

# Spectrum management: recent developments and challenges

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# Agenda

- The characteristics of spectrum
- Spectrum assignment vs spectrum allocation
- Evidence of spectrum allocation policies
- Spectrum trading
- Spectrum used by public bodies

# Spectrum

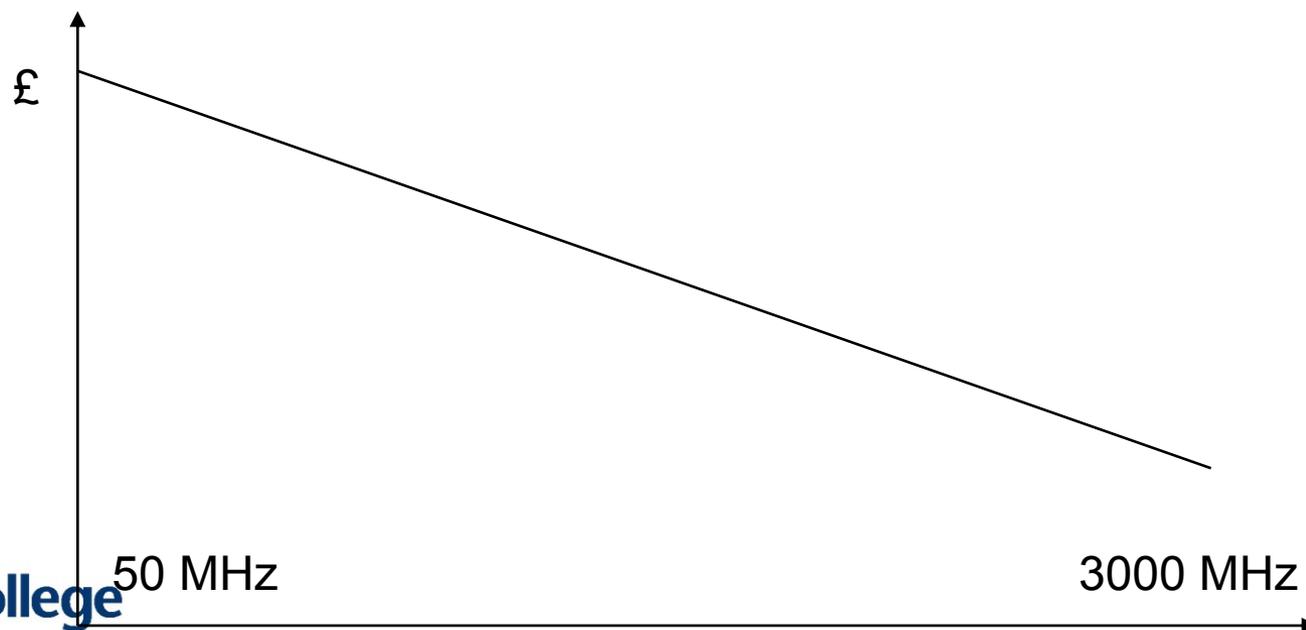
- Spectrum is limited.
- Need spectrum management.
- Historically: Market alone cannot work -> congestion and interference.
- Misunderstanding: markets without property rights/rules cannot work.
- Distinction between spectrum *allocation* and spectrum *assignment*.

# Spectrum

- Strange procedure. Akin to central planning:
  - Spectrum allocated to some use/technology.
  - Licences are then assigned (auction, beauty contest,...).
- Hot debate on licence assignment (3G auctions!) but very little on prior allocation.
- Licence prices likely to reflect a licence rent, not a spectrum rent.
- Scarcity problem created artificially by licence scarcity and oligopolistic market structures.

# Different characteristics of spectrum

- Technically feasible frequencies and their competitive prices.
- Higher frequencies signals have lower range, thus require more base stations. In principle, in a fully functioning market, spectrum prices should be like in figure below.
- But several blocks are restricted, or pre-empted!



# Unlicensed?

- In US, less than 3% of spectrum below 3GHz unlicensed.
- Smart antennas, cognitive (software) radios (WiFi).
- Most frequencies are under-used most of the time.
- TV could be reallocated to cable, satellite.
- Investment incentives:
  - Tragedy of the commons in the absence of IPRs.
  - But what about investments in wireless infrastructure and devices?
  - IPRs can also deter investments in complementary IP.
  - Not “free”: emergence of networks based on an equipment-provider model, instead of a service-provider model.

