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# Productive Structure, Key Sectors and Economic Complexity in Portugal: a long run analysis

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**Abstract**

The main purpose of this paper is to analyse the evolution of the Portuguese productive structure between the end of the 1950s and 2020, based on the relationship between the productive sectors, i.e. the so-called intersectoral (or input-output) flows. Firstly, the history of the construction of Input-Output tables in Portugal is presented. Secondly, to analyse the evolution of the density of the industrial network over time based on quantitative indicators of the most relevant flows, all the tables are harmonized and made compatible (same number of sectors, as homogeneous as possible). Thirdly, the key sectors of the Portuguese economy are identified, using several indicators and fourthly, the evolution of "economic complexity" in Portugal between 1959 and 2020 is studied using two distinct input-output based quantitative measures.

**Keywords:** Productive structure; Key sectors; Economic complexity; Input-output flows; Portugal

**JEL Codes:** C67; D57.

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# 1. Introduction

The main objective of this paper is to analyse the evolution of the productive structure in Portugal between the end of the 1950s and 2020, based on the relationship between the productive sectors, i.e. the so-called intersectoral (or input-output) flows.

This analysis is made in four steps. First, the history of the construction of Input-Output (IO) Tables in Portugal is presented, from the pioneering work carried out at the National Institute for Industrial Research (INII), through the matrices constructed by Group for Basic Studies in Industrial Economics (GEBEI) and those drawn up by the Central Planning Department (DCP), later the Department for Prospective and Planning (DPP) and ending with the most recent tables, which are being made in Statistics Portugal (INE).

Second, to analyse the evolution over time of the density of the industrial network based on quantitative indicators of the most relevant flows, all the input-output tables available were harmonised and made compatible (same kind of flows – domestic; at the same type of prices – producer, without indirect taxes and trade margins; same number of sectors, as homogeneous as possible - 19).

Third, the key sectors of the Portuguese economy are identified, using several indicators relevant for the matter, namely: i) strength of intra-sectoral and intersectoral flows; ii) strongest direct backward linkages – bigger buyers of intermediate products; iii) stronger direct forward linkages – bigger suppliers of intermediate products; iv) industries with higher technical coefficients– larger demand for intermediate products of all sectors per unit of industry's gross output; v) higher Leontief multipliers – bigger effect in the economy arising from a unitary expansion of the final demand for one industry's products, the so called total (direct + indirect) backward linkages.

Fourth, the evolution of "economic complexity" in Portugal between 1959 and 2020 is studied, using two quantitative measures: one considering the relevant flows of the input-output table (positive or above a certain threshold); the other weighting the dimension of flows located outside the main diagonal (intersectoral relations) in the total flows of the matrix (sum of inter- and intra-[sectoral relations), which is an interrelatedness (or interdependence) indicator.

The paper is organized as follows, beyond this introduction. After a brief literature review (section 2), the history of the construction of Portuguese IO tables is presented and the work of its harmonization and compatibilization is shown in section 3. In section 4, the key sectors of the Portuguese economy are identified and visually shown. Section 5 is dedicated to the quantification of economic complexity of the Portuguese economy since 1959 until 2020. Finaly, some concluding remarks are highlighted in section 6.

## 2. Brief literature review

The productive structure of the Portuguese economy suffered profound transformations since the 1950's until 2020, the last year covered by this study. Although detailed analyses of these transformations at the sectoral level are not abundant in the economic literature on Portugal, they have been addressed in important studies, namely the pioneering works of Moura (1969) and Lopes (1996) and also the works of many Portuguese economic historians, notably Mata and Valério (1994), Aguiar and Martins (2006), Costa, Lains and Miranda (2016), Amaral (2022), among others.

The main trends highlighted by these authors are well known: i) strong economic growth until 1973; ii) subsequent slowdown until the end of the 20th century; iii) near stagnation thereafter; iv) sharp decline in agricultural employment, with an initial shift to industry and then to services, and strong outsourcing in recent decades; v) progressive strengthening of medium and advanced technology sectors in exports.

Studies on the Portuguese productive structure based on input-output (IO) analysis are relatively scarce, with the works of João Ferreira do Amaral and his co-authors deserving special attention. In Amaral et al (2007), a new measure of economic complexity as sectoral interrelation is proposed and applied to the Portuguese economy. In Lopes et al (2012), this and other measures of economic complexity are used to compare 9 OECD economies, Portugal among them.

The economic performance of Portuguese industries and national industrial clusters is studied by Lopes et al (2011), with an interesting stochastic geometry approach. In Amaral et al (2012), a new kind of production and value-added multiplier is used to study

the continental economies of Portugal and Spain, comparing them to the insular economies of Azores and Balearic Islands.

Albuquerque and Lopes (2010) study the impact of the evolution of consumption patterns associated with ageing on the relative importance of industries in Portugal, quantifying the changes in production, value added, imported intermediate inputs, and employment.

Lopes and Amaral (2014) quantify the external imbalances between North and Southern Euro Area members, by means of an input-output based methodology, covering the period that culminated in the sovereign debt crisis of 2011/2013. For the case of Portugal, an input-output approach to the external dependence and low efficiency of many sectors is used by Lopes et al (2011).

In Lopes and Amaral (2016), the self-defeating austerity of the Troika imposed fiscal consolidation measures in Portugal was highlighted and the forecasting errors made in the context of the corresponding adjustment programme were shown.

In terms of the identification of the key sectors of the Portuguese economy, namely those with more employment creation potential, by means of an input-output approach, the work of Lopes (2012) is worth mentioning.

