was chosen as a reasonable estimate, it is highly uncertain, so it was important to examine the effects of errors in this estimate on the behavior of the system. Run 7-7 (Figure 7-10) illustrates the model's behavior when the estimate of nonrenewable resources initial NRI is doubled. Note that Run 7-7 plots the nonrenewable resource fraction remaining NRFR rather than the absolute level of nonrenewable resources. The overall behavior of the system is quite similar to that of the reference run except in three areas: industrial output per capita IOPC continues to grow 15 years longer than in Figure 7-7, or until the year 2030. Population POP also continues to grow for an additional 15 years, reaching a level of over 8 billion in the year 2045. Pollution increases to 32 times its 1970 value in the year 2070, compared with the level of 11 times its 1970 value reached in 2035 in the reference run. Thus, after a 15-year postponement, growth is again halted by the effects of a decline in available resources—through a mechanism similar to that described for the reference run (Figure 7-7). Increasing our estimate of NRI by 100%, that is, assuming a static resource index of over 500 years instead of 250 years in 1970, has no significant influence on the basic behavior mode, and very little effect on the timing of the overshoot.

Nonrenewable Resources Initial NRI—*Ten Times* NRI In Chapter 5 it was stated that the most likely range of the 1970 static resource index was 50 to 500 years. Run 7-7 depicted the behavior of the model when the initial value of nonrenewable resources was increased to its maximum likely value. Run 7-8 (Figure 7-11) examines the sensitivity of the model's behavior to an order-of-magnitude increase in the initial value of nonrenewable resources NRI.

Run 7-8 shows that an extremely high estimate of nonrenewable resources eliminates resources as a constraint to growth within the time horizon of the model. With initial resources raised by a factor of 10, population POP and industrial output per capita IOPC continue to grow until constrained by other, more immediate limits—in this run, the high level of persistent pollutants. Even with the effective removal of one limit to growth, the basic behavior mode of the system remains one of overshoot and decline. The limiting factor is changed, changing the order in which the variables decline, but the behavior mode remains unstable.

Fraction of Industrial Output Allocated to Agriculture FIOAA In Chapter 4 the fraction of industrial output allocated to agriculture FIOAA was defined as the relationship governing the redirection of industrial output IO into or out of agricultural investment. The magnitude of this factor depends on the discrepancy between actual food per capita FPC and the desired or indicated food per capita IFPC. The fraction of industrial output allocated to services FIOAS performs an analogous function in the service sector.

As described in Chapter 4, a steeper slope for the FIOAA relationship represents a faster and stronger response to food shortages or surpluses. To test the sensitivity of the model's behavior to stronger economic responses to food shortages, the slope of the FIOAA relationship was increased as shown in Figure 7-12.

The effect of this change on the behavior of the reference run (Figure 7-7) is shown in Run 7-9 (Figure 7-13). A comparison of Run 7-9 with the reference run indi-

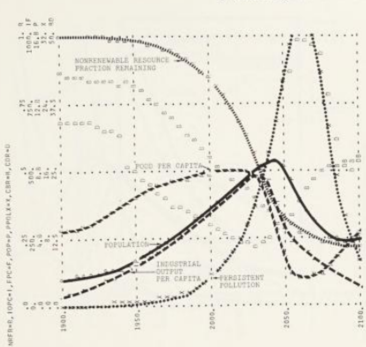

Figure 7-10 Run 7-7: sensitivity of the initial value of nonrenewable resources to a doubling of NRI

To test the sensitivity of the reference run (Figure 7-7) to an error in the estimate of initial nonrenewable resources, NRI is doubled. As a result, industrialization continues for an additional 15 years until growth is again halted by the effects of resource depletion.

cates that a change in the slope of this relationship will not alter the basic behavior mode of the model. Changes in the fraction of industrial output allocated to agriculture FIOAA have little effect on the model's behavior because this relationship governs only the short-term efficiency of the allocation of available industrial output. The purpose of this variable is to equilibrate actual food per capita FPC with indicated food per capita IFPC. The slope of the FIOAA curve determines the time necessary for the equilibration to take place, and this time is always very short compared with the more significant delays in other parts of the model. Thus the exact numbers that express the FIOAA relationship are important only in minor, short-term adjustments of the agriculture sector and have almost no effect on the long-term development of the total system.

Average Lifetime of Industrial capital ALIC The average lifetimes of service and industrial capital ALSC and ALIC were derived from international data on capital depreciation, as described in Chapter 3. These derivations are at best approximations because the international statistics are not uniformly accurate and because changes in the mix of capital items will change the average lifetime of capital. It was useful, therefore, to test the sensitivity of the model to changes in these parameters. As an