Network externalities and mobile termination

1. In this note, I give an economic justification for the inclusion of a "network externality" surcharge in the mobile call termination (MCT) charge. I also review the evidence supporting the surcharge of 0.3 ppm recommended by Ofcom in its latest Statement on mobile call termination. On the basis of this evidence, I conclude that this size of surcharge is reasonable for the UK market.

Background

2. When an individual joins a communications network, typically (s)he does not take into consideration the costs and benefits of her/his subscription decision on other individuals. In short, subscription decisions are subject to externalities. A similar consideration applies to calls. The decision to make a call, and the decision about the length of that call, involve costs and benefits to others which may not be taken into account fully by the caller. (In fact, there may be a number of other externalities that affect mobile usage.)

3. When externalities are present, market outcomes are likely to be inefficient. Moreover, when termination charges are regulated (because of other market failures, such as market power), the socially-efficient regulated charge should reflect the presence of externalities. In the case of mobile call termination (MCT), these two conclusions have been supported by a number of different models.

4. Hence the theoretical grounds for externality adjustments to regulated MCT charges are clear. The main issue involves *quantification* of the adjustments. The largest externalities are likely to be so-called *network externalities*. These are defined to be the discrepancy between an individual's private benefit from subscription, and the wider benefits that fixed and other mobile subscribers derive from contacting and being contacted by them, and from the ability to contact and

be contacted by them.[1] This can be contrasted with *call externalities*, which arise when only one side of a call (in Europe, usually the caller) pays, even though both sides of a call receive benefits (or bear costs). Call externalities are not insignificant; but they are likely to be internalized, at least partially, by the individuals involved in a call. As the UK's Competition Commission (CC) noted in its 2003 inquiry on mobile termination[2]: "it was possible that call externalities were already largely internalized as people tended to be in stable calling relationships with each other" (paragraph 8.257); and "[w]e did not think that we would be able to make accurate estimates of the value of these alleged externalities ourselves. We did not, therefore, investigate whether these alleged externalities should be attributed to calls, customers or coverage" (paragraph 8.264).

5. Following the CC's enquiry, most National Regulatory Authorities (NRAs) in Europe have focussed on network externalities as quantitatively the most important form of externality. For example, the UK NRA, Ofcom, considers only network externalities in its latest Statement on mobile call termination. [3] I follow the same approach in this note; I leave the consideration of other types of externalities to further work.

6. NRAs within Europe have taken different positions on the quantitative importance of network externalities for MCT charges. In Belgium, Greece, Ireland, Italy, Sweden and the UK, the NRA has included a network externality surcharge within the regulated MCT charge. But in Austria, France, Netherlands, Norway and Portugal, the NRA has opted not to include an externality surcharge.[4] This diversity is consistent with the quantitative nature of the issue. There should be no

[1] This definition of network externalities includes what has previously been known as the "option externality", relating to the *ability* to call and be called, as opposed to the benefits arising from actual calls.
[2] See Competition Commission (2003): *Vodafone, O2, Orange and T-Mobile: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O2, Orange and T-Mobile for terminating calls from fixed and mobile networks*. HMSO, London.
[3] Ofcom (2007): *Mobile call termination: Statement*, 27 March.

[4] Source: Philippe Defraigne, Current regulatory best practices and implications: Mobile termination, 2nd Black Sea and Caspian Regulatory Conference, Istanbul, June 22 - 23, 2007.

single figure for the size of network externalities; instead, their importance should be assessed for each market.

7. Given the importance of quantification, it is crucial to use best practice in terms of theoretical and empirical modelling of network externalities. The UK has been at the forefront of analysis, with major developments made by the NRA (previously Oftel, now Ofcom) and the CC. As part of its inquiry into mobile termination in 2003, the CC held a full public consultation process on the value of network externalities. As a result of this process, a comprehensive framework was developed for estimating the size of network externalities for mobile networks in the UK. This framework has subsequently been extended by Ofcom, as part of its latest review of MCT charges. In the rest of this note, I review and evaluate the CC's framework and Ofcom's extensions.

The UK Competition Commission's framework

8. The 2003 CC inquiry followed the approach proposed by Oftel to including network externalities within the setting of the mobile termination charge. This was to add a surcharge to the MCT charge, which MNOs could then use to subsidize retail prices. The subsidy was aimed at two types of individuals. The first is the *marginal current subscriber*, who is liable to give up their mobile subscription, in the absence of a subsidy. The second is the *marginal non-subscriber*, who does not subscribe currently, but might.

