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MOBILE TELEPHONY IN THE U.K.

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***Abstract**: This paper discusses aspects of recent policy towards mobile telephony in the U.K., including (i) the level of retail charges for calls from fixed to mobile networks, (ii) the level of call termination charges on mobile networks, and (iii) the level of connection subsidies offered by mobile networks. A formal model of the market is introduced, which offers a direct linkage between call termination rates and the level of connection subsidy. This provides a framework for discussing the ideal level of call termination charges on mobile networks, a topic of current controversy in the U.K.*

1. INTRODUCTION

The desirable degree of liberalisation in fixed telephony is a controversial topic within many countries in Europe and elsewhere. Most countries, however, have in recent years followed a policy of reasonably full liberalisation for mobile telephony, and two, three or four mobile networks often compete for subscribers in the same area. Partly this contrasting approach is due to the different cost characteristics of mobile telephony, with sunk costs playing a less important role than in the fixed sector, and partly it is due to the perception that social obligations, which are often used as a justification for entry restrictions, apply more to the fixed sector. Because of this greater liberalisation, many of the complicating factors which arise in the fixed sector are not an issue in mobile telephony, which in many respects behaves as other unregulated oligopolies.

However, there remain a number of special features in the sector which are important for public policy to address, and these are discussed in the context of the U.K. industry in this paper. These include (i) the level of retail charges for calls from fixed to mobile networks, (ii) the level of call termination charges on mobile networks, and (iii) the level of connection subsidies offered by mobile networks, all of which are the subject of recent debate in Britain.[1]

[1] This paper will not discuss other mobile services such as radio paging, the method by which mobile licences are allocated (such as spectrum auctions), nor the desirable number of licences which should be issued. Also, Britain has a somewhat complicated industry structure in the mobile sector in which the network operators are restricted in their ability to retail services directly to the public, and must often act through intermediaries. As this system appears to be coming to an end, this aspect of U.K. policy is not discussed in the paper, but see Oftel (1997b) for more details.

The mobile sector in the U.K. very briefly is as follows.[2] The U.K. is a fairly typical country in Europe when it comes to mobile telephone usage, and the fraction of the population who are mobile subscribers is given below for various countries:

Table 1: Mobile penetration rates in selected countries (1997)

France	Germany	Spain	U.K.	Italy	Nordic
4.3%	7.2%	7.7%	11.9%	12.1%	28.2%

(Source: *Financial Times*, 11 June 1997.)

The U.K. has four mobile network operators, and there are no plans to license further firms for the foreseeable future. These were licensed in two stages. In 1985 *Cellnet* and *Vodafone* began operations initially using analogue technology, and in 1994 these were joined by *Mercury One-2-One* (*MOTO*) and *Orange* using (DCS) digital technology. (At the same time, Cellnet and Vodafone were granted licences to use another digital technology, GSM, in addition to their existing analogue networks.) Cellnet is majority-owned by BT, the main fixed operator in the U.K., and MOTO is majority-owned by Mercury, which is one of BT's main competitors in the fixed sector. Thus Cellnet and Vodafone had a substantial head-start in the industry which is reflected in the current market shares of mobile subscribers. Of the approximately 6.3 million subscribers in Britain in 1996, the four operators had market shares as follows:

Table 2: Market shares of subscribers in the U.K. (September 1996)

Vodafone	Cellnet	Orange	MOTO
41%	40%	11%	8%

(Source: Oftel, 1997a, Table 24.)

A different pattern of market shares is seen if we look at outgoing call-minutes:

Table 3: Market shares of outgoing call-minutes in the U.K. (July 1996)

Vodafone	Cellnet	Orange	MOTO
31%	28%	11%	30%

(Source: Oftel, 1997a, Table 23.)

The reason for this disparity is that MOTO currently has a tariff policy of offering unlimited free calls in off-peak periods in many regions, which of course promotes the use of its network. Naturally, this high usage is not mirrored in the revenue shares:

Table 4: Market shares of revenue from outgoing calls and rentals (July 1996)

Vodafone	Cellnet	Orange	MOTO

[2] See Armstrong (1997) for a more detailed survey of the whole telecommunications industry in the U.K., together with an account of recent policy by Oftel (the industry regulator in the country).

45%	38%	9%	7%

(Source: Oftel, 1997a, Table 25.)

(Note that is not possible to disentangle revenues corresponding to the monthly rental charge from the call usage revenues since all operators offer tariffs in which a subscriber receives a, possibly large, number of 'free' calls included in the monthly fee.) Thus we see that Vodafone tends to attract subscribers with a slightly higher revenue stream than the other operators.

