



# On-net Pricing in Mobile



# Foreword

I hope you enjoy our eighth Vodafone Policy Paper. Our aim in these papers is to provide a platform for leading experts to write on issues in public policy that are important to us at Vodafone. These are the people that we listen to, even if we do not always agree with them. These are their views, not ours. We think that they have important things to say that should be of interest to anybody concerned with good public policy.

**Arun Sarin**, Chief Executive, Vodafone Group

# Contents

	Page
<b>Foreword</b>	<b>00</b>
– Arun Sarin, Chief Executive, Vodafone Group	
<b>Introduction</b>	<b>01</b>
– Richard Feasey	
<b>Virtual private networks and the risk of price squeezes</b>	<b>03</b>
– Jordi Gual	
<b>Two-way access charges and on-net/off-net differentials</b>	<b>11</b>
– Dan Elliott	
<b>On-Net Pricing in Mobile Services</b>	<b>26</b>
– Halvor Sannæs	
<b>Theory and practise of on-net pricing</b>	<b>36</b>
– Dr. Jonathan Sandbach	

This paper can be seen online at [www.vodafone.com/publicpolicyseries](http://www.vodafone.com/publicpolicyseries)

**Richard Feasey**Public Policy Director,  
Vodafone Group

Richard is the Public Policy Director for the Vodafone Group, coordinating global public policy and regulatory affairs throughout Vodafone's operating companies including Europe, the Americas, and the Asia-Pacific. Richard has over fifteen years experience in international telecommunications in fixed, internet and wireless sectors; having been responsible for public policy at MCI Worldcom International, Ionica plc and TeleWest Communications plc. He has chaired worldwide industry bodies and is currently chair of the Regulatory Advisory Board of the GSM Association.

## Introduction

On-net call discounts, which allow customers to pay less for calls which remain within their own home network, have been a feature of telecommunications markets for many years. But they have recently begun to receive attention from regulators and anti-trust authorities as smaller operators claim that they are being used by large operators to restrict competition.

It might be thought that regulators would be more concerned if on-net discounts did not exist. Cheaper on-net calls mean lower prices for customers who take advantage of them. In Europe's calling party pays environment the marginal costs of making calls to other networks are higher than those of making calls on-net. The fact that these differences are reflected in retail prices would tend to suggest that competition is working, rather than suggesting the opposite. As Jonathan Sandbach shows in his paper, on-net discounts have been part of an increasingly competitive European market, and have not prevented new entrants from gaining market share.

It is also possible that customers are more sensitive to the price of calls between users who benefit by being on the same network (e.g. friends and family) or that customers value receiving calls as well as making them (in which case on-net tariffs allow these benefits to be kept within the same network rather than shared with other networks). It is pretty clear that most customers have both characteristics to a greater or lesser degree. This suggests that on-net discounts will make sense, and are likely to be more efficient, even in the absence of a calling party pays termination rate environment. This may be why we observe differentials in the United States, despite much smaller differences in the costs of making on-net and off-net calls in that market. Nor is it clear that networks have

to be large to benefit from these effects. Frequent calling circles can be small, and consumers can gravitate to the same network regardless of its size.

Some firms and regulators take a different view. They argue that on-net price discounts are best understood as a form of predatory pricing by larger networks, raising concerns that they will eventually 'tip' customers onto a single network. These fears echo concerns about 'snowballing', 'tipping' and other network effects which have featured in many discussions about the internet, normally in relation to global backbones or search.

These concerns appear to be growing as one important explanation for on-net discounts – the imposition by regulators of 'asymmetric' termination charges for calls to smaller networks – is being withdrawn in Europe. This has led some regulators and operators to argue that these higher termination rates should be retained in order to 'protect' smaller operators from on-net price discounts. Other regulators and operators use the same reasoning to come to the opposite conclusion, suggesting that on-net pricing supports the case for much lower termination rates for all operators.

Simple ex ante remedies like these are unlikely to be appropriate because the challenge for regulators and anti-trust authorities here – as with most predation cases – is to distinguish between conduct which is efficient, benefits consumers and reflects competitive forces on the one hand; and conduct which leads to foreclosure on the other. Crude prohibitions fail to do this, resulting in more harm than good. The European Regulators Group wisely said in its May 2006 version of its 'remedies' document that: 'There is no

presumption that any such on-net discounting will inevitably distort competition... Each case would need examination on its merits' (p.114).

Vodafone has been thinking about on-net pricing issues since 2001 and has been involved in most of the enquiries to be undertaken by regulators or anti-trust authorities in Europe during this period.<sup>1</sup> Some of the papers contained in this pamphlet date back to 2004 or earlier, but none have been published before.

The papers have been intended to help us address the questions we have encountered on this subject. Jordi Gual's paper provides an overview of the economics of on-net pricing, particularly as it relates to the use of on-net pricing in a converging environment. This paper was written to address complaints from fixed operators in Spain that mobile operators were using on-net pricing to 'unfairly' compete with them. Gual shows that on-net pricing is an efficient and welfare enhancing strategy in this case.

Dan Elliott's paper addresses competition between mobile networks rather than between mobile and fixed operators. He addresses a question about what economic theory tells us about the conditions under which on-net discounts are welfare enhancing and those under which they are anti-competitive. In other words, how might regulators decide when to intervene and when to leave the market to work? Dan Elliott presents the modelling which is needed to solve these questions and shows that 'tipping' is only a rational strategy under very extreme conditions which rarely occur in real world markets.

Teligen were asked to use their tariff databases to examine what had happened in practice in some major European markets. They find that on-net prices have been a long standing feature of most markets, and that in the early phase of duopolistic competition they were used by both operators in the race to bring new customers into the market. Interestingly, this race did not have the 'winner takes all' characteristics of 'tippy' markets, and market shares remained reasonably symmetric throughout the period. No operator was able to use on-net discounts to force its rival out of the market, but neither did on-net discounts disappear once this became clear.

Another round of licensing then brought new entrants into the European markets from the mid-1990s onwards. These new entrants used on-net discounts, normally at deeper discounts than the existing operators. Competition between the new and existing operators took the pattern of leader-follower in all markets – with the larger networks reacting to on-net pricing moves by the smaller networks.

Teligen's findings support Elliott and Gual's view that on-net discounts are more likely to be driven by competitive pressures than the result of anti-competitive intent (or effect). Jonathan Sandbach finds no correlation between on-net discount and market concentration or network size. If anybody thought on-net discounts would limit competition in European mobile markets then the evidence presented here suggests they were wrong.

## Notes

- 1 see [http://www.ofcom.org.uk/bulletins/comp\\_bull\\_index/comp\\_bull\\_ccases/closed\\_all/cw\\_615/?a=87101](http://www.ofcom.org.uk/bulletins/comp_bull_index/comp_bull_ccases/closed_all/cw_615/?a=87101) and Spanish Competition Court ruling with respect to casefile 572/03 of 22 December 2004.

**Jordi Gual**

Chief Economist and Head of Research,  
"la Caixa"

Jordi Gual is Professor of Economics at IESE Business School (University of Navarra). He is also Research Fellow of the Centre for Economic Policy Research (CEPR, London).

During the Fall of 2000 he was Visiting Professor at the Economics Department of the University of California at Berkeley, and has been for several years the Head of the Economics Department and the Academic Director of the research centre "Public Sector-Private Sector" at IESE Business School.

Between September 1994 and September 1996 he was Economic Adviser to the Director General for Economic and Financial Affairs of the European Commission in Brussels. In 1999 he won the European Investment Bank Prize for essays on European economic affairs.

His most recent books are Integration of European Banking: *The Way Forward*, CEPR, London (2005); and *Building a Dynamic Europe: The Key Policy Debates*, Cambridge University Press, (2004).

Other recently published work includes "Integrating regulated markets in Europe" in *Subsidiarity and Economic Reform* (forthcoming in Springer-Verlag); "Time to Rethink Merger Policy" in *Competition Policy International* (2007); "An Economic Approach to Article 82" in *Competition Policy International* (2006); "Vertical industrial policy in the EU: an empirical analysis of the effectiveness of state aid" in *European Investment Bank Papers* (2006); and "Telecommunications Policies: Measurement and Determinants" in *Review of Network Economics* (2006).

## Virtual private networks and the risk of price squeezes

This report examines the economic nature of the pricing of virtual private networks (VPNs) commonly used by Vodafone and other telecoms operators in the Spanish telephony industry. The price of some calls within VPNs is set below the price of call termination charged to third parties. It has been alleged that this practice may be detrimental to competition. The objective of this report is to assess whether that is the case in light of what economic analysis has to say with regard to competition in telephony markets.

From the perspective of costs and technology, telecommunications operators are characterized by large fixed and sunk costs, related to the deployment of the network, very low variable costs and the presence of

common costs. The nature of costs leads to the appearance of non-linear pricing: price schedules such that prices decline (like average costs) with usage. Faced with competitive pressure, companies try to grab market share from competitors by capturing heavy-use consumers with price schemes that closely mimic the cost structure of the industry.

From the demand side, telecommunications markets are characterized by network externalities that arise because the users of a network derive more benefits from its use the larger the network is. In the presence of competing networks, operators will have an interest in developing this externality effect, with the goal of "endogenously" generating a larger network, and are likely to offer subscription subsidies and low

on-net call prices. When we consider groups of individuals which share social ties (ie. families, groups of friends, co-workers, etc.), we have an “exogenous” network, where the externality effect is particularly strong. Under the calling party pays principle, users will have a strong interest in the internalization of this network effect, since they care about –and often pay for– the bills of their callers. It is therefore not surprising that on-net calls tend to be much lower than off-net calls in telephony markets. Operators either try to develop “endogenously” closed user groups or communities or try to capture market share by incorporating into their client base “exogenous” networks.

The evolution of competition has led to the continuous decline of the price of voice telephony services served by mobile operators. This downward trend has modified the competitive strategies of mobile operators and they have tried to win market share through the introduction of innovative services, with the goal of better serving the needs of specific customers. The widespread use of alternative pricing plans and VPNs with expanded functionalities is a reflection of this trend.

VPN products target corporate clients with an integrated product offering that solves many of the communications needs of corporations. The product includes a variety of calls and several corporate value added services such as short-code dialling. The operators can only provide them to corporate users with closed user groups comprising a minimum number of users, since the upfront and fixed costs of virtual networks imply that the service is not viable commercially otherwise.

Overall, it appears that intense competition among the three mobile operators and customer buying power is driving this product innovation. Given the nature of supply and demand in this industry this may lead to pricing structures which, in some circumstances, could be regarded as detrimental to third parties, such as fixed network operators. In order to assess whether this is a matter of concern from the point of view of competition policy, it is fundamental to ascertain what are the drivers of the observed behaviour in the market.

There are three conceivable explanations for the observed conduct. The first two would be of concern to competition policy authorities, but the third – which is found to be supported by the facts of this case – is fully in accordance with the natural evolution of a competitive market.

## Protecting existing market power

From the analysis of the competitive situation in the mobile market, it is clear that there cannot be an issue of a dominant position enjoyed by Vodafone, which the company might be trying to protect. The market share of the company is low even in the narrowly defined market of voice telephony provided by mobile operators.

Nor is there an issue of trying to protect a hypothetical source of market power arising from call termination. The relative prices of the different services provided by mobile operators reflect the optimal markups to be charged by operators and

any excess profitability is competed away by the high level of rivalry in the overall mobile market.

## Leveraging market power into downstream markets through predation, bundling or foreclosure

Very low prices for certain services could under certain circumstances constitute a predation strategy, whereby a company with a very large share of the market attempts to expel competitors from the industry. This however, cannot be the case here, since Vodafone has a small market share in the fixed industry. In mobile origination and related mobile services the market share is larger, but far less than the one that could allow any tipping of the market. Moreover, the second stage of the predation strategy involves a price increase, which is likely to trigger new entry into the industry.

Bundling could also be a problem in telecoms if a company is both an operator of fixed and mobile telephony, but it requires strong, if not dominant, positions in both markets or a virtual monopoly in one. This is, obviously, not the case here.

Finally, foreclosure is another potential problem whenever a company that operates a network tries to increase the costs of rivals through its pricing of access. If this were to be the case with regards to the Vodafone pricing practices, we should observe that the market shares of the affected parties (fixed network operators in the fixed to mobile segment and possibly the wider fixed market), should have been declining while Vodafone's share is increasing. This has not been the case as is evident from Vodafone's very small share of fixed to mobile traffic. Finally, even if we were to observe an increase in the market share of Vodafone in the fixed to mobile segment of the industry, this need not be the result of restrictive practices and could well be the outcome of the third, procompetitive, scenario.

## Competitive outcome

The practice under investigation could also be the outcome of an attempt by the company to improve efficiency in the face of market pressures from competitors and customers. From the analysis of the evolution of the market, it appears that this is the case. VPNs are demand driven and, given the nature of costs and demand in this industry, it makes sense from the point of view of the operators to reflect their own cost structures in the pricing of these products by offering bundles of services to customers and quantity discounts. Moreover, since many of the services are complementary in use, there are significant network effects and there are a variety of customers with different market needs, it will also be economically rational and efficient for the operator to establish a diverse set of pricing plans and alternative contracts to meet the varying needs of different customers.

These pricing schedules, which are based on different combinations of fixed fees and per unit prices, accommodate the different preferences of clients and allow the legitimate



internalization of network effects by the operators, to the benefit of both the customers and the producers. The companies are rightly interested in developing these pricing schemes, since they will lead to a higher and more efficient utilization of the network.

Overall, the analysis of the market indicates that competition in the mobile segment remains vigorous. The facts of the market show that the behaviour of mobile operators is not driven by the activities of fixed operators but by fierce competition from the other mobile operators. Any potential impact on fixed operators is irrelevant to the case in hand, in any case it has been immaterial empirically, and should not be a concern of competition policy.

## 1. Summary of conclusions

This report examines the economic nature of the pricing of virtual private networks (VPNs) commonly used by Vodafone and other telecoms operators in the Spanish telephony industry. The price of some calls within VPNs is set below the price of call termination charged to third parties. It has been alleged that this practice may be detrimental to competition. The objective of this report is to assess whether that is the case in light of what economic analysis has to say with regard to competition in telephony markets.

## 2. The economics of telecoms and recent market trends in the Spanish voice telephony market

### Costs and technology

The economics of the telecoms industry determine to a large degree the nature of competition in this market and the pricing and overall competitive strategies deployed by competitors.

From the perspective of costs and technology, telecommunications operators are characterized by large fixed (and sunk) costs, related to the deployment of the network, and very low variable costs. In other words, costs are determined by the installed capacity and, to a much lesser degree, by the use of this capacity or the output (minutes of traffic) effectively provided by operators.

A second important feature of the cost structure of network operators is the presence of significant costs which are shared by the large variety of services that network operators provide. These services comprise different types of calls and, when a very narrow product definition is used, services such as call origination, call termination or access. The presence of common costs shared by different services has important implications for optimal pricing, both from a private and a social point of view.

All these technological characteristics imply that scale and scope economies are key factors that drive competition in this industry. In particular, the nature of costs leads to the appearance of special pricing practices involving both **non-linear pricing** and **differential mark-ups** across products.

**Non-linear pricing** refers to the use of pricing schedules whereby the unit price effectively paid by the user varies with the quantity of the service consumed. Two-part tariffs, where the user faces a fixed monthly charge and a per-minute fee, are examples of non-linear prices, since the cost per minute of the service diminishes as consumption increases. A similar effect is obtained with minimum monthly charges, where the tariff schedule consists of a constant per minute fee with a minimum charge that is levied if consumption falls below a certain threshold. Other pricing schemes include vouchers that provide a certain amount of minutes at a flat rate, and schemes with a sequence of vouchers, with declining flat rates for additional blocks of minutes.

These pricing schedules are the natural result of competition in the industry. Faced with increased competitive pressure, companies try to grab market share from competitors by capturing heavy-use consumers and encouraging the use of their networks. This is achieved with price schemes that closely mimic the cost structure of the industry: large fixed payments and low variable (per unit) charges, or other schedules such that prices decline (like average costs) with usage.

The cost structure of the industry has also important implications for the optimal markups that have to be applied to individual products, both from the point of view of companies as well as from the social perspective. In the presence of large fixed and common costs, it is efficient, both privately and socially, to impose larger (**differential**) **markups** for those services that face a more inelastic demand, and thus generate the revenues that contribute to the payment of the fixed and shared costs without imposing excessive distortions in terms of reduced consumption. This implies also that it will not be appropriate to assess the pricing structures of a group or bundle of services by trying to link the price of individual services included in the bundle to accounting measures of "imputed costs".

### The network externality

From the demand side perspective, telecommunications markets are characterized by the presence of network externalities. At the most general level, network externalities arise because the users of a network derive more benefits from its use the larger the network is. That is to say, when someone decides to join a network, the private benefit that she or he obtains falls short of the social benefit generated, since the individual that joins the network provides also benefits to third parties which she or he does not take into account when deciding to join.

This general statement assumes that the user joining the network was not previously connected to an alternative network. In the presence of competing networks it is clear that network operators will have an interest in developing this externality effect, with the goal of "endogenously" generating a larger network, that attracts more users. To do this, network operators are likely to offer subscription subsidies and low on-net call prices.

The general definition of network externalities assumes also that communication with the individual joining the network is valued positively by all users already connected. This need not be the case in general, but it will certainly be a very

relevant fact when we consider groups of individuals which share social ties (ie. families, groups of friends, co-workers, etc.). These social groups determine “exogenous” networks, for which the network effect is particularly strong.

The network effect becomes even more relevant if the billing system is ruled by the calling party pays (CPP) principle. When CPP is used, as in Europe, users generally do not care much about the price of call termination, since they do not pay directly for that service. This is not, however, the case within so-called closed user groups (CUGs). Within the members of a family or a company, users care for the welfare of their callers (and very often, as in families or companies, they even pay for the bills of their callers) and, as a consequence, this increases their sensitivity to the costs of terminating calls. In this case, the network externality is “internalized”.

It is therefore not surprising that on-net calls tend to be much lower than off-net calls in telephony markets. With these price differentials companies either try to develop “endogenously” closed user groups or communities (ie. this has been the strategy recently of the retailer Carphone Warehouse<sup>1</sup> in the UK and Spanish cable operators such as ONO), or try to capture market share by incorporating into their client base exogenous CUGs, such as families, groups of friends or groups of employees working for specific companies (in mobile, pricing plans target families (ie. TME’s Plus Familia) or friends (ie. Amena’s Duo) and this is of course also a feature present in many products of Vodafone targeting the business market (ie. Planes Universales and VPN). To be able to capture these customer groups, firms compete by offering pricing plans that lower the cost of on-net calls. Users recognize that most of their calls are placed within the CUG and, as a consequence, they are attracted by these price advantages. Examples of low (or even free) on net calls abound both for fixed and mobile telephony in many EU markets.

These basic economic features of telephony markets and their consequences for firm strategy are clearly detected in the recent evolution of the Spanish voice telephony market and, in particular, in mobile telephony.

#### Mobile competition

In the Spanish market there are three main providers of mobile network and retail services: Telefónica Móviles España (TME), Vodafone and Amena, although a fourth licensee (Xfera) can enter the market with the introduction of 3G services. The current market leader is TME with more than half of the market, followed by Vodafone and Amena, both with market shares below 30% (see table 1). In recent times, the third provider (Amena) has gained market share at the expense of both TME and Vodafone.

**Table 1. Spanish Mobile Market**

	Year 2000	Year 2001	Year 2002
<b>Traffic volume market share</b>			
TME	65,35%	63,72%	60,00%
Vodafone	24,32%	22,07%	25,00%
Amena	10,33%	14,21%	15,00%
<b>Customer market share</b>			
TME	56,33%	56,63%	54,90%
Vodafone	28,34%	25,75%	25,80%
Amena	15,33%	17,62%	19,30%
<b>Retail revenues market share</b>			
TME	62,18%	60,52%	57,30%
Vodafone	27,08%	25,45%	26,30%
Amena	10,74%	14,03%	16,40%

Source: CMT. Market shares refer to all retail services and not only voice.

The competitive dynamics of the industry in recent times has been characterized by the gradual maturity of the market. Competition has changed in focus, away from bringing new customers onto the networks with the use of heavy handset subsidies, and towards the competitive fight for existing telephony customers. Handset subsidies and overall customer acquisition costs have been reduced, although they continue to be substantial.

The trend towards increasing competition for existing telephony users has been reinforced by the introduction of number portability which has increased churn. The fraction of customers that changed provider in a given period has increased from 19% in 2000 to 23,45% in 2003<sup>2</sup>.

The evolution of competition has led to the continuous decline of the price of voice telephony services served by mobile operators. Revenues per minute have declined by 8% in 2001 and by 12% in 2002.

This downward trend has modified the competitive strategies of mobile operators in several directions. The companies are trying to increase revenue per customer through the development of data services (not discussed here); they are encouraging incremental usage of existing services like voice, competing fiercely on price; and they try to win market share through the introduction of innovative services, with the goal of better serving the needs of specific customers. The increased use of alternative pricing plans and VPNs with expanded functionalities is a reflection of this trend.

#### Mobile Virtual Private Networks (MVPNs)

The supply of VPNs by mobile operators follows a practice pioneered by fixed operators. VPN products target corporate clients. The objective is to provide the customer with an integrated product offering that solves many of the communications needs of corporations, with a comprehensive service that is independent of the network and infrastructure that provides the technological support.

The product includes a variety of services. The employees of the client form a Closed User Group (CUG) and the services provided include calls within the CUG, calls to and from the



CUG towards a Vodafone number, and calls to and from other mobile and fixed networks. The mobile VPN also includes, as part of the integrated service offering, fixed to mobile and mobile to fixed calls to the customer's premises, as well as the usual mobile services.

It must be emphasized that VPNs are complex products. They include not only a variety of call types but also a set of functionalities which improve the performance of corporate telecommunications networks. These features are highly demanded by corporate customers and include private numbering plans (ie. short-code dialling), users' profiles (with permission and barring), and hierarchical functionality and billing, among others.

VPNs may or may not include a direct link between the customer's PBX and the mobile network. When there is no fixed link, calls from a customer desk phone are generated as mobile calls through a mobile traffic concentrator connected to the corporate PBX. What is important to realize is that the product is fundamentally a bundle of services, including a variety of calls and value added offerings, and does not target specifically the fixed-to-mobile market or any other narrowly defined type of service.

Another key characteristic of these services is that the operators can only provide them to corporate users with closed user groups comprising a minimum number of users (handsets). This is not surprising, since the upfront and fixed costs of virtual networks imply that the service is not viable commercially unless a large volume of usage is achieved. As usual in telecoms, low per unit prices can only be provided to heavy users, when average costs are also low. This is the case in general, but more specifically for VPNs, since these products involve important upfront investments tailored to each particular corporate network.

In accordance to its basic economics, the pricing of MVPNs has been traditionally based on a combination of one-time upfront fees, fixed monthly fees and a set of per minute call charges for some, but not necessarily all, of the services offered. Nevertheless, strong competitive pressures have led to the gradual erosion of upfront and monthly fees.