9. The CC's calculation of the externality surcharge had three major components: (i) the subsidy to existing subscribers; (ii) the subsidy to current non-subscribers; (iii) the subsidy to existing subscribers who would be attracted by the deal offered to non-subscribers.

10. **The subsidy to existing subscribers 1**:

    10.1. The average subsidy was UK£70 per subscriber (the assumed price of a handset). If the handset subsidy were removed, then those customers with a valuation less than £70 would leave the network.

10.2. Suppose that MNOs can target subsidies perfectly e.g., can pay the subscriber with zero valuation £70, and nothing to the subscriber with a valuation of £70. The mid-point of this range is £35.

10.3. A handset lasts 4 years, so that 25% of handsets are replaced every year.

10.4. Survey data indicate that there were 11.6 million such customers in total; and so 2.9 million such customers each year who might leave the network.

10.5. The forecast of minutes terminated in 2005/06 was 29.953 billion.

10.6. Hence the subsidy per minute was calculated as (35 * 2.9)/29953 * 100 = 0.34 ppm.[5]

11. **The subsidy to non-subscribers**: this step involves the notion of the value of the network externality. Oftel and the CC represented this with the "Rohlfs-Griffin" (RG) factor. The RG factor is defined as the ratio of the marginal social benefit of an additional mobile subscriber to the marginal private benefit. Oftel and the CC assumed that the RG factor would have a lower bound of 1 (when existing subscribers did not much value contact with the additional subscriber) and an upper bound of 2 (proposed on the grounds that it is unlikely that existing members would benefit by a greater amount in aggregate than the additional subscriber). The CC assumed that the value of the RG factor was 1.5, on the basis of previous estimates by Oftel and a specially commissioned survey (see paragraph 8.208 of the CC's report).

11.1. There were 15.911 million individuals without a mobile phone at the time of the inquiry. Of these, survey data suggest that 26% would consider getting a mobile phone. With a 4-year review period, this gives 1.03 million marginal non-subscribers.

11.2. Survey data suggest that 12% of non-subscribers would be willing to pay the cost of a handset (£70) to join.

11.3. The subsidy required per non-subscriber to induce them to join is the cost of a handset (£70) minus their private benefit. The external benefit generated by that non-subscriber is their private benefit times the RG factor

[5] The factor of 100 appears to convert the answer to pence per minute (ppm).

minus 1. (This comes from the definition of the RG factor.) This implies a subsidy of £23.33 per non-subscriber.

11.4. With a linear distribution of valuations of the non-subscribers, between £0 and £70, a subsidy of £23.33 would induce 33.3% of non-subscribers to join.

11.5. Hence the total proportion of non-subscribers who would subscribe with a subsidy of £23.33 is 12% (those who would join anyway) plus 33.3 * (1-0.12) (those who will join with the subsidy). The total number of non-subscribers who would be paid the subsidy is therefore 0.43 million.

11.6. With the subsidy of £23.33 and forecast minutes, this gives a subsidy of 0.03 ppm.

12. **The subsidy to existing subscribers 2:**

12.1. Those existing subscribers paid a subsidy of less than £23.33 would prefer to take the subsidy offered to non-subscribers. This therefore bounds the subsidy paid to subscribers from below by this figure.

12.2. A straightforward calculation shows the value of this additional subsidy to be 0.04 ppm.

13. The three components together give a value of the subsidy of 0.41 ppm. The CC considered alternative values for the handset cost (£75 instead of £70) and the RG factor (1.7 instead of 1.5). The total subsidy under this alternative is 0.50 ppm. The CC chose a final subsidy mid-way between these two figures i.e., 0.45 ppm.

14. I have detailed CC's approach in order to make clear that there are a number of assumptions made in the approach. Four are particularly important:

14.1. MNOs are able to target marginal subscribers quite well. They cannot prevent marginal subscribers from opting for the subsidy offered to non-subscribers. But they are able to discriminate between marginal subscribers that require higher subsidies.

14.2. It is socially optimal to retain all marginal subscribers.

14.3. All revenue from a termination surcharge is used to subsidize subscription.

14.4. There are no deadweight losses from higher termination charges.

15. In its 2007 Statement, Ofcom modifies the CC approach to address each of these assumptions:

    15.1. Two extremes are considered: perfect price discrimination (which is close to the assumption made by the CC);[6] and no price discrimination.

    15.2. The number of subscribers is determined by equality between marginal social benefits and marginal social costs; the latter includes any deadweight loss (see below).

