

Competition in Regulated Markets: Telecommunications

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Outline of session 2

1. Interconnection and its regulation (one-way)
2. Cost concepts useful for regulation
3. Regulation based on cost, when cost are unobservable by regulator
4. Interconnection: market analysis
5. IP-interconnection

What services to regulate (ex ante)?

Recommendation 2003

A- retail markets

- 1- access to fixed public networks
- 2- voice services in fixed networks
(Resid/Busin.) (local, national, internat.)
- 3- leased lines
- 4- roaming (internat.)

B- wholesale services

- 5- origination of calls in fixed networks
- 6- termination calls in fixed networks**
- 7- transit services
- 8- Unbundling local loop
- 9-wholesale broadband (indirect) access
- 10- termination of calls in mobile networks**
- 11- leased lines- termination segments
- 12- leased lines- trunk services
- 13- access and origination in mobile netw.
(MVOs)
- 14- broadcasting (TV signals)

Recommendation 2007

A- retail markets

- 1- access to fixed public networks
(+ international roaming)

B- wholesale services

- 2- origination of calls in fixed netws.
- 3- call termination in fixed netwks.**
- 4- physical access at wholesale level to network infrastructure from fixed location (including local loop)
- 5- wholesale broadband (indirect) access
- 6- termination of calls in mobile netws.**
- 7- segments of leased lines
(irrespective of technology used)

Recommendation 2014

wholesale services

- 1- call termination in mobile networks**
- 2- call termination in fixed networks**
- 3-a) wholesale local access provided at a fixed location**
- 3-b) wholesale central access provided at a fixed location for mass- market products**
- 4- wholesale high quality access provided at a fixed location**

1. Interconnection and its regulation (one-way access problem)

Interconnection: enables one operator to establish communications between its customer and the customer of another operator/ network

-**Interconnection- or call termination- (in fixed and mobile networks) has been regulated since beginning of the liberalisation process (1997)**

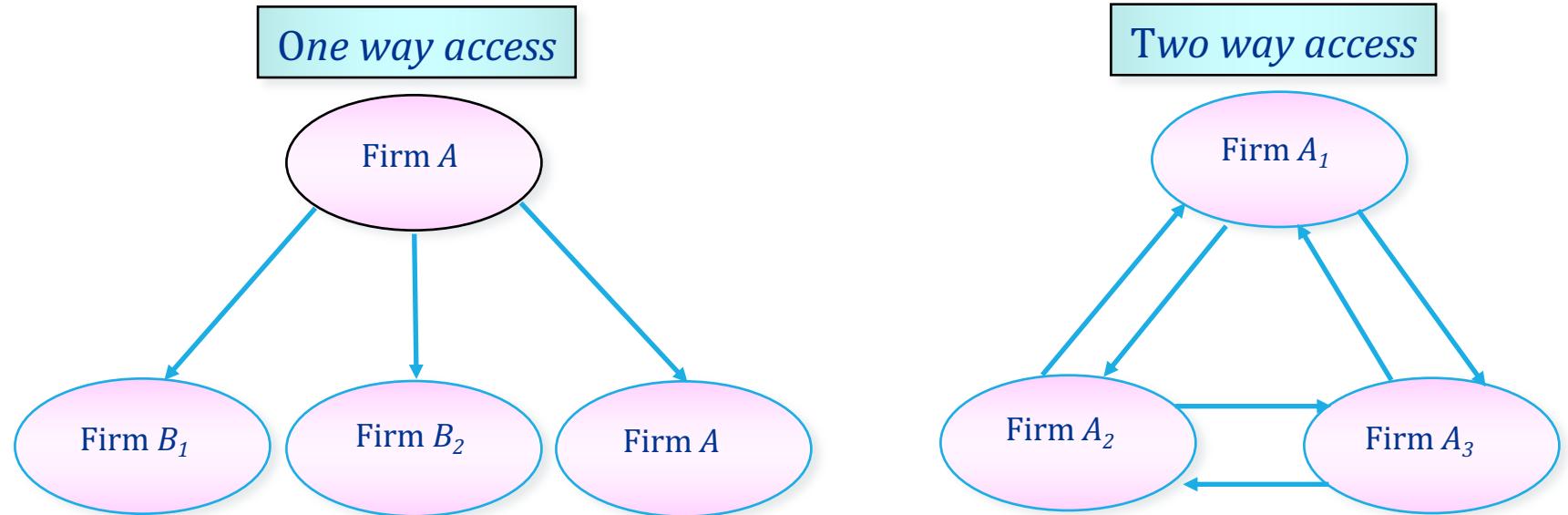
so the two terms mean the same?

- In traditional switched networks: lack of interconnection would result in connectivity breakdown. Hence, regulation establishes: **obligation to interconnect to all networks** (to ensure connectivity).
- Another problem is the price at which this service is offered.....
- **In IP networks**, normally peering agreements are used (exchange traffic among two operators, usually at no specific charge, unless very asymmetric in size).

Access: enables an operator to use the physical facilities of another operator to provide a service to its own customers

Access and Interconnection

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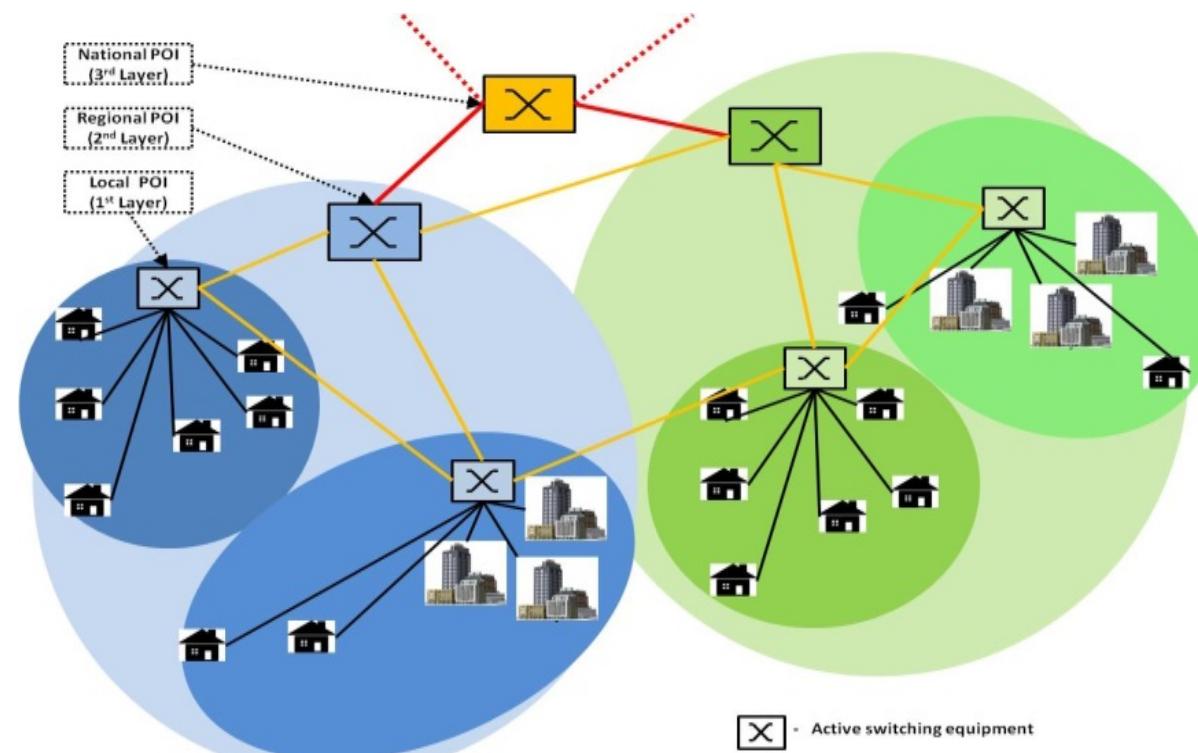


| | Sectors | Input |
|--|---|---|
| <i>One-way access</i> | Provisioning of natural gas and electricity Railway services Telecoms | Oil pipeline High voltage transport network Stations, rolling stocks Local access (local loop) |
| <i>Two-way access without retail competition</i> | International mailing International calls | Distribution abroad. Termination on foreign operator's network |
| <i>Two-way access with retail competition</i> | Fixed and Mobile Telecoms Patent pools | Termination services IP |

-**traditional interconnection in fixed networks:** one – way access problem since all new entrants had to ask for interconnection to the incumbent

-in traditional (copper based)- legacy networks, interconnection may be provided at different layers of the network (local, single and double transit).

-An alternative operator in order to cover the whole territory may have to interconnect at all local Points of Interconnection (Pol), at all regional (smaller) Pols or at just one (or few) national Pol.



- **Railway case in USA (XIX)- first case on “interconnection” (rather “access”) on a bottleneck facility.**
- one firm (firm 1) owns the «local» interval or network (A-B) and also the long distance (B-C), and competes with another rival (2) having only an alternative long distance B-C network

Local network (interval A-B) has very high fixed (or sunk) costs K Euros and variable costs are low (depend on amount of traffic used) of c Euros per unit, x,

$$\text{Costs (local network)} = C(x) = K + c * x$$

The access deficit occurs if we mandate the incumbent to charge for access an amount equal to marginal costs (c). He would get revenues only to cover variable costs (not the fixed part)

Let:

a = access price

c = marginal cost of access

If regulator sets $a = c$, then profits $\Pi = -K < 0$, and the firm incurs in losses
(access deficit)

- We need tariff rules that allow a margin, above marginal costs, for incumbent on the access service

$$a = c + \text{mark-up}$$

But, how to determine this mark up so that welfare is maximized?

1- Who pays?

Three models of compensation:

- 1) Receiver party- pays:** the subscriber (i.e., network) receiving the call pays all or most of the cost of the call
- 2) Calling party- pays:** the subscriber (i.e., network) initiating the call, pays for the entire cost of the call
- 3) Bill and Keep/ peering:** the operators do not charge each other any price for interconnecting, at least for specific volumes traded. Costs are recovered by each under different regimes.

2- How much you pay?

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Cost concepts useful

Directly attributable costs:

Variable, fixed

Non directly attributable costs:

Joint costs are the cost of an input that produces outputs for two different increments in fixed proportions. It occurs when the production of one service requires that another be produced at the same time. Reducing the output of a single activity will not reduce joint costs; reducing the output of all activities will reduce these costs. In telecom there are joint costs among different time periods, so the creation of capacity to meet demand at the peak period automatically creates the same capacity for off-peak periods. Fixed common costs and joint costs make up common costs.

Common costs refer to the cost of those inputs necessary to produce one or more services, which cannot be directly assigned to specific services. For example, transmission costs are common to all the services that use and share transmission capacity.

=AC

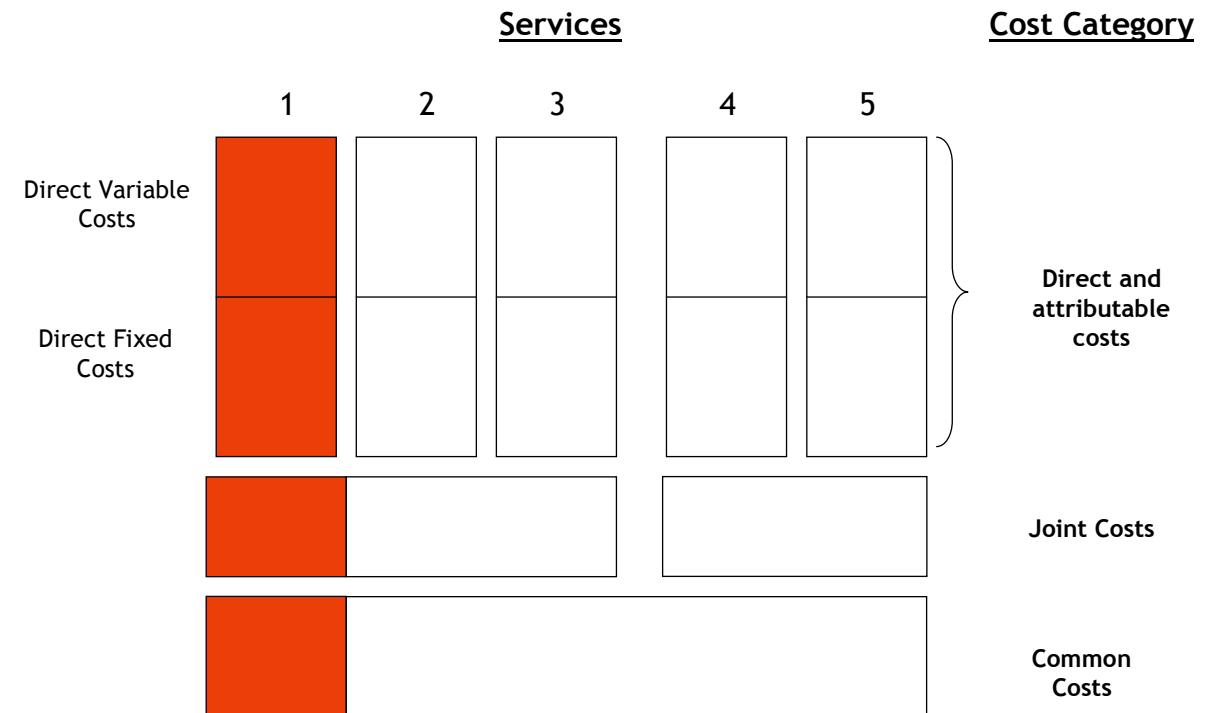
1- Fully Distributed Costs (FDC): allocate all directly or indirectly attributable costs and a share of the joint and common costs (based on the causality principle).

