TIME-STABILITY OF THE COEFFICIENTS: AN INPUT-OUTPUT ANALYSIS ON ROMANIA CASE

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Abstract

A country's economy involves complex input-output (IO) structures of goods and services. The IO models, important instrument for economic and forecasting analysis, provide a reliable background for scientists of structural economic changes acting under the influence of various factors. In this paper, the IO method was used to test the time-stability of technical coefficients using the IO statistical tables for 2000 and 2006 years. The main conclusion is that the IO method can be used as a quantitative and qualitative instrument for analysis on short and medium term (not more than five years).

Keywords: Input-Output analysis, stability, coefficients, multipliers, Romania
JEL classification: C67, D57

1. INTRODUCTION

The present paper has two main objectives. First, consider the analyse of the size and evolution of the technological coefficients of Romanian input-output (IO) table of interdependencies between products and branches in 2000 and 2006, in order to identify some elements to characterize the structural changes of Romanian economy in terms of the IO model. Secondly, starting from the fundamental of the IO model, total production of the

economy could be determined taking into account the interdependencies of the branches to ensure a unit increase in final consumption in a planed, desirable structure and volume.

The IO multipliers reflect the total production necessary to ensure a unit growth of final consumption. They offer the ranking possibility in terms of differentiating the degree of efficiency between different branches of the national economy, as well as for predictive estimations based on consumed resources in the national economy to achieve a certain production levels and structures on short and medium term as a support for planned volume and structure of final demand, a component part of a sustainable development.

Leontief's IO analysis is a useful tool used to assess the economic impact of various measures of economic policy starting with the impact on the output (e.g. employment, incomes, value added, and taxes). The estimation of the economic effects of various technological changes in the productive industries, having as starting point Leontief inverse matrix, is a crucial step in the context of rising intensity and frequency of economic, social and political changes.

In the literature, various papers deal with aspects related to analytical and predictive potential of IO model. Chen et al. [1986] explore, for example, the relationship between the stability of the allocation version of the IO model (Ghosh) and the conventional production version of the model (Leontief). The authors present a theoretical analysis of joint stability.

Other approaches aimed to investigate the time-stability of the technological coefficients and short-time prediction methods of their dynamics.

De Mesnard [2000] presents methods for comparing two IO matrices at two different time periods. The survey methods allow the evaluation of the changes in the exchange structure between branches over time or of the differences between two exchange structures over space. Morillas et al [2008] define the coefficients importance as a fuzzy concept, and the importance considering the absolute flows.

Rueda-Cantuche et al [2008] argue that the fixed industry sales structure model emerges as the best one to construct industry tables as compared with the fixed product sales structure model. The authors investigate the fixed product and fixed industry sales structure models. Oosterhaven [2002] analyzes why the key sector concept should be broadened including not only the size of its forward and backward linkages, but also a sector's ability to generate autonomous growth. Oosterhaven [2008] proposes to replace the traditional (gross) forward and backward linkages with net linkages that take into account the two-sidedness of each sector's interdependency with the rest of the economy. The author uses some examples for various countries. An alternative approach for measuring the diversity based on the technical coefficients matrix of an IO model is outlined and computed by Wagner et al [1993]. According to the authors, the empirical results suggest that higher diversification levels within the theoretical constructs of the IO model are associated with higher levels of stability.

From the brief presentation of the research literature focused on the IO analysis, it results an improving of the vision and analysis instruments addressing the complexity of the transaction between branches of an economy.

This paper is organized as follows: the presentation of the IO methodology used, analysis of the technical coefficients and multipliers for Romania, conclusions and proposals.

2. METHODOLOGY DESCRIPTION

The IO analysis is usually used to determine the effect of structural changes in the national economy, taking into account the interdependencies between economic sectors, based on the following relation:

$$X = A*X + Y \qquad (1)$$

where:
A is the matrix of technical coefficients (*direct requirements table*);
X is the vector of results;
Y is the final demand vector.

If x_{ij} represents the amount of inputs of sector *j* purchased from the selling sector *i*, and X_j the total output of sector *j*, the technical coefficients or the IO coefficients are determined as:

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad (2)$$

The equation' coefficients (1) reflect specific structural features, the flows of goods and services among all sectors of the economy in the same period.

