Spectrum Management: Strategic Planning and Policies for Wireless Innovation

Theories influencing choices in development of spectrum policy and strategic planning

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Introduction to Session 2

- Policy makers chose amongst sometimes competing goals and objectives when developing spectrum policy.
- Competing goals and objectives are rooted in theories and concepts which provide substance and shape analysis.
- Key theories influencing policy development and spectrum planning are introduced in this session. We will return to them later on when we review and examine them in more detail in Sessions 11,12, and 13 and apply them in the Case Study Assignment in Session 14.

Session Objectives

- Overview of several of key theories influencing choices in development of Spectrum Policy and Strategic Planning. These include legal, technical and economic concepts such as: Spectrum User Rights, Technical and Economic Efficiency and ideas about efficient Competition in the mobile sector.

- The need to weigh various interests and consider inevitable and practical trade-offs in making good spectrum policy choices.

Module Topics

- Technical and Economic Efficiency
  - Liberalized Markets
  - Spectrum Prices
  - Monopolies and Oligopolies
  - Competition
- Transparency
- Spectrum User Rights

Liberalization

- There has been a move away from relying predominantly on the traditional planning and allocation model (command and control), most notably in countries where demand for radio spectrum access is rising fast.
- The hallmarks of contemporary spectrum management have become liberalization and flexibility.
- Liberalization refers to managing spectrum through market-based mechanisms.
- This covers issues ranging from competitive assignments (such as auctions) to secondary trading.
- This approach delegates as much spectrum “management” as possible to participants in the marketplace. Spectrum management agencies in liberalized settings perform the role of “light-handed” regulators.

Market methods

Maximize social value by allowing as many users as possible while preventing undue interference

- No licensing for short range devices
- Technology and service neutral licenses
- Auction spectrum where possible
- Spectrum pricing where auctions impractical
- Allow spectrum trading , Popular in US and Australia but very infrequent in Europe
- Encourage sharing

Cons of Market methods

- Ability for the market to harmonise spectrum use across a large region proves very limited, and the non-harmonised spectrum costs low.

Flexibility

- Flexibility involves relaxing constraints and prescriptions that specify particular uses and technologies for specific spectrum bands. This might mean just setting technical rules to preclude interference, and then letting licensees choose whatever technologies meet those criteria. But it can also mean setting up spectrum "commons" or managed-sharing bands, along with licence-exempt usage.
  - Very few countries have opened up large parts of the spectrum as pure commons bands. But many allow licence-exempt use of certain bands for low-power devices.
- The benefits of liberalization are enhanced by greater flexibility, and the benefits of flexibility reach their full potential within a liberalized environment. So liberalization and flexibility are closely intertwined.