### 3. The alleged practice

The alleged practice of Vodafone is to charge for mobile call termination in a business product (Virtual Private Networks) a per minute price which is below the termination price charged to operators in the wholesale market. This pricing practice is alleged to amount to a price squeeze which may exclude rivals in a downstream or related market. The market allegedly foreclosed in this way is the "market" for fixed to mobile calls for business users.

The basis for the allegation of a price squeeze is that operators seeking to offer a similar business service would need to buy a wholesale input (namely, mobile call termination in the Vodafone network), for which they face a wholesale price above the retail price and this places them at a competitive disadvantage in the downstream "market".

### 4. The observed market behaviour

Voice telephony services are provided by both mobile network operators and fixed network operators, and one may consider the extent to which mobile and fixed telephony are increasingly being considered as substitutes by consumers. In fact, the overall voice market has been growing substantially in volume (10% in minutes in 2002). It is indeed true that the share of the usage served by fixed operators has been declining (in minutes from 79% in 2000 to 72% in 2002), with a corresponding increase in the share of voice minutes served by mobile networks. However, despite the fact that the mobile market grew faster in terms of minutes by 27% in 2002, volumes in the fixed market have been still growing (5% in 2002), and it appears that the growth in mobile is still principally incremental minutes rather than substitution. Revenues per minute dropped by 7% in fixed telephony both for 2001 and 2002, which is less than the decline observed in the mobile market (8% in 2001 and 12% in 2002). The evolution of competition within the fixed telephony market led also some time ago to the introduction of so-called fixed virtual private networks (FVPNs).

As the mobile and fixed markets start to converge, mobile and fixed operators may have an interest in supplying comparable services, even if, as argued before, the products so far have been complementary. If intermodal competition develops, mobile operators will be obliged to lease or own fixed assets, in order to replicate the offers of fixed network operators and, similarly, fixed network operators may have to own mobile networks in order to be able to supply a very comprehensive service. Indeed, fixed operators may participate in the provision of mobile services through affiliated mobile companies, ie Telefonica with Telefónica Móviles and Auna with Amena, or through joint product offering<sup>3</sup>, eg Vodafone's alliances with BT, NeoSky, Telecable Asturias, Retecal and Comunitel. Alternatively, even with mobile-fixed convergence, each type of operator may decide to exploit the competitive advantage provided by the assets it owns. Mobile operators could decide, for example, to provide low on-net call charges, while fixed operators could offer corporate clients very competitive rates for fixed high capacity connectivity between several company sites.

Each of the platforms offers a different and non-coincidental set of services, combining to varying degrees mobile telephony, fixed telephony, internet access and broadcasting. There may be varying degrees of intra-platform competition (and, in this regard, mobile operators register a substantial degree of rivalry compared to other platforms), but more fundamentally it will be increasingly the case that rivalry takes place across platforms.

The offerings of the different platforms are determined by technological capabilities, the business model adopted by companies, and to a certain degree by the existing regulatory framework, which can never be entirely neutral. However, and more importantly, each platform provides a different value proposition to its customers according to customer demand. In doing so, each competitor – whether fixed or mobile – chooses different pricing strategies for its bundle of services,

with an increasing role for flat monthly payments, quantity discounts as well as pricing schemes – such as free on-net calls – which legitimately internalize network externalities in an attempt to increase the customer base.

It must be stressed also that mobile operators have always used fixed elements to provide their mobile services (eg. fixed backhaul circuits from radio base stations to the mobile switching centre) and mobile VPN services, likewise, use various fixed network components in the provision of mobile services. The fixed to mobile element is a small part of the whole corporate package, which is predominantly a mobile package and generally complements a fixed VPN offering. In fact, many corporate customers have both fixed and mobile VPNs, and this reinforces the idea that the introduction of mobile VPN is not the result of an attempt to obtain market share in the fixed-to-mobile market, but rather the consequence of strong competition between the three mobile operators.

As reviewed above, this strong competition has led to rapid drop in revenues per minute, 12% in 2002, ahead of the drop in prices of fixed operators. Low on-net prices and, in particular, low within-CUG prices translate in lower per call revenues for the mobile suppliers. They reflect, thus, increased competition and the fact that the operators are obliged to offer these deals to sophisticated corporate clients<sup>4</sup> while offering at the same time a whole new set of enhanced services. These clients are heavy users of voice telephony services. It is therefore not surprising that they are requesting from providers an overall lower per minute price and, in particular, that they are able to request low on-net prices which allow them to internalize the call externality built in to the Calling Party Pay system without the need to build a physical private network (whether fixed or mobile).

Overall, it appears that intense competition among the three mobile operators and customer buying power is driving this product innovation. Given the nature of supply and demand in this industry this may lead to pricing structures which, in some circumstances, could be regarded as detrimental to third parties, such as fixed network operators and which may increase the degree of inter-modal competition in the future. In order to assess whether this is a matter of concern from the point of view of competition policy, it is fundamental to ascertain what are the drivers of the observed behaviour in the market.

## 5. Possible explanations for such behaviour

Whether the observed behaviour is anti-competitive or not will depend on the reasons and circumstances that lead the mobile operators, and in particular Vodafone, to offer these services, with their specific pricing structure. There are three conceivable explanations for the observed conduct:

- Is Vodafone developing this type of products in order to protect a current source of market power that the company may enjoy in the overall mobile market? Or, more specifically, could the company be trying to

protect the market power derived from the control of mobile call termination in its own network?

- Is Vodafone engaging in these practices with the goal of leveraging its market power in those areas (for example through predation, bundling or foreclosure), in order to obtain a dominant position in other related markets, such as any putative fixed to mobile calls market or the wider fixed market?
- Or, alternatively, are these offers the result of product innovation which benefits customers, is demanded by clients and is consistent with the industry achieving increased efficiencies in the operation of its networks?

### Protecting existing market power

From the analysis of the competitive situation in the mobile market, it is clear that there cannot be an issue of a dominant position enjoyed by Vodafone, which the company might be trying to protect. The market share of the company is low even in the narrowly defined voice telephony market provided by mobile operators, and, in fact, that market share has been declining slightly recently. Indeed, the practices under investigation are precisely the result of strong competition between the three mobile network operators, which compete for clients once the market has achieved a high degree of penetration.

Nor is there an issue of trying to protect a hypothetical source of market power arising from call termination. The prevailing “calling party pays” principle has led to a pricing structure for mobile services which results in relatively higher prices for mobile termination compared to some of the prices charged for other services included in the mobile bundle (i.e. call origination). This fact has led regulators to argue that there may be opportunities for excessive pricing in call termination and that risk is being dealt with by means of “price cap” regulation in many jurisdictions, including Spain.

It must be emphasized, however, that high charges for an individual service in the group of services offered by mobile operators is by no means an indication of market power. As argued before, the relative prices of the different services reflect the optimal markups to be charged by operators (with relatively higher markups in those services with more inelastic demand) and any excess profitability will be competed away if there is sufficient rivalry in the overall mobile market. This has been the case in mobile telephony, where the profitability obtained in specific services such as call termination has been lost in the expensive process of customer acquisition. This reflects the competitive dynamics of the industry, where it is important to build market share and retain customers through the continued supply of upgraded handsets at subsidised prices and expensive customer loyalty programs. Note also that if call termination prices are a source of profitability and market power, it is certainly a reflection of increased competitive pressures if these termination rates are reduced for the customers with the greatest buying power – as is the case when business customers pay very low on-net prices under MVPN tariffs to terminate calls to mobile handsets. A monopolist would certainly prefer to charge the full markup to all clients for this particular type of “bottleneck service”.

Finally, even if we were to consider the prices on call termination as a potential reflection of market power, it has to be highlighted that excessive pricing is not the issue here, since this has never been contemplated in the allegations of the Spanish competition authorities.

#### Leveraging market power into downstream markets through predation, bundling or foreclosure

It is certainly the case that predation, bundling and foreclosure strategies are practices which could be anti-competitive in telephony markets. However, they are not present in this particular case.

Very low prices for certain services could under certain circumstances constitute a **predation** strategy, whereby a company with a very large share of the market attempts to expel competitors from the industry. This could happen in telecommunications in extreme cases, since the characteristics of the industry (both on the supply and the demand side of the market) could lead to a tipping of the market. However, the case presented here is not a predation case, since Vodafone has a small overall market share in the industry. This is the situation in particular in the fixed-to-mobile segment and in the wider fixed market (see table 2 below). Note also, that the narrowly defined fixed to mobile market is precisely the focus of the complaint on the alleged anti-competitive behaviour of Vodafone.

In mobile origination and related mobile services the market share is larger (see table 1 above), but far less than the one that could allow any tipping of the market. Moreover, predation is a strategy which is unlikely to be successful in this industry. In the event that a competitor is expelled from the market (unlikely as TME and Amena are strong competitors), the second stage of the predation strategy involves a price increase, which is likely to trigger new entry into the industry, whether of fixed operators or of mobile operators. In this last case, in the event that a competitor runs into financial difficulties, this may lead to the exit of a rival, but need not lead to a reduction of the installed capacity since the mobile licence and the network would not disappear, but in all likelihood be bought by a new owner at a fraction of its cost, thereby creating a stronger new competitor.

**Bundling** could also be a problem in this industry if a company is both an operator of fixed and mobile telephony, but it requires strong, if not dominant, positions in both markets or a virtual monopoly in one. If the company has

a very dominant position in fixed telephony, bundling fixed and mobile services could be a practice which excludes competitors from the mobile market, since the dominant firm could leverage its position in one market and extend it in the other through the offer of products which could not be replicated by competitors. The bundling problem is not an issue in this case, however, since Vodafone does not have a large market share in any of the two markets involved and any attempt to bundle services can be replicated easily by other mobile operators.

**Foreclosure** is another potential problem whenever a company that operates a network tries to increase the costs of rivals through its pricing of access. It must be noted, though, that in the case of call termination in the Spanish market, instead of increasing prices had dropped by 15% between 2000 and 2002, when price regulation was introduced. It is true, however, that differential termination prices could erode the competitive position of rivals in related markets. If this were to be the case with regards to the Vodafone pricing practices, we should observe that the market shares of the affected parties (fixed network operators in the fixed to mobile segment and possibly the wider fixed market), should have been declining while Vodafone's share is increasing. This has not been the case as is evident from Vodafone's very small share of fixed to mobile traffic, and therefore, it appears that the company is not attempting or able to increase (an already low) market share in the fixed to mobile segment of the industry (see table 2 below). The only explanation must be that there has been no such leverage (or perhaps that there was no dominance in the first place, and therefore no actions that were trying to protect or extend dominance)<sup>5</sup> Finally, even if we were to observe an increase in the market share of Vodafone in the fixed to mobile segment of the industry, this need not be the result of restrictive practices and could well be the outcome of procompetitive behaviour, as we will see next.

#### Competitive outcome

The practice under investigation could also be the outcome of an attempt by the company to improve efficiency in the face of market pressures from competitors and customers. From the analysis of the evolution of the market, it appears that this is the case here. This product is demand driven – corporate customers want the economics of a private network (lower ongoing variable costs in return for higher upfront or

**Table 2. Vodafone market share in the fixed markets**

	Year 2002	Full Market (1)	Vodafone (2)	Vodafone Market Share
<b>Lines (Thousands)</b>	Fixed Lines	17.641,00	125,91	0,71%
	Corporate Fixed Lines	2.998,00	82,52	2,75%
<b>Minutes (Million)</b>	Fixed Minutes	126.577,00	313,89	0,25%
	Corporate Fixed Minutes	52.149,72	115,95	0,22%
	F2M Minutes	7.564,05	32,46	0,43%
	Corporate F2M Minutes	3.116,39	20,96	0,67%

#### Notes:

General: Indirect (including preselection) and direct access included.

(1) Source: CMT 2002 Report.

(2) Source: Vodafone answer to CMT request for the annual report elaboration.

fixed costs and increased functionality). First fixed and then mobile operators have tried to satisfy this demand through virtual private networks using tariffs rather than physical private networks because of cost of build and duplication of existing infrastructure. Vodafone's mobile VPN product is simply a mobile copy of the fixed product that was developed by fixed operators like Telefonica. Cheap or free on-net calls are an integral part of a VPN product for customers and without them the product would not exist and an identifiable and substantial demand from business customers would not be met.

Indeed, as argued in section 2 above, given the existence of large fixed up-front costs, low marginal costs and significant scope economies, it makes sense -from the point of view of the operators- to reflect their own cost structures in the pricing of services by offering bundles of services to customers and quantity discounts. This is the same for both fixed and mobile telecoms services.

Moreover, since many of the services are complementary in use, there are significant network effects and there are a variety of customers with different market needs, it will also be economically rational and efficient for the operator to establish a diverse set of pricing plans and alternative contracts to meet the varying needs of different customers. A customer who buys 1000 minutes a month will clearly want a different tariff to the occasional caller who buys just 10 minutes a month.

These pricing schedules, which are based on different combinations of fixed fees and per unit prices, accommodate the different preferences of clients and allow the legitimate internalization of network effects by the operators, to the benefit of both the customers and the producers. The companies are rightly interested in developing these pricing schemes, since they will lead to a higher and more efficient utilization of the network.

Economic efficiency is improved, thus, on both accounts. On the demand side, non-linear tariffs allow the satisfaction of customers with different demands and willingness to pay for different amounts and types of telephony services. On the supply side efficiency is improved also, since the fixed network costs are financed through fixed fees unrelated to consumption, and this implies that per unit fees get lower when average costs also drop. To effectively outlaw such products would drastically reduce efficiency and customer choice for both mobile and fixed services and, most importantly, increase prices.

Overall, the analysis of the market indicates that competition in the mobile segment remains vigorous. The facts of the market show that the behaviour of mobile operators is not driven by the activities of fixed operators but by fierce competition from the other mobile operators. Any potential impact on fixed operators is irrelevant to the case in hand and should not be a concern of competition policy or regulation.

## Notes

- 1 This company has a product "TalkTalk" which offers free on-net prices. Other examples of extremely low on-net prices include Telfort (Netherlands), Meteor (Ireland) and Orange (Denmark).
- 2 Information provided by Vodafone Spain. It corresponds to Vodafone customers.
- 3 Related mobile-fixed deals were announced in May 2004 in other markets. In the USA between ATT and Sprint, and in the UK between BT and Vodafone.
- 4 The countervailing buyer power of business customers has been one of the factors considered by the UK regulator Ofcom in its recent decision on some UK pricing practices similar to the ones analysed in this article. The UK regulator finds that the practices do not constitute an abuse. Apart from buying power, other key determinants that lead to this conclusion are the extent of rivalry in the overall mobile market and the fact that the practices do not appear to have had any material effect in the market (Ofcom, Case: CW/00615/05/03, 21 May 2004).
- 5 The failure to win substantial market share could also be the result of an aggressive competitive reaction by the incumbent fixed network operator. If that is the case, it is certainly a reflection of a competitive environment,


**Dan Elliott**

 Director,  
Frontier Economics

Dan Elliott is a founder Director of Frontier Economics Ltd, with over 18 years experience as a consulting economist. He is a leading expert in the field of regulatory and competition issues in network industries, in particular focusing on the telecommunications, water and transport sectors. He has worked on modelling the competitive implications of complex tariff packages in telephony markets and has been advising on regulatory issues in the UK water sector since 1989. Dan has also worked with companies on all of the major Competition Commission cases in the sector and has in-depth understanding of tariff issues and detailed practical experience in economic modelling and investment appraisal for a range of industries.

## Two-way access charges and on-net/off-net differentials<sup>1</sup>

What are the incentives on operators and can large MNOs use high access charges to foreclose the market?

*This paper presents a discussion of two-way access charging in the context of mobile phone networks. I examine the determinants of access charges and price differentials between on-net and off-net tariffs. I consider the welfare implications of above-cost access charges and on-net/off-net differentials and the potential for larger networks to use high access charges as a means of foreclosing their markets. In doing so, for the first time, I compare the relative magnitude of the different effects identified in the literature so as to identify which effects are most important in driving MNOs behaviour. In addition I use a simulation model to extend the results so far presented in the literature to more complex combinations of factors, including on-net/off-net differentials in the presence of a variable consumer participation rate.*

In many, but not all countries, M2M access charges are set at a level in excess of cost<sup>2</sup> and mobile phone customers have to pay higher charges to call subscribers of different mobile networks ("off-net" calls) than to call other subscribers on their own network ("on-net" calls). Such behaviour raises questions regarding the incentives on mobile networks to set efficient M2M access charges and the impact that on-net off-net price differentials have on consumer welfare.

There is a considerable and growing academic literature on the issue of pricing between competing mobile networks. The earliest work in this area was by Armstrong (1998)<sup>3</sup> and Laffont, Rey & Tirole (LRT, 1998)<sup>4</sup>. Both papers show

that networks can use their reciprocal access charge as an instrument of collusion: by raising each other's costs they can dampen the effects of competition between them and thus raise their profits. In addition to this basic result, LRT relax some of the initial assumptions, and in doing so call the collusion result into question. Under more realistic assumptions it appears that networks do not have incentives to drive up reciprocal access charges. LRT and other papers published to date typically indicate that mobile operators would prefer to set reciprocal M2M access charges (and thereby off-net retail charges) at cost<sup>5</sup>. LRT show that Armstrong's result is special to the case where networks are not able to charge any form of fixed rental charge (which would include periodic handset charges for pre-pay customers). Further work (Gans & King (2000)<sup>6</sup>), actually suggests that it may be profit maximising to set call termination charges and retail off-net charges below cost when operators can discriminate between the retail price of on-net and off-net calls, while Carter and Wright (2003)<sup>7</sup> suggests that when networks are of unequal size it is the larger network that has the stronger incentive to set termination (and off-net retail charges) at cost.

However, despite the developments in the academic literature, a relatively recent phenomenon in discussions between national telecoms regulators is that it seems to



be becoming accepted both that mobile networks have an incentive, if left unregulated, to set high reciprocal M2M access charges and furthermore that differential on-net and off-net pricing can be used as a foreclosure mechanism by large operators against smaller competitors.

The fear of foreclosure is often expressed in one of two ways. The first is summarised by the European Regulators Group of National Regulatory Authorities (the ERG) in its consultation on appropriate remedies under the new EU framework<sup>8</sup> The ERG puts the case that low on-net and high off-net charges generate “tariff mediated network externalities” for the customers of the larger network and thus put small networks with few participants “at a disadvantage”.<sup>9</sup>

The second way the problem is expressed concern is summed up by the Irish regulator, Comreg, in its notification to the EC on call termination.<sup>10</sup> This document suggests that M2M access charges could be raised to “directly influence the retail tariffs of competitors in the mobile market and could cause potential margin squeeze issues”.<sup>11</sup>

The argument runs as follows: setting the M2M access charge above cost means that off-net calls are more expensive than on-net calls. Comparing a large network with a smaller competitor it is to be expected that the customers of the large network will make proportionately more on-net calls than the customers of the smaller network. Hence subscribers to the smaller network experience a higher average call charge. This is the “disadvantage” to which the ERG refers.

The margin squeeze argument is essentially the same: a new subscriber wishes to call existing subscribers on the larger network. If call termination charges are set above cost then the large network will charge the new subscriber less to call their existing subscribers than it would cost the smaller network to connect a call to that customer. Hence the idea of margin squeeze.

I will address both these points specifically later. However, I need first to address the fact that these statements are based on a partial analysis of the determinants of access charges between competing networks, their impact on retail charges and their impact on the intensity of competition between the networks. The fact that the results of more detailed models seem not to have made an impact on the policy debate results, to some extent, from the fact that the theoretical literature in this area is complex, highly mathematical and difficult for a non-technical audience to follow.

To understand fully the relationship between two-way access charges and on-net/off-net differentials it is necessary to think rigorously about the interaction between these factors. In this note I summarise the key findings from the literature on “two-way” access charges so as to build up an overall picture of the determinants of access charges and on-net/off-net price differentials. This summary shows that there are many effects on access charges and that these may drive access charges in different directions.

Drawing practical inferences for access charges requires us to understand the relative magnitude of the different effects and how they combine. Therefore Frontier has designed a flexible simulation model that I use to compare the relative

magnitude of the different effects identified in the literature so as to identify which effects are most important in driving MNOs behaviour. In addition I use the model to extend the results so far presented in the literature to more complex combinations of factors, including on-net/off-net differentials in the presence of a variable consumer participation rate.

## Summary of Conclusions

I show that there are many influences on both the profit maximising and welfare maximising<sup>12</sup> level of access charge. It cannot be relied upon that the profit maximising and welfare maximising levels of access charge will coincide or that cost-based access charges will maximise consumer welfare.

The result showing a collusive outcome for two-way access under linear retail tariffs appears to have dominated the policy debate about two-way interconnection, in spite of (perhaps because of) the fact that this model is very simple and in spite of the fact that subsequent work in the area has shows that this conclusion appears to be special to the very restricted assumptions on which it is based. More realistic models do not produce this collusive result.

The review I present below shows that:

- If networks compete using rentals and call charges then the joint interest in driving up reciprocal access charges evaporates.
- While LRT derived the profit neutrality result, it seems that this too is quite a special case. Allowing for either an endogenous market size or asymmetry in the sizes of networks creates an incentive for the networks to set a cost-based reciprocal access charge to maximise profits. However, modelling indicates that this incentive may not, in practice, be very strong.
- By contrast, it seems that differential on-net and off-net tariffs have a dramatic impact on the dynamics of the market. Tariff mediated network externalities (TMNEs) have a dynamic impact, intensifying competition, reducing profits and increasing consumer surplus. Given the chance, therefore, even larger networks would choose low reciprocal access charges, possibly even “bill and keep” to reduce the intensity of competition for these subscribers.
- The dynamic effect of TMNEs on the intensity of competition reveals that the idea of the “waterbed” effect between access charges and profits is overly simplistic. The key factor for the waterbed effect is not the intensity of retail competition but rather how much that intensity is affected by the access charge. The example of M2M access reveals that the waterbed can be more than 100% effective, even if the retail market is imperfectly competitive.
- Forcing up reciprocal access charges is an expensive way for a large operator to attempt to gain market share. Unless it can completely exclude the competitor from the market the large network will simply doom itself to perpetual and significant damage to its profits in doing so. Moreover, in most circumstances it can be shown



that simply cutting retail prices would be a much more “cost effective” predatory strategy.

- In the presence of externalities it does not follow that cost-based access charges are appropriate for maximising total welfare. Furthermore, in many circumstances above-cost access charges have the effect of increasing the welfare of consumers, albeit at the expense of the networks, by intensifying inter-network competition.
- Allowing the participation rate to vary strengthens the effect on competition of above-cost access charges (and hence increases further the consumer benefit they create) but mitigates to some extent the desire for MNOs to reduce access charges to zero.

My conclusion is therefore that, on the basis of the types of models considered here, there is no clear incentive for mobile networks to set high reciprocal access charges. Furthermore, it does not appear that larger networks gain any particular advantage as a foreclosure strategy from attempting to force up reciprocal access charges.

By contrast, mobile networks in most circumstances have an incentive to set access charges at or below cost while welfare maximising levels can be expected to be above marginal cost either to allow the exploitation of network externalities (in whose presence total welfare may be enhanced by above-cost access charges) or to accentuate competition between networks (in which case total welfare may not be increased, but consumer surplus certainly is).