    15.3. Leakage may occur: not all revenues from a termination surcharge are used to subsidize subscription. This factor increases the termination surcharge necessary to generate a particular subsidy: see paragraph A16.38 of the Statement.

    15.4. A deadweight loss occurs because fewer calls are made as a result of a higher termination charge.

16. Ofcom do not give sufficient detail in the Statement to replicate their calculations. In Figure A16.5, they state that their calculations yield an externality surcharge of between 0 ppm (low RG factor; full price discrimination; low handset cost; no leakage) and 0.51 ppm (the other extreme). These outcomes can be compared to the equivalent figures calculated using the CC's 2003 approach, but with Ofcom's updated numbers on subscribers, traffic etc.. As Ofcom states in Figure A16.6, this is 0.38 ppm for Ofcom's 'medium' traffic scenario (terminated minutes of 58.49 billion). For the 'low' traffic scenario, the figure is 0.47 ppm; for the 'high', 0.27 ppm. Ofcom chooses a figure of 0.3 ppm as the appropriate network externality surcharge. This is above the mid-point of the values derived using Ofcom's method; but at the low end of the values given by the 2003 CC approach.

17. In my opinion, the approach to the network externality surcharge in Ofcom's 2007 Statement is a significant improvement on the method used by the CC in the 2003 inquiry. Specifically, it recognises that it is not optimal to retain all current (marginal) subscribers; that there is a deadweight loss from increasing the

[6] Whether it is identical depends on what Ofcom has assumed about marginal subscribers' ability to opt for the subsidy offered to non-subscribers. Ofcom does not say in its statement what it assumes about this aspect.

termination charge; that not all revenues gained from termination are used to compete for subscribers; and that MNOs cannot practice perfect price discrimination.

18. Moreover, in my view, Ofcom has used reasonable values for the key parameters in their model, for reasons that I explain below.

Arguments against the network externality surcharge

19. A number of arguments can be made against Ofcom's surcharge figure of 0.3ppm:
    19.1. It involves an implausibly large number of marginal customers.
    19.2. The social value assumed to be attached to these customers is too large.
    19.3. MNOs can price to internalize network externalities (and indeed want to).
    19.4. A termination surcharge is ineffective, due to "leakage".
    19.5. The assumed handset cost is too great.

20. These arguments appear in e.g., BT's *Notice of Appeal*[7] and witness statements that BT has provided.[8]
    20.1. Paragraph 178 of BT's Appeal: "It is implausible to assume that 34% of customers are marginal which seems to mean that they would not pay more than £70 for a handset".
    20.2. Paragraph 180 of BT's Appeal: "Ofcom is also wrong to assume that the marginal social benefit from mobile ownership (after some externalities have been internalized) is 70% higher than the private benefit. This is a very large mark-up and does not appear to have been justified by any recent evidence in Annex 16 of the Decision." (Note that 70%-i.e., a Rohlfs-Griffin factor of 1.7-is the upper figure used by Ofcom: the lowest is 30%.)
    20.3. Paragraph 181 of BT's Appeal: "Ofcom assumes without any evidence to support its view that the subsidy has not largely been internalised."

[7] *BT Notice of Appeal*, undated.
[8] *Witness statement of George Yarrow,* dated 14 November 2007.

20.4. Paragraphs 97 and 98 of Yarrow's Statement: the effect of a termination surcharge on network subscriptions is "highly indirect"; and ineffective regulation should be consigned to the "dustbin".

20.5. Paragraph 182 of of BT's Appeal: "[T]he cost of a mobile handset … £70 … is too high a cost for a basic handset which is all that is needed to generate network externalities."

The number of marginal customers

21. Ofcom's calculations (see e.g., Figures A16.3 and A16.4 in the Statement) are based on survey evidence and data from the Office of National Statistics. In Ofcom's market survey,[9] 621 mobile subscribers were asked questions about their willingness to replace their handsets, in the event that it was broken or stolen. Of these 621, 423 were pay-as-you-go (PAYG) subscribers. Of these, 391 individuals state a willingness to replace their handsets; but 56% of these are willing to pay a price no greater than £69.99 (see Figure 5.4). From this sample, therefore, the proportion of marginal subscribers is 56 * 391/621 = 35%. (The remaining 197 subscribers in the sample, on contracts, are assumed to be willing to replace at a handset cost of £70.)

