
Spectrum Sharing and Tariffs

Impact of Sharing on Prices

**Regional Seminar - economic and financial
aspects of telecommunications Study Group 3
Regional Group for Latin America and
Caribbean (SG3RG-LAC)**

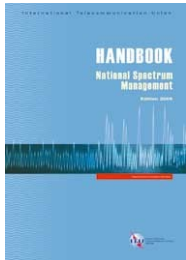
SG3RG - LAC - El Salvador 2011

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References



<http://www.ictregulationtoolkit.org>

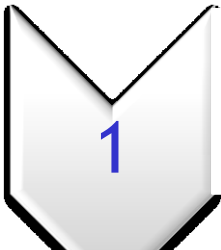


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Outline



1

- Introduction - Scarcity and Spectrum Sharing



2

- Implications of Sharing on Tariffs and Prices



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- Spectrum Valuation Methods



4

- Conclusions

Central Questions

- Questions about sharing and tariffs. Two concepts with multiple dimensions and relationships:
 - First is Spectrum Sharing - what is it and why do we do it? Here we will briefly review:
 - Types of Spectrum Sharing
 - Second is Tariffs - there are two aspects:
 - Do higher spectrum prices lead to higher end user prices? - this is the operators argument. We will look at this at closer level of detail.
 - How does sharing affect spectrum prices and end user prices.
- Regulators are interested in valuing spectrum. We will look at some of the ways to do that:
 - Administrative and market means.

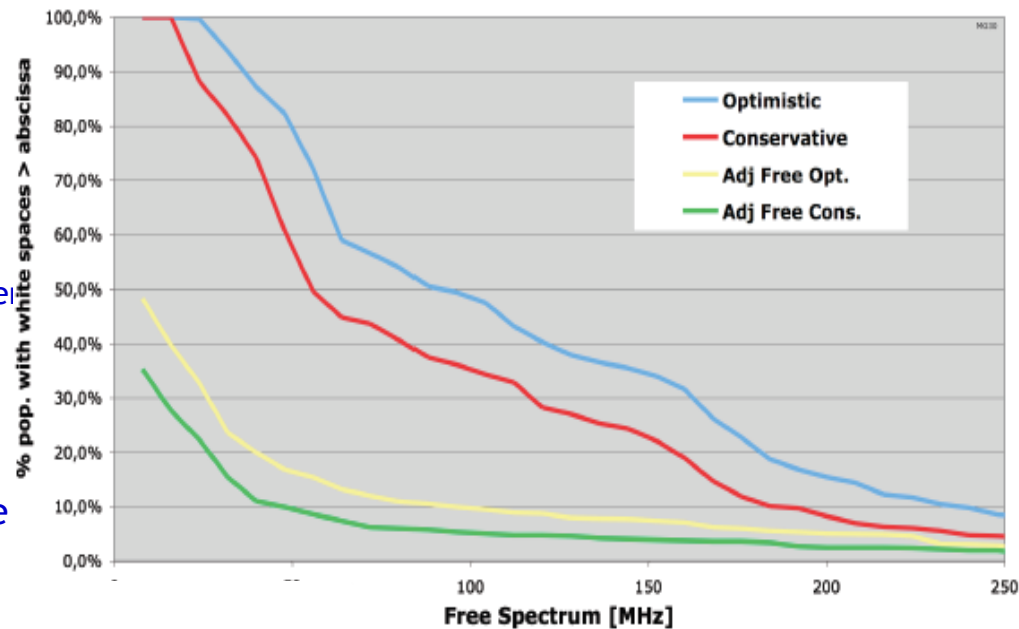
Spectrum Sharing

- Spectrum sharing encompasses several techniques - some administrative, some technical, and some market-based.
- Spectrum can be shared in several dimensions: time, space, and geography.
- Limiting transmission power is also a way to permit sharing among low-power devices operating in the spectrum “commons, *dynamic spectrum access*, which takes advantage of power and interference reduction techniques. Use of whites spaces.
- Sharing can also be accomplished through licensing and/or commercial arrangements involving spectrum leasing and trading.

Sharing Whitespaces

- The first step in determining whether it is feasible to use whitespace spectrum involves knowing the extent to which whitespace spectrum exists in a geographic area. There are several options for the use of whitespace spectrum - when and how it will be assigned and managed:
 - Allowing the use of unlicensed devices;
 - Assigning whitespace spectrum to local broadcast;
 - Allowing existing users to share the spectrum;
 - Assigning whitespace spectrum to band manager who manages the spectrum for users;
 - Choosing between market based or administrative assignments.
- Study will be necessary and consultation should be done in every case to communicate how technology may affect whitespace spectrum in certain locations and to obtain input into decisions on appropriate options and strategies

Whitespace estimates for Italy, where DSO is completed - by population density, with both conservative and optimistic projections.



When is Spectrum Sharing Needed?

- It should be conceptually straightforward to answer the question of when sharing is required?
- Essentially, spectrum sharing may be needed when:
 - Demand for spectrum exceeds the supply;
 - There is congestion and the potential for harmful interference;
 - The technical means exist to permit different users to share; and
 - Other means for adjusting spectrum use and assignment (such as re-farming) have become burdensome and costly, undermining the goals of economic and technical efficiency;
- The bigger implication is that spectrum management policies are evolving towards more flexibility and market-oriented models to increase opportunities for efficient spectrum use.

Sources of Scarcity

- There are three "causes" of spectrum scarcity:
 - Increased demand;
 - Administrative processes; and
 - Technical issues, such as interference management and technical obsolescence.
- It is important to note that spectrum scarcity is a relative term - scarcity can vary within a country and from one country to another.
 - When examining various spectrum management approaches for spectrum sharing it is important to keep in mind that differences do exist between countries and between urban, rural, and remote regions.

Which bands can be shared?

- The bottom line is that all bands potentially can be shared. In fact, many bands remain underutilized and could be shared using a combination of:
- Administrative rules -- time, geographic, and interference-management constraints; and
 - Technical solutions - filters, smart antenna, smart transmitters (such as SDR and cognitive radio) and transmit power limitations.
 - An important exception to sharing may result from a policy decision to maintain exclusive bands and assignments for public safety and security services.

