

ECONOMIC INTERDEPENDENCE AND INPUT-OUTPUT THEORY

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ABSTRACT

The objective of this paper is to summarize the historical evolution of the concept of economic interdependence within the general frame of reference of the input-output model. Modern macroeconomic thought has been profoundly influenced by two general equilibrium systems, the Keynesian one and the Input-Output model developed by Leontief. Although Keynes' New School is considered an alternative to the Classical one, his approach is based on classical and neoclassical works. The first explanations of economic interdependence were examined by François Quesnay's Tableau Économique, published in 1758. The recognition of Quesnay as pioneer of inter-industrial analysis was made by whom many years later became one of the greatest modern exponents of this type of analysis: Wassily W. Leontief. In his book The Structure of the American Economy. Leontief wrote that the statistical study presented in his Introduction to Part I could be better defined as an attempt to produce a "Tableau Économique" of the United States for 1919 and 1929. Leontief's input-output model was originally intended to functionalize Léon Walras' general equilibrium and interdependence model. That is why Leontief defined Input-output as an adaptation Neoclassical theory of general equilibrium to the empirical study of the quantitative interdependence among interrelated economic activities.

OBJECTIVE

The fundamental objective of this research effort is to summarize the historical evolution of the concept of economic interdependence within the general frame of reference of the conventional accounting system and the input-output model.

GENERAL EQUILIBRIUM SYSTEMS: J. M. KEYNES VERSUS W. W. LEONTIEF

Modern macroeconomic thought has been profoundly influenced by two general equilibrium systems, the Keynesian one and the Input-Output Model developed by Leontief. Although Keynes' New School is considered an alternative to the Classical one, his approach is based on classical and neoclassical works. Both Keynes and the Classicists and Neoclassicists were interested in all possible macroeconomic forces affecting market equilibrium. Keynes' new approach, however, induced a tremendous blow to the Neoclassical school by placing the employment determination issue at the center of the Great Debate, and by relegating price determination to a secondary level. His system considered the economy as a whole, not differently to the Classical school; that is, like a general equilibrium system, in contrast to the Neoclassical partial equilibrium approach. Leontief's Input-Output Model was originally intended to functionalize Léon Walras' general equilibrium and interdependence model (Myernik, 1965). That is why Leontief defined input-output as an adaptation of the Neoclassical

theory of general equilibrium to the empirical study of the quantitative interdependence among interrelated economic activities.

QUESNAY'S TABLEAU ÉCONOMIQUE

The first theoretical explanations of economic interdependence were examined more than two centuries ago by the French physician of King Louis XV and Madame Pompadour, who became a famous member of the School of Economics known as Physiocracy, François Quesnay (1694-1774), in his notorious treatise *Tableau Économique*, published in 1758. For Quesnay and other Physiocrats, as Anne Robert Jacques Turgot (1727-1781) and Pierre Samuel Du Pont de Nemours (1739-1817), their economic principles were just a part of a more transcendental entity deeply rooted in the concept of Natural Law and the Positive Rules of Nature, in other words, the so called Natural and Positive Order, from where they got their denomination. It can truly be said that Quesnay is the real founder of modern political economy (Phillips, A. 1955; Smith, A. (1869; Marx, K. 1952). According to Quesnay and his colleagues, wealth or national income, production and distribution belonged to the domain of scientific analysis and constituted a reflection of the universal truth (Gray, 1931; Haney, 1949, Schumpeter, 1954). There were, however, other economists that objected the perception of the *Tableau* as a central piece of the physiocratic thinking. According to Quesnay, what his *Tableau* demonstrated was a graphical representation of a simplified version of general economic interdependences, reducing them to just three sectors (Blaug, 1997). The recognition of Quesnay as pioneer of inter-industrial analysis and accounting was made by whom many years later became one of the greatest modern exponents of this type of analysis: 1973 Nobel laureate, Wassily W. Leontief (1906-1999). In his classic book *The Structure of the American Economy*, Leontief wrote that the statistical study presented in the following pages of his Introduction to Part I, could be better defined as an attempt to produce a “*Tableau Économique*” of the United States for 1919 and 1929 (Leontief, 1951, p. 9).

