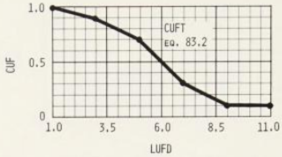

Figure 3-35 Postulated relationship between the labor utilization fraction delayed and the capital utilization factor

As LF falls, LUFD rises and CUF falls, decreasing the effective amount of capital available to produce industrial and service output. We assumed that if LUFD rises to 10, corresponding to ten jobs for every worker, CUF will fall to 0.1. The slope and the asymptotes of the curve must be roughly correct. However, since the curve comes into effect only during the collapse of population, the precise form of the relationship is subject to speculation.

The actual relation between LUFD and CUF depends on the distribution of the labor shortage across the industrial, agriculture, and service sectors. Here we assume that the industrial and service sectors bear proportionately the same burden of coping with any lack of labor. An alternative approach would be to multiply each sector by its own capital utilization factor. However, this refinement is certainly not justified in World3, where the labor sector is active only during the collapse mode of the model. Because so many relationships that are likely to be important during a collapse are completely missing from World3, the model's utility in studying a population decline would not be increased by slightly refining the labor sector.

3.7 SIMULATION RUNS

The combined capital and job sector can be simulated in isolation from the rest of World3 if exogenous values are provided for population POP, the fraction of capital allocated to obtaining resources FCAOR, the fraction of industrial output allocated to agriculture FIOAA, the population of working age P2 and P3, arable land AL, and agricultural inputs per hectare AIPH. For the simulations reported here, these variables were specified directly or indirectly as functions of time; in the complete model runs, these variables were endogenously determined by the other model sectors. The equations used to generate the following runs are listed in the appendix to this chapter.

Standard Run

In this simulation we established values for the exogenous variables so that population POP follows its historical values, growing from 1.6 billion in 1900 to 3.6 billion in 1970, the fraction of capital allocated to obtaining resources FCAOR remains constant at 0.05, and the fraction of industrial output allocated to agriculture FIOAA stays constant at 0.10. Arable land AL and agricultural inputs per hectare AIPH are assigned the same values over time that they exhibit in the World3 standard run. Arable land increases from 0.9 to 2.4 billion hectares between 1900 and 2100. The inputs per hectare rise from 5 to 123 dollars per hectare-year between 1900 and 2020 and then decline. The populations from ages 15 to 44 and 45 to 64, P2 and P3, are each taken to be one-fourth of the total population. The values for the five driving functions between 1900 and 1970 are shown in Figure 3-36.

The behavior of the capital sector in response to these inputs is shown in Run 3-1 (Figure 3-37). Industrial output per capita IOPC and service output per capita SOPC roughly pass through their assumed historical values for 1900 and 1970: IOPC(1900) = 40 dollars per person-year, IOPC(1970) = 250 dollars per person-year, SOPC(1900) = 90 dollars per person-year, and SOPC(1970) = 350 dollars per person-year. The fraction of industrial output allocated to services FIOAS is constant at about 0.12, implying that indicated service output per capita ISOPC is slightly higher than SOPC. The labor force is great enough to make the capital utilization fraction CUF equal 1.0 throughout. The growth resulting from positive feedback in the capital sector is clearly evident.

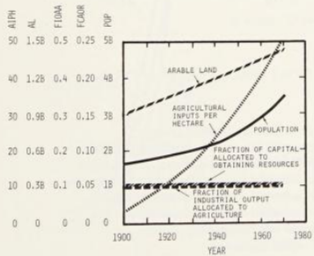

Figure 3-36 Driving functions for the standard run of the capital sector