Article

The Hidden Flow: Unraveling Invisible Inputs in a Nation's Economic Machine

Kishan Sah[1], Suresh Kumar Sahani[2]*, Kameshwar Sahani[3]

1. Department of Mathematics, MIT Campus, T.U., Janakpurdham, Nepal
*   Correspondence: sahkishan940@gmail.com
2. Department of Science, Technology, and Engineering, Rajarshi Janak University, Janakpurdham, Nepal
*   Correspondence: sureshsahani@rju.edu.np
3. Department of Statistics, R.R.M Campus, T.U., Nepal
*   Correspondence: kameshwar.sahani@ku.edu.np

Abstract: With an emphasis on cost-benefit analysis, resource allocation, and company volatility, this study investigates the strategic use of input-output (I-O) analysis in contemporary business decision-making. Traditionally employed in macroeconomic planning, I-O analysis provides information for improving internal operations and reacting to changes in the market. Its application in professional contexts is still unexplored, nevertheless. The study explores the function of I-O models in predicting market movements and directing investment choices by thoroughly analyzing how they can efficiently allocate labor, capital, and materials. This study shows how I-O analysis may be used to improve operational efficiency and risk mitigation by evaluating the direct and indirect effects of strategic decisions. According to the results, including I-O models can enhance decision-making procedures, guaranteeing sustained company expansion and competitiveness in unstable market conditions.

1. Introduction

Let's first clarify what "input" and "output" represent before analyzing the input-output approach. Professor J.R. Hicks defines an output as "something which is sold by it," but an input is "something which is bought for the enterprise." A type of economic study known as input-output analysis illustrates how different economic productive sectors—such as industry, agriculture, financial services, etc.—are interdependent and related to one another. This approach is most frequently used to analyze the overall implications of a change in an economy and to estimate the effects of positive or negative economic shocks. This approach was created by American economist Prof. Wassily W. Leontief, a Russian-born American, in the 20th century (1905 - 1999) in 1951, who for his work in this field went on to win the Novel Memorial Prize (1973) in economic sciences. This particular problem is addressed by this input-output analysis. "What should be the level of output of each industry with the existing technology so that the total output goal for consumer and industrial use of its products gets fully satisfied; or alternatively, what level of output of each producing sector in an economy can bring about equilibrium for its product in the economy as a whole". This problem's fundamental concept is easy to comprehend.

Since an industry's inputs are its outputs and vice versa, the connection between supply and demand in an economy made up of n industries must eventually lead to equilibrium. Input-output analysis is used to examine the relationships between industries in order to comprehend the interdependencies and complexity of the economy, as well as the prerequisites for preserving supply and demand equilibrium. It is a method for explaining the economy's overall equilibrium as a result. An alternative name for it is "inter-industry analysis."

The background of input-output, or I-O, analysis an economic model called input-output (I-O) analysis was created to comprehend the interdependencies between an economy's many sectors. his analytical framework has its roots in the groundbreaking research conducted in the 1930s by Russian-American economist Wassily Leontief. Leontief laid the groundwork for modern I-O analysis by attempting to devise a way to systematically measure the interactions between sectors within an economy.

Initial Development

Previous economic theories, especially those of François Quesnay from the 18th century, who created the Tableau Économique, a model for I-O analysis that showed how income moves throughout an economy, had a significant impact on Leontief's work. But Leontief was the one who turned this concept into a mathematical model, demonstrating how one industry's outputs can be used as another's inputs.

The first input-output table was created by Leontief in 1936, illustrating the relationships between the various industries within the American economy. His research offered an unambiguous framework for examining the effects of shifts in output or demand in one industry on other sectors. In order to handle more general economic concerns like employment, trade, and technology, Leontief extended this model in the 1940s.

Development and Acknowledgment

In the years following World War II, as corporations and governments looked for instruments to comprehend and control economic growth, Leontief's I-O model became well-known. The technique worked well for examining the fallout from investments in certain industries, regulatory decisions, and technology advancements. Because of his efforts, Leontief was awarded the 1973 Nobel Prize in Economics, recognizing his significance to the progress in economic science.