WALRAS, PARETO, JEVONS AND MENGER

The next step in the evolution of economic interdependence had to wait more than 100 years. In 1874, Léon Walras published the first part (*Theory of Exchange*) of his book *Elements d'Économie Politique Pure*. The second part (*Theory of Production*) was published in 1877. He was the first one to conceptualize general equilibrium, rather than what is nowadays known as partial equilibrium in the context of Alfred Marshall's school of thought. The General Equilibrium method became the central focus of the Lausanne School of Economics, where Walras acquired a professorship position in 1870. With William Stanley Jevons (1835-1882) from Cambridge, England and Carl Menger (1840-1921) from Vienna, Austria, Walras became one of the co-founders of the subjective theory of value. This theory that has also been called Neoclassical theory of value evolved from the classical works of Adam Smith, (1723-1790); David Ricardo (1772-1823); Karl Marx, (1818-1883) and John Stuart Mill, (1806-1873) and constitute the seed of the Marginalist revolution of the second half of the XIX century. The essence of that subjective theory of value was determined by the idea that the “natural value” of a commodity is only a function of its relative scarcity, or the degree of what the consumers' perceptions of need or want exceeds the commodity's availability. It begins with the idea of scarcity (*rareté*) as a function of desire (perception of need or want). In other words, it is a matter of personal preferences among scarce or limited alternative goods or services and is

exactly equal to their prices. As Vilfredo Pareto (1848-1923), also a member of the Lausanne School of Economics put it, prices should reflect scarcity and personal preferences. In other words, preference is pricing. Walras goes beyond other Neoclassicists by exploring the simultaneous determination of prices and the conditions for the existence of general equilibrium in the theory of production.

Production can be analyzed in two phases: The first one is related to the combined use of inputs or factors of production, and the second one is the role of time or timing in the production process. According to Hicks, the first phase is ultimately an extension of the theory of value by studying a special case of an inter relationship of prices (H.W. Spiegel pp. 580-591 and Haney pp. 781-802).

Walras focused on the specific case of fixed production coefficients in such a manner that the amount of inputs required to produce a certain amount of output is technically given. In other words, coefficients are pre-determined by technology and measure the inputs needed to produce a unit of final output. Given the fixed-coefficients condition and assuming perfect competition, equilibrium price should depend on the price of the inputs. Consequently, total prices can be derived by simple addition. In this total prices system, supply of and demand for goods and services can be determined by individuals' preferences and ability (budget) to exercise those preferences (Hicks, p. 587).

Although Walras' General Equilibrium model was a brilliant theoretical work, it was not empirically executed. In the meantime, the Great Neoclassical model was challenged by the historical conditions of the last part of the 1920's and the 1930's. A pure theoretical frame of reference without empirical application is as useless as a collection of data without a theoretical frame of reference.

THEORIES WITHOUT FACTS AND FACTS WITHOUT THEORIES: LEONTIEF'S CONTRIBUTION

Leontief in an article written for *Scientific American* (Leontief, 1966) made reference to his previous works of the 1950's discussing this matter, when he pointed that "nowadays we have in Economics a high concentration of theories without facts and facts without theories". In other words, while a group of theorists were building "empty boxes" and becoming experts in implicit theorization, the empiricists were using a series of very sophisticated statistical tools in the process of economic measurement without any theoretical foundation. Leontief developed a practical system guided to consolidate both processes. He not only developed a theory of production grounded in the concept of economic interdependence but also equipped it with empirical foundations by publishing an Input-Output Table of the U.S. economy in 1936 (Leontief, 1954).

