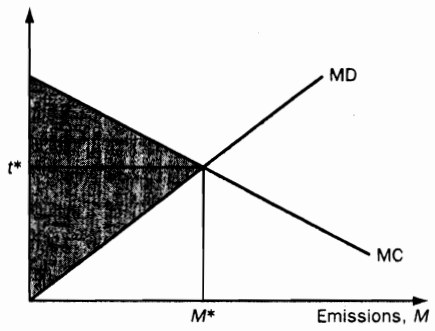

Figure 8.2 Target setting under perfect information

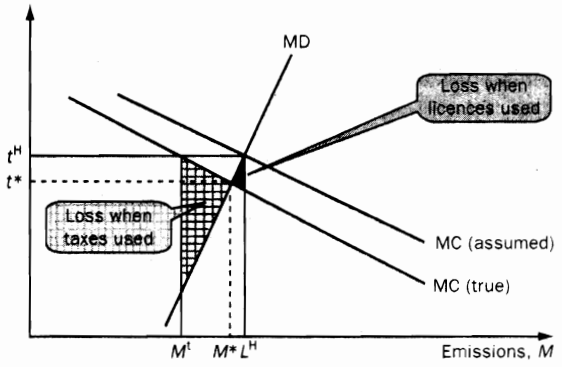

Figure 8.3 Uncertainty about abatement costs – costs overestimated

this, look at Figure 8.2. This establishes a 'baseline' against which the efficiency losses from errors due to uncertainty can be measured. The efficient target, M^*, is that level of emissions which equates the marginal cost of emissions abatement (MC) and the marginal damage of emissions (MD). The shaded area in Figure 8.2 represents the total net social benefit that would be generated at that level of emissions. This is the maximum net benefit available. The efficiency losses we have in mind are those in which emissions are at any level other than M^*, and so attained net benefits fall short of their maximum level.

8.3.3.1 Uncertainty about abatement costs

Uncertainty about abatement costs may result in an efficiency loss of this kind. Suppose that the EPA knows the pollution marginal damage function (MD) but has to estimate the marginal emissions abatement cost function (MC), and will often make errors in doing so. Overestimation and underestimation of abatement costs will each lead the EPA to wrongly identify the efficient level of emissions, and so to an efficiency loss. But, as we shall see, the magnitude of that loss will differ depending on which instrument the EPA chooses to use. In this section, we investigate the relative magnitudes of efficiency loss under an emission tax system and an emission licence scheme.

Figure 8.3 shows the case in which the marginal cost of abatement is overestimated. Consider first an emissions fee. On the (incorrect) assumption that the marginal abatement cost curve is the one labelled 'MC (assumed)', the EPA imposes a tax at the rate t^H (as opposed to its true efficiency level, t^*). Firms will abate emissions as long as their actual (true) marginal abatement costs are below the tax, and so will emit at M^t, a rate less than the efficient level. The resulting efficiency loss is defined by the shortfall of net benefits at M^t compared with the maximum obtainable level at M^*; this is indicated by the hatched area in the diagram.

Compare this efficiency loss with that which results from using an emissions licence system. Using incorrect information, the EPA believes the efficient target is L^H (when in fact it should be M^*). Incorrect information has led the regulator to pursue an insufficiently tight control. The efficiency loss is indicated by the solidly shaded area (corresponding to the surplus of marginal damages over marginal abatement costs for the excessive units of emissions).

Of course, errors may also take the form of underestimation of abatement costs. This is represented in Figure 8.4, in which the shapes and positions of the 'true' functions are identical to those in Figure 8.3 to allow direct comparison of the two diagrams. Now the assumed marginal abatement cost curve lies below its true position. Using similar reasoning to that given above, it can be seen that an emissions tax results in a loss (shown by the hatched area) that is greater than the loss associated with licences (the solidly shaded triangle).

An incorrectly estimated abatement cost function results in an efficiency loss. In the case we have

From Natural Resource and Environmental Economics, 3rd Edition, by Perman, Ma, McGilvray and Common.