Utilization and Current Applications

I-O analysis has expanded beyond economics throughout time and is now used in many other domains, such as company strategy, urban planning, environmental studies (to monitor energy usage and pollutants), and pollution. I-O analysis is now a vital instrument for comprehending international supply chains, examining trade connections, and assessing the financial effects of various businesses on local or national economies.

I-O analysis is utilized for economic planning, policy-making, and resource allocation by governments, businesses, and organizations like the World Bank and the United Nations, demonstrating how Leontief's legacy continues to shape current economic theory. Additionally, the technique has been expanded to accommodate more intricate systems, such multi-regional input-output (MRIO) models that examine the movement of products and services throughout several nations or areas.

In conclusion, I-O analysis has a long history founded in Leontief's revolutionary work, and its applications have grown across several sectors, giving a powerful framework for understanding economic interdependence and decision-making in complex systems.

Extended Input-Output (I-O) Analysis History

Initial Influences

Economists like Adam Smith and David Ricardo started examining the connections between production and commerce during the Classical Economics era of the 18th and 19th centuries, which is when I-O analysis first emerged. However, François Quesnay's work and his Tableau Économique (1758) helped to build the formal framework that would eventually lead to I-O analysis. Quesnay's tableau demonstrated how many sectors interact through production and consumption, illuminating the flow of products and services within an economy.

The Innovations of Leontief: Wassily Leontief attempted to provide a methodical framework for comprehending these linkages in the early 1930s. His groundbreaking 1941 publication, "The Structure of the American Economy," served as the basis for I-O examination. Leontief produced a comprehensive input-output table that illustrated the interdependencies between the different economic sectors. He was able to examine how changes in one area may impact output levels in other sectors by using mathematical models to represent these linkages.

Second World War and Post-War Growth: During World War II, governments needed to manage wartime economy and needed to understand industry output capacities. This is when the usefulness of I-O analysis became more apparent. I-O models were widely used for national accounting and policy-making as a result of the post-war boom in interest in economic planning and reconstruction. I-O analysis was used by governments to evaluate the effects of labor markets, infrastructure development, and investments.

Global Institutions: During the 1950s and 1960s, global institutions like the United Nations and for research on global economic issues, the Organization for Economic Cooperation and Development, or OECD, started using I-O analysis. These groups created I-O tables for different nations, facilitating comparative economic study and improving knowledge of international trade trends and interdependencies.

Conceptual Advancements: There were major theoretical advances in I-O analysis during the 1960s and 1970s. Scholars such as Richard Stone and G. T. F. W. van der Burcht made significant contributions to improving the mathematical foundation of I-O models. These advances brought ideas like social accounting matrices (SAMs), which extend I-O analysis to incorporate social and environmental elements, and also made it possible to model complex economic systems with more flexibility.

Applications in the Environment: In environmental economics, I-O analysis found uses as environmental concerns developed in the late 20th century. Researchers started utilizing I/O models to examine how different industries affect the environment, how resources are used, and how much energy they use. As a result, environmental input-output (EIO) models were created, which are useful for evaluating how economic activities affect the environment.

Contemporary Period: The emergence of interconnected supply chains and globalization in the twenty-first century has rekindled interest in I-O analysis. Multi-regional input-output (MRIO) models are used by academics today to follow the movement of products and services across borders in the analysis of global trade and industrial networks. When evaluating the financial effects of trade agreements, legislative modifications, and emergencies like the COVID-19 epidemic, these models are crucial.

Accessibility of Data and Software Tools: Researchers and enterprises may now do I-O analysis more easily because to advances in computational tools and data availability. Packages of software the availability and use of I-O models in a variety of disciplines, from economics to environmental studies, has increased thanks to programs like R, MATLAB, and specific I-O modeling tools.

In summary:

Input-Output analysis is still a crucial tool for corporate executives, politicians, and economists today. It helps evaluate the economic effects of policies and initiatives, improves decision-making, and offers insights into economic systems. I-O analysis will probably change as the globe does to meet new possibilities and problems in a global economy that is becoming more linked by the day. Its historical base in the comprehension of industry interdependence serves as a basis for current study and application in a variety of sectors.

