



# Network externalities in telecommunications

**Theory and application**

**29 June 2005**



# Introduction

Regulatory authorities around the world have been focusing their attention on regulating mobile call termination charges. This has raised a number of issues concerning the 'correct' level for these charges. In this context, the topic of network externalities has become an important issue.

The purpose of this presentation is to provide an introduction to the subject and explain how network externalities have been applied by regulators and how they might be applied in Africa.

The presentation is divided into four components:

- In the first section, we explain the regulatory background to the regulation of mobile termination charges
- We go on to explain the economics of telecommunications network pricing and network externalities. It begins with an intuitive explanation, followed by a brief summary of some of the most recent academic literature.
- The third section describes regulatory decisions on mobile call termination which have taken account of network externalities.
- Finally, we discuss the implications for regulatory decisions in Africa.

# The regulation of mobile termination charges

# Telecommunications operators (mobile and fixed) provide multiple services

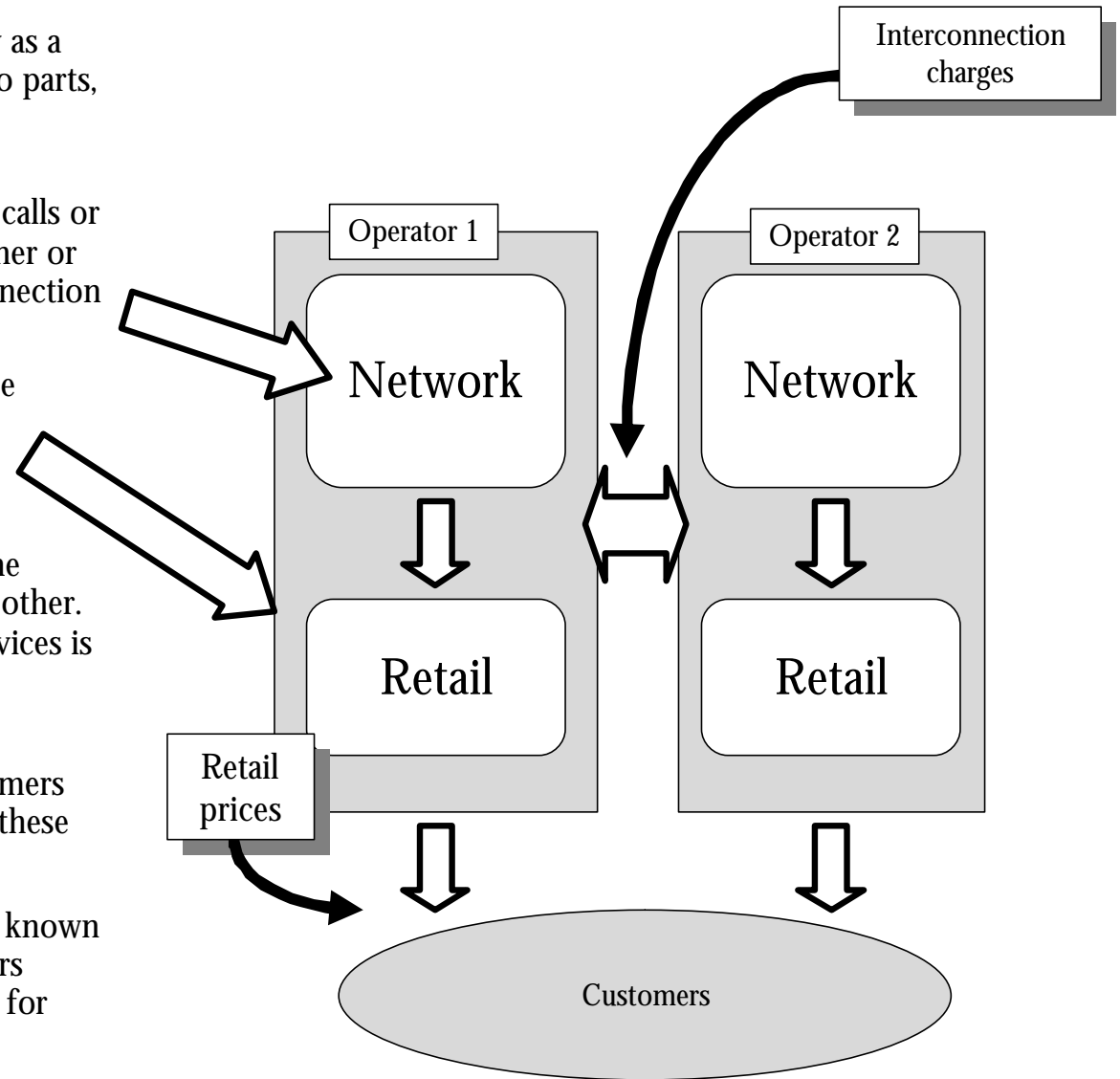
We can think of the telecommunications industry as a group of firms. Each firm can be divided into two parts, one part provides network services and the other provides retail services.

- The network part of the business carries calls or data services from one customer to another or to/from customers to points of interconnection with other networks.
- The retail part of the business handles the relationship with customers: customer acquisition, customer retention, billing, customer services etc.

When calls pass from one operator to another, the networks are providing network services to each other. The most important of these interconnection services is call termination. This allows a subscriber on one network to call a subscriber on another network.

Services (i.e. calls or data) provided to final customers are known as 'retail services' and the charges for these services are retail prices.

Services provided by one network to another are known as wholesale services. In many countries, operators charge each other for these services. The charges for these services are known as 'wholesale prices'.



## Which services are regulated ?

The markets are defined using general principles of competition law and practice. The key retail markets are fixed access, call services and leased lines for residential and business customers. The mobile retail market is defined as access & calls.

There are a number of wholesale markets defined as well. These include call termination on mobile and fixed networks.