The policy implications that arise from these results would appear to be as follows. First, before any other measures for regulating M2M access charges are considered, a requirement of reciprocity should be placed on all operators.

Secondly, neither prohibiting on-net/off-net differentials (to the extent that these reflect underlying access charges) nor mandating cost-based access charges is necessarily in the interests of consumers. If access charges are currently above cost then prohibiting on-net/off-net differentials has the effect of softening competition, increasing profits and reducing consumer surplus. This follows because prohibiting on-net/off-net differentials saves the networks from the intense competition to which they are subjected by network price differentials.

Conversely, setting access charges above cost (combined with on-net/off-net differentials) actually increases consumer surplus even in the absence of network externalities, because of the impact that higher access charges have on the intensity of competition.

## What determines M2M access charges?

There are a number of articles investigating the two-way access problem. These have generally been written to examine the impact of particular factors on the profit or welfare maximising access charge and therefore do not attempt to model the “real” situation in mobile markets. In the following discussion I review the results of the major articles in the literature. However, in most cases these

articles present purely algebraic analysis, which identifies equilibrium conditions but gives little or no insight into the relative magnitude of the effects identified or how they might combine in a more comprehensive model. To address this, Frontier has designed a flexible simulation model that can be used to quantify the effects identified in a framework that applies common empirical values. By using this model I am able both to appraise the relative magnitude of different effects but also to extend the academic analysis by modelling more complex combinations of factors than can be feasibly handled algebraically.

### Competition through linear tariffs

The earliest and in many ways best known contribution to this literature came from Armstrong (1998). This paper sets the standard framework for modelling imperfect competition between networks. In this paper consumers are assumed to choose between two mobile networks within a “Hotelling” framework.<sup>13</sup> The networks compete to provide the highest possible level of consumer surplus.

Armstrong assumes that the networks can only charge a uniform linear call price for all calls, regardless of whether they are on-net or off-net calls. Importantly, Armstrong assumes that the networks cannot charge subscribers a fixed rental; hence all competition takes place through the linear call prices.

Under these circumstances, Armstrong finds that the networks can increase their equilibrium profits by agreeing a reciprocal access charge in excess of cost. This is Armstrong’s key result, that *networks can use their reciprocal access charge as an instrument of collusion: by raising each other’s costs they can dampen the effects of competition between them and thus raise their profits*.<sup>14</sup>

This result is illustrated in Figure 1 from my model, which graphs total profits as a function of the access charge under Armstrong’s assumptions.

Figure 1: Collusive outcome with linear pricing



Source: Frontier model

However, before we assume that this result might have general applicability to real situations it is worth outlining the simplifying assumptions Armstrong makes:

- networks cannot charge subscribers a fixed rental charge, this would include any charge not variable with usage, neither a monthly rental charge nor a periodic charge to replace the user’s handset;

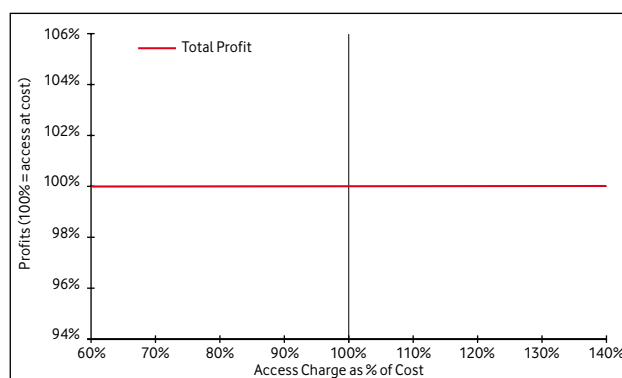
- networks cannot charge subscribers a different on-net and off-net call charge;
- the networks are symmetric: in equilibrium they will be the same size, and they know this fact when they choose their tariffs;
- the level of subscription is fixed: all possible subscribers are assumed to join one of the two networks so the level of charges has no effect on market penetration;
- there are no network externalities: the level of calls made by each subscriber is independent of the total number of subscribers. If the volume of calls made by each subscriber depends on the total number of subscribers in the market then there are externalities that may affect the profit and welfare maximising outcome;
- all subscribers are the same: the marginal subscriber is the same as the average subscriber, hence there is no reason for networks to offer different packages to different customers (i.e. to engage in second degree price discrimination).

Subsequent papers have attempted to relax several of these assumptions.

### Rentals

Laffont, Rey and Tirole (LRT 1998) introduce rental charges (but keep the other simplifying assumptions, including, importantly, equal on-net and off-net prices). They find two important results. *First, under these circumstances calls are priced at (perceived) marginal cost. Secondly, they find that network profits are independent of the level of the access charge.* The first result (calls priced at marginal cost) is common to virtually all models with two-part tariffs. The second result shows that the "raise each others costs" result is special to the case where rental charges are not possible. However, LRT's profit neutrality result leaves ambiguous where the networks would choose to agree a reciprocal access charge. The output of the model under LRT's assumptions is shown in Figure 2.

**Figure 2: Profit neutrality result with two-part tariffs**



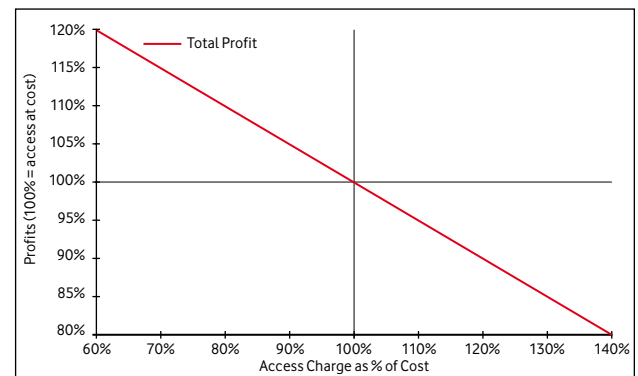
Source: Frontier model

### On-net/off-net differentials

LRT's model was further generalised by Gans & King (2000) by the introduction of differential on-net and off-net call charges. This paper also finds that it is profit maximising for networks to price calls at marginal cost. Hence if the access charge exceeds cost then off-net call charges will be higher than

on-net charges, but if access is priced below cost then on-net charges are set *higher* than off-net charges. Gans & King find a result that at first sight seems surprising: *the level of access charge that maximises network profits unambiguously lies below cost.* Indeed Gans & King show that under almost all likely circumstances joint profits will be maximised by networks agreeing a "bill and keep" arrangement.<sup>15</sup> Joint profits under the Gans & King assumptions are illustrated in Figure 3.

**Figure 3: The effect of access charge on profits with network price discrimination**



Source: Frontier model

The first thing to note is that the effect of varying the reciprocal access charge on profits is not only the reverse of that shown by Armstrong but the impact on profits is much greater.

Gans & King refer to this effect as networks using bill and keep to "soften competition". This result casts light on *several* key drivers of network competition.

- The first is the effect of tariff mediated network externalities (TMNE). The ERG paper referred to previously talks about TMNE in terms of favouring large networks over small ones. While this is true in a static sense, it ignores the *dynamic* effect of TMNE. For any *given* relative size of networks (in the Gans & King case they are assumed to be symmetric) setting access charges above cost drives up off-net call charges, which creates positive TMNE. The existence of these TMNE means that *both* networks have a strong incentive to increase their market share to benefit from these externalities. Thus setting access charges above cost results in networks competing more ferociously to gain market share. This intensifying of competition *reduces* joint profits. However the reverse also applies if access is priced below cost: in this case off-net calls are priced below on-net ones *and* the networks make a loss on every incoming off-net call, thus creating negative TMNE. In these circumstances both networks actually have an incentive to reduce market share in order to gain from TMNE. Thus they compete less aggressively. In conclusion, therefore, setting access charges above cost may favour larger networks to some extent, but misses the point that access charges above cost make networks compete harder with each other, while access charges below cost make them want to compete less hard. Thus, given the choice, competing networks would want to avoid high two-way access charges *regardless* of their effect on equilibrium market shares.

- The second point picks up from this conclusion: the key phrase is “given the choice”. It has to be recognised that it is difficult to treat a model like Gans & King’s seriously from a policy-making perspective when its conclusions appear to differ so strikingly from what is observed in practice. Clearly it is the case that in markets pricing by CPP<sup>16</sup> two-way access charges are typically above cost; bill and keep is the exception, not the rule. However it is critical to understand that competition between networks can be expected to arrive at some form of “Nash Equilibrium” at which neither network can increase its profits by *independently* changing its prices. Gans & King show that if networks have no choice but to set a reciprocal access charge then they would prefer bill and keep. However, if either network is free to set its termination charge independently it is easy to show that the Nash equilibrium is for both networks to set access charges above cost, because at a low access charge either network can gain temporarily by cheating and raising their access charge to the other network.

- The final point to be highlighted by Gans & King relates to the interaction between access charges and competition in the market (in truth this is also highlighted by the original linear pricing models). In models of imperfect competition the relationship between prices and costs depends on the strength of competition between the parties. In a Cournot oligopoly model (in which competition occurs in quantities) the number of players in the market determines the strength of competition. However in models of the type being discussed here, which are forms of “differentiated Bertrand” models, competition occurs in prices and the relationship between prices and cost is a function of the degree of differentiation between the competing firms. In a simple differentiated Bertrand model differentiation is an exogenous factor in the model. However, what these models show is that when competing networks charge each other for two-way access the level of the access charge affects the terms of competition between them. Competition can be stronger or weaker depending on the level of access charges. In a “first best”, perfectly competitive world consumer surplus is typically maximised when prices equal marginal cost. In the case of competition between networks it is reasonable to assume some degree of imperfect competition as being necessary to recover fixed and common costs.<sup>17</sup> In this case the consumer surplus generated will depend on the intensity of competition in the market: the more intense the competition the nearer the higher will be overall welfare.

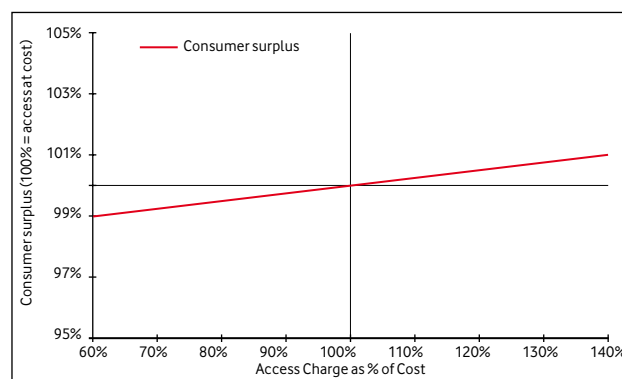
The significance of these observations for two-way access pricing is that in an imperfectly competitive market consumer surplus will depend on the strength of competition, while the strength of competition itself depends on the access charge. Hence it cannot be taken for granted that consumer surplus is maximised by setting access charges equal to marginal cost (or by having equal on-net and off-net call charges).

Gans & King conclude that regulators might be happy to allow networks to choose bill and keep, because at least it avoids the problem of high access charges. However, they do not

discuss the welfare implications of this proposal. Because of the effect of access charges on the intensity of competition, Gans & King’s model predicts that consumer surplus *increases* with the access charge. The implication is therefore that setting an access charge above cost can actually benefit consumers, because the effect of more intense competition outweighs the inefficiency resulting from pricing calls above their true marginal cost.<sup>18</sup>

The effect of the access charge on consumer surplus in the Gans & King model is illustrated in Figure 4 below. It should be noted that the impact on consumer surplus of varying the access charge is much weaker than the effect on profits.

**Figure 4: The effect of access charge on consumer surplus with network price discrimination**



Source: Frontier model

The importance of these results cannot be under-estimated because they call into question many of the concerns that regulators have about two-way access charges being above cost.

It is also worth noting in passing that these results show that simple regulatory arguments about the “waterbed effect” have little basis in a proper theory of imperfect competition. The term was coined by the UK Competition Commission when considering how much of any movement in F2M access charges would be passed on to retail customers in the mobile market.<sup>19</sup> However the concept is equally applicable to the case of M2M access charges.

The Competition Commission argued that if the outbound market is imperfectly competitive then the mobile operator will retain a proportion of any increase in F2M access charges above cost, indeed an entire chapter of welfare analysis was based on this presumption. This argument is profoundly flawed. As I have shown, if the level of access charge (F2M or M2M) does not affect the intensity of competition then equilibrium profits will be invariant to the level of the access charge irrespective of the extent to which outbound competition is imperfect. Thus in the Competition Commission’s terms the waterbed will be 100% effective. However, if the access charge does affect the intensity of competition then equilibrium profits will change. But as the intensity of competition could (in theory) increase or decrease as access charges increase it is clear that the waterbed effect is not limited by 100%. Gans & King show that with tariff differentials and Hotelling competition the waterbed effect from M2M access charges could exceed 100%. That is, an increase in access charges is more than fully passed on to subscribers because of the intensifying of competition.

## Network asymmetry

The examples discussed so far all assume that the two competing networks are symmetric. Hence, in equilibrium, they will both have 50% market shares and will charge equal prices. Carter & Wright (2003) extend LRT's model into the case of asymmetric networks.

In this model it is assumed that, due to brand reputation or some other property, one of the two networks provides subscribers with an additional benefit of membership. As a consequence, if the two networks charge equal prices, the network that offers this additional benefit will have a larger market share.

This model is interesting both because it starts to examine how the interests of small and large networks may differ in setting access charges but also because it is the first model I have discussed in which it is possible for there to be an imbalance in interconnection traffic in equilibrium. Under these assumptions it is easy to show that it is still efficient to price calls at perceived marginal cost:<sup>20</sup>

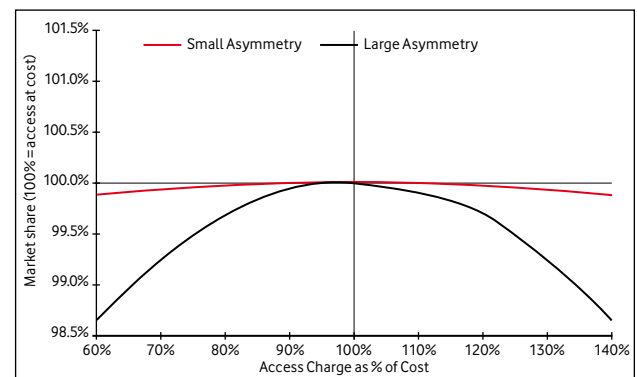
If the access charge is set above cost then both networks will charge more than cost for calls. However, the larger network charges will charge a lower average call charge because a smaller proportion of the calls its customers originate will be terminated than the other network. Because the larger network charges a lower call price, its subscribers will make more calls than the subscribers of the smaller network. As a result the larger network will also incur an interconnection deficit.<sup>21</sup> So setting access charges above cost appears to benefit the larger network because it can charge lower call charges than its rival, but the interconnection deficit this creates works *against* larger networks wanting above cost access charges as they create an interconnection deficit, because it loses money on this deficit. The equilibrium outcome will be the trade off these two effects.

Carter & Wright find that *in these circumstances the profit neutrality result of LRT breaks down and the larger network will always strictly prefer to set a reciprocal access charge at marginal cost. By contrast setting access at cost minimises the smaller network's profits provided the asymmetry is not too great. For more extreme asymmetry between the two networks, the smaller network also maximises profits with a reciprocal access charge at cost. Consumer (and total) surplus is maximised by cost-based access charges.* In this model, if access is priced above cost, the larger firm experiences a traffic deficit, which gives it an incentive to reduce access charges, whereas if access is priced below cost it experiences a surplus on which it loses money, so it has an incentive to raise access charges. The converse is true for the smaller firm. If access is priced above cost it experiences a profitable surplus. However, as access charges rise it loses market share. Provided the smaller network is not too small the first effect outweighs the second, but for a very small network the loss of market share outweighs the profit from termination, leading it to prefer cost-based access charges.

These effects are shown from the results of Frontier's model below. I note that there are two effects, one on market share and one on traffic surpluses and deficits. However the effect on market share is not simply that the larger network takes an

increasing market share if access is priced above cost. In fact, it is possible to show that in equilibrium the smaller network maximises its market share with cost-based access charges and loses market share to the larger network for *high or low* access charges. This is illustrated in Figure 5 below. This figure shows that the greater the initial asymmetry between the two networks the greater is the impact on the smaller network's market share of a divergence of access charges from cost. When the networks are close in size the effect on the smaller network's market share is negligible. However, for larger asymmetries the smaller network loses proportionately more market share when access diverges from cost.

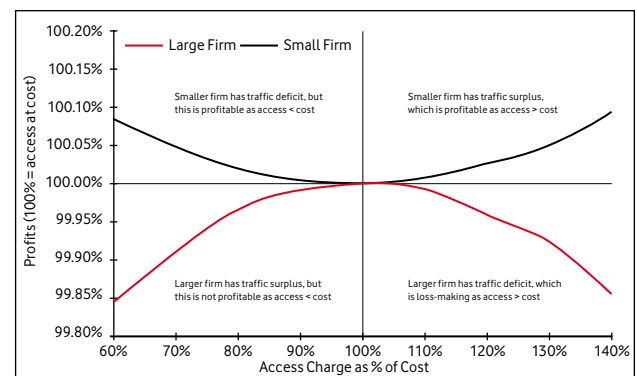
**Figure 5: Effect of access charge on smaller operator's market share**



Source: Frontier model

It is the impact on the smaller network's market share for different degrees of asymmetry that drives Carter & Wright's results. Figure 6 shows that the variation in profits – resulting from the size differences between networks – is small (as in the red line in Figure 5).

**Figure 6: The effect of access on profits with small asymmetry**



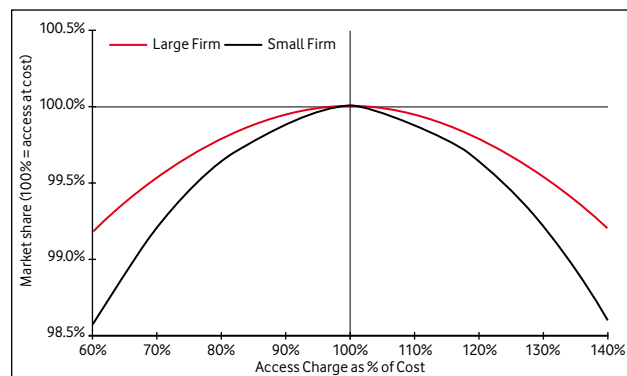
Source: Frontier model

Figure 6 shows that when the asymmetry is small, the interests of the two networks diverge. This is because the market-share effects of varying access charges are small, so the results are dominated by the effect of traffic imbalances.

This result is tested in Figure 7, where I model the impact of different access charges with a more extreme asymmetry (that leads to 83/17 market shares when access is priced at cost – the black line in Figure 5 above). This shows that with greater asymmetry the sensitivity of profits is greater but still extremely small compared to the effects identified by Gans

& King<sup>22</sup> Furthermore, Figure 7 shows Carter & Wright's result that with asymmetry greater than 67/33 the smaller network *also* prefers cost-based reciprocal access. In this case the loss of market share for the smaller firm from varying access charges from cost outweighs the benefit the smaller network gets from profits on interconnection.

**Figure 7: The effect of access on profits with significant asymmetry**



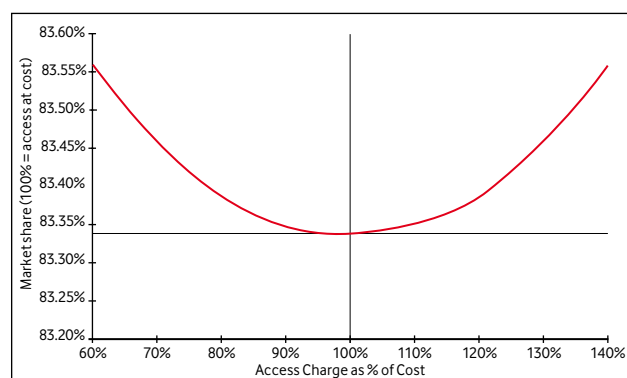
Source: Frontier model

These results strongly suggest that the effect of asymmetry between networks on equilibrium access charges is extremely small compared to the impact of on-net/off-net differentials.

#### The possibility of foreclosure in the Carter & Wright model

In the context of suspicions of the use of high access charges for predation whether, under Carter & Wright's model, a large operator could increase its market share by driving up (or down) the reciprocal access charges (which it might arguably be able to do as a result of greater bargaining power). In Figure 5 I have already shown that setting the reciprocal access charge either above or below cost can reduce the smaller network's market share. Figure 8 below shows the equivalent market share figures for the larger network under the more extreme assumption of asymmetry.

**Figure 8: Effect of different levels of access charge on larger operator's market share**



Source: Frontier model

This demonstrates clearly that varying the access charge has a very small impact on the larger network's market share, even when the initial asymmetry is great. Furthermore, its market share is not strictly increasing with the access charge, rather it is minimised at the profit maximising point.

Further sensitivity tests with the model indicate that given an initial asymmetry of 95/5, setting an access charge of twice cost would only increase the larger network's market share from 95% to 96%. To put this in context as a credible strategy for foreclosure, the larger network could achieve the equivalent increase in equilibrium market share by reducing rental charges by 1% relative to their profit maximising level.

I have also tested this result for different values of the parameter that determines the intensity of inter-network competition and conclude that for values that allow an equilibrium to exist<sup>23</sup> the impact of the access charge on market share under this model is very small indeed.

I conclude therefore that exploration of Carter & Wright's model, adding network asymmetry, provides no support for the suggestion that forcing up reciprocal access charges could be advantageous to a larger network as part of a foreclosure strategy.

#### Network asymmetry in the presence of on-net/off-net differentials

In my earlier analysis I showed that on-net/off-net differentials mean that symmetric networks can jointly profit maximise by setting a low reciprocal access charge, possibly adopting a bill and keep arrangement.

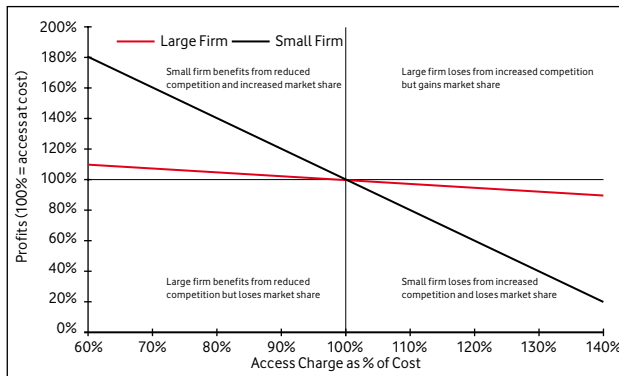
I am interested in analysing how the network asymmetry modelled by Carter & Wright might affect the findings in the presence of network-based price discrimination. I am not aware of any published paper covering this topic, and the outcomes are mathematically complex. As a consequence, Frontier's model is an ideal tool for examining this scenario.

We have seen that Carter & Wright's work suggests that asymmetry should strengthen the preference of a larger network for cost-based access charges. I would expect this effect to carry over into a world with price differentials, but would expect it to be swamped by the greater effect of TMNEs. I would expect the large network to retain its interest in bill and keep, because of the impact of TMNEs on competition at the margin described above. However, because positive TMNEs will tend to favour larger networks I would expect the profits of the larger network to be less sensitive to the access charge than in the symmetric case, while I would also expect the smaller network's profits to be more sensitive than in the symmetric case.