If *I* is the unit matrix, *X* is the vector of industry outputs and *Y* is the vector of final demand, it results that:

$$X = (I-A)^{-1}*Y \qquad (3)$$

Where $(I-A)^{-1}$ is called total requirements matrix or Leontief inverse matrix. If noted Leontief inverse matrix with B, then the output multipliers (B_j) will be:

$$B_j = \sum_{i=1}^{n} b_{ij} \qquad (4)$$

The Leontief inverse matrix represents the starting point in deriving other important multipliers (e.g. income, employment, value added and taxes). The output multiplier shows the change of the output for all branches from the line due to changes in final demand with one unit in the relevant branch.

The increase of the total production of sector *j* increases its total supply to the rest of the economic sectors in the model that use sector *j*'s product as an input in their production process [Binfiglio et al, 2006]. The term forward linkage is used to indicate these intersectoral transactions. If the backward linkages are demand oriented, the forward linkages are supply oriented. The backward linkage coefficients are usually known as output multipliers. According to Augustinovics [1970], the forward linkage coefficients reveal the intermediate consumption as a percentage of total sectoral sales including final demand. The term forward linkage is used to indicate this interconnection of a particular sector to those to which it sells its output.

Eurostat [2008] suggests that if linkages are used to identify key sectors with high multipliers in a particular economy, only domestic intermediates should be used to assess the forward and backward linkages in the national context.

3. THE ANALYSIS OF THE COEFFICIENTS AND MULTIPLIERS

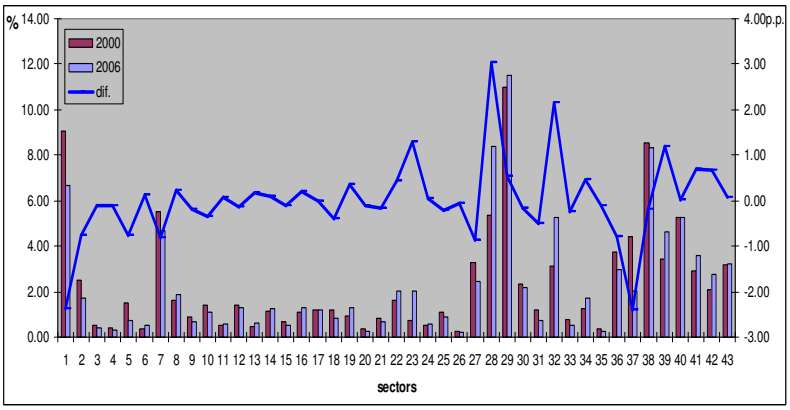
In the following is presented an analysis of the multipliers (for outputs), the data used being from the *TEMPO* database provided by *Romanian National Institute of Statistics* for two years 2000 and 2006 respectively. The first step of our analysis is the aggregation of 105 branches in 43 branches (Annex 1).

The branches having a higher participation in the creation of the national GVA for both analysed years are: Crops (9.04% in 2000 and 6.67% in 2006); Food Industry (5.50% and 4.68%); Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (3.29% and 2.43%);Constructions (5.35% and 8.40%);Wholesale and Retail (10.96% and 11.51%); Other Transport (3.10% and 5.26%);Telecommunications (3.75% and 2.97%); Financial, Banking and Insurance Activities (4.43% and 2.03%); Real Estate (8.54% and 8.34%); Professional, Scientific and Technical Activities (3.46% and 4.65%); Public Administration and Defence, Compulsory Social Assistance (5.24% and 5.26%); Education (2.89% and 3.59%); Health and Social Assistance (2.09% and 2.75%); Other Collective Services, Social and Personal Activities (3.17% and 3.24%).

In the analyzed period, increases in the contribution of branches to the creation of national GVA could be seen in: Constructions (+ 3.04 p.p.), Wholesale and Retail (+0.54 p.p.), Other Transport (+2.16 p.p.), Professional, Scientific and Technical Activities (+1.19 p.p.), Public Administration and Defence, Compulsory Social Assistance (+0.03 p.p.), Education (+0.70 p.p.), Health and Social Assistance (+0.67 p.p.), Other Collective Services, Social and Personal Activities (+0.07 p.p.).

A decrease could be observed in the following branches: Crops (-2.37 p.p.), Food Industry (-0.82 p.p.), Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (-0.86 p.p.), Telecommunications (-0.78 p.p.), Financial, Banking and Insurance Activities (-2.40 p.p.), Real Estate (-0.20 p.p.).

The tertiary sector increased its contribution to the creation of national GVA, while the primary sector has significantly reduced it, resulting a targeting of the economy to services sector (transport, trade, constructions).