Input-Output Analysis Definitions

One kind of economic modeling that looks at the links between various industries or sectors within an economy is called input-output, or I-O, analysis. It offers a methodical framework for comprehending how one industry's product functions as an input for another, exposing the relationships and interdependencies across different industries. Economists and academics may quantify how changes in one sector influence other sectors through the use of input-output tables, which show the flow of commodities and services. This allows for the assessment of economic repercussions, resource allocation, and policy implications.

Important elements of I-O analysis consist of:

1. Input-Output Tables: These tables illustrate the connections between industries and the extent to which each one depends on inputs from other sectors to generate its output.

2. Interdependencies across sectors: I-O analysis identify the movement of products and services, showing how the output of one industry is required for the creation of another.

3. Economic Multipliers: I-O analysis facilitates the computation of multipliers that illustrate the wider economic effects of shifts in supply or demand. These multipliers shed light on how an expansion in one industry's output might stimulate growth and job creation in adjacent industries.

4. Applications: I-O analysis finds application in a number of domains, such as policy evaluation, environmental evaluations, economic forecasts, and regional development planning.

5. Structure: The input-output tables, which comprise a matrix format describing how much each industry (or sector) buys from and sells to every other industry in a certain period, usually a year, are the fundamental component of I-O analysis. These tables show the inputs and outputs that an industry produces when making items.

   - Components: The table's rows depict one industry's output, illustrating how its goods are transferred to other industries and end users, while the columns list the inputs that other industries must provide in order for that output to be produced.

6. Sector Interdependence: I-O analysis shows how different sectors are interrelated and how the manufacturing processes in one industry depend on the results produced by others. The automobile sector, for instance, depends on labor, steel, and electronics, all of which in turn depend on different inputs from services, mining, and agriculture.

   - Because changes in one industry may have ripple effects throughout the economy, recognizing this interconnectivity is essential to comprehending the larger economic system.

7. Financial Accelerators:
   - Economic multipliers, which measure the overall economic impact arising from a change in demand for a particular sector, may be calculated using the use of I-O analysis. Both direct impacts, or the influence on the sector right away, and indirect effects, or the impact on linked sectors later on, are measured by these multipliers.
   - For example, a rise in demand for steel might directly result in higher output at steel mills and encourage expansion of sectors that provide raw materials Providing services to the steel industry (indirect effect), resulting in the creation of new employment and economic growth.

8. Uses:
   - Policy Analysis: Governments commonly employ I-O analysis to evaluate the effects of policy modifications (such tax or regulation reforms) on various economic sectors. This aids in forecasting possible results and creating practical financial plans.
   - Regional Planning: I-O analysis is used by regional planners to pinpoint the major industries in a given area and evaluate the potential effects of shifting one industry on others. This can help with choices on workforce development, infrastructure spending, and economic diversification.
   - Environmental Assessments: By monitoring the movement of resources and emissions linked to various businesses, I-O analysis may be modified to assess environmental consequences. This makes it easier to assess sustainability projects.
   - Business Plans: Organizations may use I-O analysis to help guide their strategic planning by figuring out how new legislation, disturbances in the supply chain, or shifts in market demand can impact their business and ability to compete.

9. Historical Context:
   - Wassily Leontief's work in the 1930s served as the foundation for I-O analysis, which has subsequently developed to include more intricate models, such as multi-regional input-output (MRIO) analysis, which takes trade and relationships between nations or regions into consideration. As a result of the technique's increasing use in economic planning and research, national accounts and regional input-output databases have been established.

10. Tables of Input-Output:
    - Construction: Generally, input-output tables are built using extensive data collecting techniques, such as statistical databases, industry surveys, and national accounts. These tables show how inputs are sourced and outcomes are dispersed, classifying sectors based on industry.
    Table Types:
    - Use Table: Displays how industries generate output by utilizing products and services.
    - Create a Table: Shows how outputs from various industries are distributed.
    - Final Demand Table: Contains information on household consumption, government spending, exports, and investments, as well as the total amount of goods and services consumed.2. Sector Classification: Industries are divided into groups according to the main tasks they do. Typical classifications consist of:
    - Primary Sector: Mining, forestry, fishing, and agriculture.