Connection Between Scarcity and Prices

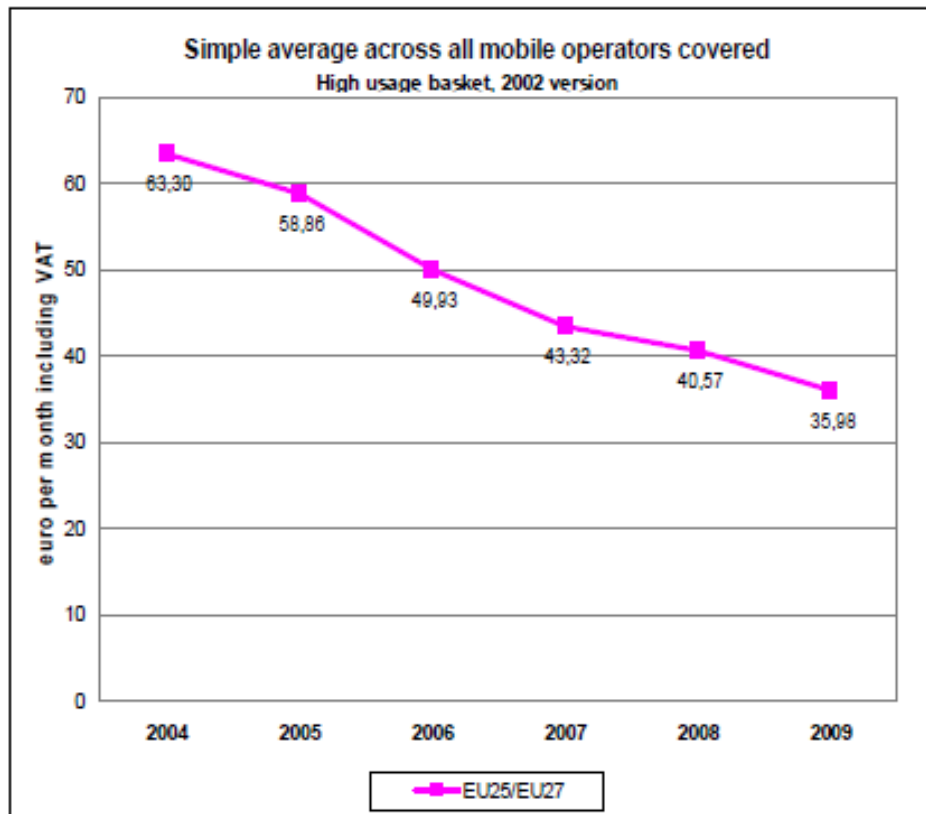
- Improving access to spectrum has a powerful influence on both spectrum prices and end user prices - they both will fall:
 - Limiting spectrum decreases competition. Ways this can be done (creating administrative scarcity) include:
 - Reserving or holding back spectrum;
 - Use of spectrum caps when not warranted;
 - Restrictive frequency band and channelling plans (failed 2.6 GHz. OFTA auction in 2009);
 - Excessive transaction costs reduce sharing by impeding trading (Ofcom suspects this is a primary reason for low levels of trades)

Spectrum Prices and Tariffs

- Do high spectrum prices lead to higher end user prices?
 - OECD Study on Telecom 2009 - telecom expenditures as a % of household disposable income is steady at 2% and in some cases declining. Getting more for less.
 - Several regulators monitor post auction consumer prices - ACMA and Ofcom have seen no impact.
 - Independent Study - based on analysis of retail prices in different regions with different underlying spectrum, license costs show prices are not different and there is no statistical correlation between auction prices and retail prices.

Spectrum Prices and Tariffs

- EU Telecoms Market Study - in a period of rising spectrum prices, retail prices have fallen.



Equilibrium prices

- These examples lead us back to the Theory of Prices:
 - Equilibrium prices are generally set in a competitive market when relative prices have been established for the cost of good X in terms of the cost of good Y reflecting consumers willingness to pay for the transformation.
 - economic efficiency and price equilibrium are related. The right # goods are created at the price in a competitive market place equating supply and demand which is efficient.
- Supports the view that spectrum prices are sunk costs and do not determine end user prices.

Spectrum Sharing and Tariffs

- Now we can come back to the question of how does spectrum sharing impact tariffs.
- The simple answer is that sharing *reduces* spectrum prices but these prices don't have an impact on retail prices.
- *The most important influences on high retail prices are 1:*
 - *Competition or the lack of it;*
 - *Interconnection and termination rates.*

Spectrum Prices and Sharing

- Spectrum sharing reduces the spectrum rights of the users sharing the band or the frequencies. What is worth more?
 - An exclusive assignment of a band or range of frequencies? Example Cellular bands and email.
 - A shared assignment?
- Caution - There can be unintended consequences of sharing which could impact retail prices for consumers:
 - Collusion between operators sharing frequencies, other infrastructure;
 - Loss of innovation and service evolution

Three Examples of Sharing

➤ Unlicensed Band

- No cost beyond regulatory costs. ISM bands have been a significant source of innovation acting as a catalyst and proving ground - WiFi, RFIDs, SDR and Cognitive Radio.

➤ White spaces

- Limited spectrum user rights and range of options. Prices set by the regulator.

➤ Exclusive bands - cellular is the best example. High value, important GDP impact, scarcity and prices set by auction.

