VISION رؤية 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

هيئة الاتصالات وتقنية المعلومات
Communications and Information Technology Commission

Theory and Practice in Spectrum Value Estimation

ITU Regional Seminar for CIS and Europe
Development of Modern Radiocommunication Ecosystems
6-8 June 2018, St. Petersburg, Russian Federation

Mohammed Alotaibi
Communications and Information Technology Commission
Kingdom of Saudi Arabia

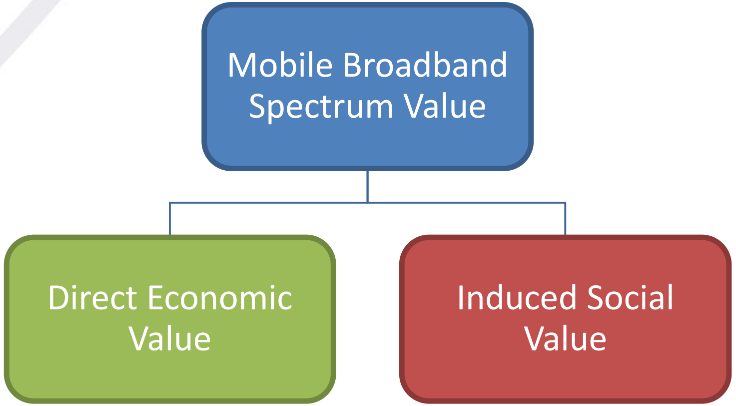
Scope

1) Value of Spectrum
   - Economic value
   - Social value
   - Examples on spectrum values
2) Theory of Spectrum Valuation
   - Valuation methods
   - Factors in assessing value
   - Market-based approach
   - 5G affecting spectrum value
3) Spectrum Pricing: Case of Saudi Arabia
   - Spectrum usage fee policy
   - Spectrum auctions for IMT spectrum

Spectrum Value

- **Spectrum alone has no inherent value, its value is derived from the economic and social values it enables as an input into the production of wireless services**
- **Spectrum managers role is to ensure that each spectrum band is put to its highest and best social and economic use**

It has direct economic value to the service providers. it also creates consumer surplus for the service providers' customers



Economists estimated that the total social benefits from licensed spectrum are 10 to 20 times the direct economic value of the spectrum

Economic Value

- The economic value of a spectrum license is equal to the net present value of the future stream of profits a license holder expects to receive from the spectrum
- Mobile spectrum has immense tangible as well as intangible benefits to the national economy
- Mobile wireless services have driven enormous innovation, spurring entirely new industries
- Thus the Mobile industry generates significant economic activity and creates a large footprint in the overall national economy

Social Value

- Spectrum generates immense social value through the services it enables
- Mobile broadband spectrum creates consumer surplus for the service providers' customers
- Consumer surplus is equal to the welfare benefits to consumers of the services enabled: generally measured as the difference between the value of a good to the consumer and the price paid by the consumer
- Several empirical studies have found that the annual consumer surplus created by wireless broadband services using a particular spectrum allocation is roughly equal to the total market value of that spectrum allocation

Examples of Spectrum Valuation

- **645.5 MHz of spectrum licensed for mobile services in the US is estimated to have economic value of $500 billion**

- **In UK, a study estimated the welfare effects of seven notable spectrum-using sectors. It showed the spectrum value to be £52 billion:**

Mobile	Wi-Fi	TV Broadcast	Radio Broadcast	Fixed Links	Satellite Links	Private Mobile
£ 30B	£ 1.8B	£ 7.7B	£ 3.1B	£ 3.3B	£ 3.6B	£ 2.3B

Spectrum Valuation Methods

- **Business-model Valuation:** based on estimating how much profit the spectrum will generate - the analysis requires data on total revenues and costs
- **Macro-Economic Approach:** assesses the value of spectrum in terms of its contribution to the national economy
- **Benchmarking Approach:** estimates the value of spectrum by comparing spectrum valuations from past concluded auctions and other valuations both within the country and internationally
- **Opportunity Cost Approach:** estimates the cost saved as a result of using particular spectrum rather than its next best alternative
- **Econometric Approach:** analyses past economic data in order to generate a mathematical model for showing relationship between spectrum value and various affecting factors/independent variables