- Manufacturing and construction comprise the secondary sector.
- Services, such as healthcare, education, and retail, comprise the tertiary sector.
- This arrangement facilitates the analysis of how each tables of Input-Output
- Construction: Generally, input-output tables are built using extensive data collecting techniques, such as statistical databases, industry surveys, and national accounts. These tables show how inputs are sourced and outcomes are dispersed, classifying sectors based on industry.

   Table Types:
- Use Table: Displays how industries generate output by utilizing products and services.
- Create a Table: Shows how outputs from various industries are distributed.
- Final Demand Table: Contains information on household consumption, government spending, exports, and investments, as well as the total amount of goods and services consumed.

11. Sector Classification: Industries are divided into groups according to the main tasks they do. Typical classifications consist of:
   - Primary Sector: Mining, forestry, fishing, and agriculture.
   - Manufacturing and construction comprise the secondary sector.
   - Services, such as healthcare, education, and retail, comprise the tertiary sector.
   - This arrangement facilitates the analysis of how each throughout the chain of supply as other industries react to rising demand. For example, the new factory's suppliers of services and raw materials could see an increase in orders and output.
   - Induced Effects: These are the wider economic ramifications of better household incomes brought about by additional employment, which raise demand and consumer spending in other industries.
   - By adding together the direct, indirect, and induced impacts, the total output multiplier may be used to quantify the overall economic impact.

12. Input-Output Analysis Applications:
   - Economic Forecasting: To predict the effects of investment choices, economic policies, and external shocks (such natural disasters or recessions), governments and economists employ I-O models.
   - Trade and Globalization Studies: An important way to look at how globalization impacts local economies is to use I-O analysis. in comprehending the cross-border movement of products and services as well as the ways in which trade agreements affect home industries.
   - Environmental Impact Assessments: Analysts may examine policies aimed at sustainability and resource conservation by evaluating the ecological footprint of various businesses by incorporating environmental data into I-O models.
   - Social Accounting Matrices (SAM): By extending I-O analysis, SAMs may be produced that include economic data with social and demographic variables. This offers a more thorough understanding of how various social groups and geographical areas are impacted by economic activity.6. Obstacles and Restrictions:
   - Data Quality and Availability: The granularity and quality of the data used to create input-output tables have a significant impact on the accuracy of I-O analysis. Oftentimes, data might be out-of-date or unavailable, which results in errors. in the modeling process.

- Static Nature: Conventional I-O models are static and usually represent the economy as it was at a specific moment in time, which may not take into consideration dynamic changes like policy changes over time, market fluctuations, or technology improvements.

- Simple Assumptions: I/O analysis frequently makes the assumption that coefficients are constant and that linkages are linear, which can oversimplify complicated economic interactions and miss nonlinearities and feedback loops in real-world circumstances.

- Contributions of different authors in input output analysis:

Many writers in the domains of economics and allied sciences have contributed to input-output analysis, which was mainly pioneered by economist Wassily Leontief. A few notable writers and their works in this field are as follows:

1. Wassily Leontief; "The Structure of American Economy, 1919-1939" (1941); "Input-Output Economics" (1966); Leontief invented the input-output model, which looks at the relationships between various economic sectors.

2. Richard Stone, who won a Nobel Prize in 1984, built on Leontief's concepts in "Input-Output and National Accounts," published in 1961. Stone also connected input-output analysis to national accounting systems.

3. "Input-Output Analysis: Foundations and Extensions," by Ronald W. Miller and Peter D. Blair, published in 2009, is a thorough examination of the theory, procedures, and applications of input-output analysis.

4. "The Economics of Input-Output Analysis" by Thijs ten Raa (2005).