Domingues et al (2021) analyse global value chains, value-added generation and structural change in EU core and periphery economies, in which the performance of Portugal is compared with other northern and southern European countries.

Finaly, three other important (although older) contributions deserve emphasis: the study of the Portuguese competitiveness made by Martins (2004c); the quantification of intersectoral linkages, with the distinction between imported and domestically supplied inputs, to evaluate the importance of international trade in the production process, by Ruas and Reis (2006); the analysis of the economic structure of the Portuguese economy, related to the energy intensity and CO2 emissions, by Cruz and Barata (2007).

The present paper contributes to this line of research applying the input-output methodology to the study of the Portuguese economy and develops work previously presented at the XLIII APHES Meeting (held at ISEG on November 15 and 16, 2024).

## 3. Database used: IO Tables

In this section a brief history of the construction of IO Tables in Portugal is provided, and then the steps taken to harmonize these matrices for use in this paper are presented (the first part of the section follows closely Amaral et al (2018, Chapter 6).

Before proceeding with this brief chronological presentation of the IO Tables produced in Portugal, it is worth mentioning the very important work of Natalino Martins and Vítor Dionísio, published in 1987 (Martins and Dionísio, 1987), which provided an invaluable service to the Portuguese IO community by compiling and making compatibl all the IO Tables constructed at INII, GEBEI and INE between 1959 and 1982. Thanks to these two authors, it is possible to have Domestic Output Tables at production prices (or close to it), compatible with each other, for the years 1959, 1964, 1970, 1974, 1977, 1980 and 1982, for 19 sectors. These sectors are the ones with which we work in this paper and are presented in Appendix 1.

### *3.1 - 1st Phase: IO Tables from Instituto Nacional de Investigação Industrial (INII)*

The first available IO Table in Portugal was constructed at the now-defunct National Institute of Industrial Research (INII) in 1959, under the direction of João Cruzeiro, and with the initial interest and impetus of Francisco Pereira de Moura (then at AIP – *Associação Industrial Portuguesa*). It is a matrix of total flows, at acquisition prices, with a sectoral disaggregation of 40 sectors. This matrix, which highlighted the deficiencies of the Portuguese statistical system at the time, was inspired by the first version of the United Nations System of National Accounts (SNC) of 1953, which did not explicitly incorporate international principles and standards for the construction of IO tables, something that would only be done in the SNA 1968.

The second Portuguese IO Table was also constructed at INII, for the year 1964, under the direction of Eugénio Borralho. In this matrix, the number of sectors was expanded to 67, and a distinction was made between flows of national origin and imported flows. However, the flows were still recorded at acquisition prices, and other limitations of the 1959 Table remained, such as the incomplete accounting of the public administration, financial institutions, and non-marketable education and health services sectors.

### *3.2 - 2nd phase: IO Tables from Grupo de Estudos Básicos de Economia Industrial (GEBEI)*

The second phase of constructing IO (Industrial Economics) frameworks in Portugal corresponds to the Tables of the (now) extinct Basic Studies Group in Industrial Economics (GEBEI), chaired by João Cravinho, which were based on a sophisticated and effective computer-based methodology, although not compatible with the official statistical procedures of the National Institute of Statistics (INE) National Accounts. GEBEI constructed matrix systems for 1970, 1974, 1977, and 1982, under the technical direction of Maria Manuela Santa Maria. These systems consisted of articulated and coherent sets that allowed the production of matrices of total transactions and matrices of national production, depending on the treatment given to imports, and also the production of matrices with different forms of valuation of flows, according to the treatment given to commercial and transport margins and indirect taxes – at acquisition prices or at production prices. Starting from rectangular tables with a high degree of disaggregation (2700 products across 60 branches of activity), GEBEI produced, by aggregating the lines, symmetrical IO tables for 60 branches of activity (branch by branch).

### *3.3 - 3rd phase: IO Tables from INE (I)*

The third phase of constructing intersectoral data in Portugal corresponds to the Tables of the Portuguese National Accounts System (SCNP – 1977), developed by INE, based on the European System of Accounts – ESA 1970, which in turn is based on the SNA 1968, already mentioned. This system includes two types of matrices: i) the annual input-output table, used by INE to determine the value of GDP, which is a table of total transactions at acquisition prices; ii) the five-year matrix system, consisting of: matrix of total flows at factory outlet prices; matrix of national production at production prices; matrix of imports at CIF prices; matrix of taxes and subsidies on products; matrix of trade margins at production prices. For our purposes here, and to summarize, it should be noted that INE produced a Domestic Output Table at production prices for the year 1980, comprising 49 branches of activity.

### *3.4 - 4th phase: IO Matrices from Departamento Central de Planeamento/ Departamento de Prospetiva e Planeamento (DCP/DPP)*

Although INE is the entity that has the obligation to produce five-year systems of intersectoral matrices, which allow for the availability of the Domestic Output Table, at production prices (in the 1970 SEC) and at basic prices (in the 1995 SEC), for various reasons and vicissitudes, it stopped doing so, and we moved on to what we can consider the fourth phase of elaboration of IO matrices, that of the (then) Central Planning Department, DCP, later renamed the Department of Foresight and Planning, DPP, which was dissolved in 2013.

In very synthetic terms, it can be mentioned that the DCP/DPP produced the 1992 Matrix System, although only in terms of finalization, because the bulk of the work was done at the INE, and also the system for the year 1995, both based on the methodology of the 1970 SEC, for 49 branches of activity. After that, it produced five-year systems for 1995 and 1999 (base 1995), under the direction of Natalino Martins (Martins, 2004a and 2004b), and for 2005 and 2008 (base 2000), under the direction of Ana Maria Dias, all of them framed within the methodological procedures of the SEC 1995, covering 59 branches of activity (Dias, 2008).