If cost function:

$$C(x) = K + c * x$$

Then:

FDC: $C(x)/x = (K/x) + c$ per unit

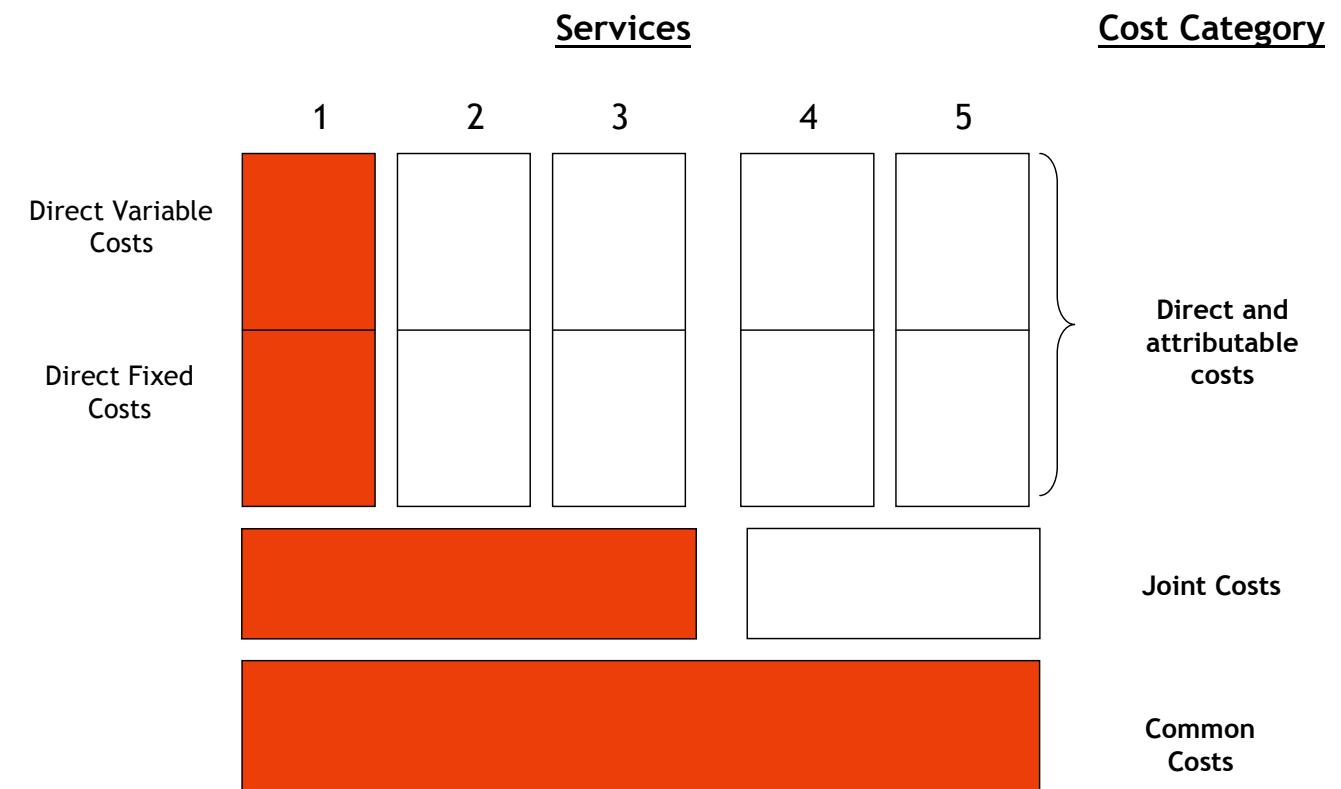


2- Stand Alone Costs (SAC): is the cost of providing the service in isolation to other services of the firm. Hence, it allocates all the attributable costs to (only) one service.

Does not lead to economic efficiency; users of the service will bear the whole burden of resources- costs- that are incurred in the production of other services.

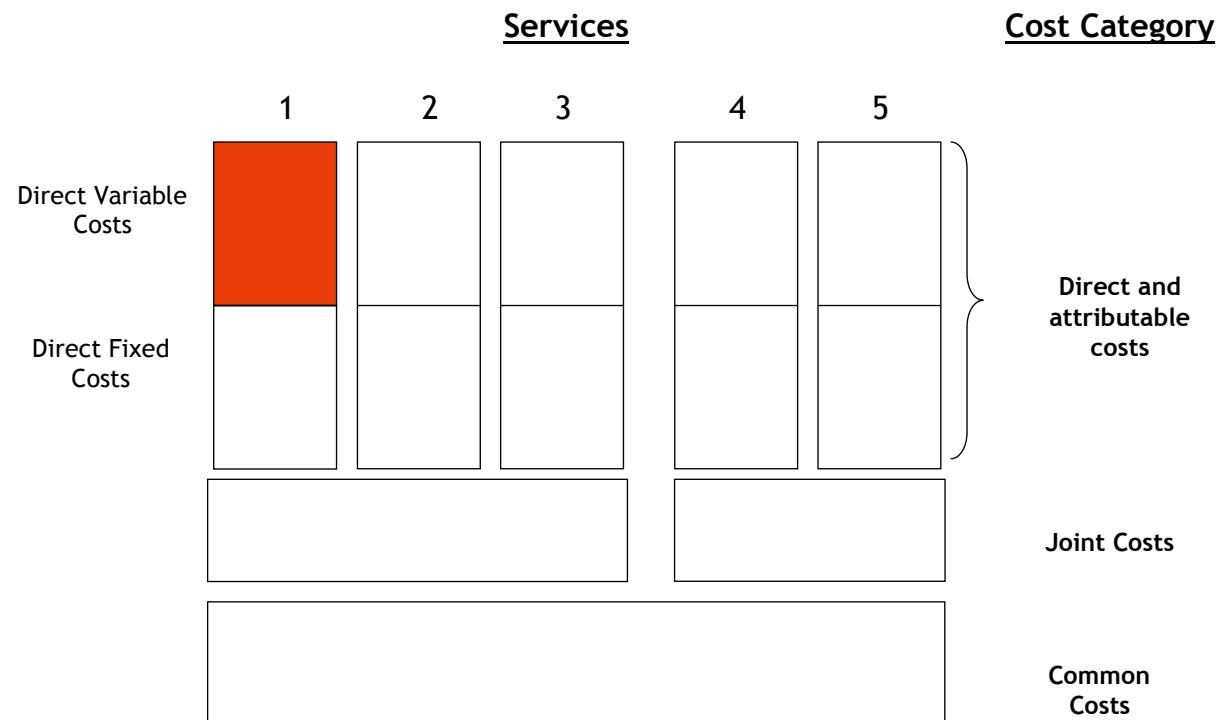
It incorporates all joint and common costs (imputed directly to these set of services)

Stand alone costs of one individual service (or subset S) as the total costs incurred by a firm when it offers only these S subset of elements, C(S).



3- Marginal costs (MC): is the costs incurred when increasing the output in one unit. It includes only the direct variable costs (and ignores any non directly attributable costs), in the *short -run*.

MC do not recover all costs, may lead to negative profits overall for the firm.



4- Long Run Incremental Costs (LRIC):

based on the idea of marginal costs if we think on the long run; all factors are variable, then we can include the capital costs as well in the rule.

The difference between the MC and the LRIC is the **increment** we assume when calculating it: the increment is “one additional service” to be included in the portfolio, then capital and fixed costs are to be included (i.e., are needed in order to produce the additional “increment”). It is a long-run concept.

- **incremental costs**: how much do *total costs* increase when there is a specific increase in the output supplied? (long- run)

→ what is “increase in output”, not infinitesimal but lumpy increases, as for example, a new service being offered through the same infrastructure

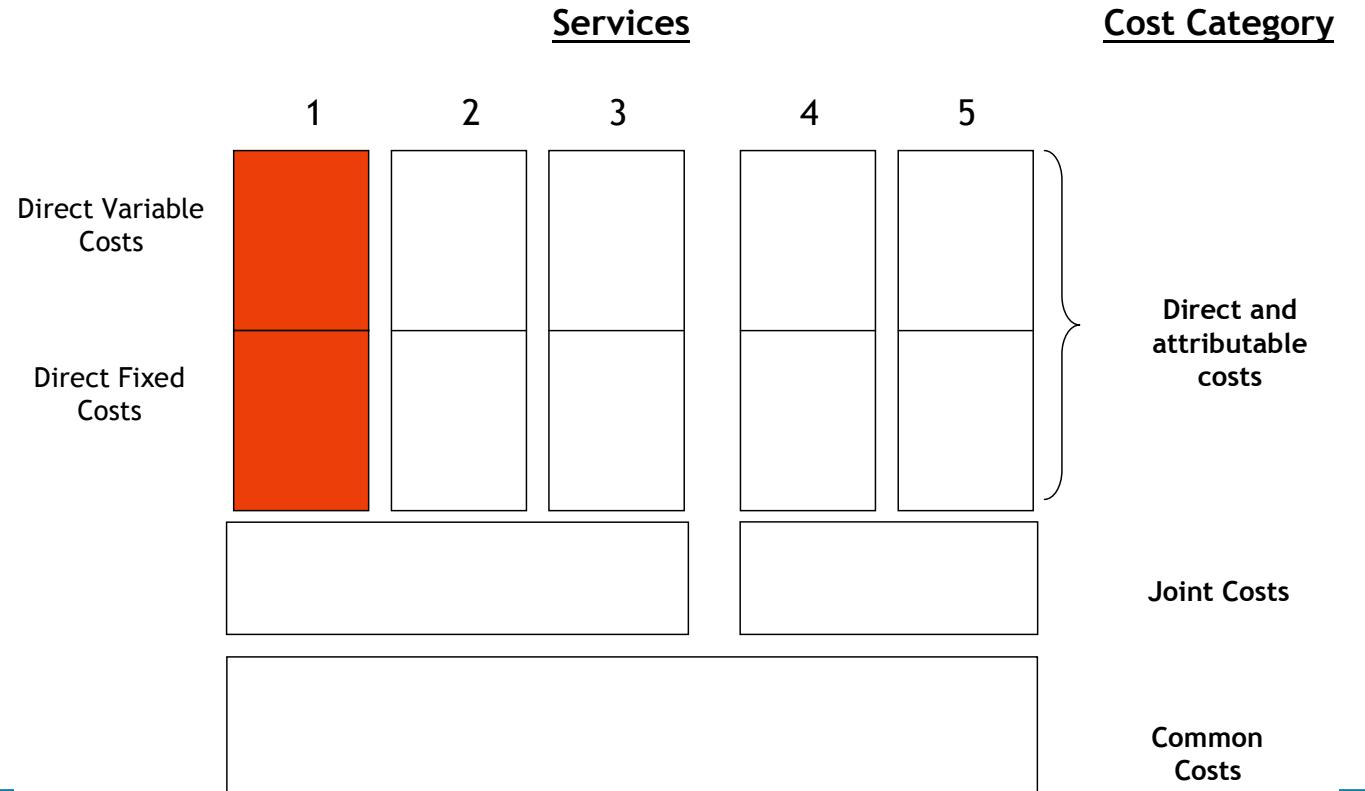
- we have one firm offering a number of services, N , and the firm decides to supply only a subset of them S .
- the incremental costs of offering the subset of S elements is defined as the total costs of offering the whole array of services $C(N)$, minus the total costs of offering the S services of interest, $C(N-S)$, hence

$$IC(S) = C(N) - C(N-S)$$

-IC is the inferior limit of costs to remunerate to a firm

- it does not incorporate common and joint costs, since these are already imputed to the base (N) over which we define the incremental service (and costs) to calculate.
- very much used in (theory) in telecom regulation (for access/ interconnection)

LRIC+: specifically incorporates as well joint and common costs



- now determine the mark up, over marginal costs of giving access based on the lost revenues (or profits) lost by the incumbent when granting access and losing, in favour of the rival, one unit of final demand

The Efficient Component Pricing Rule (ECPR), -Baumol, Willig, 1994

- optimal interconnection price has to recover, on the one side, the marginal costs of the access service itself, and also the direct opportunity costs incurred by incumbent of giving access to a rival to the final market

$$a(\text{ECPR}) = c_0 + [p_1 - (c_0 + c_1)] = p_1 - c_1$$

where

c_0 : marginal costs of giving Access

c_1 : marginal costs of the final service in the competitive segment (i.e., long distance traffic)

p₁: retail price for long distance traffic charged by incumbent

-the term **[p₁ - (c₀+c₁)]**, represents the lost revenues by the incumbent derived from granting access to a rival, and losing himself these client/consumption (displacement ratio assumed to be =1)

-it is supposed to work for contestable markets, where no fixed entry or exit cost exist (and entry/exit dynamics are quick enough)

- it guarantees productive efficiency in that if entrant has lower costs than incumbent, he shall be offering the service.

