Title: An Input-Output Model of Water Consumption: Analysing Intersectoral Water Relationships in Andalusia

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Abstract

This paper presents an input-output model of sectoral water consumption, created by combining the extended Leontief input-output model with the model of energy use developed by Proops. The analysis is applied to Andalusia, a region situated in the South of Spain which is characterized by water shortage. We determine which economic sectors consume the greatest quantities of water, both directly and indirectly, and to what extent this natural resource may become a limiting factor in the growth of certain production sectors. The model allows us to distinguish between direct and indirect consumption, thus offering the possibility of designing an economic and environmental policy oriented towards water saving. Additionally, the model allows simulation of possible changes in water consumption caused by certain environmental measures, as well as their consequences on the regional economy.

1. Introduction

The structural relationships between the sectors of an economy have been studied from different perspectives. However, very little attempt has been made to analyze the interrelation between the production sectors of an economy and the consumption of natural resources. It is important to observe that there exists a close relationship between the production structure and the natural resources which this structure consumes; in spite of this fact, economics has devoted little time and effort to analysing such relationships in depth. This paper addresses some of these issues, focusing on the interrelations between the production structure and the consumption of water.

The objective of this study is twofold. Firstly, we propose a methodology to analyze the structural relationships between a production activity and its physical relationships with the environment; this methodology consists in the development of an input-output model of sectoral water consumption which combines the extended Leontief input-output model with the model Proops (1988) developed for energy use. Secondly, we apply the proposed methodology to the analysis of Andalusia in order to determine which relationships are established between the production structure and the consumption of water resources in the region, as well as the relationships established between the different sectors concerning this resource. In other words, the attempt is to identify which sectors consume the greatest amounts of water, both directly and indirectly, and to analyze to what extent this resource may become a limiting factor in the growth of certain production sectors.

The model will enable us to determine the relationships between sectors and water resources, as well as the corresponding sectoral interrelations. It also allows simulation of the changes that the production structure would undergo if there were variations in water consumption, together with the effects that changes in demand and in sectoral production would have on the water resources of the region.

1.1. Background

Studies which relate the economic system to the natural system and the environment date back to the 60's. The pioneer in analysing this type of relationships is Isard (1968), who proposed a methodology based on input-output tables in which economic and environmental variables are related to each other in order to offer alternatives in economic policy.

Most of the studies that relate environmental and economic factors by means of input-output analysis expand the Leontief model with new rows and/or columns to accommodate new inputs and/or outputs derived from production. The three models of reference are the Daly Table, the Victor Table and the Leontief Table. The Daly Table consists basically of an extended 'industry-by-industry' matrix with several rows and columns which represent the different environmental sectors. The extended Victor Table substitutes the 'industry-by-industry' framework by a 'commodity-by-industry' formulation, thus allowing the matrix not to be square – a necessary requirement in the Daly model. Leontief also expanded his table in 1970, in an attempt to explain that external factors may be incorporated into a conventional input-output model and, additionally, that solutions may be found to problems that arise from the undesired effects on environment of modern technology and uncontrolled economic growth. The extended Leontief table is characterized by representing the generation of pollutants and their elimination by the system itself. The main purpose of this matrix is to reflect the fact that pollutants are part of the production process and, for this reason, they appear in rows. Two years later, Leontief and Ford (1972) analyzed direct and indirect pollution derived from the economic activity by means of the drag coefficients in the conventional model. That same year, Stone (1972), based on the numeric example proposed by Leontief, explicitly introduced the consumer in the model, which permitted him to discuss the consequences of the different methods of eliminating pollution.

Hudson and Jorgeson (1974) proposed a new methodology based on the integration of an econometric model and input-output analysis, in order to assess the impact of economic policy on energy demand and offer. They developed a production model for nine industrial sectors, a demand model and a growth model. This framework was used, first of all, to estimate economic activity and energy utilization for the period 1975-2000, under the assumption that the energy policy remained unchanged. Secondly, the model was used to design a tax policy that encouraged energy saving, thus reducing dependence on imported energy.

In the 80's, Forsund (1985) carried out an analysis focused on atmospheric pollution with an extended input-output model. In 1988, Proops used the extended input-output framework to establish a number of indicators of direct and indirect energy consumption (on which we base our water consumption indicators). Some years later, in 1993, Proops, Faber and Wagenhals carried out a comparative study of Germany and the United Kingdom in which they applied these indicators to atmospheric pollution.

In 1995, Hawdon and Pearson showed how a complex number of interrelationships between energy, environment and economy can be analyzed within the input-output framework, and they applied their model to ten productive sectors in the United Kingdom. Their work also included an extensive account of the literature on the topic.

In Spain, it was Pajuelo (1980) who first constructed an extended input-output model to study atmospheric pollution. An important contribution is that of Alcántara and Roca (1995), who analyzed the elasticity of demand and value added in relation to CO_2. Regarding atmospheric pollution, we must also note the work of Morillas, Melchor and Castro (1996), who carried out a dynamic study on the influence of demand structure on the growth and the environment in Andalusia.

The first environmental input-output tables in Spain were those issued by the Environmental Agency of the *Junta de Andalucía* for the year 1990. These tables included data – expressed in physical units – concerning both the environmental inputs used by the production sectors and the pollutants generated by those sectors. Similar tables were developed in Valencia by Almenar, Bono and García in 1998.

