Increase in Resource Exploration and Extraction Technologies Run 7-12 (Figure 7-16) analyzes the behavior of the model in response to an advance in resource exploration and extraction technologies implemented in 1975. The technological improvements affect the fraction of capital that must be allocated to obtaining resources FCAOR as shown in Figure 7-17. It was postulated in Chapter 5 that the fraction of capital allocated to obtaining resources FCAOR is a function of the fraction of nonrenewable resources remaining NRFR. Run 7-12 (Figure 7-16) assumes that advances in exploration and extraction technologies beyond those expected in the reference run will tend to offset rising resource costs for a large fraction of the lifetime of resources. Thus FCAOR will remain at its minimum value of 0.05 until very low values of NRFR are reached (Figure 7-17).

A comparison of Run 7-12 with the reference run (Figure 7-7) indicates that this policy is successful only in the short run. Industrial output per capita IOPC rises until the year 2025, just 10 years longer than in the reference run. Population POP is allowed to grow only an additional 10 years, to a level of 8 billion people in 2035. The policy's effectiveness is short-lived because of the continued growth of population and per capita resource usage. In the reference run, growth is halted when the nonrenewable resource fraction remaining NRFR reaches 0.5; in Run 7-12 growth continues until NRFR equals 0.2. Because of the continued growth in the nonrenewable resource usage rate NRUR, the additional amount of resources made available at lower resource costs by improved technology is consumed in only 10 years.

In the long run, a policy of increased investment in resource exploration and extraction technologies is ineffective and even counterproductive if not combined with other resource-conserving policies. Although the decline in industrial output IO is postponed for a few years in Run 7-12, the eventual rise in the fraction of capital allocated to obtaining resources FCAOR precipitates a more rapid decline in industrial output per capita IOPC than that exhibited in the reference run (Figure 7-7). This behavior is attributable to our assumption that advances in exploration and extraction technologies reduce resource costs in the short run, which encourages resource depletion. In the long run, the effects of resource depletion cause FCAOR to rise more rapidly (Figure 7-17), and the system has little time to adjust. As a result, industrial output per capita IOPC falls sharply after the year 2025 in Run 7-12.

Recycling Technologies Run 7-13 (Figure 7-18) illustrates the behavior of the model when the technological advances in resource exploration and extraction of Run 7-12 are supplemented by improved recycling techniques in 1975, allowing the annual usage of nonrenewable resources to be reduced by a factor of 8.0. Improvements in the efficiency of resource use may be represented in World3 in two ways—through changes in the table of per capita resource consumption PCRUMT or through changes in the nonrenewable resource usage factor NRUF. When the former is reduced, the magnitude of persistent pollution generation PPGR will also be reduced. When the latter is reduced, per capita resource consumption is decreased with no effect on the generation of persistent materials.

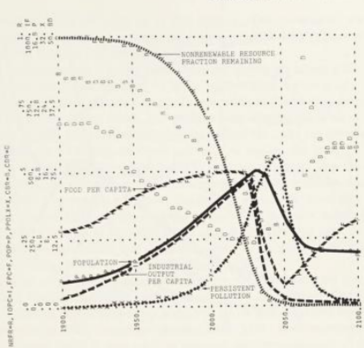

Figure 7-16 Run 7-12: improved resource exploration and extraction technologies
The implementation of improved resource exploration and extraction technologies in 1975 is modeled by lowering the capital cost of obtaining resources for industrial production. This policy allows industrial production to continue growing for a few more years than in the reference run, but it is ineffective in avoiding the effects of resource depletion.

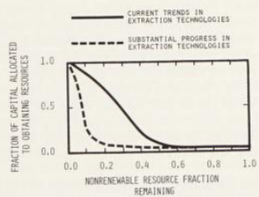

Figure 7-17 The effects of resource exploration and extraction technologies on the fraction of capital allocated to obtaining resources