### *3.5 - 5th phase: IO Matrices from INE (II)*

With the extinction of DPP in 2013, the fifth phase of preparing symmetrical IO tables began, with the INE once again responsible for this task, as is its responsibility (and always has been, although it did not perform it), within the framework of the general regulations for the production of statistics by EUROSTAT, for all countries of the European Union. In fulfilling this obligation, the INE published in 2016 the system of intersectoral matrices for the year 2013, at two levels of aggregation, 64 and 82 branches of activity ant then the latest Domestic Input-Output Tables at basic prices used in this paper, which are product-by-product tables, constructed according to the methodologies of the new European System of Accounts – ESA 2010, based on the SNA 2008, for the years 2017 and 2020.

### *3.6 – Harmonization of all IO Tables available for the Portuguese economy*

In a previous version of this work, in order to study the evolution of the productive structure and quantify the economic complexity of the Portuguese economy, Lopes and Escária (2024) made a harmonization of all the Domestic Output Tables at producer prices/basic prices, using the disaggregation in 19 sectors (see Appendix 1), for the years: 1986; 1992; 1995; 2005; 2008; 2013; 2017; 2020. These tables, together with the ones made by Martins and Dionísio (1987), previously mentioned, constitute the full series of tables used in this paper, i.e.: 1959; 1964; 1970; 1974; 1977; 1980; 1982; 1986; 1992; 1995; 2005; 2008; 2013; 2017; 2020. As far as we know, this is the most complete and comprehensive set of input-output tables used for studying the Portuguese economy at sectoral level.

## 4. Identification of key-sectors

In this section, the key sectors of the Portuguese economy are identified, for all the years with IO Tables available (those indicated in the previous section) starting in 1959 and ending in 2020. Several criteria for identifying key sectors were used, each one of them corresponding to one of the following subsections.

### *4.1 – Stronger Intra-sectoral / intersectoral relations*

The first indicator used to measure key sectors was the strength of intra-sectoral and intersectoral relations, measured by the absolute value of each cell of the IO Tables (Figure 1). For example, the main value of the 1959 Table (4 580) was the supply of intermediate products of Agriculture to Food Industries. The second one was the intra-sectoral flows in Textiles. And the following 3 main values were intra-sectoral flows among Agriculture, Food and Wood firms. According to this criterium, it is possible to observe a tendency from the predominance of the traditional manufacturing sectors and Agriculture to one where predominate Construction and Services (Trade, Transport and other) but also Mining (petroleum refining).

**Figure 1: Key sectors: larger Intra-sectoral / intersectoral flows**

| Year / Order | 1959 | 1964 | 1974 | 1980 | 1986 | 1992 | 1999 | 2005 | 2008 | 2013 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Agric 4,580 | Agric 7,215 | Agric 19,121 | Agric 95,559 | Agric 286,615 | Agric 417,558 | Construc 6,009 | Construc 8,772 | Construc 9,986 | TradServ 9,486 | TradServ 12,099 |
| 2 | Textile 2,226 | Textile 3,991 | Textile 13,191 | Mining 42,849 | Textile 212,688 | Mining 357,441 | TradServ 4,412 | TradServ 7,680 | Mining 9,798 | Mining 9,330 | Mining 9,662 |
| 3 | Agric 1,818 | Trade 2,211 | NonMetMin 6,558 | NonMetMin 37,201 | Mining 194,766 | Textile 348,666 | Textile 2,962 | Mining 4,457 | TradServ 9,390 | Construc 4,964 | TradServ 6334 |
| 4 | Food 1,374 | Agric 1,608 | Agric 5,094 | Food 31,560 | Food 113,423 | NonMetMin 254,656 | Agric 2,752 | TradServ 4385 | TradServ 5762 | TradServ 4226 | Construc 5,240 |
| 5 | Wood 1,146 | Chemic 1,492 | Food 5,090 | Food 27,481 | Food 110,628 | Transport 241,731 | TradServ 2,540 | Transport 3,500 | Transport 4,615 | Transport 4,180 | Transport 5,129 |

Source: IO Tables and author's calculations

### *4.2 – Stronger direct backward linkages*

The key sectors of an economy can also be considered those with the strongest direct backward linkages. These linkages are obtained through the sum of all the purchases of intermediate products by each sector.

The key sectors of the Portuguese economy according to this criterium (those with larger direct backward linkages, corresponding to the biggest buyers of intermediate products) are shown in Figure 2.

**Figure 2: Key sectors: stronger direct backward linkages - bigger buyers**

| Year / Order | 1959 | 1964 | 1974 | 1980 | 1986 | 1992 | 1999 | 2005 | 2008 | 2013 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Food 6,609 | Food 13,758 | Food 30,554 | Food 167,026 | Food 584,409 | Trade 1,005,336 | Construction 12,033 | Construction 16,136 | TradServ 18,798 | TradServ 15,685 | TradServ 21,234 |
| 2 | Agric 3,887 | Textile 6,236 | Textile 21,072 | Construction 110,736 | Textile 337,683 | Food 986,077 | TradServ 10,062 | TradServ 16,005 | Construction 18,245 | Energy 12,028 | Trade 13,308 |
| 3 | Textile 2,824 | Agric 5,961 | Agric 18,252 | Textile 110,355 | Trade 296,284 | Textile 742,102 | Trade 9,120 | Trade 11,396 | Trade 14,986 | Transport 10,829 | Construction 12,318 |
| 4 | Wood 2,274 | Construction 4,679 | Construction 17,051 | Trade 82,938 | Construction 292,928 | Construction 699,092 | Food 6,557 | NonTradServ 8,760 | Energy 12,599 | Trade 10,815 | Energy 12,077 |
| 5 | Chemical 2,243 | Chemical 3,467 | Transport 8,387 | Agric 72,161 | Agric 251,143 | TradServ 628,849 | NonTradServ 5,395 | Transport 7,977 | Transport 11,869 | Construction 9,847 | Transport 11,453 |