22. Ofcom's method and estimate of the number of marginal subscribers are entirely reasonable. In particular, they point to an important fact about the UK market. The UK has high mobile penetration: a recent Ofcom survey[10] shows that approximately 81% of the UK adult population had at least one mobile phone. This fact might indicate that network externalities are not important in the UK. Ofcom's statistics show, however, that a major proportion of marginal customers are those who are currently subscribers, and who would choose not to subscribe if handset costs were higher. In short, high penetration does not imply low network externalities.

[9] See Ofcom (2006): *Mobile Call Termination – Report of market research findings*, 13 September.

[10] Source: Ofcom third quarter of 2006 tracking survey.

The social value of marginal customers

23. It is extremely difficult to obtain hard evidence on the size of social externalities due to mobile access and usage. In the CC inquiry report in 2003, there was general agreement that the RG factor lay in the range 1.3-1.7. These two points correspond to the social values of 30% and 70%. Are there reasons to think that the RG factor has changed since 2003? The usual presumption is that as mobile networks grow, social externalities decrease. In fact, this presumption is incorrect.

24. To see why, it is necessary to recall that the RG factor is the ratio of social benefit to private benefit when the marginal subscriber joins (or leaves) the network. Let *P* denote the private benefit of subscription to the marginal subscriber; and let *E* denote the external (i.e., the gap between social and private) benefit to everyone else when this individual subscribes. The RG factor is then, by definition:

$$RG = \frac{P+E}{P} = 1 + \frac{E}{P}.$$

25. With a positive externality, as in the case of the network externality, *E* is strictly positive and the RG factor is greater than 1. Note that the magnitude of the RG factor depends on the ratio *E/P*: the relative size of external to private benefits.

26. What happens to the RG factor as mobile penetration grows? The RG factor will increase or decrease according to whether the ratio *E/P* rises or falls with mobile penetration. When an additional subscriber joins the network, (potential) connections are formed between this individual and each of the existing subscribers. The private value *P* of these connections is their marginal valuation-i.e. their value to the additional subscriber. The external valuation *E*, on the other hand, depends on the average valuation of these connections across all existing subscribers. So, the RG factor depends on the ratio of average to marginal valuations.

27. It seems plausible that the marginal valuation of network benefits falls as the size of the network increases: later joiners presumably have lower valuations of being

able to connect with other subscribers. Meanwhile the average valuation decreases more slowly: the addition of subscribers with successively lower valuations reduces the average valuation, but at a slower rate than the fall in the marginal valuation itself due to the bulk of existing subscribers with higher valuations. Hence it seems reasonable to suppose that the marginal valuation falls *more* quickly than the average. In other words, *P* falls more rapidly than *E* and the RG factor *increases* as the size of the network goes up. As a result, the RG factor today would be higher now than it was in 2003.

28. In the absence of any fresh evidence (such as survey data) on the size of network externalities, I conclude that it is reasonable to use RG factors that are comparable to those used in the 2003 CC inquiry.

Internalisation of network externalities

29. There are strong reasons to think that MNOs cannot fully internalize the network externality (and so the number of subscribers will be below the social optimum).

30. To understand why this is the case, consider the distribution of benefits when a new subscriber joins a mobile network (For the sake of this argument, ignore any benefits that accrue to fixed subscribers.) There is a benefit to the subscriber him/herself. Part of this is extracted by the MNO in the form of subscription and other fees; the rest is consumer surplus to the subscriber. These are the internal benefits from the transaction. Due to network effects, there are also external benefits to other mobile subscribers. Some of these beneficiaries are on the same network as the new subscriber. Part of these benefits may be extracted by the MNO and is therefore internalized, while the rest go to consumer surplus. Furthermore, many subscribers are on other networks: they and their host MNO benefit from the new subscription, but the new subscriber's MNO does not.

31. So, there are two reasons why competition between MNOs does not fully internalize network externalities accruing to mobile subscribers:

- *Unappropriated consumer surplus*: part of the external benefit accrues to the mobile subscribers themselves, not their MNO; since this is not appropriated by any MNO, it cannot be internalized.
- *Profits accruing to other operators*: when an MNO is considering what price to charge a new subscriber, it is willing to reduce the price below cost by the amount that it can expect to gain in increased profits from its own subscribers. But it will not include the profits gained by other firms in this calculation.

32. So, the only case in which externalities accruing to other mobile subscribers will be fully internalized is when
    - Perfect (first degree) price discrimination is used to extract the entire consumer surplus from each subscriber; and
    - There is a single MNO.

    The entire external benefits to mobile subscribers will be extracted by the MNO in this case only.

