

APPENDIX 5.2

(referred to in paragraphs 2.242, 2.248, 5.35, 5.81, 5.82, 5.83, 5.85, 5.88 and 5.89)

Externalities

Introduction

1. An externality is a cost or benefit that flows from some decision where this cost or benefit is not taken into account by the decision-maker. One example of an externality in the case of mobile phone networks is what is known as an option externality which is the benefit to fixed-line subscribers (and existing mobile subscribers) when a new subscriber joins a mobile network. There is a benefit because all these people now have the option of contacting the new subscriber at times when previously they could not. The benefit to the fixed-line caller is an external benefit because it is one which does not *per se* enter into the decision-making of the new subscriber to the mobile network when deciding whether to become a subscriber or not. This decision is presumed to depend only on the costs and benefits of becoming a mobile owner that accrue directly to the subscriber him- or herself (ie the internal costs and benefits). We have noted at least four other potentially relevant externalities during the inquiry: call externalities, scale externalities, an externality associated with updating the HLR and one associated with voicemail (see paragraphs 7, 8 and 48 to 51).

Vodafone's views

2. Vodafone told us that service provider incentives and marketing costs were not a direct cost of either outgoing or incoming calls. It said that if these costs were to be allocated in an economically efficient way the allocation method had to take account of externalities. It told us that by encouraging new subscribers, service provider incentives and marketing costs increased the size of the network and this gave rise to externalities. Vodafone stated that if mobile operators were forced to recover all these costs from outgoing call charges then, because of price elasticity with respect to outbound charges, there would be fewer mobile subscribers and/or lower levels of traffic, and, as a result, lesser gains to the generality of consumers. It said that recognition of this wider gain lay behind the UK Government's policy objective that telecommunications networks should compete and interconnect with each other.

3. Vodafone told us that it was not its view that in all circumstances it would be efficient to pass on all service provider incentives and marketing costs to those who call mobile phones but that in the present state of the market development it would be efficient to pass on some of these costs to incoming callers. Vodafone stated that on this basis there were three possible ways of allocating service provider incentives and marketing costs between inbound and outbound callers. These were to allocate these costs to inbound and outbound callers in the ratio of:

- (a) inbound and outbound calls or call minutes which would give an allocation of approximately 40 and 60 per cent respectively;
- (b) inbound and outbound revenue which would give an allocation of 34 and 66 per cent respectively; and
- (c) inbound and outbound prime margin which would give an allocation of 25 and 75 per cent respectively.

4. Vodafone opted for what it considered to be the most conservative approach, namely on the basis of prime margin, which allocated £48.5 million of its service provider incentives and marketing costs to incoming calls for 1997/98.

The DGT's views

5. The DGT identified three types of externalities. These were:

- (a) an option externality;
- (b) a call externality; and
- (c) a scale externality.

We look at each of these externalities in turn.

Option externality

6. The option externality arises because fixed-line customers (and existing mobile customers) receive a benefit from being able to contact new mobile users. The DGT told us that he had the following four reasons for believing that it was not appropriate to adjust the termination rates to take account of this externality in the case of mobile phones:

- (a) The appropriate adjustment would be extremely difficult to estimate. It would require knowledge of the relationship between the marginal private benefit and the marginal social benefit (which combines the internal and the external benefits) as well as knowledge of demand elasticities, both of which, in the DGT's view, were uncertain.
- (b) The value of the externality would be quite small. The relevant benefits would be the incremental gains to customers of originating callers being able to contact new mobile users via a mobile rather than a fixed phone.
- (c) The externality would only require regulatory action if users (fixed phone users, existing mobile users and new mobile users) could not internalize the benefit. The DGT told us that it was possible that family members, friends or business colleagues (which could be thought of as closed user groups) would be able to make adjustments to take account of these benefits.
- (d) Increasing termination rates above costs would improve economic efficiency only if all tariffs had been set with economic efficiency in mind, which the DGT believed did not appear to be the case. He said that such an intervention to correct for the perceived externality would reduce rather than increase economic efficiency if other prices were subject to distortions taking them away from their economically efficient levels. The DGT stated that there would also have to be a way of ensuring that the surcharges on termination rates (and on outgoing rates) were passed on to new subscribers.