Problems:

- the mark up, (p₁- c₁) represents a “competitive” mark up? Or rather, monopoly rents???
- need to impose on top a price cap to control final price, p₁
- New Zealand case

- **Interconnection:** In the EU(28) the LRIC standard is used (for FTR and MTR)
- non-incumbent operators also regulated but sometimes allowed to set higher termination rates

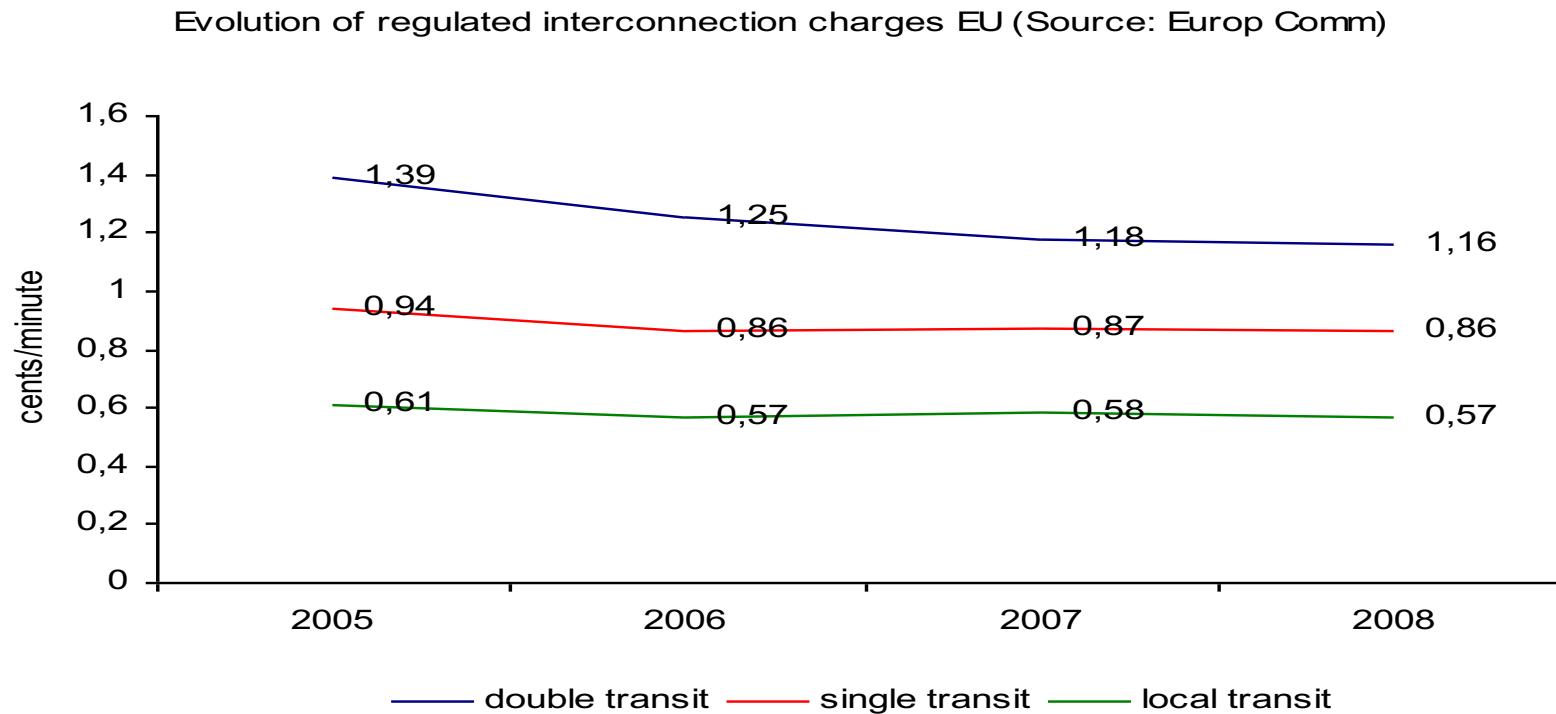


Figure 4 Simple averages^{2,3} of incumbents' fixed termination rates at the European level per layer

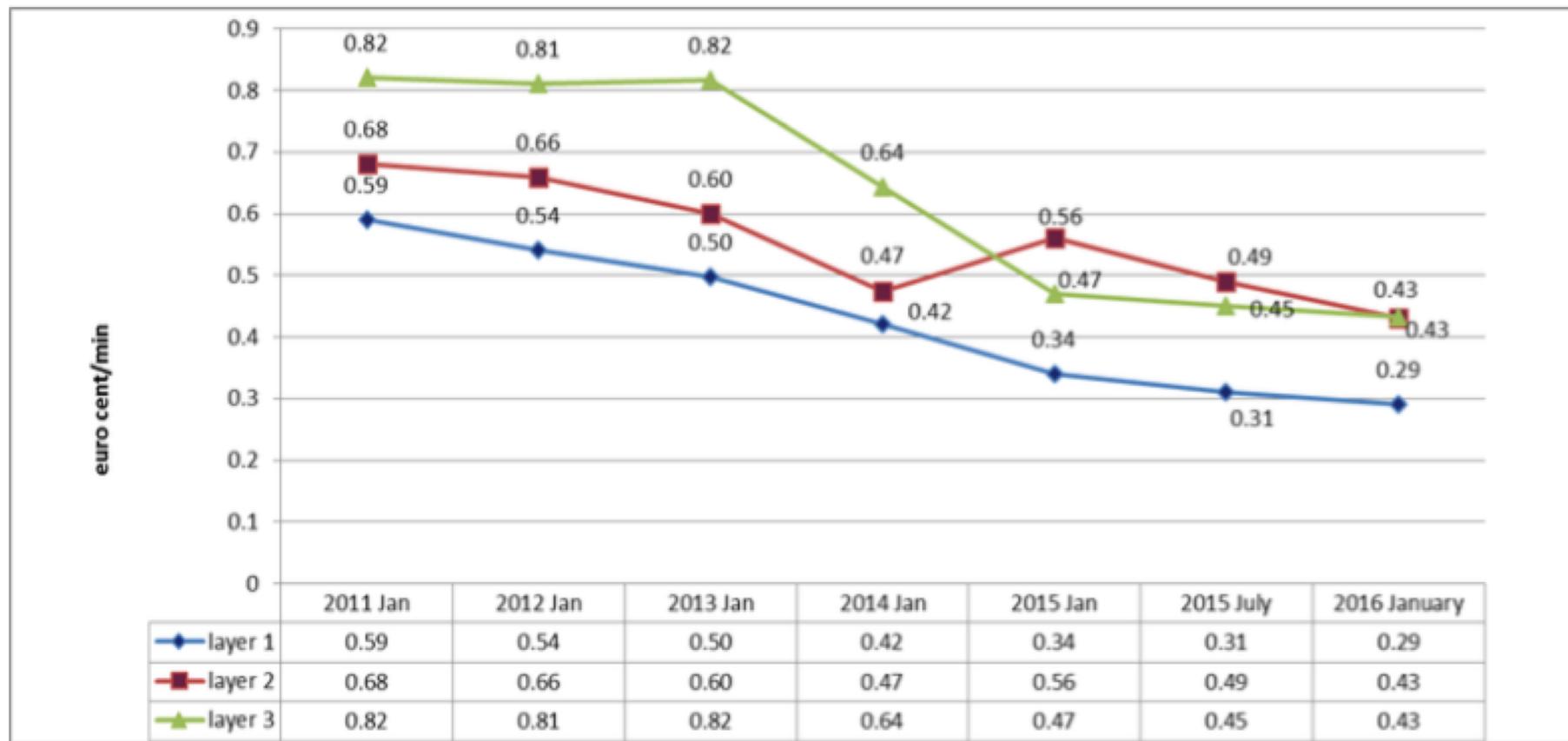
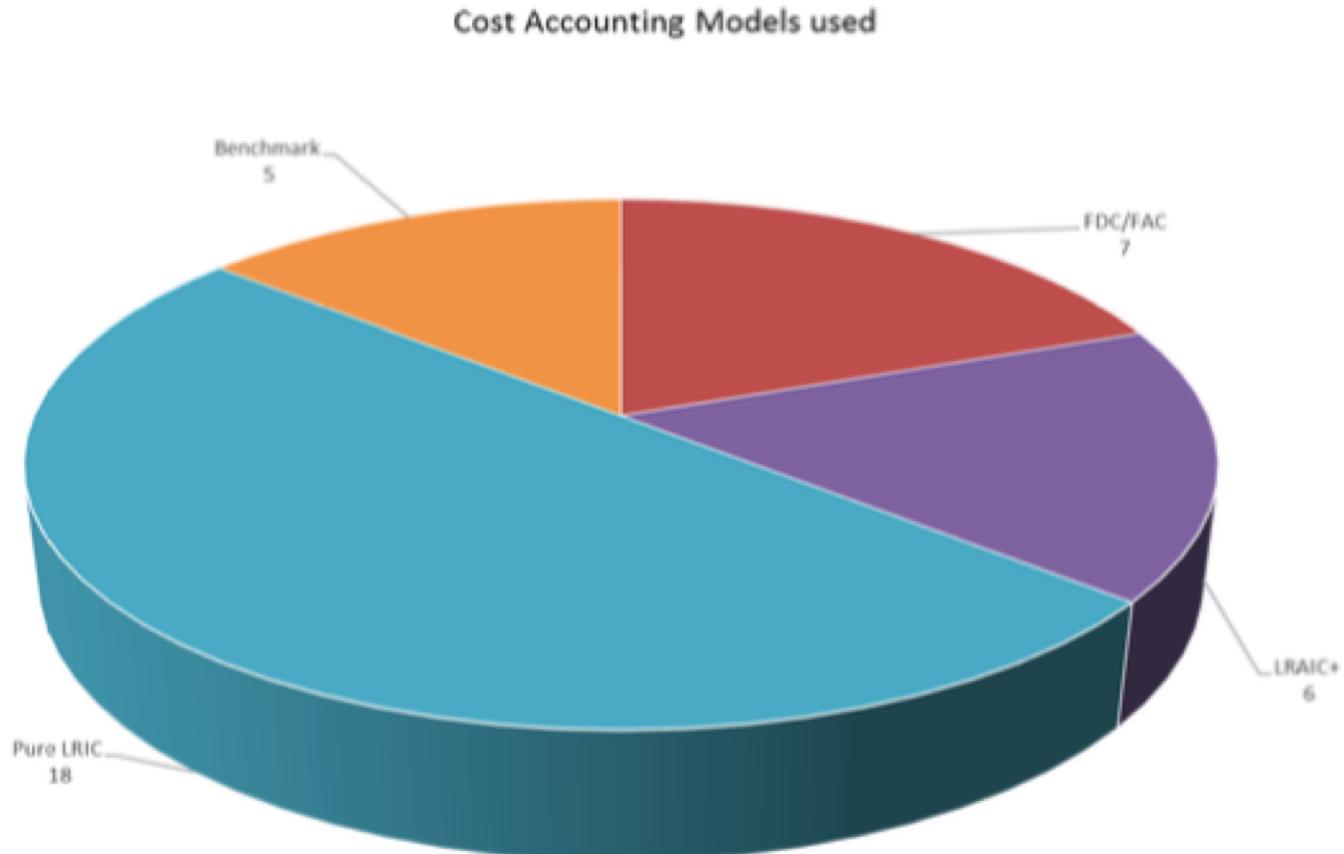


