

Input-Output Analysis in Perspective

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In some sense, every economic model is an input-output analysis. Consider the much cited definition of economics by Lionel (Lord) Robbins:

“Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses.”

Here, the “scarce means” are the inputs, which can be used for different “ends”, which are the outputs.

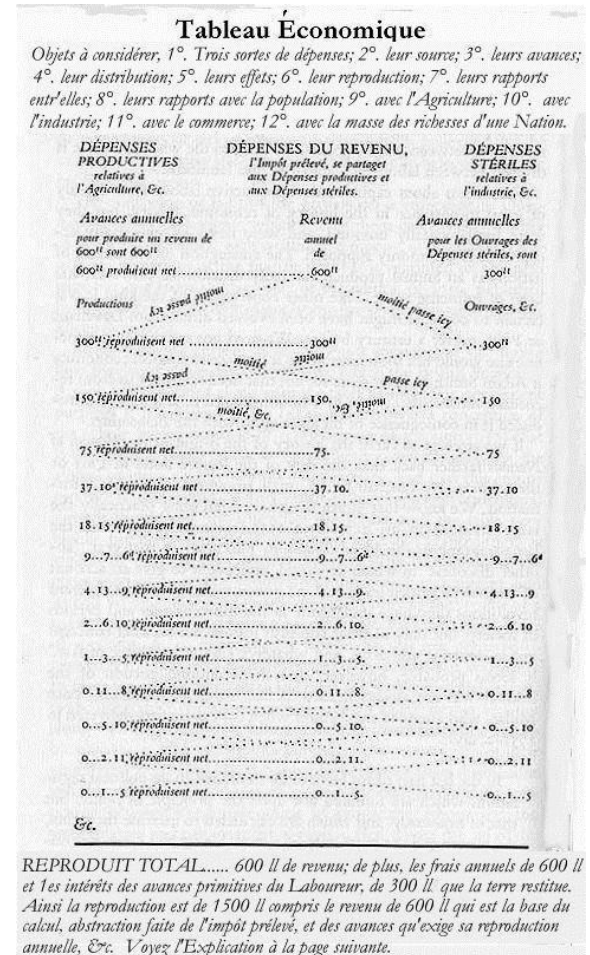
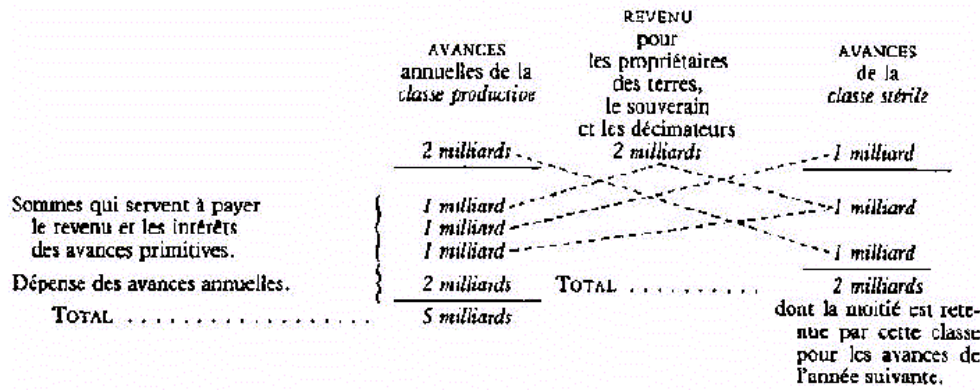
Thus input-output modelling is related to varying degrees to a great number of economic modelling efforts. These links are built around the natural view that economics is (a) a process of transformation that (b) integrates all parts of an economy in a web of reciprocal interferences and, possibly, (c) that this process is circular.

In the following, we will try to provide some perspective to identify the most pertinent links between the work of Leontief (1906-1999) on linear input-output modelling (1951, *The Structure of the American Economy*) and other strands of economic thought.

One of the first and most influential economic models was an input-output model:

François Quesnay (1694-1774), a medical doctor and economic guru at the royal court, developed his *Tableau économique*, a 3-sector, 2-good input-output model, in 1758. While understanding the dynamics of the original (right) requires a labour of love, a later one-year version (1766) is clear enough:

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The *Tableau économique* already highlights a number of features that interest us:

- Inclusion of the whole economy for total output accounting (under mercantilism the inflow of precious metals was the relevant metric);
- Division of the economy in sectors, industries or classes such as, later, capital and labour (this is less automatic than it seems to us today);
- Constant returns to scale with a difficult transition towards dynamics that are centred around investment;
- An emphasis on distributional issues, incomes and rent.

Quesnay would have had a greater impact still if he had not insisted on the earth (*physis*) and agriculture being the only sector capable of producing value added.