Source: IO Tables and author's calculations

In 1959, the top 5 sectors were Food, Agriculture, Textiles, Wood and Chemicals. In 2020, the situation has completely changed. The Key sectors are: Tradable Services; Trade; Construction, Energy and Transport. The main change in the productive structure of the Portuguese economy, according to this criterium, seems to happen in the 1990's, with the disappearance of Agriculture and Manufacturing sectors from the top 5 group of sectors. In 1992 and 1999, only Food and Textiles appear in this group, and after this year none of them remains.

### *4.3 – Stronger direct forward linkages*

The third measure used for identifying the key sectors is the strength of direct forward linkages, which corresponds to the sum of all the sales of intermediate products by each sector. The top 5 suppliers in each of the years is shown in Figure 3.

**Figure 3: Key sectors: stronger direct forward linkages – bigger buyers**

| Year / Order | 1959 | 1964 | 1974 | 1980 | 1986 | 1992 | 1999 | 2005 | 2008 | 2013 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Agric 8,371 | Agric 11,321 | Agric 31,155 | Energy 135,947 | Trade 448,613 | Trade 1,232,209 | TradServ 15,717 | TradServ 23,094 | TradServ 27,143 | TradServ 25,956 | TradServ 32,255 |
| 2 | Textile 3,201 | Trade 7,854 | Trade 19,525 | Agric 135,870 | Energy 447,601 | Financial 1,009,335 | Trade 8,528 | Construction 11,524 | Energy 19,115 | Energy 16,886 | Energy 16,596 |
| 3 | Metalic 2,574 | Textile 5,991 | Textile 14,521 | Trade 103,668 | Agric 390,107 | Energy 876,350 | Construction 7,573 | Energy 11,308 | Construction 14,010 | Transport 11,330 | Trade 12,634 |
| 4 | Chemical 2,323 | Food 5,062 | Energy 13,524 | Food 86,207 | Food 324,481 | TradServ 662,354 | Energy 6,449 | Transport 9,993 | Transport 12,924 | Trade 10,978 | Transport 12,182 |
| 5 | Trade 2,084 | Chemical 4,323 | Food 10,560 | Textile 85,399 | Chemical 274,827 | Agric 660,393 | Financial 6,417 | Trade 9,063 | Trade 12,883 | Financial 8,776 | Financial 9,038 |

Source: IO Tables and author's calculations

A similar pattern to the previous indicator occurs in this case, with the change in predominance from Agriculture and traditional manufacturing sectors to Construction, Energy and Services.

### *4.4 – Higher technical coefficients*

The fourth criterium to identify the key sectors consists in summing the values of each column of the technical coefficients matrix, $A$, whose generic element is $a_{ij} = x_{ij} / x_j$, where $x_{ij}$ is the intermediate supply of sector $i$ to sector $j$ and $x_j$ is the gross output of sector $j$.

This indicator corresponds to the demand for additional output of all domestic industries arising from a unitary expansion of the production of each sector. The most significant values are shown in Figure 4.

**Figure 4: Key sectors: higher technical coefficients**

| Year / Order | 1959 | 1964 | 1974 | 1980 | 1986 | 1992 | 1999 | 2005 | 2008 | 2013 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Food 0.62 | Food 0.69 | Food 0.57 | Food 0.62 | Food 0.64 | Wood 0.54 | Food 0.55 | Food 0.59 | Food 0.56 | Food 0.54 | Food 0.52 |
| 2 | Wood 0.58 | Wood 0.59 | Wood 0.49 | Paper 0.54 | Wood 0.53 | Paper 0.53 | Construction 0.55 | Construction 0.58 | Construction 0.56 | Construction 0.52 | Paper 0.52 |
| 3 | Chemical 0.48 | Paper 0.51 | Paper 0.46 | Wood 0.51 | Hotels 0.52 | Agric 0.52 | Hotels 0.51 | Wood 0.54 | Wood 0.53 | NonMetalMin 0.50 | Construction 0.50 |
| 4 | Construction 0.43 | Chemical 0.46 | Textile 0.44 | Construction 0.50 | Paper 0.50 | Food 0.50 | Paper 0.51 | NonMetalMin 0.50 | NonMetalMin 0.49 | Paper 0.50 | Mining 0.49 |
| 5 | Paper 0.38 | Construction 0.43 | Construction 0.42 | Hotels 0.49 | Construction 0.49 | BaseMetal 0.50 | NonMetalMin 0.49 | NonSpecMan 0.44 | Paper 0.49 | Wood 0.49 | Transport 0.48 |

Source: IO Tables and author's calculations

In this case, the most important sector is the Food industry, in all the years except 1992 when it is Wood Products, also an important sector. Particularly important are also Construction (mainly since 1999), Paper products, Non-Metallic Minerals (in the most recent years) and Mining and Transport in 2020.