Figure 8 Cost accounting models used by NRAs



How FTRs are regulated in the EU

Almost all countries regulate FTR based on LRIC; some apply pure LRIC and some LRIC +, which incorporates some joint and common costs in the calculation

A few countries still adapting the model, meanwhile benchmarking or FDC standard

All countries apply:

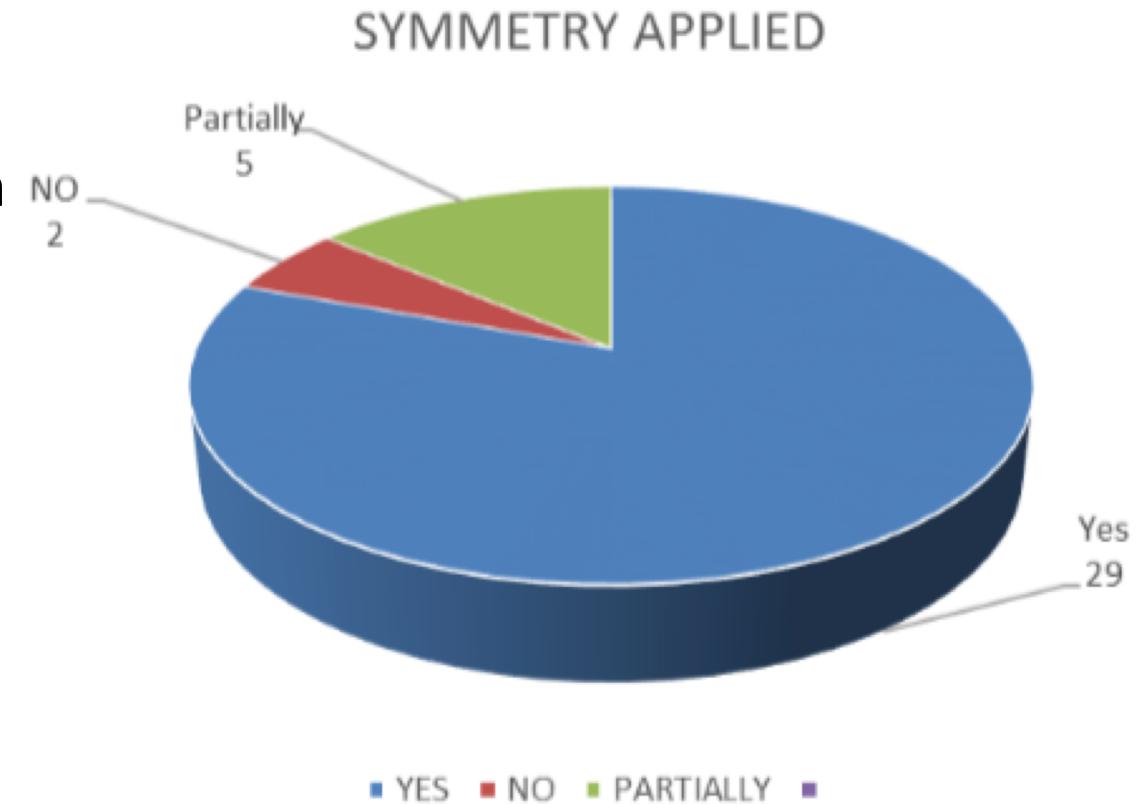
- **Price control** (based on costs)
- **Transparency** (Reference Offer)
- **Non discrimination**
- **Accounting separation**

And some apply **symmetry** (between incumbent and entrants)

| | 22 | cost standard |
|-------------|----|---------------|
| Austria | | LRIC |
| Belgium | | LRIC |
| Bulgaria | | LRIC |
| Denmark | | LRIC |
| Estonia | | FDC |
| Finland | | no SMP |
| France | | LRIC |
| Germany | | LRIC + |
| Greece | | LRIC |
| Hungary | | LRIC |
| Ireland | | LRIC |
| Italy | | LRIC |
| Latvia | | FDC+ symmetry |
| Lithuania | | LRIC |
| Luxembourg | | LRIC |
| Netherlands | | LRIC+ |
| Poland | | Benchmarking |
| Portugal | | LRIC |
| Spain | | LRIC |
| UK | | LRIC |

Additional conditions possible:

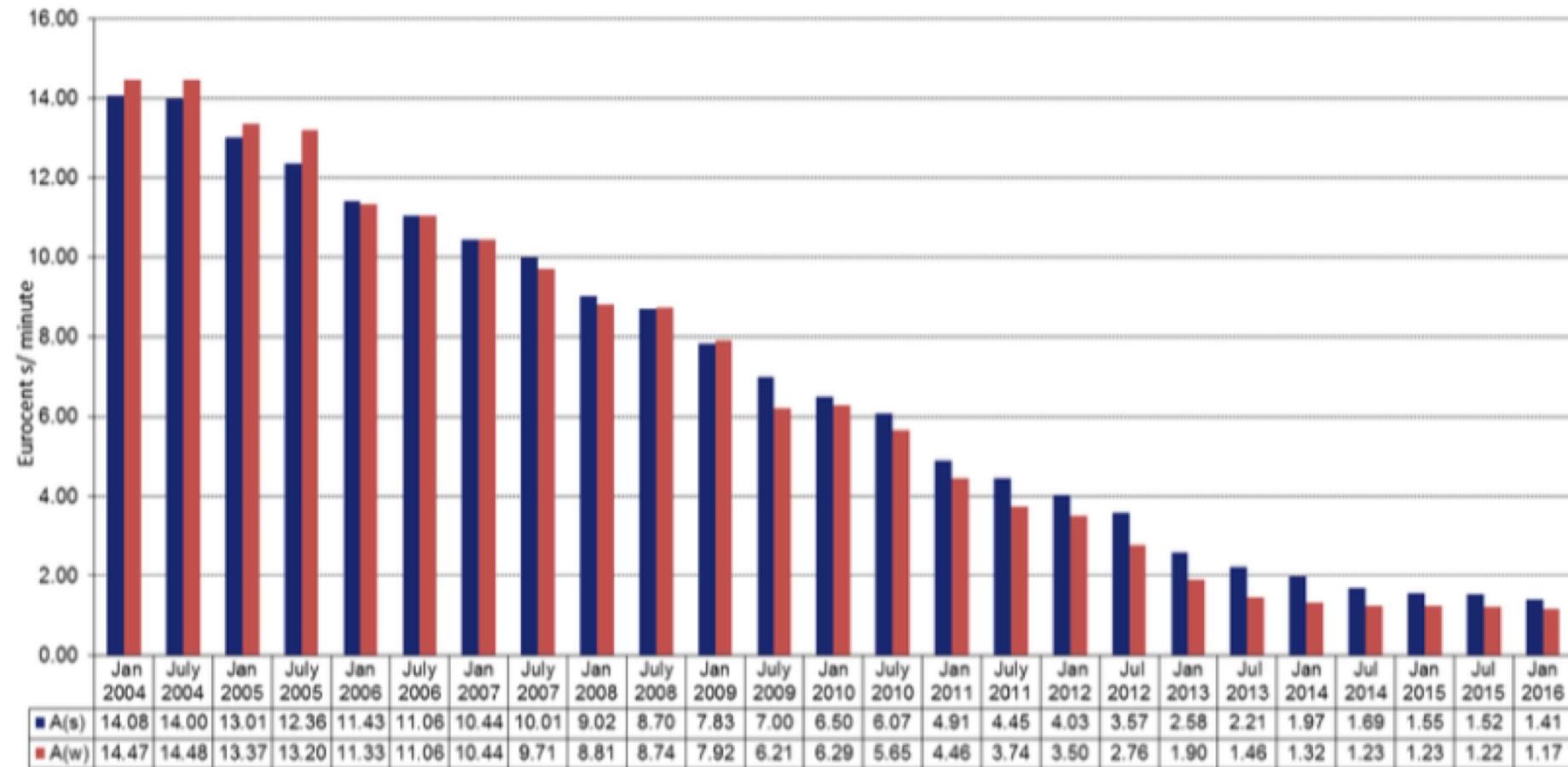
- **reciprocity**: same price applies operator i to j,
as j applies to i
- **symmetry**: operator i applies same a to any
other operator, j, k, m..... (no- discrimination
in *light* sense)
- in the EU, usually symmetry is imposed
- (reciprocity + symmetry) ? (non-
discrimination in *strict* sense)



Mobile termination rates (MTR) in the EU(28), Cents/ minute. Source: BEREC, 2017

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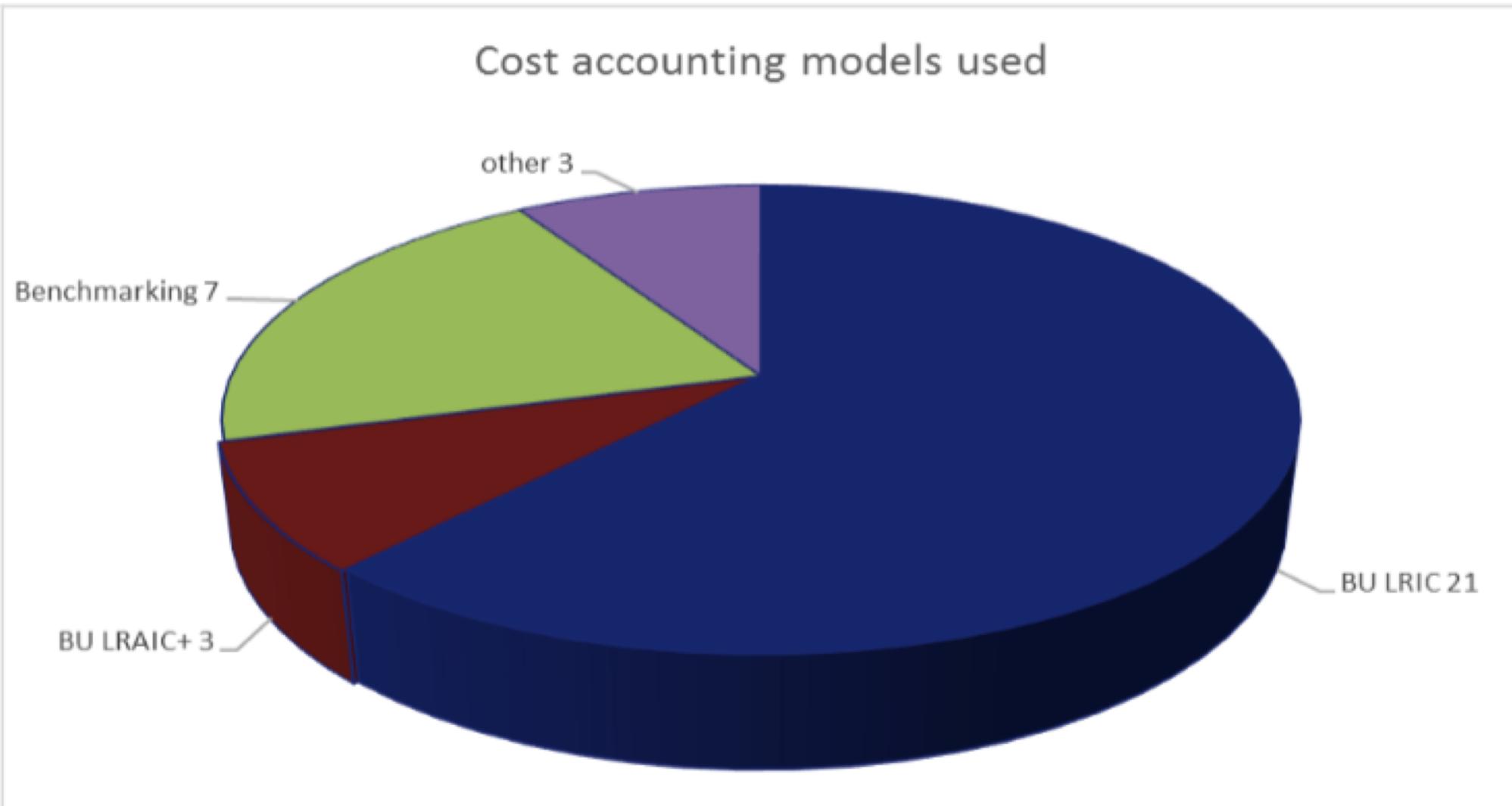
Figure 12 Evolution of simple A(s) and weighted A(w) averages