With regard to the study of water using input-output tables, we must point out that this natural resource has received little attention from an economic point of view, and even less within the input-output framework, although the first studies in which water requirements were integrated with economic variables date back to the 50's. However, these models were abandoned due to the difficulties in operating with them and to the methodological problems that arose when these variables had to be introduced into an input-output model.

These difficulties were overcome in the work of Lofting and McGauhey (1968), who considered water requirements as input in a traditional input-output model. The authors also brought up to date the data in a model for California and implemented a program of linear optimization to identify the temporal path of the shadow prices of water in 24 productive sectors. The main objective of this study was to evaluate the water requirements of the Californian production system.

In Spain, Sánchez-Chóliz, Bielsa and Arroyo (1992) were the first researchers who applied the input-output methodology to water. These authors calculated the so-called water values for Aragón; some years later, in 1994, they employed the same methodology to calculate pollution levels for the same area. We must also mention the work of Sáenz de Miera (1998), in which water consumption in Andalusia was analyzed by means of the model of prices and quantities in a conventional input-output framework. Bielsa (1998) also studied water consumption using the input-output model. In his input-output approach to the role of water in the production network, he considered water values and pollution values to be an extension of the work value or, more specifically, *k-values*. Finally, the work of Duarte (1999) analyzes the relationship between water pollution and the production structure in the Ebro Valley.

1.2. Organization of the study

This paper is organized in four sections. After this first introductory section, an input-output model of sectoral water consumption will be presented. Besides the model itself, a number of indicators of sectoral water consumption in Andalusia will be developed in order to analyze consumption, both direct and indirect, of this resource by different sectors. The model will enable us to create a matrix of intersectoral water relationships; this matrix, together with the above-mentioned indicators, will allow us to define the matrices of technical coefficients and distribution coefficients, expressed in terms of water.

In the third section, we will present the results we have obtained, as well as their subsequent analysis. Finally, the main conclusions drawn from the study will be outlined in the last section of the paper.

2. The input-output model of sectoral water consumption and the matrix of intersectoral water relationships

In this section, an input-output model of sectoral water consumption is constructed. For this purpose, the major equations which define the *input-output model of production* are used as the basis for developing an *input-output model of water consumption*.

2.1. A first approach: The input-output model of production

The basic equation in the Leontief model determines that the production of an economy depends on intersectoral relations and final demand. For a sector i, the set of equations which expresses these relations can be summarized as follows:

$$x_i = \sum_{j=1}^{j=n} x_{ij} + y_i \quad (1)$$

This equation can be rewritten so as to include the technical coefficients of production (a_{ij}), which are defined as the purchases that sector j makes from sector i per total effective production unit of sector j, and which represent the direct input required by that sector j:

$$x_i = \sum_{j=1}^{j=n} a_{ij} x_j + y_i \quad (2)$$

In matrix notation and for the economy as a whole, this becomes:

$$x = Ax + y \quad (3)$$

Solving for x, we obtain total production delivered to final demand:

$$x = (I - A)^{-1} y \quad (4)$$

where $(I - A)^{-1}$ is known as the Leontief inverse matrix representing the *total* production every sector must generate to satisfy the final demand of the economy. It is important to clarify this expression and its meaning because it is the basis of the model of water consumption which we will develop later. The production of sector i may be formulated as follows:

$$x_i = \alpha_{i1} y_1 + \alpha_{i2} y_2 + ... + \alpha_{in} y_n = \sum_{j=1}^{j=n} \alpha_{ij} y_j \quad (5)$$

where α_{ij}, the generic element in the matrix $(I - A)^{-1}$, is the increase in production generated by sector i if the demand of sector j increases in one unit. In other words, the α_{ij} coefficients are the amount by which sector i must change its production level to satisfy an increase of one unit in the final demand from sector j. Thus the column sums of the Leontief inverse matrix express the direct and indirect requirements of a sector to meet its final demand. Manresa, Sancho and Vergara (1998) clearly sum up the importance of this fact: if the production vector x is substituted by its expression in the Leontief model, then the matrix A describing just the specific *direct* requirements of producing sectors is substituted by the matrix $(I - A)^{-1}$, which expresses the *total* requirements of the sectors, in terms of both direct and indirect inputs.

2.2. The input-output model of water consumption

So far, we have summarized the Leontief input-output model; next, we will develop a model in terms of water consumption[1] and demand. We will begin by defining the variables in the model:

w_d : (nx1) vector of direct water consumption.

w_{di} : water consumed directly by sector i, expressed in cubic meters.

w_t : (nx1) vector of total water consumption.

w_{ti} : total consumption of water by sector i, expressed in cubic meters.

W : n matrix of intersectoral water relationships.

w_{ij} : element in W which determines the water consumed directly by sector i in providing inputs to sector j.

Q : n matrix of technical coefficients of water.

q_{ij} : element in Q defined as a technical coefficient of water consumption, which expresses the 'purchases' sector j makes from sector i, in relation to the total purchases of sector j, in terms of water.

$(I - Q)^{-1}$: Leontief inverse n matrix in terms of water.

[1] Water *consumption* here means the water used by each sector minus returns.

β_{ij} : element in $(I-Q)^{-1}$ defined as the additional quantity of water that sector i will consume if the demand for water of sector j increases in one unit.

L : n matrix of water distribution coefficients.

l_{ij} : element in L defined as the distribution coefficient of water consumption, which expresses the 'sales' sector i makes to sector j, in relation to the total sales of sector i, in terms of water.