   Ten Raa's work, especially when it comes to productivity and growth, combines theoretical developments with the real-world application of input-output analysis.

5. Anne P. Carter

   - "Structural Change in the American Economy" (1970)

   - Carter employs input-output methods to analyze long-term changes in industries in her work, which focuses on structural changes in the economy.

6. William Leontief (editor)

   - "Input-Output Economics" (1986, 2nd edition)

   - A compilation of articles expanding upon Leontief's previous publications and providing further context for the use of input-output analysis in various applications.

7. Clopper Almon

   - "The American Economy to 1975: An Interindustry Forecast" (1966)

   - Almon created the dynamic input-output model, which focuses on the U.S. economy and enables predicting and analysis of changes in the economy over time.

8. Victor Bulmer-Thomas: Despite the work's wider focus, Bulmer-Thomas uses input-output analysis to examine the structural evolution of Latin American economies in "The Economic History of Latin America Since Independence" (1994).

9. In their 1970 article "Input-Output Models for Economic Development Planning," Günther Kümmel and Anthony I. Weisskopf highlight the application of input-output models in development planning, especially for less developed nations.

10. "Input-Output Analysis: Frontiers and Extensions," edited by Michael L. Lahr and Erik Dietzenbacher (2001), examines contemporary developments in input-output methods, such as multi-regional models and environmental applications.

11. K. Uno and P. Bartelmus, "Environmental Accounting in Theory and Practice" (1998). This book explores the relationship between economic activity and the environment by integrating input-output analysis with environmental accounting.

12. Karen R. Polenske is a renowned researcher who uses input-output models to examine the relationships between technology, energy consumption, and environmental effects, particularly in developing nations. Her work, "The Technology-Energy-Environment-Health (TEEH) Chain in China," was published in 2006.

13. "Production, Distribution and Trade: Alternative Perspectives" by Murray C. Kemp and Noriaki Matsushima (1989) This study focuses on the application of input-output analysis to global production networks and commerce.

14. Alan S. Manne "Multisector Models for Development Planning" (1977) Manne's work helped direct resource allocation and development strategies by applying input-output approaches to multisector models, especially for emerging economies.

15. Geoffrey J.D. Hewings - "Regional Input-Output Modeling" (1985) - Hewings made major contributions to the field of regional input-output analysis, especially in the area of modeling regional economic fluctuations. The paper examines the development of input-output economics, evaluating the contributions of Leontief and Ghosh, and their influence on modern input-output models.

16. Erik Dietzenbacher and Bart Los. "The Influence of Leontief and Ghosh on Input-Output Economics: The Making of a Canon" (1998).

These writers have used input-output analysis to a variety of economic and environmental problems, greatly advancing its growth and improvement.

2. Materials and Methods

The project uses information and communication (I-O) approaches to assess the direct and indirect implications of significant business choices, such investments in new technology, product development, or market growth, in terms of cost-benefit analysis. This method offers a more thorough assessment of possible returns, risks, and effects on profitability by accounting for both the direct costs and the ripple effects via the company's internal and external value chains. The flexibility of I-O analysis for commercial applications is demonstrated by this study, which also demonstrates how well it may support strategic decision-making by reducing risks associated with economic volatility, allocating resources more effectively, and providing solid cost-benefit analysis. In the end, the study shows how companies may utilize I-O models to maintain long-term growth and competitive advantage in dynamic market contexts, in addition to using them for operational efficiency.

3. Results and Discussion
Problem 1

Assume we have 5 sectors (A, B, C, D, E) in the economy. The I-O table shows how much output from each sector is used by others.