Mobile termination rates (MTR) – cost model implemented by countries

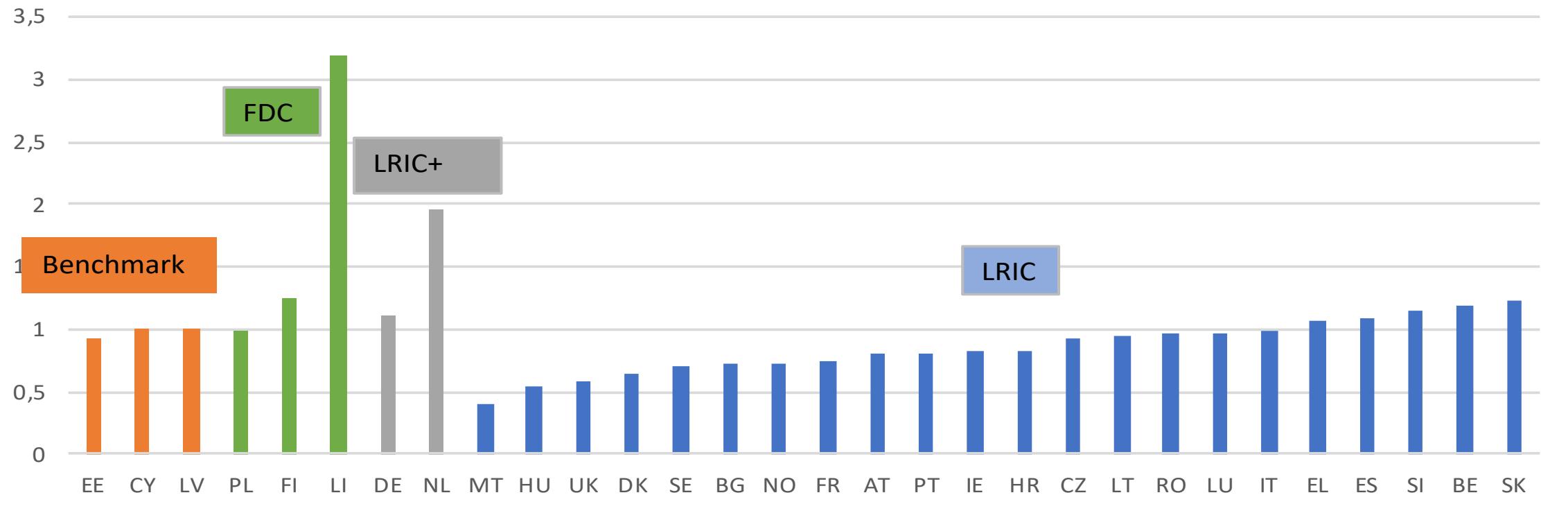
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Figure 15 Cost accounting models used by NRAs



MTR regulation and rates in EU(28), January 2017 (Source: BEREC)

Mobile termination and regulatory mechanism in the EU(28), January 2017
(Source: BEREC)



regulatory
mechanism

| | |
|-----------|------|
| FDC | 1,81 |
| LRIC | 0,85 |
| Benchmark | 0,98 |
| LRIC+ | 1,53 |

Regulating a monopolist with unknown costs

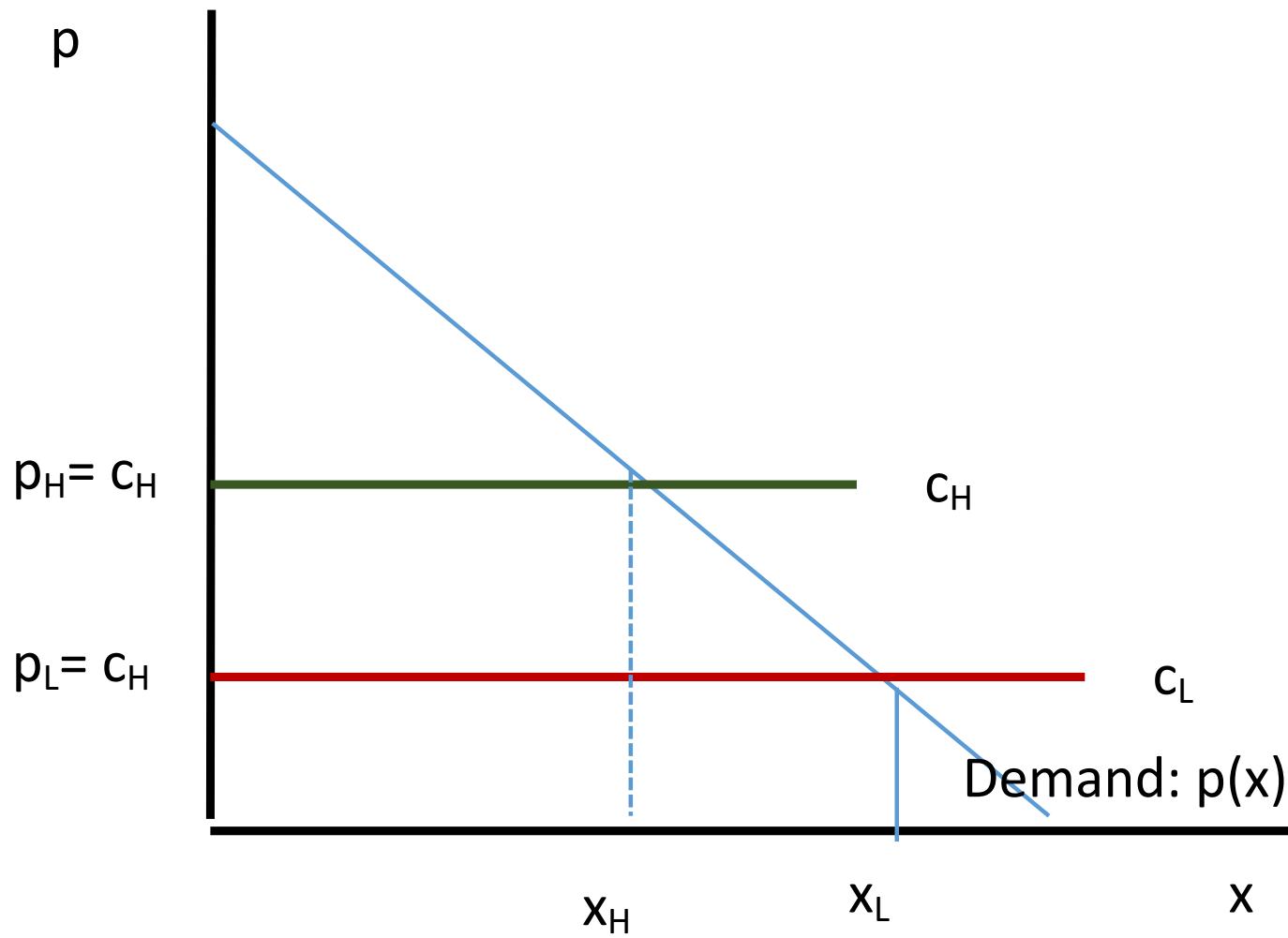
(a simplified versión of *Baron- Myerson, 1982*)

One firm faces a final demand: $p = a - x$

The regulator decides to regulate the final price of the good x , based on the following mechanism

“If c^d is the unit (marginal and average) cost of the good x declared by the firm, then the regulator will set the final price: $p = c^d$ ”

The monopolist knows the level of (unit) cost, but the regulator only knows that those costs can be either high, c_H , or low, c_L , each with a specific probability, but does not know which costs has the monopolist.



The objective function of the regulator is to maximize social surplus:

$$\max_p W = CS + \pi^M$$

The regulator has incomplete information on the (real) cost of the firm, and only knows that

with probability q , the firm has *high costs*, $c = c_H$

and with probability $(1-q)$ the firm is *low cost*: $c = c_L$.

The regulator wants a ***truth revealing mechanism***: wants that the firm declares its own real costs, c^*

i.e., the regulator wants that if the firm is of high costs, it ends up revealing: $c^d = c_H$, if in effect it has high cost, $c^* = c_H$

and, wants the firm to reveal low costs, $c^d = c_L$, if in effect it is a low cost firm, $c^* = c_L$,

The regulator proposes the **following mechanism** (truthful revealing):

- (a) **pricing rule:** $p = p(c^d) = c^d$ (based on declaration c^d)
- (b) and a **subsidy:** $s = s(c^d)$ (based on declaration c^d)

Hence, the regulator announces that it will set the final price equal to the level of declared costs by the firm, $p = c^d$ and additionally, announces a **subsidy** to be given to the firm based on the declared costs, $s = s(c^d)$

-Define: c^* as the **real cost** by the firm, which is in the interval $[c_H, c_L]$

and let c^d be the cost **as declared by the firm**

-Final demand is: $x = a - p(c)$

-The profits for the firm for a cost level c and a declaration c^d are:

$$\pi(c^d, c) = \underbrace{p(c^d)(a - b p(c^d))}_{\text{revenues}} - \underbrace{c (a - p(c^d))}_{\text{costs}} + s(c^d) = (a - p(c^d))(p(c^d) - c) + s(c^d) \quad (3)$$

Assume first that the firm declares its real costs: $\pi(c^d) = \pi(c^d = c^*)$

then, $\pi(c^d = c^*) = (p(c^*) - c)(a - p(c^*)) + s(c^*)$ (4)

The regulatory mechanism $\{p(c^d), s(c^d)\}$ satisfies

(1) incentive compatibility

i.e., the firm cannot increase its profits by declaring otherwise (by declaring a different cost level than it really has). For all. $c^d \in \{c_H, c_L\}$ we have now,

$$\pi(c^d, c^*) \leq \pi(c^*, c^*) = \pi^*(c)$$

and (2) individual rationality (*or participation constraint*)

The firm obtains non-negative profits $\pi \geq 0$ if it declares its real cost

$$\pi^*(c) = \pi(c^*) \geq 0$$

→ Incentive compatibility (1)

$$\pi(c^d, c) < \pi(c^*) = \pi^*(c)$$

That is (in our case with linear demand),

$$[p(c_H) - c_H][a - p(c_H)] + s(c_H) \geq [p(c_L) - c_H][a - p(c_L)] + s(c_L) \quad (5)$$

: if the firm is of high costs, (c_H), it cannot increase its profits by declaring it has low cost (by cheating).

- Similarly, if the firm is of ***low cost*** and declares its real (low) cost

$$[p(c_L) - c_L][a - p(c_L)] + s(c_L) \geq [p(c_H) - c_L][a - p(c_H)] + s(c_H) \quad (6)$$

if the firm is of low cost, c_L , it shall not increase profits by declaring it is of high cost, $c^d = c_H$.