The market definition for mobile termination is unusual in that termination on each individual network is defined as a separate market. This is for the following reasons:

- In markets where the calling party pays the full cost of the call ('Calling Party Pays' or CPP), the receiving party does not pay anything to receive a call. Operators make payments to each other to cover the cost of terminating calls.
- The receiving party chooses which network to subscribe to. The calling party (i.e. the customer that originates the call) usually has no influence on this choice of network.
- The party that pays the termination charge (indirectly through retail prices) therefore has limited or no influence on the choice of network. This limits the downward pressure on mobile termination charges.
- As a result, regulators are increasingly finding mobile operators to be dominant in the provision of call termination. This has provided a rationale for imposing a remedy. The remedy chosen by several regulators has been to regulate mobile call termination charges at cost.
- This includes both the charges that are paid for terminating fixed-mobile (FTM) calls and mobile-mobile (M2M) calls.

## How are termination charges regulated ? (The basics)

The objective of governments and regulators is to ensure that prices are set at a level which maximises long-term consumer welfare. In general, this is achieved when the price that is charged for a good equals the marginal cost of its production (i.e. the additional cost that is incurred to produce one more unit of a good). This includes a reasonable or fair level of profit.

In competitive markets, prices are forced down to match the cost (including profit) of producing and delivering products and services. In general, markets that are competitive do not require direct economic regulation.

However, where competition is not fully effective, the market may not set prices equal to cost. Such a situation results in prices being set above cost and the amount of the good that is produced and consumed is reduced. Where this happens, governments and regulators have a reason, in principle, to intervene to ensure that prices are not excessive.

The objective of such regulation is to emulate the effect of the market in setting prices as close as possible to the cost of production. This ensures that economic welfare is maximised while the industry is able to finance its activities on a sustainable basis.

A simple approach would be to regulated termination charges at marginal (or incremental) cost. However two additional issues have to be taken into account at this stage.

- First, fixed costs are a significant part of the total costs of telecom networks. These must be recovered from charges if operators are to remain viable. This is done through setting prices using a mark-up over marginal cost.
- Second, the telecommunications industry is characterized by network externalities which affect the desirability of pricing at cost in order to maximize social welfare.

# Network externalities – the theory



## What are externalities

“An externality is an effect (i.e. a cost or a benefit) that impacts on a third party by a decision (i.e. to consume or produce) taken by another party. Since this cost (or benefit) does not affect the party that makes the decision, the latter does not, in general, take account of this cost/benefit in his decision.”

*Source: ITU, 24-28 January 2005*

The textbook examples of externalities have traditionally focused on negative externalities such as pollution. In these cases, producers of goods do not take into account the cost that the pollution associated with the production of the goods imposes on third parties.

By itself, the market mechanism will result in an inefficient level of pollution. Society overall would be made better off if the level of pollution was reduced because the cost of reducing the pollution would be less than the benefit to the third party.

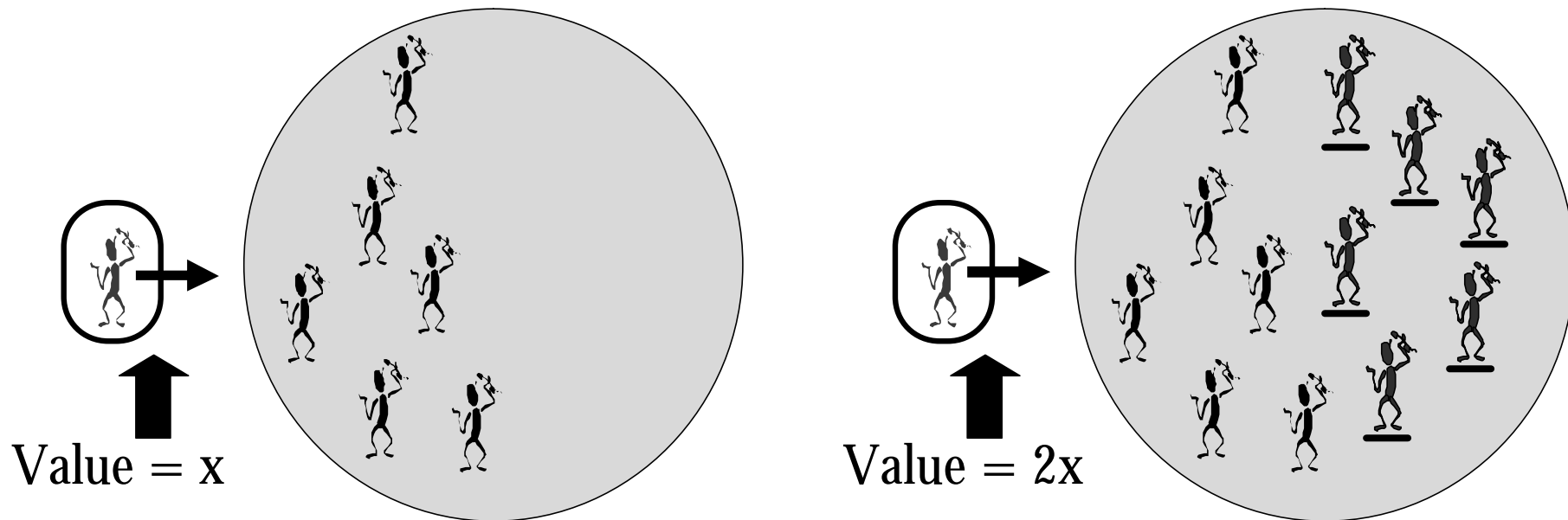
Externalities provide an economic rationale for intervention in the market. This intervention is usually in the form of a tax or a regulation.

However, not all externalities are negative. There are also positive externalities in which the market, by itself, would result in too little production or consumption of a good. Network externalities are a special type of positive externality.

## What are Network Externalities ?

Customers joining a network obtain benefit from making and receiving calls. They therefore have a private valuation of being part of the communications network.

This value derives from being able to communicate with other people. It therefore increases with the number of people connected to the network: the bigger the network, the more valuable it is to both existing and potential members. Hence, a customer's decision to join a network affects both their own welfare and that of other people. This effect is known as a "network externality".



When new subscribers (underlined) join the network making it twice as big, the value of the network doubles because twice as many people can be contacted.

Total value of the new subscribers joining the network is their own valuation + the impact on the existing subscribers .

## Why don't 'normal' market rules apply ?

In 'normal' markets, in which there are no externalities, the value of consuming a product accrues to the person who consumes it. They are therefore able to determine whether or not their valuation of it is greater or less than the price. It can be assumed that the valuation of a product by all consumers is at least as great as the price that they pay for it.