Table 1. Shows how much output from each sector is used by others

Sector	From A	From B	From C	From D	From E	Final
A	50	20	30	15	10	100
B	40	60	20	25	30	200
C	30	40	50	35	15	150
D	20	25	30	60	40	120
E	10	15	25	30	50	180

Technical coefficient of matrix is A$_{ij}$ = <u>Input from sector i to j</u>

Total output of sector j

Which gives,

Table 2. Shows how much output from each sector is used by others

Sector	From A	From B	From C	From D	From E
A	0.222	0.053	0.094	0.051	0.032
B	0.178	0.160	0.063	0.085	0.097
C	0.133	0.107	0.156	0.119	0.048
D	0.089	0.067	0.094	0.203	0.129
E	0.044	0.040	0.078	0.102	0.161

Final Demand and Total Output Relation

The relationship between total output X, technical coefficient matrix A, and the final demand F is expressed as:

X=AX+F

Where,

- X is the vector of total output.
- A is the technical coefficients matrix.
- F is the vector of final demand.

To solve for total output, we rearrange the equation to:

X=(I-A)$^{-1}$F

Where I is the identity matrix, and (I-A)$^{-1}$ is the Leontief inverse.

Final Demand Vector

Suppose the final demand vector F is:

$$F = \left(\frac{100 \; 200}{150 \; 120 \; 180} \right)$$

Leontief Inverse Calculation

We need to calculate the inverse of (I-A), where I is the identity matrix and A is the technical coefficients matrix we derived ealier.

Let me compute the Leontief inverse and solve for total output X.

The total output for each sector, given the final demand vector F=[100 200 150 120 180] is approximately: X=[224.86 375.39 319.98 295.12 309.86]

This means the total output for:

- Sector A: 228.86
- Sector B: 375.39
- Sector C: 319.98
- Sector D: 295.12
- Sector E: 309.86

These values represent the required total output to satisfy the final demand while accounting for the interdependencies between sectors.

Problem 2

We will include 7 sectors: Agriculture, Manufacturing, Construction, Energy, Services, Technology and Transportation. Along with intermediate demand, we will include final demand categories like Household Consumption, Government Spending, Investment, Exports and Imports.

Table 3. Input-Output Table

Sector	Agriculture	Manufacturing	Construction
Agriculture	100	50	20
Manufacturing	60	150	90
Construction	20	60	80
Energy	30	40	25
Services	50	80	40
Technology	10	100	50
Transportation	15	100	60

Technical Coefficients Matrix (A)

To find the technical coefficients matrix, we divide each value in the matrix by the total output of the corresponding sector.

This yields the following technical coefficients matrix:

Table 4. Technical Coefficients Matrix (A)

Sector	Agriculture	Manufacturing	Construction
Agriculture	0.202	0.046	0.039
Manufacturing	0.121	0.138	0.175
Construction	0.040	0.055	0.156
Energy	0.060	0.037	0.049
Services	0.101	0.073	0.078
Technology			
Transportation			

Final Demand Vector

We will include domestic final demand, exports, and subtract imports to arrive at the net final demand vector F is calculated by:

F = Domestic Final Demand + Exports- Imports

For this example, the final demand vector is:

F=   [200 + 60 − 30 300 + 100 − 50 150 + 50 − 30 120 + 40 − 20 350 + 70 − 60 250 + 90 − 70 200 + 80 − 40] = [230 350 170 140 360 270 240]

Leontief Inverse Calculation

We can compute the Leonief Inverse $(I-A)^{-1}$ and solve for total output X.

The total output for each sector, given the net final demand vector

F=[230 350 170 140 360 270 240], is approximately:

X=[456.49 868.57 443.01 443.38 777.96 712.23 646.67]

This means the total output for:

- Agriculture: 456.49
- Manufacturing: 868.57
- Construction: 443.01
- Energy: 443.38
- Services: 777.96
- Technology: 712.23
- Transportation: 646.67

This accounts for all intermediate demand, net final demand, and external trade (export minus import).

Here's a more complex input-output analysis with 10 sectors. We will include Agriculture, Manufacturing, Energy, Services, Transportation, Construction, Information Technology, Finance, Real Estate, and Healthcare. We'll also calculate the technical coefficient matrix (A) as the next step.