W_d^y : (nx6) matrix of direct water consumption according to destinations.

w_{di}^y : element in W_d^y which expresses the water consumed directly by sector i to meet its own demand (y_i).

w_d^* : (nx1) indicator of direct water consumption per unit produced, defined as direct consumption per production unit.

w_{di}^***:** indicator of direct water consumption per unit produced by sector i, expressed in cubic meters per Spanish peseta.

w^* : (nx1) indicator of total water consumption, defined as the change in the total amount of water consumed by the economy if the demand of any given sector changes in one unit.

w_i^* : indicator of the total amount of water consumed by sector i, expressed in cubic meters.

wcm : (nx1) vector of water consumption multipliers.

iwc : (nx1) vector of indirect water consumption.

Equation 1, which is defined in terms of production in the Leontief model, can be expressed in terms of the variables of water consumption listed above, in such a way that the amount of water directly consumed by sector i depends on the intersectoral relationships established between that sector and the remaining sectors of the economy and on the quantity of water consumed by sector i to meet its own demand:

$$w_{di} = \sum_{j=1}^{j=n} w_{ij} + w_{di}^y \qquad (6)$$

In accordance with the Leontief production model, we can formulate a number of technical coefficients of water consumption (q_{ij})[2], defined as the quantity of water consumed by sector j in providing inputs to sector i, with relation to the total amount of water directly consumed by sector j:

$$q_{ij} = \frac{w_{ij}}{w_{dj}} \quad (7)$$

If these coefficients are taken into account, equation (6) becomes:

$$w_{di} = \sum_{j=1}^{j=n} q_{ij} w_{dj} + w_{di}^{y} \quad (8)$$

or in matrix notation:

$$w_d = Q w_d + w_d^{y} \quad (9)$$

where Q, by analogy with the standard Leontief model, is a square n matrix of technical coefficients of water consumption with elements q_{ij}. By solving this equation, we obtain the expression which defines the model of water consumption:

$$w_t' = u'(I - Q)^{-1} \hat{w}_d^{y} \quad (10)$$

where $(I - Q)^{-1}$ is the Leontief inverse matrix in terms of water, u is a unit column vector, **(^)** places the vector on the diagonal of the matrix, and **(')** indicates transposition of the vector. By analogy with the inverse matrix in the production model, the matrix $(I - Q)^{-1}$ determines the change in water consumption if the demand for water changes in one unit, and its elements – which we call β_{ij} [3] – indicate the additional quantity of water sector i will consume if the demand for water of sector j increases in one unit. As we noted with regard to the model of production, when the Leontief inverse matrix is rewritten in terms of water, $(I - Q)^{-1}$, the model can account for the direct and indirect requirements of water, that is, the total amount of water any given sector consumes in order to satisfy an increase in demand, as opposed to the matrix Q which only reflects the direct requirements of water. This is the reason why the vector of direct

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[2] The q_{ij} coefficients are equivalent to the technical coefficients in the Leontief model (a_{ij}).

[3] Notice that these coefficients are analogous to those in the Leontief inverse matrix (α_{ij}).

water consumption (w_d) in equation (9) is substituted by a vector of total water consumption (w_t) in (10).

2.3. Indicators of water consumption

In this section, we will take a step further beyond the input-output model of sectoral water consumption. As we have just mentioned, this model has been defined for *total* water consumption. However, it is interesting to distinguish between *direct* and *indirect* consumption, so that these concepts can be introduced in the model, thus enabling us to formulate a matrix of intersectoral water relationships and to analyze consumption according to this distinction. Total water consumption (which has been dealt with so far) is obviously the sum of direct plus indirect consumption. On the one hand, direct consumption is the quantity of water consumed by sector i to satisfy its own demand; on the other hand, indirect consumption of sector i is the amount of water consumed by sector j to generate the inputs required by i to satisfy its own demand. In other words, indirect consumption represents the inputs produced by sector j which sector i uses to meet its demand.

In order to distinguish between direct and indirect consumption, we will begin by defining three indicators: one of direct water consumption per unit produced, one of total water consumption, and a third one of indirect water consumption per unit produced. Once these indicators are defined, we will introduce them in the matrix of water.

We will take as the starting point the data regarding sectoral water consumption provided by the Andalusian Environmental Input-Output Tables (*Tablas input-output medioambientales de Andalucía*, TIOMA), issued by the Andalusian Environmental Agency (1996). These tables list the quantity of water consumed directly by each sector, in cubic meters. Hence we obtain a column vector of direct water consumption (w_d). We have also taken into consideration the data regarding the effective production generated by each sector as shown in the Andalusian Input-Output Tables (*Tablas input-output de Andalucía*, TIOAN), issued by the Andalusian Institute of Statistics (1995). Hence we obtain a column vector (x), expressed in currency units. These data allow us to calculate an indicator of total direct consumption per unit produced (w_d^*), which is defined as the amount of water consumed directly by each sector per currency unit produced, and which is expressed as a column vector where each element is defined as follows:

$$w_{di}^* = \frac{w_{di}}{x_i} \qquad (11)$$

In matrix notation, this becomes:

$$w_d^{*\prime} = w_d' \hat{x}^{-1} \tag{12}$$

Once we have obtained the indicator of direct water consumption per unit produced for each sector (w_d^*), matrix (12) can be rewritten so as to express the *total* water consumption of the economy[4] (w) as an indicator of the water consumed directly multiplied by the quantity generated by each sector. In matrix notation, this is:

$$w_d^{*\prime} x = w \tag{13}$$

We may also express the production vector (*x*) according to the open Leontief model. Thus (13) can be rewritten as:

$$w = w_d^{*\prime} (I - A)^{-1} y \tag{14}$$

which reflects the total water consumption (w) of the economy according to its own demand. The expression $w_d^{*\prime} (I - A)^{-1}$ is a row vector in which each element determines the *total* amount of water that the economy as a whole will consume both directly and indirectly if the demand of any given sector changes in one unit. We call this vector *indicator of total water consumption* (w^*):

$$w^{*\prime} = w_d^{*\prime} (I - A)^{-1} \tag{15}$$

We consider this expression to be a means of measuring total water consumption, also known as the *water content* (*k-content*), according to Manresa, Sancho and Vergara (1998).