33. The scenario is implausible. The informational requirements for perfect price discrimination are impossible to meet in practice. An MNO would have to know the willingness to pay of every single individual, not just the aggregate demand curve. Furthermore, transaction costs would be excessive: a different price would have to be set for each subscriber; and such a scheme would be regarded as highly unfair by consumers. (These arguments are formalized in e.g., Farrell and Klemperer (forthcoming) and Segal (1999).)[11] Even though second degree price discrimination (where consumers self-select from a menu of tariff schemes) is used in the mobile industry, this may not extract a high proportion of the total surplus created by the transaction. MNOs presumably increase their profits by employing such schemes. But total surplus is also likely to be increased, since consumer needs are better met and subscription is expanded when consumers can choose their preferred scheme. Finally, there is clearly more than one MNO in the UK.

11 Farrell, J., and P. Klemperer (forthcoming): "Coordination and Lock-In: Competition with Switching Costs and Network Effects," in *Handbook of Industrial Organization*, ed. by M. Armstrong, and R. Porter, vol. 3. North Holland, Amsterdam, The Netherlands. Segal, I. (1999): "Contracting with Externalities," *Quarterly Journal of Economics*, 114(2), 337–388.

34. In summary: there is little reason to believe that MNOs are able to internalize network externalities.

Leakage

35. Ofcom's inclusion of a leakage factor is an important improvement to the analysis, relative to the CC's method in its 2003 report. By making this factor explicit, Ofcom has usefully drawn attention to the issue. It is clear that Ofcom appreciates the significance of the issue. For example, in paragraph A16.18 of the Statement, it is noted that is leakage is too severe, "the justification for a surcharge falls away entirely".

36. One approach to the issue of leakage is to conclude that it means that a termination surcharge is a poor instrument for tackling network externalities.

37. It is crucial at this point to have consistency in the overall framework for setting the termination charge. As Ofcom make clear in their Statement (see paragraph A16.3), leakage occurs because of two factors: (i) imperfect pass-through to retail prices (i.e., an incomplete "waterbed effect"); (ii) the inability of the MNOs to target marginal mobile subscribers. Hence, in order to argue that leakage is so high as to render the network externality surcharge unacceptably inefficient, one must also argue that pass-through and targeting are both highly imperfect.

38. Ofcom do not do this. Ofcom accepts-realistically-a degree of leakage; but evidently considers it to be sufficiently small that it is still worth using a termination surcharge to address network externalities.

Handset cost

39. The assumed handset cost is an important bearing on the MCT charge.[12] Ofcom has considered a range of £50 to £70. The exact basis for this range is not clear

[12] I have not been able to replicate Ofcom's calculations in their Statement. A check using the 2003 CC approach shows that the externality surcharge is approximately linear in the handset cost. A £10 reduction in the handset cost corresponds to a reduction in the externality surcharge of around 0.053 ppm.

from Ofcom's Statement. Information supplied confidentially by Orange supports this figure (and in fact provides evidence for higher costs). Others have argued for significantly lower figures; for example, BT argues that a basic handset can be bought for £20-£30: see paragraph 182 of their Appeal. Again, the basis for this range is not entirely clear.

40. There are several difficulties in arriving at a reliable figure for handset costs. First, any handset price observed in the market will contain some element of subsidy from termination charges. Secondly, it is tempting to infer from second-hand handset prices that the price of a handset should be relatively low. It is far from clear, however, that marginal subscribers and non-subscribers would be willing to buy second-hand handsets. A reasonable guess is that marginal (non-)subscribers are individuals who are less comfortable with technology and gadgets, lower income, and more risk averse. With the information asymmetries that plague second-hand markets, it would not be surprising if these individuals were unwilling to buy second-hand handsets.

41. This is an area in which it should be possible to collect further data. The cost of manufacturing a basic handset can be found out from a manufacturer. An estimate can be added of retailing spend to attract and supply marginal subscribers. Survey data of marginal (non)-subscribers attitudes to second-hand handsets could be collected.

Conclusion

42. In my view, Ofcom's approach to calculating a network externality surcharge to the MCT charge is reasonable. Its methodology has several important improvements to the approach taken by the CC in its 2003 inquiry report. The values of key parameters that Ofcom has chosen are, on the whole, justified by the evidence. (Some further work on the cost of handsets is warranted.) The methodology and evidence show that network externalities are quantitatively important within the UK, and should add around 0.3ppm to the MCT charge. The

framework developed by Ofcom can be used by other NRAs to assess whether a network externality surcharge is warranted in their markets.

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