# Spectrum management

- How to assign a licence?
- Auctions versus beauty contests.
- Main differences: transparency, discretionality, incentives.
- Auctions work well (Australia, New Zealand, USA, UK). However: mechanism design is crucial.

# Europe: 3G mobile auctions

Country	Date	Licences	Total (€ million)	€ per capita
Austria	11/2000	6	825	100
Belgium	2/2001	3 (+1?)	450	45
Denmark	9/2001	4	510	95
Germany	8/2000	6	50,770	615
Greece	7/2001	3	500	45
Italy	10/2000	5	13,700	240
Netherlands	7/2000	5	2,720	170
Switzerland	12/2000	4	140	20
<i>UK</i>	<i>4/2000</i>	<i>5</i>	<i>36,400</i>	<i>630</i>

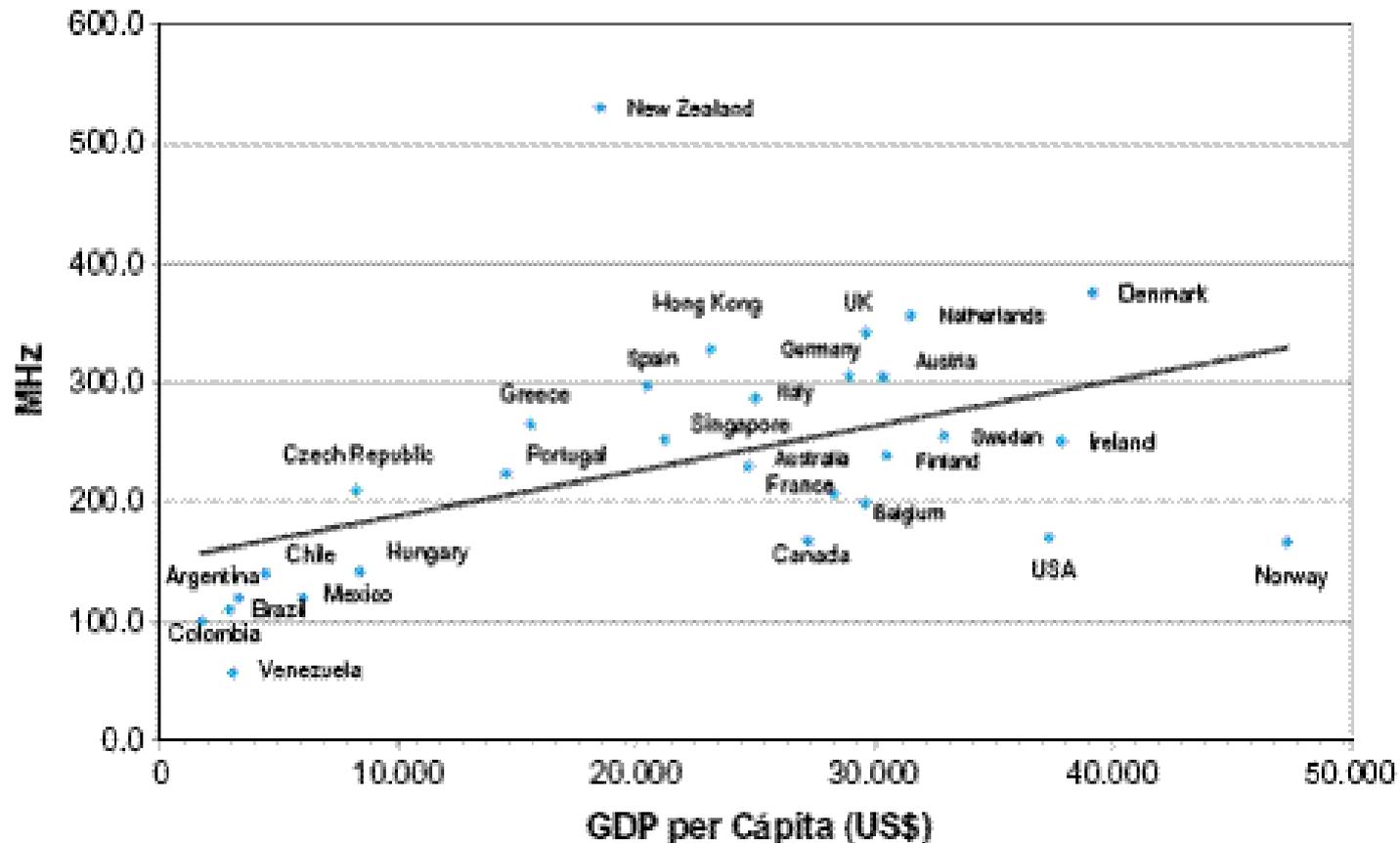
# Criticisms? Discuss

- Higher future prices;
- Higher likelihood of collusion;
- Revenue maximisation for governments;
- Missed opportunity for industrial policy;
- Irrational behaviour: firms pay "too" much;
- Erode finances and risk of bankruptcy;
- Lower investments;
- Don't take into account other objectives: quality and level of service, promotion of new entrants, etc.

# Auctions and prices

- Rent versus flexibility.
