The development of the Input-Output tables in Italy and Spain.
A View through H. B. Chenery and V. Cao-Pinna contributions

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(Work in progress, not to be quoted)

1. Introduction

Through the Economic Cooperation Administration (ECA), and its head Mr. Paul Hoffman, the 1948 European Recovery Program (ERP), or Marshall Plan, required Italy to set up a regular compilation of statistical data on national income, consumption and investment (Ricossa 1964, p. 818). Then the Italian team of the ECA, later the Mutual Security Agency (MSA) coordinated by the American economist Hollis B. Chenery, in 1952 developed the first Italian *Input-Output* (IO) table for 1950. The first articles describing the results of the teams were published in a special issue of the journal *L'Industria. Rivista di economia politica*, in 1952; in 1953, as collected book, the team's *The Structure and Growth of the Italian Economy* (MSA 1953) [1972] was published, too.

This paper attempts to reconstruct the contribution to the IO analysis of the team and, in particular, the roles played by Chenery and Vera Cao-Pinna in the period 1951-1975. The work reinforces the interpretation that IO evolution in Europe was due both to Wassily Leontief's work and to ECA-MSA administration. In the early 1950s, the «momentum» of the developments of IO tables in Western Europe (Akhabbar, Antille, Fontela, Pulido 2011), the construction of the first Italian table should be mainly related both to the engineering contribute of Chenery (Section 2), and to the real making of Cao-Pinna, together with a seminal conference (Section 3). One addition of the work is to reconnect the origin of the IO Italian studies, from the early engineering approach to the claim that the original trait of the IO analysis evolved together with Chenery's research program, influencing the Associazione per lo Sviluppo dell'Industria del Mezzogiorno (SVIMEZ) regional model and targets (Section 4).

Furthermore, an external history can be added: another economic team, the one led by Valentín Andrés Álvarez at the Spanish Instituto de Estudios Políticos, began to study the intersectoral economic relations of IO at the end of 1954, asking for the collaboration of the ECA Italian experts. Cao-Pinna, in 1956, went to Madrid to support the researchers and the Spanish IO table for 1954 was drafted and published in 1958. This external history of the construction of the Spanish table is discussed in Section 5, trying to understand if the

influence of Chenery was important in Spain as it was in Italy; and if Cao-Pinna represented a transfer figure able to disseminate her scientific outcomes and those of the American economist among the main areas of research of the Spanish colleagues. The final part of the paper attempts to hypothesise a transfer case of ideas through the classic approach of the national histories of economic thought (Spengler 1970).

2. Hollis Chenery, an economist "as" an engineer

2.1 IO in the first half of the twentieth century

The proposal for a more complete and analytical national accounting scheme which covers the entire economic system and allows the study of the relationships and of the structure of a national economy and the resulting income flows, dates back to 1931. Wassily Leontief, at the time member of the National Bureau of Economic Research (NBER) of the US, conceived the project of quantitatively describing the structure of the American economy on the basis of the *Tableau Économique* (1758) of François Quesnay and using the Walrasian theory of general equilibrium. Leontief made a great leap forward, not only beyond the liberal Quesnay, but also beyond Karl Marx and Ladislaw Bortkiewicz, too, his Ph.D. thesis adviser in Berlin. IO could represent building a general arena in which the analysis shaded light on several items, no matter how great their difference from Leontief himself initial concerns was (Baumol 200, p. 149).

IO analysis hypothesises that all transactions that involve the sale of products or services within an economy, during a given period, are arrayed in a square indicating simultaneously the sectors making and the sectors receiving delivery. More specifically, every row in an IO table shows the sales made by one economic sector to every other sector, and every column shows what each economic sector purchased from every other sector. The nature of the table and the individual entries are determined by the number and definition of the sectors. Most of the IO tables divide the commodity-producing sector very finely so that interindustry relations, i.e., sales of intermediary products between industries, can be followed in detail.

Taking this brief description for granted, in the 1950s some sceptical economists denied that IO tables were nothing but a convenient way of presenting information on transactions during a period by a framework for classifying data. On the other hand, other economists believed that, by making very laborious calculations simple and practicable only with the advent of computing, the IO tables could yield reports that were much more than shorthand descriptions of transactions in a past period (Goldsmith 1955, pp. 3-5).

Before 1950, apart from the United States, where the scheme was used, IO analysis was officially adopted only in the Netherlands where the Central Planning Office, periodically, built the matrices. A first rudimentary construction of boards occurred also in the USSR in 1924 and 1925. The first experience of the United Kingdom refers to 1935. In Denmark there were boards from 1930 to 1939. Another application was developed in 1950 in Israel for a four-year development plan (Fabbrini 1953, p. 514).

In contrast with the US, the post-war history of IO in Europe cannot be dissociated from the history of national accounting (Kenessey 1994). Even main applications of the IO analysis dealt with the broad area of

economic development (Rose, Miernyk 1989, p. 230). An early European attempt to measure the economic development was introduced in the first international conference on IO Techniques in Driebergen (Holland, 1950) where some scholars analysed the relations between national tables and national accounts. The topic was in the programme of the second conference of Varenna (Italy, 1954). Here, six national experiences were discussed: Denmark (two 30-industry IO tables), France (general IO table), Italy (IO and a Cao-Pinna's concrete application to the declining textile exports), Netherlands (appropriate parameters for aggregative projections in IO), United Kingdom (1948 census of 400 industries in IO basic data) and Norway (experiments with devices for alternative sets in IO) (Clark, 1957, pp. 406-407). At the third conference (Geneva, 1961), the standardization of IO statistics was the topic of a panel discussion (Skolka ed. 1982).

The IO evolution path was marked by an important transfer from its original home, Harvard University, to Europe. In this rather heterogeneous picture, the Italian case acquired particular importance.

2.2 Engineering IO economic relations

The scientific framework of Marshall Plan favoured the analysis of innovative planning methods, such as IO and linear programming. If Leontief was one of the reference figures in these areas, as Ragnar Frisch, Richard Stone and Jan Tinbergen, just to name the best known, Chenery was destined to apply this theoretical and quantitative program by starting to collaborate in Paris with the ECA, together with its political-institutional objective to effectively make the ERP operative. Lincoln Gordon[1], head of ECA's staff in Paris and for the job of program officer in the individual country missions, recruited Chenery for his staff to work on the problem of the investments policy, with special attention to the usage of the counterpart funds. Chenery had degrees both in engineering and economics and was strongly recommended for his double knowledge of the discipline (industrial and development economics) by Edward Mason, the leading applied economist at Harvard[2].

In a book of essay in his honour (Syrquin, Taylor, Westphal 1984), Chenery is associated with several areas of economic studies[3]. Mainly, Chenery was one of the first development economists to suggest that there was no linear path to growth, hardly accepting the views of earlier development theorists such as economic historians Alexander Gerschenkron and Walt Rostow. According to him, there were differences in the experiences of individual countries and only similarities in different countries' paths to development (Uitto 2019, pp. 106-107).

In the 1950s, the main quantitative methods still linked economic policy to macroeconomics within scenarios of closed economies and accelerated growth, in accordance with the neoclassical 'father' contribute of Harrod-Domar. Instead, Chenery claims a structural approach to problems of economic policy concerning

[1] Consultant in the U.S. Department of State working on the Marshall plan, director of the Program Division Office of ECA special representative in Europe, Assistant Director for MSA.