It is reasonable to describe the market for mobile subscribers as being quite competitive, especially since the entry of Orange and MOTO: operators advertise heavily about their prices, tariff innovations (such as per-second billing, and discounted calls to others on the same network), and regional coverage. Although Orange and MOTO have relatively small market shares at present, they are starting to catch up. For instance, the percentage growth of subscribers over the year 1995 to 1996 for the four networks is as follows:

Table 5: Net subscriber growth from September 1995 to September 1996

Vodafone	Cellnet	Orange	MOTO
29%	22%	151%	34%

(Source: Oftel, 1997a, Table 24.)

This fairly competitive marketplace is likely to be made more so since Oftel has announced that it intends to require all mobile operators to provide "number portability", so that a subscriber is allowed to keep her old mobile telephone number if she chooses to change operator, from 1998 (see Oftel, 1997d). Many subscribers, on both fixed and mobile networks, believe that having to change telephone number if they change operator is a major barrier to switching, and hence without number portability operators can to some extent treat existing subscribers as being "captive".

However, the fact that this market is competitive has little bearing on the effectiveness of competition in the market for calls *to* mobile subscribers, and this is discussed in the next section.

2. CALLS FROM FIXED TO MOBILE NETWORKS

The charges that fixed networks make for calls to mobile subscribers is currently unregulated in the U.K., even for BT, and there is some concern that such charges may be too high in relation to the associated cost, even taking as given the (high) termination rates payable to mobile networks. (These termination rates are discussed in the next section.) The market share of calls from the various fixed networks to mobile subscribers is as follows:

Table 6: Market share of call minutes from fixed to mobile networks (July 1996)

BT	Mercury	Others
84%	12%	4%

(Source: Oftel, 1997a, Table 5.)

Thus we see that there is at least the possibility that market power in the fixed sector could be exploited to the disadvantage of fixed subscribers (and also to mobile subscribers who thereby receive fewer calls than is desirable). The following table summarises the charges involved in this market for the two main players, BT and Mercury:

Table 7: Retail and call termination charges for calls from fixed to mobile networks (July 1996)

	BT	Mercury
Average per-minute retail charge for calls from fixed to mobile networks	25p	26p
Average per-minute call termination charge paid to mobile networks[3]	16.5p	16p
Average per-minute "margin" received by fixed network	8.5p	10p

(Source: Oftel, 1997a, Tables 4, 5, 20 and 21.)

The average per-minute retail charge for calls from fixed to mobile subscribers include various discounts offered by BT and Mercury for high-usage subscribers, but exclude value-added tax. For comparison, BT's current charge for calling the U.S.A. during peak-time is around 20p per minute (excluding value-added tax and any discounts offered by the company). Similarly, BT's average per-minute charge for a 'National' call, i.e. a long-distance call within the country, is less than 5p excluding value-added tax (see Oftel, 1997a, Tables 4 and 5). Thus subscribers on fixed networks currently are required to pay a rather substantial charge when they call mobile users. Moreover, there is evidence that subscribers are not always aware of the high charges for calling mobile networks - see Oftel (1997c, section 7).

[3] Care must be taken when calculating average call termination payments from Oftel (1997a). For instance, Table 20 shows that BT paid £110 million to mobile networks for interconnection during July to September 1996, Table 5 shows that 534 million minutes of calls originated on BT's network destined for the mobiles networks, and Table 21 shows that BT required 668 million minutes of call termination from mobile networks (all during the same period). The discrepancy between 534 and 668 is due to the fact that other networks (including mobile networks) use BT as an intermediary to deliver calls destined for mobile networks, and so BT demands more call termination than is required from its own subscribers. (It is costly for many small networks to negotiate bilateral interconnection contracts with each other.) The average payment BT makes for call termination is thus 110 divided by 668, not divided by 534.

The table shows that a large part of this retail charge is paid out in call termination payments required by mobile networks. In fact, the charges that fixed operators must pay mobile networks to deliver their calls are subject to individual negotiation, and therefore differ according to both the fixed and the mobile network. For instance, in 1996 BT paid substantially more to Vodafone and Cellnet than it did to Orange and MOTO, although this differential has been narrowing recently, and this difference is reflected in its retail charges - see Oftel (1997c, section 2) for more detail. One possible reason for why BT was prepared to offer more generous terms to Vodafone and Cellnet than to Orange and MOTO is that BT has a controlling interest in Cellnet, and hence has less incentive to negotiate low charges.