- **Individual rationality** (or participation constraint) **(2)** is satisfied if:

$$[p(c_H) - c_H][a - p(c_H)] \geq [p(c_L) - c_L][a - p(c_L)] \geq 0 \quad (7)$$

The mechanism announced by the regulator $\{p(c_H) = c_H, p(c_L) = c_L, s = s(c^d)\}$ works for all $s(c_H)$ and $s(c_L)$ that satisfy:

$$(c_H - c_L)(a - c_H) < s(c_L) - s(c_H) \leq (c_H - c_L)(a - c_L) \quad (9)$$

→ Substituting $p(c_H) = c_H$ and $p(c_L) = c_L$ in eq. (5) and eq. (6) and obtain (9)

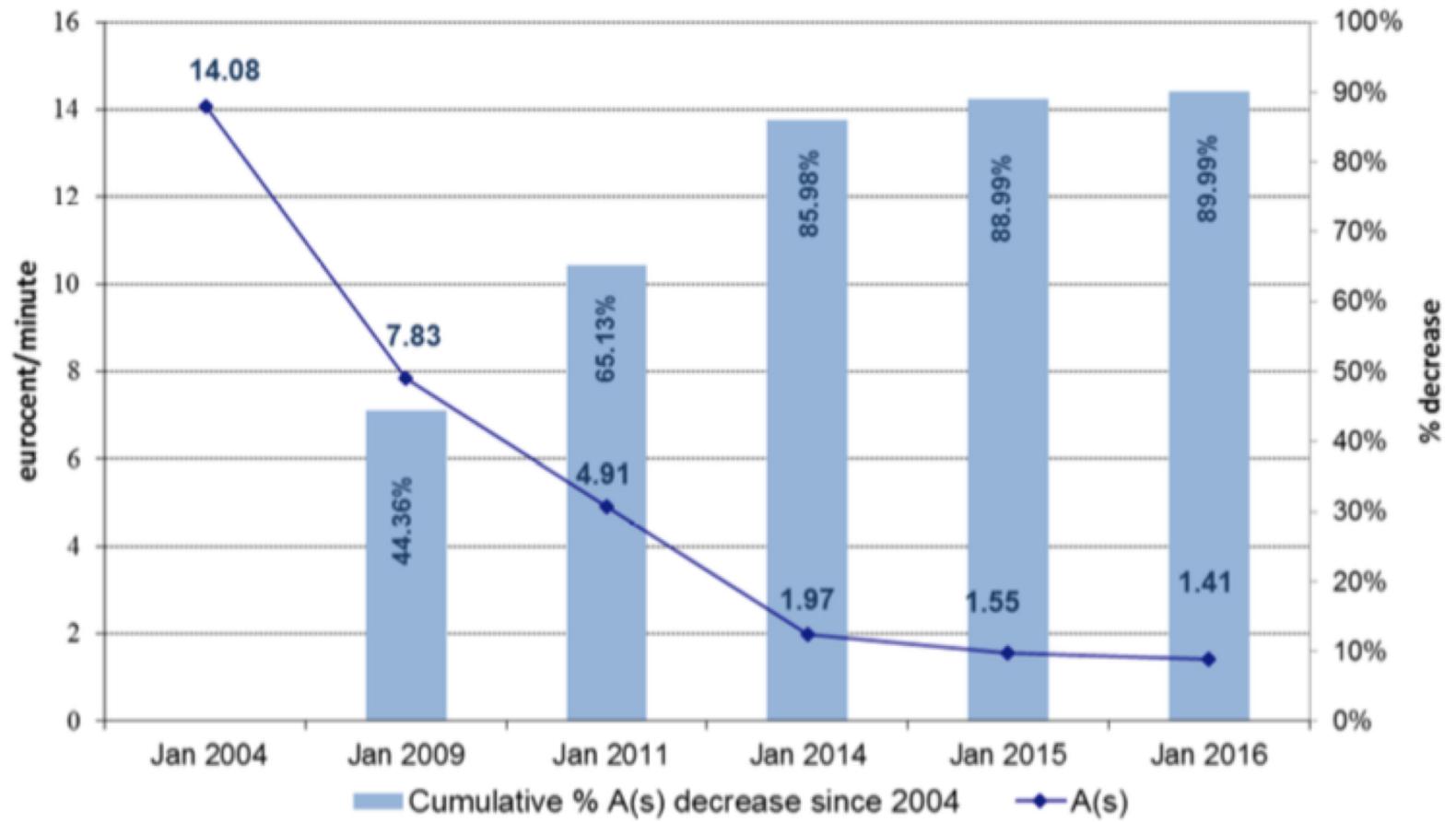
- the regulator sets the final price equal to marginal costs, for each type of firm (high/ low cost firm), and ***achieves a first best, but***
- to induce the firm to declare its real costs, it has to give the firm a collateral payment, or subsidy, so that the firm if it really has low costs, c_L , in fact declares low cost, $c^d = c_L$. And conversely, if the firm is of high cost, c_H , in fact declares that it has high cost, $c^d = c_H$.
- any firm has a priori incentives to inflate its declared costs, ($c^d = c_H$), knowing that the final price (regulated) will be set based on his declaration of costs. Hence, the regulator has to provide a subsidy (a “carrot”) greater for that firm that declares having low costs, (c_L):

$$s(c_L) > s(c_H)$$

The difference: $[s(c_L) - s(c_H)] \rightarrow$ informational rent

Evolution of MTR in the EU (simple average, per minute) based on LRIC, 2004-2016. Did (real- unobserved) LRIC levels change that much in the same period?

Figure 13 European MTRs simple average cumulative decline



- **Some regulatory mechanisms and their properties**

- **Rate of Return (RoR)**
- **Price caps**
- **Cost orientation**

and how they are used all across the world regions for FTR
and MTR regulation

Table 1. The comparison of some approaches to price regulation

| Criteria | RoR | Price-cap | Cost orientation |
|--|--|--|---|
| Prevents exercise of market power | Yes. A regulated operator can only earn a normal rate of return. | Yes. The CPI-X constraint prevents the firm from exercising market power (if chosen with care). | Yes. Price of a service will consist of its cost + reasonable rate of return only. |
| Ensures productive efficiency | No. An operator will not reap the benefit from reducing costs and so has no incentive to do so. | Yes. Firms are automatically rewarded with higher earnings when they reduce costs (penalized when costs increase). | No. In the case of Historical cost accounting. Yes. In the case of Forward-looking cost accounting. |
| Ensures allocative efficiency | No. Prices for individual services need not equal the costs of the service. | Yes. Firms have flexibility to set prices for individual services based on forward-looking costs. It is possible for individual prices to deviate from costs. | Yes. Prices for individual services equal the costs of the service. No possibilities to deviate from costs. |
| Ensures dynamic efficiency | No. No incentive to invest and introduce new technologies or services | Yes. The firm has incentives to invest efficiently. | Yes. The firm has incentives to invest efficiently. |
| Promotes competition | No. Does not generally permit pricing flexibility for the firm to set prices to reflect forward-looking costs in response to competition. | Yes. The firm has sufficient pricing flexibility to respond to competitive pressures by setting prices that reflect underlying costs and demand conditions | Yes. The firm has to set prices that reflect underlying costs. No cross-subsidization. |
| Minimizes regulatory costs | No. Rate determination proceedings are often lengthy and resource intensive. | Yes. Price-cap setting proceedings are infrequent (once every 3 to 5 years). | No. Control proceedings are lengthy and resource intensive. |

CPI-X - a basic formula employed to set price caps. It takes the rate of inflation, measured by the Consumer Price Index (CPI) and subtracts expected efficiency savings X.

Productive efficiency requires that goods should be produced at the lowest possible cost.

Allocative efficiency requires that the prices one observes in a market are based upon and equal to the underlying costs that society incurs to produce those services (generally the long run incremental cost of producing the service).

Dynamic efficiency requires that firms should have the proper incentives to invest in new technologies and deploy new services.

Table 2: Summary of MTR and FTR regulations by region

| | FTR regulation | MTR regulation | Rank of FTR* | Rank of MTR* | |
|--------------|--|---|--------------|--------------|---|
| The Americas | In the majority of countries FTRs are regulated using cost based pricing approach. The average FTR is the lowest between compared regions. | More than half of analyzed countries don't impose ex ante price control on MTRs. The average MTR is higher than in the Africa region, but lower than in Europe & CIS, and Arab States regions. | 1 | 2 | The Commonwealth of Independent States (CIS) formed when the former Soviet Union (now called Russia) totally dissolved in 1991. At its conception it consisted of ten former Soviet Republics: Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. |
| Europe & CIS | Heavily regulated in almost all EU countries generally using cost based pricing approach. Not regulated in some CIS countries. The average FTR is the second lowest between compared regions. | MTRs have been increasingly regulated since 2001 in EU countries; many relying on international benchmarking to regulate MTRs. MTRs are left unregulated in some CIS countries. | 2 | 3 | The nations of Azerbaijan and Georgia later joined the association in 1993. This group of states (countries) loosely agreed to work together on a large list of mutual issues, including economics, defense and foreign policy. Many of the CIS members receive (buy) their natural gas and oil from the vast reserves owned by Russia, and that is a front burner, contentious issue for some as prices and supplies are tightly controlled in Moscow. In 2005, Turkmenistan withdrew from the CIS, and is now classified as an associate member |
| Arab States | Different approaches are applied to interconnection regulation. Because of relatively recent liberalization in many Arab states, regulation of interconnection charges is relatively light (if any) so far. The average FTR and the average MTR are the highest between analyzed regions. | | 4 | 4 | |
| Africa | In countries that regulate FTRs, most use cost based pricing approach. The average FTR is the second highest between compared regions. | Cost based pricing approach is applied to regulate MTRs in many African countries. The average MTR is the lowest between the regions. | 3 | 1 | |

* Where 4 indicates the highest rate and 1 – the lowest.

Source: ITU Survey on Tariff Policies 2009

Price caps

- very widely used for retail level regulation on the incumbents' offer of services during first years of liberalisation process (1997- 2004)
- but as retail services have been liberalised completely from regulation, not used any more (except: roaming in the EU)

| Price caps on incumbents' retail services (Euros/minute) in Spain | | | | | | | | |
|---|--------------------------------|--------|--------|-----------|-----------|------|-------|-------|
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| installation fee | 95 a 100 for installation?? | 59,5 | 59,5 | 59,5 | 59,5 | 59,5 | Δ RPI | Δ RPI |
| monthly (fixed) fee | 10,4 | 11,7 | 12,6 | 13,2 | 13,4 | 13,4 | Δ RPI | Δ RPI |
| local calls | ▽ = 0 | ▽ = 0 | ▽ = 0 | Δ RPI -4% | Δ RPI -3% | free | free | free |
| national and intern. calls | ▽ < 50 | ▽ < 50 | ▽ < 50 | Δ RPI -4% | Δ RPI -3% | free | free | free |
| fixed-to-mobile | ▽ = 0 | ▽ = 0 | ▽ = 0 | Δ RPI -4% | Δ RPI -3% | free | free | free |

Question:

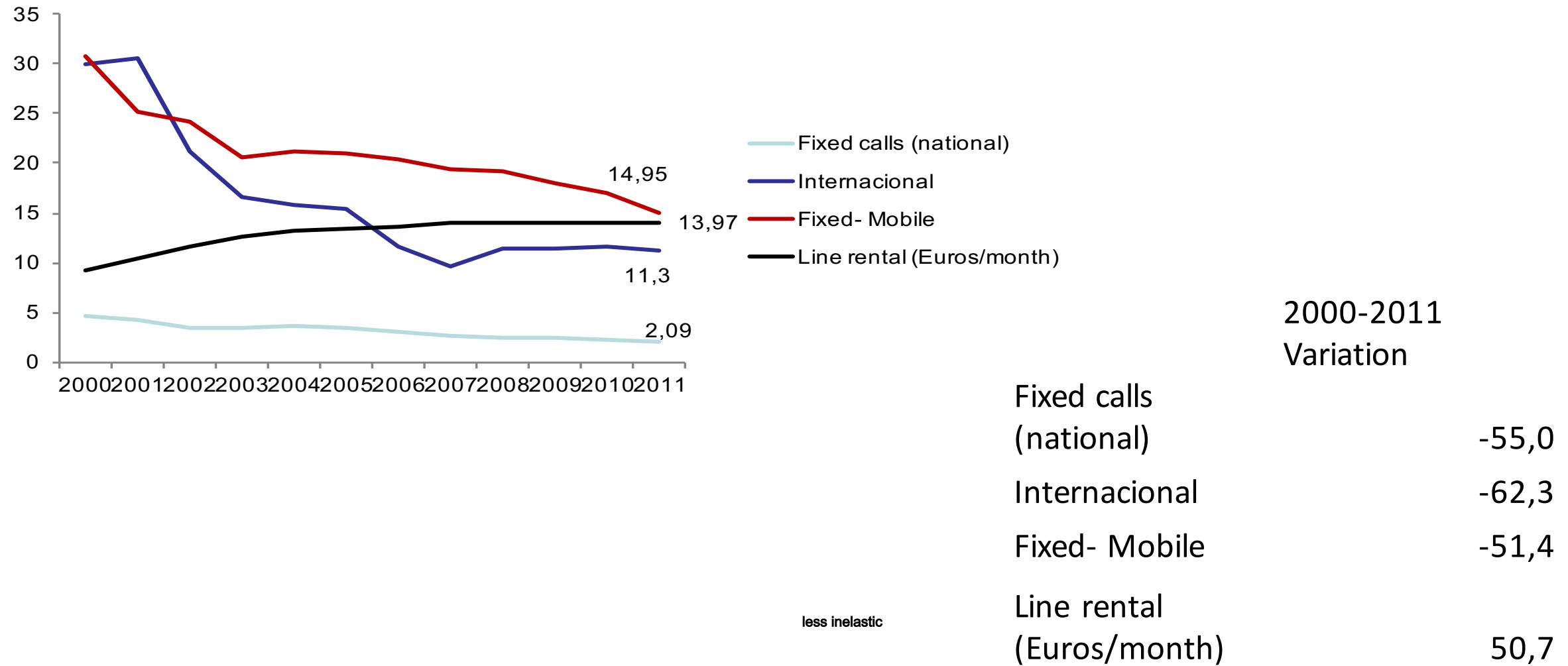
Ramsey pricing in the telecom industry after liberalisation???