- Study of 24 countries conducting 38 auctions for spectrum used for mobile services: prices paid in countries extending very liberal usage rights to licensees (Australia, New Zealand, Guatemala, and El Salvador) were 61% below the prices paid in other countries, *ceteris paribus*.
- No impact on consumer prices.

# Spectrum available to mobile (2003)

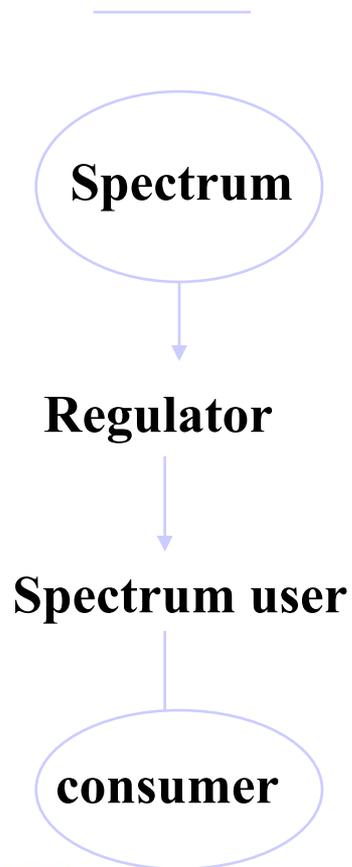


# Welfare analysis of spectrum allocation policies

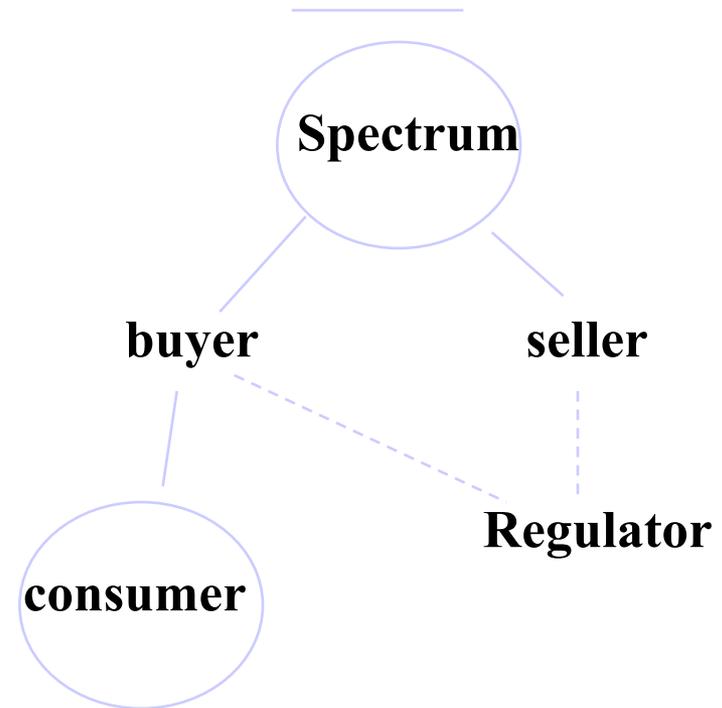
- Hazlett and Munoz (2009).
- Shift focus to relationship between spectrum policy and efficiency in output markets.
- Cross-country analysis in 28 markets, 1999-2003
- Allocating greater bandwidth generates more competitive market structures and considerable welfare gains.
- E.g., US has had 85 auctions in 1994-2009. They have generated \$53bn (NPV) -> social benefit of raising funds (1/3)
- But wireless yields annual \$150bn of CS (flow!), and also PS
- Similar results for LA countries: +20MHz -> CS +\$54 per capita (again, yearly).