On average, however, Table 7 shows that both BT and Mercury have a substantial margin of nearly 10p per minute on their calls to mobile networks, a margin which is approximately double the level of BT's average long-distance charge. Therefore, unless it costs a fixed network much more to deliver a call to the point of interconnect with a mobile network than it does to provide an end-to-end long-distance call within its own network, it seems likely that fixed networks indeed charge more for calls to mobile networks than is justified by the associated costs. Moreover, even though BT has more market power than Mercury in this market (see Table 5), Mercury behaves no "better" than BT in this regard. One possible remedy for this problem might be for Oftel to require, perhaps informally, that the main fixed operators do not charge more for calls to mobile networks than the associated call termination charges plus their associated long-distance retail charge.

To get a very rough impression of the scope for possible welfare gains from controlling these retail charges, consider the following table which describes the reduction in "dead-weight loss" caused by bringing price down from its current unregulated level of about 25p per minute to marginal cost. I know of no public data about demand elasticities for calls from fixed to mobile networks, and so have included a range of elasticities in the table. Two levels of marginal cost are considered: 20p per minute, which corresponds to a fixed network cost of 5p together with a mobile call termination cost of 15p (roughly equal to their current average termination charge), and 15p per minute which corresponds to a fixed network cost of 5p together with a mobile call termination cost of 10p (which is less than their current average charge which Oftel believes are too high compared to cost).

Table 8: Reduction in dead-weight loss resulting from setting price equal to marginal cost (£million per annum)[4]

	elasticity = 0.5	elasticity = 1	elasticity = 2
marginal cost = 20p	5	11	21
marginal cost = 15p	21	43	85

Thus we see that welfare gains from regulating the retail prices for calling mobile users from fixed networks are neither negligible (unless elasticity of demand is low or costs are high),

[4] These calculations have been made assuming a linear demand function for calls from fixed to mobile networks, a constant marginal cost of making such calls, an initial retail charge of 25p per minute, and equal welfare weights placed on consumer surplus and industry profits. The initial level of demand is taken to be 2136 million minutes per annum, which is four times the last available quarterly figure given in Oftel (1997a, Table 5). Finally, the effect of value-added tax has been ignored.

nor enormous. Whether these benefits outweigh the associated regulatory costs of imposing new controls is a judgement best made by players in the industry.

A complementary way to reduce the high retail charges to that of new regulation, of course, would be to reduce call termination charges, which is discussed in the next section.

3. TERMINATION CHARGES BY MOBILE NETWORKS

Charges made to their subscribers are by no means the only source of revenue to mobile operators, and a network will also receive payments for terminating calls made to its subscribers originating on other networks. The vast majority of these incoming calls originate on the fixed networks. The revenue received by mobile operators from providing call termination typically makes up a large proportion of their overall revenue. For instance, between July and September 1996 the mobile operators in the U.K. received £461 million in revenue from calls and monthly rentals from their subscribers and received £140 million in revenue from providing call termination. (They paid out the relatively small sum of £20 million for call termination on the fixed networks - see Oftel, 1997a, Tables 18, 20 and 22.) There is currently some debate as to whether the level of these charges is too high when compared to associated costs.

Current policy in the U.K. is that in the first instance a mobile operator enters into bilateral negotiation with another network such as BT over the choice of its termination charges, and if such negotiations succeed then there is no intervention by Oftel. (Such a policy has an obvious drawback when one network has a controlling interest in the other, as BT has with Cellnet and Mercury has with MOTO, in that high charges may be agreed.) If, however, the parties fail to agree, as has happened between Mercury and both Vodafone and Cellnet, then Oftel steps in to determine the appropriate charges. The basis on which these charges are determined is that of "fully allocated costs", a necessarily vague basis leaving much room for argument over which costs are truly "common" and which can be allocated unambiguously to certain services.

This issue is complicated considerably in the mobile sector in the U.K. by the prevalence of various kinds of subsidies and inducements paid to subscribers when they join a mobile network. For instance, networks often offer "free" handsets to new subscribers which cost the network itself £200 or more, together with "free" insurance for a year, and so on. Sometimes a network will even offer direct bribes, such as a free compact disk player, upon joining. It is true that such subsidies are usually paid in return for signing a long-term contract with the network, typically for a year.[5] Thus some of these subsidies will be paid back over the course of the contract, and so are not true subsidies. Nevertheless, there is usually a large element of actual subsidy, even taking into account the long-term contracts, paid to new subscribers.