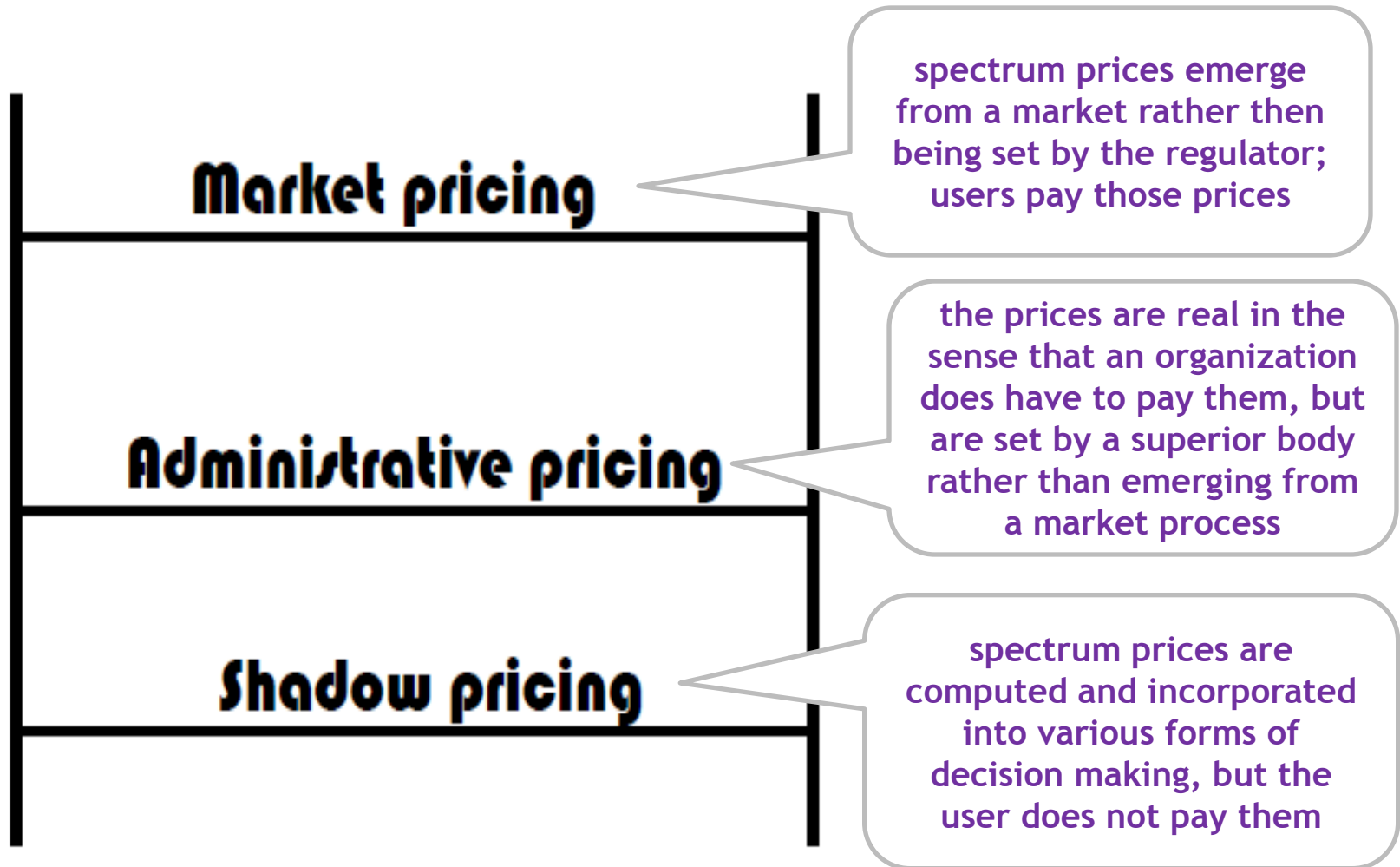
- Cellular operators with adequate assignments in competitive markets are driven to maximize the value obtained from assigned spectrum. So prices are high and the impact on end users prices is determined in the market.

Spectrum Valuation

➤ Why of interest?

- Not all regulators are in a position to nor do markets appear to support readiness for market-based prices for new licenses established by way of an auction.
- Licenses are up for renewal and license values need to be reset.
- Need to understand values to support refarming initiatives.
- Spectrum user charges need to be sufficiently high to properly act as an incentive encouraging efficient utilization and technology choice.

TYPES OF PRICING: PRICING CONCEPTS



ADMINISTRATIVE PRICING PRINCIPLES

- Should aim at producing an estimate of the opportunity cost of each frequency;
- Should focus on possibilities for technical substitution between the given frequency and other frequencies or other inputs;
- The resulting input prices for spectrum should encourage inefficient uses and inefficient users of spectrum.

Approaches to setting administrative spectrum prices

➤ The *‘individual band’ approach*:

- It involves the examination of use of a given band for a particular purpose.

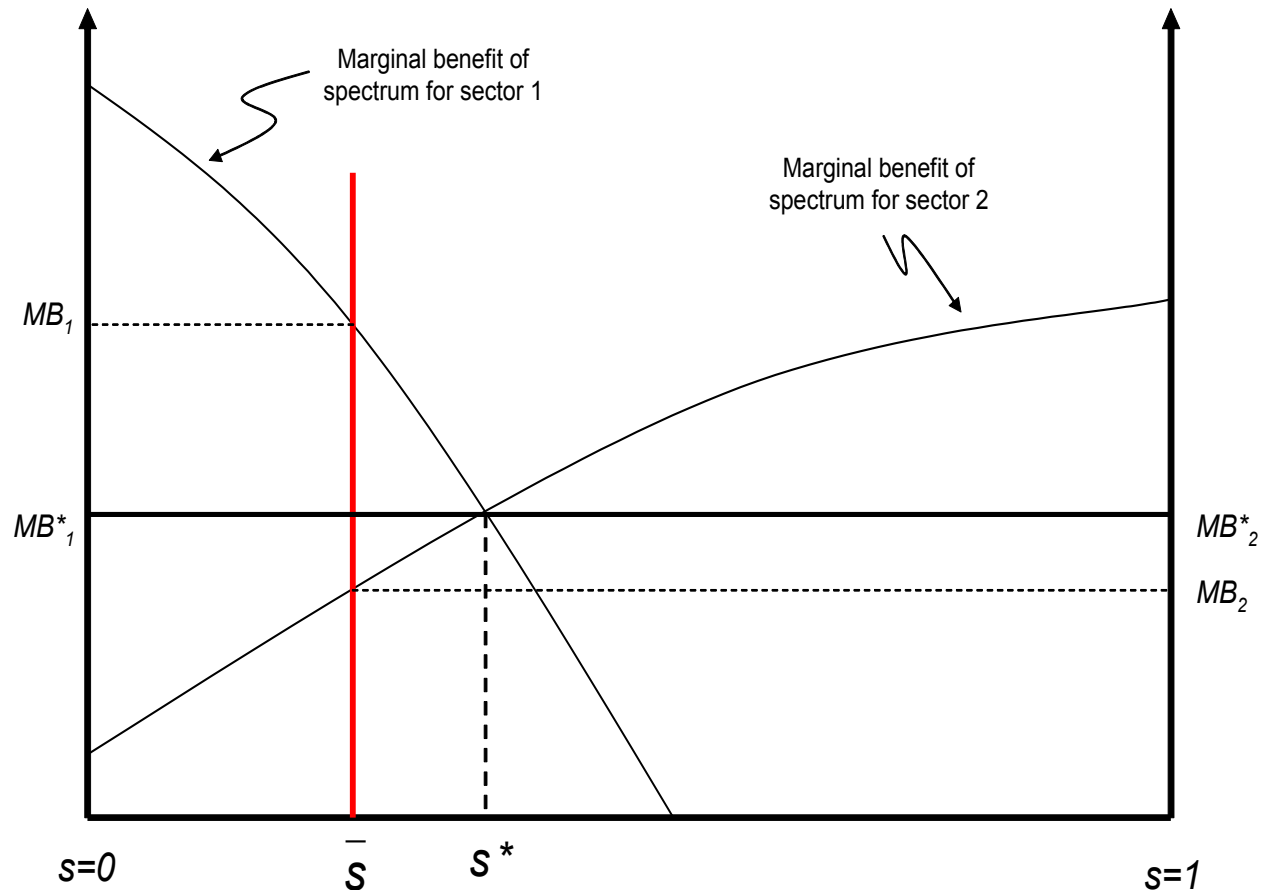
➤ The *‘across the board’ approach*:

