Spectrum Pricing – Theoretical Approaches and Practical Implementation

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Demand for radio spectrum is steadily increasing → The responsible authorities have to provide a framework for an optimal use of spectrum.

Questions for spectrum authorities are inter alia:

- Which are the pricing mechanisms for spectrum usage?
- How to overcome scarcity in a frequency band by creating incentives to foster optimal use of radio frequencies?

Aim of this presentation:

- Describe the relevant “toolbox” for spectrum pricing available to authorities
- Demonstrate current international trends in radio frequency pricing (based on 15 selected countries)
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General strategies available for spectrum authorities

- Large number of issues are relevant for the spectrum strategy, e.g. efficient usage, public and social benefits, innovation and growth, framework conditions, licensing regimes, etc.
- Various strategies available for setting the appropriate fees for spectrum users.

**Cost based**
To derive the license fees from the associated costs of spectrum management

**Contribution based**
To consider license fees as a contribution to the national budget

**Market based**
To apply market mechanisms to ensure efficient usage

Maximizing benefits for investors

Maximizing benefits for government and optimal usage
The ecosystem for spectrum pricing

**Policy:**
- Efficient/optimal use of spectrum
- Interference free use
- Public and social benefit
- Promotion of competition

**The Toolbox:**

1. **Framework Conditions:**
   - Spectrum Trading / Leasing
   - Spectrum Sharing

2. **Pricing Methodologies:**
   - Cost Orientation
   - Incentive Pricing
   - Administered Incentive Pricing (AIP)
   - Auctions

*increasing market orientation*
Framework conditions for usage

The usage conditions determine the economic value of the spectrum and therefore have an important impact on spectrum pricing policies.

- **Trading and leasing**
  - Creates a secondary market: allows spectrum users to trade their exclusively assigned usage rights in the market.

- **Sharing**
  - Increases network efficiency and reduces costs for spectrum users.

- **License conditions**
  - Roll-out obligations, access obligations, prescribed services etc.

- **Others**
  - Scarcity of spectrum, international standardization
Spectrum trading and leasing

- Strengthening of market forces enabling an efficient allocation of the available spectrum.

- A precondition is that a competitive market for usage rights exists:
  - Transparent offers and a sufficient degree of demand for spectrum
  - Legal environment for a transfer of rights to secondary users

- Competition aspects are crucial:
  - It must be ensured that spectrum is not acquired for strategic purposes only, e.g. to keep market entrants away from essential resources (“hoarding”)

- Leasing and trading are an option in a few countries with liberalized telecommunications markets:
  - Introduced in the United States
  - Encouraged by the European Union
  - Recently introduced in the UK
Spectrum sharing

- Sharing allows to reuse spectrum in three dimensions: frequency, time, and location.

- Spatial spectrum sharing:
  - The coexistence of several service providers in the same licensed frequency band can be allowed (also called “light licensing”). In this case, the coordination of access has to be handled by the radio systems.
  
  - “White space sharing”: A primary system is defined which has the highest priority for accessing the resource, coexisting with a lower-priority secondary system allowed
  
  - License exempt access: all systems/providers have the same right to access the band without implied spectrum ownership. (e.g. 2.4 GHz used for WLAN). 


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There are four main generic pricing methodologies which can also be implemented in mixed forms:

- **Cost orientation**
  Recovers the costs of the administration

- **Incentive pricing**
  Extracts the rent and promotes socio-economic policy goals

- **AIP**
  AIP: Administered incentive pricing.
  The aim is to set market based prices based on opportunity costs.

- **Auctions**
  Market based approach
For the purpose of cost recovery, the fees for radio frequency licenses are set according to the costs associated with the management and administration of all related processes.

- May involve the cost of several administrative bodies, i.e., ministries and agencies.
- Related processes: application and assignment of frequencies, handling, site preparation, national and international co-ordination, interference management, etc.

In theory it guarantees that license fees are appropriate, justifiable, and transparent but...

...in practice, the exact implementation, definition, and operation of cost recovery may vary:

- Which costs should be regarded and how are costs defined?
- How to define and treat indirect costs: Costs of the related administrative work performed directly or indirectly
- Costs for individual licenses or the average for a license category.