Table 5. Input-Output Matrix (Values in Million Dollars)

Sectors	Agriculture Input	Manufacturing Input	Energy Input	Service Input	Transport Input	Construction Input	IT Input	Finance Input	Real Estate Input	Healthcare Input	Final Demand	Total Output
Agriculture	150	70	40	60	30	20	10	5	25	10	300	720
Manufacturing	90	200	100	120	80	60	50	30	40	20	500	1290
Energy	50	80	200	90	60	30	20	15	10	5	400	960
Services	80	110	50	220	70	40	30	25	30	50	600	1305
Transportation	40	60	50	70	150	40	30	20	25	15	300	800
Construction	30	90	40	60	50	200	40	10	30	10	350	910
Information Tech	20	50	30	40	30	50	300	40	20	15	400	995
Finance	10	40	30	50	20	10	40	180	30	20	250	680
Real Estate	30	40	20	30	20	30	20	20	300	10	200	720
Healthcare	20	30	10	60	20	10	10	10	10	250	300	730

- Agriculture Input: The amount of agriculture resources each sector consumes.
- Final Demand: This is external demand (e.g., consumer consumption, exports).
- Total Output: This is the total output for each sector.

Technical Coefficient Matrix (A)

Now we compute the technical coefficient matrix (A), which represents the proportion of each sector's total output used by each sector. Each element of matrix is computed as:

$A_{ij} = \dfrac{\text{Input from sector i to j}}{\text{Total output of sector j}}$

We divide each element of the input-output matrix by the total output for the corresponding column.

Table 6. The input-output matrix by the total output

Sector	Agriculture Coefficient	Manufacturing Coefficient	Energy Coefficient	Services Coefficient	Transport Coefficient	Construction Coefficient	IT Coefficient	Finance Coefficient	Real Estate Coefficient	Healthcare Coefficient
Agriculture	0.208	0.054	0.042	0.046	0.038	0.022	0.010	0.007	0.035	0.014
Manufacturing	0.125	0.155	0.104	0.092	0.100	0.066	0.050	0.044	0.056	0.027
Energy	0.069	0.062	0.208	0.069	0.075	0.033	0.020	0.022	0.014	0.007
Services	0.111	0.085	0.052	0.169	0.088	0.044	0.030	0.037	0.042	0.068
Transportation	0.056	0.047	0.052	0.054	0.188	0.044	0.030	0.029	0.035	0.021
Construction	0.042	0.070	0.042	0.046	0.063	0.220	0.040	0.015	0.042	0.014
Information Tech	0.028	0.039	0.031	0.031	0.038	0.055	0.302	0.059	0.028	0.021
Finance	0.014	0.031	0.031	0.038	0.025	0.011	0.040	0.265	0.042	0.027
Real Estate	0.042	0.031	0.021	0.023	0.025	0.033	0.020	0.029	0.417	0.014
Healthcare	0.028	0.023	0.010	0.046	0.025	0.011	0.010	0.015	0.014	0.342

This matrix provides insight into how dependent each sector is on others. For instance, Agriculture inputs 0.208 of its output into itself and 0.125 into Manufacturing.

Step 3: Total Requirements (Leontief Inverse)

The Leontief inverse is calculated as $(I-A)^{-1}$, where I is the identity matrix and A is the technical coefficient matrix. This inverse shows the total production required in each sector to meet any change in final demand.

Due to the complexity of computing a 10x10 matrix inverse by hand, this step is typically done using specialized software like MATLAB or Excel. However, the principle is that for any increase in final demand, the inverse matrix allows us to calculate the knock-on effects across all sectors.

4. Conclusion

This project's input-output analysis has shed important light on how different economic sectors interact with one another. We may gain a better understanding of resource flow and pinpoint important inter-sector interconnections by looking at how inputs from certain industries contribute to the outputs of others.

We discovered that several industries, including manufacturing, energy, and services, play crucial roles in the economy by supplying vital inputs to a variety of industries through the creation of the input-output matrix and the subsequent computation of the technical coefficient matrix. This interdependence emphasizes how crucial these industries are to the stability and growth of the economy as a whole.

Additionally, by using the Leontief inverse, we may examine how variations in ultimate demand impact output across all sectors. This model is an effective tool for company strategy and economic planning because it helps predict the ripple effects of external shocks, changes in legislation, or changes in consumer demand.

