Regional workshop on "Spectrum Management: Economic Aspects"
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Spectrum pricing: What it is and OCP in Australia

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1. **Regulatory calculation / procedure: what does the price reflect?**

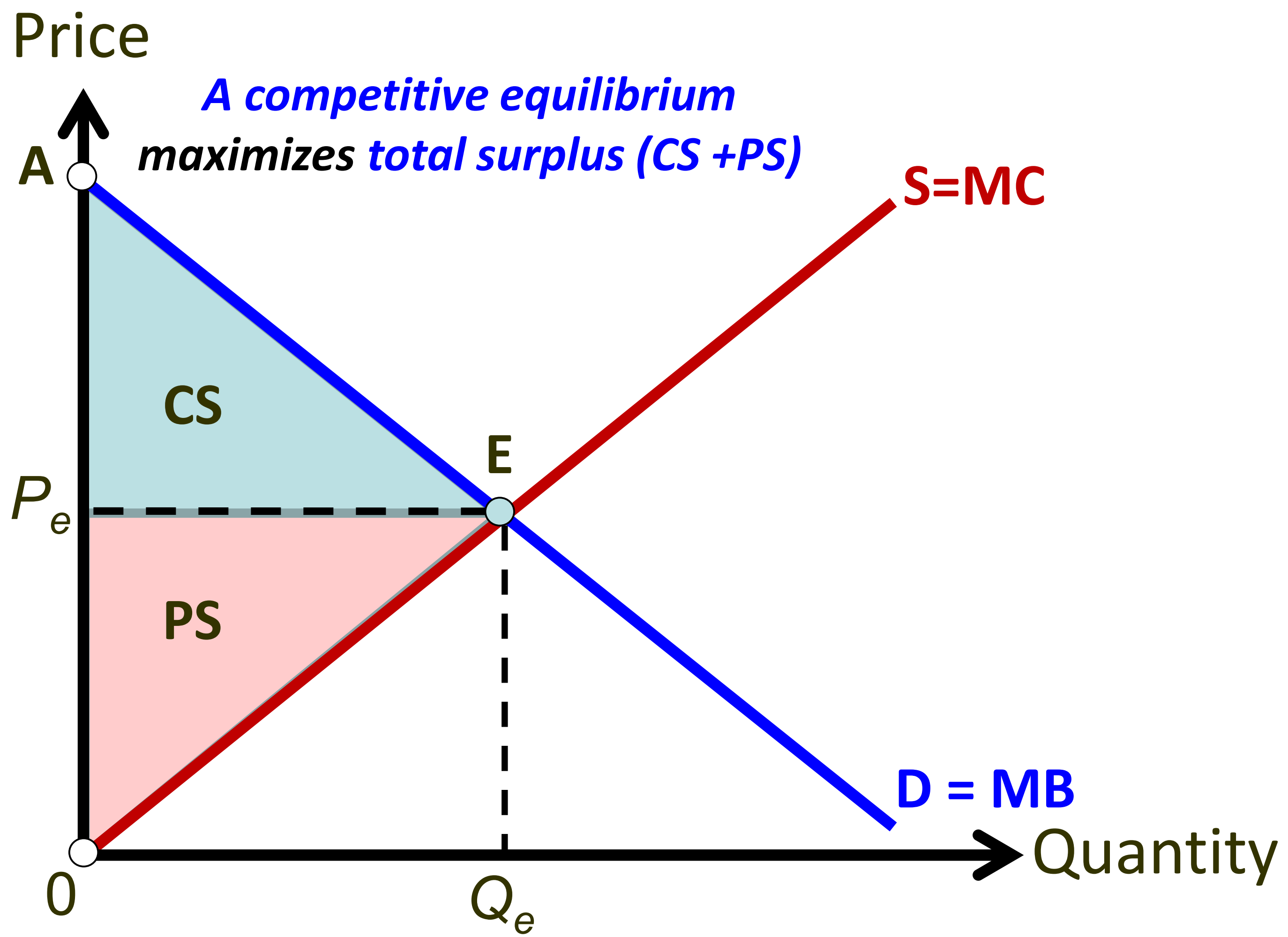
- **Ex.1**: A MNO earns rents from spectrum acquired by beauty contest or lottery:
  - regulator recover parts of the rents by charging an annual tax (e.g. a royalty)
  - the royalty reflects a % of the rents (excess returns)
- **Ex.2**: A government department was assigned spectrum at no cost in the 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