Factors in Assessing Value

Physical Characteristics	700 MHz frequency has better coverage than 3500 MHz frequency band
Global Harmonization	Creates mass-market ecosystem for equipment and end-user devices
Allocated Radio Services	Mobile services generate higher demand and value than, for example, broadcasting service
Environment	Like geography and climate of the country
Socioeconomic factors	Population density, economic and political variables
Regulations	Design of the award, terms and conditions of license, obligations, allowing trading and sharing and infrastructure regulation

Market-based approach

- When value is set based on administrative decision, it provides opportunity to include more characteristics related to social benefits
- Complicated process:
  1. Identify the players (service providers, users and their sectors) to map the range of stakeholders involved in the relevant band's ecosystem
  2. Identify products and services that use subject spectrum band
  3. Assess the economic and social value from using the spectrum, based on valuation method

- "allocation of resources should be determined by the forces of the market rather than as a result of government decisions" - Ronald Coase (1959)
- Spectrum treated like property — auctioning it off to the highest bidder and giving that bidder flexibility to use it — or even sell or trade it, much like land
- More efficient approach, when the demand exceeds supply of spectrum

5G affecting spectrum value

- **Carrier aggregation:** fragments of spectrum can be utilized and become more usable
- **mm-Wave spectrum:** large swaths of “new” spectrum could be utilized for mobile use in indoor and short range data-intensive scenarios like autonomous vehicles and industrial automation
- **Spectrum sharing:** when it is introduced in some higher bands, it would affect the value compared to exclusively-assigned spectrum
- **Network architecture:** ad-hoc and mesh networks can utilize high-bands more efficiently
- **Flexible Duplexing:** Improvement in filters performance will make TDD and SDL arrangements more usable and utilize bands center gap. Unlike in the past, TDD-arranged spectrum might be as valuable as FDD paired blocks

Spectrum Pricing – Case of Saudi Arabia

- **Appropriate spectrum pricing helps to promote efficient use of valuable national resources**
- **Help preventing "free parking" by inactive holders**
- **The aim is to maximize the spectrum value by utilizing for its best use**

Demand exceeds Supply:	**Demand doesn’t exceed Supply very often:**
Bands identified for IMT	Bands for other radio services
Licensing spectrum through competitive Process (Auction)	First-come First-served
Market competition decides the price	Regulator policy decides the price

Frequency usage fees

- Priority is placed on the role of frequency usage fees in promoting efficient spectrum use
- The KSA frequency usage fee schedule comprise the following elements:
  1) A general **fee formula** which will be applied to derive fees for PMR, fixed links, satellite earth stations and broadcasting services
  2) **flat rate fees** which are applied to aeronautical, maritime, amateur and satellite terminals.
  3) **Mobile (IMT) fees** which should be decided based on a competitive process like auction. Otherwise, such as for historic assignments, fees are specified on a per MHz basis for each IMT band
- The method used to set values for the different fees were mainly the benchmarking approach in combination with simplified econometric analysis of collected data

Fee Formula

$$Fee = C \times BW \times FBF \times AF \times DF$$

C = constant value per MHz that is set at a level that recovers a target level of revenues – at a minimum the regulator's spectrum management costs.

BW = Licensed Bandwidth in MHz (Note).

FBF = Frequency Band Factor, which reflects the increased utility and more limited availability of spectrum in lower frequency bands and in some cases the higher spectrum management costs associated with those bands (due to increased probability of interference).

AF = Area Factor, which reflects the area over which use by other licensees is denied. This varies depending on the type of services licensed and the assignment approach used.