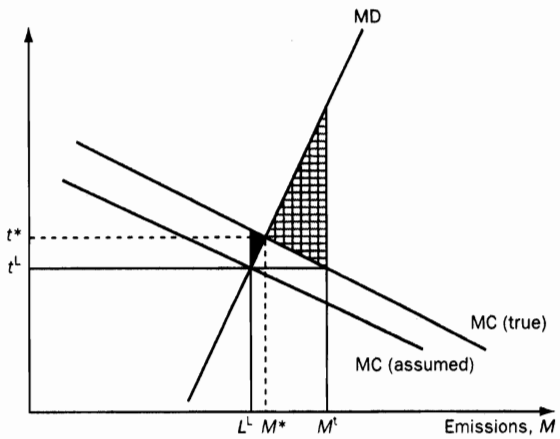

Figure 8.4 Uncertainty about abatement costs – costs underestimated

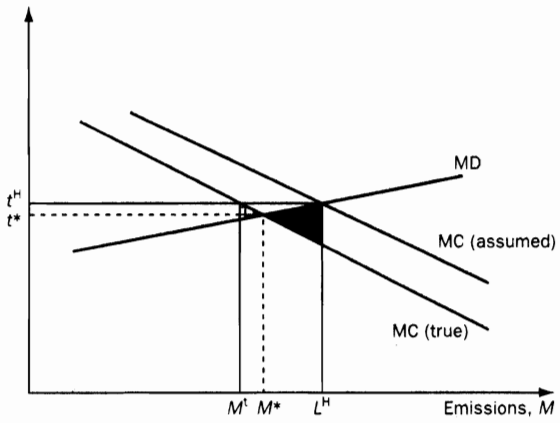

Figure 8.5 Uncertainty about abatement costs – costs overestimated

investigated, irrespective of whether the error is one of over- or underestimation, the loss from using taxes exceeds that from using licences. However, this result depends on the manner in which we constructed the functions in Figures 8.3 and 8.4. Compare these with the cases shown in Figures 8.5 and 8.6. These are analogues of the two situations just investigated, but are drawn with a substantially flatter marginal damage curve. Once again, both instruments generate efficiency losses when mistakes are made about abatement costs. But the ranking of the two instruments is now reversed: the loss is larger with licences than with a tax.

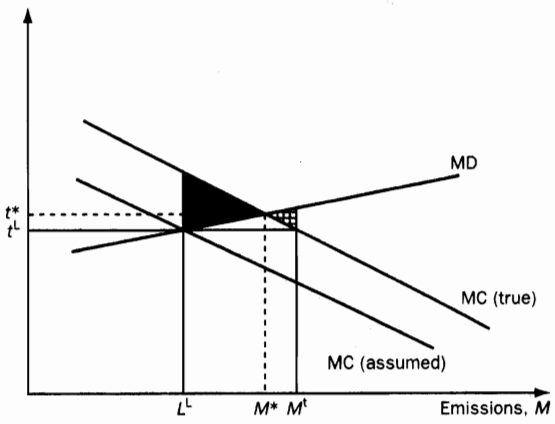

Figure 8.6 Uncertainty about abatement costs – costs underestimated

It turns out to be the case that what differentiates these two pairs of cases is the relative slopes of the MC and MD functions. We obtain the following general results:

- When the (absolute value of the) slope of the MC curve is less than the slope of the MD curve, licences are preferred to taxes (as they lead to smaller efficiency losses).
- When the (absolute value of the) slope of the MC curve is greater than the slope of the MD curve, taxes are preferred to licences (as they lead to smaller efficiency losses).

8.3.3.2 Uncertainty about pollution damages

The arguments so far have been conducted in the context of uncertainty about abatement costs. The conclusions we reached do not carry over to uncertainty about damage costs. In this case, the choice of quantity- or price-based instruments has no bearing on the magnitude of the efficiency loss arising from errors in estimating damage costs. The size of that loss is the same in each case, and so knowledge about the relative slopes of functions can give no information that would minimise such losses. This result is illustrated in Figure 8.7.

Given the estimated marginal damage function and the marginal cost function (assumed here to be correctly estimated), an EPA might set a tax at the rate t or a quantity control at the amount L. In either