Source: [authors own calculations]

Figure no. 1 Branches' contribution to the national GVA, 2000 and 2006 (%)

These changes in coefficients' value of service branches highlight the tendency of tertiarization of Romanian economy, on the one hand, as an adjustment response to the neglect or service peripherisation during the socialist period, but also as an effect of pseudo- tertiarization considering the speculative segments of intermediary services, particularly financial and commercial ones. Contrary, branches from the primary and secondary sectors experienced a collapse on relative terms.

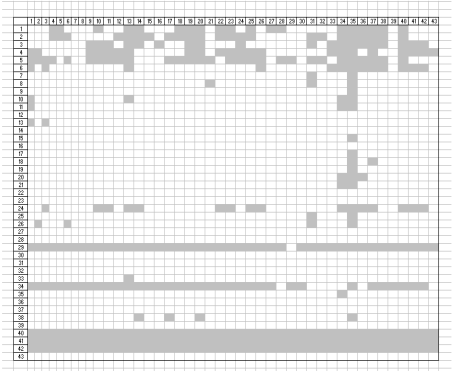
3.1. TECHNICAL COEFFICIENTS

The *A* matrix gives a comprehensive image of the interdependence among the branches of the economy. The coefficients of this matrix show the amounts of inputs (purchases) required by a column branch from each of the row branches in order to produce 1 RON of output from that column branch. Each column of the *A* matrix represents a production function for the corresponding branch.

The structural analysis of technical coefficients matrix for 2000 and 2006 was conducted in this research in the following ways:

- The ratio of total number of coefficients with "zero" values and other coefficients with positive values for each branch of the IO model so it can establish the many interdependencies between the branches of national economy;
- The size of main diagonal coefficients reflecting self-consumption of industries as element for characterization of a higher or smaller "independence" of one industry;
- Arrangement of technical coefficients in matrix *A*, after its "triangulation" by blocks of relatively independent branches in which the links between branches of the blocks are relatively intense (e.g. food industries block, textiles block, chemistry block, metallurgy block, machine building block);
- Universal vocation of some branches to serve all the other industries such as energy, water supply, scientific research and technological development, ICT, education, health etc.

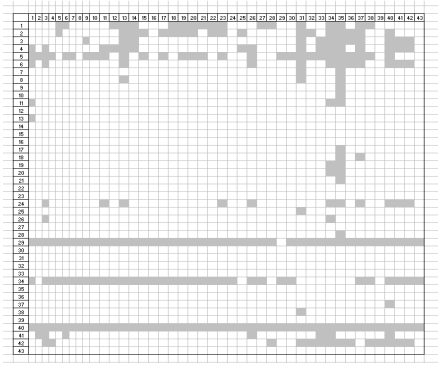
The results of the technical coefficients analysis based on each above mentioned criteria, serve as useful benchmarks to substantiate different mixed of economic policies.



Source: [authors own calculations]

Figure no. 2.1 matrix, 2000

Note: Gray colour means the existence of zero coefficients. The total number of zero coefficients is 385.



Source: [authors own calculations]

Figure no. 2.2 matrix, 2006

Note: Gray colour means the existence of zero coefficients. The total number of zero coefficients is 279.

The a_{ij} coefficients' number decreased, being with 106 fewer coefficients in 2006 as compared with 2000, meaning an increasing interdependences between branches, i.e. an increase in the complexity of the Romanian economy.

In 2006, the interdependences level of the economy increased, being observed more sector influencing the production of others, such as: Metallic Construction and Metal Products and Manufacturing of Equipment for the Production and Use of Mechanical Energy stimulating Forestry, Fishing and Fish Farming and Coal Mining. Compared with 2000, the sector Education and Health and Social Assistance provide inputs for the majority of branches in the economy. One could notice complex links to many branches having a large number of technical coefficients different from zero (their production depends on the output of others) unlike the branches with fewer coefficients and therefore less dependent.

Increasing interdependences could be considered as a growth engine, but also as vulnerability factor for declining or disturbance registered in some sectors of activity. Moreover, the emergence of other industries providing inputs might be also due to the data recording by the National Institute of Statistics and also the aggregation techniques of the branches.