Input-output modelling can be linked with different degrees of justification to a variety of strands in economic thought. We will identify five of them:

1. “Classics” believing in objective value of “things”

Pre-classic François Quesnay (1694-1774)

David Ricardo (1772-1823)

Karl Marx (1818-1883)

Piero Sraffa (1898-1923)

The Production of Commodities by Means of Commodities (1960)

3. Socialist planning theory

P.I. Popov ()

Oskar Lange (1904-1965)

Wassily Leontief (1906-1999)

5. Computable general equilibrium (CGE) modelling

Leif Johansen (1930-1982) and many others

Enabled by increasing computer power CGE models integrate prices, substitutability and dynamics into I-O models. However, complexity and necessary *ad hoc* assumptions make it “black box”.

2. General equilibrium theorists

Léon Walras (1834-1910)

Vilfredo Pareto (1848-1923)

Kenneth Arrow (1921-)

Gérard Debreu (1921-2004)

Careful ! Despite superficial similarities GE-modelling projects a continuous price vector unto itself to find a “fixed point”. No linear production functions.

4. Keynesian macroeconomics

John M. Keynes (1883-1946)

Richard Kahn (1905-1989)

The link to I-O modelling is established only through the notion of the multiplier (Kahn, 1931). Keynesian macroeconomics where the whole is more than the sum of its parts does not have an I-O flavour.

Input-output modelling does not catch on with liberals that believe in the auto-organisation (“spontaneous order”) of decentralised decision-making of profit-maximising individuals coordinated by the price mechanism. Think only of

Adam Smith (1723-1790), Jean-Baptiste Say (1767-1832), or Friedrich Hayek (1899-1992, the whole Austrian School in fact) as well as many others.

Also the first generation of the Chicago School, with scholars such as Frank Knight (1885-1972) and Ronald Coase (1910-2013) would have scoffed at a linear matrix representation of economic activity. Because:

- Firms and individuals not “industries” create value; this automatically brings with it a change of focus from constant to increasing returns to scale (IRTS);
- Dynamic changes are everywhere (quality, input ratios, tastes and prices change constantly and thus drive the economy; **substitutability not fixed coefficients**);
- Static distribution issues obscure the real motor of the economy which is short-term rent seeking.

Criticism becomes more valid with rapid technological change and IRTS.

Two issues really define the nature of input-output models in the Leontief spirit:

1. Physical flows and fixed production coefficients **not prices** determine economic output, the distribution between sectors, employment and income. This is ultimately a very static view of things, even if investment and year-on-year changes can be (cumbersomely) modelled.
2. The defining equation of IO-modelling, $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}$, provides an **ideal level** of all outputs in order to solve the good by good input equations including fixed production coefficients and final demand. This is a model for the planner (socialist or capitalist), government, state, king, benign dictator or manager. It is also useful for optimising intra-firm processes.

IO models are about **organisation** not **auto-organisation** by individual market participants with ideas of their own. To make sense of IO-modelling you need to substitute the invisible hand of the market with the visible hand of the planner.

Is Measuring Employment with I-O Models a Good Idea?

In principle, one can measure the ideal level of direct and indirect labour inputs in an IO-models for different levels of a given good such as nuclear power. Several specific questions however arise:

1. IO-models have difficulty taking into account unemployment (a macroeconomic variable) ; measuring employment levels without explicit labour market modelling is always slightly awkward.
2. How does one decide on the total reference output for the counter-factual level of nuclear power? (Does GDP stay constant? Electricity Output? Final Consumption?)

Both issues can probably solved by means of approximations and *ad hoc* assumptions. The limits of the analysis, however, need to be recognised.

1. Stay away from “induced effects”. Induced effects arise through the impact on GDP (**total** GDP, see point two). Economics (and if IO-analysis wants to stay inside that perimeter it will have to concur) is about maximising GDP (income) and not about maximising labour input (otherwise treadmills would be a great way to generate electricity), which needs to be then fairly shared.

The way to maximise GDP (and economics is formal about that) is to use the most efficient means of producing a given output (MWh). Changing an overall optimised system will inevitably lower GDP, even if it will provide higher levels of employment.

2. Careful with multipliers when using them (chronologically or geographically) in a partial manner. Even the Keynesian multiplier (see above) will lose its magic once it needs to be repaid in an inter-temporal budget constraint. Regional or sector-wide multipliers will need to be netted out with the displacement of funds from other regions or sectors. Keynes’ genius was to identify positive externalities (“confidence”, “aggregate demand”) in a given situation (“slump”) where the spontaneous benefits of additional expenditure were greater than the future cost of re-payment. The utility of multipliers in IO-analysis will hinge on the identification of similar externalities that justify the transfer of funds from one sector to another.

Thank You for Listening !