Evolution of the line rental and per minute charges over time: until 1997 the status quo implied a direct subsidy from traffic-> access charge, due to policy objectives when monopoly. Once competition is open (entry occurs) the cross subsidies (i.e., from long distance to local or to the monthly fee) were not sustainable and a re-balancing of the access charge was needed → **Ramsey rebalancing**

like international calls have higher elasticity than national ones?

so lower prices there and raise them for national calls?

**Price per minute (cents) of fixed telephony and the line rental price
(Euros/month)**



-Market Analysis: interconnection in fixed network in Spain

1. Market Definition
2. Market Structure Analysis
3. Obligations imposed to operators with SMP

- **Product Market – Definition of the wholesale call termination service**

The call termination service is provided by an operator of a fixed line network to the rest of the operators, both fixed and mobiles, so that those can complete the calls that they manage and having as called party a subscriber connected to such fixed line network.

- **Services included in the market**

- Call termination of geographical numbers, to intelligent network numbering and to short numbers. Still not enough degree of substitution with mobile telephony or with voice over broadband (Skype....)

- **IP termination for voice is included in the market along with switched termination**

Principle of technological neutrality

- **Scope of the geographical market:**

Network coverage of the considered operator.

- **A market is defined by each of the existing networks**

Each one of the operators with their own infrastructure forms a **single termination market** (termination market on Telefónica´s network, termination market on ONO´s network, termination market on Jazztel´s network...)

- **Barriers to entry**

Absolute, as no operator may provide a call termination service in a network that is not his.

- **Market share**

Each one of the operators has a 100% market share in the call termination service market in his own network.

- **Bargaining power of demand**

Absent regulation, the compensatory power would depend on the size of the networks, as well as the number of customers connected to them.

- **Declared Operators with SMP**

Each fixed line operator with its own network possesses SMP in its relevant market, because of: (i) Monopoly position (100% market quota); (ii) Absolute barriers into entry and (iii) Lack of bargaining power of demand

Competition issues within the market

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- Even though all the SMP operators can develop anti-competition practices, Telefónica has a bigger incentive than the others to take them to fruition, considering the number of direct access customers it possesses (around 80% of the market)

Other problems encountered if no regulation:

- ~~refusal to~~
~~denial of supply~~,
- excessive prices (due to high FTR and Calling- Party- Pays),
verzögernd
- dilatory tactics and
like let an entrant wait for the technical implementation of interconnection etc and artificially delay entry this way
- price discrimination

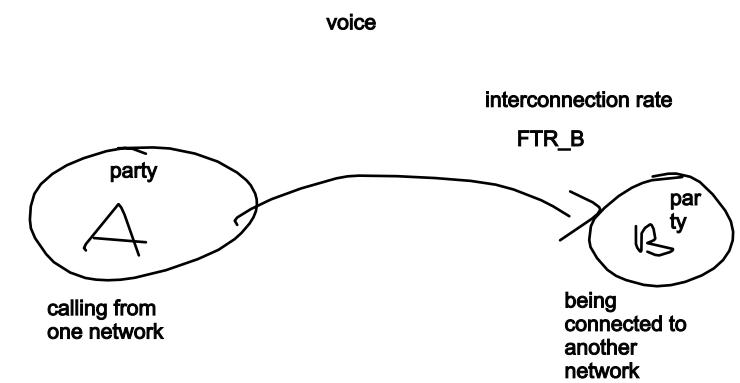
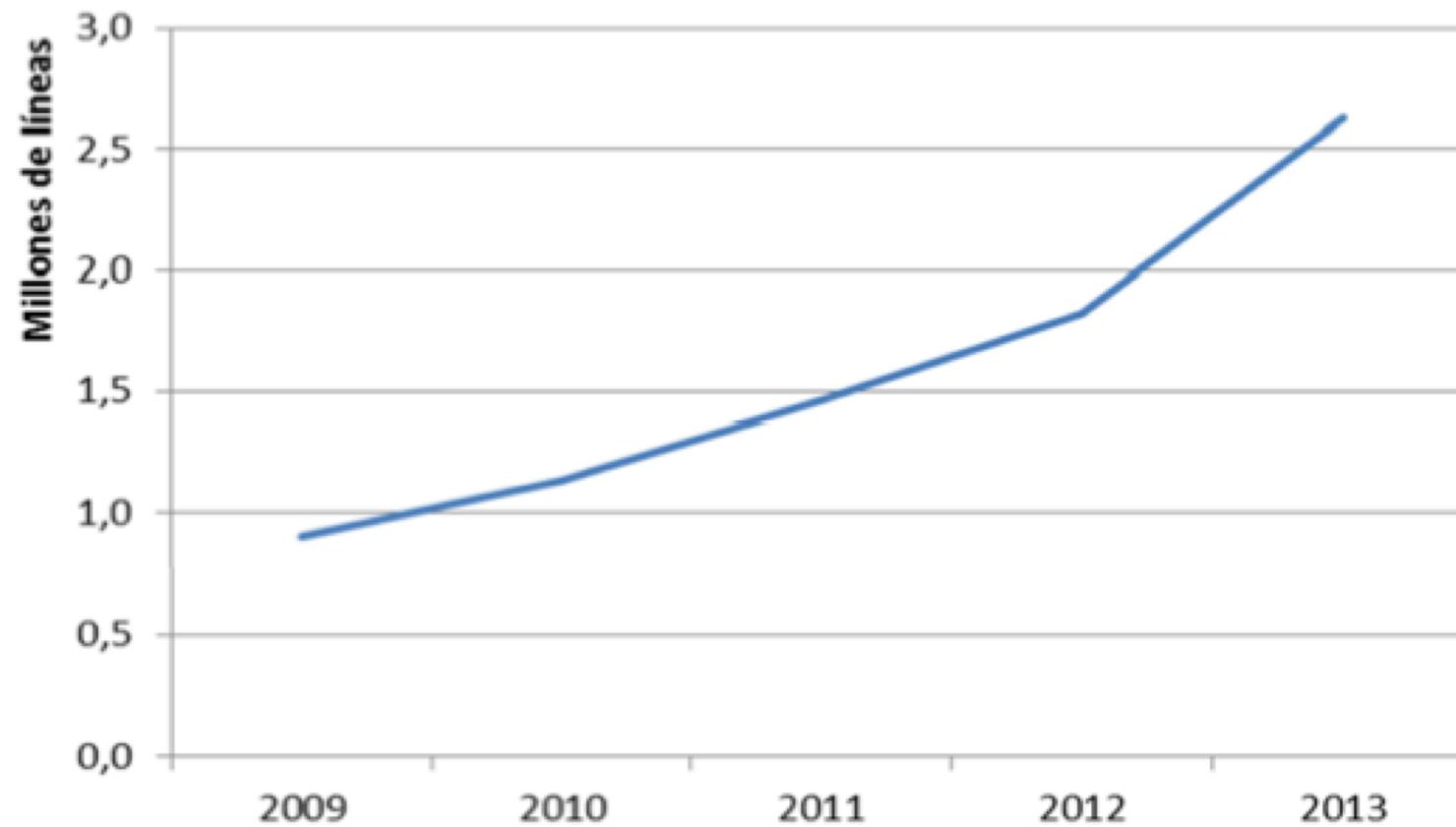
Remedies imposed on FTR:

| | Telefónica | Other SMP Operators |
|-----------------------------------|--------------------|------------------------|
| Access to specific resources | Yes | Yes |
| Price control and cost accounting | Yes, cost-oriented | Yes, reasonable prices |
| Accounting separation | Yes | No |
| No discrimination | Yes | No |
| Reference Interconnection Offer | Yes | No |

EU Recommendation (2014): FTR/MTR must follow the Long Run Incremental Cost (LRIC) principle. In the whole EU the FTR/MTR shall be homogeneous.

Migration towards all- IP networks

Gráfico 4. Evolución líneas VoIP



A will pay for both, i.e. pay his network provider who will pay B's network provider at price FTR_B

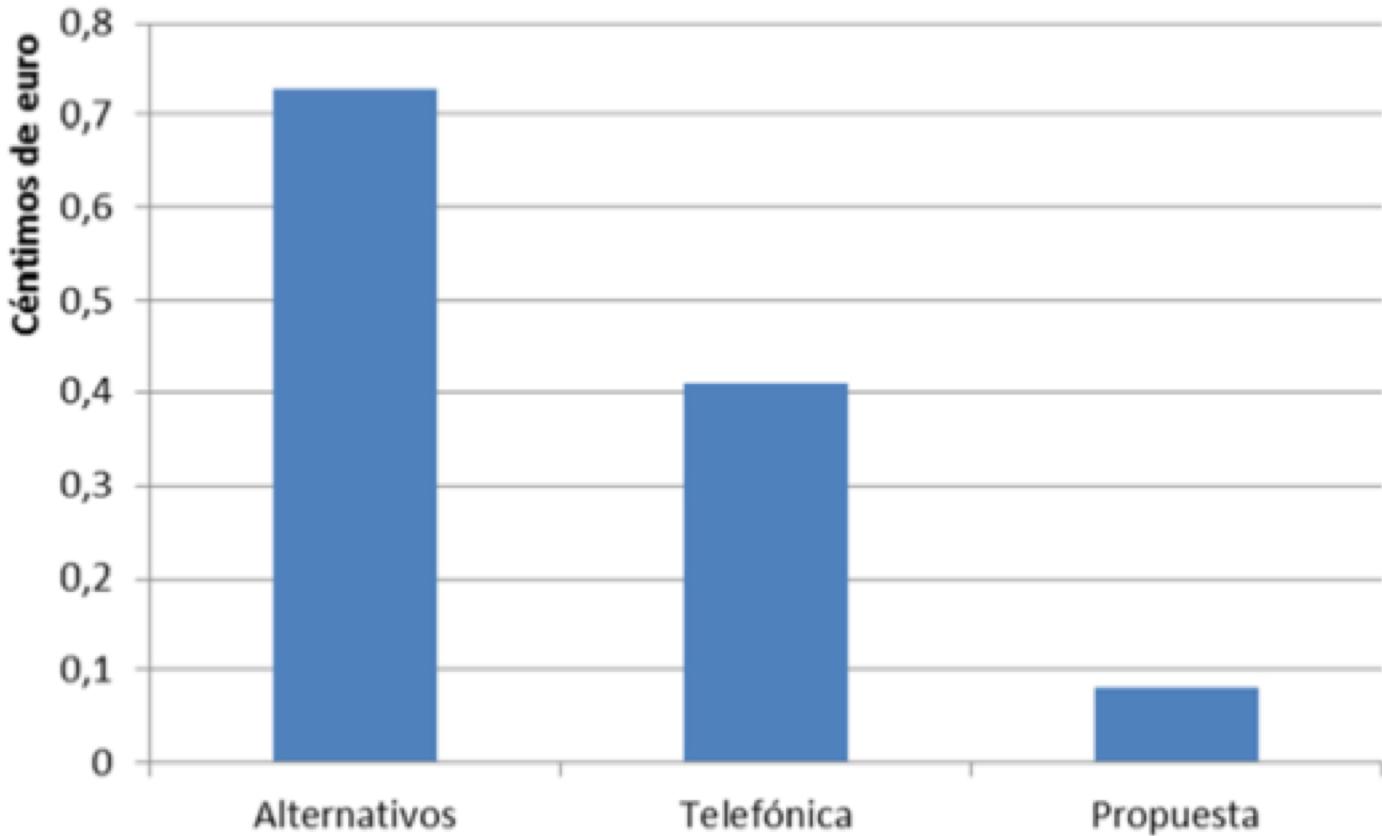
With IP- networks (call termination):