- it involves establishing a declining sequence of prices for frequency bands arrayed in ascending order, with the sequence of prices being independent of the specific uses made of the frequencies.
- Becomes increasingly difficult to implement as the number of competing uses of spectrum gets large

Definitions

- **Marginal Benefits:** refer to the value resources saved or foregone when resources allocations are changed between factors of production. Marginal benefits typically decline due to decreasing returns to scale. In other words, as the number of units increase the benefit attributed to each additional unit decreases.
- **Opportunity Cost:** is found by estimating what other resources which will be saved if the same spectrum is redeployed to produce another service; or what are the extra costs which will be incurred if the spectrum not available (i.e. less spectrum is available) to provide the service for which it is currently employed.
 - Spectrum should be priced in any use, at its opportunity cost which will then apply the right level of price pressure.
 - Prices should not be too high to force excessive economies which will leave valuable spectrum unused .

A Methodology for administrative pricing



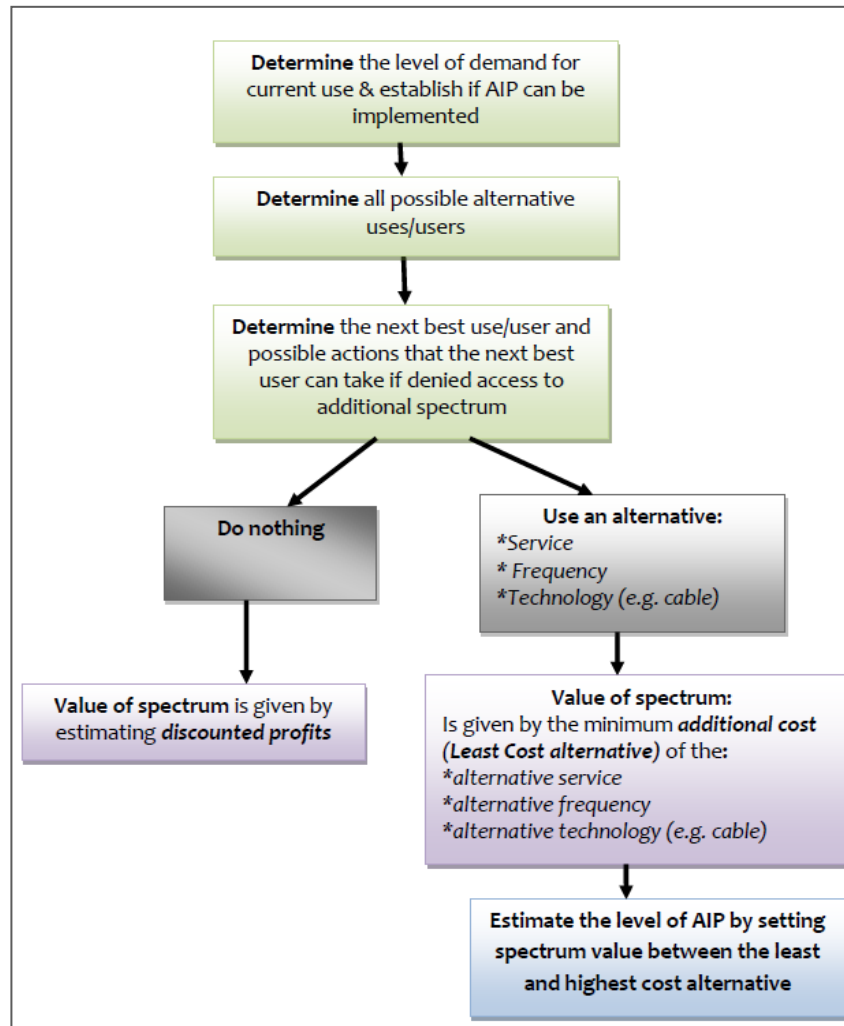
Spectrum assigned to sector 1

Spectrum assigned to sector 2



Committed to connecting the world

Cost based Analysis and AIP



Spectrum Pricing Methodology: Summary

1. For a given frequency band identify the current and other potential uses of the band.
2. Calculate the opportunity cost of spectrum for the current use of the band and other uses until a use is found which has a higher marginal value than the current use.
3. If there is a use with a marginal value higher than the current use of the band then set the valuation between the two values, but towards the bottom end of the range of values.
4. If there is no use with an opportunity cost higher than the current use of the band then set the valuation equal to the opportunity for the current use.
Administrative costs should be recovered.

Factors that influence the choice/price of a frequency

- Exclusive versus shared bands;
- Level of international harmonisation of the frequency range
 - determines the availability and cost of network equipment and access devices
- Range/capacity of the cells
 - determines the radio network cost
- Availability of a given frequency range and the cost of dislodging current users
 - Also determines the total network cost

Broadcast 794.0-960.0 MHz

794-960 MHz	
Current use	2G mobile voice and text services, aeronautical fixed links
Possible alternative uses	TV broadcasting
Level of excess demand for current use	HIGH for mobile services, LOW for aeronautical fixed links. Should rise significantly as <i>UMTS 900</i> network equipment and access devices are set to hit the market in the medium term.
Level of demand for alternative uses	negligible
Auction in the near future	No , although NTC is set to remove technology restrictions on the band.
Policy issues limiting pricing mechanisms?	NO.
Is there a positive Opportunity Cost?	YES for current use and NO for alternative uses
Proposed Pricing mechanism	Auctions, AIP, market benchmarks.