### *4.5 – Higher total backward linkages (Leontief multipliers)*

The fifth and final indicator of key sectors picks the most significant Leontief multipliers. These values are obtained through the output multipliers matrix, the so-called Leontief inverse, *B*: $B = (I - A)^{-1}$, where *I* is the identity matrix of order *n* (with *n* the number of sectors) an *A* is the technical coefficients matrix, previously mentioned. The total (direct + indirect) backward linkages of sector *j* results from the vertical sum of all the elements of the *j* column of this matrix. The generic element of this matrix, $b_{ij}$ represents the increase in output of sector *i* necessary to obtain one additional unit of gross output of sector *j*. For more details about this and other IO measures, see Amaral and Lopes (2018) or Miller and Blair (2009).

**Figure 5: Key sectors: Highest total (direct + indirect) backward linkages**

| Year / Order | 1959 | 1964 | 1974 | 1980 | 1986 | 1992 | 1999 | 2005 | 2008 | 2013 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Wood 1.93 | Food 2.04 | Food 1.84 | Food 2.01 | Food 2.10 | Wood 1.93 | Construction 2.01 | Construction 2.11 | Construction 2.04 | Food 1.92 | Paper 1.91 |
| 2 | Food 1.87 | Wood 1.90 | Wood 1.72 | Paper 1.89 | Hotels 1.96 | Paper 1.89 | Food 1.93 | Food 2.04 | Food 2.00 | Construction 1.91 | Mining 1.88 |
| 3 | Chemical 1.68 | Paper 1.83 | Paper 1.68 | Hotels 1.84 | Wood 1.87 | Agric 1.87 | Hotels 1.88 | Wood 1.96 | Wood 1.95 | Wood 1.85 | Food 1.88 |
| 4 | Construction 1.61 | Chemical 1.67 | Textile 1.68 | Wood 1.80 | Paper 1.83 | Food 1.87 | Paper 1.84 | NonMetMin 1.83 | NonMetMin 1.86 | Paper 1.85 | Construction 1.87 |
| 5 | Paper 1.51 | Construction 1.62 | Construction 1.60 | Textile 1.79 | Construction 1.77 | BaseMetal 1.77 | NonMetMin 1.82 | NonSpecMan 1.78 | Agric 1.83 | NonMetMin 1.83 | Wood 1.80 |

Source: IO Tables and author's calculations

The results obtained for this criterium are like those of the previous one, because there is a close correspondence between the relative importance of the values of the technical coefficients (*A* matrix) and the values of Leontief output multipliers (*B* matrix). It is worth mentioning that the dominant sectors here (for instance, Paper, Mining, Food, Construction and Wood Products, in 2020) are not necessarily those with a stronger backward economic impact in absolute values (bigger buyers of intermediate products), but with a relevant impact in relative (technological) terms.

## 5. Measuring Economic Complexity

In this section, the economic complexity as interrelatedness (or interdependency) of productive sectors is studied. Will economies in general, and in this case the Portuguese economy, become more complex as they grow and develop over time? We expect so, as the industrial fabric becomes denser.

To measure economic complexity in this sense, two different indicators are used: C1 - the percentage of relevant (input-output) flows and C2 – the relative weight of outside the main diagonal flows.

### *5.1. C1 - Percentage of relevant flows*

The first indicator, C1 - Percentage of relevant flows, is subdivided in two: C1.1: the percentage of positive flows, based on the work of Peacock and Dosser (1957); C1.2: the percentage of significant flows, proposed by Lopes and Escária (2024). The description and results for these indicators are the following:

*C1.1: Percentage of positive flows*

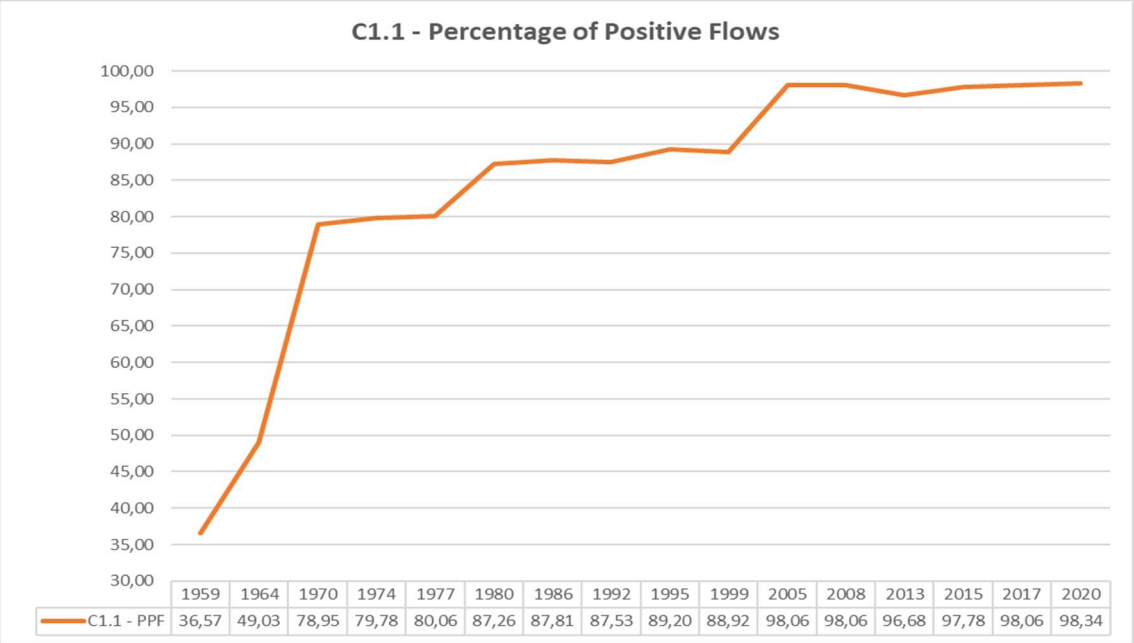
$$C1.1:\ PPF = \frac{100}{n^2} i'Ki$$

With *K* a Boolean matrix, such that:

$$k = [k_{ij}], k_{ij} = \begin{cases} 1 & if\ f_{ij} \neq 0 \\ 0 & otherwise \end{cases}$$

The results obtained for this indicator (see Figure 6), point to a clear increase of the complexity of the Portuguese economy, very strong in the 1960s, more nuanced from then until 2005, and a stabilization thereafter.