The impact of different levels of reciprocal access charges on profits is shown in Figure 9. In this figure and those following I have assumed the more extreme example of asymmetry used earlier, that is an 83/17 split at cost-based access charges:<sup>24</sup> Figure 9 confirms expectations.



**Figure 9: Sensitivity of profits to access charge with significant network asymmetry (83/17)**

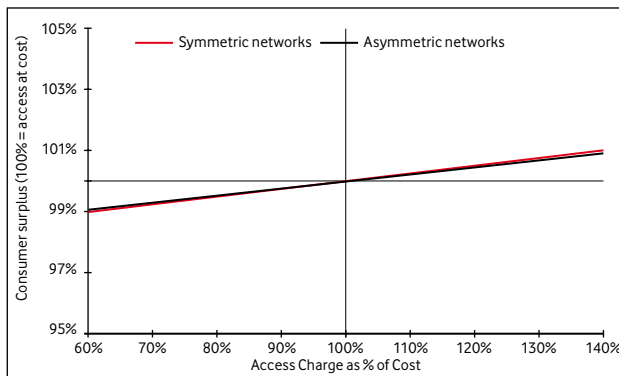


Source: Frontier model

It is clear that the presence of TMNEs in this model significantly change the implications of asymmetry. The marginal effect of TMNEs outweighs the effect identified by Carter & Wright for both networks. However, the advantage for the larger network of lower access charges is significantly less than in the symmetric case.

On the other hand Figure 10 shows that consumer surplus still increases with the access charge in the presence of network asymmetries.<sup>25</sup> Hence the result I found earlier holds even in the presence of significant network asymmetries: consumers benefit from above cost access charges in the presence of network price discrimination because of way price discrimination intensifies competition.

**Figure 10: Network asymmetry does not affect the relationship between consumer surplus and the access charge**

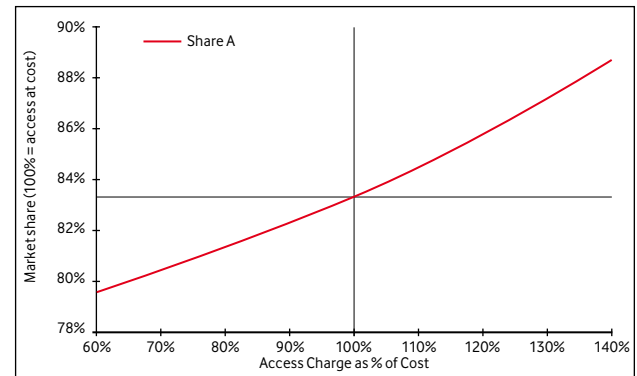


Source: Frontier model

#### Implications for the possibility of foreclosure

When we consider the use of an inefficiently high access charge to maintain a high market share, the impact of TMNEs means that there is a much more pronounced effect, as shown in Figure 11.

**Figure 11: Effect of access charge on larger operator's market share with differential pricing**



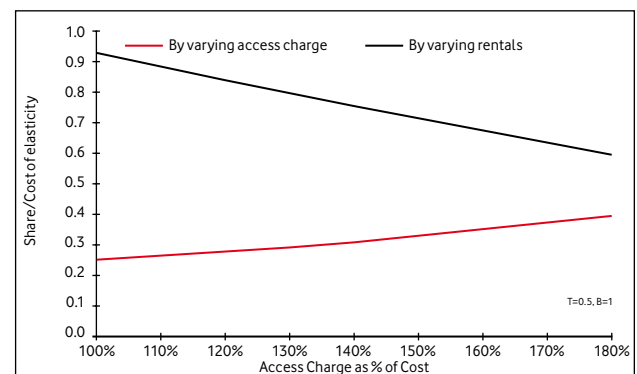
Source: Frontier model

In contrast to Figure 8, this shows that the TMNEs created by differential charging allow the larger network to increase market share if it can raise the reciprocal termination charge above cost. Furthermore, sensitivities on the value of the intensity of competition show that for low values of  $t$  (i.e. more intense competition) the impact on the market share of the larger operator can be even greater.<sup>26</sup>

In order to examine the likelihood of larger networks using high reciprocal access charges as a foreclosure strategy, I have used my model to compare the relative cost to a larger network of building market share by one of two strategies: either by cutting consumer rental charges or by raising reciprocal access charges.<sup>27</sup> Both strategies reduce profits in the short-run, but might (in theory) be adopted in an attempt to drive a smaller rival out of the market so as subsequently to reap the benefit of monopoly profits. It seems logical to ask which one of the two strategies is most cost effective in achieving this end.

The answer I have found inevitably depends on the degree of (intrinsic) asymmetry between the networks and on the intensity of competition between them. When the market is highly competitive, the gain in market share per unit of profit foregone can be shown always to be higher by cutting rentals than by forcing up the reciprocal access charge in the range for which an equilibrium exists (see Figure 12).<sup>28</sup>

**Figure 12: Relative effectiveness of cutting rentals or raising reciprocal access charge to gain market share, with strong competition**

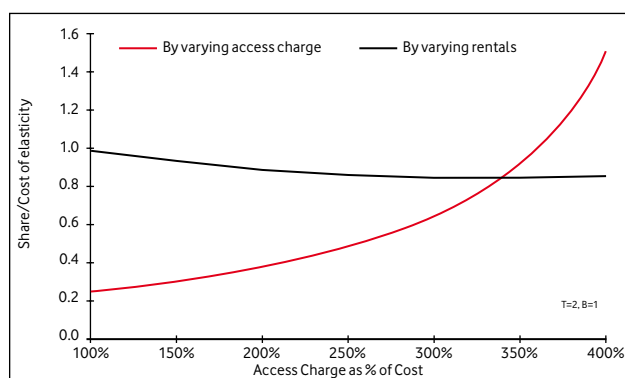


Source: Frontier model



If competition between the networks is weaker then the range over which an equilibrium in access charges exists is wider. In these circumstances I can show that it may become more effective for the larger network to win market share by pushing up reciprocal access charges, but only once access charges are already several times cost (see Figure 13). Provided access charges are in the vicinity of cost this indicates that cutting rentals is likely to be a much more cost effective way for a larger network to artificially increase its market share.

**Figure 13: Relative effectiveness of cutting rentals or raising reciprocal access charge to gain market share, with weak competition**



Source: Frontier model

These results do not prove that a larger network would not under any circumstances attempt to use high reciprocal access charges to increase its market share (assuming it was able to force these through negotiation). What they do strongly indicate, however, is that there is a substantial cost of profits foregone to the large network if it were to do so. Moreover, there are more obvious routes (e.g. the conventional approach of cutting retail prices) which appear to be a much more effective means of increasing market share.

### Endogenous market size

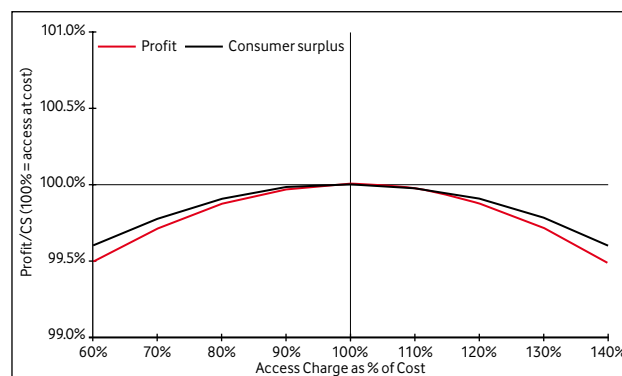
The analysis presented so far assumes that the number of network subscribers is a given. Clearly this has not been true historically and it could be argued that it remains the case that the number of subscribers is sensitive to the price of rentals and calls.

Schiff<sup>29</sup> presents a variant of the LRT model (i.e. without on-net/off-net price discrimination) but with an endogenous subscriber numbers and with or without network externalities.<sup>30</sup> In all these models, Schiff finds that it is still efficient to price calls at marginal cost and compete over the level of the rental charge. Schiff finds that *an endogenous market size without externalities*<sup>31</sup> intensifies competition relative to the LRT model (because networks compete for new subscribers as well as for market share) but profits and consumer surplus are maximised by cost-based access charges.

Figure 14 illustrates Schiff's model, applying the same parameterisation as in the previous analysis, but allowing for an endogenous participation rate (but no externalities). For illustration, I have used a linear distribution of subscriber values that determines participation. This distribution is independent of consumption once they have decided to

subscribe. The parameters I have chosen deliberately imply a very high elasticity of subscription with respect to the rental (of around -2.5) in order to demonstrate clearly both the impact of endogenous participation and its relatively small effect for what is a very high elasticity from a real-world point of view. Figure 14 demonstrates Schiff's result that endogenous market size leads to profits and welfare being maximised by cost-based access charges, but shows that this effect is very weak in comparison to the TMNE effect identified above.

**Figure 14: Schiff model of endogenous market share**



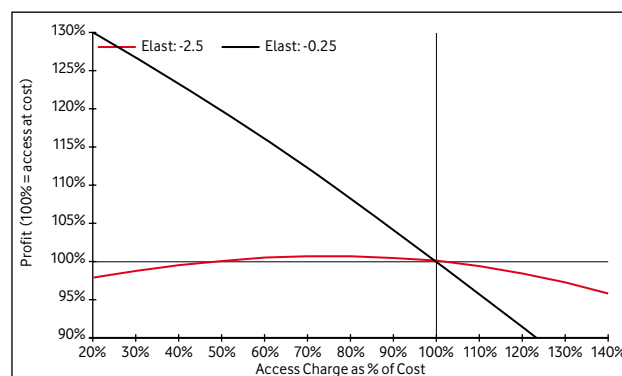
Source: Frontier model

### Endogenous participation with network price discrimination

Schiff shows that an endogenous market size increases the incentive for networks to price reciprocal access at cost. I have extended his analysis therefore to the case of endogenous subscription in the presence of on-net/off-net differentials and in the presence of network asymmetry. In each of these cases it is extremely difficult to solve these problems algebraically, but relatively straightforward to obtain answers using Frontier's modelling framework.

Intuitively I would expect an endogenous market size to reduce the incentive for symmetric networks to adopt bill and keep. Depending on the elasticity of subscription it is possible that profits may be maximised at a positive access charge, although this charge will always be less than cost.<sup>32</sup> This result is demonstrated in Figure 15, which shows that for a subscription elasticity of -2.5 there exists a profit maximising access charge, less than cost but greater than zero, whereas for an elasticity of -0.25 profits are increasing as the access charge falls to zero.

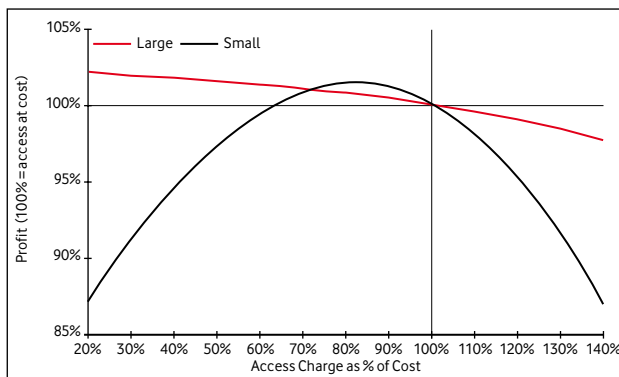
**Figure 15: Effect of subscription elasticity on profit maximising access charge with endogenous market share**



Source: Frontier model

Introducing network asymmetry, I find that it is the smaller, rather than the larger network that is affected more by the endogenous penetration rate. Figure 16 shows, with the same exaggerated subscription elasticity of -2.5, that the larger network would still prefer bill and keep, while the smaller network would strictly prefer a positive (although below-cost) reciprocal access charge.

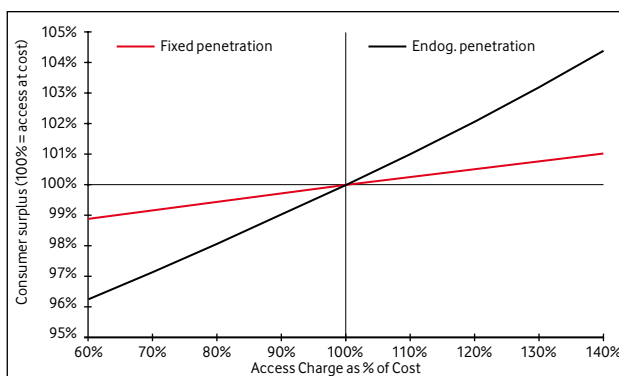
**Figure 16: The effect of endogenous participation and asymmetry on profit-maximising reciprocal access charge**



Source: Frontier model

I stated previously that because TMNEs intensify competition, setting above-cost access charges can increase consumer surplus. My modelling shows that the introduction of an endogenous penetration rate intensifies competition even further. As a consequence the result that consumer surplus can be increased by setting access charges above cost is even stronger in the presence of an endogenous penetration rate. This is illustrated in Figure 17 below.

**Figure 17: Impact of access charge on penetration**



Source: Frontier model

### Comments on network externalities

In the presence of network externalities Schiff shows that the networks will *profit maximise by pricing access below marginal cost (even though they are charging uniform on-net and off-net prices), while consumer surplus is maximised by pricing access above marginal cost*. The intuition of this result is that externalities make competition even fiercer in a non-linear way. Adding a customer when access is priced above cost creates profits directly *and* increases the volume of calls by existing customers, which multiplies the profit. The networks would choose to mitigate competition by setting the price of access (and calls) below cost to offset the effect of the

network externality. Total welfare on the other hand is maximised with access priced above marginal cost, because this leads to a lower rental charge, which in turn drives up the penetration rate.<sup>33</sup>

I have not replicated this modelling in the current analysis, because the modelling of externalities is extremely sensitive to the parameters used. However my intuition is that Schiff's results are consistent with the preceding analysis. The introduction of externalities may somewhat strengthen the tendency of profit maximising operators to set access charges below cost, but also strengthens the welfare argument for above cost access charge.

### Comments on customer heterogeneity

In each of the models presented above it can be shown that it is efficient for networks to price calls at (perceived) marginal cost and for them to compete over the level of the rental charge. However, this results from the fact that in each model subscribers are assumed all to have the same demand to make calls once they have joined a network.

If the models are generalised further so that consumers vary in their characteristics, either in terms of the volume of calls they would make at a given call price, or in terms of the volume of calls they receive, then it no longer is the case that it will be efficient for networks to price calls at marginal cost.

This is an aspect of pricing dealt with by Dessein and by Houpiis & Valletti.<sup>34</sup> The specific insight that these papers bring is that they show that when the marginal subscriber makes fewer calls than the average caller then it will be efficient to price calls above marginal cost and reduce rentals.

Both LRT (1998) and Armstrong (1998) argue (without formal proof) that once customers are heterogeneous in their consumption and access prices differ from marginal cost then the market outcome is likely to resemble the collusive outcome created by linear pricing, even if two-part tariffs are used in practice. Dessein demonstrates that this is *not* the case. He shows that LRT's profit neutrality result holds even in the presence of customer heterogeneity. Moreover, he extends Schiff's result by showing that in the presence of customer heterogeneity *and* externalities networks would choose to price access below marginal cost while welfare is maximised by pricing access above marginal cost. Houpiis & Valletti note specifically that results are sensitive to the way in which heterogeneity is modelled. If the differences between subscribers are additive then marginal cost pricing will remain efficient, while other formulations tend to result in pricing calls above marginal cost.

Schiff's paper is a good example of this. An endogenous participation rate is explained by customers having an "option value" from subscription which is randomly distributed, but unrelated to the calls they make if they become subscribers because of the additive structure that Schiff has chosen. Hence in Schiff's model, even in the presence of externalities, the marginal customer makes the same number of calls as the average customer so the conditions for marginal cost pricing still hold. By contrast, in Dessein's model, customers are split into low and high calling (and receiving) behaviour. Inevitably marginal

customers are drawn from the low-use group, hence it becomes efficient to raise call charges above marginal cost and lower rental charges.

## Conclusions

The result showing a collusive outcome for two-way access under linear retail tariffs appears to have dominated the policy debate about two-way interconnection, in spite of (perhaps because of) the fact that this model is very simple and in spite of the fact that subsequent work in the area has shown that this conclusion appears to be special to the very restricted assumptions on which it is based. More realistic models do not produce this collusive result.

This review has shown that:

- If networks compete using rentals *and* call charges then the joint interest in driving up reciprocal access charges evaporates.
  - While LRT derived the profit neutrality result, it seems that this too is quite a special case. Allowing for either an endogenous market size or asymmetry in the sizes of networks creates an incentive for the networks to set a cost-based reciprocal access charge to maximise profits. However, my modelling indicates that this incentive may not, in practice, be very strong.
  - By contrast, it seems that differential on-net and off-net tariffs have a dramatic impact on the dynamics of the market. Commentators have noted that setting access charges above cost creates (positive) tariff mediated network externalities (TMNEs), which should favour larger networks. This view is static, however, and fails to account for the interaction of TMNEs and inter-network competition. Positive TMNEs make customers more profitable, and therefore more attractive for each network, giving all networks a strong incentive to increase their market share. This intensifies competition, ultimately reduces profits and increases consumer surplus. Given the chance, therefore, networks would choose low reciprocal access charges, possibly even “bill and keep” to reduce the intensity of competition for these subscribers, which would be to the detriment of the consumer surplus of subscribers.
  - The dynamic effect of TMNEs on the intensity of competition reveals that the idea of that the “waterbed” effect between access charges and profits is overly simplistic. This concept has usually been applied to the case of F2M access charges, but can equally be considered in the case of two-way access. What is critical to the effectiveness of the waterbed is not the intensity of competition in the retail market *per se*, but rather the extent to which changes in termination charges alter the intensity of retail competition. If access charges (one-way or two way) do not affect the intensity of competition then changes in termination charges would not be expected to alter the equilibrium level of profits. Hence the waterbed will be 100% effective regardless of the absolute level of competition in the outbound market. In the case of two-way access this is likely to be the case when on-net and off-net prices are uniform. In the presence of differentials however, higher access charges *increase* the intensity of competition, which means that networks pass on more than 100% of any movement in access charges. Although the consideration of waterbed effects in one-way access is outside the scope of this paper, these observations highlight how important it also is for regulators not to make simplistic assumptions about the relationship between F2M access charges and competition in the retail market.
  - Forcing up reciprocal access charges is an expensive way for a large operator to attempt to gain market share. In the absence of on-net/off-net differentials it seems to have a negligible effect on market share. With network price discrimination, on the other hand, it is possible for the larger network to increase its market share if it can force up the reciprocal access charges. However, unless it can completely exclude the competitor from the market it will simply doom itself to perpetual and significant damage to its profits in doing so. Moreover, it is not at all clear why a large incumbent attempting to adopt a predatory strategy would behave in this way. Modelling shows that, unless the access charge is substantially in excess of cost, it is almost certainly more cost effective for the dominant firm to cut retail prices than to force up reciprocal access charges (even if it has the power to do so) in order to build market share.
  - It is usually assumed that welfare will be maximised by cost-based access charges. However, the evidence I have reviewed shows that this need not be the case. First, in the presence of network externalities (for which an endogenous market size is a necessary but not sufficient condition) total welfare will be maximised by setting access charges above cost. Secondly, even without externalities setting access charges above cost can be an effective method of intensifying competition provided networks charge differential on-net and off-net tariffs. This does not increase total welfare, but does increase consumer surplus. Thus in many circumstances above-cost access charges have the effect of increasing the welfare of consumers, albeit at the expense of the networks.
  - I also find that allowing for the level of consumer participation in the market to be variable (i.e. a participation rate of less than 100% that varies depending on the prices offered) strengthens the effect on competition of above-cost access charges (and hence increases further the consumer benefit they create) but mitigates to some extent the desire for MNOs to reduce access charges to zero. It remains the case however, that MNOs would choose to set two-way access charges below cost so as to maximise profits.
- My conclusion is therefore that, on the basis of the types of models considered here, there is no incentive for mobile networks to set high *reciprocal* access charges. Furthermore, it does not appear that larger networks gain any particular advantage as a foreclosure strategy from attempting to force up reciprocal access charges.

By contrast, mobile networks in most circumstances have an incentive to set access charges at or below cost while welfare maximising levels can be expected to be *above* marginal cost either to allow the exploitation of network externalities (in whose presence total welfare may be enhanced by above-cost access charges) or to accentuate competition between networks (in which case total welfare may not be increased, but consumer surplus certainly is).

All this, of course, begs the question as to why mobile networks do not choose reciprocally to reduce M2M access charges when they are free to do so? There are two answers to this, the first practical the second economic. The practical argument is that it may not be possible for mobile networks to set different F2M and M2M access charges because of the risk of arbitrage. Given that it is accepted that mobile networks have incentives to maintain high F2M access charges (the classic one-way interconnection problem) it is to be expected that mobile networks will not reduce their M2M access charge.

The economic argument returns to the concept of Nash equilibrium that underpins this analysis. While I have shown that a low reciprocal access charge will maximise joint profits, it is straightforward to show that this level of access charge is not a Nash equilibrium if reciprocity is not mandated. For a given, low, access charge either network can raise profits by increasing its own access charge. Unless reciprocity is mandated, the only outcomes that will be stable will involve high access charges. This is in the nature of competition and what prevents collusive outcomes in competitive markets. The policy implications are therefore: before any other measures for regulating M2M access charges are considered, a requirement of reciprocity should be placed on *all* operators.

The second policy implication of this analysis is that neither prohibiting on-net/off-net differentials (to the extent that these reflect underlying access charges) nor mandating cost-based access charges is necessarily in the interests of consumers. If access charges are currently above cost then prohibiting on-net/off-net differentials has the effect of softening competition, increasing profits and reducing consumer surplus. This follows because prohibiting on-net/off-net differentials saves the networks from the intense competition to which they are subjected by network price differentials.

Conversely, setting access charges above cost (combined with on-net/off-net differentials) actually increases consumer surplus even in the absence of network externalities, because of the impact that higher access charges have on the intensity of competition.

## Annexe 1: Mathematical Derivation of Models

### Linear pricing

Firm  $i$  charges a uniform outbound price  $p_i$  and no fixed rental. The marginal cost of origination and termination is  $c$  (therefore the marginal cost of an on-net call is  $2c$ ). A common call termination charge of  $a$  is set for off-net calls, hence the perceived marginal cost of an off-net call is  $c + a$ .

There are two firms competing for market share  $s_i \in [0, 1]$  by attempting to offer the greatest consumer surplus to customers. Market share is determined by the difference between the consumer surplus offered by the two firms and a search cost parameter  $t$ . The bigger is  $t$  the weaker is competition between the two operators.

Each firm maximises:

$$\Pi_i = s_i(p_i - 2c)q(p_i) + s_i s_j(a - c)(q(p_j) - q(p_i)) - s_i f \quad (1.)$$

subject to share  $s_i$ :

$$s_i = \frac{1}{2} + \gamma(w(p_i) - w(p_j)) \quad (2.)$$

where consumer surplus  $w(p_i)$  is defined relative to the indirect utility function  $v(p_i)$ :

$$w(p_i) = v(p_i) - r_i \quad (3.)$$

and  $\gamma = 1/2t$ .