BWA 2500-3500 MHz

2500–3500 MHz	
Current use	Voice/low speed data (WiMax, 4G)
Possible alternative uses	WiMax, fixed links including aeronautical fixed links, radar services
Level of excess demand for current use	HIGH. This is the most widely used spectrum for 3G services.
Level of demand for alternative uses	negligible
Auction in the near future	Unknown.
Policy issues limiting pricing mechanisms?	NO.
Opportunity Cost?	Maybe. Depends on overall demand for services. This band could be congested or it could provide ‘overflow’ capacity for preferred bands; but note other uses.
Proposed Pricing mechanism	AIP, market benchmarks

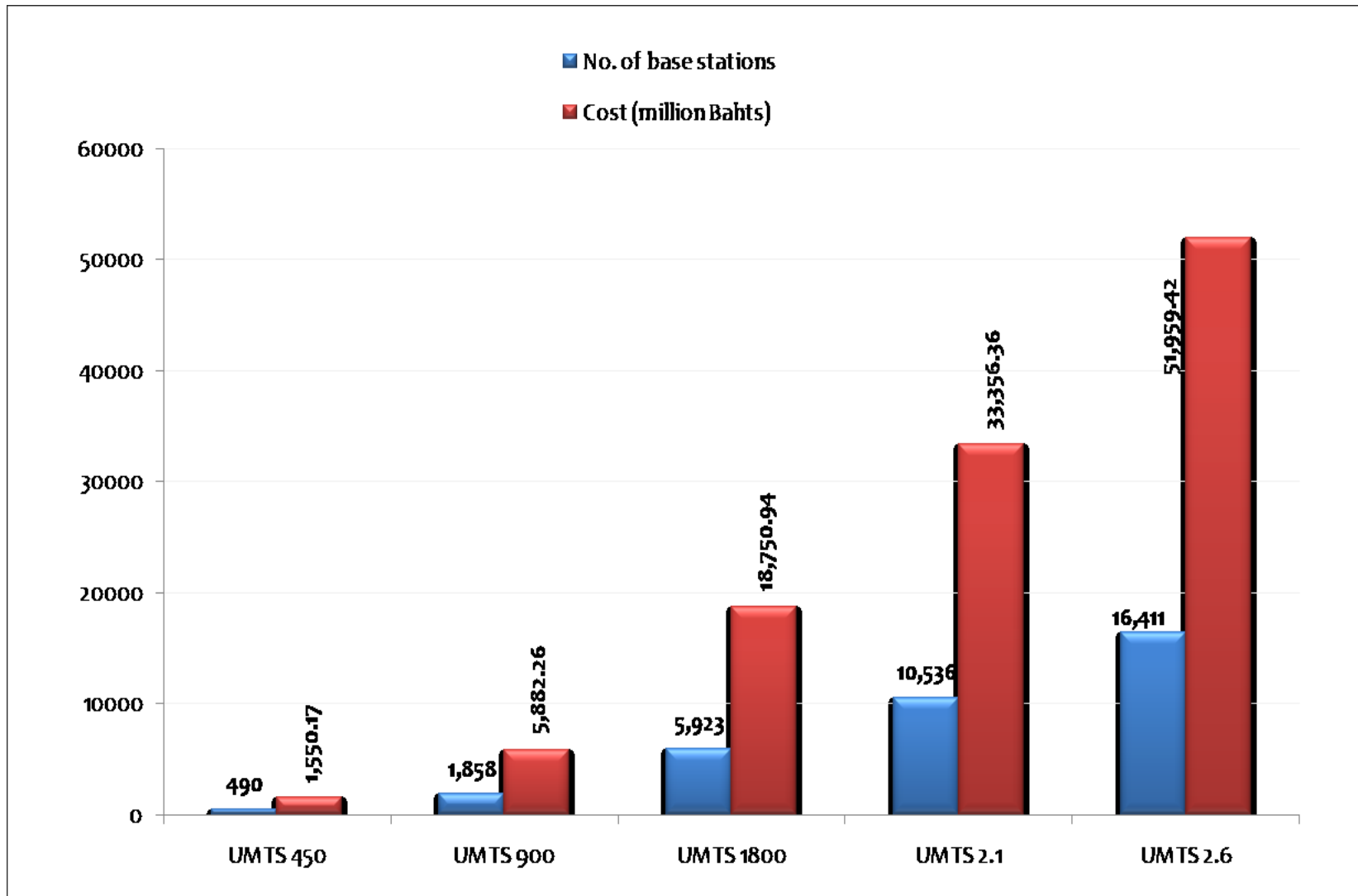
Assessing marginal value of mobile communications spectrum

- The opportunity cost of a given frequency used for mobile communications spectrum is the cost saved as a result of using that frequency rather than its next best alternative.
- This 'cost saving' hinges on the fact that base stations using lower frequencies have a longer range, hence a network using them can be constructed.
- This consideration is the basis of our approach to valuing and pricing spectrum for mobile communications.
- Because we are using **theoretical** cost models to calculate differences in the cost of networks using different frequencies, there is risk of overestimating the value of spectrum. Hence the regulator should adjust the valuations derived, probably downwards, before use.

3G UMTS: Relationship Between # of Base Stations, Frequency and Costs

	Demand	cell radius (km)	base station coverage(km2)	Area of Thailand to be covered (km2)	number of base stations
UMTS 450	Rural (20 % density)	35.39	3932.70	467740 (91%)	118.9
	Urban (85% density)	11.99	451.41	30840 (6%)	68.3
	Business District (100% density)	4.03	51.00	15420 (3%)	302.4
	TOTAL			514000	489.6
UMTS 900	Rural (20 % density)	18.15	1034.39	467740 (91%)	452.2
	Urban (85% density)	6.15	118.76	30840 (6%)	259.7
	Business District (100% density)	2.07	13.45	15420 (3%)	1146.1
	TOTAL			514000	1857.9
UMTS 1800	Rural (20 % density)	10.16	324.13	467740 (91%)	1443.1
	Urban (85% density)	3.44	37.16	30840 (6%)	830.0
	Business District (100% density)	1.16	4.23	15420 (3%)	3649.5
	TOTAL			514000	5922.6
UMTS 2100	Rural (20 % density)	7.61	181.84	467740 (91%)	2572.2
	Urban (85% density)	2.58	20.90	30840 (6%)	1475.5
	Business District (100% density)	0.87	2.38	15420 (3%)	6488.1
	TOTAL			514000	10535.8
UMTS 2600	Rural (20 % density)	6.44	130.23	467740 (91%)	3591.7
	Urban (85% density)	1.98	12.31	30840 (6%)	2505.3
	Business District (100% density)	0.69	1.49	15420 (3%)	10314.7
	TOTAL			514000	16411.7