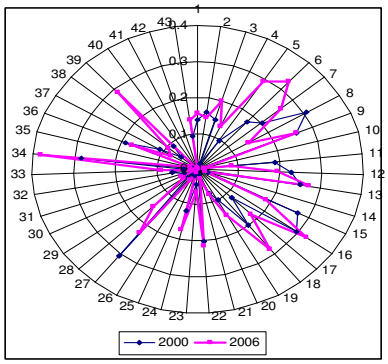
The IO model represents an instrument for analysis and prediction on short and medium term, particularly useful to investigate the impact of the current financial and economic crisis of whose intensity spreads differently on branches with a higher or smaller number of direct and indirect links with other branches.

3.1.1. SELF-CONSUMPTION

The technical coefficients indicate the sectors having the highest self-consumption or dependency on the inputs of other sectors to produce one unit of output. In terms of self-consumption, the highest coefficients reveals branches with a relatively independence, in that they offer their highest post-production. A low self-consumption, for example, reflects the dependence of one industry to other industries.

Self-consumption represented by the coefficients of the main diagonal of A matrix reflects higher or smaller interdependence of each industry.

In accordance with the coefficient values in the main diagonal of the A matrix (see Fig. 2), in 2000 the largest self-consumption registered in: Manufacture of Beverages and Tobacco Products *(0.305);* Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (0.304); Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products (0.295).



Source: [authors own calculations]

Figure no. 3 Self-consumption (the main diagonal of matrix A)

In 2006, the top three branches are: Ancillary and Auxiliary Transport Activities, Activities of Travel Agencies and Tourism Assistance (0.382), Mining of Metal Ores, Other Mining Activities and Mining Related Services (0.326), Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products (0.323), the third position remaining the same.

Table no. 1 - Classification of the branches depending upon the coefficients of the main diagonal of matrix A, 2000 and 2006

		Between 0.0 and 0.1 (including)	**Between 0.1 and 0.2 (including)**	**Between 0.2 and 0.3 (including)**	**Over 0.3**
Branches	2000	40, 41, 42, 29, 10, 35, 4, 21, 25, 26, 14, 28, 33, 31, 30, 23, 38,32, 20, 39, 43, 5, 19	37, 17, 24, 1, 3, 2, 6, 11, 36, 18, 7, 22	12, 13, 9, 15, 34, 16, 27	8
	2006	40, 42, 41, 31, 25, 10	32, 14, 35, 21, 26, 29, 30, 23, 37, 20, 11, 33, 38, 4, 43, 8, 2, 19, 28, 1, 24, 36, 17, 15, 12, 3	22, 27, 9, 7, 13, 18, 39, 5	16, 6, 34

Source: [authors own calculations]

In the case of *A* matrix it could be noticed that in 2006 unlike 2000 the coefficient values have increased, and in 2006 there are only 6 branches in the interval between 0.0 and 0.1 (including), opposed to the 2000 situation when there were 23 branches in this interval. In 2006 as compared with 2000 the self-consumption increased for most of the branches and especially for: Professional, Scientific and Technical Activities; Oil and Natural Gas Extraction.

3.1.2. THE SIZE OF TECHNICAL COEFFICIENTS

The direct requirements matrix (also called the technical coefficients matrix) shows the proportion of inputs required to produce one unit of output. The comparative analysis of the

size of technical coefficients in 2000 and 2006 reveals a number of relevant aspects for the study of macroeconomic multisectoral structure, in terms of their consistency over time and structural changes primarily resulting from the impact of the technological progress.

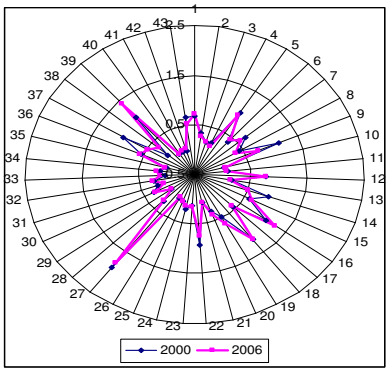
In Fig. 4 and 5 are plotted the values of technical coefficients, by branches and years, reflecting the degree of interdependences of branches or the intensity of the links. It may be noted that in 2006, the following coefficients retain their positions as in 2000: $a_{5,14}$ (branches Oil and Natural Gas Extraction with Manufacture of Coke Products and Products Derived from Oil Processing); $a_{1,2}$ (branches Crops with Livestock and Ancillary Services); $a_{6,18}$ (branches Mining of Metal Ores, Other Mining Activities and Mining Related Services with Metallurgy).

