```
FCAOR1 - FCAOR, VALUE BEFORE TIME=PYEAR
         (DIMENSIONLESS)
TIME   - CURRENT TIME IN THE SIMULATION RUN
PYEAR  - YEAR NEW POLICY IS IMPLEMENTED (YEAR)

FCAOR1.K=TABHL(FCAOR1T,NRFR.K,0,1,.1)                    135, A
FCAOR1T=1/.9/.7/.5/.2/.1/.05/.05/.05/.05                 135.1, T
    FCAOR1 - FCAOR, VALUE BEFORE TIME=PYEAR
             (DIMENSIONLESS)
    TABHL  - A FUNCTION WITH VALUES SPECIFIED BY A TABLE
    FCAOR1T- FCAOR1 TABLE
    NRFR   - NONRENEWABLE RESOURCE FRACTION REMAINING
             (DIMENSIONLESS)

FCAOR2.K=TABHL(FCAOR2T,NRFR.K,0,1,.1)                    136, A
FCAOR2T=1/.9/.7/.5/.2/.1/.05/.05/.05/.05                 136.1, T
    FCAOR2 - FCAOR, VALUE AFTER TIME=PYEAR
             (DIMENSIONLESS)
    TABHL  - A FUNCTION WITH VALUES SPECIFIED BY A TABLE
    FCAOR2T- FCAOR2 TABLE
    NRFR   - NONRENEWABLE RESOURCE FRACTION REMAINING
             (DIMENSIONLESS)
```

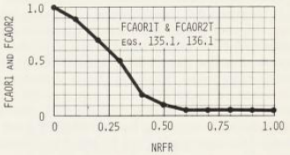

Figure 5-18 Fraction of capital allocated to obtaining resources table

The capital available to produce finished industrial output IO is defined as the total industrial capital IC multiplied by 1−FCAOR, where FCAOR is the fraction of capital that must be allocated to obtaining resources. The assumption of finite resources demands that FCAOR must approach one as resources near depletion so that industrial output IO (defined as manufactured material goods manufactured from resources) will gradually fall to zero. When the level of obtainable resources nears zero, industrial output IO must be curtailed because any level of IO demands resources. Thus the value of FCAOR at any time defines the necessary fraction of the capital stock that must be allocated to obtain the resources required for the present level of IO. The assumption that FCAOR must approach one as resources approach zero provides an adjustment mechanism that curtails the use of resources before the finite stock is exhausted. It corresponds to a rise in capital costs (and thus resource prices) as resources are depleted. Since the rising costs reduce the resource usage rate, the fraction of nonrenewable resources remaining NRFR never actually reaches zero in any model run; therefore, FCAOR never reaches one, and resources are never completely depleted. The form of the assumed relationship for FCAOR is shown in Figure 5-18.

Barnett and Morse (1963) have also examined the hypothesis that the fraction of capital allocated to obtaining resources FCAOR must rise as resources are depleted. Figure 5-19 shows time-series data for total capital, capital in mining, and capital in agriculture for the U.S. economy. Barnett and Morse conclude from this figure that the fraction of capital allocated to all extractive industries (agriculture and mining) is decreasing rather than increasing. Figure 5-20 illustrates the time-dependent behavior of the fraction of capital allocated to obtaining nonrenewable resources only, derived from Figure 5-19 by dividing mining capital by total capital. It appears that FCAOR has increased slightly over the long term, although it remains a very small fraction of total capital (2 percent). It is clear that technological advances in both extraction and substitution tend to counteract the hypothesized economic effects of resource scarcity and are undoubtedly responsible for the drop in the fraction of capital allocated to mining after 1920.

Although the data presented in Figure 5-20 are for the U.S. economy, they give some insights into the determination of a small portion of the FCAOR relationship hypothesized in Figure 5-18. Over the model's historical period (1900–1970), we assumed that the world economy consumed only one-tenth of its total initial stock of nonrenewable resources NR, so the nonrenewable resource fraction remaining NRFR decreases from 1.0 to 0.9 between 1900 and 1970. From Figure 5-20 it is clear that this small fraction of total resources, representing the highest grades and the most accessible locations, were available at a very low cost in terms of the fraction of total capital that had to be allocated to obtaining them. During this period, the economic effects of depletion were not great and were rather easily counteracted by technological advances. Figure 5-20 shows that for the U.S. economy the fraction of capital

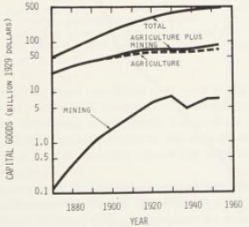

Figure 5-19 Capital goods in the U.S. private domestic economy and in agriculture and mining, 1869–1953
Source: Barnett and Morse 1963, p. 220.