Number of base stations and corresponding investment costs for national coverage - in Thailand



Number of base stations and corresponding investment costs for national coverage

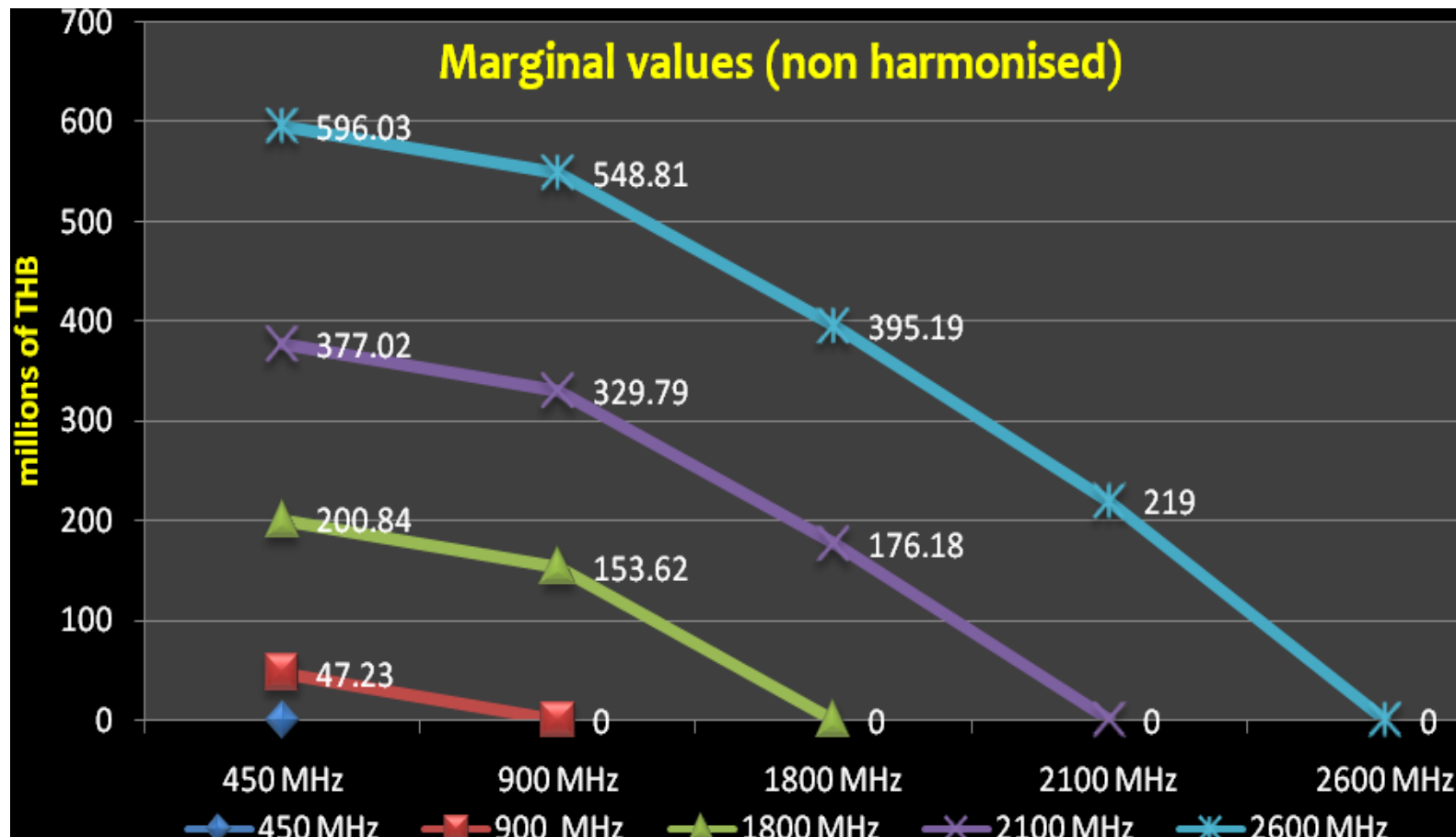
➤ Example for Thailand

- According to the slide above, there are substantial cost implications on the choice of the spectrum on which to deploy mobile telephone services on a commercial scale. It is approximately 13 times cheaper to build a mobile telephone network using UMTS 450 compared to using UMTS 2100 if only the radio frequency costs are taken into consideration. Also, a UMTS 900-based network can actually provide the same quality of services as a UMTS 2100-based network at a cost lower by 11089.44 million THBs.