Table no. 2 - Technical coefficients with the highest values, except self-consumption

a_{ij} - 2000	a_{ij} - 2006
$a_{5.14}$=0.667; $a_{9.10}$=0.352; $a_{1.2}$=0.338; $a_{27.15}$=0.241; $a_{5.27}$=0.214; $a_{12.25}$=0.209; $a_{18,20}$=0.198; $a_{6,18}$=0.179; $a_{16,42}$=0.162; $a_{9,42}$=0.154	$a_{5.14}$=0.542; $a_{5.27}$=0.364; $a_{1.2}$=0.353; $a_{9.10}$=0.329; $a_{16,42}$=0.221; $a_{27,15}$=0.209; $a_{12,25}$=0.205; $a_{6,18}$=0.204; $a_{18,19}$=0.171; $a_{18,20}$=0.149

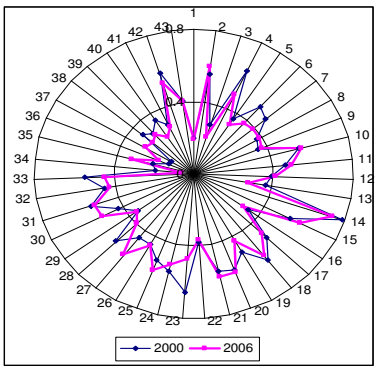
Source: [authors own calculations]

The branches using the highest inputs from other economic branches to produce one unit of output are: Manufacture of Coke Products and Products Derived from Oil Processing (0.789); Means of Road Transport (0.660); Coal Mining (0.632). In 2006, the situation changes and the second and third positions were occupied by Manufacture of Chemicals and Chemical Products (0.604) and Livestock and Ancillary Services (0.601). The lowest purchases needed to produce one unit of output were in branches such as: Crops (0.195); Telecommunications (0.187); Ancillary and Auxiliary Transport Activities, Activities of Travel Agencies and Tourism Assistance (0.062).



Source: [authors own calculations]

Figure no. 4 Sums on lines in A matrix (without self-consumption), 2000 and 2006



Source: [authors own calculations]

Figure no. 5 Sums on columns in A matrix (without self-consumption), 2000 and 2006

Note: The main diagonal values were not considered when calculated sums on lines and columns.

The same direct requirement matrix offers useful information on the branches offering the highest inputs for other branches in the economy. According to the sums on lines of *A*

matrix, Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning was on the first place in 2000 and also in 2006 (1.866 and 1.760 respectively), but the second and third positions changed during this period. In 2000, the second and third positions were Metallurgy (1.178) and Textile Industry and Textile Products (1.123) and in 2006 the second position was occupied by Professional, Scientific and Technical Activities (1.411), and third place by Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products (1.263).

More than a half of the branches have offered higher inputs to other branches in the economy in 2006 as compared with 2000, revealing a resumption of the process of economic growth during this period, in opposition to the decline period between 1996 and 2000.

In its evolution processes, Romanian economy had several "enablers" sectors because they have the highest contribution on the creation of total output. For both analysed years, these branches are: Wholesale and Retail; Constructions; Food Industry; Real Estate; Crops; Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning. Due to the interdependency existing in the economy in terms of production, different branches have to purchase inputs from various suppliers to produce their products. Also, these suppliers would need to purchase inputs to meet the demands for their commodities and the indirect impacts would continue through each of the branches that supply an input.

For 2000, Crops purchased about 0.34 RON worth of inputs from various branches of the economy to produce 1 RON of output (from Crops itself is 0.14 RON, Livestock and Ancillary Services – 0.03 RON, Manufacture of Chemicals and Chemical Products - 0.09 RON, etc). Constructions purchase about 0.57 RON worth of inputs with significant contributions from: Manufacture of Other Non-Metallic Mineral Products (0.10 RON worth), Metallurgy (0.06 RON), itself (0.04 RON), Wood Processing Industry, Cellulose and Paper (0.02 RON).

In 2006, Food Industry purchases about 0.65 RON worth of inputs: itself (0.26 RON), 0.12 RON worth of inputs from Crops, 0.10 RON from Livestock and Ancillary Services, 0.03 RON from Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning etc. As it regards Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning, the branch purchases about 0.79 RON worth of inputs stimulating the production of other branches to produce 1 unit of output, namely: Oil and Natural Gas Extraction (0.36 RON), Coal Mining (0.06 RON) etc.

