Spectrum pricing: What it is and OCP in Australia

Ben Freyens

Faculty of BGL, University of Canberra
Center of Law & Economics, Australian National University
1. **Regulatory calculation / procedure: what does the price reflect?**

   - **Ex.1:** A MNO earns **rents** from spectrum acquired by beauty contest or lottery:
     - regulator recovers parts of the rents by charging an **annual tax** (e.g. a royalty)
     - the royalty reflects a % of the rents (excess returns)

   - **Ex.2:** A government department was assigned spectrum **at no cost** in the past
     - spectrum rises in value but the department leaves large portions unused
     - regulator charges a **user fee** → fee does not apply on returned spectrum
     - the fee should reflect the **value of alternative uses**

   - **Ex.3:** A regulator wants to conduct an auction but worries about **price fixing**
     - regulator sets a **reserve price** → to avert collusion on low bids
     - the fee should reflect the **minimum value** of the spectrum to the government

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Is this what spectrum fees and prices should reflect?

Why not let markets determine the price?

at least the price would reflect relevant information for market players
2. **Competitive market process:** → price reflects market information

- How do competitive markets work?

**Diagram:**

- A competitive equilibrium maximizes total surplus ($CS + PS$)

- $P_e$ and $Q_e$ represent the equilibrium price and quantity.

- The shaded areas represent $CS$ and $PS$, indicating consumer surplus and producer surplus, respectively.

- The line $D = MB$ represents the demand curve, and $S = MC$ represents the supply curve.
3. **What if the market is not competitive?**

- **market failure**: prices relay *distorted information* → will be too high or too low
- **EX 1**: **market power**: one firm accumulates (‘hoards’) spectrum licences
- **EX 2**: **negative externalities**: interferences from unregulated spectrum trading

![Two examples of market failure](image-url)
• Externalities are a salient feature of spectrum use
• Market power as well (more recent)
• ➔ historical practice of regulating usage rights and charging license fees
  ➢ generally unconcerned with capturing economic or scarcity value of spectrum
  ➢ consisted of an application fee and a regulatory fee (US), or ‘recovery fee’ (AUS)
• What was the aim of cost-recovery pricing (CRP)?
  ➢ discourage frivolous applications
  ➢ recover the cost of regulating
Issues with CRP

- inefficient: CRP is a source of:
  - allocative inefficiency: does not balance supply of- and demand for spectrum
  - productive inefficiency: services not produced at least cost (operational slack)
  - technical inefficiency: no incentive for full use, no penalty for lack of use

- arbitrary:
  - set too low: \(\rightarrow\) excess purchases, hoarding, excess demand (congestion)
  - set too high: \(\rightarrow\) discourages potential users, innovators, entrepreneurship

Generally, CRP was always set too low
CRP: examples

● What should be relevant for CRP (Cave and Webb 2015)
● Canada / Australia:
  ➢ CRP depends (positively) on bandwidth, geographic area, and exclusivity
  ➢ CRP based on a (vol. spectrum cons. / vol. spectrum avail.) for ‘grid cells’
  ➢ CRP designed to capture higher values in metro areas
  ➢ But these values remain arbitrary (capped at cost recovery)
● Thailand
  ➢ Government departments do not pay for spectrum
  ➢ State enterprises pay little
  ➢ Private enterprises pay according to a formula: $Fee = BW \times AC \times FC \times (NT)$
  ➢ where:
    ➢ AC is service-specific
    ➢ FC is much lower for higher frequencies (10 for < 1GHz, 0.001 for >20GHz)
● Wide array of different approaches to CRP
  ➢ (see also Bengla-Desh presentation yesterday)
Four broad categories of pricing options:

- Cost recovery pricing (CRP) (fees set to recover costs of managing applications, assigning frequencies, assessing risks, site preparation, international coordination)
- Rent-based pricing (RBP) (fees set so as to extract the economic ‘rent’ associated with use of a scarce resource: e.g. set higher fees for metropolitan or high-demand technologies)
- Opportunity cost pricing (OCP) (fees set to recover the value of the best alternative forgone – other users of same service, other services - by assigning the spectrum to the current user / applicant)
- Market-based pricing (MBP) (prices determined by market forces: suppliers and buyers of radio frequencies (RF) exchange spectrum rights on primary or secondary spectrum markets)

Not pricing spectrum:
- unlicensed
- class licensed
- public Commons

Lundborg 2013
Rent-based pricing (RBP)

- Main principles *(Freyens, Caputo & Levy, JPET 2017)*
  - license fee should capture users’ *economic rents*
  - to use when there are presumptions users make *windfall gains*

- Examples:
  - *royalties* and other charges levied on users’ revenues, profits, gross turnover etc.