In the absence of externalities, we would expect prices to be set equal to cost and the market process would arrive at the welfare maximising level of consumption. However, this is not the case where there are externalities.

If other people obtain benefit from a consumer's decision to join the network, society's total benefit (i.e. the benefit obtained by the individual plus all other people on the network) exceeds that of the private individual. In this case, we may not expect a market to arrive at a welfare-maximising level of consumption of the product.

In the case of network externalities, we would expect 'too few' people to be connected to the network, if prices were set at the level of costs.

## How do network externalities affect the level at which prices should be regulated ?

In regulating charges, a regulator may want to deviate from a cost-based pricing rule in order to take account of network externalities and encourage more people to join the network. This would raise overall economic welfare.

In order to do this, it would be necessary to set some prices below cost in order to increase network participation. A subsidy is therefore required for some services.

Who should pay for these subsidies ? Ideally, we want the beneficiaries of externalities to finance any subsidies that are required. In the case of network externalities, the beneficiaries are other customers who are able to make calls to the additional subscribers who join the network as a result of the subsidies.

When a new customer joins a network, the potential beneficiaries can be divided into two groups:

- Customers of the same network as that which the new customer joins
- Customers of other networks

Operators have an incentive to maximise the number of customers on their networks. This can therefore be expected to set a structure of subscription and call tariffs in such a way that subsidies are internally transferred from existing subscribers to new subscribers.

However, operators clearly do not have an incentive to increase the welfare of the customer base of their competitors through a subsidy. An alternative solution is therefore to introduce a mechanism for funding the required subsidy – this is done through termination charges. This is the rationale for setting termination charges at a level above cost to take account of the network externality.

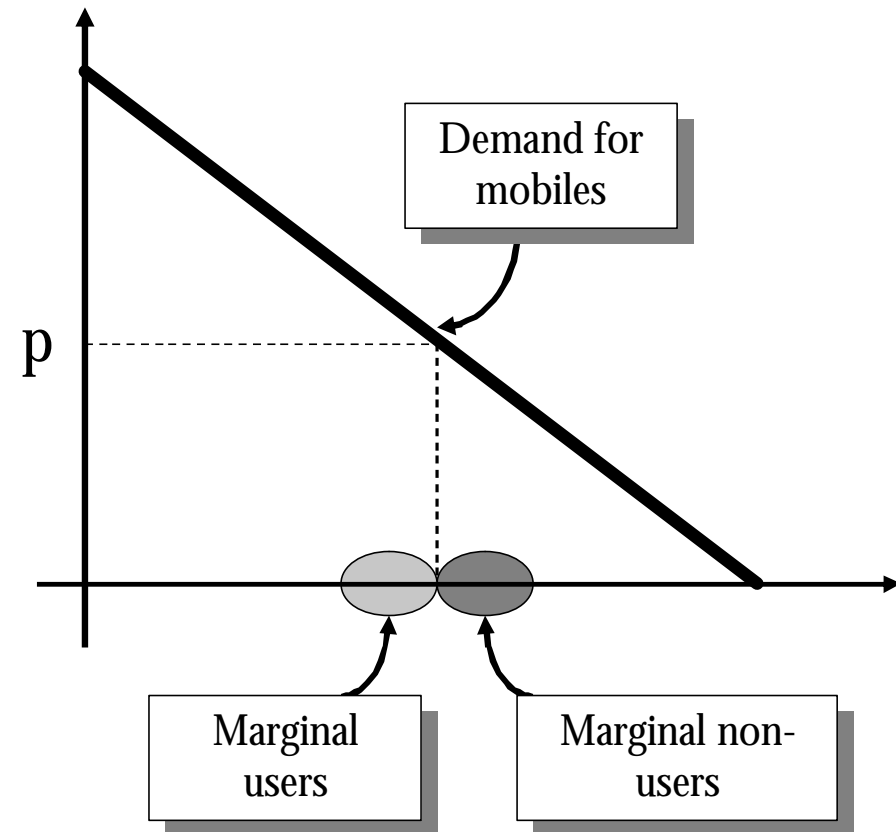
Operators obtain profits from having termination charges set above cost. These profits are used to subsidise other services (e.g. subscription or handsets) in order to encourage more people to join the network. This system of subsidies is designed to achieve the welfare maximising level of network participation.

## The key is attracting and maintaining marginal subscribers

The issue of network externalities primarily concerns increasing access to the network for customers who are either on low income or in areas which are not currently served by the network. It is a form of subsidy from high value users of the network to marginal users.

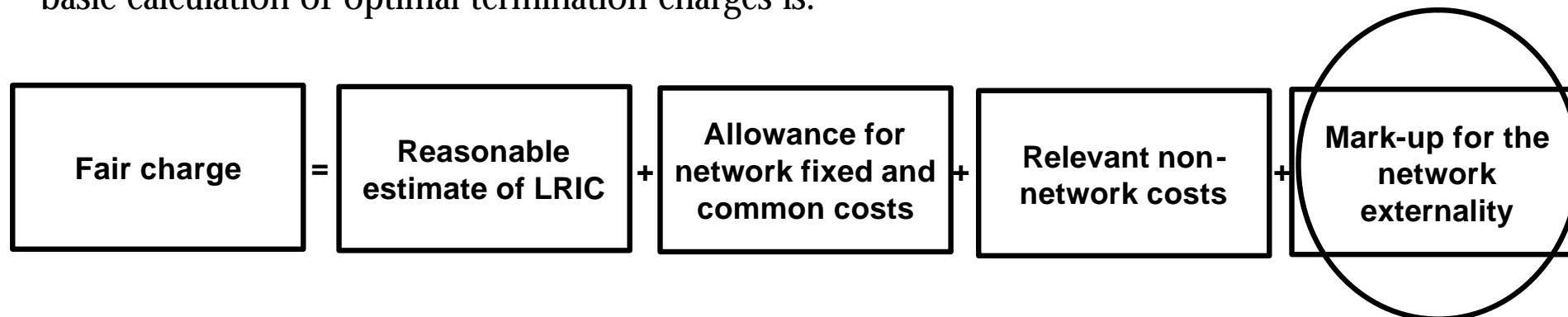
Marginal subscribers are:

- those people who value being on the network only just enough to make them subscribe at the current prices; and
- those people who choose not to subscribe at the current prices but would subscribe if prices were only slightly lower.