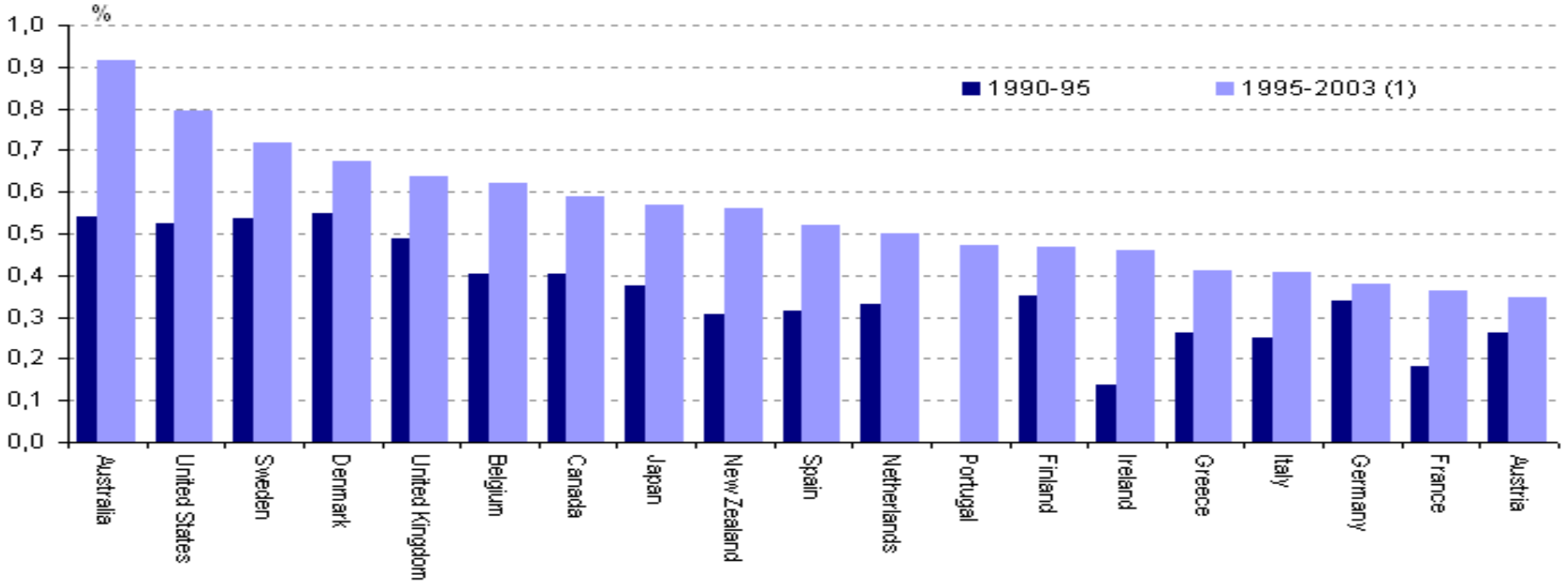
Impact of Liberalization

- Since the latter quarter of the last century, liberalization is arguably the most powerful influence on the way spectrum use has evolved and how it is managed. The development of liberalized legislation and regulation has been the subject of extensive review, analysis, and monitoring and reporting by international agencies such as the UN, OECD and the ITU.
- The major transformative changes attributed to liberalization are:
  - Privatization
  - Growth in penetration and usage
  - Increased competition and significantly reduced prices for consumers
  - Innovation and growth in services and investment
- Liberalization has been the most significant influence on spectrum policy development.