The call externality

7. The DGT said that this externality arose from the fact that both the calling and the called party benefited from calls though only the calling party paid. He stated that because the social benefit was therefore greater than the private benefit it was appropriate to provide a subsidy on call charges to increase call volumes to capture this benefit. This externality therefore suggested that call charges (including charges for incoming calls) should be below their market price. The DGT told us that for fixed-line networks call externalities were usually assumed to be internalized (for example, phone users taking it in turns to ring each other). He said that this assumption would need to be re-examined if work was to be undertaken to estimate the value of the externalities for the mobile phone networks.

The scale externality

8. The DGT noted the possibility that an externality might arise if greater use of the network led to scale economies that reduced call charges. This could then be a reason for subsidizing new subscribers.

9. However, the DGT rejected the case for an adjustment to the call termination charge on this account for three reasons:

- (a) extra calls might not be generated;
- (b) considerable scale economies would be necessary if there were to be such benefits; and
- (c) there would have to be a way of ensuring that the surcharges on termination rates were passed on to new subscribers.

Quantification

10. We asked Vodafone and the DGT to see if they could give any quantification of the value of the externalities. They both told us that any estimates would be subject to uncertainty due to the lack of available data. Vodafone's and the DGT's estimates were derived in very different ways. Vodafone used a methodology based on estimating the change in the consumer surplus to existing callers from the growth in subscribers. This constitutes a benefit in that the value of a call-to-mobile to a caller typically, as with most goods and services bought, is higher than the price paid. The DGT estimated the prices at which the marginal social benefit to those using mobile phones would equal the marginal cost of using mobile phones. He also estimated the potentially offsetting effect of call externalities. We look at Vodafone's and the DGT's methods and their estimates in turn.

Vodafone's estimates

11. In estimating the change in the consumer surplus Vodafone used the formula $(p \times q)/2e$. In the formula, p was the weighted average retail price paid by fixed-to-mobile callers which Vodafone estimated at 23 ppm. The term q was the number of call minutes which was caused by Vodafone's service provider incentives and marketing costs. Vodafone estimated the increase in call minutes in two ways: first, by applying the percentage increase in the total number of subscribers between 1996/97 (6.427 million) and 1997/98 (8.072 million), an increase of 25.6 per cent, to Vodafone's incoming call minutes in 1997/98 (1.8 billion) which gave a figure for increased call minutes of 460 million; and secondly, by applying the percentage increase in the total number of Vodafone's own subscribers between 1996/97 (2.66 million) and 1997/98 (3.153 million), an increase of 18.5 per cent, to Vodafone's incoming call minutes in 1997/98 (1.8 billion) which gave a figure for increased call minutes of 333 million. The e term is the elasticity of demand. Vodafone said that it had no direct estimate of the elasticity of fixed-to-mobile calls and therefore it used what it considered a range of plausible values (0.1 to 0.2) and what it considered an upper bound (0.5). Vodafone told us that its plausible values were based on research that indicated that demand was quite inelastic.

12. Table 1 shows Vodafone's estimates of the externality benefits.

TABLE 1 Vodafone's estimates of the value of externality

<i>Elasticity</i>	<i>Price ppm</i>	<i>Increased number of incoming minutes m</i>	<i>Value £m</i>	<i>Value ppm*</i>
0.1	23	460	529	29.4
0.1	23	333	383	21.3
0.2	23	460	264	14.7
0.2	23	333	191	10.6
0.5	23	460	106	5.9
0.5	23	333	77	4.3

Source: Vodafone and MMC calculations based on data provided by Vodafone.

*Based on 1.8 billion incoming minutes.

13. Vodafone estimated the value of these externalities at between £77 million and £529 million, 4.3 to 29.4 ppm when allocated to incoming minutes.

14. Vodafone told us that these values underestimated the benefits to fixed-line users because they were calculated at current prices and quantities. It said that if prices were lower, because of the assumption that fixed-to-mobile callers did not bear a share of the service provider incentives and marketing costs, the quantity of calls would also be higher. Using the same elasticity assumptions, Vodafone estimated that this factor would add £6 million to £13 million to its initial estimates.