DF = Demand factor, which adjusts the fee levels to reflect the degree of band congestion or demand for particular frequency bands or at certain locations (i.e. major cities).

Note: refers to the total transmit channel bandwidth used by the licensed service. For receive-only earth stations which require protection from interference, licensed bandwidth refers to the total receive bandwidth..

Flat Rate Fees

- Flat rate fees are appropriate for spectrum licenses which provide access to a common pool of internationally coordinated frequencies rather than individually assigned frequencies
- The main services for which this form of spectrum access applies are aeronautical, maritime, amateur and satellite terminals
- The fees are typically charged on a per station or equipment basis

Mobile (IMT) fees

- The fees for mobile (IMT) bands are based on international benchmarking of IMT band auction results around the globe
- These fees are only applicable to spectrum which is directly assigned or renewed, and to spectrum awarded via a beauty contest
- For market-based award mechanisms like auctions, the fees will be determined by bidding
- These fees could be useful as a guide on reserve prices for future auctions

IMT Spectrum Auctions

- Two auctions of IMT spectrum held in Saudi Arabia in 2017 and 2018
- They were the first of their kind to be held in the Middle East
- A total of 180 MHz in the 700, 800 and 1800 MHz bands was awarded to the three incumbent operators,
- This award increased the IMT spectrum held by Saudi mobile operators by 60% (from 260 MHz to 420 MHz)
- The value of this 180 MHz of spectrum was about SAR 7.5 Billion (US $ 2 Billion)

Auction Design

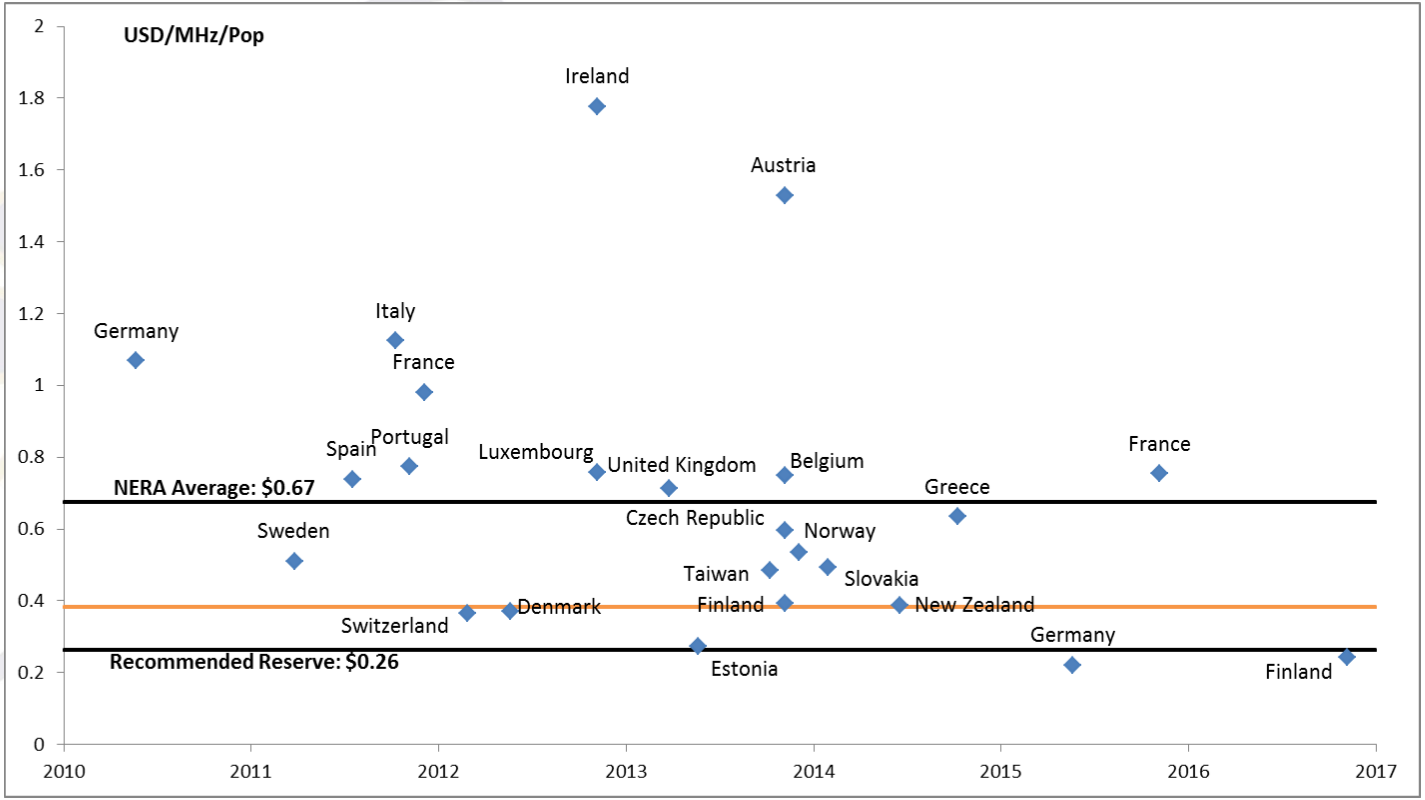
- **Participation:** CITC decided to limit participation in the auction to the three existing mobile operators
- **Spectrum packaging:** to sell all newly available spectrum in “generic” blocks of 2x5 MHz, which would then be assigned to bidders as contiguous blocks
- **Spectrum caps:** bidders were subject to three separate spectrum caps: Sub-1 GHz Cap, General Spectrum Cap and 700 MHz Cap
- **Reserve Price:** was set below expected market value, so as to allow plenty of headroom for competition in the auction to identify a market price;