Liberalization and Growth

OECD Key ICT indicators

15. Contributions of ICT investment to GDP growth, 1990-95 and 1995-2003 (1), in percentage points

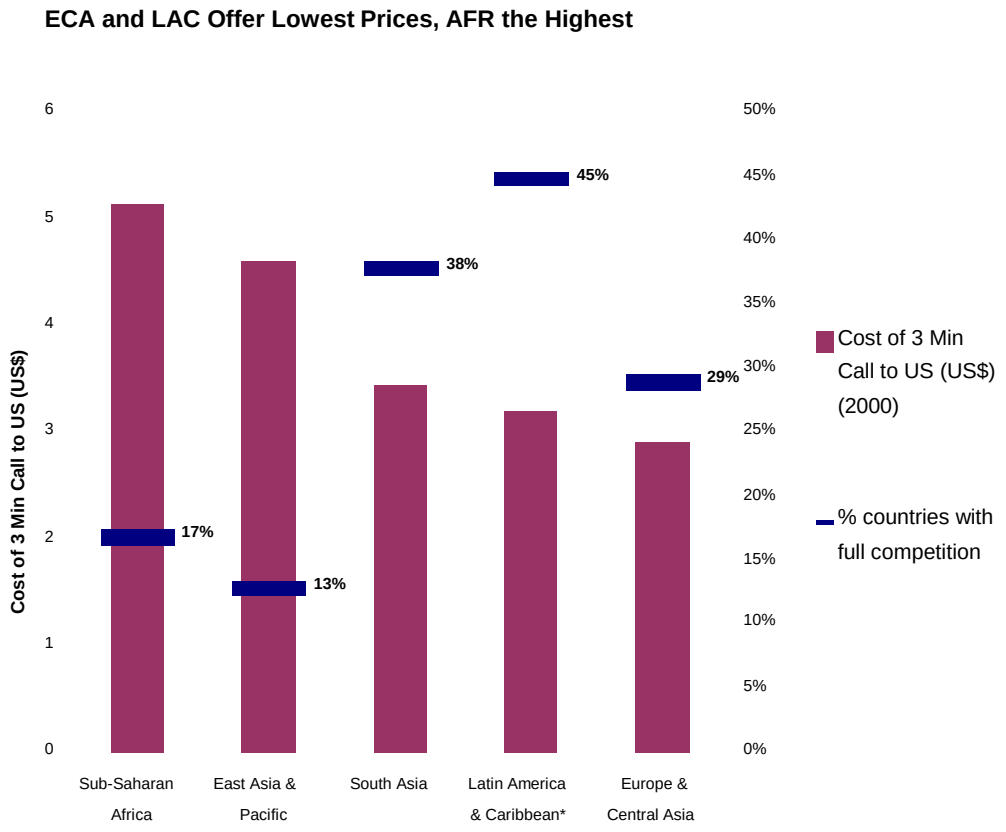


1. 1995-2002 for Australia, France, Japan, New Zealand and Spain.

Source: OECD Productivity Database, September 2005, [www.oecd.org/statistics/productivity]

