ITU-T

Methodologies for valuation of spectrum

Technical Report

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Summary

This technical report proposes various methodologies that can be used for valuation of spectrum arriving at reserve price for auction of the air-waves.

Keywords

Spectrum, valuation, methodologies, pricing, radio

Change Log

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Methodologies for **valuation of spectrum**

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Introduction

Spectrum is a scarce natural resource: it is finite and limited by geographical range. Unlike other natural resources which are exhaustible, electromagnetic spectrum cannot be depleted. Owing to its limited availability, the need for its efficient allocation is appreciated. Pricing of spectrum is important to avert any «tragedy of the commons» problem. If every individual (spectrum user) tries to reap the greatest benefit from a finite common resource, the demand for the resource will overwhelm supply. Every individual who consumes an additional unit directly imposes a cost on others who can no longer enjoy commensurate benefits. Allocation of spectrum through auction leads to efficiency as spectrum is sold to those who value it the most.

The demand for spectrum as a natural resource is not a direct one like for most commodities. It is derived from the demand for final goods and services that are produced using spectrum as an input. The demand for spectrum is a derived demand. Valuation of spectrum is determined to a large extent by its demand which, in turn, depends on the willingness and ability to pay of a large number of spectrum users or Telecom Service Providers (TSPs) who use it as an input in the production of telecom services. Thus, valuation represents: what price would the market eventually be willing to pay for spectrum?

1-Scope

This Technical report proposes various methodologies that can be used for valuation of spectrum arriving at reserve price for auction of the air-waves.

2- Abbreviations and Acronyms

ARPU, BTSs, CII, EBITDA, NPV, PLR, RAN, TSPs, WACC.

3- Methodologies for valuation of spectrum

3.1. There are different ways of arriving at the value of the spectrum, all of which have their merits as well as their drawbacks. Rather than count on one method, prudence suggests it would be better to rely on a number of such models to arrive at a final reasonable valuation and then to base a reserve price on such valuation. The valuation has to be based on clear and cogent reasoning, transparency, logic, and scientific method. Member States taking into account specific national or regional conditions could look at the following methodologies for guidance purpose:

3.1.1 Price from previous auctions duly indexed

The price realised from previous auctions for various spectrum bands duly indexed can be used as one method of valuation of spectrum. The indexation can be done using the following:

a) **Base Rate:** The Base Rate (in many countries also known as prime lending rate (PLR) is a term for a reference interest rate used by banks. Base Rate is used as a guide for computing interest rates for most of other categories of borrowers which are linked to Base Rate. Annual Base Rate over a period of years - weighted average Base Rate for the years in which Base Rate varied over the course of the year can be applied to calculate the present indexed value.

b) **Weighted Average Cost of Capital (WACC):** The Weighted Average Cost of Capital (WACC) indicates the rate of return that an entity needs to earn to reward its investors. An adequate return say 15% on capital employed can be applied to compute the present indexed value.

c) **Cost Inflation Index (CII):** The Cost Inflation Index (CII) is a measure of inflation that finds application in tax law, when computing long-term capital gains on the sale of assets. The CII can also be used to compute the indexed present value of assets purchased in the past. The year-wise CII can be applied to compute the present indexed value of spectrum previously purchased.