In addition to these subsidies, networks usually make "incentive payments" to the high-street dealers who actually sign up subscribers, say around £50 per new subscriber. Thus, to illustrate, a network may face a cost of £250 to connect a new subscriber (£200 for the handset and £50 as a reward to the dealer), and may get back £120 in guaranteed revenue

[5] In Britain it is actually quite difficult to join a mobile network without having a handset supplied at the same time. Why handsets and the retailing of airtime are so strongly bundled together in the U.K. is unclear.

stream from a 12 month contract (if the subscriber pays £10 per month in rental charge) - see Oftel (1997c) for more detail on the complex pattern of cross-subsidy within the sector. The question is, if one is using a fully allocated cost methodology to determine call termination rates, should these subsidies paid to new subscribers count as a "cost" to be allocated partly to the cost of terminating calls? Oftel (1997c, para. 5.11) states that if such subsidies *are* included as common costs to be allocated partly to call termination, termination charges would be about 4p per minute higher than otherwise.[6]

Oftel argues that there are really three basic services offered by mobile operators: outgoing calls, incoming calls and "access". The last service consists in simply being connected to the network, and is separate from making or receiving calls. With this categorisation of services, any "costs" to do with subsidising network connection should be allocated to the "access" service, and hence not at all to the cost of terminating incoming calls - see Oftel (1997c, section 5). Naturally, the mobile operators disagree with this methodology, and insist that there are just two basic services, incoming and outgoing calls, and that the cost of connection subsidies should be allocated to the two services in proportion to traffic in each direction. Indeed, Oftel (1997c, para. 5.16) states that Vodafone argues that if Oftel does *not* allocate a proportion of connection subsidies to call termination, i.e. if its termination charges are reduced significantly, then its connection subsidies could be reduced and call charges for outgoing calls could be increased.

While one can have some sympathy with the position that there are only two basic services - it is not clear what exactly the "access" service is other than the ability to make and receive calls - it is not obvious that connection subsidies are necessarily desirable. (For instance, such "connection" subsidies are only rarely observed in other industries with somewhat similar characteristics, such as cameras and film, or compact disk players and compact disks.) It is useful to have an economic framework for discussing the issue of call termination charges together with connection subsidies, and one way to do this is discussed in the following section.

4. A Model of the Mobile Telecommunications Industry

There are two sectors: fixed and mobile. The latter is assumed to be competitive and all charges except for call termination are unregulated there. All mobile operators and all mobile subscribers are assumed to be identical. The cost of structure of a mobile network consists of a fixed connection cost k per subscriber, a constant marginal cost c for providing outgoing calls and a constant marginal cost C for terminating calls from other networks. The cost k is the cost of a handset together with any other costs associated with subscribers (e.g. billing costs, and the "incentive payments" to dealers if these are really essential). The cost of making calls c is taken to be the average cost of making calls to other networks. Therefore, if a subscriber receives Q calls and makes q calls, a firm's costs for that subscriber are

$$CQ + cq + k \ .$$

The model is simplified if we make the following series of strong assumptions:

[6] As mentioned above, in 1991 Mercury was unable to agree interconnection terms with Cellnet and Vodafone, and Oftel was asked to intervene. When it did so it did *not* allow connection subsidies to be allocated to the call termination service - see Oftel (1997, section 5).

(A1) All calls from mobile networks are made to the fixed sector.
(A2) Mobile subscribers gain no utility from receiving calls.
(A3) The number of mobile subscribers is not affected by tariffs in the mobile sector, and is normalised to one.
(A4) The price of calls from the fixed to the mobile sector is equal to the associated marginal cost (including the termination charge on mobile networks).

We make assumption A1 so that the choice of the charge for mobile call termination does not affect the cost c of making calls from mobile networks. While this is not precisely true, in the U.K. at least it is a good approximation.[7] The likely effect of relaxing the other assumptions is postponed until later.