Affordability and Access

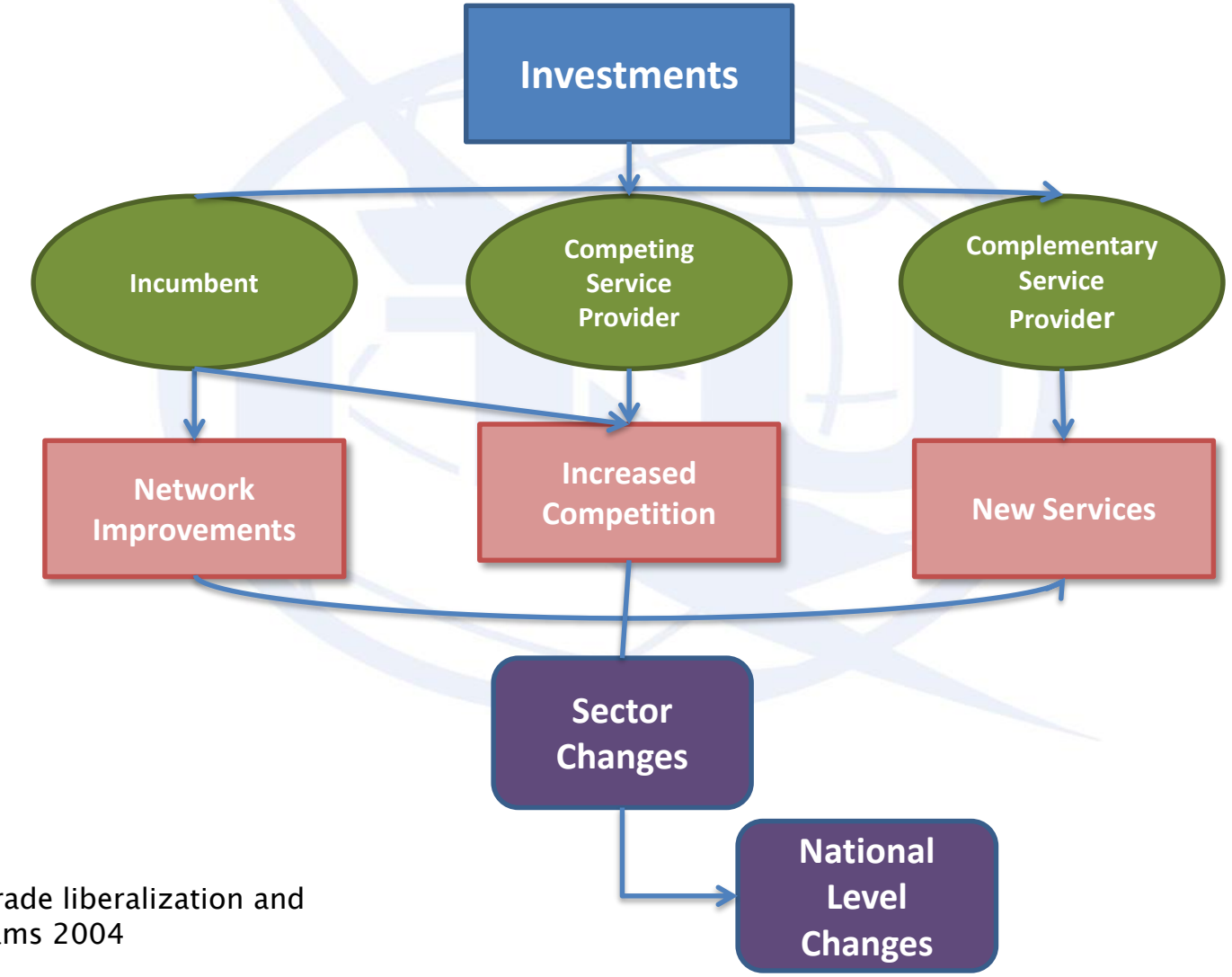
Through market liberalization, and private sector expansion combined with fair and effective competition have led to lower prices for consumers throughout the global telecommunications sector.