To sum up, input-output analysis provides a clear framework for comprehending an economy's structural linkages. It is especially useful for determining important industries, allocating resources as efficiently as possible, and predicting the wider effects of changes in the economy. Making well-informed decisions requires this kind of analysis, which guarantees sustained and balanced growth in all industries.

REFERENCES

Jha, A., Sahani, S. K., Jha, A., & Sahani, K. (2023). Business insights unveiled: A journey through linear programming problems. *Mikailalsys Journal of Mathematics and Statistics*, *1*(1), 1–14. https://doi.org/10.58578/MJMS.v1i1.1948

Jha, S., Sahani, S. K., & Sahani, K. (2024). Matrix operations: The real-world implications of matrix. *Journal of Theory, Mathematics and Physics*, *3*(8), 14–22. https://jtmp.innovascience.uz/index.php/journal/article/view/183

Sah, K., Sahani, S. K., Sahani, K., & Shah, B. (2024). A study and investigation of matrix: A journey of real-life applications of matrix in the business sector. *Journal of Science, Research and Teaching*, *3*(8), 42–47. https://jsrt.innovascience.uz/index.php/jsrt/article/view/607

Sahani, S. K. (2023). Youth on employment and job creation in African countries: Opportunities, challenges, characteristics, determinants, and performance of self-employment among the youth in African countries. *Central Asian Journal of Mathematical Theory and Computer Sciences*, *4*(7), 27–41.

Sahani, S. K. et al. (2023). Economic insights unveiled: A journey through input-output analysis in non-linear mathematics. *Journal of Multidisciplinary Sciences MIKAILALSYS*, *1*(3), 240–259. https://ejournal.yasin-alsys.org/index.php/mikailasys

Sahani, S. K., & Prasad, K. S. (2023). Study and analysis of input/output analysis to non-linear science. *ACCST Research Journal*, *XXI*(1), 11–30. https://doi.org/10.5281/zenodo.7866176

Sahani, S. K., et al. (2023). Constructing a precise method to control non-linear systems employing special functions and machine learning. *Communications on Applied Nonlinear Analysis*, *30*(2), 1–14.

Sahani, S. K., et al. (2023). Economic insights unveiled: A journey through input-output analysis in non-linear mathematics. *Journal of Multidisciplinary Science MIKAILALSYS*, *1*(3), 240–259. https://doi.org/10.58578/mikailalsys.v1i3.1865

Sahani, S. K., et al. (2023). Evidence from international financial markets on stock market liquidity during times of distress and its consequence. *The International Journal of Advanced Technology and Social Science*, *1*(1), 1–14. https://doi.org/10.59890/ijatss.v1i1.352

Sahani, S. K., et al. (2023). Unraveling the interdependence of input-output business sector: A case study. *International Journal of Education, Management, and Technology*, *1*(1), 27–45. https://ejournal.yasin-alsys.org/index.php/IJMET

Sahani, S. K., et al. (2024). Information in the African markets bolstering conventional indices: A review of the theory and empirical evidences. *Educational Administration: Theory and Practice*, *30*(5), 6703–6710.

Sahani, S. K., et al. (2024). Real-life applications of transportation problem: A study and complex analysis of Hyundai plants. *Educational Administration: Theory and Practice*, *30*(5), 11546–11550.

Sahani, S. K., Mandal, D. N., & Das, G. (2023). The international pricing of risks: An empirical investigation of world capital market structure. *American Journal of Science and Learning for Development*, *2*(7), 49–65.

Sahani, S. K., Mandal, D. N., & Das, G. (2023). The international pricing of risks: An empirical investigation of world capital market structure. *American Journal of Science and Learning for Development*, *2*(7), 49–65.

Sahani, S. K., Sah, R., Kumari, S., Sahani, K., & Prasad, K. S. (2023). Unraveling the interdependence of input and outputs in the business sector: A case study. *International Journal of Education, Management, and Technology*, *1*(1), 27–45. https://ejournal.yasin-alsys.org/index.php/IJEMT