[2] It was typical of Mason to come to research starting from policy concerns. He represented a true practitioner academic. Mason's advice was sought after by governments, and he was privy to their problems (Papanek 2018, p. 8472).

[3] Engineering and production functions; Investment criteria and shadow pricing; IO analysis; Programming models for development planning; Economies of scale and timing of investments; Dynamic comparative advantage; Patterns of development and source of growth; International economic trend and shock; Income distribution and development strategies.

growth, and he was part of the early generation of Leontief's boys in his special workshop together with Abram Bergson, Sidney Alexander, Shigeto Tsuru, Lloyd Metzler, Dick Goodwin, Jim Duesenberry, Bob Solow and Paul A. Samuelson (Samuelson 2004, p. 3). Thus, he saw development as a set of interrelated changes in the structure of an economy, required for continued growth. Interrelation was very important because of the complex framework of the economic sectors that implied a quantitative approach of studies and repeating a Walrasian general equilibrium expressed through the contents of Leontief's IO (Beaud, Dostaler 2005, pp. 195-196), now called interindustry model of economics (Chenery, Clark 1959).

Mainly, Chenery considered IO a special theory of production for an entire economy in which the functional relations between factors of production and output were simplified, to permit empirical study of many sectors together. He assumed prices as given, studied the movements along the short-run expansion line and rejected partial equilibrium analysis because it took the output (or incomes) of users as given. Therefore, he was primarily concerned with changes in demand for inputs. According to Chenery, the method of IO had the same value as other economic abstractions in exploring a single set of relationships in isolation. *Ceteris paribus*, assumptions of IO analysis were no more restrictive than those of the typical application of value theory or income analysis.

IO assumptions of interindustry analysis were well-interpreted as working hypotheses pending further robust empirical study, and the most serious charge was that government agencies devoted substantial resources to the implementation of a large-scale empirical model whose basic assumptions had been inadequately tested (Chenery 1956, p. 185).

For his Ph.D. thesis, *Engineering Bases of Economic Analysis* (1949), Chenery was followed by Leontief, but the propensity to assimilate the variables that both engineers and economists use to describe the production process, was certainly decisive in his career. As a member of Leontief's Harvard Economic Research Project, Chenery 'wrote' more sophisticated empirical production functions using an engineering understanding of how inputs are transformed into outputs. As noted by Boerger (2008), an effective example were his functions for gas transmission, evaporation, electrolysis and electrical transmission presented in the 1953 book *Studies in the Structure of the American Economy*, edited by Leontief. Chenery's interaction faced economics–engineering nexus as a difference between the variables that the economist and the engineer use to describe the process of production: «The cost function of the economists can be derived by replacing some of the engineering variables with economic variables that conceptually define output as a function of various types of capital goods, labor and raw materials» (Chenery 1992, p. 373).

In Chenery's approach the production functions derived from the type of engineering calculations made in designing industrial plants and applying it to the IO analysis. The advantages were: 1) the range of industrial processes to which the function applies was known in advance, and the effect of changing various technological parameters could be calculated; 2) the results were less limited due to the equipment installed in actual plants and approximated more closely the long-run production function of economic theory. From an engineering approach, the coefficients depended less on the sample studied than on purely statistical results, and the effects of varying any of the parameters could be estimated. Moreover, a combination of engineering and statistical

techniques could give the best results, with the proportion of each depending on the type of technology (Chenery 1953c, p. 322).

> The pioneering papers by Hollis Chenery and other associates of Wassily Leontief at the Harvard Economic Research Project deserve credit for having first introduced economists to the potentialities of the use of engineering data and principles in the economic analysis of production problems» (Smith 1961, p. 18) but «it appears that very little of general interest has been done since the early papers of Chenery» (Solow 1967, p. 26, both quoted in Forsund 1999, p. 4, f. 4).

Chenery underlined that Joseph Stigler had already suggested that an engineering approach would provide advantages in the derivation of production functions and cost curves, but «the suggestion does not seem to have been taken up by economists» (Chenery 1949, p. 508).

Recalling these judgements, from a perspective of history of economic thought, Chenery's indicative starting point are the production functions «elaborated by Paul Samuelson in 1947» (Chenery 1992, p. 372). Effectively, the MIT asked Samuelson if *Economics: An Introductory Analysis* (1948) could be used as an economics textbook for engineering students in order to share ideas and multidisciplinary strategies (Bix 2020, p. 31-32). Economics at MIT was part of the engineering school that had received the lion's share of wartime science funding and, with its massive research laboratories, became one of the preeminent locations of big science (Backhouse 2015, p. 327). Chenery believed that the mathematical analysis of Samuelson could be applied to his engineering production functions «by substituting my equations (4) and (6) for his eq. (1) and (3) in Ch. IV, *Foundations of Economic Analysis*» (Chenery 1949, p. 512 n. 5) and he was persuaded that «engineering data may sometimes be used to approximate the production functions of economic theory in the industrial field […]. The use of engineering relations may be of value in clarifying the problems which must be met in bridging the gap between engineering and economics» (Chenery 1949, p. 508).

Recently, Huei-Chun and Colander (2021) reiterated that a good economist should act like an engineer, and they define the applied policy method of doing applied economics as the engineering approach, subject to the engineering methodology. On one hand, this approach demands knowledge and judgements far beyond scientific knowledge; on the other hand, it uses a less restrictive methodology and accepts rough estimation of needed parameters. Then, an economist needs to transform himself into an engineer or a plumber, according to another metaphor (Duflo 2017). They should adopt a similar mindset of his pair for his work because, after all, engineers are at least professionals and closer to scientists than most economists believe themselves to be. Economics is not a single entity, and each entity is better done with different methodologies and mindsets. Engineering fields are problem-oriented disciplines that do not develop but employ fundamental scientific principles from the physical sciences (García-Díaz 2021, pp. 601-602).

Some researchers early on pointed to the need for micro-utilising engineering information directly: «the production function is established empirically by studying the technical production processes directly instead of remaining more or less outside the walls of the enterprise, merely registering inputs and outputs and then

using statistical methods to analyse these data» (Johansen, 1969, p. 305, quoted in Forsund 1999, p. 4). If we follow today the debate opened by Mariotti aimed to re-establish an alliance between economics and engineering, Chenery's contribution seems to represent a clear historical reference to economics "as" engineering (Mariotti 2021) for its epistemology for market design and problem solving.

3. Chenery, Cao-Pinna and the making of the first Italian table

In Italy, the first real assessment of national income took place after the Second World War and was possible thanks to the results of the 1937-39 industrial and commercial Census, whose realization was strongly desired and influenced by the statistician Alessandro Molinari (1898-1962). The 1937-39 census was able to acquire all the data necessary to measure the system of enterprises, distinguished according to size and geographical location in the national territory (Misiani 2010, p. 449-450). According to the Lincoln Gordon, head of ECA, in Italy there would be a borrowing ceiling imposed by the Central Bank; the government would be up against that borrowing ceiling, and then the availability of counterpart funds, which Italians didn't have to borrow from their Central Bank, would be of great importance. Since Italians couldn't use the counterpart funds without US concurrence, there was an opportunity for joint programming of counterpart funds. The prevision was that Italians should concentrate on projects important for recovery, and particularly on projects which would improve the balance of payments situation of the country.