Source: World Development Indicators 2003, World Bank, citing International Telecommunications Union data.

* LAC data are for 1999. MNA data were unavailable. There are no countries in the MNA region with full competition.

Investments



Source: Telecommunications trade liberalization and the WTO, Bressie, Kends, Williams 2004

Spectrum Prices

- While there have significant real declines in the prices of services to end users, there has been a corresponding significant real increase in the price of spectrum to users in a variety of services, most notably mobile communications.
- We will now review three important concepts that underlying spectrum prices which influence spectrum policy, which are:
  - Economic Efficiency
  - Equilibrium Prices
  - Economies of Scale
- We shall see how these concepts provide a basis for establishing prices and justification for selecting certain methodologies. We will also learn that some methodologies are better suited for achieving specific objectives

Economic Efficiency

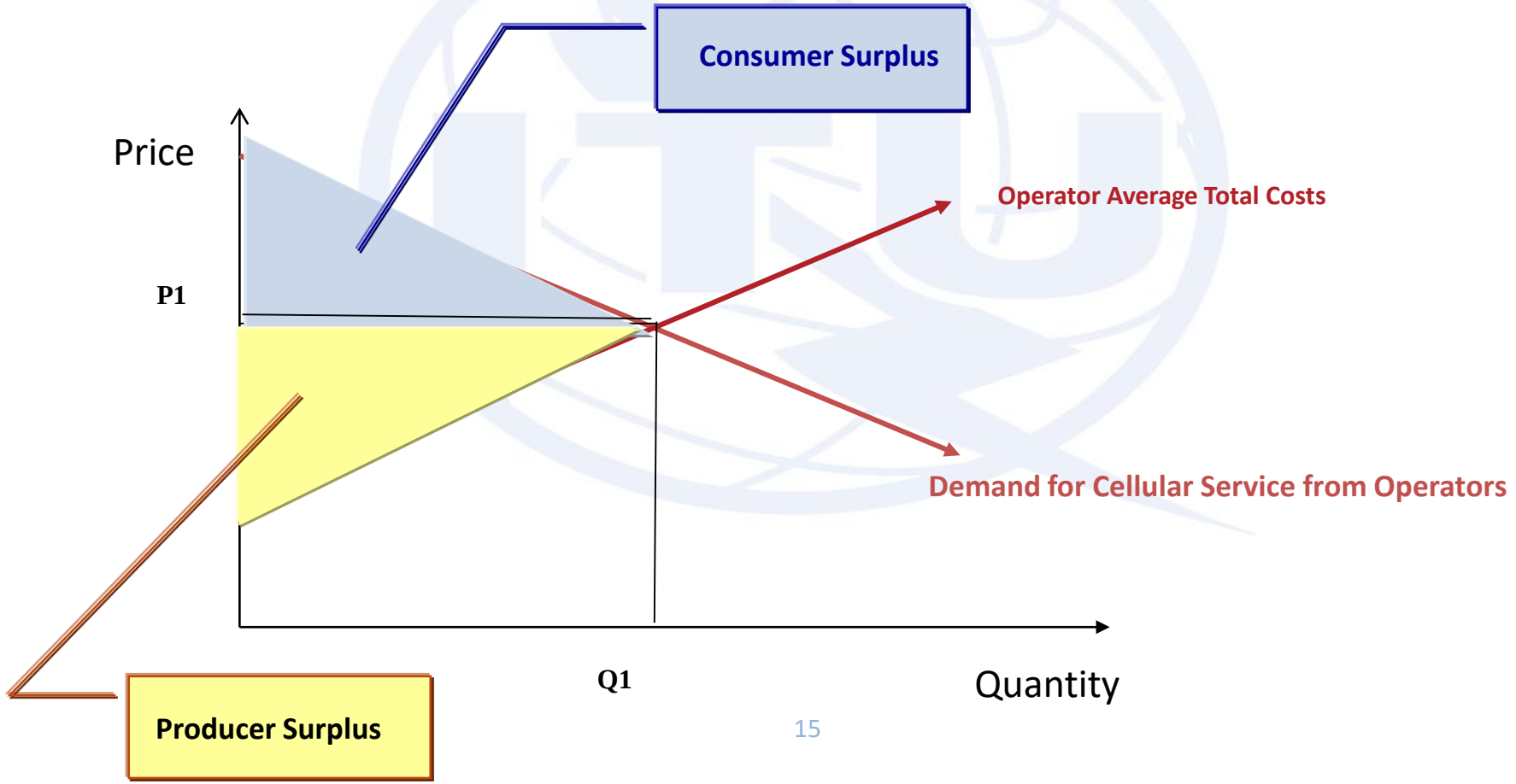
- Economic Efficiency has three dimensions relating to the production, consumption, and use of a resource over time:
  - Productive Efficiency – goods should be produced at the lowest possible cost for inputs;
  - Allocative Efficiency – the mix of goods and services produced should be optimal.
  - Dynamic Efficiency – resources are used in such a way to encourage investment and innovation.

Equilibrium Prices

- Equilibrium prices in a competitive market exist when relative prices have been established for the cost of good X in terms of Y reflecting what consumers are willing to pay in the exchange.
- This equilibrium is illustrated in the next chart where consumers are willing to pay for the services provided and perceive additional value or surplus whereas suppliers, i.e. operators are able to generate revenues in excess of costs producing profit or supplier surplus.
- The notion of surplus for consumers and operators is important to spectrum policy.
  - Sufficient spectrum is needed to ensure efficient operations and permit offering of competitive values services to consumers.
  - Equilibrium prices help to ensure efficient markets.

Spectrum Prices and Surplus

P1Q1 equals the market clearing price for cellular services in a competitive market where operators have acquired spectrum at an economically efficient price (through an auction).



Economies of Scale

- Declining Average Total Costs per Unit over the long-run (LRATC) resulting from large scale production.
- larger scale leads to lower minimum unit costs, why?
  - Economies from large scale mass-production methods;
  - Higher productivity through specialization, (learning affects – efficiency doubles as volume increases geometrically);
  - Economies in promotion and procurement
- Increased economies of scale seem to be an argument in support of monopolies or tight oligopolies.