Our results can be proved by adapting to water consumption the model of energy use developed by Proops (1988, 203-206)[5].

$$w = w_d^{*\prime} (I - A)^{-1} y \tag{16}$$

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[4] *Total* consumption expressed <u>for each sector</u> (w_t) must not be confused with *total* consumption of <u>the economy as a whole</u> (w). The former is a column vector where each element represents the total quantity of water consumed by each producing sector, whereas the latter is a scalar vector defined as the row sum of the column vector. Thus $w = \sum_{i=1}^{i=n} w_{ti}$

[5] Indeed, the total water consumption of an economy (w) can be attributed to either total production (x) or to final demand (y). Therefore, we have two equations: (A) $w = w_d^{*\prime} x$; and (B) $w = w^{*\prime} y$. By substituting equation (4) in (A) we can prove that the expression previously defined as *indicator of total water consumption* is actually identical with the total consumption of this natural resource.

After the indicators of direct consumption and total consumption have been defined, it is of interest to define an indicator of indirect consumption per unit produced. In order to do so, let us go back to the input-output model of water. Equation (10) served as the basis to define the elements β_{ij} of the Leontief inverse matrix in terms of water. Recall that these elements indicated the additional quantity of water sector i will consume if the demand for water of sector j increases in one unit. Hence, by analogy with the conventional Leontief model, the row sum in that matrix expresses the additional amount of water consumed by the economy as a whole when sector j increases its demand for water in one unit.

The Leontief model also takes into account the drag effect, thus called because it indicates how the evolution of a given sector can 'drag' the total economic production; in fact, the Leontief formulation pays particular attention to those sectors with a greater 'drag' effect. Now we could call that effect *water consumption multiplier* (wcm), with a negative value the larger it gets, since it shows how the total water consumption is multiplied when there are increases in the demand of a given sector.

Proops shows that (wcm) can be obtained as the quotient between the two consumption indicators defined earlier – the indicator of total consumption (w^*) and the indicator of direct consumption per unit produced (w_d^*) – in such a way that this multiplier gives an idea of the total quantity of water consumed by sector i for each 1 cubic meter consumed directly[6].

$$wcm_i = \frac{w_i^*}{w_{di}^*} \tag{17}$$

Therefore, the water consumption multiplier can be interpreted in the same way as the column sum of the coefficients of the Leontief inverse matrix in terms of water.

If (wcm) gives a measurement of the total amount of water consumed per each unit produced in relation to the amount of water consumed directly per unit produced, then we can obtain an indicator of indirect water consumption (iwc) per currency unit produced, simply by subtracting the unit from that multiplier:

$$iwc_i = wcm_i - 1 = \frac{w_i^*}{w_{di}^*} - 1 \tag{18}$$

This new indicator expresses the quantity of water used indirectly by a given sector, per each unit of water used directly, to satisfy the demand of that sector.

[6] The analytic proof that (wcm) can be defined as the quotient of the two indicators of water and that it is identical with the column sum of the coefficients in the Leontief inverse matrix in terms of water can be found in Proops (1988), Appendix 1, p. 213.

2.4. The Matrix of Intersectoral Water Relationships and associated matrices

Once the input-output model for water and the consumption indicators have been defined, we can proceed to formulate a Matrix of Intersectoral Water Relationships in accordance with those indicators. We have defined (w_{di}^{y}) as the water directly consumed by sector i to satisfy its own demand. Thus by definition, (w_{d}^{y}) can be obtained as:

$$w_d^y = \hat{w}_d^* y \tag{19}$$

Substituting this expression in equation (10) and placing the vector (y) on the diagonal gives:

$$W = (I - Q)^{-1} \hat{w}_d^* \hat{y} \tag{20}$$

where W , defined above as the vector of the total amount of water consumed by the economy (w_t), now becomes the (nxn) Matrix of Intersectoral Water Relationships (Table 3), which lists all transactions of water between the productive sectors, expressed in cubic meters.

After this matrix has been obtained, we shall carry out an in-depth input-output analysis of intersectoral water relationships, since this is one of the most interesting possibilities of the model. We will analyze in detail the matrix of technical coefficients and the matrix of distribution coefficients in order to determine *direct* intersectoral relations. Although we believe this may be a valuable contribution, the analysis is nonetheless limited by the fact that it only takes into consideration the direct relationships, being incapable of accounting for indirect relations. In this section, we will use the indicator of indirect consumption obtained earlier to study this type of relationships, though we are aware of the fact that there are other suitable tools which can be used to achieve the same purposes[7].