15. Vodafone stated that there was another reason why its estimates were low. It said that it had assumed that one year's service provider incentives and marketing costs increased the number of mobile subscribers for one year. Vodafone told us that since many subscribers could be expected to remain mobile users for some years, the discounted value of the benefit to fixed callers in the future should, in principle, be included.

16. Vodafone said that it was not proposing that these estimates should be used to represent the value of its marketing and service provider costs that should be allocated to incoming callers. Rather the estimates should be seen as a test of the reasonableness of the £48.5 million of its service provider incentives and marketing costs that it believed should be allocated to incoming callers.

17. Vodafone estimated the value of the externality to mobile subscribers from fixed-line operators' marketing costs by using the same methodology. Vodafone estimated the value of p at 24 ppm (retail price of unbundled minutes for outgoing calls). The value of q was estimated by Vodafone at 49.5 million outgoing minutes (Vodafone's 3 billion outgoing minutes \times the growth in the number of fixed lines (3.3 per cent) \times 0.5 (half of the growth in the number of fixed lines was assumed to be due to connections to fax machines or for Internet use). Vodafone used the same values for the elasticity term as in its estimates of the externality for incoming calls (0.1, 0.2 and 0.5) but it said that there were good reasons for believing that the elasticity for outbound calls would be higher (more elastic) than that for incoming calls. These assumptions gave externality values for mobile users of £12 million to £59 million.

18. Vodafone told us that in its view call externalities were symmetrical and therefore they could be omitted from the calculations.

The DGT's view of Vodafone's estimates

19. We showed Vodafone's method and its estimates to the DGT who told us that he had reservations about Vodafone's method. He said that Vodafone considered only two possible positions: one position related to all of the marketing and service provider incentives being funded by Vodafone and the other to no marketing or service provider incentives being funded by Vodafone. The DGT stated that there were alternatives which might be better than either of these positions, such as Vodafone continuing to provide marketing and service provider incentives but funding them out of charges to its own customers, or a smaller amount being recovered from call termination charges than proposed by Vodafone. The DGT told us that Vodafone's estimates did not lead to the identification of the appropriate expenditure on marketing and service provider incentives and their allocation: it simply compared two positions.

20. The DGT said that a second problem with Vodafone's approach was that it was partial, identifying the benefits to one group of customers of a particular change in prices. The DGT told us that even if robust estimates could be made of the benefits claimed by Vodafone to accrue to fixed network users, it would still be unclear what the implications were for optimal price setting. The DGT also had reservations about the assumptions used by Vodafone. In particular he said that it was inappropriate to assume that all of the increase in traffic was due to service provider incentives and marketing costs. He stated that nevertheless Vodafone's approach could be used to consider whether Vodafone's allocation of marketing costs and service provider incentives had the potential to improve welfare. The DGT calculated, on the basis of what he regarded as reasonable assumptions, that only a small proportion of new subscribers were the result of service provider incentives and marketing. The DGT calculated that when corrected for this factor, Vodafone's approach produced estimates of the

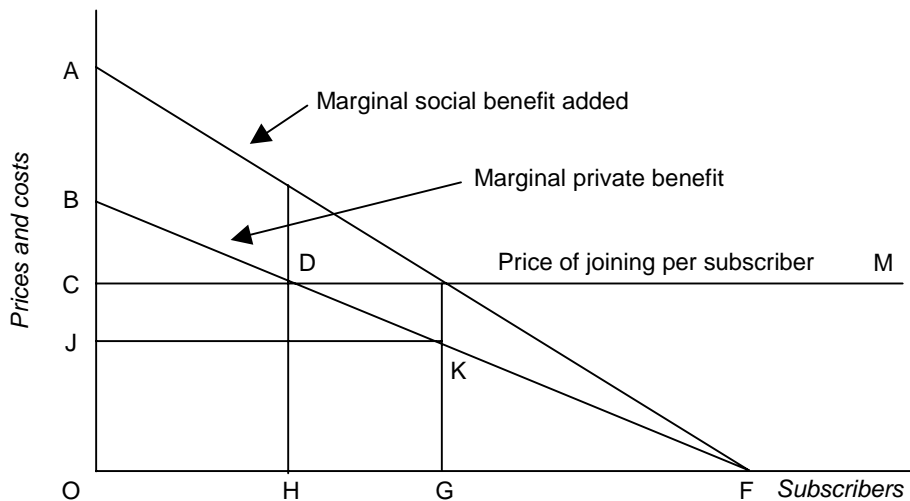
value of the externality in the range of £2 million to £10 million (0.1 to 0.55 ppm). He said that Vodafone's estimates did not include any offsetting effects arising from call externalities.

