Variable	Units
Population POP	Persons
Industrial output per capita IOPC	1968 dollars per person-year
Food per capita FPC	Vegetable-equivalent kilograms per person-year
Index of persistent pollution PPOLX	Dimensionless
Nonrenewable resource fraction remaining NRFR	Dimensionless
Crude birth rate CBR	Births per thousand person-years
Crude death rate CDR	Deaths per thousand person-years

Full descriptions of these variables and their units are included in the five sector chapters and in Appendix B to this volume. Appendix E to this volume describes the format of a DYNAMO output for readers unfamiliar with this type of computer run. To facilitate comparisons between the runs, we maintained the same scales for the variables, where possible, in the successive runs.

Figure 7-1 is a DYNAMO flow diagram of the word model, showing the interconnections between the model variables described in Chapters 2 through 6. The diagram can be roughly divided into five sectors, clockwise from the upper left corner, which describe the structures of the population, nonrenewable resource, persistent pollution, agriculture, and capital sectors. The appendix to this chapter lists all the DYNAMO equations of the world model and summarizes the parametric and structural changes made in the model equations to produce each of the simulation runs discussed in this chapter. Any reader with access to a computer of sufficient capacity and a DYNAMO compiler can refer to the appendix and reproduce all the global simulation runs.

The runs described in this chapter were obtained by simulating the complete world model as shown in Figure 7-1. In these runs, all the sectors interact during the simulations, and none of the variables were assumed to be exogenously determined.

7.2 HISTORICAL RUNS

The utility or relevance of any model is directly dependent on the degree of confidence one has in the model. To increase our confidence in the World3 model, we tried to make certain that each individual model relationship not only was a plausible representation of the real world but also was consistent with the available data. (The preceding five chapters have described the individual model assumptions and compared them with empirical data.) In addition, the total behavior of World3's relationships, acting together, had to reproduce the pattern of world growth over the historical period of the model. The first five simulation runs of this chapter show the behavior of the variables within the five sectors as the complete model is run over the 1900–1970 period. A summary of the observed historical trends precedes the run for each sector so that the two can be compared.

The historical time trends are presented verbally rather than graphically for two reasons. First, in most cases the aggregate world time-series data are of an extremely low quality. Second, the verbal descriptions of the historical trends deemphasize the precise quantitative interpretation of the model output. It should be remembered that we are interested in the overall behavior *modes* of the model. Therefore, the evaluation of the actual values of the variables at any point in time is not a significant test of the model's utility.

Population Sector Variables The historical behavior modes characteristic of the world population over the years 1900–1970 are:

1. Exponential growth of the world population caused by:
   a. Falling mortality.
   b. Intermediate values of fertility.
   c. An inverse correlation of fertility with industrialization.
2. A delayed response of population behavior to changes in external influences due to:
   a. The population age structure.
   b. Inherent delays in adjustment to social change.
3. Falling birth rates lagging behind falling death rates, a characteristic of the demographic transition as industrialization proceeds.

Run 7-1 (Figure 7-2) shows the behavior of important variables in the population sector when the world model is run from 1900 to 1970. In accordance with the major time trend of the world population, population POP exhibits exponential growth over the period. The model population was initialized at 1.6 billion people in 1900 and passes through the historical value of 3.6 billion people in 1970, representing an average population growth rate of 1.2 percent per year for the period. The rate of growth varies over time in the model (as in the real world) and at any given time is equal to the difference between the crude birth rate CBR and the crude death rate CDR.

During the 1900–1970 period, the global population exhibited a trend toward falling mortality (see Figure 2-6). In Run 7-1 the crude death rate CDR also declines over time, principally as a result of improved health services. The world population is also characterized by intermediate values of fertility, as shown in Figure 2-7, where the observed behavior of the crude birth rate CBR is in a range well below the maximum biologically possible rate but above the replacement level of fertility. Run 7-1 shows that the model-generated crude birth rate CBR also operates in this intermediate region. Third, world populations have generally shown an inverse correlation between fertility and industrialization (see Figure 2-8). This correlation is evident in the model runs, for as industrial output per capita IOPC rises through time, as shown in Run 7-2 (Figure 7-3), the crude birth rate CBR falls (Run 7-1).

The rising life expectancy LE in Run 7-1 has been attributed principally to the increase in health services over the past century (see Chapter 2, section 2.5). In the model, the influences on life expectancy from health services, food, pollution, and crowding are represented by the lifetime multiplier from health services LMHS, the lifetime multiplier from food LMF, the lifetime multiplier from pollution LMP, and