From the matrix of intersectoral relationships, two more matrices can be obtained: a matrix of water coefficients (Table 4) and a matrix of water distribution coefficients (Table 5). The technical coefficients of water consumption (q_{ij}) were defined in equation (7) as the quantity of water consumed directly by sector j in generating products for sector i, with relation to the total amount of water consumed directly by j. Hence the columns in the matrix of technical coefficients indicate the quantity of water each sector buys from sector j. These coefficients can be also expressed according to the indicator of direct consumption which was defined above:

$$q_{ij} = \frac{w_{ij}}{w_{dj}} = \frac{w_{di}^*}{w_{dj}^*} a_{ij} \tag{21}$$

[7] The Graphs Theory allows a deep study of both direct and indirect consumption relationships (see Velázquez Alonso, 2001).

Substituting in (21) above equation (11) and the expression that defines the technical coefficients of production as the quotient between the relationships of sectors i and j, in relation to the production of j:

$$q_{ij} = \frac{w_{di}/x_i}{w_{dj}/x_j}\frac{x_{ij}}{x_j} \tag{22}$$

by definition of w_{ij} *y* w_{dj}:

$$q_{ij} = \frac{w_{di}x_{ij}}{w_{dj}x_i} = \frac{w_{ij}}{w_{dj}} \tag{23}$$

On the other hand, the coefficients of water distribution (l_{ij}) reflect the amount of water directly consumed by sector j in generating products for sector i, in relation to the total quantity of water consumed by i:

$$l_{ij} = \frac{w_{ij}}{w_{di}} \tag{24}$$

Hence the rows in the matrix of distribution coefficients express the amount of water sold by sector i to the rest of sectors. With an analytical development analogous to the former, we can obtain the matrix of distribution coefficients, L, with elements l_{ij} defined in terms of the aforementioned indicators:

$$l_{ij} = \frac{w_{di}^{*}}{w_{dj}^{*}} d_{ij} \tag{25}$$

where d_{ij} are the distribution coefficients in the matrix of distribution coefficients of the Leontief model in terms of production.

3. Results derived from the model

In the previous section, we have developed an input-output model of water consumption, and we have formulated the indicators derived from the model, as well as the Matrix of Intersectoral Water Relationships and associated matrices. Next, we will summarize the results obtained and their analysis.

Table 1 lists direct water consumption (w_d), the indicator of direct water consumption per unit produced (w_d^*), and the indicator of total water consumption (w^*). The data show that the amount of water consumed directly by the agricultural sectors is much greater than that consumed by the industrial and services sectors, since the consumption of the former is above 100 millions of m^3, whereas the consumption of the latter sectors is far below this figure. These data confirm the well-known fact that agriculture is the main consumer of water resources in Andalusia, with figures that amount to 80% of the total resources consumed in the region.

However, we must also notice three important facts regarding the comparison of direct consumption to the indicator of direct consumption per unit produced. Firstly, there is a change in the situation of the agricultural sectors, because certain sectors – such as 'Vegetables and Fruits' (2) – consume great quantities of water according to the figures of direct consumption, but if this consumption is related to the quantity of goods produced by any of these sectors, we can observe that the consumption per unit is not as high as it would appear at first. In fact, 'Vegetables and Fruits' (2) consumes 26% of the total water resources but its consumption per unit produced does not reach 10%, due to its high production. The opposite phenomenon is represented by those sectors whose direct consumption is lower, but whose production level is also lower, so the consumption per unit is higher. This is the case of, for example, the citrus fruits sector.

Secondly, the relationships of the industrial and services sectors, whose consumption per unit produced is lower, do not exhibit the kind of variation discussed above. This means that 'Chemical and plastics industry' (11), 'Paper Industry' (18) and 'Hotel and Catering Trade' (22) are sectors with a high direct consumption and a correspondingly high consumption per unit produced. In other words, the data show that their consumption of water is high as compared to their respective productions.

Thirdly, we must also point out that the data for the sectors 'Food and Agriculture' (14) and 'Textiles and Apparel' (15) evidence a low *direct* consumption per unit produced. If this indicator were solely considered, those would be the sectors that would probably go unnoticed by water policy planners; however, these sectors consume great amounts of this resource, as we shall see below.

We may also compare the indicator of direct consumption per unit produced with the indicator of total consumption. The agricultural sectors are those which consume the greatest amounts of water as shown by both indicators, but their consumption is almost exclusively direct. On the other hand, sectors such as 'Food and Agriculture Industry' (14), 'Hotel and Catering Trade' (22), 'Paper, Printing, and Publishing' (18) and 'Textiles and Apparel' (15), among others, consume a small quantity of water directly, but their indicator of total consumption is rather high.

Thus it can be assumed that these sectors consume a great amount of water indirectly, as we will show below. This means that they use directly a small amount of water in production but, in order to produce the inputs (generated by other sectors) that they incorporate into their productive processes, a high consumption of water has indeed been necessary.

The above assumption can be confirmed by analysing the water consumption multiplier and the indicator of indirect consumption (Table 2). If only direct water consumption were taken into account, sectors such as 'Food and Agriculture Industry' (14) and 'Textiles and Apparel' (15) would be disregarded, due to the fact that their direct consumption is insignificant. However, these sectors' indirect consumption is particularly high, a fact that could pass unnoticed due to the high figures of direct consumption for other sectors. It is noticeable how 'Food and Agriculture Industry' (14), for each 1 m^3 of water consumed directly, consumes indirectly 36.19 m^3; similarly, 'Textiles and Apparel' (15), for each 1 m^3 consumed directly, consumes indirectly 11.98 m^3. Water consumption by 'Hotel and Catering Trade' (22) is also significant; in spite of the fact that this sector's indirect consumption is lower than that of the above-mentioned sectors, it approaches 4 m^3 for each 1 m^3 consumed directly.

