tially. The life expectancy decreases slightly over the course of the run, and the death rate rises again because of increased crowding under low-income health conditions. The population will continue to grow in this run until the death rate is raised again because of crowding—since food per capita is held constant, crowding is the only mechanism remaining to halt growth.

Exponential Economic Growth Run 2–7 (Figure 2-90) shows the behavior of the population sector under constant exponential growth in economic output. The initial values and growth rates are those used in the historical Run 2–1, but the growth in industrial, service, and food output is continued without limit for a 200-year period (pollution is still held constant). The behavior mode illustrated in Run 2–7 is essentially the demographic transition. Industrial output, services, and food per capita have all grown off the top of the graph by the year 150. Birth and death rates continue their decline and finally level off at values of about 18 and 13 per thousand, respectively, for a final net growth rate of 0.5 percent per year. Over the 200-year period the total population grows by a factor of 5 in the one-level model and by a factor of 10 in the fifteen-level model, the large difference being the result of accumulating a small differential in the net growth rate over a long period. The general behavior mode generated by all three models is the same. Fertility control effectiveness reaches 100 percent in the year 110, and world average life expectancy levels off at 65 years (slightly reduced because of crowding).

The variations in the age structure and the multipliers of life expectancy during this transition are shown in Run 2–8 (Figure 2-91). The lifetime multipliers from food and health services saturate at their maximum values. The lifetime multiplier from crowding increases as cities develop improved health services; it then decreases

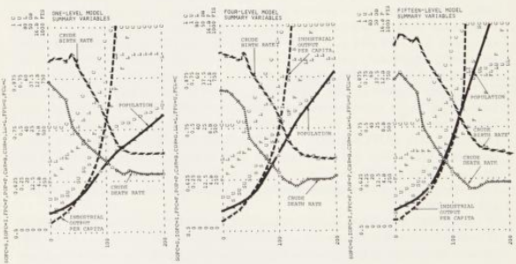

Figure 2-90 Run 2–7: exponential economic growth

as the cities become overcrowded and heavily industrialized. The age structure shifts from one that is characteristic of a high-birth-rate population. The fraction of the population under the age of 15 drops from 0.40 to 0.25. The age structure generated by the fifteen-level model at three different times in this transition is shown in Figure 2-92.

The behavior of the birth rate variables in this exponentially industrializing population is shown in Run 2–9 (Figure 2-93). With increasing health the maximum total fertility increases rapidly, but at the same time the desired total fertility falls because of an industrializing social structure and a perception of a lower child mortality. As fertility control effectiveness reaches 100 percent, actual total fertility becomes equal to desired total fertility. The multiplier from income expectations plays a minor role in this run, for per capita income grows at a nearly steady rate.

Under the assumption of exponentially increasing economic output, the model can be used to test the potential impact of various population policies. For example, in Run 2–10 (Figure 2-94) the fifteen-level model is used to test the policy of raising the marriage age (and thus the age-specific fertility schedule) as a way of minimizing the large population increase that occurs during the demographic transition. In this run the assumed age-specific fertilities are shifted as indicated in Figure 2-95. The resulting behavior in Run 2–10 can be compared directly with that of the fifteen-level model in Runs 2–7, 2–8, and 2–9. Total population in the year 200 decreases from 15 billion to 12 billion as a result of the policy, indicating that raising the marriage age has a small, quantitative effect on population size.

In Run 2–11 (Figure 2-96), an attempt is made to encourage a lowering of the birth rate by introducing 100 percent fertility control effectiveness in the model year

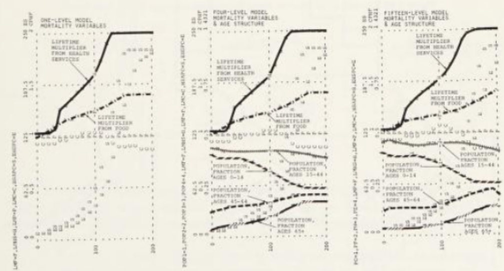

Figure 2-91 Run 2–8: exponential economic growth, mortality variables