## What is the correct level of network externality mark-up ?

The correct level of termination charge should be one which maximises economic welfare. The basic calculation of optimal termination charges is:



The economic theory underlying the optimal level of the network externality mark-up can be very complex. It is difficult to achieve consensus among academics on the exact correct level of termination charges. However, a number of regulators think that there is sufficient agreement to make an allowance for network externalities in regulated mobile termination charges.

Traditionally, the design and application of economic models has treated fixed and mobile networks separately. Hence, models consider Fixed-to-mobile (F2M) and Mobile-to-mobile (M2M) charges differently. The reason for this is that F2M termination charges are in most cases, a source of revenue only for mobile operators, while M2M call termination charges can be both a source of revenue and cost for MNOs.

## Optimal fixed-to-mobile termination charges

A number of recent papers have considered the regulation of F2M termination charges under a calling party pays system.

Key assumptions:

- Mobile networks are profit-maximising and compete with each other
- Competition can vary in intensity and operators set multiple prices.
- Customers are heterogeneous
- There are network externalities

Model

- The model calculates the optimal termination charge when the regulator sets the F2M termination charge but the operators set other prices competitively.

Conclusions from the model:

- The welfare-maximising termination charge is above marginal cost
- the setting of F2M termination charges needs to take into account the degree of competition and the type of customer preferences in the mobile outbound market (I.e. optimal F2M charges should take account of competition in the *mobile* market)
- The size of the mark-up on cost should reflect the intensity of competition in the F2M retail market, the utility from receiving F2M calls and the presence of fixed and common network costs.
- Regulators would require detailed information to set optimal F2M termination charges.

## Optimal mobile to mobile (M2M) termination charges

There are a number of different models of mobile tariff structures. Common assumptions include: Hotelling model of competition between 2 MNOs; homogeneous customers; no fixed network and networks with equal costs.

The models are complex and conclusions vary. However, the result of an interesting model is that, under two-part tariffs (i.e. fixed subscription charge and a per minute call charge), where network externalities exist and the market is not saturated:

- The welfare-maximising M2M termination charge is typically above cost but converges towards cost when
  - the mobile market is close to saturation or.
  - the firms are highly differentiated.
- Interestingly, the model also concludes that the profit-maximising reciprocal M2M termination charges are
  - below the welfare maximising M2M termination charges and,
  - below cost.

Why do regulators often treat M2M in the same way as F2M?

- There may be practical difficulties in maintaining a difference between M2M termination charges and F2M termination charges because, for example, arbitrage



## Conclusions on the theory

The modelling of optimal mobile termination charges is complex and there is some variation between models

Economic theory indicates that the welfare-maximising level of mobile termination charges is above cost for F2M termination charges – this is the effect of the network externality .

The results are more mixed for M2M termination charges. However, there is some theoretical support for the view that welfare-maximising M2M termination charges are above cost

The size of both optimal M2M and F2M mark-ups vary according to a number of factors

In practice the calculations of the optimal mobile mark-up have been carried out using more simple economic models

## Network externalities – in practice

## UK, Competition Commission enquiry into mobile termination 2001-03

The telecommunications regulator referred the decision on mobile termination charges to the Competition Commission (“CC” – the higher regulatory authority) in 2002. It concerned the charge for terminating calls on the networks of all four UK MNOs (Vodafone, O2, Orange and T-Mobile) from both F2M and M2M termination charges

The CC concluded that each MNO had a monopoly over call termination on its own network because the calling party has no choice on which network their call is terminated and, under CPP, there is no competitive pressure on call termination charges. In addition, the structure of incentives on MNOs distorted the volume and direction of traffic in the network.

The CC concluded that terminating charges should be cost-reflective and that the appropriate method to determine costs was long-run incremental costs (LRIC). However, it was noted that some costs were fixed and common to outgoing and incoming calls.

The CC concluded that call termination charges of the MNOs were well in excess of a “fair charge” which was defined as LRIC + a mark-up for fixed and common network costs + any relevant non-network costs. The CC also accepted that there should be a small mark-up for the network externalities.

*“A person (new potential subscriber) considering whether to subscribe will often **only take account of the benefits that he obtains** and not the benefits that accrue to others and, if this happens, **‘too few’ people will subscribe.**”*

*UK Competition Commission 2003 report*

## How was the network externality mark-up calculated ?

The parties to the enquiry (i.e. the regulator and the operators) expressed views on the correct method for calculating the optimal mark-up to account for network externalities.