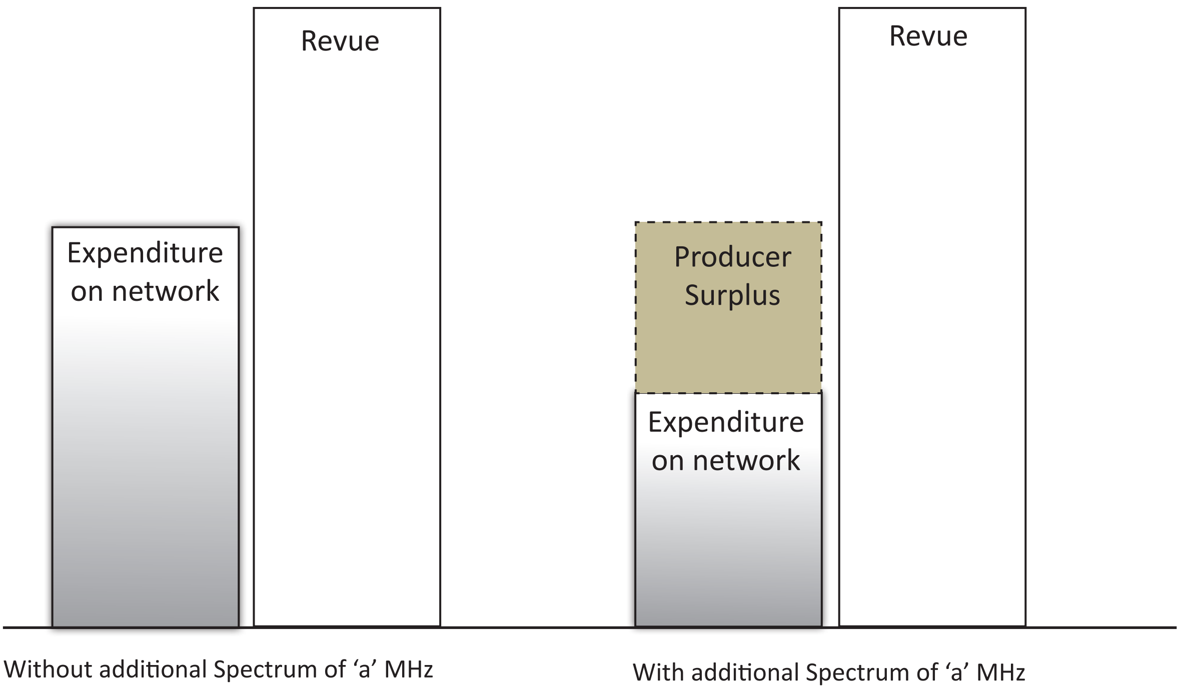
3.1.2 Estimating the Value of Spectrum by Assessing Producer Surplus on Account of Additional Spectrum

Spectrum may also be valued on the basis of 'Producer Surplus' that arises when additional spectrum is allocated to an existing TSP. As there is an inverse relationship between the quantum of spectrum allocated and the expenditure on the radio access network (RAN) required for serving a particular level of demand, the allocation of additional spectrum to an existing TSP will create a producer surplus.

Let us consider a TSP offering GSM service having ‘x’ MHz of spectrum. The TSP has drawn its long term demand model and thereby it has made projections of (i) geographical coverage requirements and (ii) network capacity requirements in each year with ‘x’ MHz of spectrum available to it. In order to fulfil its requirements of coverage and capacity, the TSP has to make capital expenditure on the network apart from incurring operating expenditure to run the network every year. Accordingly, the TSP has estimated the total expenditure on the network to be incurred in each year during the next ‘y’ years, which shall be required to fulfil its projected demand.

If the TSP obtains an additional spectrum of ‘a’ MHz today, the capital expenditure on the network and operating expenditure to run the network in each year, required to fulfil the same demand, will be lower owing to the inverse relationship between the spectrum available and the expenditure on the network. A working hypothesis could be that the value that the TSP places on the additional spectrum is approximately equal to the cost savings upon its acquisition.

It would be necessary to estimate the expenditures to be incurred during the next ‘y’ years for the two cases described above i.e. one with the available spectrum of ‘x’ MHz and the other with spectrum of ‘x+a’ MHz on the basis of demand and network expenditures and compute the present value (PV) of the estimated expenditures. The following Figure indicates how the producer surplus would arise:



The producer surplus on account of additional spectrum of 'a' MHz may be estimated as below:

Producer surplus on account of additional spectrum of 'a' MHz

= Present value of the expenditure on the network during the next 'y' years without additional spectrum of 'a' MHz *minus* Present value of the expenditure on the network during the next 'y' years with additional spectrum of 'a' MHz

The amount of producer surplus can be estimated by using the industry data of number of subscribers, usage and cost of radio access network available with the relevant authorities.