Cost oriented pricing leaves considerable room for varying prices and preferential treatment of specific frequency categories.
Incentive pricing

- The fee is deemed to be an indirect approximation of the market value.
- In the context of spectrum pricing, incentive pricing is mainly related to extract the rent arising from the (public or private) use of a scarce common good.
  - In pure incentive formulas one of the overall goals is to promote (technical) efficiency and other socio-economic policy goals.
  - Typically a mixture of parameters addressing technical aspects and others reflecting the economic value of spectrum (e.g. spectrum may be more valuable in densely populated areas).
- Main objectives behind incentive fees:
  - Extraction of a rent arising from the public or private use of a scarce common good.
  - Fostering and ensuring efficient use of spectrum.
  - Incentive fee formulas consist of relatively few and easily measurable elements.
Incentive pricing

The fee should impact spectrum users in several ways

- Preventing users from stockpiling spectrum that they do not really need.
- Encouraging users to utilize spectrum in an optimal way.
- Providing incentives to move to alternative (less congested) frequency bands (i.e. improve allocation efficiency).
- Encouraging users to move to more spectrally efficient equipment.
Incentive pricing

- Parameters typically used:
  - Amount of spectrum (bandwidth)
  - Geographic area
  - Type of frequency band (modeled by a band factor)
  - Population covered/population density
  - Level of exclusivity
  - Technology
  - Number of terminals
  - Financial coefficient

- Challenge in setting the right price levels:
  - Too low prices: Inefficient use might result in a shortage of spectrum
  - Too high prices: Spectrum may remain unused and will provide no benefits.
Administered incentive pricing

- AIP applies the opportunity cost principles for deriving spectrum fees in order to promote efficient usage.
  - Opportunity cost shall be set at the value of an asset or resource in the next best alternative that is foregone by virtue of its actual use.

- The UK is a forerunner in using administered incentive pricing:
  - AIP has been introduced in the UK for most services gradually since the beginning of 2000.
  - Until now, only very few other countries are using opportunity pricing principles for specific services (e.g. Australia).

- It is generally recommended that AIP and incentive fees on top of cost based fees should only be introduced if there is excessive demand.

- The calculation of opportunity cost values for certain frequency bands is extremely challenging.
  - A multitude of scenarios, decisions, and economic as well as technical estimates, e.g. related to prices for alternative infrastructure and services.
  - Thus, the burden of determining the optimal level of fees is often put upon the administrations' shoulders.
Auctions

- Market based approach where prices are set by potential licensees bidding for a given amount of spectrum.
- The problem is that auction design and other regulatory conditions may strongly influence the resulting price level.
- The market value of spectrum is not absolute (e.g. due to changing shareholder expectations).

<table>
<thead>
<tr>
<th>Where?</th>
<th>When?</th>
<th># Bidders</th>
<th># Licenses</th>
<th># Incumbents</th>
<th>€/Pop</th>
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<tbody>
<tr>
<td>UK</td>
<td>March/April 2000</td>
<td>13</td>
<td>5</td>
<td>4</td>
<td>630</td>
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<tr>
<td>Netherlands</td>
<td>July 2000</td>
<td>9/6</td>
<td>5</td>
<td>5</td>
<td>170</td>
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<tr>
<td>Germany</td>
<td>July/Aug. 2000</td>
<td>12/7</td>
<td>4-6</td>
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<td>615</td>
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<tr>
<td>Italy</td>
<td>Oct. 2000</td>
<td>8/6</td>
<td>5</td>
<td>4</td>
<td>210</td>
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<td>Austria</td>
<td>Oct. 2000</td>
<td>6</td>
<td>4-6</td>
<td>4</td>
<td>103</td>
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<td>Switzerland</td>
<td>Nov./Dec. 2000</td>
<td>10/4</td>
<td>4</td>
<td>3</td>
<td>19</td>
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International trends – policies

1: Efficiency
- The efficient/optimal use of the spectrum is one of the major goals to be fulfilled.
- Public or social benefits are also prime policy goals.