Monopolies and Oligopolies

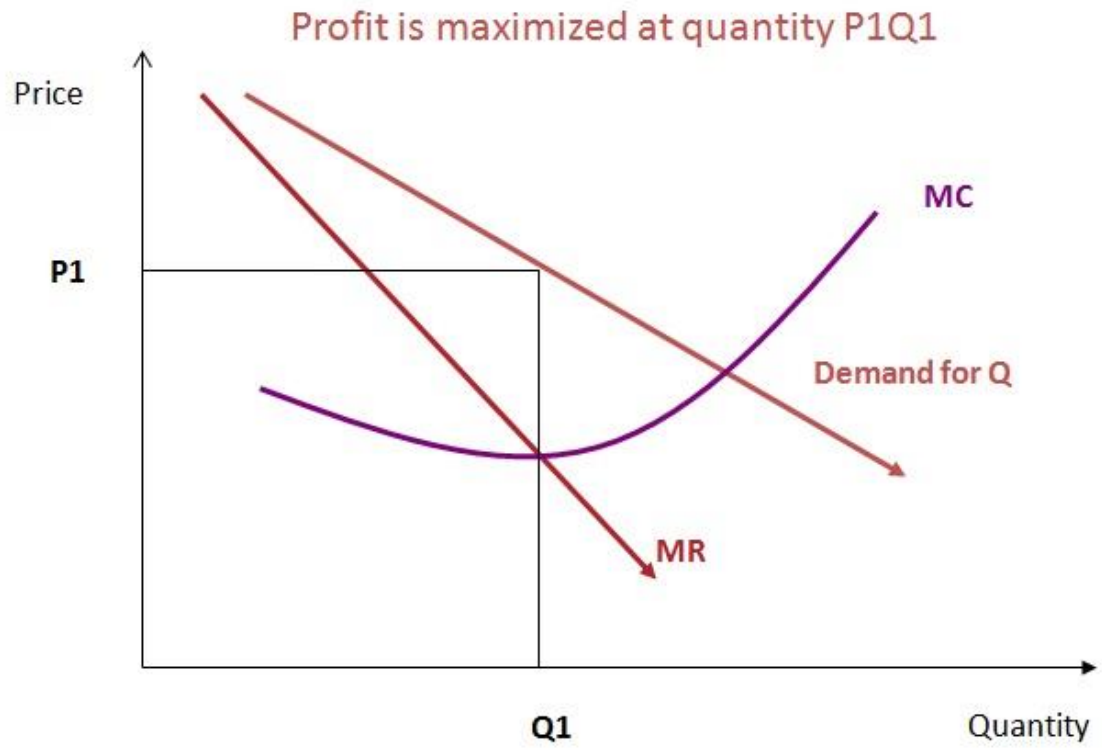
- A monopoly as a market characterized by (1) *high barriers* to entry (2) a single seller of a well defined product for which there are *no good substitutes.*
- By Law monopolies are created in some important industries – electricity, water distribution, local telephone service.
- However, when there are only few firms price collusion is a possibility
- Economies of scale are important.

Monopolies and Oligopolies (Cont.)

- Sometimes economies of scale are so important that per-unit cost will be lowest when only few firms produce.
- Natural monopoly is a market situation where average costs of production continually decline with increased production. Therefore the LRATC will be lowest when there is only one firm.
- In the case of natural monopoly, breaking up the firm to create competition only serves to increase average cost and so is counterproductive.

Monopoly Prices and Output

- The monopolist firm will act to expand output until marginal revenue equals marginal cost. The Profit maximizing price is obtained at a level of output on the demand curve where MR=MC.



Effective Competition

- Increased competition, leading to lower prices in the mobile and ISP sectors, is the net effect of liberalization, deregulation and privatization in telecommunication services.
- Competition: a market where firms elastic demand (downward sloping demand curves) and entry and exit from the market are relatively easy. There are degrees of product differentiation with varying quality, design, location and marketing.
- Sustained competitiveness requires adopting long-term strategies to raise efficiency, boosting levels of skills and technology, and investing in critical infrastructure for a country's long-term future.