First order conditions on (1.) assuming symmetry give:

$$p^* = 2c + \left( \frac{\frac{1}{4}(a - c)q'(p^*) - \gamma f q(p^*) - \frac{q(p^*)}{2}}{\frac{1}{2}q'(p^*) - \gamma q(p^*)^2} \right) \quad (4.)$$

It can be shown that  $p^*$  is above perceived marginal cost and increases with the access charge at  $a = c$ , hence the suggestion that networks could collude to raise profits by setting above-cost access charges.

### The profit neutrality result

Firm  $i$  charges subscription price  $r_i$  as well as a uniform outbound price  $p_i$ .

Each firm maximises profit:

$$\Pi_i = s_i(p_i - 2c)q(p_i) + s_i s_j(a - c)(q(p_j) - q(p_i)) + s_i(r_i - f) \quad (5.)$$

with the same derivation of share  $s_i$  as in the Armstrong case above.

First order conditions on (5.), assuming symmetry give:

$$p_i = 2c + s_j(a - c) \quad (6.)$$

given symmetry  $s_i = s_j = 0.5$ ,  $p_i = p_j = p$

$$p^* = 2c + \frac{1}{2}(a - c) \quad (7.)$$

which shows that network  $i$  prices calls at perceived marginal cost.

Also first order conditions on (5.) show:

$$r_i = f + \frac{s_i}{\gamma} - (p_i - 2c)q(p_i) - (s_j - s_i)(a - c)(q(p_j) - q(p_i)) \quad (8.)$$

As in equilibrium, the outcome will be symmetric ( $s_i = s_j = 0.5$ ),

$$r^* = f + \frac{1}{2\gamma} - \frac{1}{2}(a - c)q(p^*) \quad (9.)$$

which implies that equilibrium profits are:

$$\Pi = \frac{1}{2}[(p^* - 2c)q(p^*) + (r^* - f)] = \frac{1}{4\gamma} \quad (10.)$$

Equation (10.) shows that profits are independent of the access charge  $a$ . This is the standard profit neutrality result, implying that the competing firms *cannot* collude to raise profits by manipulating the level of the access charge.

### Introducing on-net/off-net differentials

The previous model can be generalised by allowing the networks to charge different on-net and off-net call charges. This is Gans & King's model.

Each firm maximises profit:

$$\Pi_i = s_i^2 (\bar{p}_i - 2c) q(\bar{p}_i) + s_i (1 - s_i) (\hat{p}_i - c - a) q(\hat{p}_i) + s_i (1 - s_i) (a - c) q(\hat{p}_j) + s_i (r_i - f) \quad (11.)$$

where  $\bar{p}_i$  is network  $i$ 's on-net call charge and  $\hat{p}_i$  is its off-net call charge.

subject to share  $s_i$ :

$$s_i = \frac{1}{2} + \gamma (w(\bar{p}_i, \hat{p}_i) - w(\bar{p}_j, \hat{p}_j)) \quad (12.)$$

and consumer surplus  $w(p_i)$  is defined relative to the indirect utility function  $v(p_i)$ :

$$w(\bar{p}_i, \hat{p}_i) = s_i v(\bar{p}_i) + s_j v(\hat{p}_i) - r_i \quad (13.)$$

First order conditions on (11.) show that give:

$$\bar{p}^* = 2c, \hat{p}^* = a + c \quad (14.)$$

hence it is profit maximising for firms to price call at marginal cost, which is  $2c$  for on-net calls and  $a + c$  for off-net calls.

Also first order conditions on (11.) show that:

$$r_i = f - s_i \left( v(\bar{p}_i) - v(\hat{p}_i) + v(\bar{p}_j) - v(\hat{p}_j) - \frac{1}{\gamma} \right) - 2s_i (\bar{p}_i - 2c) q(\bar{p}_i) + (s_j - s_i) (\hat{p}_i - c - a) q(\hat{p}_i) - (s_j - s_i) (a - c) q(\hat{p}_j) \quad (15.)$$

However, because the solution will be symmetric, with  $s_i = s_j = 0.5$ ,  $\bar{p}_i = \bar{p}_j = \bar{p}^*$ ,  $\hat{p}_i = \hat{p}_j = \hat{p}^*$ , (15.) simplifies to:

$$r^* = f + \frac{1}{2\gamma} - (v(\bar{p}^*) - v(\hat{p}^*)) \quad (16.)$$

which implies equilibrium profits of:

$$\Pi_i = \frac{1}{4\gamma} + \frac{1}{4} (a - c) q(\hat{p}^*) - \frac{1}{2} (v(\bar{p}^*) - v(\hat{p}^*)) \quad (17.)$$

Clearly at  $a = c$ ,  $\bar{p}^* = \hat{p}^*$ , profit equals the Hotelling profit of  $1/4\gamma$ , as in the case with no differentials.

However, differentiating (17.) with respect to the access charge  $a$  we see that:

$$\begin{aligned} \frac{d\Pi_i}{da} &= \frac{1}{4} q(\hat{p}) + \frac{1}{4} (a - c) \frac{dq(\hat{p})}{da} + \frac{1}{2} \frac{dv(\hat{p})}{da} \\ &= -\frac{1}{4} q(\hat{p}) + \frac{1}{4} (a - c) \frac{dq(\hat{p})}{da} \end{aligned} \quad (18.)$$

given Shepherd's lemma  $v' = -q$ .

Equation (18.) shows that when access charges are at cost,  $a = c$ , profits are strictly declining as the access charge increases. Hence the networks can increase profits by reducing access charges below cost.

As  $a$  falls below  $c$ , the first term remains negative, but the second is positive. Whether there a profit maximising access charge exists will depend on the second order conditions.

$$\frac{d^2 \Pi_i}{da^2} = \frac{1}{4} (a - c) \frac{d^2 q(\hat{p})}{da^2} \quad (19.)$$

In a linear demand system (19.) is zero, hence profits will *always* be increasing as the access charge falls. Assuming the

lowest feasible access charge to be zero. In a constant elasticity model a profit maximising value of  $a$  may exist, but it is very likely to be negative. This is how Gans & King come to the conclusion that networks may well prefer bill and keep arrangements to maximise profits.

However, it is also possible to show that in Gans & King's model consumer surplus is *increasing* with the level of the access charge when  $a = c$ :

Differentiating (13.) at the profit maximising level with respect to the access charge gives:

$$\frac{dw(\bar{p}^*, \hat{p}^*)}{da} = \frac{1}{2} \frac{dv(\hat{p}^*)}{da} - \frac{dr^*}{da} \quad (20.)$$

but from Shepherd's lemma and (16.) it is clear that:

$$\frac{dw(\bar{p}^*, \hat{p}^*)}{da} = \frac{q(\hat{p}^*)}{2} \quad (21.)$$

which is greater than zero, hence consumer surplus is increasing with the access charge for any value of that charge.

### Network asymmetry

Carter & Wright's model maximises the same profit function as LRT, (5.), but does not assume symmetry between the two networks. This is achieved by assuming that network  $i$  provides additional network specific benefits to subscribers, equal to  $B^*t$ , where  $t$  is the search cost defined above.

Thus:

$$w(p_i) = v(p_i) - r_i + Bt \quad (22.)$$

$$w(p_j) = v(p_j) - r_j \quad (23.)$$

It is easy to show that equation (6.) still holds, so the two networks both price at perceived marginal cost.

However, because  $s_i^* > s_j^*$ , if access is priced above cost the larger network will charge a lower average price than the smaller one, and will experience an interconnection deficit in equilibrium.

Solving this model reveals that:

$$s_i^* = \frac{1}{2} + \frac{B}{6} + \frac{\gamma}{3} (v(p_i^*) - v(p_j^*) + (a - c) (s_j^* q(p_i^*) - s_i^* q(p_j^*))) \quad (24.)$$

$$s_j^* = \frac{1}{2} - \frac{B}{6} + \frac{\gamma}{3} (v(p_j^*) - v(p_i^*) + (a - c) (s_i^* q(p_j^*) - s_j^* q(p_i^*))) \quad (25.)$$

$$\Pi_i = \frac{s_i^{*2}}{\gamma} + s_i^{*2} (a - c) (q(p_i^*) - q(p_j^*)) \quad (26.)$$

Carter and Wright show that:

$$\left( \frac{ds_i}{da} \right)_{a=c} = 0, \text{ and} \quad (27.)$$

$$\left( \frac{d^2 s_i}{da^2} \right)_{a=c} = \frac{\gamma}{3} \left( s_j^{*2} \frac{dq(p_i)}{da} - s_i^{*2} \frac{dq(p_j)}{da} \right) \quad (28.)$$

At  $a = c$  the first derivative of market share is zero and the second derivative is negative for the smaller firm (because  $q''(p_i) = q''(p_j) < 0$  and  $s_j^2 > s_i^2$ ). Hence  $a = c$  represents a local *maximum* for the market share of the smaller firm.



Also

$$\left(\frac{d\Pi_i}{da}\right)_{a=c} = 0, \text{ and} \quad (29.)$$

$$\left(\frac{d^2\Pi_i}{da^2}\right)_{a=c} = s_i \frac{dq(p_i)}{da} \left(4s_i^2 - \frac{10}{3}s_i + \frac{2}{3}\right) \quad (30.)$$

where the term in brackets is negative if and only if  $\frac{1}{3} < s_i < \frac{1}{2}$ , so that:

$$\left(\frac{d^2\Pi_i}{da^2}\right)_{a=c} \begin{cases} > 0 & \text{if } \frac{1}{3} < s_i < \frac{1}{2} \\ = 0 & \text{if } s_i = \frac{1}{2} \\ < 0 & \text{otherwise} \end{cases} \quad (31.)$$

hence the result that the larger network ( $s_i > \frac{1}{2}$ ) strictly prefers cost-based access charges, while for the smaller network cost based access *minimises* profits for a market share less than a half but more than a third, but *maximises* profits if the market share is less than one-third.

## Annexe 2: Description of the Frontier Model

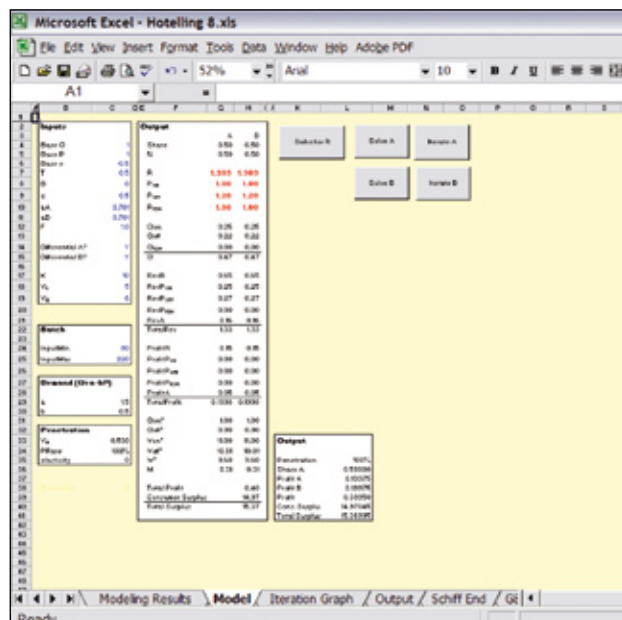
Frontier's model is an Excel spreadsheet encompassing a Hotelling model of price competition between two operators that charge each other an access charge for traffic interconnection. The model uses circular calculations to calculate demand, market shares, profits and consumer surplus for a given set of retail prices and access charges.

Demand is assumed to be linear and traffic proportional to the number of subscribers on each network.

The model allows each network independently to choose whether to differentiate on-net and off-net retail prices. However, call prices are always set at perceived marginal cost.

Figure 18 shows a screenshot of the Frontier model.

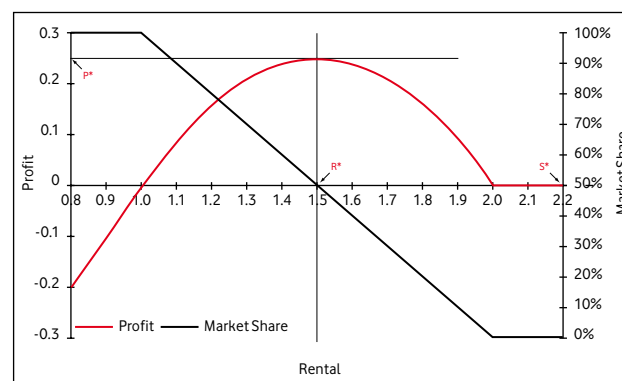
Figure 18: Screenshot of Frontier model



A Nash equilibrium for a given access charge is identified as follows.

1. Access charges are set.
2. Call prices and rentals for network A and B are set at cost.
3. Call prices and rentals for network B are held fixed.
4. Call prices for network A are set equal to marginal cost (by formula, hence in the case of uniform on-net/off-net charging, call prices will vary as the rental is altered, because of the effect on market share).
5. The rental charge for network A is varied across a range to identify the profit maximising rental charge, give network B's charges. The output of one pass of this process is shown in Figure 19 below.

Figure 19: Illustration of solving routine



Source: Frontier model

6. The rental charge for network A is fixed at the maximum found in step 5.
7. Retail call charges for both networks are recalculated for the current rental charges and market shares.
8. Steps 3 to 7 are repeated for network B, holding network A's prices constant.
9. The process is repeated until the model converges to a Nash Equilibrium.

## Notes

- 1 I would like to offer my thanks to Patrick Rey, Tommaso Valletti, Richard Feasey and George Houpis for invaluable comments on an earlier draft of this paper.
- 2 Usually measured as LRIC.
- 3 Armstrong, M. (1998), "Network Interconnection In Telecommunications", *Economic Journal*, 108 (May), pp. 545-564.
- 4 Laffont J.J., Rey P. and J Tirole (1998), "Network Competition I: Overview and Nondiscriminatory Pricing", *RAND Journal of Economics* 29 (1-37)
- 5 If charges were set reciprocally and without the risk of arbitrage with F2M call termination charges.
- 6 Gans, J.S & King, S.P. (2000), "Using 'Bill and Keep' Interconnection Arrangements to Soften Network Competition".
- 7 Carter M. and W. Wright (2003), "Asymmetric Network Interconnection, Review of Industrial Organisation 22 (27-46).
- 8 "Consultation Document on a Draft joint ERG/EC approach on appropriate remedies in the new regulatory framework", 21st November 2003.
- 9 A "network externality" occurs when the value that each subscriber to a network gets from being a subscriber increases as the total number of subscribers increases. Assuming equal pricing for all calls, interconnection between two competing networks, allowing subscribers to call other subscribers on either network, also creates a network externality effect by increasing the number of people with whom each subscriber can communicate. If the price of on-net



- and off-net calls differ then "tariff-mediated network externalities" are created, because subscribers care about which network the people they want to call are on.
- 10 "Response to Consultation and Notification to the European Commission – Wholesale voice call termination on individual networks", Comreg Doc. No. 04/62a, 8th June 2004.
  - 11 See para. 4.35.
  - 12 It is also possible to consider different interpretations of welfare maximisation. Given that we are dealing with models of imperfect competition, the same solution may not maximise profits, consumer surplus and total welfare. From the policy perspective it is a matter of debate whether the appropriate welfare benchmark should be total welfare, or consumer surplus. I try and draw a clear distinction in the discussion that follows.
  - 13 Consumers are assumed to be located along a line. Two competing firms locate one at each end of the line. Consumers are assumed to choose one of the firms based on a trade off between the utility they would get from each firm and the "cost" of buying from each firm. The utility they get depends on the prices each firm offers. The cost of buying from a firm is assumed to be a linear function of the distance from the consumer to each firm. The lower is this cost the more competitive will be the market.
  - 14 The proof of this and other results discussed here is presented in Annexe 1.
  - 15 Including linear demand or constant elasticity demand within normal bounds for the elasticity.
  - 16 Calling Party Pays.
  - 17 In the absence of externalities.
  - 18 It should be noted that while consumer surplus is maximised by raising access charges above cost, total welfare is maximised in this model by cost-based access charges. The implications of this for policy depend on the extent to which the authorities value producer surplus as opposed to consumer surplus.
  - 19 Competition Commission (2003), Vodafone, O2, Orange and T-Mobile. See also Comreg Doc. No. 04/62a.
  - 20 In the absence of on-net/off-net differentials, perceived marginal cost will be the average marginal cost of on-net and off-net calls, taking into account the access charge on off-net calls.
  - 21 The large network's subscribers will make more calls to the small network than will be made from the small to the large network.
  - 22 These results are, of course, sensitive to the intensity of competition between the networks. However, for an equilibrium to exist across the range of access charges shown here competition cannot be too intense. My sensitivity analysis indicates that, for any values for the intensity of competition parameter  $t$  that allow stable equilibria in this range, the impact of access charges on profits is very small indeed.
  - 23 For very small values of this parameter it can be shown that there are no stable internal equilibria.
  - 24 In practice it is my view that such an asymmetry is extreme and unlikely to be relevant to a real world example. Actual market shares may be split in this way in the short-run, especially shortly after the launch of a new network. There is no reason, however, to believe that a single network should permanently hold such a huge intrinsic advantage that cannot be competed away over time. Nevertheless, I use this extreme asymmetry to illustrate clearly the qualitative results generated by these models.
  - 25 This measure of consumer surplus excludes network specific benefits, which I take to be a modelling device to create asymmetries.
  - 26 However, I would question how realistic a scenario is which posits a huge intrinsic asymmetry in networks co-existing with a highly competitive retail market.
  - 27 It should be emphasised that these two strategies are not equally easy. In the latter case it is not clear how a larger incumbent could force a smaller network to accept high reciprocal access charges, especially if the smaller network had recourse either to a competition or regulatory authority.
  - 28 In this modelling I have assumed an intrinsic asymmetry of 67/33, which I believe represents a reasonable upper bound.
  - 29 Schiff, A. (2001), "Two-way interconnection with partial consumer participation", University of Auckland Working Paper # 223.
  - 30 The former is modelled by assuming that potential subscribers have an option value associated with joining the market, which is randomly distributed. Once the decision to subscribe is made, based on expected benefits from joining, the subscriber chooses network in the same way as in the other models discussed here. All subscribers still make the same volume of calls. Schiff by models network externalities assuming that the calls made by each subscriber are a linear function of the number of subscribers.
  - 31 This is modelled by assuming the number of calls made by each subscriber is a function of the price of calls but is not affected by the number of subscribers.
  - 32 See Annexe 1 for proof.
  - 33 Dessein, W. (2001), "Network Competition In Non-Linear Pricing". Shows that the welfare result is not completely general, but is true provided that two duopolists offer a larger net surplus to customers than a monopolist.
  - 34 Houpis, G. & Valletti, T., (2004), "Mobile termination: what is the right charge?" This article concerns optimal F2M access charges and so is not directly relevant to the present case, but contains important insights about how customer heterogeneity affects efficient pricing.

## Halvor Sannæs



Director Tariff Services  
Teligen, Harris Interactive UK Ltd.

Having worked in the telecoms industry for over 30 years, Halvor has spent the last 17 years with Teligen, analysing tariffs and developing tariff databases and analysis tools. Teligen has a global focus on tariffs, and Halvor has been working with major companies and organisations around the world to analyse and structure tariff information, and compare prices and offerings from telecom operators in Europe, North America, Asia, the Pacific, the Caribbean and in the Middle East.

Since 1995 Halvor has been responsible for the development and implementation of the Teligen T-Basket product, which covers the OECD Price Benchmarking methodologies. Halvor has also been responsible for the updating and re-development of the OECD methodologies over time, and has been using tailored versions of these basic methodologies to cover specific benchmarking requirements for individual clients around the world. Halvor works out of Norway.

# On-Net Pricing in Mobile Services

## 1. Introduction

The pricing of mobile calls have developed dramatically over the years. From a simple price per minute for any type of call from a mobile phone, we now see highly differentiated prices depending on call destination and time of day. This paper looks at one particular aspect of mobile pricing: the practice of differential pricing for on-net and off-net mobile-to-mobile calls, and the reasons for its development.

When the GSM system was launched in 1992 the pricing did not differentiate between calls within the “home” network (on-net) and calls to other mobile networks (off-net). Even calls to the fixed network were generally priced the same flat rate.

This report looks at the development of prices for a range of operators in markets where mobile services developed early, with the objective to find out when and where on-net price differentiation has been used, and by which network operators.

In order to find out more about how and when the concept of on-net pricing started, and how it developed, Teligen has taken historical data from its old “Voicebooks” of the 1990’s and the later “T-World” databases. There are unfortunately gaps in the data, so some uncertainty as to exact times remains, but the available data does provide a good picture of the development of on-net and off-net price differentiation over time in European countries.

The data suggests that on-net pricing was used as a competitive instrument by all operators in a market (country), triggered by intensifying competition.

## 2. Findings

The data presented in Appendix B shows the range of discounts offered by the individual operators over time. Highest and lowest on-net discount is shown relative to the off-net call charge. The conclusions drawn from the available data can only be as good as the data coverage allows. As there are gaps in the data at different times the exact pricing behaviour of the operators can be hard to identify, but for the purpose of the objectives of this study it is still possible to see the traces of the price development since the early years of GSM, and to the present day.

The first sign of on-net price differentiation is found in Germany, Norway and Portugal in 1995, followed by most other major European countries throughout the second half of the 1990s.

Table 1 shows how the first appearance of on-net price differentiation in many countries occurred soon after the launch of a new 2<sup>nd</sup> or 3<sup>rd</sup> network operator, corresponding to a point at which competition intensified.

**Table 1: Examples of introduction of on-net price differentiation by established operators**

	Incumbent on-net pricing	Launch of new network
Germany	Jul-95 (T-Mobile)	May-94 (E-Plus)
Norway	Oct-95 (Telenor)	Sep-93 (NetCom)
France	Jul-97 (SFR)	Jan-96 (Bouygues)
Ireland	Jun-99 (Eircell)	Mar-97 (Digicell)
Italy	Mar-00 (TIM)	Mar-99 (Wind)
Spain	May-99 (Movistar)	Jan-99 (Amena)

Source: Teligen &amp; GSM Association

The exceptions to the above are Portugal, Sweden and the UK, where on-net pricing was introduced at a time not directly related to the launch of a new network.