The results obtained reveal certain important facts. The sectors which exhibit the highest figures of indirect consumption are those normally known as the 'driving forces' of the Andalusian economy due to the strong influence that their respective demands exert on the production of the rest of sectors. In other words, the demand of these leading sectors conditions the outputs other sectors must generate to satisfy that demand. This explains why the Andalusian economic policy has traditionally supported these sectors. However, a broader economic policy that took into account not only productive criteria but also environmental factors would adopt a more cautious attitude towards the sectors, since supporting them could endanger the water resources of the region and could even strangle the Andalusian productive activity.

The matrix of intersectoral water relationships (Table 3) can be read either by rows or by columns. Column j lists the 'purchases'[8] that sector j makes from the rest of sectors i, so the row sums of this matrix give us an idea of the total water requirements of sector j. On the other hand, the rows of the matrix must be interpreted as the 'sales'[9] of water that sector i makes to the rest of sectors j, being the column sums the total amount of water sold by sector i.

Two other matrices are derived from the matrix of intersectoral water relationships: the matrix of technical coefficients of production (Table 4) and the matrix of distribution coefficients (Table 5). If these two new matrices are analyzed, the first outstanding fact is that most coefficients – both

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[8] By 'purchases' of water from sector j to sector i we understand the quantity of water incorporated by the products sector j buys from sector i, products that are used by sector j as inputs in its production process.

[9] By 'sales' of water from sector i to sector j we understand the amount of water used by sector i in producing goods and services which it sells to sector j and which sector j uses in its production.

technical and distribution coefficients – are rather low[10], which shows that most transactions of water between sectors can be disregarded, since these transactions are limited to a few sectors.

It is noticeable that the sectors which stand out because of their purchases are ‘Food and Agriculture Industry’ (14), whose demand is satisfied with products generated by agriculture (1, 2, 3, 4, 5, 6) with a high water content; ‘Textiles and Apparel’ (15), supplied mainly by ‘Industrial Plants’ (4); and ‘Hotel and Catering Trade’ (22), which is also supplied with agricultural goods. Sectors 14, 15, and 22 sell to few sectors and, in any case, the quantity of goods they do sell are insignificant. Apart from these three sectors, other significant sales are those made by ‘Metallurgy’ (9) and ‘Construction Materials’ (10) to ‘Construction’ (20). Finally, we must also point out that the highest percentages of sales in all sectors are transactions *within* the sectors, which reveals a high rate of self-consumption with regard to water.

4. Conclusions

In this section, we will summarize the main ideas and results derived from our study. We believe that one of the most relevant contributions of this paper is the development of a model that allows us to analyze both the production potential of an economy and the consumption of water resources, thanks to the introduction of water consumption in a production model. The model provides us with indicators and matrices which can be used as tools for economic planning, and which take into account not only productive variables but also environmental factors.

One of the first conclusions that can be drawn from the analysis of these indicators is that it is necessary to make a clear distinction between direct and indirect consumption. We think this distinction is important because each production sector exhibits different values depending on the type of indicator under consideration. These differences are shown, for example, by the agricultural sectors, which present in general a high rate of direct consumption and low rates of indirect consumption. On the other hand, industrial and services sectors show low indicators of direct consumption and high indicators of indirect consumption. Paradigmatic examples of these sectors are ‘Food and Agriculture Industry’ and ‘Hotel and Catering Trade’, with high rates of indirect water consumption. For this reason, total water consumption – that is, indirect consumption together with direct consumption – must be taken into consideration in planning the productive economy of a region or country.

The combination of previously known aspects of Andalusian economy with the data regarding total water consumption obtained from this research leads us to the conclusion that Andalusia is a region which, despite its water shortage, possesses an economic structure that is based on sectors which are great water consumers, and that is centred mainly on the agricultural sectors,

[10] ‘Low’ means below 10%.

the food and agriculture sector and tourism. To this we must add the well-known fact that the highest demand for water of these sectors takes place precisely in the summer months, when this natural resource is most scarce. Therefore, it is surprising that Andalusia is specialized in such water-consuming sectors whose demands overlap during the periods of greatest shortage. This reality might result in the strangulation of the production activity of one of these major sectors due to the lack of one of the main inputs required by the sector, with obvious negative consequences for the economy as a whole.

Once we have reached this conclusion, we think it is necessary to introduce a change in the productive specialization of the region, based on exhaustive studies which take into account economic, social and environmental factors. We are aware that this paper is merely a first and incomplete approach to the issue; however, it could serve as a framework for the analysis of the problems which may arise if all the variables mentioned above are not included in economic studies. With this aim in mind, we have attempted to contribute to the beginning of change.

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Table 1. Direct water consumption (w_d) (thousands of m^3), Indicator of direct water consumption per currency unit produced (w_d^*) and Indicator of total consumption (w^*) (m^3/million of Spanish pesetas).

	SECTORS	w_d	w_d^*	w^*
1	Cereals and leguminous plants	882,700	11,017	11,526
2	Vegetables and fruits	905,700	4,107	4,166
3	Citrus fruits	321,000	18,807	18,849
4	Industrial plants	183,000	1,549	1,671
5	Olive groves	464,800	5,487	5,520
6	Other agricultural productions (*)	278,839	879	1,548
7	Extractive industry	16,415	21	37
8	Water	0	0	24
9	Metallurgy	25,277	90	111
10	Construction materials	5,708	27	55
11	Chemicals and plastics	41,398	144	189
12	Machinery	733	4	23
13	Transportation material	2,532	10	30
14	Food and agriculture industry	30,097	30	1,124
15	Textiles and apparel	4,598	25	318
16	Footwear and Leather products	266	16	41
17	Lumbre industry	2,932	21	54
18	Paper, printing and publishing	23,800	230	347
19	Miscellaneous manufacturing	1,133	14	32
20	Construction	17,392	14	44
21	Trade	17,103	17	33
22	Hotel and catering trade	71,145	105	479
23	Transportation and comunications	11,595	19	35
24	Sales related services	33,150	22	40
25	Non-sales related services	23,348	24	45

Source: Created by the author with data extracted from TIOMA and TIO
(*) In ‘Other Agricultural Productions’, cattle raising is included.

