capital to remain idle, and the effective service capital would be less than the value of SC. To incorporate this possible effect we defined a capital utilization factor CUF whose value may range from zero to 1.0 depending upon the availability of labor. Typically, CUF equals 1.0 and thus does not affect the model's behavior.

Service Output per Capita SOPC

```
SOPC.K=SO.K/POP.K                                          71, A
   SOPC   - SERVICE OUTPUT PER CAPITA (DOLLARS/PERSON-
            YEAR)
   SO     - SERVICE OUTPUT (DOLLARS/YEAR)
   POP    - POPULATION (PERSONS)
```

Service output per capita SOPC is a measure of the average amount of service output SO available to each person in the population POP. By definition, SO is intangible and entirely consumed. As is the case with industrial output per capita IOPC, uneven distribution of service output SO is not explicitly represented in the equation for SOPC but is reflected in the formulation of the variables that depend on it.

Service Capital-Output Ratio SCOR

```
SCOR.K=CLIP(SCOR2,SCOR1,TIME.K,PYEAR)                      72, A
SCOR1=1                                                    72.1, C
SCOR2=1                                                    72.2, C
   SCOR   - SERVICE CAPITAL-OUTPUT RATIO (YEARS)
   CLIP   - A FUNCTION SWITCHED DURING THE RUN
   SCOR2  - SCOR, VALUE AFTER TIME=PYEAR (YEAR)
   SCOR1  - SCOR, VALUE BEFORE TIME=PYEAR (YEAR)
   TIME   - CURRENT TIME IN THE SIMULATION RUN
   PYEAR  - YEAR NEW POLICY IS IMPLEMENTED (YEAR)
```

Although we could find no direct empirical evidence to suggest an appropriate value for the service capital-output ratio SCOR, the provision of services is typically much more labor-intensive than the manufacture of industrial output. Because labor was excluded from our production function for services, SCOR was reduced to compensate for the omission. We assumed SCOR to be equal to 1.0 years in most runs, but we incorporated in the model a CLIP function that permits the value of SCOR to be changed from SCOR1 to SCOR2 when TIME=PYEAR.

3.6 THE JOB SECTOR

We suggested in the basic concepts section (3.3) of this chapter that more labor has been available historically than was required for full utilization of the world's capital stock. Given the form of our industrial production function, labor normally has no influence on the industrial output produced by a given amount of industrial capital. Only if the labor force were very small compared with the industrial capital stock would one expect the effective capital to decrease. The job sector was incorporated in World3 to represent this possible effect of an extreme labor scarcity. Because of a lack of available data on a global basis and the high level of aggregation of the entire model, it is improper to interpret the interactions within the job sector as anything more than a demonstration of the possible effect of a drastically reduced work force on the amount of goods and services produced by the world's capital. The main effect of the sector is to avoid unrealistically high values of SOPC and IOPC during those runs in which population declines more rapidly than capital.

The addition of this sector to World3 was our only effort to include model relationships that may be in effect during the period of population decline. The model's utility remains in its ability to clarify the dynamics of growth, not in portraying realistic collapse modes. Thus the job sector described here is a preliminary representation of the gross physical implications of an extreme labor shortage; it is not an adequate representation of the factors involved in the problem of global unemployment. The causes of unemployment are sufficiently important and complex to warrant separate modeling efforts. Some of the data and concepts presented here may provide useful points of departure for those efforts.

Jobs J

```
J.K=PJIS.K+PJAS.K+PJSS.K                                   73, A
   J      - JOBS (PERSONS)
   PJIS   - POTENTIAL JOBS IN INDUSTRIAL SECTOR
            (PERSONS)
   PJAS   - POTENTIAL JOBS IN AGRICULTURAL SECTOR
            (PERSONS)
   PJSS   - POTENTIAL JOBS IN SERVICE SECTOR (PERSONS)
```

The total number of jobs J in World3 is calculated as the sum of the potential jobs in the industrial, agriculture, and service sectors (PJIS, PJAS, and PJSS, respectively).

Potential Jobs in Industrial Sector PJIS

```
PJIS.K=(IC.K)(JPICU.K)                                     74, A
   PJIS   - POTENTIAL JOBS IN INDUSTRIAL SECTOR
            (PERSONS)
   IC     - INDUSTRIAL CAPITAL (DOLLARS)
   JPICU  - JOBS PER INDUSTRIAL CAPITAL UNIT (PERSONS/
            DOLLAR)
```

The number of potential jobs in the industrial sector PJIS equals the industrial capital IC multiplied by the number of jobs per unit of industrial capital JPICU (a function of the industrial output per capita IOPC). Employing data from the International Labor Organization (ILO 1970) and the United Nations (U.N. 1969), we estimated the relationship between IOPC and JPICU by

1. Multiplying the entries in column 4 by the entries in column 5 of Figure 3-25 to determine the number of jobs in the industrial sector of each country.
2. Multiplying the entries in column 6 of Figure 3-7 by the entries in column 3 of Figure 3-25 to approximate each country's industrial output.
3. Multiplying each country's industrial output by 3.0 (ICOR) to produce an estimate of the level of industrial capital in each country.