3.4 CAUSAL STRUCTURE

In the real world the relative fractions of output allocated to consumption or to investment in the agriculture, service, and industrial sectors are determined by market mechanisms and by political processes. Presumably the allocation is based in part on some assessment of the marginal utilities of additional units of output in each of the four categories. Because we are interested only in the gross sectoral composition of output and because the details of the investment process have led to the same development pattern in most countries, we chose not to model the detailed structure of investment decisions. Instead, we incorporated into the capital sector an allocation mechanism that allows the economy in the model to reproduce any specified development pattern.

The allocation mechanism involves one positive feedback loop that can lead to various rates of growth in industrial capital and output. Four negative loops influence the gain of the positive loop by diverting variable amounts of industrial output to the service and agriculture sectors. The principal elements constituting these loops are portrayed in Figure 3-10.

The relationships constituting the positive feedback loop in the capital sector are emphasized with heavy lines in Figure 3-10. As industrial capital increases, the industrial output rises. With increased industrial output, the industrial capital investment rate may increase, raising the industrial capital stock even more. The gain around this positive loop, hence the determinant of whether and how fast the industrial capital stock grows, is influenced in part by the fraction of industrial output allocated to capital investment. This fraction varies inversely with the fractions of industrial output allocated to services, agriculture, and consumption.

$$FIOAI = 1.0 - FIOAS - FIOAA - FIOAC,$$

where

FIOAI = fraction of industrial output allocated to industry
FIOAS = fraction of industrial output allocated to services
FIOAA = fraction of industrial output allocated to agriculture
FIOAC = fraction of industrial output allocated to consumption

The fractions of industrial output allocated to services and to agriculture depend on the level and composition of societal demand—a composition that shifts as industrial output grows. We call the aggregate demand functions the indicated service and food outputs per capita and express them as functions of the industrial output per capita. Many conceivable relationships between industrial output per capita and the indicated service and food outputs per capita could be postulated and incorporated into World3. We based the relationships in the standard version of World3 (Figure 3-11) on the development patterns discovered by Chenery and Taylor (Figures 3-3 and 3-4). Figure 3-11 was obtained from the historical data of the earlier two figures by simply converting each GNP figure to the figure for industrial output per capita with which Chenery and Taylor show it has traditionally been associated.

The fractions of industrial output allocated to services and to agriculture depend on the ratio of the actual and the indicated output levels in the respective sectors.

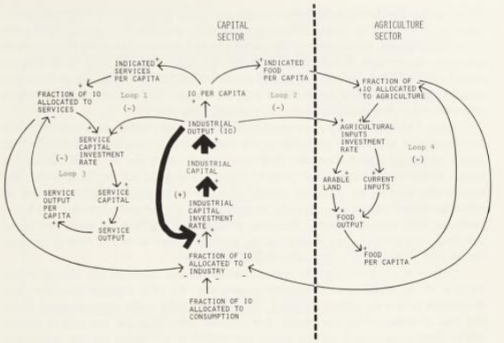

Figure 3-10 The causal relationships that can produce any specified development patterns

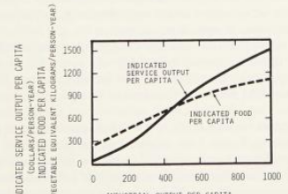

Figure 3-11 Standard form of the relationship between industrial output per capita and indicated service and food outputs per capita