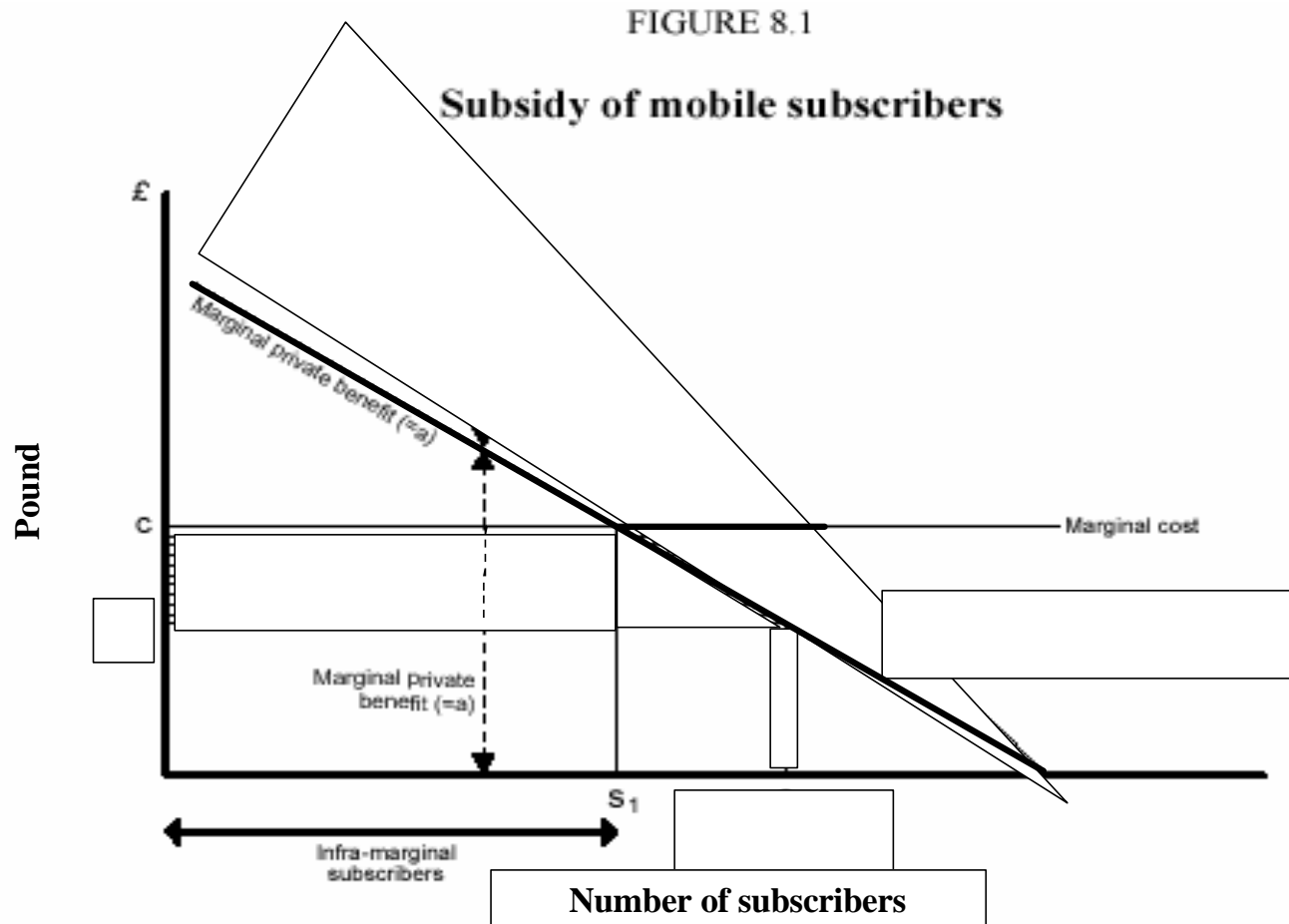
One approach involved the construction of a system of simultaneous demand equations which were calibrated using estimates of price elasticities. These estimates of the elasticities contain information on the magnitude of the optimal mark-up.

The second approach, proposed by the sector regulator (OfTel), was based on an assumed value of the network externality (referred to as an R-G factor). The R-G factor is defined as the ratio of the marginal social benefit of an additional mobile subscriber to the marginal private benefit. This was the approach adopted by the CC.

Following OFTEL, the CC assumed that the R-G factor would have a lower bound of one (when existing subscribers did not much value contact with the additional subscriber) and an upper bound of 2 (proposed on the grounds that it is unlikely that existing members would benefit by a greater amount in aggregate than the additional subscriber).

In practice, the CC assumed that the value of the RG factor was 1.5. This arose from previous estimates by OfTel and a specially commissioned survey. The CC also assumed that subsidies could be targeted at marginal subscribers. This meant that the subsidy (and therefore the mark-up) required to increase the number of subscribers to optimal levels would be significantly reduced.

# How was the network externality mark-up calculated ?



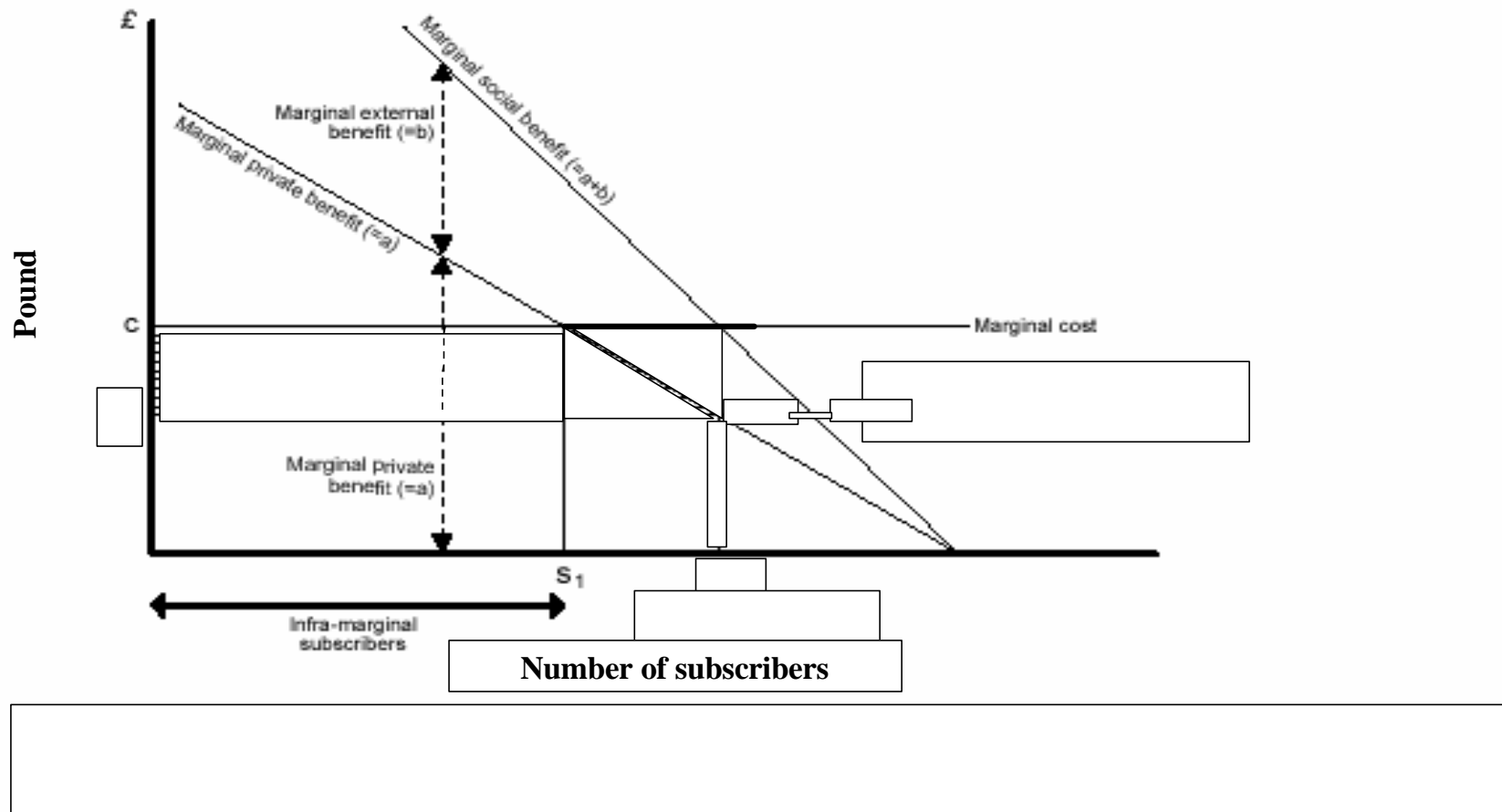
Source: Oftel.