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

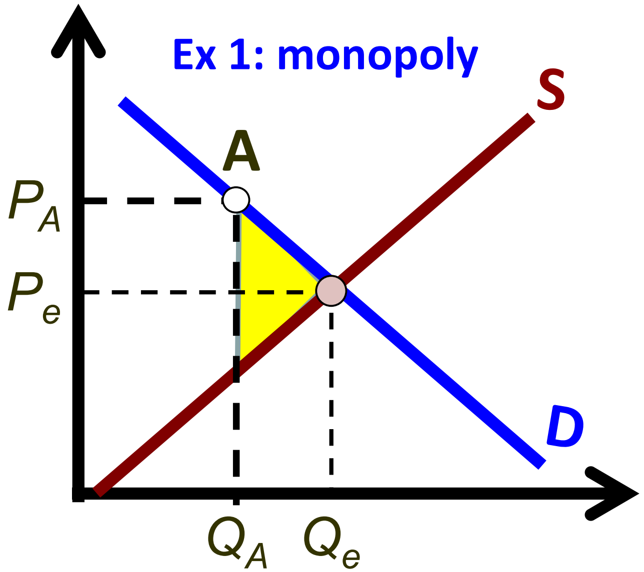
2. **Competitive market process: → price reflects market information**
   - ❖How do competitive markets work?

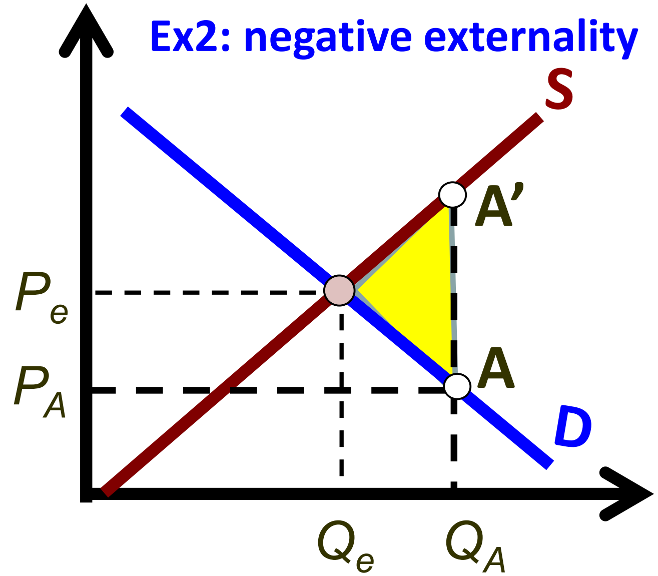


3. What if the market is not competitive?

- ❖**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





Historical practice

- 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

Historical practice

- 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**: → excess purchases, hoarding, excess demand (congestion)
    - ☹ set **too high**: → 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)

What are the main pricing options?

- Four broad categories of pricing options:

Cost recovery pricing (CRP)	Rent-based pricing (RBP)
(fees set to recover costs of managing applications, assigning frequencies, assessing risks, site preparation, international coordination)	(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)
Pricing spectrum	
Opportunity cost pricing (OCP)	**Market-based pricing (MBP)**
(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	(prices determined by market forces: suppliers and buyers of radio frequencies (RF) exchange spectrum rights on primary or secondary spectrum markets)

Lundborg 2013

Not pricing spectrum

- unlicensed
- class licensed
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Rent-based pricing (RBP)

- Main principles *(Freyens, Caputo & Levy, JPET 2017)*
  - license fee should captures 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