- Pros:
  - attractive to improve efficiency for non-auctioned spectrum
  - e.g. for high-value spectrum assigned by beauty contests, lotteries, small fees...
  - royalty fee could be market-adjusted based on number of entrants, congestion etc

- Cons:
  - unattractive to improve technical efficiency for non-auctioned spectrum
  - does not provide incentives to use or trade idle spectrum
  - hasn’t been used much in practice except indirectly for *broadcasting* (AUS, CAN)
Opportunity cost pricing (administrative incentive pricing)

- **Direct calculation methods** (ACMA 2009)
  - **Output-oriented OCP (NPV):**
    the OC of a frequency F1 is the *highest-valued alternative use denied* by granting access to one party rather than next best user
  - **Input-oriented OCP (ODV):**
    the OC of F1 is the cost the owner would occur if access to F1 was withdrawn → cost of using another frequency or another input (proxy for *cost saving* from using F1)

- **Key difference with RBP:**
  - OCP focuses on *value forgone* or *cost savings* rather than realized value
  - under RBP, idle spectrum incurs no penalty (no activity → no RBP)
  - under OCP, idle spectrum can be very costly (value of highest alternative forgone)
  - improves technical and productive efficiency
Opportunity cost pricing (administrative incentive pricing)

- **The NPV method (ACMA 2009)**
  - inferring ‘business plan’ data
    - project value: inferring NPV of users’ expected profitability from spectrum (revenues, cost structure...)
    - data easier to guess if the user is a former state enterprise (Telstra, BT, etc.)
    - add defence value: limiting competition, raising cost for competitors
    - add option value: holding option to trade at a profit in the future

- **Indirect approach: market based valuations**
  - using market information from comparable MBP bands
    - key determinants of users’ WTP (sales, at auction, in trades)
    - → nearest to MBP as possible
Optimal deprival value (ODV)

- **ODV ~ Aka ‘least-cost alternative’ method:**
  - assumes the level of output and service remains constant (to keep away from calculating revenue effects)
  - assumes no market power, information asymmetries, spectrum rights are freely tradeable, many profit-maximising market participants etc.
  - if a marginal unit of spectrum is denied (due to congestion) to an operator what are the associated costs to incur to maintain output quantity and quality constant?

- Next best alternative:
  - how many base stations / infrastructure need be erected?
  - cost of moving equipment to higher / lower bands?
  - cost of acquiring technology for more efficient transmissions?
  - cost of moving operations out of spectrum use altogether?

- The lowest cost alternative is then considered the OC of the spectrum
Ordered pricing schemes

- CRP (administrative information, high regulatory oversight)
- RBP (unpriced)
- OCP (market information, low regulatory oversight)
- MBP (unpriced)
How does a pure ODV approach work?

- replace spectrum by next cheapest set of inputs
- derive a **deprival value** then compare with **existing fees**

Example: deprival value for DTT spectrum in UK

<table>
<thead>
<tr>
<th>Alt. modes of transmission</th>
<th>Alt. options</th>
<th>Spectrum saved / mplex</th>
<th>Source of added cost</th>
<th>Added cost/MHz ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>geostationary</td>
<td>Sat.</td>
<td>48MHz</td>
<td>dishes, set top boxes</td>
<td>90-120m</td>
</tr>
<tr>
<td>technology</td>
<td>SFN</td>
<td>&lt;40 MHz</td>
<td>12 x more sites</td>
<td>11.5m</td>
</tr>
<tr>
<td>other standard</td>
<td>DVB-T2</td>
<td>&lt;40 MHz</td>
<td>set top boxes</td>
<td>[0 – 37m]</td>
</tr>
<tr>
<td>fixed network</td>
<td>fiber, coaxial</td>
<td>56MHz (e)</td>
<td>network built-up</td>
<td>NC</td>
</tr>
</tbody>
</table>