# Spectrum

## Old world



## New world ?



# “Old” regime

- Central planner decides allocation:
  - how much spectrum is used for what service;
  - mandate spectrum for particular technologies;
  - then decides assignment methods.
- UMTS assignment: “probably” OK, but what about allocation?
- Why determine it centrally?

# “New” regime: spectrum trading

- Objective: achieve economic efficiency, not spectral efficiency alone.
- Give property (usage) rights.
- Property rights should be flexible and possibly given in perpetuity.
- Spectrum could then be traded, leased, aggregated and disaggregated.
- Interim phase: use Administered Incentive Pricing (AIPs), calculating opportunity cost.

# Spectrum trading

- Why? If property rights are clearly defined, then trade ensures that the efficient allocation is ensured (Coase Theorem).
- But what about:
  - Technology (interference and standards);
  - Market power (hoarding);
  - Social objectives;
  - Transition problems.

# Interference

- Negative externalities exist in the absence of property rights.
- With property rights, trade occurs only if it increases efficiency, taking into consideration all the operators affected.
- Regulator not really needed. Arbitrator needed, but only as a backstop if negotiations fail.
- Enforcement via courts could replace enforcement via a technical protocol or via an administrative body. (Courts more efficient?)

# Standards

- Standards are important.
- They emerge *de facto*.
- Does a central agency enjoy knowledge of the information necessary to predict future demand or the future direction of new technologies?
- Technology neutrality.

# Market power

- *Ex post* competition policy: like any other market.
- Applied to the relevant market (there is no spectrum market *per se*: derived demand).
- Entry: current system freezes market structure and insulates incumbents from new entrants.
- Spectrum hoarding?

# Spectrum hoarding

- Acquiring or retaining frequencies with a zero or low expectation of efficient use.
- Easier with administrative methods as administrative charges tend to be low.
- Liberalisation reduces the profitability of anti-competitive conduct.

# Remedies against hoarding

- **Competition Law**
  - Useful analogy with MVNOs;
  - Dominance likely to be Joint Dominance, thus action unlikely to be forthcoming. High burden of proof.
- **Vetting of secondary trades**
  - Establish if trade leads to SLC;
  - Time consuming.

# Remedies against hoarding

- Use it or lose it
  - Difficult to verify;
  - Disincentives to efficient utilisation.
- Spectrum caps
  - US: 45MHz (1994-2001), then 55MHz (2001-03), then abandoned (consolidation followed);
  - Penalty for efficient (organic) growth;
  - If last too long, then market structure is frozen;
  - ‘Soft’ caps, akin to waivers (quota that triggers further investigation);
  - Easy to impose on the award (fewer legal problems...).

# Social objectives (non-marketed spectrum)

- Defence, broadcasting,... are important.
- But is spectrum different from any other scarce resource used to achieve public policy goals?
- Why procure spectrum by force?
- Need to know opportunity cost:
  - Cannot ask MoD if they need it.
  - Also not sufficient to monitor if they use it.
  - Need spectrum trading to reveal it.
  - AIPs in the UK (interesting case with MoD).

# How do we get there...

- Release additional spectrum.
- Give property (usage) rights.
- Property rights should be flexible (no reference to specific technology or service).
- Spectrum could then be traded, leased, aggregated and disaggregated.
- Value of licence is source of social gain but minor part compared to welfare generated by incremental spectrum allocations.
- Look at Australia, NZ, UK, ...

# Basic references:

- If you found this interesting, then here is some extra reading:
  - M. Cave, C. Doyle and W. Webb, 2007, Essentials of modern spectrum management, Cambridge University Press.
  - P. Crocioni, 2009, “[Is allowing trading enough? Making secondary markets in spectrum work](#)”, Telecommunications Policy.
  - T. Hazlett and R. Munoz, 2009, “A Welfare Analysis of Spectrum Allocation Policies”, RAND Journal of Economics.
  - T. Hazlett, and R. Munoz, 2009, “[Spectrum allocation in Latin America: An economic analysis](#)”, Information Economics and Policy.
  - A. Prat, and T. Valletti, 2001, “Spectrum auctions versus beauty contests: costs and benefits”, Rivista di Politica Economica/OECD.
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Muito Obrigado!

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