Within this analytical framework and policy perspective, Chenery would develop his theoretical analysis in Italy. Previously working for Gordon in Paris in 1949, Chenery arrived in Rome in November 1950 as local director of the Programs Division of the ECA, which later became the Mutual Security Agency (MSA). He would declare: «the most fruitful phase began with my appointment as chief economist for both the State Department and ECA in Italy. It was during this period that, together with Paul Clark, Vera Cao-Pinna, and others, I began to experiment with the use of interindustry models to heighten the case for program lending» (Chenery 1992, p. 375). Inside the debate of what the impact of alternative investments on the balance of payments might hand the funds in such a way as to push them in one direction rather than another, Chenery got the merit of introducing IO in Italy, having been optimistic on the recourse to the IO approach for the organization of the European reconstruction[4].

The di Fenizio's chronology[5] of the Italian IO project consists of a first phase (January-October 1951) in which the prospectus of the pre-war Italian economic situation was developed by the Central Institute of

[4] «[w]e have made considerable progress in getting the Input-Output idea accepted, although the scale of the proposed operation to be undertaken initially has been reduced. The first memorandum was generally accepted in ECA as a basis for further discussion. The Dutch, as you will notice, were considerably more pessimistic but did agree that this was at a minimum a useful way to organize existing data and should be tried out in the OEEC» (Letter from Chenery to Leontief, November 14, 1950, Box 4, Folder "C,", Wassily Leontief Papers, Harvard University, quoted in Carret 2022, p. 33)

[5] In 1946, di Fenizio, together with Libero Lenti, Roberto Tremelloni and others, founded the financial newspaper, *24 ore* (Lunghini, Targetti Lenti 2003).

Statistics, starting from the data of the industrial and commercial census of 1937-39. Since then, a working group composed of six people collaborated with the MSA: Cao-Pinna, Camillo Righi, Luciana Carcassi, Luigi Cugia, Aldo Guetta and Enrico Bonomi (di Fenizio 1952, p. 460)[6]. Between November 1951 and October 1952, the first table was adapted to the structural relations existing in the Italian economy during the year 1950. This special adjustment to the characteristics of Italy was performed by Paul G. Clark, another collaborator of Leontief at Harvard[7].

Chenery called Cao-Pinna to work on the construction of the IO for the period 1951-1952[8]. Since her involvement, the Sardinian economist took an optimistic attitude regarding the application of IO analysis. Despite the difficulty in interpreting the complexity of economic reality, she believed in a constant research effort to achieve a «better intelligence» of macroeconomic accounts. According to Cao-Pinna, too, the national accounting, as conceived in the late 1940s in Europe, did not reach an adequate development of the structural relations between the various sectors of an economy, and was unable to highlight the underlying analysis of the cycle. Furthermore, the statistical analysis by sectors could only provide partial explanations detached from a logic of general coordination. Therefore, the studies of the relationships between the structure of a national economy and the income flows needed to be implemented. For Italy, too, Leontief's contribution developed for the American economy at the NBER could function as a guide scheme. This effort pushed to tackle the problem of economic interdependence through a detailed «logically coordinated» statistical analysis, based on a double-entry accounting system in which, to each sector of the economy, a side of sales and one of purchases corresponded (Cao-Pinna 1952d, pp. 34-36).

Cao-Pinna herself declared to have known the IO method directly from Leontief in Washington at the Bureau of Labor Statistics, during an OEEC mission of study of the US censuses and industrial statistics. From 1948 to 1950 she was on duty as an economic analyst in the financial division of the ECA and, in 1951, she

[6] The group join Renato Peretti and Sergio Donzelli (Bocconi University), Maria Elisabetta Scavo, Giorgio Cohen and Sara Diana. Marvin Hoffenberg (Division of Interindustry Economics of the Bureau of Labor Statistics), Francesco Brambilla (Bocconi University) and Henry Costanzo (Columbia University) advise on the drafting of the table. Together with Cao-Pinna, the Italian way to IO takes also the path marked by Salvatore Guidotti for the arrangement of the Leontief's model in the framework of research on national income and by Franco Pilloton for the links between structural interdependencies of technological and economic nature (di Fenizio 1952, pp. 459-461).

[7] Clark earned his doctorate at Harvard, headed its Center for Development Economics, which trained foreign civil servants. He served as deputy chief of the United States Mission to Italy for Economic Cooperation from 1951 to 1953, was chairman of the East African Institute of Social Research in Uganda from 1963 to 1965 and assistant administrator at the Agency for International Development in 1967 and 1968.

[8] Following the documented reconstruction of Fornego (1997, 160-162), Cao-Pinna graduated in economics in 1934 with a thesis on statistics under the supervision of Alfredo Nicefaro, who did not possess the mathematical skills of his colleagues (Prévost 2009, p. 184). From this point of view, Cao-Pinna was far superior to him. Thanks to Zacchia (2015; 2019), in recent years there has been a revival of the works on Cao-Pinna, mainly from a feminist perspective. She appears in the list of 120 women economists who gave an important contribution to economic thought since 1817, reported in *A Biographical Dictionary of Women Economists* (Dimand et al. 2000). Cao Pinna's applied economic research was recognized more abroad than in Italy. Leontief referred to her as the woman who «understood the importance of statistics and mathematics to explain economics in depth» and stressed that she was the first Italian economist to «deal with measuring production, with creating a link – a real liaison – between theory and the empirical observation of economic facts» (*L'Unione Sarda*, 19 November 1988, 6). No doubt Cao-Pinna was an early econometric scholar able to create a link between theory and the empirical observation of economic facts in Italian economics. She was not a secondary figure in the post-war reconstruction in Italy.

began working at the centre organized by Chenery for MSA, in favour of economic aid to Italy. The turning point – as Cao-Pinna herself will remember – were «four sheets in which in 1951 Hollis Chenery tried, in his usual hermetic style, to schematize for Righi and for me the features of the Leontief model, at that time still almost unknown in Europe» (Cao-Pinna 1964, p. 283). The project of building a national analytical balance sheet for Italy, of the type suggested by Leontief, was a target which was «rather ambitious and uncertain, given the dispersion and incompleteness of data on the post-war economic situation» (Cao-Pinna 1952a, p. 527). With this in mind, Cao-Pinna undertook to develop the analysis of «the structural interdependencies» or «immissione-erogazione» (input-supply) or «national costs and revenues» or, finally, IO.

The work in 1952 began with the confidence that Leontief's method represented «an economic planning tool far superior to the traditional and limited methods used in many European countries to estimate 'intuitively' or empirically, but with little rationale, the probable developments of the economic situation of the respective countries» (Cao-Pinna 1952d, p. 53). The statements of «logical» insufficiency of the traditional methods of economic analysis, and the conviction that Leontief's method could fill the gap, was recurrent in Cao-Pinna's early writings on IO, together with the conviction that Leontief's approach could be all the greater the more it was able to activate exchanges of necessary information. In the early months of 1952, these ideas were accompanied by the expectation of an advancement of the frontiers of economic analysis, advancements applicable in a country, like Italy, which was once again moving towards complex forms of technical and industrial organization (Cao-Pinna 1952b, p. 13). In May, at the 14th scientific meeting of the Italian Society of Economics, Demography and Statistics, Cao-Pinna specified that the difficulties of applying the Leontief scheme to the Italian economy derived «from the insufficient homogeneity, comparability and coordination of existing data, being most of the statistical documentation obtained as a by-product of public and private administrative activity» (Cao-Pinna 1952c, p. 408). However, at the end of the year, Chenery, Cao-Pinna and Clark concluded that, despite various problems, the matrix of inter-industrial relations had passed an important critical test and, therefore, it can be «honestly considered as a useful tool for approximate forecasting of the possible developments of the Italian economy in the coming years» (Cao-Pinna 1952a, p. 546).