Note: The marginal private benefit and marginal social benefit lines are drawn as straight lines purely for the purpose of illustration.

How was the network externality mark-up calculated ?

FIGURE 8.1

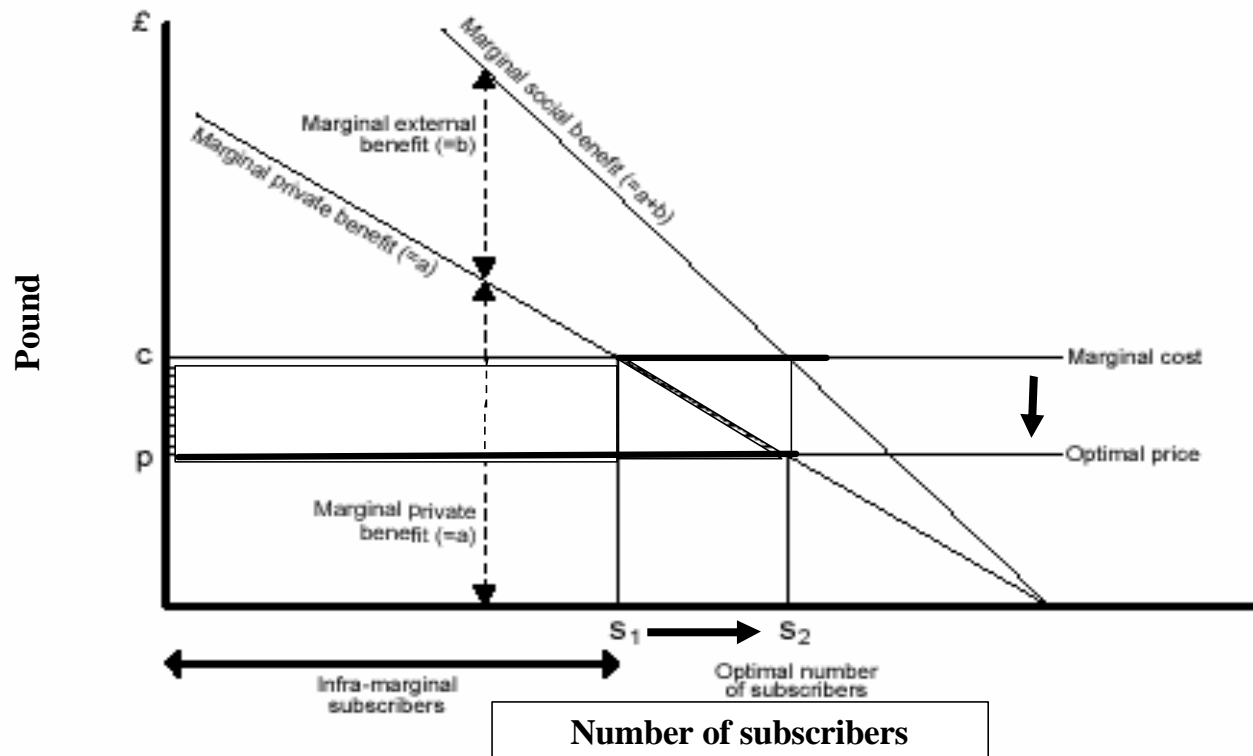
**Subsidy of mobile subscribers**



How was the network externality mark-up calculated ?

FIGURE 8.1

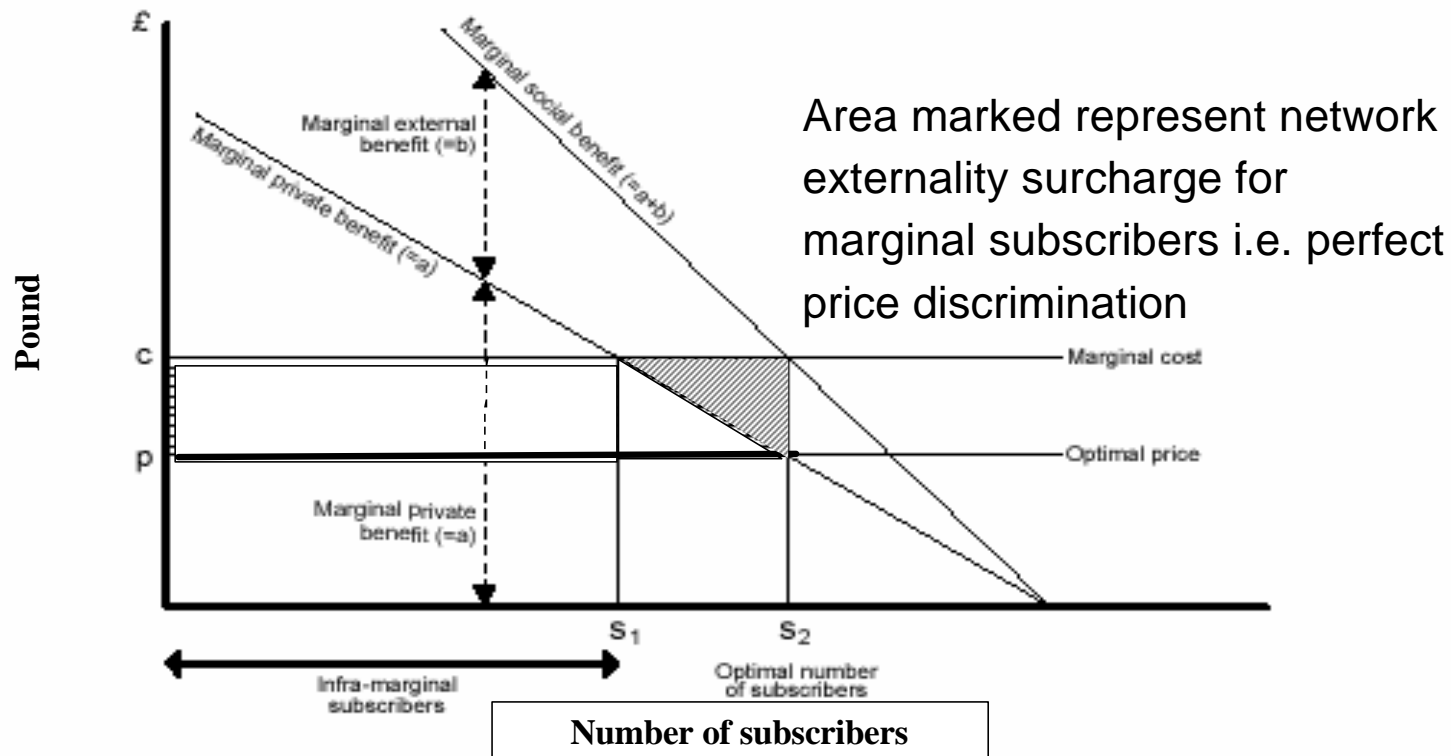
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How was the network externality mark-up calculated ?