Particulars of individual countries are described below:

- In **Germany**, T-Mobile appears to have introduced on-net pricing in 1995, before Mannesmann (Vodafone) which followed in 1996. The moves by both these operators followed soon after the launch of E-Plus in 1994. Unfortunately our data does not allow us to ascertain whether or not E-Plus launched with on-net price discounts, but E-Plus certainly had large on-net discounts by the time our E-Plus data begins in 1999.
- In **Norway** on-net pricing first appears with Telenor in 1995. This would have been at a time when the GSM network was taking over for the "old" NMT network, and competition between Telenor and Netcom (which launched in 1993) was heating up.
- Similarly, in **Portugal**, TMN was facing increasing competition from Telecel (Vodafone) in the early 1990's, and introduced a differentiated pricing in 1995. Telecel data for the same period is unfortunately not available.
- For **France** the available data does suggest that SFR came first with on-net pricing in July 1997, and that Itineris (Orange) followed in December 1997. Both these moves followed the launch of Bouygues in 1996. Unfortunately our data does not allow us to ascertain whether or not Bouygues launched with on-net price discounts, but Bouygues certainly had large on-net discounts by the time our Bouygues data begins in 2000. Unusually, Orange's on-net discounts remained at a fixed 25% until June 2001, when it was withdrawn altogether, despite on-net discounting being continued by the smaller rivals.
- In the **UK** both One2One and Vodafone had on-net pricing differentiation when our data series begin in 1997. Cellnet (now O2), however, introduced on-net pricing as late as in 2000.
- In **Ireland**, Eircell introduced on-net prices in May 1999<sup>1</sup>. This followed the launch of Esat in 1997. Unfortunately our data does not allow us to ascertain whether or not Esat launched with on-net price discounts, but Esat certainly had large on-net discounts by the time our Esat data begins in 2000. Notably Esat's discounts, compared to

those of Eircell, were both larger and often of wider scope (i.e. applying to all calls).

- In **Spain** it is likely that on-net price discounts first appeared with Movistar in May 1999 (following Amena's market entry earlier in 1999). Vodafone had on-net discounts with the first available data from July 2000.
- In **Italy**, Telecom Italia Mobile (TIM) appears to have introduced on-net pricing in March 2000 (following Wind's entry to the market in 1999). The range of price differences has remained largely unchanged over the 10 year period.
- In **Sweden** the on-net pricing was introduced by Telia in 2000. The competitive environment with Telia and Tele2 had then existed since 1992.

The data shows that on-net pricing was introduced as a competitive instrument resulting from growing competition in the mid 1990's. Once introduced by one operator, other operators in the same market(s) were quick to follow suit, and by the end of the 1990's virtually all operators had differentiated pricing for on-net and off-net calls.

Since the year 2000, although there have been numerous changes to individual operator pricing packages, on-net price discounts have remained a key feature of the market, at roughly the same overall range of discounts (see Appendix B for details). One exception to this is France where on-net discounts have not been used by the network operators since 2005.

### 3. Conclusions

On-net pricing differentiation was introduced in most markets at the time of more heated competition. Once introduced, it became a regular feature of most tariffs in the market.

The size of the market does not appear to have been a determining factor, but the competitiveness of the market probably was important. In 1995 the markets in Germany and Portugal were both highly competitive with second and (in Germany) third new entrant operators challenging the ex-incumbent operators. In other markets that followed, on-net pricing followed intensified competition by new entrants.

Once on the market it is clear that most other operators adopted the principle of differentiated pricing for different destination networks.

However, in more recent years some network operators have made a point of going the opposite way, (re)introducing uniform pricing regardless of destination network in the market (country). Examples are the three network operators in France, and Netcom in Norway.

## Appendix A: How the comparisons were made

### A.1 Definitions

For the purpose of this report the types of calls are defined as:

- On-net Calls within the same mobile service provider's network, i.e. the caller and called user both subscribe to services from the same provider.
- Off-net Calls to another mobile service provider's network, i.e. the caller and the called user subscribes to services from different providers. In principle the two providers may still use the same physical network if one or both are virtual network operators.

Only national calls originating in a mobile network are considered in this report. For the purpose of a more detailed picture the data may also distinguish between peak and off-peak calls, based on the following definitions:

- Peak The most expensive call time during a week, normally business hours on weekdays.
- Off-peak The lowest price available during the week, normally at weekend times or night times.

### A.2 Methodology

As the purpose here is not to compare prices but to investigate inter-price relationships the price data is shown relative to off-net calls. The off-net call is normally the most expensive type of voice call that can be made, making any reference to prices of other calls (in this case, on-net) equal or lower than the off-net call price. This simplifies the comparison results.

The difference between the off-net price and the corresponding on-net price is calculated as a percentage of the off-net price. This percentage is presented in the graphs shown for each operator, for each month.

As there will be several tariff packages with different prices and price differences the range of all differences is shown for each operator. This will give the highest and lowest difference between the off-net and on-net prices. The lowest difference may be zero, the highest might be -100% if the on-net calls were free.

The differences are also calculated for the highest and lowest price over the week, i.e. peak and off-peak times. While it is possible to show these separately the graphs included in this report shows them together, as the full range of differences for all packages and all times.

The tariff data is recorded with the actual valid date or the earliest available recorded date of validity (i.e. when the tariff was first recorded in the database). These dates are used to determine the times of change in between the sampling dates.

For some of the operators, and especially in the earlier years, the off-net prices were not recorded in the databases. The tariff information is then compared with earlier and subsequent updates of the data to determine whether the off-net prices were equal to the fixed line call prices or not. Most often these would be the same, but to be on the safe side this has been checked as far as possible with the available data.

## Appendix B: Results for each operator

The following sections will show the development of on-net prices relative to the off-net prices for each of the operators covered. Not all operators could be covered for the entire period back to 1992, and this will appear as missing bars in the graphs.

As the difference will vary over time, Teligen is presenting the results for each month of the period from 1992. The tariff valid dates have been used for more precise timing of the prices.

Also note that some of the data covered in the first few years did not distinguish between existing analogue and new GSM systems, so that prices may in some cases be pre-GSM-launch.

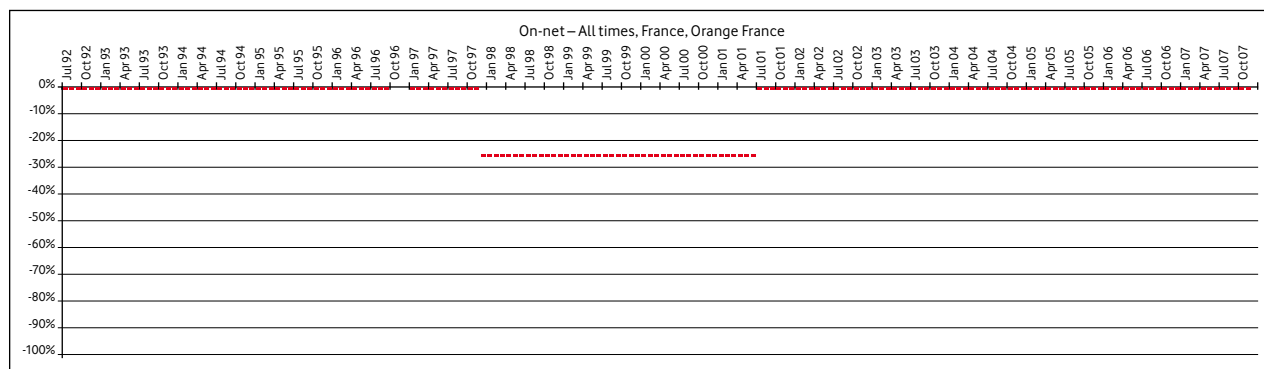
## Notes

- 1 There is a slight uncertainty about the Eircell prices for off-net calls around this time, but it is assumed to be same as fixed line calls as this was the case later on.

This report is produced by Teligen, Harris Interactive UK Ltd. for the Vodafone Group based on their scope and objectives. The price data is taken from Teligen's historical databases, and is believed to be correct. Teligen will not assume any liability for decisions and actions taken on the basis of this report or its data.

**France****Orange/Itineris**

First available data is from October 1992.

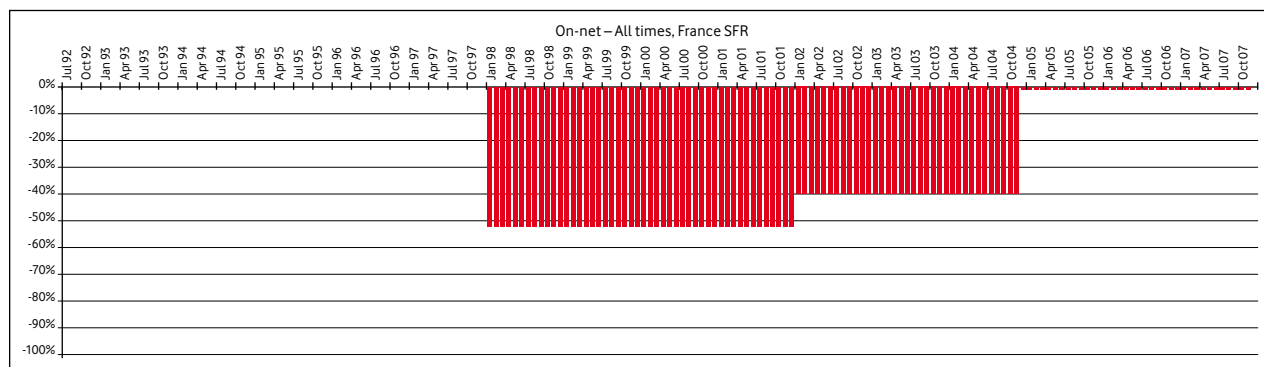


The first indication of reduced on-net prices appears in December 1997 with a general 25% reduction of all on-net calls below the price of off-net.

The on-net discount is removed in 2001.

**France****SFR**

First available data is from January 1998.

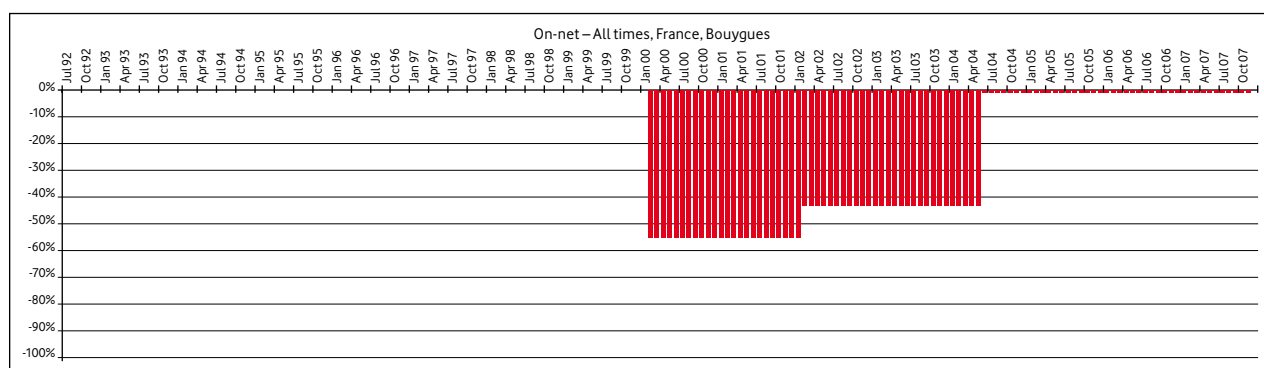


At the beginning of 1998 SFR already had established a significant discount on on-net calls over off-net, with up to 52% discount. This tariff was valid from July 1997. Unfortunately the data available does not allow a more detailed analysis of the time before mid 1997.

The on-net discount is removed in 2004.

**France****Bouygues**

First available data is from February 2000.



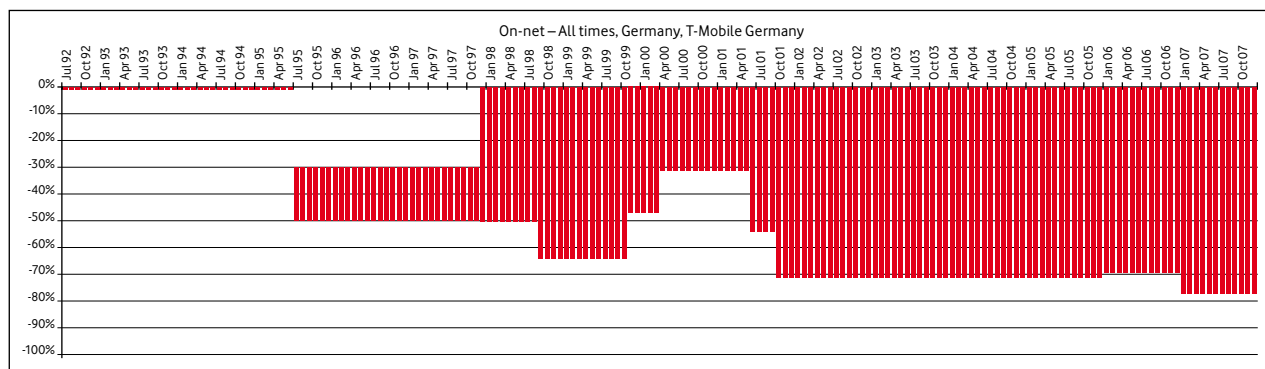
In 2000 Bouygues already had established a discount of up to 54% for on-net calls below the off-net call price.

The on-net discount is removed in 2004.

## Germany

DeTeMobile/T-Mobil/T-Mobile

First available data is from October 1992.

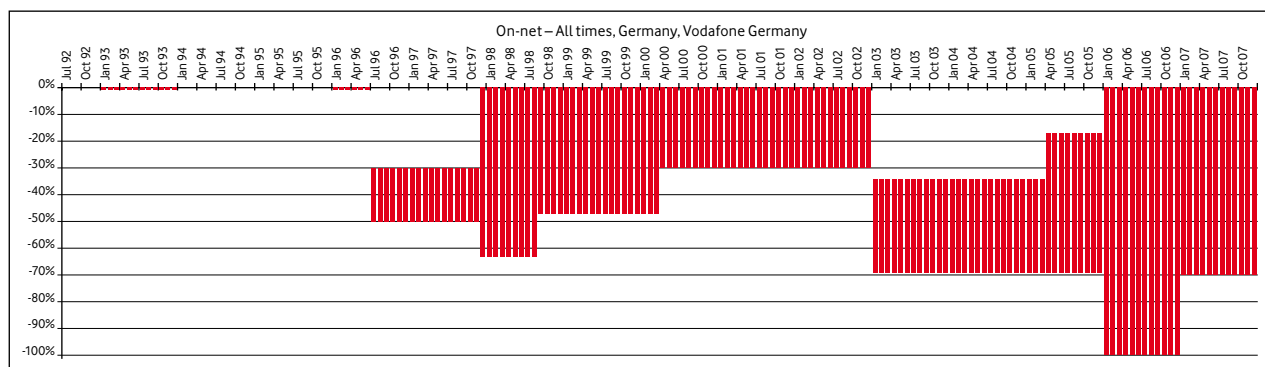


The discount for on-net calls below off-net first appears in July 1995. A discount between 30% and 50% was applied to on-net calls below the off-net call price. The discount level varied considerably over time, and by end of 2002 the on-net discounts at peak time varied between 32% and 70%, and at off-peak times between 0 and 25%. In 2007 both peak and off-peak times have the same discount range of 0 – 77%.

## Germany

Mannesmann/Vodafone

First available data is from January 1993.



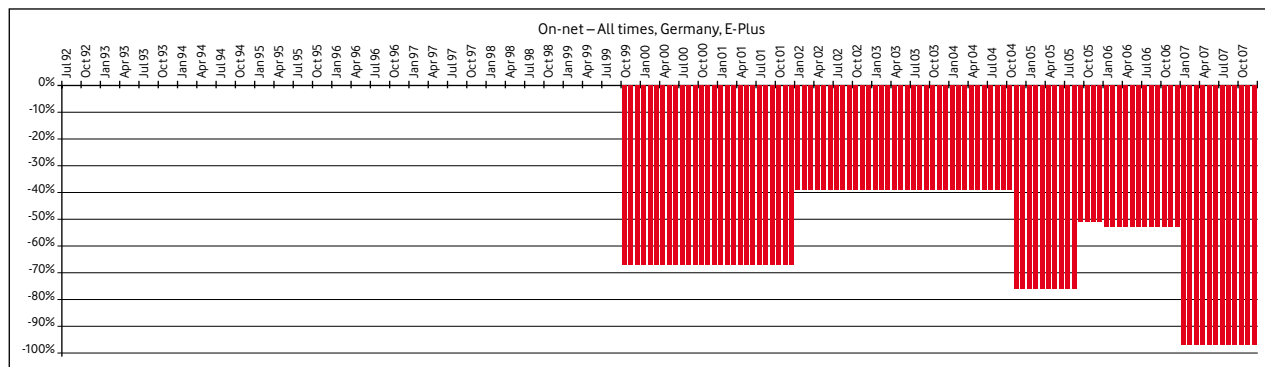
The on-net discount appears to have been first introduced in July 1996, with a 30% to 50% discount below the off-net call prices. The discount has changed over the years, and by end of 2002 the discount range was 0 to 30%, depending on package. Later the range has varied significantly.

Note: There is a gap in the source data for the years 1994 and 1995.

## Germany

E-Plus

First available data is from October 1999.



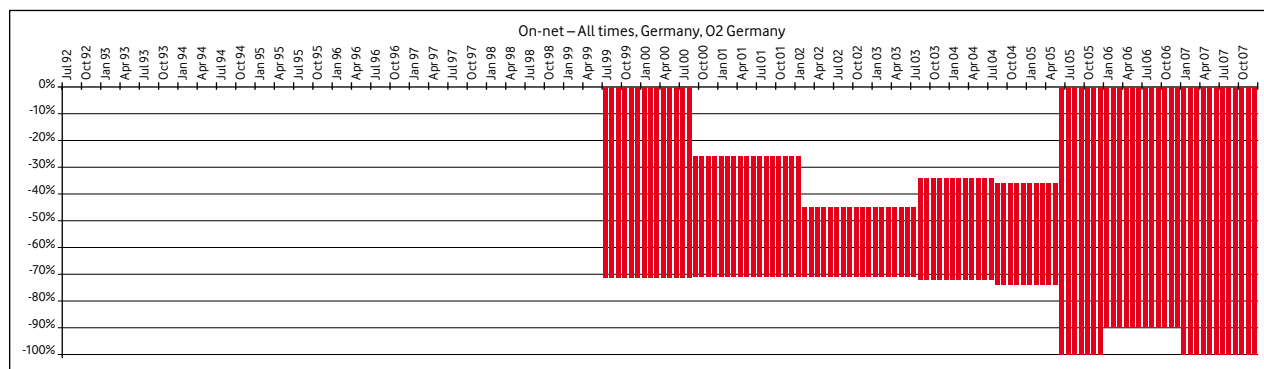
In 1999 E-Plus had already established an on-net discount of up to 67% below the off-net call price. The range has since varied a lot.



## Germany

Viag/O<sub>2</sub>

First available data is from July 1999.

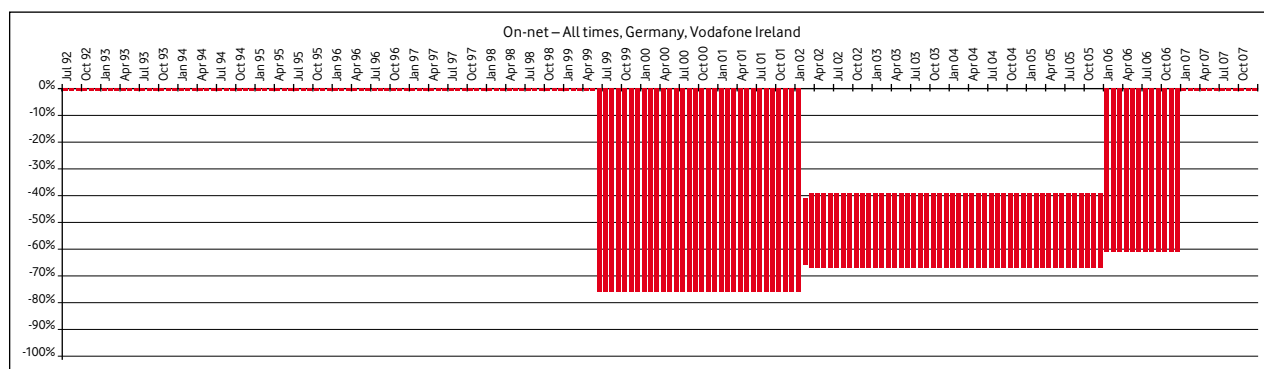


In 1999 Viag had already established an on-net discount of up to 71% below the off-net call price. The range has since been narrowed somewhat, and then widened significantly from 2005 onwards.

## Ireland

Eircell/Vodafone

First available data is from July 1992.

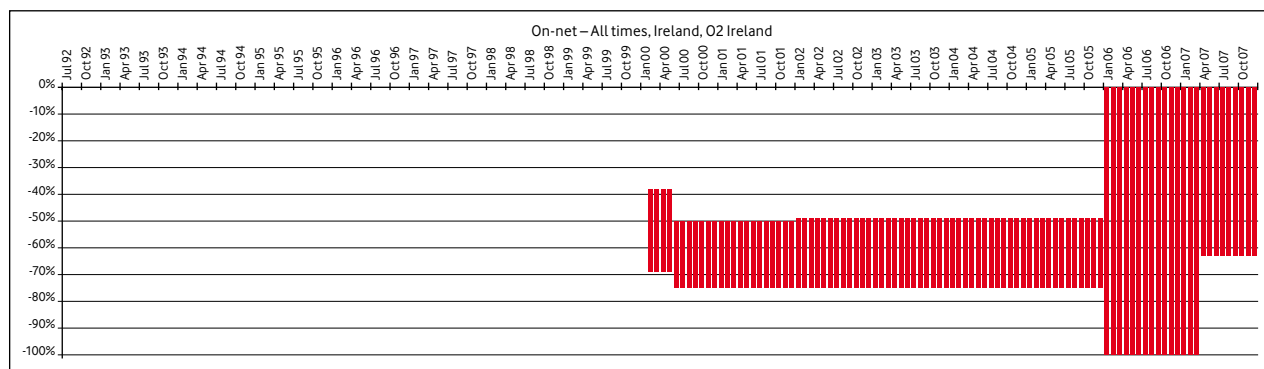


The first on-net discount appears to have been introduced in May 1999, with a discount of up to 75% below the off-net call prices. The range of discounts was later narrowed and reduced somewhat. In 2007 the discount was completely removed.

## Ireland

Esat/BT

First available data is from February 2000.

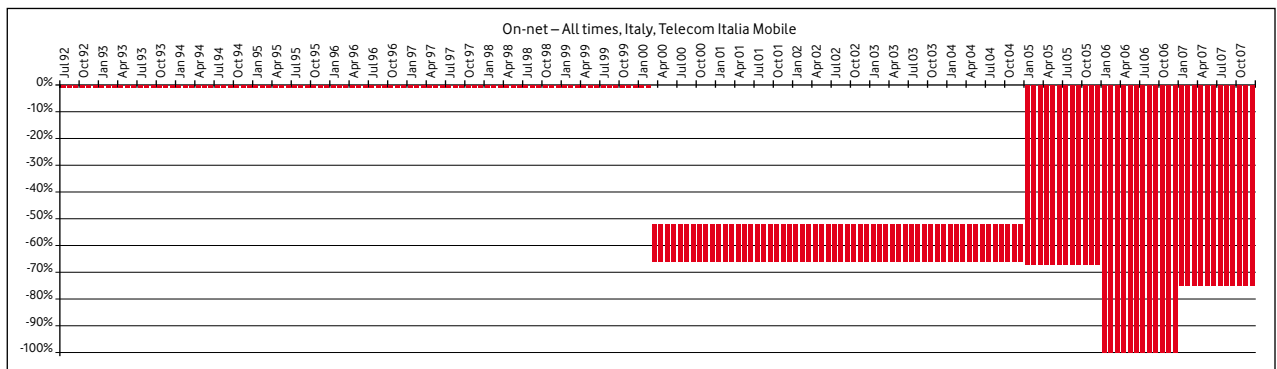


Esat had already established an on-net discount in 2000, with a discount range of 38% to 69% below the off-net call prices. There have been significant variations in later years.