Table 2. Water consumption multiplier (wcm) and Indicator of indirect water consumption (iwc).

	SECTORS	wcm	iwc
1	Cereals and leguminous plants	1.05	0.05
2	Vegetables and fruits	1.01	0.01
3	Citrus fruits	1.00	0.00
4	Industrial plants	1.08	0.08
5	Olive groves	1.01	0.01
6	Other agricultural productions (*)	1.76	0.76
7	Extractive industry	1.75	0.75
8	Water	0.00	0.00
9	Metallurgy	1.23	0.23
10	Construction materials	1.97	0.97
11	Chemicals and plastics	1.31	0.31
12	Machinery	5.63	4.63
13	Transportation material	3.09	2.09
14	Food and agriculture industry	37.19	36.19
15	Textiles and apparel	12.98	11.98
16	Footwear and Leather products	2.54	1.54
17	Lumbre industry	2.51	1.51
18	Paper, printing and publishing	1.50	0.50
19	Miscellaneous manufacturing	2.36	1.36
20	Construction	3.05	2.05
21	Trade	1.98	0.98
22	Hotel and catering trade	4.55	3.55
23	Transportation and comunications	1.88	0.88
24	Sales related services	1.80	0.80
25	Non-sales related services	1.86	0.86

Source: Created by the author with Data extracted from TIOMA and TIO.

Table 3. Matrix of Intersectoral Water Relationships (W) (in thousands of cubic meters).

	SECTORS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Sum
1	Cereals and leguminous plants	291,287	2,297	150	289	180	72,166	1,006	0	359	246	723	504	703	450,624	918	44	759	1,860	201	5,683	2,457	71,142	692	3,355	4,259	911,900
2	Vegetables and fruits	64	834,403	39	36	50	3,701	545	0	186	116	322	269	375	16,453	311	21	199	192	79	2,164	1,298	40,069	364	1,361	3,537	906,155
3	Citrus fruits	25	190	294,140	15	24	682	205	0	74	42	1,106	95	136	6,400	114	8	72	63	29	811	453	13,502	134	552	2,288	321,162
4	Industrial plants	22	112	9	15,562	12	1,829	94	0	41	28	161	49	81	58,062	17,935	49	72	330	100	437	271	6,508	91	273	459	102,589
5	Olive groves	170	860	70	89	170,502	15,669	807	0	280	198	558	400	557	537,551	535	33	356	677	128	3,511	1,928	58,962	542	2,051	3,415	799,845
6	Other agricultural productions (*)	1,102	3,685	202	519	231	147,956	404	0	167	116	253	214	302	86,913	954	24	1,018	3,183	175	5,262	1,113	23,179	314	3,176	1,768	282,231
7	Extractive industry	31	120	14	16	35	116	10,288	0	178	255	749	42	103	759	107	4	69	65	19	1,121	585	407	557	262	388	16,289
8	Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Metallurgy	61	123	11	23	47	98	63	0	19,491	43	60	240	793	848	106	8	80	6	94	2,740	38	131	34	59	91	25,289
10	Construction materials	1	5	0	0	1	10	24	0	29	1,877	9	21	12	231	4	0	9	8	2	3,278	28	85	9	31	36	5,713
11	Chemicals and plastics	214	1,754	86	133	212	465	539	0	293	88	27,806	128	233	3,147	337	20	219	275	80	2,587	251	998	287	613	333	41,100
12	Machinery	1	2	1	0	1	2	1	0	7	2	2	613	10	17	3	0	1	1	0	32	7	3	2	4	20	733
13	Transportation material	0	0	0	0	0	3	1	0	1	0	1	1	2,436	5	1	0	0	0	0	5	5	3	8	36	4	2,512
14	Food and agriculture industry	9	44	4	4	4	795	41	0	14	10	28	20	28	27,283	27	2	18	34	7	178	98	2,993	28	104	173	31,947
15	Textiles and apparel	1	3	0	0	0	34	1	0	2	1	3	1	5	44	4,416	8	3	2	1	9	14	38	7	9	18	4,621
16	Footwear and Leather products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	255	0	0	0	0	6	0	0	1	1	266
17	Lumbre industry	1	8	1	1	1	17	6	0	3	4	5	5	29	67	2	0	2,456	4	2	212	20	13	5	40	12	2,913
18	Paper, printing and publishing	7	37	3	3	5	185	60	0	158	163	102	134	97	1,801	125	43	44	16,614	250	802	492	383	213	800	1,186	23,708
19	Miscellaneous manufacturing	0	0	0	0	0	4	1	0	0	1	0	0	5	9	3	0	1	0	1,088	4	2	2	1	2	9	1,133
20	Construction	3	21	2	1	3	17	63	0	15	10	20	52	21	86	16	1	10	4	3	16,461	126	105	39	135	138	17,353
21	Trade	11	58	5	5	11	145	130	0	112	36	39	48	107	606	67	4	79	34	11	684	14,270	339	46	133	94	17,073
22	Hotel and catering trade	55	467	48	34	62	458	746	0	254	157	440	369	512	2,494	404	29	245	161	105	2,857	1,761	55,794	495	1,499	1,181	70,626
23	Transportation and comunications	24	93	10	10	23	214	254	0	136	117	174	103	160	1,070	158	10	86	80	36	1,298	982	415	5,199	481	438	11,571
24	Sales related services	25	150	13	11	26	215	612	0	252	121	239	209	505	1,333	232	16	208	124	50	1,778	2,298	1,237	518	20,926	1,639	32,739
25	Non-sales related services	1	4	0	0	1	3	6	0	0	0	0	0	0	6	0	0	0	0	0	1	1	1	0	0	23,323	23,349
	Sum	293,044	844,090	294,780	16,754	171,430	244,786	15897	0	22052	3,630	32,804	3,515	7,212	1,195,809	26,774	580	6,003	23,717	2,463	51,915	28,506	276,309	9,585	35,901	44,809	3,652,816

