6.1 FUNDAMENTALS OF INPUT-OUTPUT ANALYSIS

Consider an economy that consists of three sectors: agriculture, machinery, and construction. Let the domestic output of each of these three sectors be denoted $x_1$, $x_2$, and $x_3$, respectively. Let the final demand in each sector be denoted $y_1$: final demand is typically broken down to private consumption, government consumption (say for defense), investment and foreign trade (exports less imports). For given final demand, say machines, we write

$$
\begin{align*}
\text{mach} & = \text{Agr.} \\
\text{mach} & = \text{mach} \\
\text{mach} & = \text{Const}
\end{align*}
$$

Thus part of machine output goes to the agricultural and construction sectors—the coefficient $a_{21}$ captures the requirement for machinery per unit output of agriculture, and so on; part of the output is consumed by the sector itself, and part of the output goes to final demand (exports, purchases by government, etc.). The complete three sector economy is thus captured by the three equations

$$
\begin{align*}
\mathbf{a}_{11} x_1 + \mathbf{a}_{12} x_2 + \mathbf{a}_{13} x_3 + f_1 &= x_1 \\
\mathbf{a}_{21} x_1 + \mathbf{a}_{22} x_2 + \mathbf{a}_{23} x_3 + f_2 &= x_2 \\
\mathbf{a}_{31} x_1 + \mathbf{a}_{32} x_2 + \mathbf{a}_{33} x_3 + f_3 &= x_3
\end{align*}
$$

which, as usual, can be expressed more compactly in matrix form as

$$
\begin{align*}
\mathbf{a} x + f &= \mathbf{x}
\end{align*}
$$

1 Those familiar with conventional input-output analysis as used in the general context of development planning may proceed directly to Section 6.2

2 This input-output model is said to be “open” in the sense that final demand is exogenously specified. It is possible to “close” an I/O model by assuming that final demands can be determined in the same way as interindustry demands.
We begin with the usual identity for total supply being equal to total demand:

$$X + MC = C + G + E + I + \Delta S$$ (1)

where

$X$ = Domestic output

MC = Competitive Imports

C = Private consumption

G = Government

E = Exports

I = Gross fixed capital formation

$\Delta S$ = Stock changes

In this discussion we make the important distinction between competitive and non-competitive imports. To use the example given by Taylor (1979), wheat imports into a country growing that crop would be classified as competitive; jet aircraft imports into almost every developing country would be classified as non-competitive (or complementary). Competitive imports are treated as being equivalent to domestic output, and are therefore added to supply in Eq. (1).

The second identity relates total inputs to domestic output, i.e.

$$X = WL + VN + rK + TIND + MNC$$

where

$MNC$ = Non-competitive Imports

$WL$ = Wage rate

$VN$ = Rate of return on non-incorporated enterprise

$N$ = Capital in non-incorporated enterprise

$rK$ = Rate of return on capital (rent, dividends, interest)

$TIND$ = Indirect Taxes (value added, import tariffs)

The total return to non-incorporated enterprise, $VN$, may be quite substantial in developing countries, given the typical preponderance of peasant farmers and small independent trades people. Indeed, this distinction between incorporated and incorporated enterprise will prove useful in subsequent discussions of commercial and non-commercial energy forms.

The rate of return on capital decomposes into two parts: depreciation, and after-depreciation return on capital (e.g., dividends to stockholders). The non-competitive imports $MNC$ shown in (2) are just those necessary for domestic production (e.g., refined products for a small country without a refinery); other non-competitive imports may go to final demand (e.g., such as imported luxury goods to households).

Gross Domestic Product (GDP) is defined as

$$GDP = WL + VN + rK + TIND$$ (3)

i.e., as sum of payments to primary inputs plus business taxes. Of course, by substitution of (1) and (2) into (3) GDP is also equal to

$$GDP = C + G + E + I + S - MC - MNC$$ (4)

Finally, value added at factor cost, $Y$, is defined by

$$Y = WL + VN + rK$$ (5)

which is the sum of payments to participants in the production process. Disposable income, $yDISP$, accrues to persons, and follows from (5) as

$$yDISP = Y - \tau DIR - S$_{CORP}$$$ (6)

where

$\tau DIR$ = Direct taxes (income taxes, corporate profit taxes)

$S$_{CORP} = Corporate retained earnings and depreciation allowances.

Disposable income then is used either for consumption or for savings, i.e.

$$yDISP = C + S$_{PRIV}$$$ (7)

One can also view foreigners as an actor in a national economy: whenever imports exceed exports, then the rest of the world makes up the difference. This current account deficit is made up by foreign aid, direct investment, and commercial lending, and such payments obviously contribute to the potential savings flow. Thus

$$S$_{FOR} = MC + MNC - E$$ (8)

Finally, government receipts come from direct and indirect taxes, whilst its expenditures fall under the rubric government consumption. Thus

$$S$_{GOVT} = TIND + \tau DIR - G$$ (9)

We leave it as an exercise for the reader to show by substitution of these identities the validity of the savings-investment identity

$$S$_{PRIV} + S$_{CORP} + S$_{FOR} + S$_{GOVT} = 1 + \Delta S$$ (10)