- the three layers of interconnection are eliminated (local, single and double transit)
- the new topology of the network to provide FTR is based on an ideal NGA network
- when IP calls, the transport of a call is done and the management of calls and billing independently
- Non discrimination: same price applies to all, and to himself.
- Cost accounting and transparency applies only to incumbent, but all other remedies apply to all.
- LRIC = (cost of providing all services)- (cost of providing all services except that of FTR)

Gráfico 5. Precio de terminación fija (c€/min)

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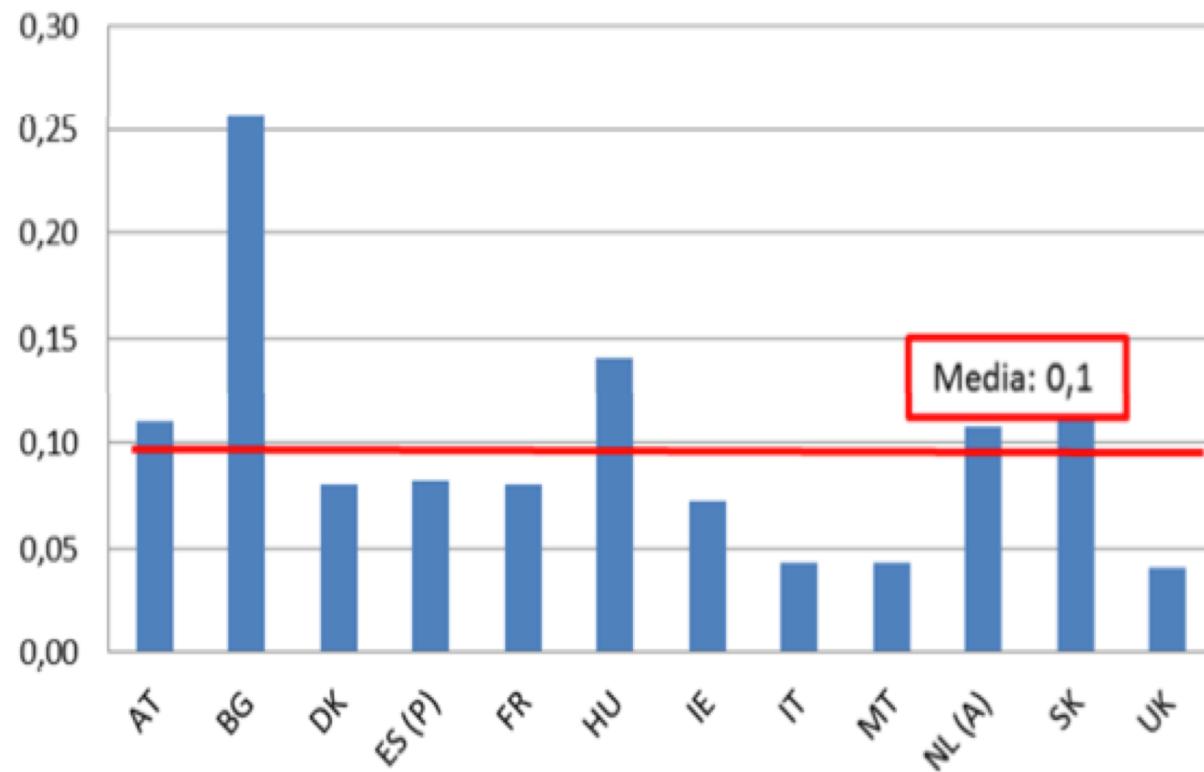
Once IP- interconnection is included as the main way of interconnection (due to adoption of NGA networks), the unit cost of interconnection falls dramatically (and no different itx layers exist any longer)



Fuente: CNMC

| Datos en c€/min | Ingreso medio actual | Nuevos precios aprobados | Reducción |
|-----------------|----------------------|--------------------------|-----------|
| Telefónica | 0,4106 | 0,0817 | -80,1% |
| Alternativos | 0,7280 | 0,0817 | -88,8% |

Gráfico 6. Comparativa internacional de precios de terminación calculados a partir del modelo BU-LRIC puro (en ct/€min)



cents of Euro/minute of FTR
(Spain 2014)

| | average revenue 2014 | new FTR (2016) |
|-----------|----------------------|----------------|
| incumbent | 0.41 | 0.08 |
| the rest | 0.72 | 0.08 |

5- IP interconnection

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Traditionally, a network was associated to a service:

- Mobile networks (initially), only voice services and SMS

- Fixed (copper) network: initially only voice

- Cable networks: TV/ content

hence, regulating a network was similar to regulating the underlying service

But the migration to IP- networks (NGA) breaks the relationship between network and service, because any NGA network can transmit any service

In IP- networks, by contrast, voice is just one additional service, in terms of capacity of the network used or traffic, is small, very small. Does it make sense to price wholesale termination of one minute of voice in the same way?

yes, but then the termination rates would drop further and NRA want to keep this to grant telcos at least some source of revenue

The internet.....based on the IP protocol for transmission

- End- to- end communication
- The network is “dumb”, it only transports data/ packets to the address it contains
- the division of information in packets and the integration on these, is made at the “ends”, i.e., the PC, smartphone, tablet.... of the user

There is a de-link of network (physical layer) and the applications: the network is agnostic to what information is transmitted. Hence, the netwok shall absorb any new application or content delivered

How IP traffic travels around the globe and agents involved

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-Transit: provide transport to a third party- Tier 1 players (akamai, Level3, Cogent, some big telecom operators)

-Peering agreements: exchange of large volumes of data: **(1) pure peering:** no one pays for this (a bilateral bill & keep), or **(2) paid peering-** if imbalances in export/ import volumes, some payments are to be made – suited for providers of content like Google (youtube) that export much more data than they import (downloading)

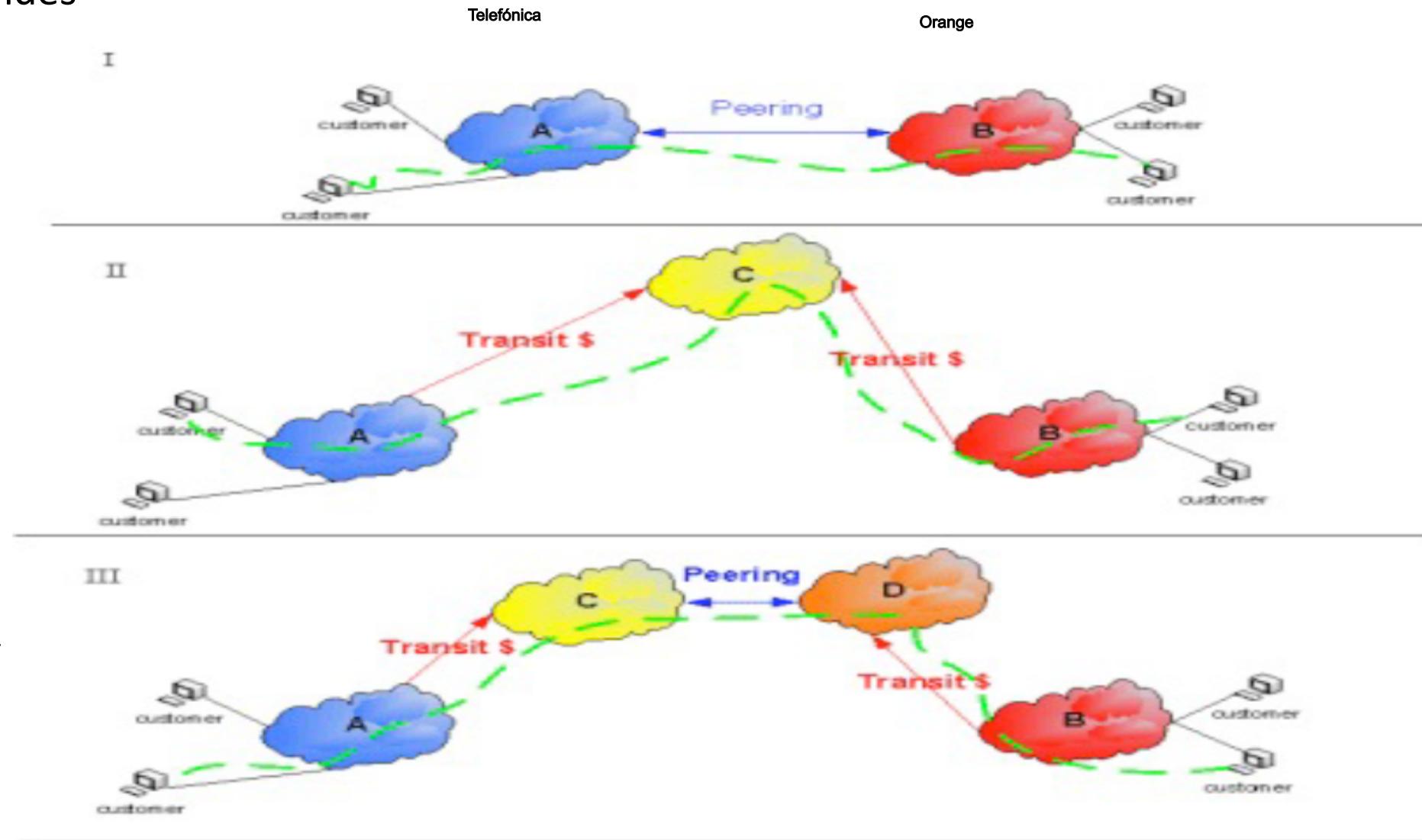
-IP-Interconnection: how to connect to the ISP local network

-Content Delivery Networks (CDNs): servers where big amounts of most demanded content is stored, closer to the final user (but not last mile)

-ISP: Internet Service Provider- owns the last mile, that connects the network to the final users premises (the provider of BB)

How IP traffic travels around the globe.....different arrangements among the stakeholders

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<http://arstechnica.com/old/content/2008/09/peering-and-transit.ars>

Netherlands have 8 IXPs, really nice because they also make the connection more efficient

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Arrangements for IP- interconnection:

Spain has only 2, Madrid and Barcelona

and it is not very expensive! 3 rooms, that's it. So you should do it,

in Latin America/Africa there are none and they pay high prices

in Mexico e.g. incumbent Telmex has no incentive because it makes money from transit agreements (it has 60% of IP points in Mexico) and actually said it will not connect to IXPs

(1) peering: two agents exchange traffic, and do not charge each other

(2) paid- peering (or transit): when very asymmetric traffic flows (exports/ imports)
one side may pay the other for the exchange of traffic

-Tier 1 players: do the transport of long distances of IP traffic (backhaul traffic). Offer this service to ISP (access providers). They may offer this as a “transit service”, or just exchange traffic with other players. Tier 1 players: Akamai, Level3, Cogent, and as well big telecom players like DT, Movistar, ATT.....

Some evidence with IP- traffics (traffic in the open internet)

- (1) IP traffic growing at 20- 30% CAGR, mainly driven by video- traffic
 - (2) emergence of **Content Delivery Networks (CDNs)**, content delivery firms (OTTs) bypass the “transit” level
 - (3) **Interconnection Exchange Points (IXP)** take growing amount of traffic, bypassing some transit level Exchange
 - (4) most common contracting mode for IP traffic: **peering**, informal and symmetric
- (evidence: BEREC report on IP interconnection, 2017)

- In the EU voice interconnection is regulated; but data interconnection is not
- market power in voice termination (CPP, monopoly in termination- no available bypass-), but no such evidence in data itx (transit vs. peering vs. paid-peering vs. CDNs)
- IP voice included in the fixed termination regulation in the EU → much smaller FTR rates
- IP traffic in the open internet is based on the “best effort” principle, and has worked until now
- Software Defined Networks (SDN) shifts control and functionality of the network services from the core network, to software (decentralized)

- network slicing (for 5G and IP networks): same physical infrastructure may provide very different functionalities and QoS to different uses
- the QoS bottleneck (in termination)- quality degradation to hurt rivals or strategically implemented-, may disappear?