The economic branches could be differentiated if looking to their contribution in terms of intermediate consumption in generating the own branch output. There are branches in which the intermediate consumption has a large contribution and other branches where other elements of gross value added (e.g. remuneration of employees, taxes) have a more significant contribution in creating output.

In the first category of branches having relatively high intermediate consumption could be included for the first and second year of analysis branches like Manufacture of Chemicals and Chemical Products (0.82 and 0.79), Manufacture of Coke Products and Products Derived from Oil Processing (0.81; 0.75), Metallurgy (0.81; 0.86), Livestock and Ancillary Services (0.75; 0.75), Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (0.75; 0.79).

In the second category could be included branches in the tertiary sector like: Telecommunications (0.33; 0.36), Education (0.30; 0.29), Financial, Banking and Insurance

Activities (0.24; 0.36), Postal and Courier Activities (0.22; 0.33), Public Administration and Defence, Compulsory Social Assistance (0.35; 0.24).

These classifications of the branches from the IO model in the two years of analyse, raise the issues of "deindustrialization" and also "new industrialization" in the context of the Romanian market economy internationally open and as EU membership. More specifically, it concerns the decrease in absolute and relative terms of the manufacturing, especially machine building and electronics characterized by the highest value added in the nationally and internationally value chain.

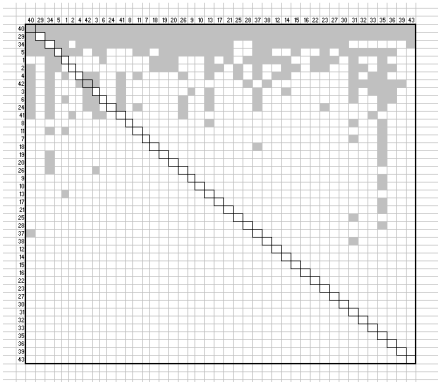
3.2. TRIANGULATION AND REARRANGEMENT ASPECTS

The sectors having universal vocation, like energy, health, education, public administration, research-development-innovation and so on, have a strategic importance for the economy. In the literature, matrix triangulation represents a method of permutation of the branches of *A* matrix, having as main objective to maximize the sum of technical coefficients below the main diagonal. The matrix triangulation may be performed on the *direct requirements matrix* (*A*) or the *transactions matrix*. In our example, the starting point in the finishing the matrix triangulation was the *A* matrix of which lines and columns were permutated so as to obtain the proposed objective. Through this method it should be obtained blocks of branches relatively independent.

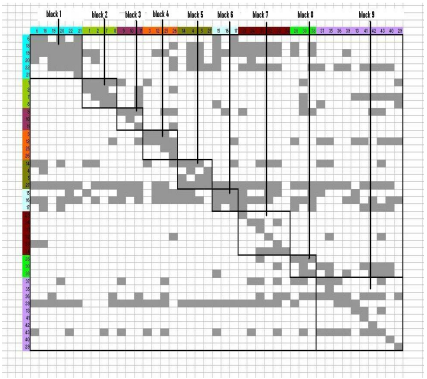
Comparing the two triangulated matrix for 2000 and 2006, it could notice a clearer tendency of restructuring of the national economy in 2006, outlining new restructuring in blocks of industries strongly affected by the processes of transition to market economy. The triangulation of *A* matrix with 43 aggregated branches started from the following judgement:

$$\text{If} \quad \begin{cases} a_{ij} \geq \dfrac{\max a_{ij}}{43}, \text{ then the value of the cell is equal to 1 (coloured cell)} & (5) \\ a_{ij} < \dfrac{\max a_{ij}}{43}, \text{ then the value of the cell is equal to 0 (uncoloured cell)} & (6) \end{cases}$$

In this approach it could be noticed that max a_{ij} = 0.542. A clear triangulation could be observed in the case of *metal block* (branches: 6, 18, 19, 20, 22, 21), in the case of *crops, food and beverages industry block* (branches: 1, 2, 7, 8), *chemicals block* (branches: 15, 16, 17) and a slight shape in the case of the *energy and mineral ores block* (branches: 14, 4, 5, 27).