The DGT's estimates

21. The DGT made his own estimates of the value of externalities for mobile phone networks by using a model OFTEL had created in 1987 to estimate the value of externalities for fixed networks.¹ The DGT's model used assumptions on the costs of joining the network (for example, cost of a handset), the costs of using the network (for example, incoming and outgoing call charges), elasticities and the relationship between the marginal social benefit and the marginal private benefit (the externality adjustment factor) to maximize social welfare. The socially optimum number of subscribers to the mobile network would be reached if the network expansion took place up to the point where the marginal benefits to all parties, including those already on the network, were equal to the marginal costs imposed by an additional person joining the network. This is demonstrated in Figure 1.

FIGURE 1

The option externality



22. The line BF shows the private benefit to each additional subscriber. CM shows the price to a subscriber of joining the network. From these it can be deduced that the starting number of subscribers will be shown by the distance OH. For everyone in this range the benefit of the joining the network exceeds the price they have to pay, and so they will subscribe. For people beyond the point H, the benefit is less than the price, and so they will not subscribe.

23. The line AF shows the benefit to society as a whole, ie to subscribers and to other people as more and more people subscribe. This naturally includes the private benefits described above, but also includes the externality benefit that accrues to others who can now contact or be contacted by people at times when this would not previously have been possible. From society's point of view, if AF shows the incremental benefits of additional subscribers, and CM shows the cost and necessary return of providing for additional subscribers, then the optimal number of subscribers is OG. Up to the point G new subscribers add more to society's benefits than they do to costs; after that they add less. Because it is assumed that subscribers take into account only their own private cost and benefit, the number of subscribers is sub-optimal, at OH instead of OG.

¹A method for determining the optimal balance of prices for telephone services, P Culham, March 1987, an OFTEL working paper.

24. Given that potential subscribers take only private costs and benefits into account, the only way to generate OG subscribers is if the price is OJ. Then subscribers will move to the point K rather than D, and the optimal number of subscribers OG will appear. Hence the externality justifies a subsidy to the price of joining of CJ off the price OC.

25. The DGT told us that the key parameter in making an adjustment for the option externality was the externality adjustment factor, ie the ratio of AF to BF. Based on previous academic work¹ the DGT told us that in principle the externality adjustment factor had a range between 1 and 2. He said that the floor of 1 was based on the view that the social benefits from additional joiners to the network were positive, and hence the ratio of social to private benefits could not be below 1. He told us that the upper bound of 2 was based on the idea that it was unlikely that the existing members of the network would benefit by a greater amount than the new joiner. The DGT stated that if there were exact symmetry of benefit from the new joiner becoming a member, then the ratio of the marginal social benefit to marginal private benefit would be 2. The higher the value of this ratio the larger the externality. The DGT told us that he believed a reasonable range was between 1 and 1.5. He stated that there was little empirical evidence to support this assumption.

26. The DGT told us that the incorporation of the externality adjustment factor into the pricing decisions was likely to result in a price for joining the network that was below cost (OJ in Figure 1 which is less than OC). This deficit had to be funded. He stated that the first-best approach would be via taxation but said that this was unrealistic. The second-best approach would be to fund the deficit by making adjustments to prices. He told us that in these circumstances the most appropriate way to increase prices was to use the Ramsey pricing rule whereby adjustments were inversely related to the elasticity of demand. The DGT therefore used his elasticity estimates to adjust prices (including the price of joining the network) to fund the subsidy to the new subscribers.

27. The DGT said that he had little information on elasticities of demand for mobile phone services. He told us that it might be reasonable to assume that all elasticities were equal. In order to test the sensitivity of the elasticity (and other) assumptions the DGT used elasticity estimates ranging from 0.2 to 0.4.