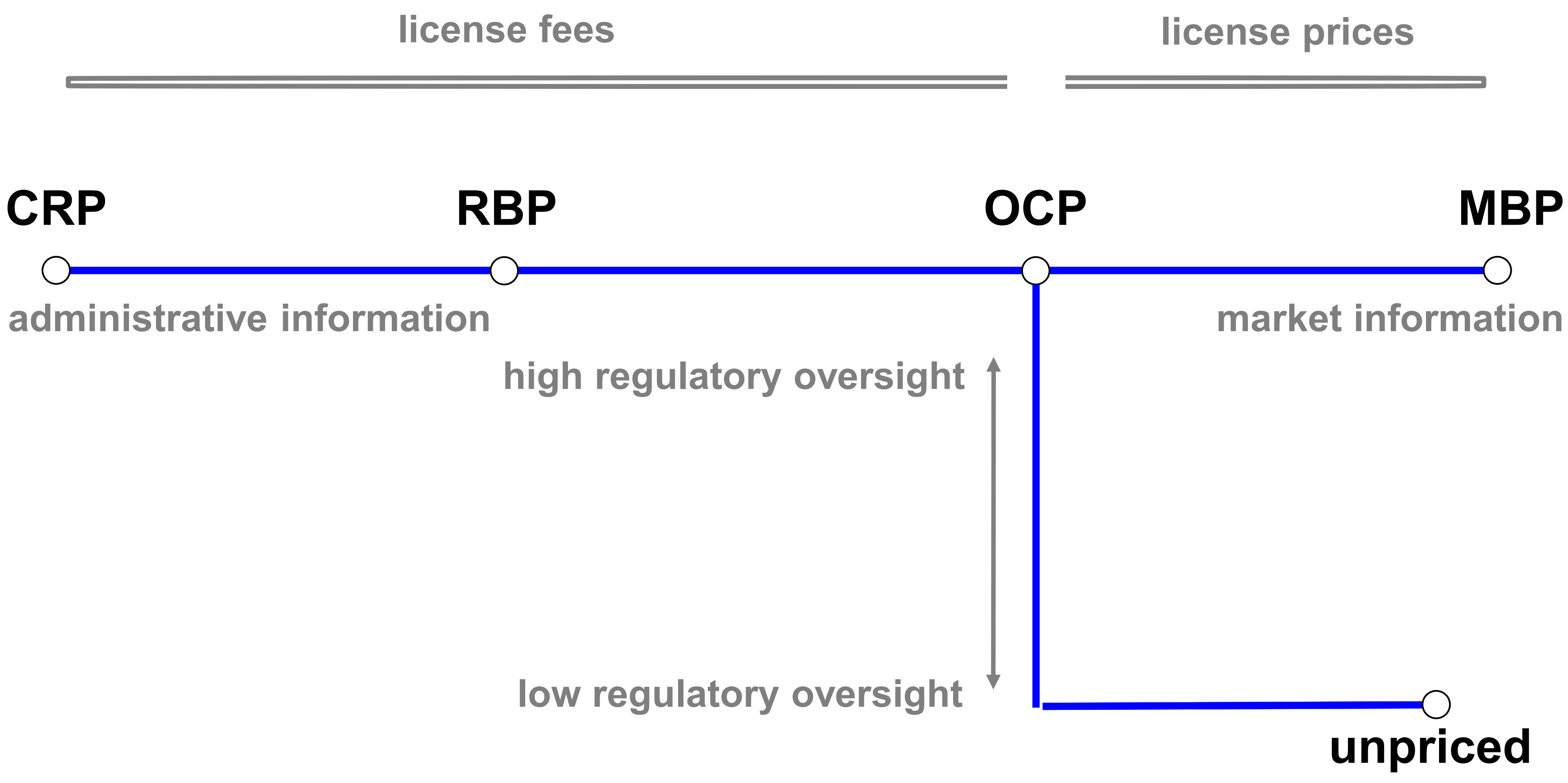
Opportunity cost pricing (administrative incentive pricing)

- **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



Application I: 500 – 800 MHz (DTT) in UK

- 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

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

(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 servrices
  - 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)

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

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??

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

(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