2: Multiple methodologies
- Cost recovery is applied in almost all countries.
- Most countries deploy two or more of the methodologies cost recovery, incentive pricing, AIP, and auctions.
- Incentive pricing is widely employed as well whereas AIP is found in a few number of countries only.

3: Auctions
- Auctions are an option in the legislation in a majority of the countries but have not been used in all of them.

4: License exempt
- License exempt regulation is widely used by almost all countries.

5: Undeveloped spectrum trading
- Spectrum trading is less developed but can be found in the legislation in most Western countries (EU, US and Australia) and in some Arab countries (Jordan, Bahrain).
Broadcast services

- A number of countries do not request any fee for broadcasting spectrum at all.
  - Distribution of media information at lowest cost for the social benefit.

- For those countries which have spectrum fees for broadcasting some charge per station and some charge per TV channel (thus: spectrum).

- Spectrum prices for broadcasting tend to be considerably lower in comparison to other commercial services (e.g. mobile or fixed services).
  - If charges are applied at all, these are usually calculated to recover cost of regulation only.
  - UK: Discussions started that AIP should be introduced and that broadcasters have been able to receive a rent from too low prices for broadcasting frequencies.

- In most countries, the social benefits / public interests of media and information can be seen as primary leading indicator for pricing for broadcasting services.
Fixed services

- Countries use a large number of different factors and parameters in their pricing formulas for fixed services.
- It seems that the higher the demand for a certain (fixed) service is, the higher the prices.
  - This is reflected by a so called band factor that allows to weigh the prices for different frequency bands and by the application of different monetary values.
- The international comparison shows e.g. for point-to-point microwave services that these are generally priced with a considerable incentive.
- For frequencies with low demand, cost orientation is often applied.
- Only a few countries apply cost based pricing for all fixed frequencies (e.g. Switzerland and USA) and only UK is using AIP pricing.
Mobile services

- The spectrum demand for mobile telephony and recently mobile data services has risen dramatically in the last two decades.
- Research results show that for public mobile services incentive pricing combined with auctions is the preferred method to allocate spectrum.
- We have found different pricing approaches for 2G/3G and 4G services:

<table>
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<th>2G / GSM</th>
<th>3G / UMTS</th>
<th>4G / LTE</th>
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<td>Initially allocated to incumbents without formal bids.</td>
<td>Typically allocated by auction. Beauty contests have also been applied.</td>
<td>Typically allocated by auction.</td>
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<td>Subsequently allocated by auctions / beauty contests.</td>
<td>In countries, that did not use auctions to award UMTS frequencies, the utilization fee is slightly higher than for GSM</td>
<td>Trend to award spectrum technologically neutral.</td>
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<td>Benchmarks show that the average values countries charge per inhabitant is about 0.84 Euro cent per 1 MHz.</td>
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<td>Hence spectrum prices likely to be aligned between different mobile technologies (2G/3G/4G).</td>
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Other services

Satellite

- Services like radio determination, space operation, and earth exploration require a limited amount of bandwidth and are generally priced with flat fees.
- For satellite earth station hubs the fee depends generally on the amount of bandwidth used.
- Prices are either cost based or incentive based.

Other services

- Maritime, aeronautical services, radio astronomy, and similar.
- Generally priced at cost, although this is not made transparent in the pricing regulations.
International trends - summary

- Broadcast: Cost orientation
- Fixed Services: Incentive Pricing
- Mobile Services: Incentive Pricing, Auctions
- Satellite Services: Cost orientation, Incentive Pricing
- Scientific Services: Cost orientation

Increasing market orientation
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<td>Key findings</td>
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<tr>
<td>1. A dynamic view on scarcity</td>
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<td>2. AIP is the exception, not the rule</td>
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<td>3. Pricing is determined by national or regional characteristics</td>
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<td>4. Compare with care</td>
<td></td>
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<tr>
<td>5. Service classification is not harmonized</td>
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<td>6. Mobile broadband is the „hot topic“</td>
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<td>7. Public use of spectrum is often license exempt</td>
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<td>8. The transparency of pricing regimes is limited</td>
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<tr>
<td>9. Spectrum trading and sharing is not yet widely applied</td>
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<td>10. Policy goals are imperfectly translated into pricing methodologies</td>
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