FIGURE 8.1

**Subsidy of mobile subscribers**

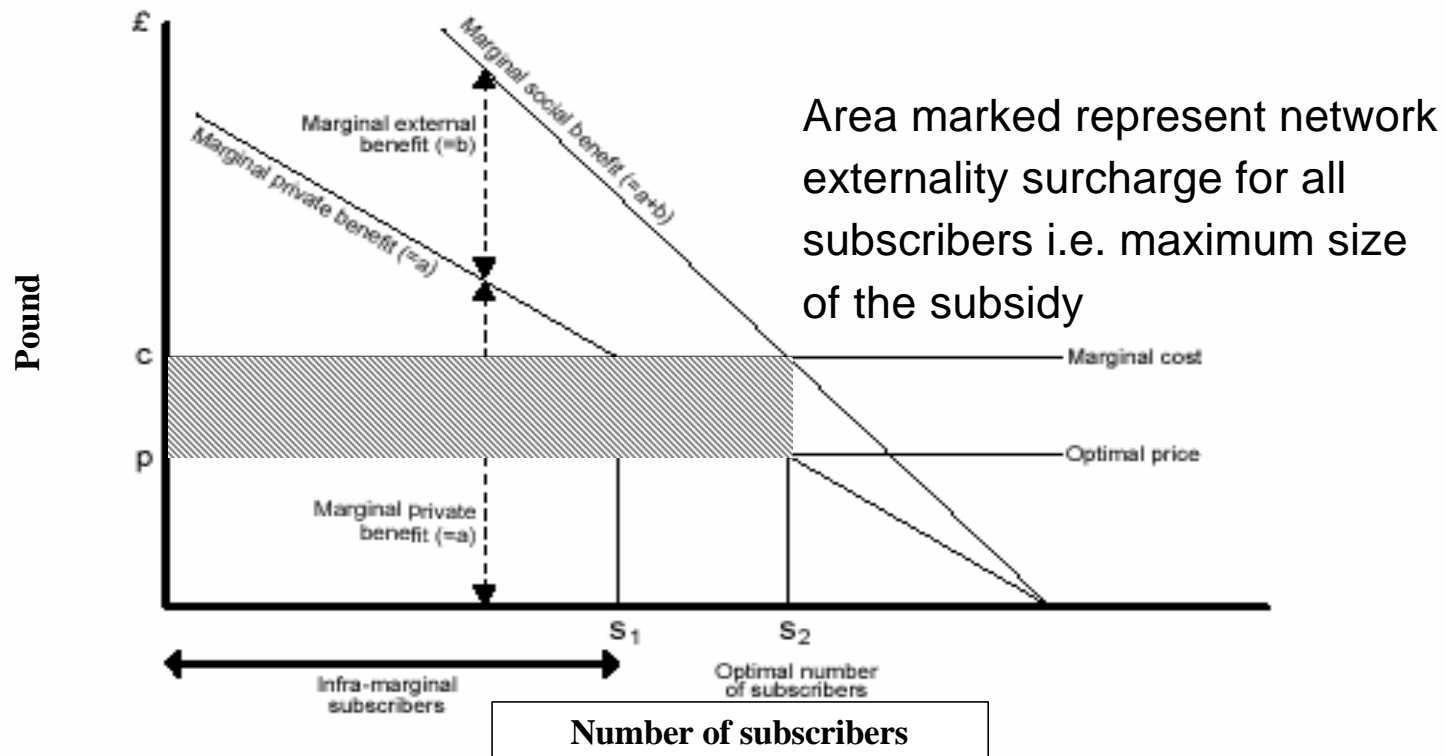




How was the network externality mark-up calculated ?

FIGURE 8.1

**Subsidy of mobile subscribers**



## How was the network externality mark-up calculated ?

The CC assumed that MNOs were able to target subsidies at customers. This allowed a lower estimate of the total amount of the subsidy required to reach the optimal number of subscribers.

The CC methodology calculated separately the subsidy required to maintain current marginal subscribers on the network and the subsidy that would be required to attract marginal non-subscribers onto the network.

### ○ Subsidy to existing subscribers:

- Average subsidies were US\$126 per subscriber (price of handset).
- A % of handsets are replaced every year and so, if the handset subsidy was removed, those customers whose valuation was less than US\$126 would leave the network.
- Assume a linear distribution of valuations of these subscribers so the average valuation is US\$63)
- The subsidy required (with perfect targetting) to maintain these subscribers on the network is therefore US\$63.
- This results in a network externality mark-up on termination charges of 0.63 US¢/min.