Source: Created by the author

Table 4. Matrix of technical coefficients (Q).

	SECTORS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	Cereals and leguminous plants	0.04	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.02
2	Vegetables and fruits	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.01	0.11
3	Citrus fruits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.01	0.08
4	Industrial plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	2.12	4.04	0.05	0.01	0.01	0.07	0.00	0.00	0.00	0.00	0.00	0.00
5	Olive groves	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Other agricultural productions (*)	0.00	0.00	0.00	0.01	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.79	0.03	0.00	0.33	0.17	0.06	0.20	0.00	0.22	0.00	0.10	0.02
7	Extractive industry	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.01	0.11	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.03	0.00	0.09	0.01	0.01
8	Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Metallurgy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.00	0.34	0.29	0.02	0.02	0.03	0.03	0.00	0.08	0.15	0.00	0.00	0.00	0.00	0.00
10	Construction materials	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00
11	Chemicals and plastics	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.01	0.03	0.10	0.14	0.07	0.04	0.03	0.06	0.07	0.01	0.06	0.12	0.00	0.01	0.04	0.02	0.01
12	Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Transportation material	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Food and agriculture industry	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
15	Textiles and apparel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	Footwear and Leather products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	Lumbre industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
18	Paper, printing and publishing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.18	0.02	0.05	0.02	0.15	0.01	0.05	0.21	0.02	0.02	0.00	0.03	0.03	0.04
19	Miscellaneous manufacturing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
21	Trade	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.00	0.06	0.04	0.02	0.01	0.01	0.03	0.00	0.01	0.03	0.01	0.00	0.01	0.00	0.00
22	Hotel and catering trade	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.01	0.06	0.01	0.53	0.17	0.06	0.07	0.10	0.08	0.01	0.08	0.13	0.10	0.00	0.08	0.07	0.04
23	Transportation and comunications	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.05	0.01	0.14	0.05	0.03	0.03	0.03	0.03	0.00	0.03	0.06	0.06	0.00	0.03	0.02	0.01
24	Sales related services	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.01	0.04	0.01	0.27	0.17	0.03	0.04	0.05	0.07	0.01	0.03	0.07	0.14	0.02	0.08	0.06	0.06
25	Non-sales related services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Created by the author

Table 5. Matrix of distribution coefficients (L).

	SECTORS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	Cereals and leguminous plants	0.32	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.08	0.00	0.00	0.00
2	Vegetables and fruits	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
3	Citrus fruits	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.01
4	Industrial plants	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
5	Olive groves	0.00	0.00	0.00	0.00	0.19	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
6	Other agricultural productions (*)	0.00	0.01	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.08	0.00	0.01	0.01
7	Extractive industry	0.00	0.01	0.00	0.00	0.00	0.01	0.63	0.00	0.01	0.02	0.05	0.00	0.01	0.05	0.01	0.00	0.00	0.00	0.00	0.07	0.04	0.02	0.03	0.02	0.02
8	Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Metallurgy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.01	0.00	0.00	0.00
10	Construction materials	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.33	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.01	0.00	0.01	0.01
11	Chemicals and plastics	0.01	0.04	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.68	0.00	0.01	0.08	0.01	0.00	0.01	0.01	0.00	0.06	0.01	0.02	0.01	0.01	0.01
12	Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.84	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.00	0.01	0.03
13	Transportation material	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
14	Food and agriculture industry	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.09	0.00	0.00	0.01
15	Textiles and apparel	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
16	Footwear and Leather products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
17	Lumbre industry	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.84	0.00	0.00	0.07	0.01	0.00	0.00	0.01	0.00
18	Paper, printing and publishing	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.08	0.01	0.00	0.00	0.70	0.01	0.03	0.02	0.02	0.01	0.03	0.05
19	Miscellaneous manufacturing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.01
20	Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.01	0.01	0.00	0.01	0.01
21	Trade	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.84	0.02	0.00	0.01	0.01
22	Hotel and catering trade	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.04	0.02	0.79	0.01	0.02	0.02
23	Transportation and comunications	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.01	0.01	0.02	0.01	0.01	0.09	0.01	0.00	0.01	0.01	0.00	0.11	0.08	0.04	0.45	0.04	0.04
24	Sales related services	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.00	0.01	0.01	0.02	0.04	0.01	0.00	0.01	0.00	0.00	0.05	0.07	0.04	0.02	0.64	0.05
25	Non-sales related services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Source: Created by the author