**Figure 6: C1.1 – Percentage of Positive Flows, 1959 - 2020**




| | 1959 | 1964 | 1970 | 1974 | 1977 | 1980 | 1986 | 1992 | 1995 | 1999 | 2005 | 2008 | 2013 | 2015 | 2017 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1.1 - PPF | 36,57 | 49,03 | 78,95 | 79,78 | 80,06 | 87,26 | 87,81 | 87,53 | 89,20 | 88,92 | 98,06 | 98,06 | 96,68 | 97,78 | 98,06 | 98,34 |

Source: IO Tables and author's calculations

Two caveats must be referred about these results: the crude, and relative weakness, of the data corresponding to the first two input-output tables (1959 and 1964, made by INII) and the crudeness of the indicator used (consider non-relevant only the null values of the input-output flows).

*C1.2: Percentage of significant flows*

The second caveat of the precious indicator can be overcome with the second sub-indicator, which considers relevant only the flows above a certain threshold (in this case, more than 10% of the average flow).

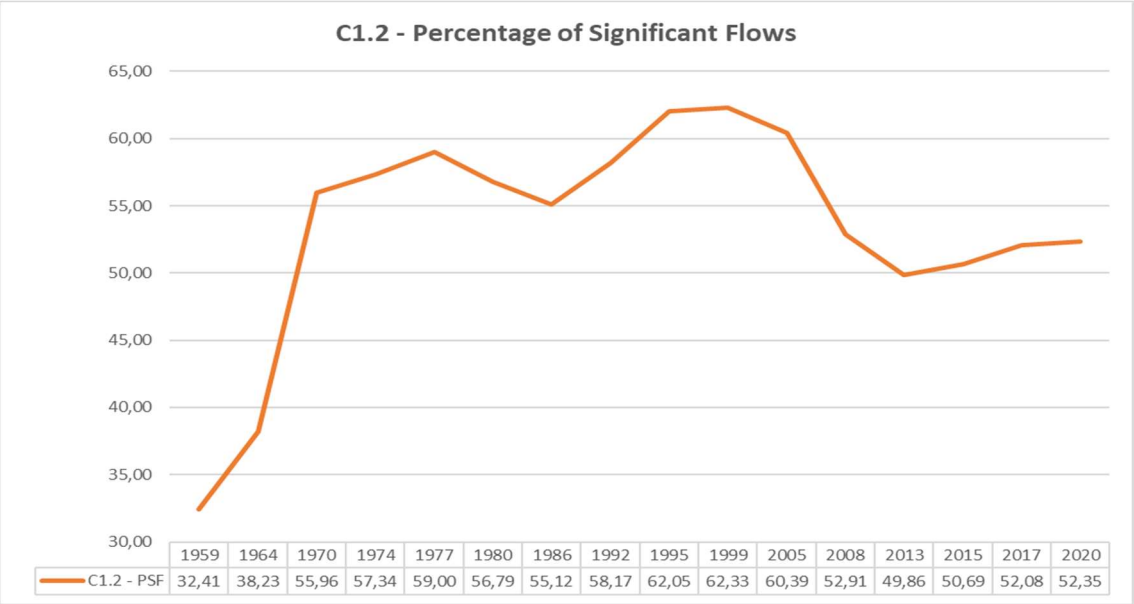
$$C1.2:\ PSF = \frac{100}{n^2} i'Ki$$

*With K a Boolean matrix, such that:*

$$k = [k_{ij}], k_{ij} = \begin{cases} 1 & if\ f_{ij} > 10\%\ of\ the\ average\ flow \\ 0 & otherwise \end{cases}$$

The results for this indicator are a little bit more nuanced (see Figure 7).

**Figure 7: C1.1 – Percentage of Significant Flows, 1959 - 2020**




| | 1959 | 1964 | 1970 | 1974 | 1977 | 1980 | 1986 | 1992 | 1995 | 1999 | 2005 | 2008 | 2013 | 2015 | 2017 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1.2 - PSF | 32,41 | 38,23 | 55,96 | 57,34 | 59,00 | 56,79 | 55,12 | 58,17 | 62,05 | 62,33 | 60,39 | 52,91 | 49,86 | 50,69 | 52,08 | 52,35 |

Source: IO Tables and author's calculations

Complexity tends in fact to grow until 2000, but with a slight decrease between 1977 and 1986, Then it experiences a strong decline between 1999 and 2013, followed by a slight recovery in its value after this year. A possible interpretation for this curious pattern of complexity is that it tends to grow in the first phases of industrialization, but it tends to stabilize, or even decay, in the tertiarization phases.

### *5.2 - C2 - Weight of Outside the Main Diagonal Flows*

The second measure of complexity used in this paper, C2 - Weight of Outside the Main Diagonal Flows, was proposed by Lopes and Escária (2024), based on an innovative and sophisticated measure proposed by Amaral et al (2007), who understand complexity as an interrelation or interdependence between the productive sectors of an economy.