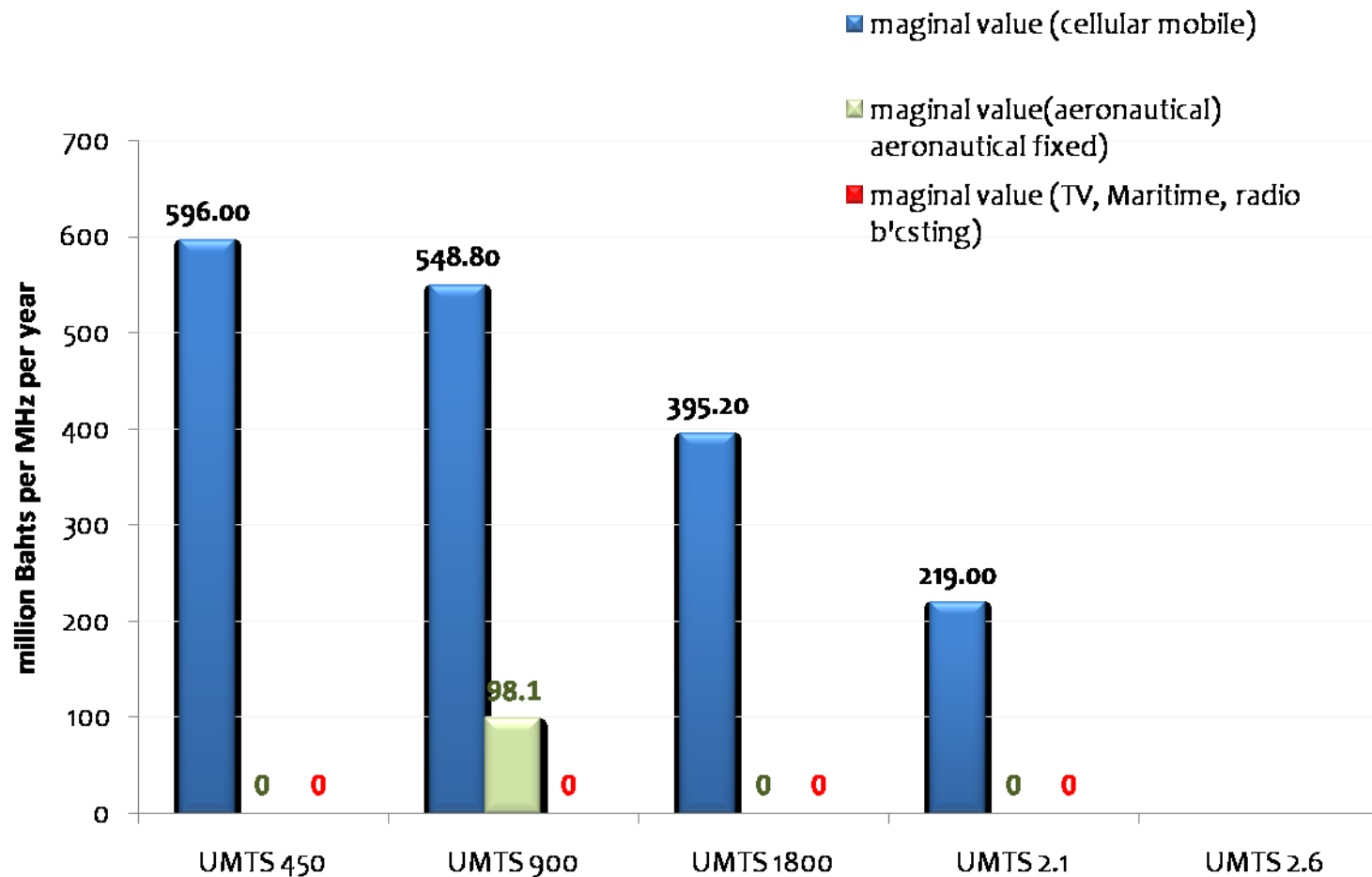
Costs included in determining AIP

- The costs noted above are investment or capital costs of constructing and the costs of operating the base stations for a network of specified capacity. In order to use these as a basis for spectrum prices, a conversion an annual cost per MHz. is requires. This is done by:
 - assuming a base station life of 20 years;
 - estimating the cost of installing and operating the network for the first half of this period as a net present value in year one, using a real discount rate of 10%.
- The net present value is then re-expressed as a sequence of equal annual costs over the ten year period, and divided by the number of MHz deployed to yield a price or value in THB million per MHz per year. The residual values of any assets at the end of the ten year period count as a negative cost.

How the valuations depend on the overall level of demand for mobile communications in Thailand



Cost-based marginal value of spectrum with consideration for alternative use.



AIP Valuations

- Requires ongoing modelling and refinement and judgemental adjustment.
- This should be done in conjunction with the choice of how they are to be used:
 - as guides to decision taking by spectrum users (for example, by assisting in procurement decisions by government departments);
 - as guides to decision taking by the NTC (for example, by assisting reforming decisions);
 - as prices charged to spectrum users.
 - each of these uses requires a different approach to setting a value for or price of the frequency.

AIP in practice

- AIP revenues in the UK
- Ofcom reviewed AIP in several categories and adjusted prices to reflect changes in opportunity costs.
- There has been a slow ramp up in the frequency bands on which defence makes payments

Sector	2004/2005	2005/2006
Aeronautical	£ 818K	£ 931K
Broadcasting	£ 15,187K	£ 11,838
Fixed Links	£ 18,203	£ 20,895
Public Wireless	£ 63,868	£ 63,011
Ministry of Defence	£ 24,314	£ 55,398

Other Methods of Spectrum Valuation

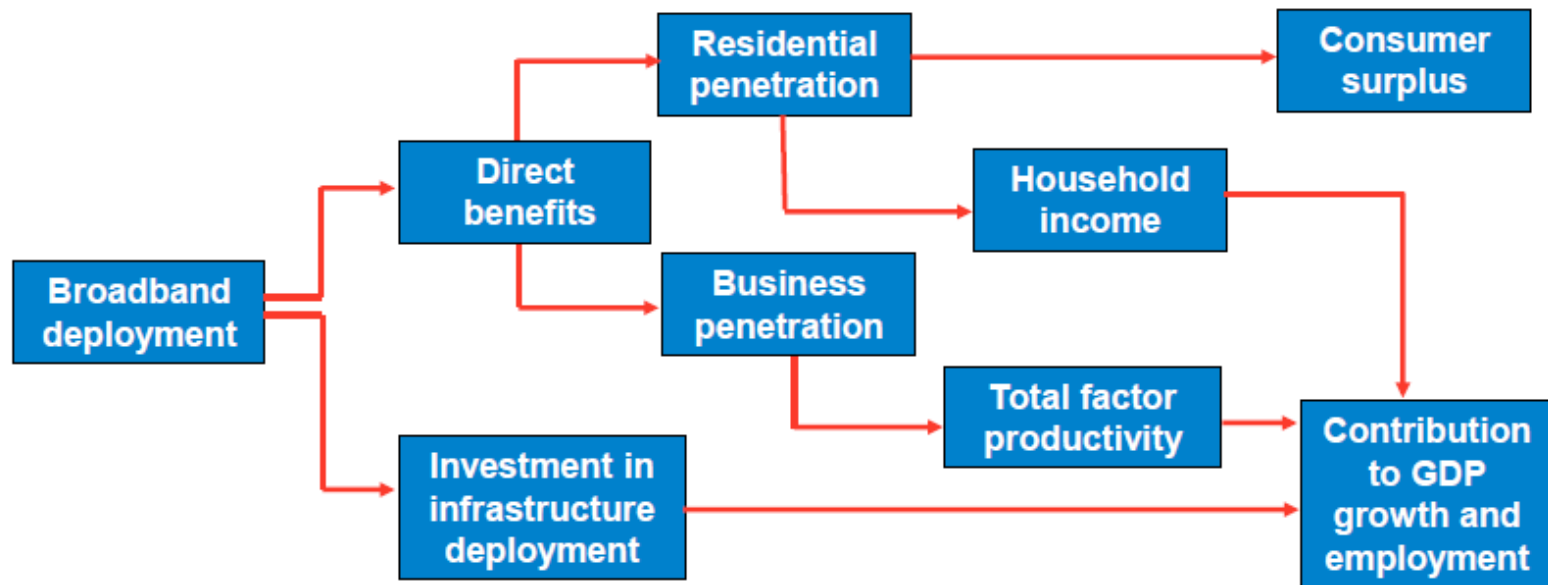
- Economic Modelling Approach
- Business-based Valuation Approach