### ○ Subsidy to non-current subscribers

- A uniform subsidy of US\$42 would induce 41 per cent of marginal non-subscribers to join the network
- This results in an additional network externality mark-up of 0.054 US¢/min

### ○ Additional subsidy:

- to existing subscribers for whom subsidy to non-current subscribers is more attractive, of about 0.07 US¢/min

## How significant were externalities in the final decision ?

The sum accounted for 0.74 US¢/min. After testing for the robustness of such estimate, the CC agreed to a subsidy of 0.81 US¢/min, lying between 0.74 US¢/min and 0.90 US¢/min, established in the the previous MMC's report in 1998.

### Summary of cost of call termination (at 2000/01 prices)

Combined 900/1800 Mhz

Cost of call termination

|                   | 2003        | 2004        | 2005        | 2006        |
|-------------------|-------------|-------------|-------------|-------------|
| Adj LRIC          | 5.41        | 4.83        | 4.35        | 3.98        |
| Non-network costs | 0.30        | 0.30        | 0.30        | 0.30        |
| Externalities     | 0.45        | 0.45        | 0.45        | 0.45        |
| <b>Total</b>      | <b>6.16</b> | <b>5.58</b> | <b>5.10</b> | <b>4.73</b> |

### Percentage of total cost of call termination

|                   |               |               |               |               |
|-------------------|---------------|---------------|---------------|---------------|
| Adj LRIC          | 87.8%         | 78.4%         | 70.6%         | 84.1%         |
| Non-network costs | 4.9%          | 4.9%          | 4.9%          | 6.3%          |
| Externalities     | 7.3%          | 8.1%          | 8.8%          | 9.5%          |
| <b>Total</b>      | <b>100.0%</b> | <b>100.0%</b> | <b>100.0%</b> | <b>100.0%</b> |

## How was the decision implemented ?

The CC found that the most appropriate remedy was a price cap, based on the relevant LRIC of the call termination service of an MNO with a 20 per cent market share, plus the appropriate mark-ups. The price cap would cover the period 04/2003 to 03/2006, starting with a 15 per cent reduction in their termination charges over an initial period.

Finally the CC recommended the establishment of a system of two price caps:

- first, charges for fixed-to-mobile calls and;
- second, charges for off-net calls.

These price-caps were, in fact, set at the same level

## Greece: mobile termination charges, 2003

Following the decision in the UK, the EETT (the Greek telecommunications authority) commenced the market review process for mobile termination charges in 2003.

Following consultation on the relevant market (termination on each individual mobile network), and the proposed designation of the 4 Greek mobile operators as having significant market power in the relevant market, EETT proposed that mobile termination charges should be cost-oriented.

EETT concluded that in the absence of any form of regulation, competitive pressures would be insufficient to constrain fixed-to-mobile termination charges.

EETT used a bottom-up LRIC model to estimate the costs of mobile termination. It also proposed to allow the recover of fixed and common costs using equi-proportional mark-ups, and to introduce also an allowance for network externalities.

EETT proposed a “glide path”, so that termination charges would converge to cost over a 3 year period (this proposal was subsequently revised to a shorter period of 18 months).

EETT has not yet published its final decision in relation to the actual level to which termination charges will converge.

Ireland, 2005

“If some people are faced with the full cost of becoming a subscriber, they may choose not to join the network, although economic welfare would be enhanced if they did, because the sum of the **benefit (those gained directly and those obtained by network others) exceed the cost.**”

“It is therefore an argument to adjust prices to reflect the network externality i.e. adding a surcharge to mobile termination and encouraging MNOs to offer lower prices to mobile subscribers e.g. **subsidy of the subscription price.**”

**Office of the Director of Telecommunications Regulation Ireland**

## Network externalities - the implications for Africa

# The background

## Market background

- There is a lot of variation between countries but, generally:
  - Fixed penetration is low and, in many countries, not increasing significantly;
  - Mobile network penetration is growing fast and has overtaken fixed penetration rates
  - The majority of people are contactable only on a mobile phone.
- The majority of mobile users are on pre-pay tariffs
- Call-by-call resale is an important component of increasing usage in low penetration areas.
- Calling party pays is commonly used although receiving party pays is in operation in some countries
- Asymmetries in rural-urban calling patterns – people more likely to call from urban to rural than vice versa.
- Significant evidence of domestic call back (“Please call me SMS”) -

## Policy and regulatory environment

- Independent regulators have been established in many countries
- In many countries, the primary policy objective is to increase penetration, particularly to low-income users and into rural areas
- Regulators are beginning to look at regulating mobile termination charges

## Marginal subscribers In Africa,

- Incomes are lower and many people do not use mobile communications as part of their daily lives so a higher proportion of the population may be marginal users
- Affordable access to telecommunications, ⇒ social economic impact by enabling more people to be able to communicate and be contactable by telecommunications (e.g. businesses, families)



## Implications for Africa

Increasing access to communications for all is a top priority for Africa

Network externality adjustments offer methodology for achieving this objective through theoretically sound approach and which has been applied by national regulators and accepted by international organisations.

Network externality adjustments used to finance handset subsidies are likely to results in a bigger demand response in Africa than in Europe because users are more price sensitive.

If network externalities are not considered in setting mobile termination rates, this could limit the growth of network penetration in Africa in future.

It would also miss an opportunity to use consumer surplus of one group of customers to subsidise an other.

# The challenges for implementing network externalities in Africa

The first challenge is estimating the magnitude of network externalities. This requires

- Research on demand and price elasticities:
  - Research into elasticities and usage profiles has already been started in Africa
  - Many of the research techniques used in Europe are equally applicable in Africa
- Estimation of demand response to different subsidy options
- Targeting subsidies from MTR to marginal network users.

The key to efficient use of network externalities as a form of subsidy is targeting it on the marginal users.

This requires identifying these users and then offering them lower prices. There are a number of options:

- Geographical targeting – identifying poor or underserved areas and offering discounts or some form of lower prices.
- Reducing monthly charges for targeted customers
- Handset subsidy mechanisms
- Supporting finance options for handset purchase
- Low-user tariff plans
- Tariff packages with first x minutes free

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