The Italian table built for 1950 was the result of an intense research and «logical coordination» of all available statistical data on the activity and structure of the Italian economy. It saw the light in a special issue of the journal *L'Industria*, in December 1952. In 1953, *The Structure and Growth of the Italian Economy* (MSA 1953) [1972] was published as the result of the work of the Program Division of the Special Mission to Italy for Economic Cooperation, with the substantial resources of the US MSA and Chenery's original engineering imprinting, Cao-Pinna's making and Clark's adapting to the Italian economy.

The team considered the table the best attainable overall estimate. It cannot be considered as a homogeneous body of actual data but was sufficiently reliable as proven by the validity of the known data from 1951. The criterion for choosing economic activities to be summed up in the same sector - noted by one of the first Italian econometricians (Castiglioni 1957, p. 577) – lied more in the similarity of production processes than in the

similarity of products[9]. In effect, the team determined a number of product groups (200 out of 200 rows) over a smaller number of production sectors (56 out of 56 columns). Because of this aspect, the Italian table was significantly different from those constructed in the US and other European countries, often based on an equal number of rows and columns. In the various stages of solving the system of interindustry transactions, a rectangular matrix of 200 x 56 squares had the important advantage of determining, for the various product groups, the extent to which their respective total requirements were to be covered by imports. The advantage of these subdivisions was clear when any limitations in the production capacity of each sector are also considered.

If *L'Industria* is the journal where the Italian IO was first presented, the *Rivista Internazionale di Scienze Sociali* was the journal where it was first considered. Here, the main research in the field of structural interdependence was explored by Luigi Fabbrini who considered Leontief IO tables under the preliminary perspective of Walrasian general equilibrium, but without micro psychology analysis and preferences (Nerozzi, Parisi 2013, p. 282-283). In Fabbrini's view, to consider the evolution and progress of technology, the technical coefficients could be corrected on the basis of past experience. However, coefficients could be determined 'a priori' rather than 'a posteriori', i.e., not using statistical data referring to past events, but more predictive data provided by technicians and engineers (Fabbrini 1952, p. 118; 1953 p. 514). Chenery's engineering solution was preferable because it could better forecast the growth rate in the Italian economy, and the studies included in *The Structure and Growth of the Italian Economy* delved deeper into some aspects which eluded observation in an initial examination of interdependence analysis, in the form exposed and employed by Leontief and by the US Bureau of Labor Statistics (Fabbrini 1953, p. 512). Therefore, to the reviewers of the main international journal of economics, e.g., *Econometrica*, the first Italian table suggested that the IO input-output approach could also be attempted Italy, namely in a place where the initial statistical resources seemed quite unpromising (Evans 1955, p. 111).

In 1954, Chenery and Cao-Pinna presented some aspects of *The Structure and Growth of the Italian Economy* at a conference in Varenna[10], a Lombard municipality located on the Como lake. Within this context, the internationalization of Italian IO studies underwent a strong boost. The University of Pisa and Prof. Giuseppe Bruguier Pacini promoted this international conference with the aim of a critical discussion of the IO method, and the exchange of information between experts from the US, Japan, the UK, Holland, Norway, Denmark, France, Germany, Austria, Belgium, and Eastern Europe. Between June 27th and July 10th, the elite of the IO world – Leontief himself, Richard Stone, Edmond Malinvoud, George Morton, Harry Markovitz, Duane Evans and other important scholars of economics and statistics – were present in the charming Italian village. According to the Norwegian economist and statistician Petter J. Bjerve (1957, pp. 184-185), the papers

[9] Pietro Castiglioni, mathematician and econometrician, in 1954 was also the Italian translator of Samuelson's 1948 book *Economics* (Turin, UTET, 1954) and author of an appendix to the volume useful as a later approximation to the deeper analysis conducted by the American author in *Fundaments of Economic Analysis* (1947).

[10] In the proceedings volume of the conference, Leontief wrote a prefatory note; the Italian Minister of Finance, Roberto Tremelloni, a foreword. A paper titled "The Changed Tasks of a Faculty of Economics" by Giuseppe Bruguier-Pacini, to whom the volume is dedicated, is also included.

from the Varenna conference gave a comprehensive presentation of structural interdependence analysis. Robert Solow (1958, p. 173), after reading the book proceedings, *The Structural Interdependences of the Economy: Proceedings of an International Conference on Input-Output Analysis* (1956), underlined how the Varenna conference helped IO technicians to transform themselves into interchangeable scholars across boundaries, and their technical terms to become a lingua franca of economics. Furthermore, Maurice Peston (1957, p. 375), in another review of the volume, claimed that the major change in the first twenty years of IO analysis had resulted from the victory of the open system over the closed system. In the 1954 conference, the tendency to construct a rectangular tableau in which a subset of the sectors was treated as endogenous and the remainder as exogenous, was well followed by Italian experience. This proved the advantage of an open rectangular table that permitted the total requirements to be covered by imports.

4. Chenery from Italian IO to regional model

The direct engagement of Chenery in the institutional history of Italian economics began to evaporate in 1953[11]. He continued his research program in interindustry structure, structural transformation, and development economies as professor at Stanford University. Around 1954, together with Hendrick Houthakker and Moses Abramovitz, he launched the Stanford Project for Quantitative Research in Economic Development. Therefore, he improved the analysis of specific industries and general laws on the shape of production functions from industry specific processes that could be modelled by power-law distributions (Cherrier, Saïdi 2020, p. 97). But the concept of economic dualism would link Chenery to Italy (Southern Italy) and also to SVIMEZ at the end of the 1950s and the beginning of the 1960s.

The concept of dualism – or unequal development – already permeating Italian economic and social history, re-emerged in the 1950s with the North experiencing vigorous growth while the South remained stagnant. Vera Lutz's studies had profound implications on the growth strategy that the Italian leadership was launching with the help of eminent foreign advisors and thanks to soft loans from the World Bank. Experiences of dualism comparable to the Italian one – industrial dualism – did not receive great attention in economic literature until the Second World War. In general, the structural evolution of late-stage economies were not exact replicas of already experienced evolutions, although authors such as Chenery and Syrquin (1975) devoted themselves to research for statistical uniformities in modern economic patterns of development. In fact, thanks to time series and spatial cross-sections comparisons, differences between functional relationships are often derived form (Fuà 1978, p. 88).

Chenery seems to well interpret the primitive role assigned to SVIMEZ in terms of «technical intelligence» and «technocratic southernism» by Barucci (1974). This was the Meridionalism which, between the end of

[11] «In 1952, I had to decide on whether to resign from government service and take up an academic career» (Chenery 1992, p. 369-374).