3.1.3 Valuation of Spectrum using a Production Function Approach

The Cobb-Douglas function is a widely used functional form to estimate a production function by estimating the relationship between inputs and output. The production function is specified as follows:

$$X = Ay^{\alpha} z^{\beta} \qquad (1)$$

In the above equation, the dependent variable (X) is the minutes of usage. The independent or explanatory variables are: (i) Allocated amount of spectrum (y) and (ii) No. of Base Transceiver Stations (BTSs) deployed by a service provider (z). The parameters α and β reflect the percentage change in minutes of usage for a percentage change in spectrum and BTS respectively.

The above specification is based on the assumption that the two inputs spectrum and BTS can be substituted for each other over a given range of output. An optimal mix of both will be used by service providers to produce the required traffic and that optimal mix is determined by input prices. A higher charge for spectrum will induce service providers to substitute the less expensive BTS for spectrum over the relevant range to get the same minutes and vice versa.

To estimate the above production function (equation 1) we can linearize it by taking logs on both the sides as follows:

$$\ln X = \ln A + \alpha \ln y + \beta \ln z \qquad (2)$$

A panel dataset for minutes, BTS and amount of spectrum held by established TSPs can be utilised.

The condition so as to realise the optimal input mix of both spectrum and BTS is given by:

$$\frac{MPy}{Py} = \frac{MPz}{Pz} \qquad (3)$$

Where,

MPy = Marginal Productivity of spectrum
MPz = Marginal Productivity of BTS
Py= the Price of spectrum
Pz = the Price of BTS

Equation (3) states that, at the optimum, a TSP will allocate expenditure between the two inputs in such a manner that they yield the same marginal productivity per rupee spent. MPy and MPz can be calculated by differentiating the above specified production function (equation 1) as follows:

$$MPy = \frac{\alpha A y^{\alpha} z^{\beta}}{y} \quad \textbf{(4)}$$

$$MPz = \frac{\beta A y^{\alpha} z^{\beta}}{z} \quad \textbf{(5)}$$

Now, by making use of the above calculated MPy and MPz the value of spectrum, denoted by Py is derived as follows:

$$Py = \frac{\alpha z}{\beta y} Pz \quad \textbf{(using 3, 4, 5)}$$

Where, z is the number of BTSs deployed and y is the amount of spectrum allocated. α and β are the estimated coefficients of the production function.

Thus, using a panel data set of minutes of usage, spectrum allocated and BTS set up in various regions for different operators over certain period, the required estimated coefficients can be obtained and then used in the above equation to derive the prices of spectrum i.e. Py (price per MHz) across regions.

3.1.4 Valuation of Spectrum using a Revenue Surplus Approach

An alternative approach to assess the value of spectrum could be from the perspective of a TSPs willingness to invest in spectrum to realize the net revenue potential/revenue surplus from the wireless market over the licence period. The approach is based on the concept of net present value (NPV).

The primary data for this approach would be industry data of number of subscribers, revenue, Average Revenue Per User (ARPU). Other inputs such as projected growth rate of subscribers and ARPU, Earning Before Interest, Tax, Depreciation and Amortization (EBITDA) Margin, projected Capex, rate of depreciation, return on capital investment, discount rate needs to be adjusted on country to country basis.

Let us assume a TSP willing to invest in a spectrum band. On the basis of available market data and other inputs, the TSP has projected number of subscribers, ARPU and corresponding revenue. Similarly quantum of investment (in fixed assets – property, plant and equipments) to be made to cater projected subscribers is to be worked out. Running expenses (including depreciation) can be estimated based on existing industry data available. Return on the estimated investment also needs to be included in the costs. The NPV of projected revenue surplus per MHz of spectrum over the license period (net of all expenses/costs) would potentially represent the maximum amount which a buyer would be willing to pay for acquiring the one MHz of spectrum.