Source: [authors own calculations]
Figure no. 6 The *A* matrix in triangulated form, 2006



Source: [authors own calculations]
Figure no. 7 The *A* matrix in triangulated form, with metals block, chemicals block, energy and mineral ores block, etc. (2006)

The 43 aggregated branches were grouped as follows:

- Block 1 contain branches 6, 18, 19, 20, 22, 21;
- Block 2 - branches 1, 2, 7, 8;
- Block 3 - branches 9, 10, 11;
- Block 4 - branches 3, 12, 25, 26;
- Block 5 - branches 14, 4, 5, 27;
- Block 6 – branches 15, 16, 17;
- Block 7 – branches 23, 24, 31, 32, 33, 34;
- Block 8 - branches 28, 30, 38;
- Block 9 - branches 37, 35, 36, 39, 13, 41, 42, 43, 40, 29.

The matrix triangulation may serve to the disclosure of the internal structure of transactions between branches, and this type of analysis have first to take into account the difference between zero entries and those with other value than zero. Also, it has to take into consideration the degree of aggregation of the analysed matrix. Thus, the degree to which triangulation reveals significant details may depend on the degree of detail of the branches.

3.3. TOTAL REQUIREMENTS COEFFICIENTS

Leontief inverse matrix refers to a series of direct and indirect effects of production expressed using some coefficients referred as "multipliers". The investigation of the multiplier effects is gaining a strategic importance *sui generis* in terms of opportunities to reduce material costs and labour costs in various industries, fuelled by long-term requirements of sustainable development as the current economic crisis is affecting Romania.

The difference between total requirements and direct requirements represents the indirect requirements coefficient; the higher it is the stronger the multiplier effect of respective industry is. In our analysis, those types of assessment were conducted to determine the industries having the greatest propagation effect.

3.3.1. COMPARATIVE ASPECTS OF TECHNICAL AND TOTAL REQUIREMENTS COEFFICIENTS

To analyze some comparative aspects regarding a_{ij} and b_{ij} coefficients, the following difference was calculated:

$$\Delta k_{ij} = b_{ij} - a_{ij}, \qquad (7)$$

where:
a_{ij} are the *A* matrix coefficients;
b_{ij} are the Leontief inverse matrix coefficients.

The high values of Δk_{ij} indicate those branches having a strong impact on other branches with which are entering into contact, their spread effect being much larger.

Regarding the size of the coefficients of the inverse of *A* matrix for 2000, the top three positions are: Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (1.551); Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products (1.463); Manufacture of Beverages and Tobacco Products (1.453). In 2006, the top three branches are: Ancillary and Auxiliary Transport Activities, Activities of Travel Agencies and Tourism Assistance (1.620); Mining of Metal Ores, Other Mining Activities and Mining Related Services (1.544); Oil and Natural Gas Extraction (1.543).

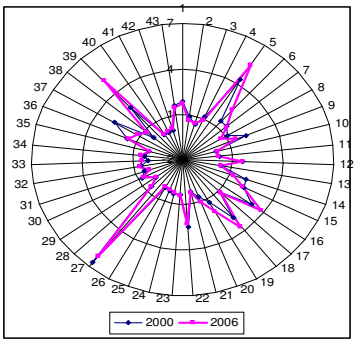
Some b_{ij} coefficients, by branches and years are plotted in Fig. 8 and 9. They are important because reflect how strongly a branch stimulates the activity of another branch.

Table no. 3 - b_{ij} coefficients with higher values, except the main diagonal

***b_{ii}* - 2000**	***b_{ii}* – 2006**
$b_{5,14}$=0.825; $b_{27,15}$=0.584; $b_{1,2}$=0.496; $b_{9,10}$=0.494; $b_{5,27}$=0.397; $b_{27,18}$=0.368; $b_{18,20}$=0.322; $a_{1,7}$=0.307; $b_{6,18}$=0.296; $b_{27,17}$=0.291	$b_{5,14}$=0.926; $b_{5,27}$=0.759; $b_{1,2}$=0.519; $b_{6,18}$=0.475; $b_{9,10}$=0.463; $b_{27,15}$=0.450; $b_{16,42}$=0.365; $b_{27,18}$=0.339; $b_{18,19}$=0.339; $b_{27,6}$=0.319

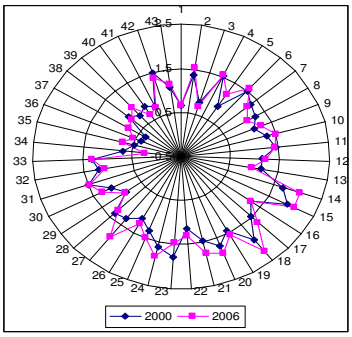
Source: [authors own calculations]

It is noted that in 2006 the following coefficients retain their positions as in 2000: $b_{5,14}$ (branches Oil and Natural Gas Extraction with Manufacture of Coke Products and Products Derived from Oil Processing) and $b_{1,2}$ (branches Crops with Livestock and Ancillary Services).