1946 and the early months of 1947, was expressed in the work *Il problema industriale del Mezzogiorno* (Cenzato, Guidotti 1946) (The Industrial Problem of Southern Italy), in the birth of SVIMEZ itself, in the work carried out in those years by Pasquale Saraceno and Rodolfo Morandi. All this represented a decisive call for industrialization for the Southern regions, and the requirement to discuss the Mezzogiorno in quantitative terms and proposals (Barucci 1975, p. 28). A new SVIMEZ "Southernism" inspired a quantitative vision of economic development, applying it to the internal dualism of a single country (Lepore 2011, p. 78). From this perspective, Chenery's application of investment criteria in underdeveloped areas was an answer to this requirement. It was based on several countries' cases (Greece, Turkey, Portugal) and one regional case (Southern Italy) similar in climate, natural resources, and stage of economic development (Chenery 1953b). The explicit connection to the South of Italy could also serve as a selection hypothesis of the numerous contributions that economic literature was accumulating on the problem of regional development and for the definition of intervention tools in areas that had structural characteristics similar to that part of Italy. Through three directions of research, Chenery's model considered the influence of the structural disequilibrium and external economies on the optimum amount and composition of industrial investments. The first was the use of capital, labor, and purchased materials and services in each type of production; the foreign exchange cost of imports; the foreign demand for exports; restrictions on the commodity composition of any increase in national income; availability of labor, foreign exchange, investment funds, and other scarce resources. The second was the statistical analysis provided by an IO table, augmented by consumer demand, export demand, etc. The third was a solution that involved choice between domestic production and imports, between production for the home market and exports, and maximization of output within the given restraints.

Looking at the total effects of an investment program, Chenery's model inspired by the Southern Italy experience claimed both the requirement to abandon the assumptions of partial equilibrium analysis and to refer to a general equilibrium system with parameters estimated from the evidence in order to establish consistent input coefficients (Chenery 1955b). Moreover, the «gap analysis» of the role of external aid became a considerable aspect of development economics. According to Chenery, a saving gap occurred when the domestic saving rate was below the necessary level to achieve the goals (while imports were sufficient). A trade gap occurred when the saving rate was adequate (while the imports are below the required level): «The two gaps are of course necessarily equal *ex post* and a major part of the great power of the Chenery studies in deriving estimates of parameters of a large number of countries such that these gaps may be shown to exist *ex ante* and their full implications explored» (Bruton 1968, pp. 1-2).

This basic model will later be revised by Chenery with the addition that, in underdeveloped economies, there was not only a savings gap between savings and investments but also a foreign exchange gap between demand and supply of foreign currencies.

5. Vera Cao-Pinna, Hollis Chenery and the Input-Output Analysis in Spain

5.1.- Instituto de Estudios Políticos and the reconstruction of Economics after the Spanish Civil War

The first Spanish IO Tables were drawn up in the heart of the Instituto de Estudios Políticos (IEP), which was founded after the Spanish war ended in September 1939 and was closely connected to Falange Española, the Spanish fascist party. The institution worked as a think tank within the Francoist regime and had a department of economics that aimed at preparing reports and memorandums on different aspects of the Spanish economy. Instituto de Estudios Políticos (IEP) in Madrid was one of the pillars on which economics reconstructed in Spain after the Civil war. The coming of the German economist H. F. von Stackelberg to the Instituto was critical as he taught and guided the members of the Instituto who would contribute to *Suplemento de Información Económica* and, *Revista de Economía Política*, the economic journals of the Instituto. Revista de Economía Política was founded in 1945 and became the economic benchmark during the 1960s when the Spanish politician attempted to substitute the autarchic economic development model. The journal included reviews of a wide range of foreign economic works, often translated from articles previously published in American journals by international scholars of economic development like Hoselitz, Singer, Kuznets, Baran, Nurkse, Hirschmann, Chenery and others. Furthermore, a series of articles discussed the new methods of applied analysis, like the input-output tables (Zabalza 2011, pp. 896-898).

Another step forward was taken in 1943 when the Faculty of Political and Economic Sciences of the University of Madrid was created, making a high standard of economic research available to Spanish society. The appointment of Valentin Andrés Alvarez, Joaquín Fernández Castañeda, and Manuel de Torres as the first professor of economic theory brought a leap forward to economics in Spain amid the autarchic period. Thanks to his teachings and guidance, the early generations of post-war Spain were brought up in the acceptance of the central role of the market in the optimal allocation of resources, the criticism of the autarchical model of economic development and the emphasis on the harmful consequences of inflation (Sanchez Lissen 1999, p. 158).

5.2.- The making of the first Spanish IO Tables and Vera Cao-Pinna's advice

The historical account of the first Spanish IO Table is due to Alvarez (in Alcaide et. Al. 1958, pp. 15-21) and Alcaide (1958; 1976), which has been recently completed by Cañada and Toledo (2000) and Sánchez Hormigo (1991; 2007). The head director of the IEP in the mid-1950s reorganised the Economics department under the advice of the liberal economist Valentín Andrés Alvarez who was also, as mentioned, a professor at the recently created Faculty of Politics and Economics at the University of Madrid. Andrés Alvarez, who had read Leontief's work on IO Tables, commissioned his assistant Alfredo Santos to organise a research team to attempt the making of an IO Table for the Spanish economy for 1954. Santos gathered a group of young economists composed of himself, Joaquín Fernández, Gloria Begué and Angel Alcaide. The group found significant obstacles. The most notable was the incomplete and partial statistical data available about the economic variables as there was barely any information on a few industries on consumed raw materials and wages, but not about sales or final demand.

On the other hand, the IEP did not have funds for financing enquiries to estimate the magnitudes required for constructing the Tables (Alcaide 1976). Therefore, there was no way but to rely on the data provided by "Servicio Sindical de Estadística" of the National Trade Union (The single Union), which handled data on the different industries. From such statistical information, the research group was able to identify the inputs and outputs of 28 sectors of the Spanish economy (Alcaide 1976).

Shortly before the statistical analysis ended, Manuel de Torres, a Keynesian economist and Dean of the Faculty of Politics and Economics, joined the project. Torres's background in the calculus of the National Income and the first Spanish accountancy spurred his interest towards the IO Table prepared in the Instituto de Estudios Políticos. He believed the Spanish IO might contribute to the calculus of the Spanish economy's macroeconomic variables, which eventually happened. His prominent position as Dean of the Faculty of Politics and Economics made him a central actor in developing the Spanish Tables. Torres also contributed to drawing attention to the Italian experience.

The first IO table for the year 1954 was finally published in 1958, attached in large format in *La estructura de la economía española: tabla "input-output"* (Alcaide et Al. 1958), The IO Table of 1954 (IOT-54) is rectangular divided into 28 productive sectors and 4 final sectors. It becomes an optimal starting point for the successive tables of 1962, 1965, 1966 and 1968. The IOT-54 was presented at the University of Madrid and counted with Leontief's participation.

5.4 The Italian link to the Spanish Input-Output Analysis

The publishing of the Italian IO Table of 1953 promoted by the American MSA of the Marshall Plan together with the similar economic structure of Italy and Spain, and the wider circulation among the academic economists of the articles that accounted the Italian research like those published in the journal *L'Industria*, extended the belief that the Italian experience may have been the model for the development of similar tools of analysis in Spain. It is known that the Catalan economist Fabià Estapé attended the famous Varenna international conference on IO analysis. There he met Leontief, Chenery, Markowitz, Cao-Pinna, Frish and Stone, from whom he was acquainted through their books (Nogueira Centenera 2019, p. 142; Barbé et al. 1989). He committed himself to spreading the results and debates of the Varenna conference in Spain, which finally became well-known in academic circles. Estapé translated Leontief's The Structure of the American Economy, 1919-1939, into Spanish in 1958 (Leontief, Wassily, *La estructura de la economía americana, 1919-1939*, Jose Maria Bosch, Barcelona).