Transparency

Transparency improved Accountability and Effectiveness	**Empowerment and participation**
Government • Revolutionizing the internal workings and external relations of public administrations • Helping countries to put issues in the spotlight as corruption etc.	Society • Information flows in both directions and gives people a voice to influence policy making and to participate
Improved transparency through the use of technology (ICT's) are strengthening the backbone of collaboration for civil society	

Defining spectrum rights

- Spectrum rights are often defined using spectrum space concepts such as in Australia (ACMA).
- Rights are defined by:
  - Geography
  - Bandwidth
  - Emission limits (out of band and out of area)
  - Other technical conditions which may include deployment constraints, antenna performance.

Spectrum User Rights are not all the same

- There is agreement in principle on what should exist:
  - A clear definition of usage rights to reduce uncertainty and enhance some desired market activity such as spectrum commons, spectrum auctions or spectrum trading.

- However, there is considerable disagreement on the application of SURs:
  - The Spectrum User Rights (SUR) package includes restrictive technical features regarding time, area (including power limitations) and frequency (Ofcom)
  - Flexible User Rights with overly restrictive conditions can act as a barrier to spectrum trading
  - Usage rights should be defined to allow spectrum to be subsequently aggregated and disaggregated including geographical partitioning.

Examples of SURs

- Australia ACMA
- UK Ofcom

Australian approach to licensing

- Most spectrum is still managed in Australia under technology specific licences:
  - The view is taken that flexibility is not needed for many parts of spectrum e.g. amateur, point to point, land mobile, broadcasting
  - Whereas more flexible (Spectrum) licences should used in conjunction with high value bands (mobile communications, etc.) in which cases the spectrum is mostly auctioned.

Elements of Australian spectrum licences

- Core conditions:
  - Frequency band
  - Geographic area
  - Emission limits
- Statutory conditions:
  - Liability to pay any charges
  - Requirement to register transmitters
- Other conditions:
  - Including licensees responsibility for managing interference within licence, co-sited devices

UK Spectrum Usage Rights

- Spectrum Usage Rights (SURs) used by Ofcom for L band auction in 2008
  - More flexible type of licence
- SURs are form of licence based on interference that can be caused, rather than power that can be transmitted
- Provides greater certainty for investors that their network will not suffer reduced capacity as result of their neighbours changing their spectrum use.

UK Spectrum Usage Rights (Cont.)

- Three forms of interference need to be considered
  - Geographic interference: PFD should not exceed a certain level at or beyond geographic boundary;
  - Out of band: Power Flux Density * (dBW/m2/MHz) at an agreed height should not exceed a set power level *at more than a certain percentage* of locations in a set area;
  - In band: As for out of band, but power levels set higher.

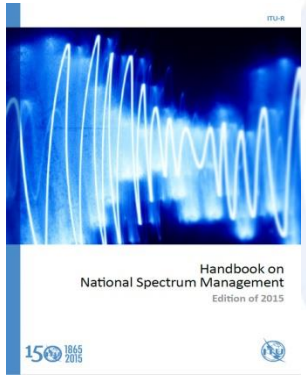
* Power Flux Density (PFD) – for more on go to module EM2-1 Part 4 which discusses at length Spectrum User Rights and PFD in that context.

UK Spectrum Usage Rights (Cont.)

- Ofcom makes an estimate of initial values based on its knowledge and experience
- Estimate is published, and stakeholders can comment, suggest changes
- Limits can be changed by mutual agreement of licensees
  - Ofcom would normally agree to make change if all potentially affected licensees had given approval.

Pre-reading and References

http://www.ictregulationtoolkit.org



http://www.ictregulationtoolkit.org/en/Publication.2451.html

http://www.itu.int/ITU-D/study_groups/SGP_2002-2006/SF-Database/index.asp

- ICT Regulation Toolkit: Module V – Spectrum Management, Section 5 on Spectrum Pricing (revised)
- ITU Handbook National Spectrum Management
- The Economics of Pricing Radio Spectrum, Chris Doyle, Martin Cave, Warwick Business School, March 2004

Thank you