28. The DGT's estimates of cost to customers were based on early results from his consultants' study of LRIC and a calculation of the annualized cost of a handset. He assumed that the cost of joining a network was £65 a year, and the costs of incoming and outgoing calls were assumed to be 9 and 5.4 ppm respectively. If adjustments for the option externality alone were considered (ie if there were no corresponding adjustment for the call externality), the DGT's estimates showed that social welfare could be maximized if incoming call charges were increased by between 0.4 and 1.4 ppm (see Table 2).

¹Economically-efficient Bell-system pricing, J Rohlfs, Bell Laboratories, Economic discussion paper 138, January 1979.

TABLE 2 Adjustments to charges for option externality

<i>Service</i>	<i>Elasticity</i>	<i>Option externality adjustment factor</i>	<i>Adjusted prices</i>	<i>Base prices</i>	<i>Change in prices</i>
Access (£pa)	0.2	1.5	49.8	65.0	-15.2
Outgoing calls (ppm)	0.4	1.5	6.1	5.4	0.7
Incoming calls (ppm)	0.4	1.5	10.1	9.0	1.1
Access (£pa)	0.3	1.5	46.8	65.0	-18.2
Outgoing calls (ppm)	0.3	1.5	6.2	5.4	0.8
Incoming calls (ppm)	0.3	1.5	10.4	9.0	1.4
Access (£pa)	0.2	1.3	55.5	65.0	-9.5
Outgoing calls (ppm)	0.4	1.3	5.8	5.4	0.4
Incoming calls (ppm)	0.4	1.3	9.7	9.0	0.7
Access (£pa)	0.3	1.3	53.0	65.0	-12.0
Outgoing calls (ppm)	0.3	1.3	5.9	5.4	0.5
Incoming calls (ppm)	0.3	1.3	9.8	9.0	0.8
Access (£pa)	0.4	1.3	51.7	65.0	-13.3
Outgoing calls (ppm)	0.2	1.3	6.0	5.4	0.6
Incoming calls (ppm)	0.2	1.3	10.0	9.0	1.0
Access (£pa)	0.2	1.15	60.1	65.0	-4.9
Outgoing calls (ppm)	0.4	1.15	5.6	5.4	0.2
Incoming calls (ppm)	0.4	1.15	9.4	9.0	0.4
Access (£pa)	0.3	1.15	58.7	65.0	-6.3
Outgoing calls (ppm)	0.3	1.15	5.7	5.4	0.3
Incoming calls (ppm)	0.3	1.15	9.4	9.0	0.4

Source: OFTEL.

29. The DGT told us that using what he considered to be the most realistic assumptions for estimating the effect of the option externality, it seemed clear that any appropriate adjustment was unlikely to exceed perhaps 0.75 ppm and it was quite likely that the price difference would be no more than 0.5 ppm.

30. The DGT also provided estimates of the total value of externalities which included the call externality as well as the option externality. He said that given the reasonably strong possibility that the call externality could be partly internalized by participants, he considered it appropriate to use a call externality adjustment factor of 1.25. The DGT's estimates are given in Table 3 which shows a surcharge on incoming call charges taking into account the option and the call externalities of + 0.8 to -0.8 ppm.

TABLE 3 Adjustments to charges for option and call externality

Service	Elasticity	Adjustment factors		Adjusted prices	Base Prices	Change in prices
		Option	Calls			
Access (£pa)	0.3	1.5	1.25	54.2	65.0	-10.8
Outgoing calls (ppm)	0.3	1.5	1.25	5.9	5.4	0.5
Incoming calls (ppm)	0.3	1.5	1.25	9.8	9.0	0.8
Access (£pa)	0.2	1.3	1.25	72.3	65.0	7.3
Outgoing calls (ppm)	0.4	1.3	1.25	5.1	5.4	-0.3
Incoming calls (ppm)	0.4	1.3	1.25	8.5	9.0	-0.5
Access (£pa)	0.3	1.3	1.25	62.0	65.0	-3.0
Outgoing calls (ppm)	0.3	1.3	1.25	5.5	5.4	0.1
Incoming calls (ppm)	0.3	1.3	1.25	9.1	9.0	0.1
Access (£pa)	0.2	1.15	1.25	78.0	65.0	13.0
Outgoing calls (ppm)	0.4	1.15	1.25	4.9	5.4	-0.5
Incoming calls (ppm)	0.4	1.15	1.25	8.2	9.0	-0.8
Access (£pa)	0.3	1.15	1.25	70.0	65.0	5.0
Outgoing calls (ppm)	0.3	1.15	1.25	5.2	5.4	-0.2
Incoming calls (ppm)	0.3	1.15	1.25	8.7	9.0	-0.3

Source: OFTEL.