In this context, Manuel de Torres contacted the Italian economist Cao-Pinna from the Istituto Italiano della Cogiuntura, who accepted visiting Spain to lecture in the Faculty of Politics and Economics on IO analysis, its origins, applications and usefulness. During his stage in Madrid, he shared office with the very Leontief, who was also staging in Spain. The lectures were summarized in the article "Principales características estructurales de dos economías mediterráneas: España e Italia", published in *Anales de Economía*, the journal of the Instituto Sancho de Moncada where worked the Spanish Keynesians led by Manuel de Torres himself. (Vera Cao-Pinna

1956; 1958a, 1958b). The group of economists of the IEP also met Cao-Pinna to discuss making the Spanish IO tables and the specific adaptations that the research team had introduced (Cao-Pinna 1956).

Cao-Pinna's visit to Spain was a significant step in developing the Spanish IOT-54. On the one hand, she contributed to overcoming the main technical problem: the calculus of the inverse matrix of 29 rows and 28 columns, as there was not a computer in Spain that may do it. Thanks to Cao-Pinna, some members of the group that drew up the IO-54 moved to Rome to invert the matrix. As Chenery recalls, « During the 1950s input-output solutions required long hours to invert matrices of modest size» (Chenery 1992, p. 377). On the other hand, Cao-Pinna was who first applied the statistical details of the Spanish IOT-54 by comparing them with the Italian IO Table of 1953. Albeit simply for descriptive purposes, this effort becomes the wide role of the «magnificent guide» for national industrial activity. Another outcome was the growing interest in regional analysis – e.g., of the Italian Mezzogiorno – as a necessary tool to predict income differences in differently developed areas of Spain (Alcaide et Al. 1958, pp. 120-122).

Cao-Pinna analysis of the IOT-54 proved to be influential in Spain. Although Manuel de Torres did not contribute to making the IOT-54, when they were eventually published, he drafted the "Epilogue", demonstrating a remarkable influence of Cao-Pinna's analysis. Torres believes however that the main strength of the IOT-54 consists in the calculus of the magnitudes at factor cost, which allows for a precise determination of the technical coefficients of production. In addition to this judgement, which indirectly referred to the Italian tables and, therefore, to Cao-Pinna's work, Torres pointed out that the tables were an eminently practical instrument. Consequently, they should contribute to solving certain problems specific to the Spanish economy, which he enumerates, drawing upon Cao-Pinna's work. This is the case of the raw materials required to achieve a particular increase in final demand; or the effects of a given scheme of industrialisation on the balance of payments, which will help assess its potential success (Torres 1958, p. 119; Cao-Pinna 1956, pp. 229-245)

According to Torres, the IO Table also allowed the possibility of achieving long-term economic objectives to be established. Torres is referring to economic development planning, in which he had been involved since the 1940s and early 1950s by promoting the first national accountancy following the footsteps of Richard Stone. Torres mentions a specific example – the Central Planning Bureau of the Netherlands – which is also taken from the work of Cao-Pinna (Torres, 1958, p. 120; Cao-Pinna 1957, p. 250). Such mention, however, was significant. According to González, who consulted Torres' archive, among Torres' papers were three documents related to the setting up a coordination agency. The first of the three documents were a report on coordination and planning in the Netherlands. González suggests that the report was written between September 1956 and the first months of 1957. Bearing that Cao-Pinna's article was published in September 1956, it seems that the Italian economists stimulated and led Torres to investigate and learn in-depth about the Dutch planning model. It is known that Torres assigned one of his students to write a report on the Dutch model of economic planning developed by Jan Tinbergen. The outcome of this was the creation of the Oficina de Coordinación y Programación Económica (OCYPE) by a decree, the planning office that Torres himself inspired.

Torres suggested a third application of the IOT-54 to the regional analysis, which according to him, was appropriate for Spain. On this, Cao-Pinna, who was an experienced expert applying the tables to the regional analysis of the Italian economy, seems to be Torre's source.

The fourth area in which Torres demonstrated to have been influenced by Cao-Pinna is when he suggested that the table may contribute to analysing the economic equilibrium of Spanish agriculture and industry. Following Cao-Pinna, he affirmed that such equilibrium depends upon the so-called productive bottlenecks that occur over time as these activities unfold (Torres 1958, p. 120, Cao-Pinna 1957, pp. 252-253). Torres was probably who first pointed out the production bottlenecks as the main problem of economic development of the Spanish economy under the autarchic model that the dictatorship had promoted in the 1940s and 1950s that finally led to the Spanish economy's collapse in 1959. The specific problem was that due to the economic autarchy and the consequent scarcity of foreign currency, many intermediate inputs of the industry could not be acquired in the international markets, and the Spanish industry was paralysed (González 266). Generally speaking, the problem had been identified by Cao-Pinna, although applying it to the relationships industry-agriculture was something original to Torres and the IOT-54 were the mean to support in quantitative terms what he had (Cao-Pinna, 1956, p. 250, 254-257)

Torres's only practical application of the IOT-54 data was to demonstrate the Spanish economy's external dependence, a highly controversial issue in Spain in the 1950s when the policy of the Franco dictatorship, albeit with some signs of openness, was still autarkic. Torres, of course, sought to demonstrate the need for openness. To this end, Torres, having divided the economic sectors into Exporters and Importers, attempts to determine those whose income-generating capacity is the greatest. In particular, Torres poses the dilemma, given the pressure caused by the soaring trade deficit, between a strategy of expanding exports or import substitution. To this end, he attempts to measure the productivity of exporting and importing industries, using a measure that he defines as the ratio of value added to the total output of the sector. According to Torres' calculations, the final result is favourable (Torres, 1958). From our point of view, it should be remarked that Torres's method relies on Cao-Pinna's approach to IO analysis (Cao-Pinna 1956, p. 250, 254, 257).

Nevertheless, Torres simplified Cao-Pinna's method, which was far more complex. Cao-Pinna classifies the imports of finished products by sector of origin and «homogeneous groups», then determines the distribution of the imports of «instrumental» goods among the various industries that acquire them, which is a complex process hampered by the existence of goods that are used in various industries. Thirdly, the coefficients of 'total requirements for imports' are ascertained, the «imports contained in the final demand» are calculated, and the 'technical requirements for imports of instrumental goods' are determined (Cao-Pinna 1956, pp. 260-270).

