrum pricing is 'Revenue and Potential Revenue' which includes 4 items i.e. Average Revenue per User (ARPU), Potential ARPU, Total Revenue and economic growth (current and potential). The above variables within this factor are having positive factor loading of 0.557 and above, total variance of 6.25 % and Cronbach's Alpha Score of 0.828.

VI. CONCLUSION

Demand for spectrum as a natural resource is not as straightforward as it is for most commodities. It is derived from the demand for final goods and services produced by using spectrum as an input. Spectrum demand is spin-off demand.

The assessment of spectrum is determined largely by its demand which, in turn, depends on the willingness and capacity to pay of a large number of spectrum users including Telecom Service Providers (TSPs) who use it as an input in the production of telecom services. Thus, evaluation represents: what price the market would ultimately be willing to pay for spectrum. This will be guided by various factors and sub factors as analyzed above. It is recognized that optimal spectrum pricing is essential and therefore a proper assessment of the factors that influence spectrum pricing must be carried out and reviewed regularly in accordance with changes in the economic and technological environments. The identification and regular review of factors will also facilitate the development of a single pricing model that can be used by regulators under various circumstances i.e. auction by the government, determining prices when the company is to dispose it off the spectrum while undergoing Corporate Insolvency Resolution Process (CIRP) or otherwise. If successful in India, other countries can also use the same model as reference in consultation with respective groups of the International Telecommunication Organization (ITU).

CONFLICT OF INTEREST

Authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Rajendra Kumar Joshi (RKJ), conducted the research,; RKJ and Dr Lata Rani (LR), RKJ along with LR jointly analyzed the data; RKJ wrote the paper. LR also contributed as reviewer. Both the authors had approved the final version.

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Rajendra Kumar Joshi was born in Jhunjhunu, Rajasthan, India, on April 13, 1969. He got the master of commerce (accountancy & business statistics), University of Rajasthan, 1990 *Highest Marks in University*; the master of science (defence and strategic studies) first division, University of Madras, 2005; the master of business administration (finance), National Institute of Financial Management, 2009 *Gold Medalist*; University Grant Commission(UGC)-National Eligibility Test (NET). He was qualified and pursuing the Ph.D. from Indira Gandhi National University (IGNOU), New Delhi.

He is presently working as senior vice president, strategy & planning, Jio Platforms Limited (Subsidiary of Reliance Industries Limited a Fortune 100 Company) at Delhi since March 2020. Prior to this, he has worked as a commissioned officer in Accounts Branch of Indian Air Force (including deputations to civil government organizations like Telecom Regulatory Authority of India (TRAI), Canteen Stores Department (CSD)), for more than 25 years. He has also worked as Senior Advisor (at Associate Partner level) with Ernst & Young, India for about a year in Risk Advisory department. He has also worked with a private limited company as President (Strategy) for about 8 month after leaving IAF.

Group Captain Joshi is fellow member of Institute of Cost Accountants of India (ICAI), associate member of Chartered Institute of Management Accountants, UK, member of Chartered Institute of Public Finance & Accounts, UK, registered insolvency professional in India and Qualified Valuer in Security and Financial Assets in India etc. He is member advisory committee of Insolvency Professional Agency (IPA) of ICAI and member Professional Development Committee of ICAI etc. He is member advisory committee of International Journal of Gurugram University, Haryana, India.



Lata Rani is an associate professor. She was born in Jalandhar, Punjab, India, on June 27, 1982. She got the Ph.D., Indira Gandhi National Open University, New Delhi, 2016; M.Phil., Kurukshetra University, Kurukshetra, 2006; the master of commerce, Guru Nanak Dev University, Amritsar, 2004; UGC-JRF-NET qualified and working as associate professor at Delhi Skill and Entrepreneurship University, New Delhi, India. She has achieved her Masters and PhD with distinction.

She has strong academic background with sufficient extra-curricular exposure; she has 15 years of experience of teaching, research, administration, training and consultancy. She has contributed widely in research from conceptual framework to analysis of different financial research topics. She has been awarded best teacher awards for many years and holds good knowledge of Research Methodology. She is a permanent member of All India Commerce Association.

Prof. (Dr.) Lata Rani is also a reviewer and technical member for Technical Program Committee for "2021 The 9th International Conference on Business, Management and Governance ICBMG-2021, organized by The University of Western Australia. She is also a member of the Advisory Committee of the World Research Society. She has delivered many talks at an academic and industry level. She has been appreciated for her academic career by different institutions at national and international level. Integrity, Leadership, Teamwork, Productivity, Dependability, Communication, Work ethic, Organizational skills, Collaboration are few words that describe her.