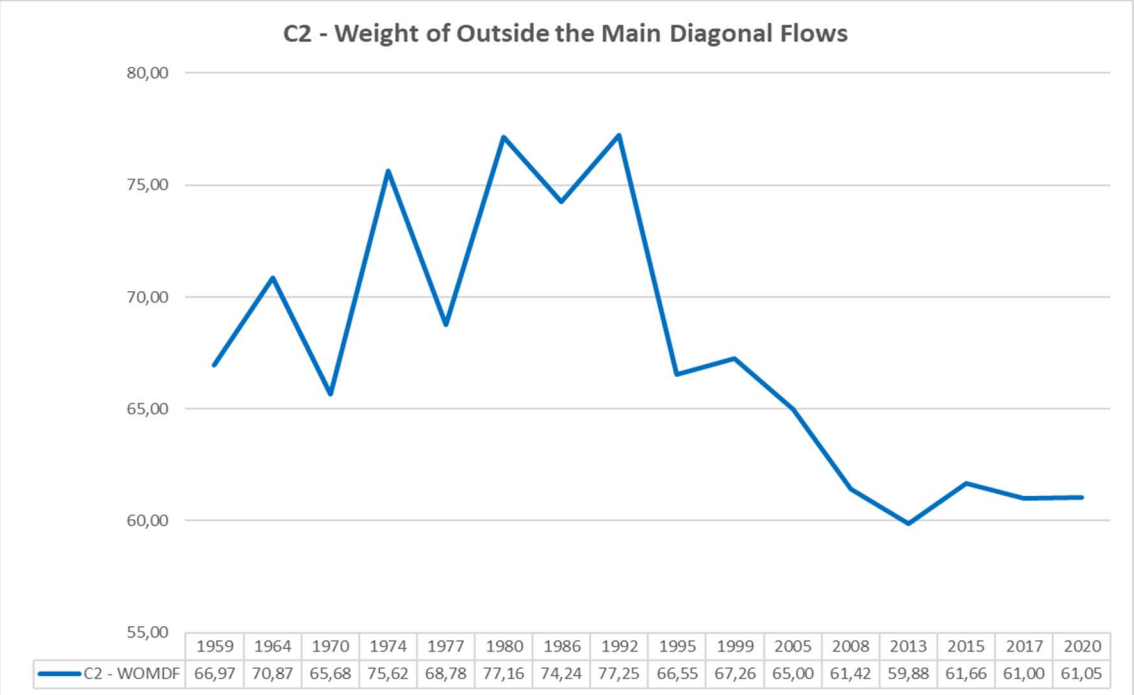
The original measure is very demanding in terms of mathematical calculations and can be substituted with merit by the measure used in this paper, because is much easier to compute and correlates with it satisfactorily.

Formally, this measure is defined as:

$$C2: WOMDF = 100\frac{\sum f_{ij}(com\ i \neq j)}{\sum f_{ij}}$$

and its results are shown in Figure 8.

**Figure 8: C2 – Weight of Outside the Main Diagonal Flows, 1959 - 2020**




| | 1959 | 1964 | 1970 | 1974 | 1977 | 1980 | 1986 | 1992 | 1995 | 1999 | 2005 | 2008 | 2013 | 2015 | 2017 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C2 - WOMDF | 66,97 | 70,87 | 65,68 | 75,62 | 68,78 | 77,16 | 74,24 | 77,25 | 66,55 | 67,26 | 65,00 | 61,42 | 59,88 | 61,66 | 61,00 | 61,05 |

Source: IO Tables and author's calculations

These results appear to confirm the trend already mentioned for indicator C1.2, of increasing complexity in the industrialization period, reversed in the tertiarization phase. But the irregular behaviour of the series, with strange ups and downs until the 1990s deserves some caution and more research in future works.

## 5. Conclusion

This paper studies Portugal's productive structure evolution since the end of 1950s until 2020. The main trends highlighted in the relevant literature were presented. The main value added of this work is to shed more light on these tendencies with an input-output approach, starting with a history of the construction of all input-output tables available in Portugal, followed by a compatibilization and harmonization of these matrices, with a disaggregation level of 19 sectors of activity, for the years: 1959; 1964; 1970; 1974; 1977; 1980; 1982; 1986; 1992; 1995; 2005; 2008; 2013; 2017; 2020.

This rich data set was then used to identify the key industries and to illustrate the big change of the structure of the Portuguese economy during the period covered, with

industrialization during the first part and then strong tertiarization in the nineties and the new millennium and the relative decay of manufacturing traditional industries (textiles, food, wood and cork), predominant until the 1990s.

The economic complexity as inter-relatedness was also measured with two different indicators, the percentage of no-zero (and significant) flows and the strength of inter-sectoral flows (those located out of the main diagonal of the input-output table). The results point to a growing complexity until the mid-1990s, during the phase of manufacturing consolidation. Since then, this trend appears to be reversed, due to the tertiarization of the Portuguese economy.

Finally, it must be recognised that more research effort is needed to better understand the evolution of the productive structure in Portugal, identifying key sectors and quantifying economic complexity with more robust and sophisticated indicators, and taking full benefit of the rich data set of input-output tables constructed for this paper.

## References


Aguiar, A. and M. Martins (2005), A indústria. In P. Lains e A.F. Silva (Eds.), *História Económica de Portugal 1700-2000, Vol. III – Século XX* (2ª ed., pp. 185–226). Imprensa de Ciências Sociais.