Leontief was rescuing the theory of purely describing a static general equilibrium model, related to Quesnay, Walras and Pareto, by inserting a format capable of examining the interdependent structure of an observable economy. According to Dorfman, Leontief simplified Walras' generalized model transforming it into empirically quantifiable equations (Dorfman, 1954). To achieve that, Leontief had to assume certain simplifications, like reducing Walras' number of outputs and considering only one by each industry. For example, the automobile industry only produces motor vehicles. This is known as the industry-product identity assumption. Products are supposed to be homogeneous, also, with total uniformity, that is, all motor vehicles are exactly the same. The most important assumption, however, is that at any

moment in time, the required input-output relationship is fixed. This is known as the fixed coefficients assumption, and it shows total independence to the level of output. According to Leontief, an instantaneous economy can only have fixed coefficients, and any change in the data in the short term, cannot lead into a substitution of productive processes (Kundo, et al, 1976). A large number of phenomena reported as input substitution when examined carefully, tend to show the non-homogeneous character of industrial classification (Leontief, 1951). Linear and constant production solve problems of input substitution and of economies of scale, but create others, like eradicating the time dimension needed when analyzing time periods in the production of capital or intermediate output. However, the final result demonstrates the numerous advantages of this model compensate all mentioned disadvantages (Richardson, 1972). The time problem can be resolved by transforming the model into a dynamic one. This is done by transferring the capital creation component of the final demand to the endogenous matrix.

Nowadays, input-output analysis is one of the most important areas of interest. As part of econometrics input-output combines economic theory, mathematics and statistics. It is used both in highly industrialized societies and developing countries. In the United States, the Department of Commerce, for example, has generated several input-output matrices, including the last one of 1997 (Called Bench-Mark Tables). In Europe, countries as Denmark, France, Germany, the Netherlands, Norway, Spain and the United Kingdom, estimate input-output matrices every five years. In Latin America input-output matrices are estimated in Argentina, Colombia, Costa Rica, Cuba, Mexico and Puerto Rico. In the case of Puerto Rico, there are input-output estimates for the years 1949, 1963, 1967, 1972, 1977, 1982, 1987 and 1992. Other countries with a long tradition of producing this analytical instrument are India, Japan and Russia.

The rationale used to show the relevance of this type of analysis is: 1)-It is unbiased and consequently has been used in centrally-planned or command economies as well as laissez-faire and market-oriented ones; 2)- It has been applied to different branches of economics such as international trade, planning, regional analysis, theory of price, forecasting and others.

POST-LEONTIEF DEVELOPMENTS

Additional studies after the pioneering works of Leontief have contributed to generalize the Input-Output Model. In 1951, for example, Samuelson, Koopmans and Arrow showed that given certain conditions, the concept of substitution could be introduced to the model, adding more acceptance and legitimacy to it (Samuelson, 1951). In the long run, linear programming constituted its most significant contribution. Linear programming can transform the input-output model into an optimization tool eliminating some of the constraints of Leontief's Simple Input-Output model. In Chenery's words "linear programming offers a means to neutralize the limiting assumption of the constant inputs coefficients of every sector, simultaneously allowing for statistical measurement" (Chenery & Clark, 1963; Koopmans, 1951; Dantzig, 1949; and T.C. Koopmans, cf. Samuelson, 1951).

There are other historical developments that should be mentioned. Firstly, it is possible to integrate economics with ecology within the general frame of reference of input-output analysis. Economists and experts in related disciplines such as Cumberland, Daly, Isard and Leontief have suggested that input-output can be applied to environmental research and policy implementation. These writers have emphasized empirical aspects while others like Ayres and Kneese have concentrated their research in the theoretical revision of the Walras-Cassel general equilibrium model. This theoretical revision provided for the satisfaction of the so called law of

mass conservation of fundamental importance both in economics and environmental interrelationships (Victor, 1972; Ayres and Kneese, 1969; Leontief, 1970). Another important development, mainly introduced by Canadian economist of Canada's Dominion Bureau of Statistics (DBS), was the implementation of input-output analysis using commodity-by-industry matrices. In traditional analysis, input-output and inter-industry economics were synonymous. In the commodity-by-industry approach, commodities and industries are introduced explicitly, avoiding the aggregation of multi-merchandise produced by each industry and considering them as compounded merchandise. It is understood that every industry uses and produces many products, and that some products are produced by more than one industry (Rosenbluth, 1968). The commodity-by-industry models' analysis requires commodities matrices quadrants. This type of matrix exists in Canada, the United States and other countries. Unfortunately and due to the high cost of producing this type of matrix, they are not generated in other countries, including Puerto Rico.

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