Economic Modelling

- Economic modelling is used to assess spectrum value in terms of its contribution to the national economy - increasing economic contribution of spectrum translates into increasing value. Modelling also allows us to examine the impact on economic activity of variables such as:
 - economic downturns, changes in taxation, new trade relationships.
- The basic model looks at economy at three levels of aggregation (individual, households, firms, industries) to get a picture of the stimulus to the overall economy assuming there are meaningful connections between and the macro-economy.
- Economic modelling gauges the increment in economic output and its effect in terms of employment and GDP per head. The essence of modelling consists of:
 - Assessing demand using various take-up scenarios;
 - Constructing a quantitative model using regression analysis and carefully selecting parameters;
 - Applying historical data and projecting forward across the three levels of the economy.
- Results are expressed often as range of value/capita

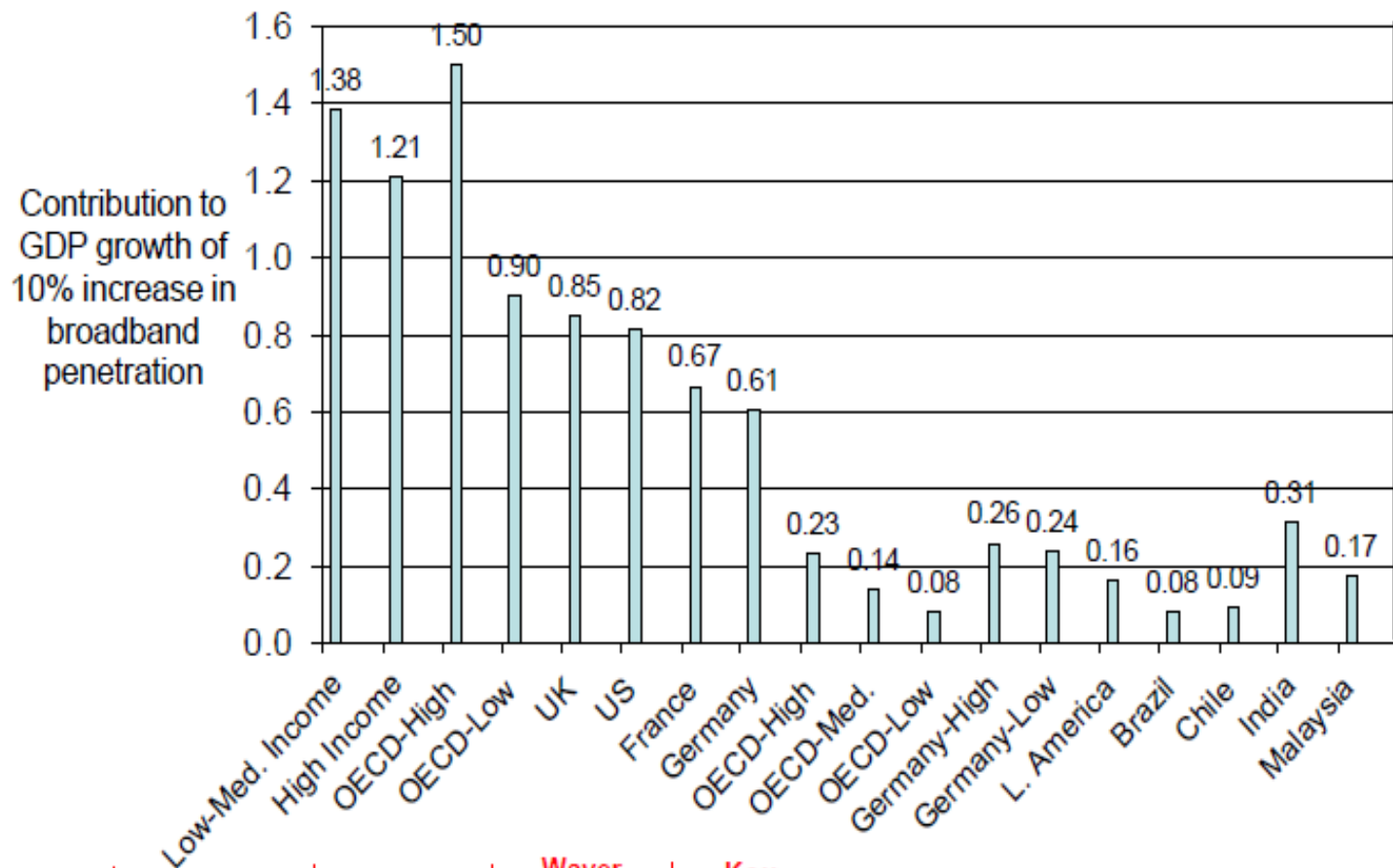
Measuring Impact

BROADBAND ECONOMIC IMPACT



BWA Impact on GDP Growth

RESEARCH EVIDENCE OF BROADBAND IMPACT ON GDP GROWTH



RESEARCHER / INSTITUTION

Qiang World Bank

Czernich U. Munich

Waverman LECG

Koutroumpis Imperial C.

Katz U. Columbia

Business-based Modelling

- A business-based valuation model assesses the value of spectrum from a commercial perspective. The objectives of both regulator and operator converge at the point when the spectrum is optimally priced. The RA is interested in economic and technical efficiency while the operator is interested in exploiting the profit potential of the assigned frequencies. The principles of the business-based valuation approach involve understanding how much profit the spectrum in question will generate.

Conclusion

- The following list the main points (+/-'s) with traditional administrative spectrum price determination:
- At best they can only reflect the scarcity of the bands to which they apply;
 - They emerge from a computational process by the regulator not from the interaction of firms in a market place;
 - The computational process is inevitably inaccurate and subjective. It is however better than adopting a zero price, which we know is incorrect;
 - A risk assessment process (consultation or a study such as this one) is required to establish the harm imposed by making them too high and too low;
 - Applying economic and business valuation modelling techniques brings much needed rigor to the exercise of valuing spectrum.

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