1. Theoretical, stable populations

Gross Reproduction Rate	Life Expectancy	Fraction of Women 15–45
1.5	35	0.237
1.5	69	0.229
3.0	35	0.222
3.0	69	0.247

2. Real populations

Country	Date	Fraction of Women 15–45
Mauritius	1959	0.210
United Kingdom	1959	0.205
Japan	1960	0.245
India	1951	0.230
United States	1960	0.205

Figure 2-56 Fraction of women of fertile ages in theoretical and real populations
Sources: (1) Coale and Demeny 1966, pp. 184, 212; (2) Ehrlich and Ehrlich 1970, pp. 26–30.

woman over her entire reproductive lifetime is called the total fertility TF. In the models where age structure is specifically calculated, TF is allocated by age according to established age-specific fertility patterns. In the one-level model, TF is assumed to be distributed evenly over the entire reproductive lifetime. Thus the average number of births per woman per year is represented by total births per woman TF divided by the number of years of female reproductive lifetime (RLT = 30). The approximation of constant age-specific fertility tends to underestimate the real birth rate slightly, since more children are actually borne during the first half of the female reproductive period than during the second half.

The equation representing the birth rate in the one-level model is given below; the birth rate equations for the age-disaggregated models are shown later in this section.

```
B.KL=CLIP(D.JK,(TF.K*POP.K*FPW/RLT),TIME.K,PET)
FPW=.22
RLT=30
PET=4000
     B      - BIRTHS PER YEAR (PERSONS/YEAR)
     CLIP   - A FUNCTION SWITCHED DURING THE RUN
     D      - DEATHS PER YEAR (PERSONS/YEAR)
     TF     - TOTAL FERTILITY (DIMENSIONLESS)
     POP    - POPULATION (PERSONS)
     FPW    - FRACTION FERTILE WOMEN (DIMENSIONLESS)
     RLT    - REPRODUCTIVE LIFETIME (YEARS)
     TIME   - CURRENT TIME IN THE SIMULATION RUN
     PET    - POPULATION EQUILIBRIUM TIME (YEAR)
```

The CLIP function in the birth rate equation represents a test option that allows the modeler to set the birth rate equal to the death rate (and thus to stabilize the population) at any chosen population equilibrium time PET. If it is not specifically reset by the operator, PET is set at the year 4000 so that the CLIP function is not activated during a model run from 1900 to 2100.

The crude birth rate CBR, like the crude death rate CDR, is calculated only for purposes of display on output graphs and does not influence any other variable in the model. The world average crude birth rate in 1969 was about 36 per 1,000 persons (USAID 1971). National averages in that year ranged from 50 (Iran, Kuwait, Ghana) to 14 (Sweden, East Germany).

```
CBR.K=1000*B.JK/POP.K                                    31, S
     CBR    - CRUDE BIRTH RATE (BIRTHS/1000 PERSON-YEARS)
     B      - BIRTHS PER YEAR (PERSONS/YEAR)
     POP    - POPULATION (PERSONS)
```

The total fertility TF is a function of many factors—some biological, some cultural or psychological, some economic. The rest of the fertility sector of World3 is devoted to the representation of inputs to this function. Total fertility can vary widely from population to population, as indicated by the values shown in Figure 2-57.

In the world model we separated the inputs to total fertility into three functional categories:

1. involuntary biological factors that influence the fecundity,* or the ability of the population to bear children (maximum total fertility MTF);
2. voluntary or social factors that influence the desire of the population to bear children (desired total fertility DTF); and
3. the means available to the population to attain the desired rather than the maximum family size (fertility control effectiveness FCE).

Determinants of each of these categories will be discussed in detail later. Here we describe how they are brought together in an equation that generates actual total fertility TF.

```
TF.K=MIN(MTF.K,(MTF.K*(1-FCE.K)+DTF.K*FCE.K))            32, A
     TF     - TOTAL FERTILITY (DIMENSIONLESS)
     MIN    - MINIMUM VALUE FUNCTION
     MTF    - MAXIMUM TOTAL FERTILITY (DIMENSIONLESS)
     FCE    - FERTILITY CONTROL EFFECTIVENESS
              (DIMENSIONLESS)
     DTF    - DESIRED TOTAL FERTILITY (DIMENSIONLESS)
```

Fertility control effectiveness FCE is defined not in terms of particular birth control methods but in terms of the degree of control afforded by the entire spectrum of methods practiced by the population, for example, abortion, long lactation, and all forms of abstinence, including late marriage and sexual taboos. It is measured on a scale from 0 to 1. If a population has no control whatsoever over its own reproductive behavior, FCE = 0, and the actual total fertility TF will be equal to the biologically determined maximum total fertility MTF. If the population is able to practice perfect

*"Fecundity" and "fertility" are used here in the English sense, which is the reverse of the French usage. Fecundity here refers to the biological capability to produce children, fertility to the rate at which they are actually produced. Thus fecundity defines the biological upper limit of fertility.