The next documented contact of Torres with Cao-Pinna took place at the Conference of the European Agency of Productivity held in Bellagio (Italy) in July 1960 when Torres discussed Cao-Pinna's "Problems of Establishing and Using Regional Input-output" accounting. The conference organisers published the "Discussion paper" in Isard and Cumberland (1961, pp. 305-337). However, more than discussing Cao-Pinna's paper, the authors present the results and methods used in making the Spanish Table of 1954 and the successive

tables 1954-55-56-57. In doing so they introduced to the international audience the tools they had specifically designed for building up the Spanish Tables. Some of them were inspired by Cao-Pinna. The article conveys a particular worry about avoiding the so-called productive bottlenecks in the development process that they identified in the scarcity of foreign currency for acquiring foreign intermediate goods. They divided the Spanish sectors into «Totally Export Sectors» and «Totally Importing Sectors» to analyse this problem. Afterwards, they defined the «Sectoral Production Effect» and the «Inter-sectoral Production effect» for calculating the direct or indirect imports per unit of output or final demand and ultimately allow the calculation of the burden on the balance of payments of a given increase in final demand. In this case, the distinction between imports from abroad or from within the country is crucial, and the authors take into account the regional analysis of Cao-Pinna (Torres Martínez, Lasuen Sancho 1961, pp. 342-343). Another instrument of analysis derived from Cao-Pinna is the overall transformation coefficient (total inputs of an economy/total outputs of an economy), which allows us to measure the degree of productivity of a given economic structure (Cao-Pinna 195, p. 264).

The input-output analysis applied to the regional level between 1965 and 2000 was quite common in Spain. Several input-output tables for different regions and territorial were drawn up during this period (Cañada, Toledo 2001, p. 65). As Cao-Pinna pointed out in an article in a special issue of *De Economia: Revista de Estudios Economicos-Sociales* dedicated to regional economics, when a detailed analysis of intra-regional and inter-regional relationships is required, the differences in the making and procedures of national tables are negligible (Cao-Pinna 1967). Cao-Pinna's contribution is part of the special issue of De Economia: Revista de Estudios Economicos-Sociales dedicated to regional economics. This article is the Spanish version of Cao-Pinna's paper (Cao-Pinna 1961), presented at the OECD Bellagio Conference, together with the contributions of John R. Meyer, François Perroux, Jacques R. Boudeville, Giuseppe di Nardi and Richard Stone. Cao-Pinna conclusions about input-output regional account spread from that Italian meeting, where the OECD recaps an initial summing up of regional policies, with discussions on the relationship between regional and national planning. Significant enough from our point of view is that Torres almost entirely accepts Cao-Pinna's statement:

> …in general terms, we agree with the basic conclusions reached by Vera Cao-Pinna. For many years the main author of this work has been in frequent contact and has worked with her, and the two authors have benefited from her research, for which they thank her. Basically, we have merely applied and completed the latest research done in Spain on the important contribution that Vera Cao-Pinna has been making in connection with input-output analysis (Torres Martínez 1961, p. 441).

The quotation exemplifies how Spanish economists saw Cao-Pinna's contribution as a helpful tool for analysing the Spanish economy, given the similarity of the economic structure between Spain and Italy (Zabalza 2003, p. 417). Furthermore, Cao-Pinna's influence in Spain is epitomised by the five entries included in the alphabetical index of the authors that have contributed to input-output analysis in Spain during a period

in which input-output tables are a complex instrument of analysis (del Castillo Cuervo-Arango, de la Grana Fernández 1993). Cao-Pinna influence did not vanish completely during the late 1960s and early 1970s. Some works prove it (Cao-Pinna 1967; 1973a; 1973b).

5.3- Hollis Chenery in Spain

The link between the Spanish development of IO analysis and Chenery is occasional and unclear like Cao-Pinna's involvement. Nevertheless, Chenery was well-known in Spain. As soon as 1955, *Revista de Economía Política*, published "Aplicación de los criterios para la selección de inversions" (Chenery 1953b) that Chenery had drafted originally for the *Quarterly Journal of Economics* in February in 1953 (Chenery 1953a). The article aimed at seeking a feasible approach to testing investment programmes in underdeveloped countries, which probably was the motivation behind promoting a Spanish translation of the work. The essential analytical tool is a proxy of the marginal social productivity of individual investments to select the most appropriate for economic development. Chenery is particularly interested in managing the constraints imposed on the analysis in underdeveloped economies. In these countries, private value and cost may diverge significantly from social value and cost. In such cases, free competition cannot be used as a criterion for determining the choice of investments in the different sectors of the economy. Thus, it is required to measure the social marginal productivity and have some government intervention to achieve a more or less efficient distribution of investment goods (Chenery 1953a).

At the end of the decade, the article "Distribucion de recursos para el desarrollo económico" by Chenery and Kretschmer (1959), published in the journal *Productividad* suggested developing a model based on linear programming and input-output techniques to assist in the formulation of development programmes for underdeveloped areas. As a practical illustration, a model was developed for Southern Italy. By then, Chenery had not advanced the substitution of IO analysis by linear programming but pointed out the usefulness of the research developed in Southern Italy. Both topics will be echoed in Chenery's following articles published in Spanish.

The selection of the most efficient investments and the possible role that the government may play by giving the correct allocation to the investment funds is undoubtedly the main interest in Chenery's works for Spanish economists. Such a fact is behind the translation of "El empleo del análisis inter-industrial en la programación económica", prepared originally for the International Conference on Input-Output Techniques, sponsored by The Harvard Economic Research Project in partnership with the United Nations Secretariat and translated into Spanish by Javier Irastorza (Chenery 1962d) shortly after the Stabilization Plan and at the threshold of the Development Plans of the 1960s and 1970s. Through this article, Chenery proposes the use of linear programming instead Leontief's input-output analysis. Although the need for inter-industry analysis was widely recognised, there is general dissatisfaction, according to Chenery, with the use of the classical input-output model for underdeveloped economies. It is assumed that the establishment of new industries, the adoption of new techniques replacing old ones and the rapid change in the composition of production within industries will disrupt the stability of input coefficients in developing economies more than in mature industrial

countries. Therefore, a more flexible analytical technique is required to determine which structural changes are most desirable and which are not, and which distributions of investment and resources are most appropriate. This technique is linear programming, which Chenery presents to a specialised Spanish audience in this article.

The third significant contribution of Chenery to the Spanish literature on economic development was the long contribution "Políticas de desarrollo para la Italia Meridional" (1963), published in *Revista de economía política,* which was not but a translation of Chenery (1962b). This article completes the research-paper drafted by Chenery at the SVIMEZ, which counted with the assistance of the Italian IO and Pasquale Saraceno. The article was worthwhile for analysing the Spanish economy not only for the differences between Southern Italy and the economies of similar income levels but because it sheds light on the nature of the structural changes thanks to the interregional growth model Chenery employed. The work is introduced by Luis Chicote Serna, who interprets Chenery's analysis as a critique of the regional policy carried out by the Italian authorities that essentially involved an approach based on the minimum of infrastructural and that leaves the responsibility of developing productive activities to privates, even if stimulated through indirect measures of fiscal type and credit, is not sufficient. In any case, the publication of the paper demonstrates that Spanish economists believe in the usefulness of the Italian experiences for assessing the different aspects of economic development and as a model of analysis to be followed in Spain. According to Chicote, such a policy was not sufficient

Several other Chenery's works are translated into Spanish in the subsequent years, but they were not connected to the group of economists in *Revista de Economía Política,* which was the main channel to introduce Chenery's ideas into Spain. Conversely, they were published in Latin America. This is the case of *Politica y programas de desarrollo* (1958) published in 1958 in the Argentinian journal *Revista de Economía y Estadística*. We suspect that the article was hardly accessible to Spanish economists. In contrast, the articles published in the Mexican journal *El Trimestre Económico* were accessible and read by Spanish economists. Still, they should be separately analysed as the since the initiative for their translation. Therefore, their selection is far from Spanish economists' circles involved in IO analysis and linear programming.