*Plum consulting 2009*
Application II: 400 MHz Band in Australia

- 400 MHz Band = narrowband land mobile country
  - also used for fixed services and wideband rural services
  - 25kHz raster
- 400 MHz band heavily congested in Sydney (100%) but less so in Perth (50%)
- ODV: alternatives for new entrants??
  - adopt a more efficient technology for narrower raster (12.5kHz, or even 6.25kHz)
  - use public trunked networks (PTN)
- Or infer from market data (sales, auctions)

<table>
<thead>
<tr>
<th>Alt. options</th>
<th>Added cost avg. load</th>
<th>Added cost light-heavy ld.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5kHz raster</td>
<td>$269/kHz/yr</td>
<td>$77 - $988/kHz/yr</td>
</tr>
<tr>
<td>PTN</td>
<td></td>
<td>$0 - $369/kHz/yr</td>
</tr>
<tr>
<td>inferred from sales data</td>
<td>$68 - $136/kHz/yr</td>
<td></td>
</tr>
<tr>
<td>inferred from int. auctions</td>
<td>$2.3 - $14.4/kHz/yr</td>
<td>(unreliable)</td>
</tr>
<tr>
<td>(ACMA 2009)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Licence currently sells for $90/kHz/yr in Sydney
- too low to encourage migration to either option
- fees of 400 MHz ALs need to double or treble
  $ 90 licence fees about right for Perth level of congestion
Application III: 7.5 / 8 GHz in Australia

- 7.5 GHz Band: usage ↑ 50% in last 10 yrs, band half full.
  - supports low capacity PtP medium haul fixed links (>20km)
  - 7 or 14 MHz raster, some legacy 3.5 and 18MHz channels
- 8 GHz Band: usage ↑ 200% in last 10 yrs, band 50-80% full on most sites (esp cities)
  - supports high capacity PtP medium haul fixed links (>10km)
  - two sets of 29.65MHz channels, main and interleaved
- no practical alternative uses than fixed links → rules out NPV
- ODV: alternatives for new entrants??

<table>
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<th>Alt. options</th>
<th>Added cost avg. load</th>
</tr>
</thead>
<tbody>
<tr>
<td>more efficient technology</td>
<td>not quantified but current fee seems to incentivize uptake</td>
</tr>
<tr>
<td>move to higher bands</td>
<td>$42 to $179/MHz/yr</td>
</tr>
<tr>
<td>use Sat. services</td>
<td>$5257 - $6971/MHz/yr</td>
</tr>
<tr>
<td>use leased lines</td>
<td>$268/MHz/yr (assuming 20 hop trunk)</td>
</tr>
</tbody>
</table>

(ACMA 2009)

Licence currently sells for $148/MHz/yr in Sydney

- good reflection of the OC of 1MHz in that band

Licences in 8.5-14GHz sell for $127/MHz/yr in Sydney
(a bit high given no congestion there → should be lowered to encourage use)
Suitability of OCP methods for different services

- ODV well suited for:
  - marginal changes in spectrum (marginal changes don’t affect revenues much)
  - when downstream service can be supplied with various alternatives to the spectrum (e.g. cellular)
  - bands where spectrum is used for private applications and for which demand is hard to forecast

- NPV well-suited for:
  - services where marginal changes cannot be considered (e.g. Broadcasting)
  - bands used by publicly-provided services (or formerly so)
  - when there are no viable spectrum or non-spectrum alternatives to the used spectrum
Constraints to OCP

- International regulatory constraints:
  - International coordination of band planning → global management regime
  - OCP promotes the idea of multiple potential uses within bands
  - If ITU restricts use within a band → restricts OCP values as well

- Domestic regulatory constraints:
  - in Australia, the BCS Act 1992 specifies a BLF based on income rather than OC
  - no room for OCP (but some AIP through AL taxes punishing non-use)

- Technology constraints:
  - spectrum generally non-fungible except for UHF
Conclusion

- Spectrum pricing is work in progress
  - it is possible in practice to set ‘incentive’ prices using OCP
  - these estimates are far from perfect and can do damage if estimated too high
  - unclear if OCP can change the way public service users view spectrum usage

- Trading in primary and secondary markets remains the best way forward
  - If spectrum markets are competitive and well-functioning
THANK YOU