Fixed operators have to pay T per call to a mobile network for call termination. If c_f is the marginal cost for the fixed network for making calls to the point of interconnect to the mobile networks, then A4 implies that with this charge the retail price for calls from the fixed sector to the mobile sector is

$$P = c_f + T \ .$$

(The assumption that the price of calls from fixed to mobile networks is equal to cost could be because the fixed sector is competitive or, more likely, because the charge is regulated.) Suppose that with the price P each subscriber on a mobile network receives $Q(P)$ calls from the fixed network. Then the profit per subscriber made by a mobile operator for terminating calls is

$$\pi_I(T) \equiv Q(c_f + T) \times (T - C) \ .$$

Suppose a mobile network sets the fixed connection charge f and the per-call charge p for making calls. Suppose that once a subscriber has joined a mobile network with call charge p she makes $q(p)$ calls. (This is assumed not to depend on the price of incoming calls P.) Then an operator's total profit per subscriber is

$$q(p) \times (p - c) + \pi_I(T) + f - k \ .$$

The mobile sector is competitive, and market equilibrium in the sector is such that (i) operators' profits are driven down to zero, and (ii) subscriber utility is maximised subject to the break-even constraint. In this case, market equilibrium results in marginal cost pricing for outgoing calls,

$$p = c \ ,$$

and the connection charge recovers any profit shortfall, i.e.

[7] For instance, in the period April to May 1996 Oftel (1997a, Tables 19 and 23) reports that there were 1.325 billion minutes of calls originating on the four mobile networks, and that the fixed sector received 1.255 billion minutes of calls from the mobile sector. This suggests that around 95% of calls from mobile subscribers are destined for the fixed network.

$$f = k - \pi_I(T) \ .$$

This implies that the termination charge T has no effect on the charge for outgoing calls p (which is always equal to marginal cost), but only on the connection charge f. In fact, rewriting the above expression shows that the connection subsidy $k - f$ is equal to the profits generated by delivering calls $\pi_I(T)$. Thus if T is set above the marginal cost of terminating calls then $f < k$ and the mobile operator "subsidises" the cost of connection. (More properly, it is the users of the fixed network who are subsidising mobile connection via their termination payments.) It may even be that $\pi_I(T)$ is so large that operators *pay* subscribers to join, so that $f < 0$. Thus, in this model the cause of connection subsidies, which is a feature of the U.K. market, is directly caused by setting termination charges above marginal cost, not because this "makes entry to the service affordable for consumers", as Oftel says that Vodafone argues (Oftel, 1997c, section 5).[8]

What, then, is the desirable choice of T in this model? Consumer surplus in the market for calls from fixed to mobile sectors with price P is $V(P)$, where $V'(P) = -Q(P)$, and the consumer surplus of mobile subscribers is $v(p) - f$ where $v'(p) = -q(p)$. Therefore, total welfare when the call termination charge is T is

$$V(c_f + T) + v(c) - [k - \pi_I(T)] \ .$$

(Profits in both sectors are zero.) This is maximised by setting

$$T = C$$

so that there is marginal cost pricing of call termination. This in turn implies that mobile connection is not subsidised in equilibrium. This, then, broadly supports Oftel's stated position that call termination should *not* have associated to it any other costs not directly associated with providing the service.

In general terms, the affect of relaxing the assumptions made in this model goes as follows:

- If A2 does not hold, so that mobile subscribers gain (positive) utility from receiving calls, then this will have *no* effect on equilibrium behaviour in the mobile industry for a given T, but in welfare terms this will give a motive to set T below marginal cost (which then implies that the retail charge P is set below marginal cost) in order to take account of the call externality.
- If A4 does not hold, say because the fixed network is unregulated and not fully competitive (as is the case in the U.K.), then $P > c_f + T$. In this case this again provides a motive for setting $T < C$ in order to overcome the price-cost markup on calls from the fixed to mobile sectors.
- Finally, and perhaps most importantly, A3 may not hold so that there is an elastic supply of mobile subscribers. If this is so, and this seems likely in practice, then setting a higher value of T will cause more people to become mobile subscribers since their utility from

[8] In this regard it is interesting to note the Finland, which like the other Nordic countries has particularly mobile usage (see Table 1 above), does not allow operators to subsidise handsets.

joining a network then increases. Since the utility of fixed network users will rise the more mobile subscribers there are because of network externalities (they then have more people to call), this will provide a reason for setting $T > C$ in order to encourage network growth.[9]

In sum, this model proposes a direct linkage between the setting of high call termination charges on mobile networks and the use of connection subsidies to new subscribers. Putting the matter argumentatively, if termination charges are high, mobile operators offer bribes to potential subscribers to join a network so that their callers then pay substantial charges to contact them. This pattern of cross-subsidy is undesirable unless the network externality effect dominates the call externality effect, in which case it is socially desirable to set termination charges somewhat above cost in order to induce mobile subscription growth.

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[9] For a greater discussion of the optimal balance between usage charges and connection charges when there are call or network externalities (or both), see Mitchell and Vogelsang (1991, section 5.3).