Albuquerque, P. C. and J. C. Lopes (2010), Economic impacts of ageing: an inter-industry approach, *International Journal of Social Economics*, 37(12), 970-986.

Amaral, J. F., J. C. Lopes and J. Dias (2007), Complexity as interdependence in input-output systems, *Environment and Planning A,* 39, 1770-82.

Amaral, J.F., J. C. Lopes and J. Dias (2012), "A new kind of production and value-added multiplier for assessing the scale and structure effects of demand shocks in input-output frameworks", *Annals of Regional Science*, 49: 103-115.

Amaral, J.F. and J. C. Lopes (2017), Forecasting Errors by the Troika in the Economic Adjustment Programme for Portugal, *Cambridge Journal of Economics*, 41(1), 1021-1041.

Amaral, J. F. and J. C. Lopes (2018), *Análise Input-Output: Teoria e Aplicações*, Lisboa: Almedina.

Amaral, L. (2022), *Economia Portuguesa: As Últimas Décadas (edição revista),* Fundação Francisco Manuel dos Santos, Lisboa.

Costa, L. F., Lains, P. and Miranda, S. M. (2016). An economic history of Portugal, 1143-2010. Cambridge University Press.

Cruz, L. and E. Barata (2007), Estrutura económica, intensidade energética e emissões de CO2: Uma abordagem Input-Output, ESTUDOS DO GEMF N.º 8, Universidade de Coimbra.

Dias, A. M. (2008), Sistema Integrado de Matrizes Input-Output para Portugal, 2005, DPP Working Paper nº 8/2008, Lisboa.

Domingues, T, J. F. Amaral and J. C. Lopes (2021), Global value chains, value-added generation and structural change in EU core and periphery economies: An Input-Output approach, REM Working Paper 0157-2021, January.

Lopes, J. C. (2012), "High Employment Generating Sectors in Portugal: an Interindustry Approach", *International Journal of Latest Trends in Finance & Economic Sciences*, 2(2): 125-135.

Lopes, J. C., T. Araújo, J. F. Amaral and J. Dias (2011), The economic performance of industries and national industry clusters: a stochastic geometry approach, *Portuguese Journal of Quantitative Methods,* Volume 2 nº 1, 53-65.

Lopes, J. C., J. F. Amaral and J. Dias (2011), "External dependency, value added generation and structural change: an interindustry approach", *Notas Económicas*, 33, 6-19.

Lopes, J. C., J. F. Amaral and J. Dias (2012), Assessing economic complexity as interindustry connectedness in nine OECD countries, *International Review of Applied Economics*, 26(6): 811-827.

Lopes, J. C. and J. F. Amaral (2014), The Euro Area north-south structural economic divide: an input-output perspective, Proceedings of the 21th International Input-Output Conference, Lisbon, 2014.

Lopes, J. C. and J. F. Amaral (2016), "Self-defeating austerity? Assessing the impact of fiscal consolidations on unemployment", *Economic and Labour Relations Review,* 28(1): 77-90.

Lopes, J. C. and V. Escária (2024), Evolution of the productive structure and intersectoral relations in Portugal, 1959/2020, Communication to the XLIII ENCONTRO DA APHES - ISEG, 15 e 16 de novembro de 2024, unpublished.

Lopes, J. S. (1996). *A economia portuguesa desde 1960*. Lisboa: Gradiva.

Mata, M. E. and N. Valério (1994), *História Económica de Portugal: uma perspectiva global*, Lisboa: Editorial Presença.

Moura, F. P. (1969), *Por onde vai a economia portuguesa*? Lisboa: Publicações Dom Quixote.

Martins, N. (2004a), Sistema Integrado de Matrizes de Input-Output para Portugal, 1999, Departamento de Prospectiva e Planeamento, Lisboa, Fevereiro.

Martins, N. (2004b), Sistema Integrado de Matrizes de Input-Output para Portugal de 1995, a preços correntes e a preços de 1999, Departamento de Prospectiva e Planeamento, Lisboa, Julho.

Martins, N. (2004c), Produção de Valor Acrescentado e Competitividade da Economia Portuguesa, no período de 1995 a 1999, Lisboa, DPP.

Martins, N. and V. Dionísio (1987), *Matrizes de input-output segundo o novo sistema de contas nacionais*, Lisboa: Banco de Fomento Nacional.

Miller, R. E. and P. D. Blair (2009), *Input-Output Analysis: Foundations and Extensions*, Second edition. New York: Cambridge University Press (First edition published by Prentice-Hall, 1985).

Peacock, A. T. and D. Dosser (1957), Input-output analysis in an underdeveloped country: a case study, *Review of Economic Studies,* 25: 21-4.

Rua, A. and H. Reis (2006), An input-output analysis: linkages vs leakages, Working Papers w200617, Banco de Portugal, Economics and Research Department.

# Appendix 1:

**List of the 19 Sectors of Activity of the IO Tables System of Martins and Dionísio (1987)**

01 Agriculture, Livestock and Fishing

02 Energy

03 Metallic Minerals and Basic Metallurgy

04 Non-Metallic Mineral Products

05 Chemical Products

06 Metal Products, Machinery and Electrical Equipment

07 Transport Equipment

08 Food, Beverages and Tobacco

09 Textiles, Tanneries and Footwear

10 Pulp and Paper and Graphic Arts

11 Wood, Cork and Furniture

12 Miscellaneous Industries

13 Civil Construction

14 Repair and Trade

15 Hotels, Restaurants and Cafes

16 Transport and Communications

17 Banking and Insurance

18 Marketable Services

19 Non-Marketable Services