31. The DGT told us that in the light of these calculations there was insufficient evidence to support any adjustment to prices to take account of externalities. He said that a much more detailed study would be necessary to obtain robust and independent estimates of the relevant parameters before any such adjustment should be contemplated.

32. The DGT also, however, provided us with some revised externality estimates. He told us that he regarded all the estimates as speculative. However, he stated that if speculative estimates had to be made, the central case might be one which had broadly equal elasticities among services, an option adjustment factor of 1.3 and a call adjustment factor of 1.25. These assumptions would lead to an increase in incoming call charges of 0.1 ppm, which the DGT said was insufficiently different from zero to justify a surcharge.

Vodafone's view of the DGT's estimates

33. We showed the DGT's method and estimates to Vodafone which had a number of criticisms of the DGT's approach. Vodafone said that the DGT's analysis had assumed that cross-elasticities of demand were zero which in its view was clearly inappropriate as demand for calls was strongly linked to the price of subscriptions. Vodafone criticized the DGT's assumption of zero fixed costs. It also criticized the lack of an empirical basis for the DGT's assumptions as to the size of the external adjustment factor. Vodafone said that whilst it accepted that the lower bound was 1, it was not the case that the upper bound was necessarily 2.

MMC analysis

The existence of externalities

34. There are two broad arguments (one in favour of externalities and one against) with regard to the issue of whether externalities should be included in the pricing of mobile phones. First, externalities as a general feature of telephony are not normally allowed for in the pricing of calls to networks. It is the case that the price of access on BT's fixed-line network is less than cost but this historically was designed in part at least to reflect the social benefit of ensuring access for lower income groups, and in any event is recovered from calls from BT. On these grounds, it might therefore be thought inappropriate to allow for externalities.

35. Secondly, the current rapid growth of mobiles, from very lower penetration rates to much higher ones, is an exceptional factor which has no significant counterpart in the fixed-line sector where the growth rate of subscribers is very much smaller. On these grounds, it might therefore be thought appropriate to allow for externalities.

36. A third point which is relevant for our assessment is that our terms of reference refer only to incoming charges.

37. We now assess the estimates of externalities provided by Vodafone and the DGT.

Vodafone's estimates

38. Vodafone argued that service provider incentives and marketing costs generated new subscribers; this resulted in more calls-to-mobiles. Callers pay for these calls of course but there is a consumer surplus, a benefit in that the value of a call-to-mobile to a caller typically, as with most goods and services bought, is higher than the prices to be paid. For some this surplus—the difference between the value and the price—is very high, for others low and for the 'marginal' purchaser—who is just on the balance of whether to buy or not—it is zero.

39. The main reason why Vodafone's estimates are so much higher than those of the DGT appears to be that Vodafone has calculated the total consumer benefit—which accrues to callers-to-mobile when additional subscribers lead to more calls-to-mobiles—at the going price which it estimated at 23 ppm. Using its average elasticity of -0.3 , this amounts to approximately 80 ppm a call for the most-valued extra calls and by definition zero for the least-valued extra call, and hence an average of 40 ppm. With around 550 incoming call minutes per subscriber in 1997/98 this values the benefit at £220 per subscriber in the same year. This figure is much higher than that estimated by the DGT.

40. The reason for this difference appears to be that the DGT implicitly estimated the private value of joining the mobile network (ie to the subscriber) at the price paid for it, ie £65, and the externality as some ratio of this. In contrast Vodafone estimated the total increase in consumer surplus for callers-to-mobiles, where this surplus is not directly related to any particular prices at all, though it is related indirectly via the elasticity and, with low elasticities, is very much higher than the price of the product.

41. Vodafone's approach is also partial; it has not investigated the numerous options other than incoming callers paying for all its service provider incentives and marketing costs or the possibility of there being no such costs. As the DGT has pointed out, there are alternatives which might be better than either of these positions, such as Vodafone continuing to provide marketing and service provider incentives but funding them out of charges to its own customers, or a smaller amount being recovered from call termination charges than proposed by Vodafone.

