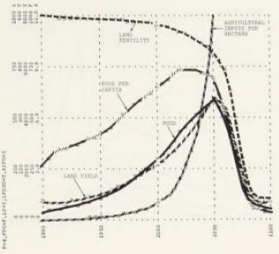
Run 4-10 (Figure 4-82) shows a simulation in which the estimates of these three relationships are changed in an optimistic fashion. The reestimates of the development cost relationship and the land erosion relationships cause arable land AL to peak at a higher value than its maximum in the standard run. Similarly, the optimistic reestimate of the adverse effect of air pollution on land yield LY causes LY to peak at a higher value. More arable land AL and higher land yield LY cause total food production F to peak at a higher value (about 20 percent higher) than in the standard run. The peak is not maintained, however, since land fertility and thus land yield are decreased by the exponentially rising level of pollution. The decline in food per capita in this run occurs only 20 years later than in the standard run.

Run 4-11 (Figure 4-83) shows a simulation in which all three relationships are reestimated in a pessimistic fashion. Despite the higher development costs the demand for food induces a rate of land development LDR sufficient to make arable land AL rise and peak at about the same value it reached in the standard run. Although arable land is more susceptible to erosion in this run, the adverse effects of air pollution prevent land yield LY from rising high enough to cause much land erosion LER. The decline in arable land AL is caused mainly by land removal for urban-industrial use LRUI. The peak value of food production F is about 40 percent lower than it was in the standard run.

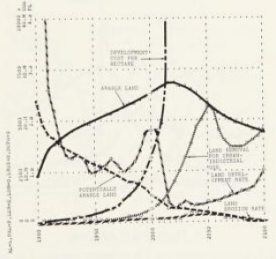
These sensitivity tests indicate that the dominant behavior mode of the agriculture sector with exponential driving functions is overshoot and decline, even given a wide variety of changes in parameter estimates. The overshoot should not be surprising, since with these driving functions all four of the necessary conditions for instability are present:

1. Rapid physical growth (assumed in the driving functions).
2. Physical limits to that growth (the upper limit on land yield LY and on the amount of potentially arable land total PALT available).
3. Delays in the feedback processes that adjust the growing quantities to physical limits (the driving conditions assume no such feedback, which corresponds to an infinitely long delay time).
4. Possible erosion of physical limits by overuse (overuse of agricultural inputs per hectare AIPH lead to higher land yield LY, which causes higher land erosion LER) or by misuse (abandoning land maintenance exacerbates the decline of land fertility LFERT).

The remaining simulation runs in this chapter further illustrate the behavior of the agriculture sector by examining its response to various policies that do more than change the numerical values within the model structure. These policies have the potential to alter the basic behavior mode of the sector, for they alter at least one of the four basic dynamic properties that lead to the unstable overshoot mode. First we discuss the results of a set of technological policies that attempt to deactivate the



A. The behavior of land yields and food production



B. The behavior of arable land

Figure 4-82 Run 4-10: sensitivity test with optimistic estimates of the cost of land development, the adverse effects of air pollution on yield, and the extent to which high land yield causes land erosion