Auction Format

- **Two stages:**
  - an Allocation Stage to determine the quantity of spectrum in each band to be allocated to each bidder; and
  - an Assignment Stage to determine the location of each bidder's spectrum within the bands
- **First Auction:** "a multi-round ascending clock auction"
  - promote price competition and discovery
  - ensure simplicity and allow swift implementation
- **Second Auction:** "first price sealed package bid auction"
  - allowed greater flexibility for implementing the reservation and spectrum caps
  - allowed for the auction to be run on a fixed timetable

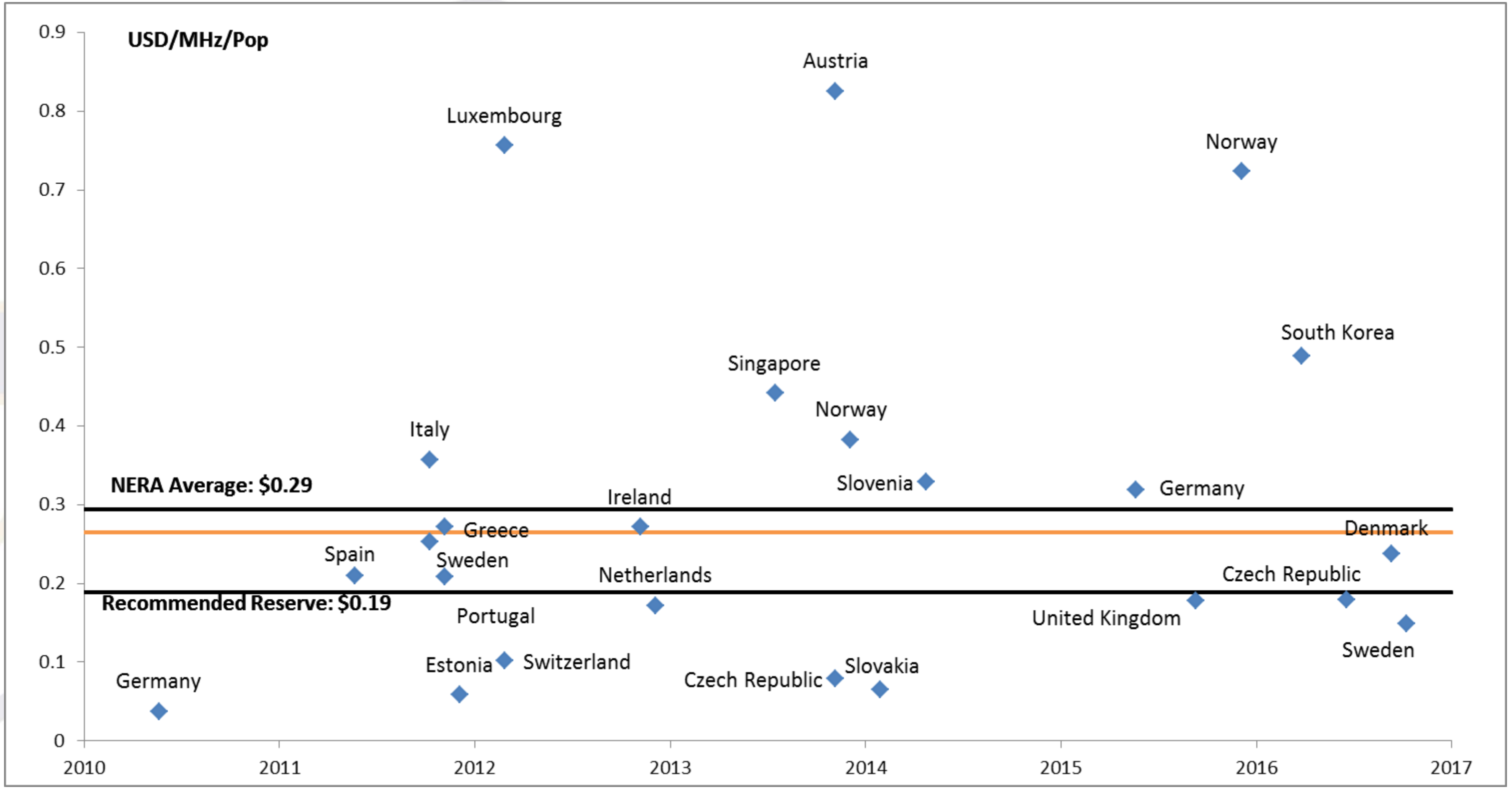
Auction Results: 700 MHz band

700 MHz benchmarking (orange line: KSA auction clearing price)



Auction Results: 1800 MHz band

1800 MHz benchmarking (orange line: KSA auction clearing price)



Lessons Learned

- Holding more than one auction within a short time puts smaller operators under great financial stress
- The approach of using auctions to award spectrum provides an effective and legally robust process
- The regulator needs to consult with the market on a roadmap for the release of spectrum bands, and publish the timeline ahead of time
- International benchmarking doesn't necessary lead to correctly predicting market value of spectrum in a given country
- Spectrum cap is useful tool to ensure competitiveness of operators, especially in asymmetric market

شكراً

Thank you

References

- Coleman Bazelon, Giulia McHenry, “Mobile Broadband Spectrum: A Vital Resource for the U.S. Economy”, May 11, 2015
- Thomas W. Hazlett, David Porter, Vernon Smith, “RADIO SPECTRUM AND THE DISRUPTIVE CLARITY OF RONALD COASE”, 2009
- Settapong Malisuwan, Jesada Sivaraks, Thitipong Nandhabiwat, Navneet Madan, and Pannakorn Laokulrat, ” Estimation of Commercial Value of Spectrum: The Approach Adopted in Thailand”, 2014
- Philip Bates, “Overview of Analysys Mason 2012 study on the value of spectrum to the UK economy”, 2018
- Martin Cave, “Spectrum and the Wider Economy”, 2015
- ITU, “Exploring the value and economic valuation of spectrum”, 2012
- Deloitte, “Spectrum Portfolios in a 5G World”, 2018