42. The partial nature of Vodafone's estimates is also demonstrated by the fact that Vodafone has only taken into account the consumer surplus to one group of users. In principle values can be estimated for the consumer surplus for other groups of users. We have not estimated these values because we do not believe that the size of the consumer surplus is an appropriate method for estimating the value of externalities.

43. In addition the assumption used by Vodafone that service provider incentives and marketing costs are responsible for all the increase in traffic is also, in our view, unrealistic.

The DGT's estimates

44. We also have reservations about the DGT's conclusions. Whilst his method does identify an optimum solution in theoretical terms, we have seen no empirical evidence which supports the assumptions he has used in his calculations.

MMC estimates

45. We have used a simplified version of the DGT's approach to produce our own externality estimates. Our model is not iterative as the level of the subsidy is not recalculated to take account of the effect on the price of joining the network. As a result our solution is not optimum in the way that the DGT's is but this does not in our view have great significance bearing in mind the uncertainties surrounding the assumptions.

46. For reasons given in paragraphs 5.85 to 5.87 we have used a price of joining the network of £65 a year which is based on our estimate of the lowest figure currently available for acquiring and being able to use a handset, an option adjustment factor of 1.3 to 1.7 and elasticities of 0.1 to 0.5. We have based our calculations on the number of Vodafone's subscribers in 1997/98 (3.43 million) and for the purpose of allocating the externality effects to incoming calls we have used the number of incoming minutes to Vodafone's network in 1997/98 (1.831 billion). We have allocated the externality effects to incoming calls in two ways. First, we have allocated a proportion of the externality effects to incoming calls (30 per cent). Second, we have allocated all the externality effects to incoming calls. The 30 per cent allocation to incoming calls is based on an assumption of the same elasticities for all services and hence a proportionate allocation. This is similar to the DGT's approach, which seeks to recover the externality from across the range of charges made. The second is based on the idea that if subscribers are to be subsidized then it must be from non-subscribers, ie callers-to-mobiles. Table 4 shows the range of our estimates for the value of the externality and for the effects on incoming call charges.

TABLE 4 Effects of the option externality on the price of incoming minutes in 1997/98

	<i>Low</i>	<i>High</i>	<i>Mid-point</i>
Value of the externality (£m)	1.4	25.5	13.5
30% of effects allocated to incoming minutes (ppm)	0.02	0.42	0.22
All effects allocated to incoming minutes (ppm)	0.07	1.39	0.73

Source: MMC calculations.

47. Table 4 shows the effects of option externalities on incoming call charges to be in the range of 0.02 to 1.39 ppm. The mid-points of the two alternative ways of recouping the externality are 0.22 and 0.73 ppm.

48. This all relates to the option externality. We have noted at least four other potentially relevant externalities during the inquiry. The first is the call externality associated with new subscribers. Allowing for this would entail a subsidy to calls from access charges and would therefore to some extent represent an offset to the option externality. Depending on the parameter values assumed this might, at one extreme, make little difference to the figures estimated above. At the other extreme it could offset most or even all of the option externality.

49. Another offsetting externality is that associated with updating the HLR. Our modelling has allocated the cost of this to incoming calls, because it is the existence of incoming calls which requires this updating. But, as explained in paragraph 3.41, there is nonetheless a gain to subscribers because location updating allows more efficient use of the network. We have not quantified this, but it is an external benefit for subscribers.

50. Another externality is that associated with voicemail. Our analysis of voicemail services leads us to conclude that the costs associated with call diversion should be borne by subscribers, because it is their decision whether to have this service. But some callers-to-mobiles will gain benefit from being diverted to another phone even though they do not pay for the diversion until another handset picks up the call. This is therefore another external benefit for callers-to-mobiles.

51. Finally there is the scale externality from new subscribers, that is the benefit to both existing subscribers and callers-to-mobiles arising from the lower unit costs which new subscribers generate. This is a more pervasive benefit and not restricted to any particular group of customers.

52. We have not attempted to estimate the size of the last three of these externalities. To some extent they offset each other and we do not think it feasible to try to incorporate their net effect into any externality adjustment. The call externality is slightly more quantifiable and could in principle be regarded as at least a partial offset to the option externality analysed above.