**Input-Output Analysis in Economics**

Input-Output (I-O) analysis is a quantitative economic technique used to study the interdependencies between different sectors of an economy. Developed by **Wassily Leontief** (who won the Nobel Prize in Economics in 1973 for this work), it provides a detailed framework for understanding how the output of one industry is an input for another, creating a network of economic activities.

**Core Concepts**

1. **Economic Sectors:**
   * The economy is divided into various sectors (e.g., agriculture, manufacturing, services).
   * Each sector produces goods or services, part of which may be used by other sectors or consumed directly.
2. **Interdependencies:**
   * One sector’s output becomes another’s input. For example:
     + Agriculture produces wheat, which the food processing industry uses to make bread.
     + The construction industry uses steel from manufacturing.
3. **Transactions Table:**
   * Input-Output analysis begins with a transactions table (or matrix), which shows:
     + Rows: Output distribution of a sector to other sectors or final demand.
     + Columns: Inputs required by a sector from other sectors or factors of production.

**Key Components of Input-Output Analysis**

1. **Input-Output Table:**
   * A matrix that captures how the output of each sector is distributed across other sectors and final consumers.
   * It includes:
     + **Intermediate consumption:** Goods and services used in production by other sectors.
     + **Final demand:** Consumption by households, governments, exports, and investments.
2. **Technical Coefficients Matrix (A):**
   * This matrix represents the **direct input requirements** per unit of output for each sector.
   * Each element *aij* shows how much output from sector *i* is needed to produce one unit of output in sector *j*.
3. **Leontief Inverse Matrix (I - A)-1:**
   * Shows **total input requirements** (direct + indirect) to meet a unit of final demand.
   * Useful for understanding the ripple effects of changes in demand across the economy.

**How It Works**

1. **Equations of Balance:**
   * For each sector:

​ Where:

* + - ​: Total output of sector *i*.
    - ​: Input required from sector *i* per unit of output in sector *j*.
    - ​: Final demand for sector *i*'s output.

1. **Modeling Economic Impacts:**
   * Solving these equations helps estimate the total output needed to meet a given level of final demand.

**Applications of Input-Output Analysis**

1. **Economic Impact Analysis:**
   * Estimate the effects of changes in demand or supply in one sector on others.
   * Example: Studying how increased demand for electric vehicles affects the mining, battery manufacturing, and energy sectors.
2. **Policy Planning:**
   * Assess the outcomes of government policies like infrastructure investments or subsidies.
3. **Environmental Analysis:**
   * Calculate resource use, emissions, or energy consumption by linking economic outputs to environmental factors.
4. **Trade Analysis:**
   * Understand how changes in international trade affect domestic industries.

**Limitations**

1. **Static Framework:**
   * Assumes fixed technical coefficients, ignoring technological changes over time.
2. **Linear Relationships:**
   * Assumes proportional relationships between inputs and outputs, which may not hold for all industries.
3. **Data Intensity:**
   * Requires detailed and accurate economic data, which can be challenging to obtain.
4. **No Price Dynamics:**
   * Ignores price changes, which may influence production and consumption decisions.

**Example: A Simple Economy**

Consider an economy with three sectors:

1. **Agriculture (A)**
2. **Manufacturing (M)**
3. **Services (S)**

**Step 1: Input-Output Table (Transactions Table)**

The I-O table shows the monetary value of goods/services exchanged between sectors and for final demand (consumption, exports, etc.).

| **Sector →** | **Agriculture (A)** | **Manufacturing (M)** | **Services (S)** | **Final Demand** | **Total Output** |
| --- | --- | --- | --- | --- | --- |
| **Agriculture** | 20 | 40 | 10 | 30 | 100 |
| **Manufacturing** | 30 | 20 | 20 | 50 | 120 |
| **Services** | 10 | 30 | 20 | 40 | 100 |

* **Final Demand:** Consumption by households, government, or exports.
* **Total Output:** Sum of all rows for each sector (how much is produced by each sector).

**Step 2: Technical Coefficients Matrix (A)**

The technical coefficients are calculated as:

For Agriculture (A → M):

For all sectors:

| **Sector →** | **Agriculture (A)** | **Manufacturing (M)** | **Services (S)** |
| --- | --- | --- | --- |
| **Agriculture** |  |  |  |
| **Manufacturing** |  |  |  |
| **Services** |  |  |  |

Technical coefficients matrix A:

**Step 3: Leontief Equation**

The Leontief equation:

Where:

* *X*: Total output vector.
* *F*: Final demand vector.
* : Leontief inverse matrix.

**Step 4: Leontief Inverse**

First, calculate I−A:

Now, calculate the inverse of I−A

Assume the Leontief inverse is:

Step 5: Final Demand and Total Output

Assume the final demand vector:

Calculate *X*:

Performing the matrix multiplication:

X=

So, the answer is total output for Agriculture, Manufacture and Service sector is 60, 72 and 66 units respectively.