## Italy

Telecom Italia Mobile/TIM

First available data is from July 1992.

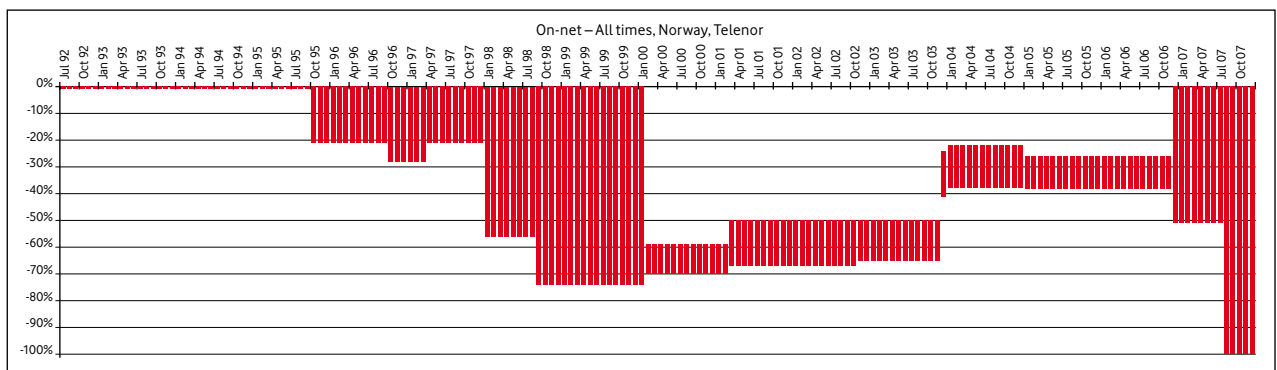


Discounted prices for on-net calls appear to be introduced in March 2000, with a discount range of 52% to 66%. In 2007 the range is 0 – 75%.

## Norway

Telenor

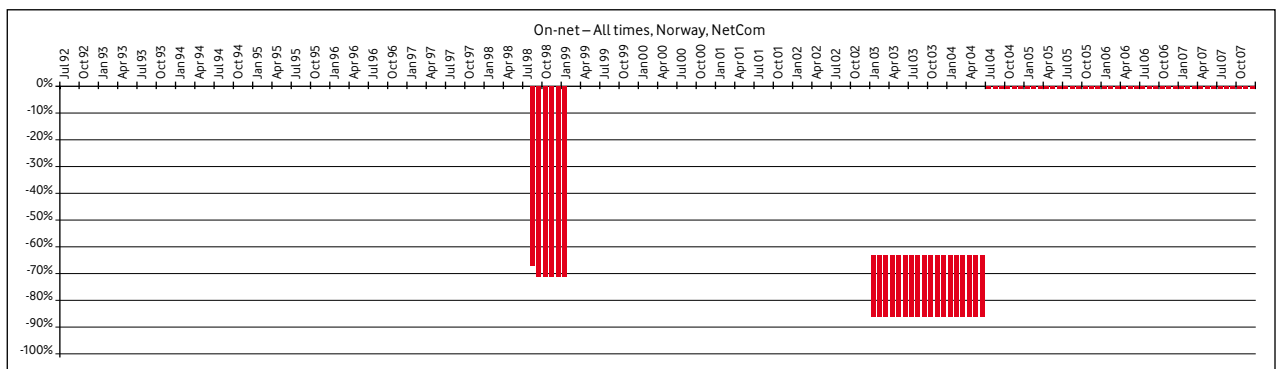
First available data is from July 1992.



Telenor appears to have introduced on-net discounts in October 1995. The original discount range was 0 to 21%, in 2002 the range was 50% to 65% discount below the off-net price level, and in 2007 the range was 0 – 100%.

## Norway

Netcom

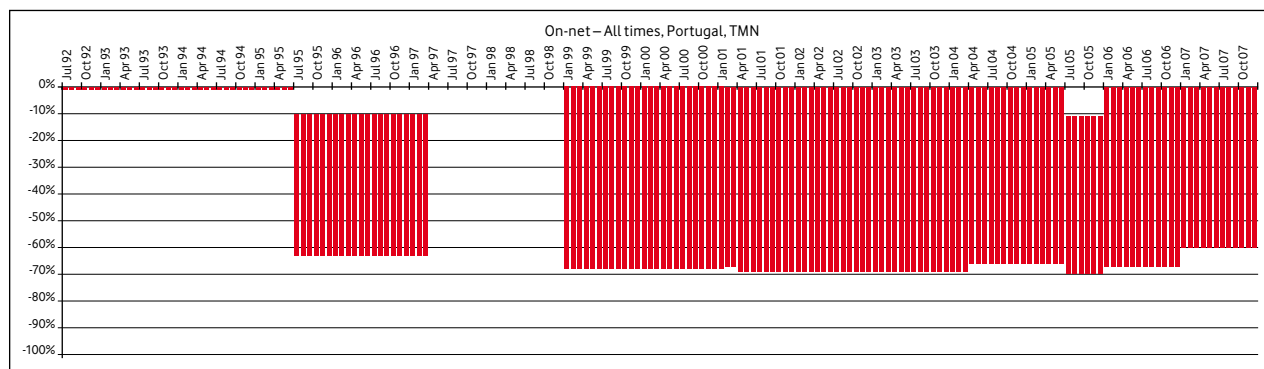


First available data is from August 1998. Unfortunately there are gaps in this data, but the on-net discount concept was clearly introduced before 1998, and most likely around the same time it was introduced by Telenor. Currently Netcom advertises the fact that all calls have the same price, regardless of destination network.

## Portugal

### TMN

First available data is from July 1992.



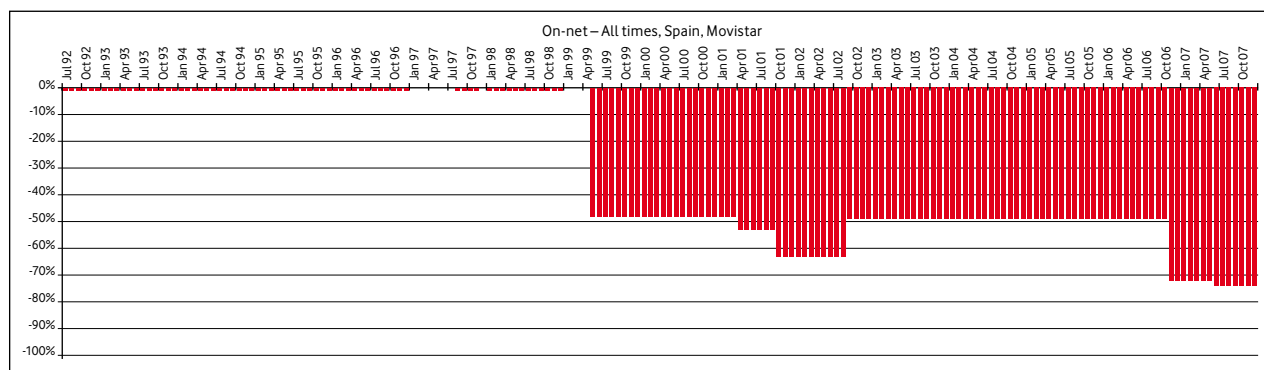
Discounted prices for on-net calls appear to have been introduced in July 1995, with a discount range of 10% to 63% below off-net call prices. The on-net discounts have been relatively stable right up until today.

Note: There is a gap in the source data from April 1997 to December 1998.

## Spain

### Telefonica/Movistar

First available data is from July 1992.

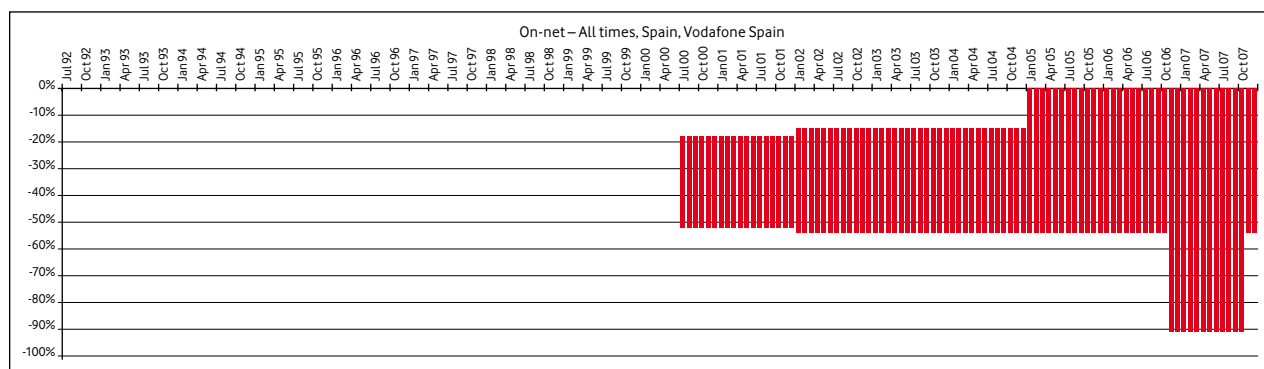


The source data suggest that a major tariff review took place in May 1999, and on-net prices became different from fixed line call prices at that time, so it is likely that this review also introduced the on-net discounts relative to off-net prices.

## Spain

### Vodafone

First available data is from July 2000.

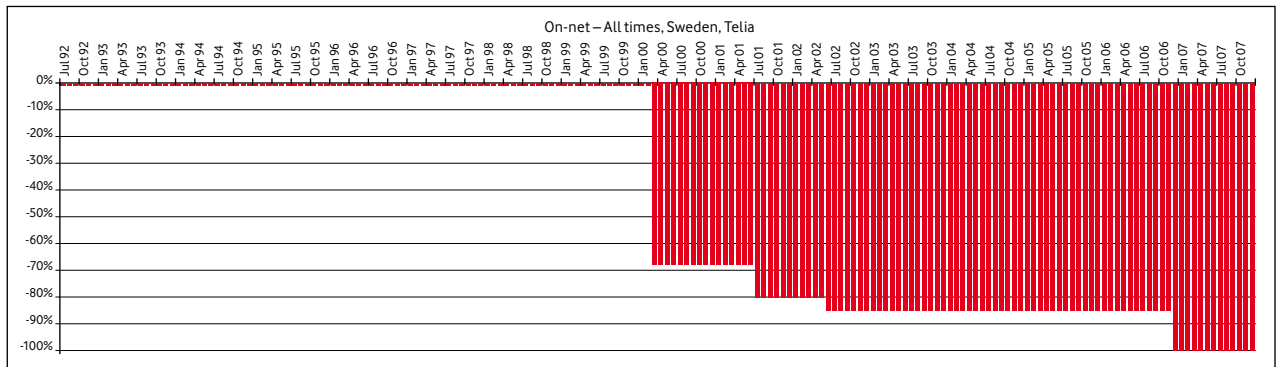


The on-net discount appears to follow (or lead on) the Movistar discount quite closely. The discount levels are rather similar.

## Sweden

### Telia

First available data is from July 1992.

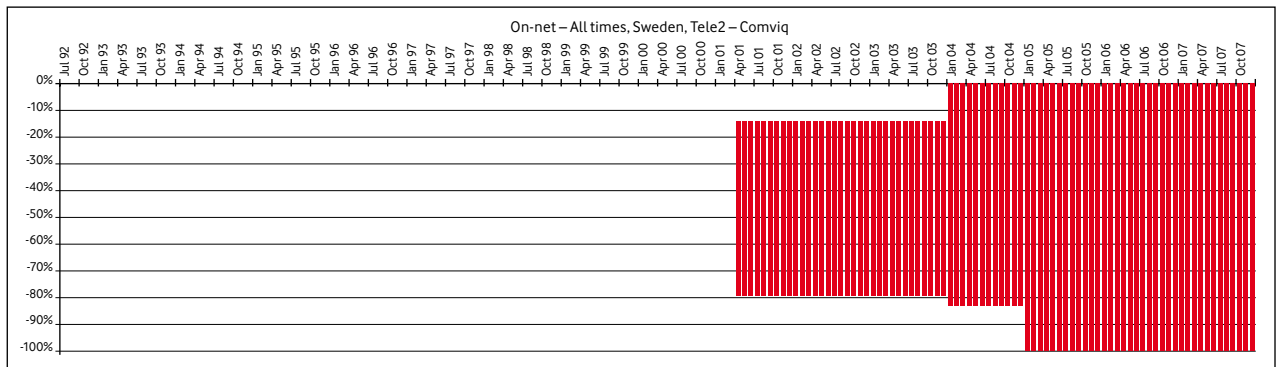


On-net discounts were first introduced in March 2000, with a discount range of 0 to 68% below the off-net call prices. Since then the discount range has expanded.

## Sweden

### Tele2

First available data is from April 2001.

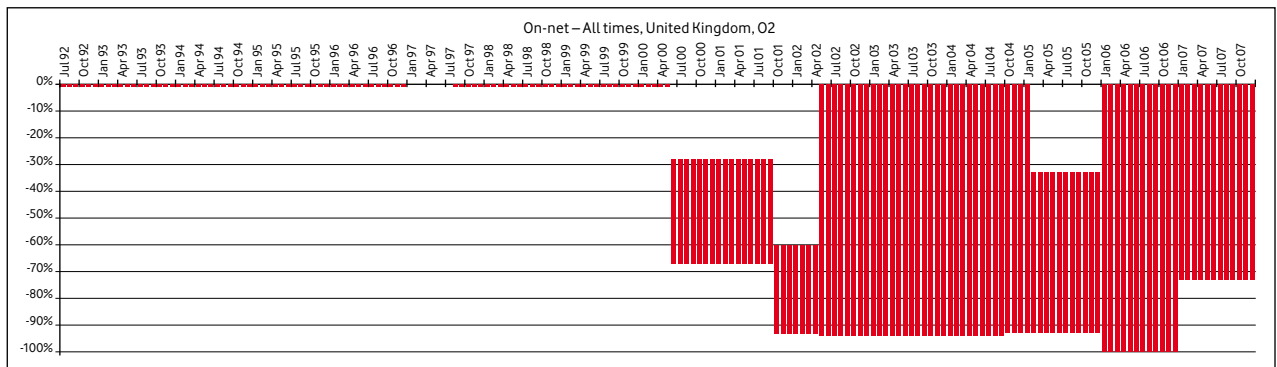


On-net discounts have been a regular feature with Tele2 at least since beginning of 2001, most probably before that.

## United Kingdom

### Cellnet/O2

First available data is from December 1992.

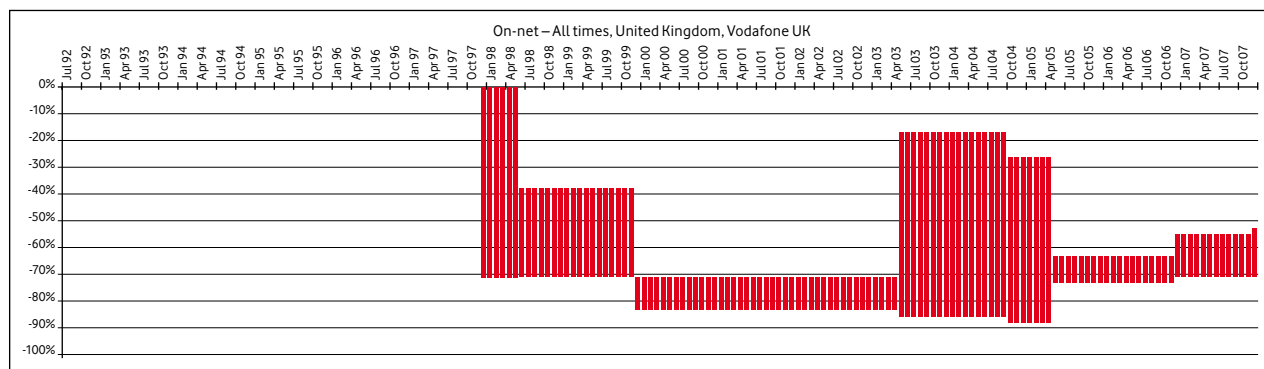


Cellnet appears to have introduced on-net discounts in June 2000. The discount range was 28% to 67% below the off-net call prices. Since the end of 2001 the discount range has been very wide, right up to including free on-net calls for a period.

## United Kingdom

### Vodafone

First available data is from December 1997.

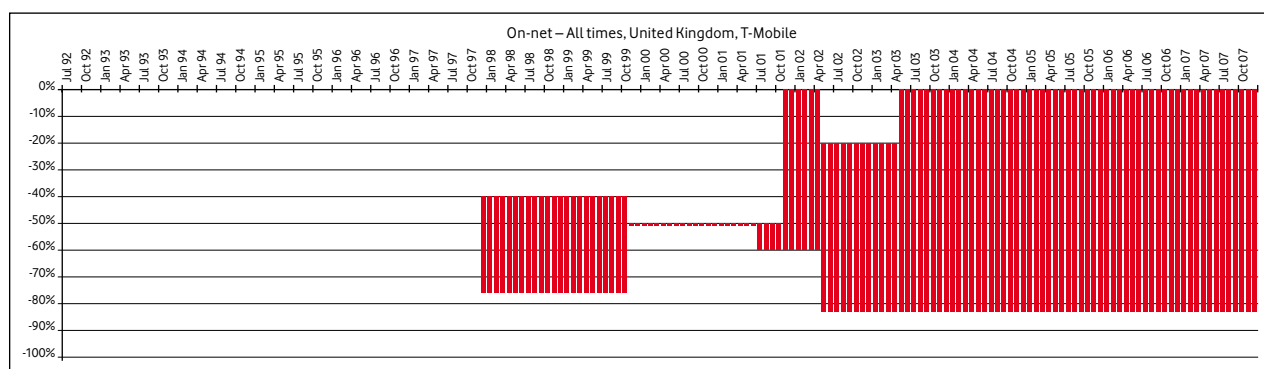


The first available data for Vodafone is from December 1997, and the on-net call prices were already differentiated from off-net.

## United Kingdom

### One2One/T-Mobile

First available data is from December 1997.

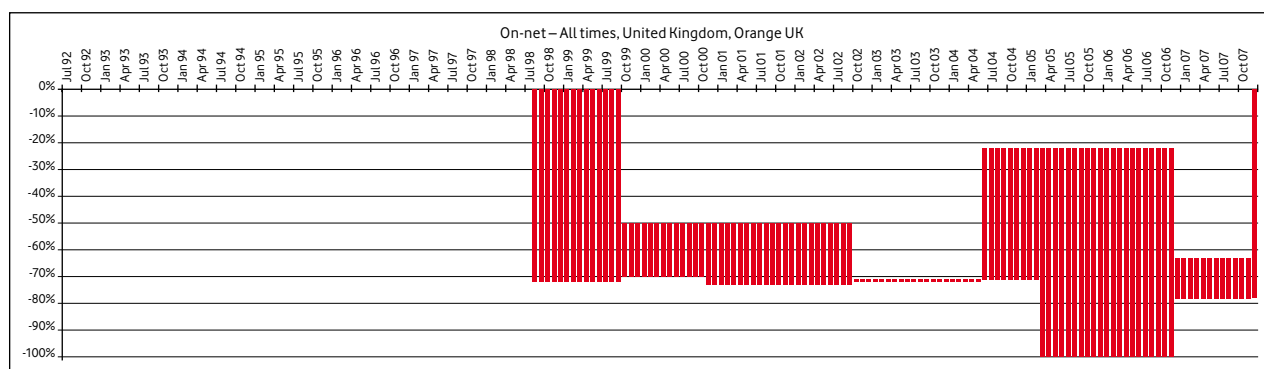


Different prices for on-net and off-net calls were already available with the first available data from December 1997.

## United Kingdom

### Orange

First available data is from August 1998.



The lower call prices for on-net calls were available with the first available data in August 1998.



**Dr. Jonathan Sandbach**

Head of Regulatory Economics,  
Vodafone Group Public Policy

Jonathan Sandbach has been a professional economist working in the telecommunications industry for over 20 years. This has included positions within British Telecom, Cable and Wireless and currently Vodafone, where he is Head of Regulatory Economics. He has also been a senior consultant at National Economic Research Associates, where he advised a number of telecommunications operators and national regulatory agencies worldwide. Jonathan Sandbach holds degrees in Mathematics, Statistics and Economics from the University of York, the London School of Economics, and a PhD from City University London.

## Theory and practise of on-net pricing

### Abstract

This paper confronts the economic theory on on-net pricing with the observed pricing behaviour of mobile network operators (MNOs). We find that on-net pricing has been a feature of the mobile telecommunications sector since the beginning of network competition. It has been used by all MNOs (irrespective of size), but has not served to tip the market in favour of any particular type or size of operator, or to produce any particular market outcome.

We also find that on-net discounting is often less aggressive than would be predicted by differences between the marginal costs of on-net and off-net calls (the latter including off-net termination charges). This suggests that call externalities (which would imply even higher observed discounts) are minimal, and/or mobile network operators believe that benefits of on-net pricing are outweighed by subscriber demands for simpler flat rate on-net and off-net pricing schemes.

### Possible reasons for on-net discounts

There have been three main reasons put forward seeking to explain the existence of on-net discounts:

1. Predatory price discrimination by large MNOs to foreclose competitive new entrants;
2. Differences in the perceived marginal costs between on-net and off-net calls; and
3. Call externalities – leading to networks discounting on-net calls to internalise these call externalities within their own network (since on-net calls provide the call externality to the networks' own subscribers).

This paper tests these three reasons against the observed reality of the European mobile markets.

### Is there any evidence that on-net has been used as a predatory tool?

Rather than being seen as a legitimate pricing strategy in competitive markets, the existence of on-net discounting has been seen by some as a predatory tool by larger MNOs to tip the market. However, such a view is not correct.

First, the assertion that on-net pricing is a tool for predation is not supported by economic literature. The paper by Dan Elliott earlier in this pamphlet questioned whether on-net pricing is indeed an effective predatory strategy. If a large network were to attempt to use on-net discounting as a predatory pricing tactic, it would be a very costly and Dan Elliott shows that there are potentially more effective routes for doing this, such as reducing monthly fees. Hoernig (2007)<sup>1</sup>

expresses this point by saying “There are ‘decreasing returns to scale’ in predation: any further reduction in the small firm’s profits is bought at increasing cost for the large firm.”

Second, all these models potentially over-state any benefit to large networks by assuming that, other than for on-net/off-net price differentials, subscribers will distribute their calls across all networks in strict proportion to network size. In practice this is not true. It is clearly not true in the business market where a high proportion of calls will be intra-company, and research shows that neither is it true in the consumer market where calls are concentrated to family and friends. For example, Birke and Swann (2007);<sup>2</sup> in the context of their study estimated that “ten million subscribers to a network have the same impact on consumer choice as one additional member from the same household being on the same network.” Thus the benefit of on-net calling is independent of network size. This is described in the paper by Jordi Gual as the difference between endogenous and exogenous network effects. To the extent that network effects are exogenous, they can be exploited in small networks as easily as in large networks.

