Which of the downward-sloping curves in Figure 2-53 best represents the real relationship between pollution and life expectancy? That question cannot be answered on the basis of currently available data. We arbitrarily chose for inclusion in World3 the curve illustrated in Figure 2-54 and described by the following equations. This relationship reduces life expectancy by only 10 percent under pollution levels 40 times the average 1970 level.

```
LMP.K=TABHL(LMPT,PPOLX.K,0,100,10)                          29, A
LMPT=1.0/.99/.97/.95/.90/.85/.75/.65/.55/.40/.20            29.1, T
    LMP     - LIFETIME MULTIPLIER FROM PERSISTENT
              POLLUTION (DIMENSIONLESS)
TABHL   - A FUNCTION WITH VALUES SPECIFIED BY A TABLE
LMPT    - LMP TABLE
PPOLX   - INDEX OF PERSISTENT POLLUTION
              (DIMENSIONLESS)
```

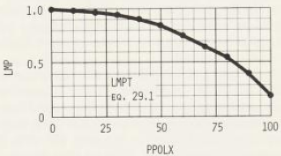

Figure 2-54 Lifetime multiplier from pollution

The numerical values we chose for the lifetime multiplier from pollution LMP probably err on the side of conservatism. The model runs in Chapter 7 will show that LMP has almost no effect on the model's behavior except under very extreme conditions—when the level of pollution grows so fast that any downward-sloping LMP curve would be activated. Alternative curves, more pessimistic and more optimistic, can be included in model runs as a test of the sensitivity of the total system behavior to variations in this poorly understood relationship. Variations in this function can have significant effects on the timing or severity of the population overshoot under conditions of high pollution. As long as the slope of the function is negative, however, the basic nature of the model behavior mode is insensitive to changes in its precise mathematical form.

Although the pollution and crowding multipliers of life expectancy LMP and LMC can be represented only tentatively at present, there is evidence that some such factors are beginning to affect aggregate mortalities in industrialized countries. In some Western countries the life expectancy at birth, which has risen steadily for decades, has not only leveled off but has turned slightly downward. This small decrease in life expectancy seems to be due to an increase in the incidence of chronic

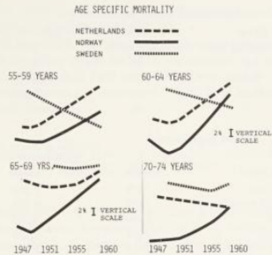

Figure 2-55 Rising age-specific death rates, Norway, Sweden, and the Netherlands
Source: Légaré 1967.

degenerative diseases in the population over age 55. The increase is illustrated by the rising age-specific death rates at high ages in three European countries, shown in Figure 2-55. It is not possible to tell whether this increase is due to pollution, crowding, or some as yet unidentified factor.

Fertility Equations

Birth Rate B The number of births per year B is calculated in World3 from a purely demographic factor, the number of fertile women in the population, and from a socioeconomic factor, the average number of births per woman per year.

The number of fertile women is determined by the total size and the age structure of the population, thereby reflecting the birth and death rates that the population has experienced over the past fifty years. In the more complete representations of population age structure (described later) the number of fertile women is calculated directly. In the simple one-level population model it is assumed that the fraction of the population consisting of women in the fertile age period (age 15–45, approximately) is constant. This constant, called the fraction of fertile women FFW, is set at 0.22. This approximation is accurate to about 10 percent, as indicated by theoretical age structures of stable populations with all combinations of low and high birth or death rates and by actual age structures of modern countries with varied demographic histories, as shown in Figure 2-56.

The average number of births per woman per year is influenced both by the total number of children borne by each woman during her lifetime and by the age of each woman at the birth of each child. The average total number of children borne per