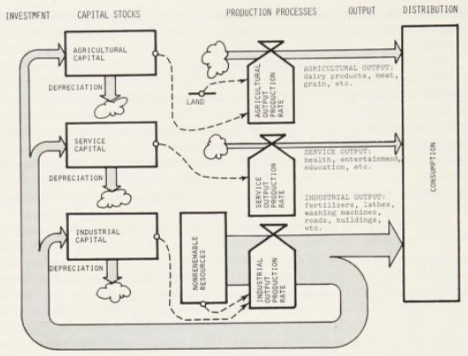

Figure 3-8 Capital stocks and output flows in the global economy

that can be used to produce goods and services. These stocks, with the addition of land and nonrenewable resources, can produce three types of output: agricultural output, which is a flow of edible foodstuffs; service output, a flow of social or personal services that are intangible; and industrial output, a flow that converts resources into material goods.

For the model we defined two uses for the output of the productive process: consumption and investment. All output that disappears within one year of its generation is treated as consumed. Thus all service outputs and all agricultural outputs are consumed (we ignored inventories of foodstuffs). The flow of material goods comprising industrial output may be either consumed or invested in the service, agriculture, or industrial sectors. The designation of the investment depends on the function it fulfills. An airplane could be classified as an investment in service, industrial, or agricultural capital if it were used for holiday tours, transporting transistors, or spraying crops, respectively. Lightbulbs are an example of industrial output that is defined as consumption. Industrial output in the form of household washing machines becomes investment in service capital, tractors an investment in agricultural capital, and coal excavators or lathes an investment in industrial capital.

Measurement of Capital and Output

So far we have discussed the production processes in physical terms, since World3 is primarily a model of physical flows. Because the model is highly aggregated, it was necessary to define some common measure for the diverse forms of capital and output. To be consistent with the four sectoral definitions described earlier, it was most convenient to use a measure that reflected a product's material content and its potential for generating pollution. It was also necessary, however, to employ a measure that would allow comparison with the financial statistics used by economists and recorded in the historical patterns of Figures 3-1, 3-3, 3-4, and 3-6. Market price itself is not an appropriate measure for our purposes, however, since the price of a product may fluctuate even though its material content and pollution potential remain the same. We thus chose to define a "dollar" measure for use in World3, making it subject to the following conditions:

1. A dollar is a material unit, not a monetary unit. A dollar of capital in the model is the average unit of capital that could have been purchased for one dollar in 1968. As a consequence of this definition, the model's capital sector is directly related to global capital and production statistics only in the year 1968.
2. Given appropriate capital-output ratios, a dollar of service or industrial output is a unit composed of the average bundle of services or material goods received for the equivalent of one U.S. dollar around the world in 1968. Food output is not measured in dollars but in vegetable-equivalent kilograms. The production of nonrenewable resources is measured in resource units. Thus there is no simple relationship in the model between dollars of output and the gross global income.
3. A dollar of capital represents the same amount of physical capital at any point during the simulation. Even if price and inflation were represented in World3, the dollar valuation of each unit of capital would not vary over time.

Use of Industrial Output Rather than GNP

Numerous studies have revealed that increases in GNP per capita are correlated in most countries with decreased demographic fertility, increased resource consumption, shifting food preferences, increased pollution generation, increased energy consumption, and shifts in the values of other important social and economic factors. Increased wealth does not cause all the social changes revealed in these studies. The correlation is observed because societies that have generated high average personal incomes have generally been characterized by the set of Western social norms, family structures, educational practices, technologies, and economic institutions that do cause decreased fertility, increased resource consumption, and so on. We concluded that industrial output per capita is superior to GNP per capita as an index of the changes in institutions, technology, and personal values that cause the secular trends often correlated with GNP per capita. Therefore, industrialization, measured by average industrial output per capita, is our general term for this total package of social changes.

The inadequacy of GNP per capita as a measure of social change is nicely illustrated by several oil-exporting countries where the typical historical relation between GNP per capita and industrial output per capita is not observed. Although their per capita GNP figures are comparable to those in the West, their industrial output per capita is low. Significantly, their social statistics (for example, crude birth rate,