Third, realities of European mobile markets clearly demonstrate that on-net pricing has occurred during a period of increasing competition – counter to what one would expect if such tactics were indeed predatory. As we will see, on-net pricing has been practised by both large and small networks in Europe for over 10 years, and during that time the larger networks have progressively lost market share.

On-net pricing can be traced back to the origins of network competition in Europe in the mid-1990s (see the accompanying paper “On-net Pricing in Mobile Services” by Teligen).

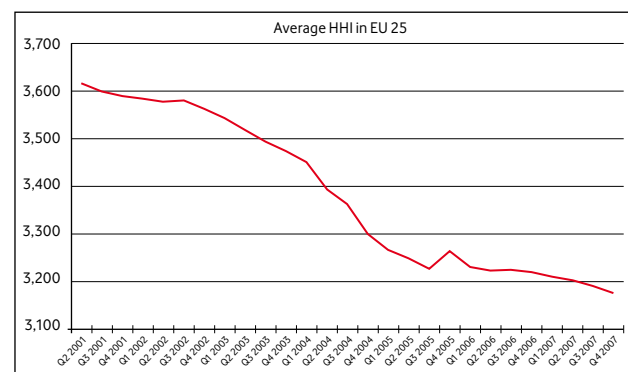
Table 1 shows a strong correlation between the introduction of on-net pricing by established operators (e.g. T-Mobile in Germany) and entry of a new operator 6-18 months previously (e.g. E-Plus). In many cases, the new entrant has initiated on-net competition with the established operator following later.

On-net and off-net price differentiation appears to be one of many tools that new and established MNOs use to engage in increasingly intense competition. On-net pricing

is firmly established as part of a competitive landscape, in which new entrants have consistently gained market share at the expense of existing networks. This appears to fit the theoretical results discussed in the paper by Dan Elliott earlier in this pamphlet, which show that on-net/off-net price differentials intensify competition between MNOs.

One of the principal indicators of the extent of competition in a market is the HHI (Herfindahl-Hirschman Index<sup>3</sup>) – a measure of market concentration. Chart 1 shows the average HHI<sup>4</sup> for the European mobile sector as a whole from 2001. On average, the HHI has fallen as new entrants have gained market share. The HHI has risen at particular points in time in particular markets (for example immediately following a merger), but the general pattern of a falling HHI (and increasing competitiveness) is clear.

**Chart 1:**



On-net pricing has been a feature of the mobile market throughout this period of falling HHI.

While on-net pricing has occurred during a period when the average HHI in the European mobile market has been decreasing, one may argue that this fails to disprove that on-net pricing in a particular country has resulted in less competition. Such an argument, however, is not supported by the facts. Chart 2 shows that there is no correlation between on-net pricing and the HHI in any European country.<sup>5</sup> That is, whether a particular country has on-net pricing or not, plays no part in determining the level of competition in its mobile market.

**Table 1: Examples of introduction of on-net price differentiation by established operators**

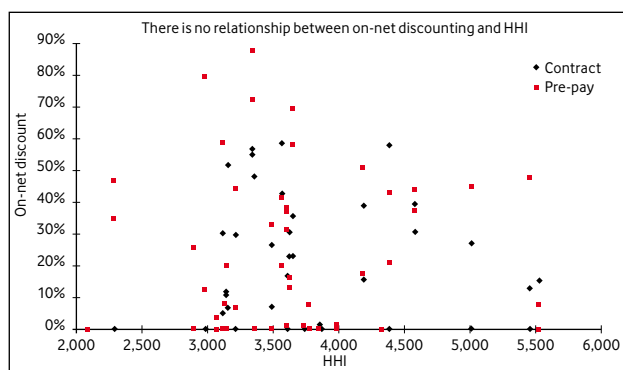
	Established MNO on-net pricing	Launch of new network
Germany	Jul-95 (T-Mobile)	May-94 (E-Plus, with on-net pricing)
Norway	Oct-95 (Telenor)	Sep-93 (NetCom)
France	Jul-97 (SFR)	Jan-96 (Bouygues)
UK	Jan-98 (Vodafone)	Sep-93/Apr-94 (One2One/Orange, with on-net pricing)
Ireland	Jun-99 (Eircell)	Mar-97 (Digicell, with on-net pricing)
Spain	May-99 (Movistar)	Jan-99 (Amena)
Italy	Mar-00 (TIM)	Mar-99 (Wind)

Sources: Teligen (Established MNO pricing)

GSMA (launch dates)

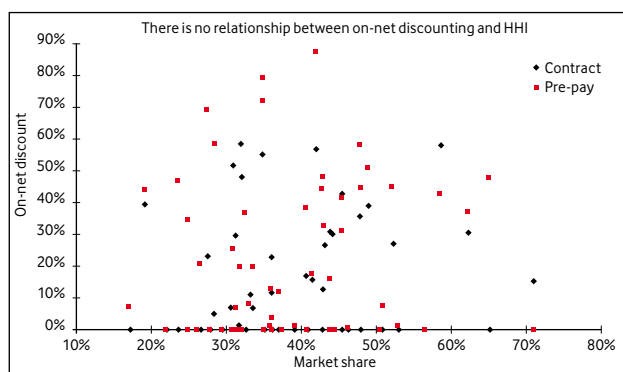
Previous Frontier Economics report for Vodafone (new network pricing)

Chart 2



In addition to this, we tested whether there is a relationship between on-net pricing and the market share of MNOs. There is no apparent relationship between the size of on-net discounts and the size of the network operator (in terms of either absolute size or market share – see Chart 3), irrespective of whether the MNO is a long established operator or a new entrant.

Chart 3



From the evidence available for European mobile markets, it is clear that the existence of on-net pricing is not related to either the level of competition in a market, or the market share of MNOs which utilise this pricing strategy.

## How important are on-net discounts?

Most MNOs offer a wide range of tariff plan options, many of which include on-net discounts. Some tariffs will not distinguish between on-net and off-net for calls made in bundles, but will distinguish for calls made outside bundles. The Teligen research shows that, for any individual tariff plan, on-net discounts (compared to mobile-to-mobile off-net prices) can range between zero and 100%. The impact of on-net pricing will, therefore, vary according to how subscribers distribute themselves between different price plans, and by their propensity to choose plans according to their on-net and off-net calling patterns. Subscribers who make few on-net calls are more likely to choose a pricing plan with no on-net discounts, whereas those that make a high proportion of on-net calls will likely choose a pricing plan that allows them to do this at minimum cost.

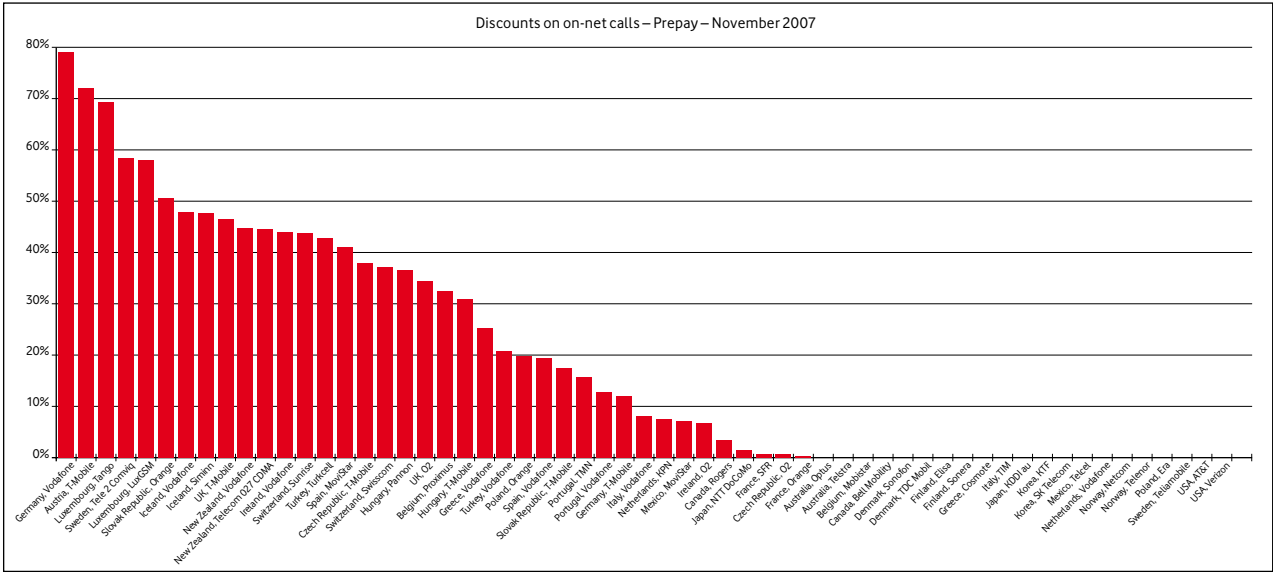
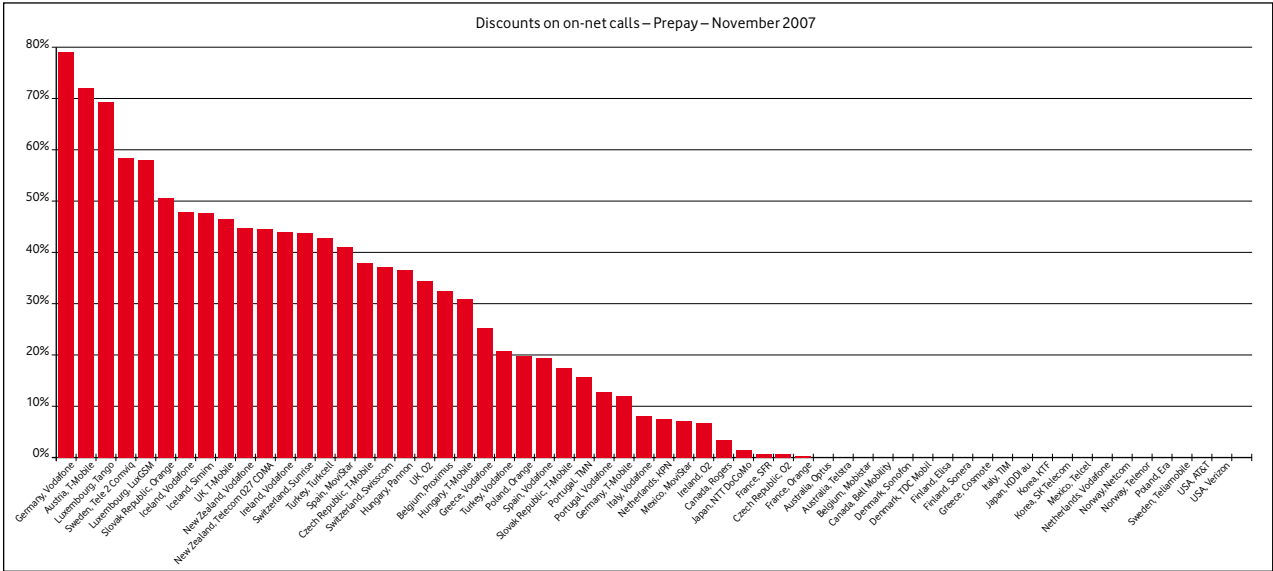
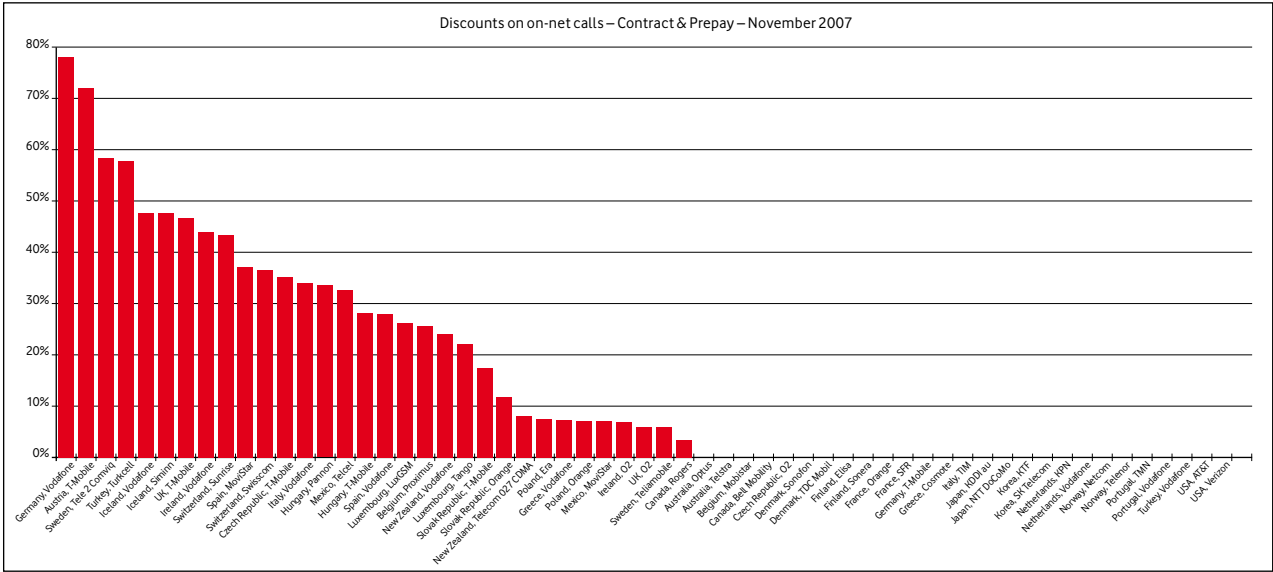
Data on take-up of individual tariff packages remains commercially confidential. But it is possible to model the impact of on-net pricing by taking a typical mobile subscriber usage, and selecting the tariff plan that would optimise that subscriber's total expenditure. By flexing the proportion of on-net and off-net calls we can then measure the impact of on-net pricing. We constructed two user profiles: one consisting entirely of on-net calls, and one consisting entirely of mobile-to-mobile off-net calls. In both cases we took 65 calls a month, at 1.8 minutes per call, corresponding to the OECD medium user basket. We used the Teligen T-Basket tool to perform the optimization calculations, on the database of all tariffs offered by the two largest MNOs in each OECD country. Results are shown in Chart 4<sup>6</sup>

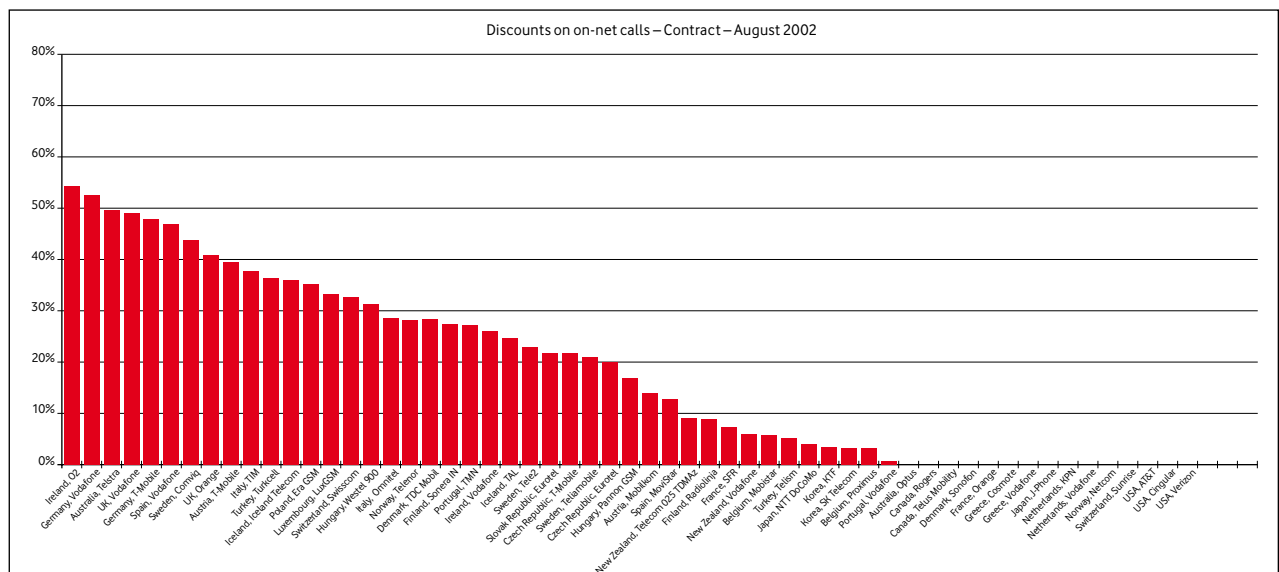
Results for pre-pay and contract tariffs are then shown separately. In Chart 5 we show the equivalent results for August 2002 (the earliest date for which broadly consistent Teligen data is available).

A number of significant observations can be derived from this data:

- In only about half the cases are on-net discounts material for typical medium users if they are optimising their tariff plan choice. The impact of headline on-net tariffs on market dynamics needs to be considered in this light;
- Where on-net tariff discounts are material, their range can be very large – up to 80%, but with a median of 28% (relative to off-net);
- On-net discounting is more significant in pre-pay than in contract tariffs; and
- Although effective on-net discounts offered by operators change rapidly, the overall pattern of on-net discounting across the OECD has changed little between 2002 and 2007.

Chart 4:







## Differences between termination rates and marginal costs

Market evidence clearly shows that there has been no anticompetitive effect of on-net pricing – disproving the assertion that it is a predatory pricing strategy. This leaves two rational economic reasons why such pricing exists:

1. Differences in the perceived marginal costs between on-net and off-net calls; and
2. Call externalities – leading to networks discounting on-net calls to internalise these call externalities within their own network (since on-net calls provide the call externality to the networks' own subscribers).

The theoretical models predict that, in the case of two-part tariff (monthly rental plus price per minute)<sup>7</sup> the ratio of on-net and off-net call charges will be<sup>8</sup>:

$$\frac{c_o + c_t}{c_o + a} \times \frac{1 - \gamma\alpha/(1 - \alpha)}{1 + \gamma} \quad \text{provided } \gamma(1 + \alpha) < 1 \quad (\text{Formula1})$$

where  $c_o$  is the marginal cost of call origination;

$c_t$  is the marginal cost of call termination;

$a$  is the termination rate;

$\gamma$  is the call externality factor (the utility of receiving calls relative to the utility of making calls – a value of 1.0 indicates equal utility);

$\alpha$  is subscriber market share.

This expression is useful because it allows us to predict on-net pricing discount as a product of two components: the first is the ratio between the marginal costs of on-net and off-net call (the latter including the other network's termination rate); and the second, a factor that is only important if there are call externalities<sup>9</sup>. The two-part tariff model accurately captures the contract market, whilst the pre-pay market is best captured by a simply linear tariff model.

The first term can be estimated. Most national regulators have an objective of cost based call termination pricing.<sup>10</sup> The existing bottom-up mobile network costing models developed by a number of European regulators are aimed at providing long run incremental costs plus common cost mark-ups (in the case of OPTA), or average costs (in the case of Ofcom). However, the models are also flexible enough to provide a basis for estimating the long run marginal network cost of call origination and termination. Typically<sup>11</sup>:

$$\frac{c_o + c_t}{c_o + a} \approx 0.5$$

Ignoring call externality effects, we would, therefore, expect to see on-net discounts of around 50%, when averaged across all tariffs offered by an operator. Comparing this value to Chart 4, we see that very few MNOs have effective on-net discounts as high as this. From this we conclude that call externalities have minimal impact in on-net pricing decisions; and/or there are other factors that moderate MNOs' incentive to offer on-net pricing. The latter would include number portability (which reduces caller awareness of when a call is on or off-net), and tariff simplicity (consumers demand the simplicity of a single retail price across all networks).

The conclusion that call externalities are of minimal importance is also supported by the fact that on-net discounts (from Chart 3) bear no obvious relationship to market share of the MNOs. From formula (1) we see that, in the presence of call externalities, we expect on-net discounts to be higher for networks with a high market share. This is because, in the presence of call externalities, receipt of off-net calls provides disproportionately higher value to small networks, and so their large competitors have greater incentive to increase off-net call prices – effectively increasing the on-net discount. In the absence of a call externality large networks derive no such benefit – and this is what we see in practise.

## Conclusion

Differentiation of on-net and off-net call prices has been an enduring feature of the competition in the European mobile services market since the mid-1990s. On-net discounting is often introduced by small networks to gain market share, and by large networks to defend market share, but neither obtains a decisive advantage. There is no evidence to suggest that it is an effective predatory tool.

Although on-net discounts vary across tariff options, the "average" level appears consistent with marginal cost differentials for on-net and off-net calls. There is no evidence for call externalities – another factor that could contribute to on-net discounting. Rather, MNOs appear to prefer to move towards eliminating on-net discounting in preference for the simplicity of flat cross-network tariffs.

## Notes

- 1 Hoernig, S. "On-net and off-net pricing on asymmetric telecommunications networks", *Information Economics and Policy*, 19 (2007) pp171-188.
- 2 Birke, D. & Swann, G.M.P. (2007) 'Network Effects in Mobile Telephony', in Benzoni, L. & Geoffron, P. (eds.) *A Collection of essays on Competition and Regulation with Asymmetries in Mobile Markets*, Quantifica Publishing.
- 3 The sum of the square of market shares.
- 4 Weighted average across 25 EU countries.
- 5 On-net discounts have been calculated in the manner described in the next section.
- 6 For a basket sensitivity test, we repeated the analysis for both the low and high baskets with very similar results in terms of on-net discounts.
- 7 Unfortunately it is not possible to derive an analytical formula for the on-net discount under a simple linear pricing model (see Berger (2004), "The Economics of Two-way Interconnection"). However, it is reasonable to assume that it differs from the two-part tariff in that prices of both on-net and off-net calls will exceed their respective marginal costs (in order to cover subscriber specific costs).
- 8 See, for example, Hoernig, S. (2007), Op. Cit. See equation (16). It is not possible to provide an equivalent mathematical formula for simple linear tariffs (per minute charges), but numeric simulations suggest that the on-net discounts will have very similar properties.
- 9 If there are call externalities, an MNO would want to reduce the price of on-net calls (below marginal cost), since stimulating greater volumes of these calls increases the value of the network to the receivers. Conversely, off-net calls provide a benefit to another network, and so MNOs will not be willing to discount these calls. In fact MNOs may want to increase the price of these calls (above marginal cost) to reduce their volumes and the benefit provided to the competing network.
- 10 Some regulators (e.g. Ofcom) add surcharges for network externalities.
- 11 This is consistent with marginal costs being about one third the termination rate; results will vary between markets and technology.



To keep the environmental impact of this document to a minimum, we have given careful consideration to the production process. The paper used was manufactured in the UK at mills with ISO14001 accreditation. It is 75% recycled from de-inked post consumer waste. The document was printed in accordance with the ISO14001 environmental management system. All the steps we have taken demonstrate our commitment to making sustainable choices.

Designed and produced by Barrett Howe Plc