Therefore, we will merely describe them to have a catalogue of Chenery's publications on the one hand and to determine Chenery's works available to the specialised Spanish reader. Chenery's work published in 1960 (Chenery 1960a) is the Spanish version (by Manuel Sánchez) of Chenery (1959), a chapter in Abramovitz's book, *The Allocation of Economic Resources* (1959). Discussing Rosenstein-Rodan external economies, Chenery presents a model to measure interdependence in production for investment decisions. Chenery (1961a) is the Spanish version (by Juan Broc) of Chenery (1960b) an article that attempts to incorporate changes in both demand and supply conditions into a more general explanation of the growth of individual sectors of production, observing the patterns of industrial growth. Chenery (1962c) is the Spanish version (by Hector Rodriguez Licea) of Chenery (1961b), a contribution to the analysis of resource allocation in less developed economies. Chenery (1966) is the Spanish version (by Fernando Rosenzweig) of the paper presented by Chenery at the 1965 Conference of the International Economic Association in Washington. It shows how the system for administering donations and public loans can be improved. Chenery, Hughes H. (1972) seeks a better division of the workforce with empirical attempts to measure the comparative advantages on a sectoral

basis. The study enhances the comparison of development strategies adopted by industrialising countries to assess potential markets for industrial exports. Chenery (1975b) is the Spanish version (by Eduardo L. Suárez) of Chenery (1975a). With the long-term aim to resolve the disequilibrium in the world economy, the article gives an analytical comparison in terms of economic and political relationships among three groups of countries: older industrialised countries, newly rich but still developing oil producers (OPEC), and other developing countries. Finally, it should be mentioned, *Economía interindustrial. Insumo producto y programación* by Chenery and Clark, published by the Mexican publishers (Chenery, Clark 1963).

5.4.- Cao-Pinna, Chenery and Spain. A brief and final remark

It looks plausible, in the light of the epigraphs above, that Cao-Pinna played a crucial role in developing the IO Tables in Spain as she inspired the Spanish team to repeat the Leontief use of the Walras scheme for the construction of a new and more analytical *Tableau Économique*, which illustrates the structure of an economy and the interdependence relationships between its various sectors (Alcaide et Al. 1958, p. 34). She also contributed to back Torres's export promotion strategy. These early macroeconomic analyses, under the perspective of economic planning, were useful for the Spanish Stabilization Plan of 1959, for the openness policy that immediately followed later – especially that of the Ministry of Commerce – and, later, for the Preferential Agreement with the European Economic Community of 1970. In fact, the first application of the 1954 table, as mentioned above, was carried out by Cao-Pinna himself, who directly compared the results of the Spanish tables with the Italian equivalents (Cao-Pinna, 1958b). Therefore, it is not surprising that Morillas, as late as 1982, continued recommending consulting Cao-Pinna (1956).

But the Italian female economist was the actual Chenery's 'right hand'. Despite the consistent pattern that she demonstrated regarding Leontief's IO analysis, she also considered the nuances introduced by Chenery's contribution that observes the economy-wide disaggregated framework as essential for assuring consistency and comprehensiveness in the Quesnay-Leontief view. Chenery's attitude looks at developing countries and growth economics as a question of efficient investment programs that require coordination (planning) because he considers structural interdependence very seriously (Syrquin 2018, p. 220, 226)[12]. That is why Morillas considers Chenery and Clark (1963) probably the best book on IO analysis translated into Spanish (Morillas 1982). Further research should clarify the true scope

6. Conclusions (from a HET perspective)

The works of Chenery, Clark and Cao-Pinna initiate and spread a series of contributions that the history of economic thought cannot overlook due to their consistency and analytical progression, as well as the

[12] Syrquin highlights that Kenneth Arrow immediately saw the potential of activity analysis (linear programming) for the type of work that Chenery was attempting to do, and that Chenery himself was an important disseminator of the development programming.

subsequent influence they have expressed on a general level and not only as an episodic transfer of ideas to Spain. The articles published in *L'Industria* (1952), and culminating with Chenery, Clark, Cao-Pinna *The Structure and Growth of the Italian Economy* (1953), constitute a major progress of IO contents in the basic model of Leontief concerning the fixed (structural) coefficients of production. Rose and Miernyk (1989, p. 232) explain the problem, claiming that IO coefficients for a given year are often used in analyses of situations several years forward. Chenery's early works propose to overcome the problem, adopting a fundamental engineering relationship and principles able to better define the scale of operation on a year-to-year basis.

This basic approach extends until Chenery and Clark's *Interindustry Economics* (1959), transforming IO into an analysis able to realize the goals of the economic development by linear programming (Chenery & Clark, 1959). In this literature, the concept of planning incorporates objectives of maximization of GNP and IO efficient plans, spreading from a general equilibrium framework that is required to prevail over the limits of partial equilibrium investment criteria. Under this perspective, an early example of simple model transformation into linear programming led to Chenery's "Development Policies for Southern Italy" (1962). The study (Chenery 1955, p. 41) investigates the influence of both structural disequilibrium and external economies on the industrial investment for Southern Italy as a pattern of a minimum of investment from Northern Italy. It takes continuously into account the difficulty of changing existing supply patterns and focuses more on its stability than on the availability of investment resources as being the main limit to growth (Chenery 1962).

The importance of this global and applied work on Italy is recognised by David Henderson, chief economist at the Economics and Statistics Department at the OECD. He judged the Italian experience as «a most impressive piece of applied economic research, which deserves a wider circulation than it seems likely to get in its present form. It should be of interest to all economists who are concerned with the quantitative aspects of national economic problems» (quoted in Zacchia 2019, p. 95). Starting in 1959, the series of tables drawn up by ISTAT for Italy begin in 1970 with the introduction of the European System of Integrated Economic Accounts and the intersectoral table becomes an integral part of the Italian national accounting and other EEC countries.

The subsequent events still involve the collaboration of Cao-Pinna when, with the ISCO, the table is updated with reference to 1953 (and then incorporated into the General Report on the economic situation of the country of 1954), creating the premise for the construction of Vanoni's plan, i.e., the first scheme for Italian economic planning. And still when she collaborates with ISTAT in the construction of the first official Italian matrix of 1959. Since 1956, moreover, Cao-Pinna's teaching and influence are channelled towards Spain, facilitating the arrive in this country of a theoretical scheme that had been known in Italy through Chenery's footprint.

At the end of 1953, thanks to these researchers, Italy was one of the countries where the studies for the application of an advanced IO method had reached a notable development. Thus, the character, the achievement of the results, and the reference in the application of the IO in Italy can be linked to a specific transfer of ideas regarding the Italian national history of economic thought and diffusion. The historiographical

case can be included within the application of Spengler's (1970) classic model because the Leontief analysis, as a source of an economic knowledge, was transmitted to Italy by an engineer economist. Furthermore, the knowledge elaborated in Italy was indirectly transmitted to Spain thanks to the contribution of a well-known applied economist like as Chenery and was directly diffused by Cao-Pinna, a frontier scholar – still without a strong academic reputation –. between statistics and the then-nascent econometrics.

Further research should clarify the transfer.

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