Source: [authors own calculations]

Figure no. 8 Sums on lines in Leontief inverse matrix (without main diagonal)



Source: [authors own calculations]

Figure no. 9 Sums on columns in Leontief inverse matrix (without main diagonal)

Branches with high b_{ij} coefficients have a greater multiplier effect. Starting the analysis from the "enablers" branches it can be observed that these not only generate direct effects, but also an indirect impact on other economic sectors as a result of the change with 1 RON in its final demand. Not all "enablers" have a great capacity to generate and increase total output, but they stimulate the output of each economic sector, however, more or less depending on the interrelationship existing in the economy.

In 2000, for Wholesale and Retail, the change with 1 RON (RON) in its final demand generates a change in economy output by 1.87 RON, of which 1.01 RON (including the initial growth of 1 RON) comes from the sector itself and the amount remaining from other endogenous sectors like Food Industry (0.11 RON), Manufacture of Beverages and Tobacco Products (0.12 RON), etc.

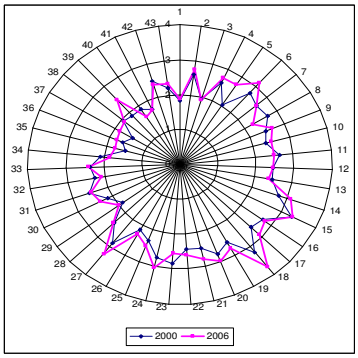
Regarding 1 RON change in Constructions final demand, this will generate a change in economy output by 2.40 RON, starting with a 1.04 RON change in the same branch and 0.15 RON change in Professional, Scientific and Technical Activities, 0.14 RON in Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning, 0.13 RON in Manufacture of Other Non-Metallic Mineral Products, 0.12 RON in Metallurgy, etc. By applying a similar approach for Food Industry it results that the change in total output is 2.63 RON, 1.28 RON from Food Industry itself, 0.30 RON from Crops, Livestock and Ancillary Services (0.23 RON), Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (0.12 RON), Manufacture of Chemicals and Chemical Products (0.07 RON), etc.

In 2006, 1 RON increase in Crops' final demand generates an increase of the economy' output of 1.86 RON, from which 1.21 RON comes from Crops itself and the remain value from other sectors, such as: Manufacture of Chemicals and Chemical Products (0.09 RON); Oil and Natural Gas Extraction (0.06 RON); Livestock and Ancillary Services (0.05 RON).

Similarly, 1 RON increase in Real Estate final demand leads to an increase in output with 0.08 RON for Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning, with 0.07 RON for Metallurgy and 0.06 RON in Other Non-Metallic Mineral Products. The branch named Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning stimulates especially the output in Oil and Natural Gas Extraction (0.76), Professional, Scientific and Technical Activities (0.19), Coal Mining (0.11).

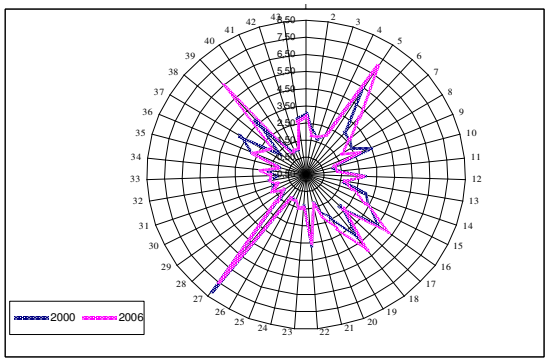
If looking at the output multipliers (see Fig. 10) in both years, the sectors with the greatest potential to generate output effects (both direct and indirect) in Romania were: Manufacture of Chemicals and Chemical Products; Metallurgy; Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning. The only changes in analyzed years were for the positions occupied by each branch, namely in 2000, first position is occupied by the Manufacture of Chemicals and Chemical Products (3.301) and in 2006 by Metallurgy (3.730).

This value means that a unit increase of final demand for Metallurgy (e.g., exports, public investment) will increase total regional production by 3.730 units as a result of indirect effects generated by that branch.



Source: [authors own calculations]

Figure no. 10 Output multipliers, 2000 and 2006



Source: [authors own calculations]

Figure no. 11 Output forward linkage coefficients, 2000 and 2006

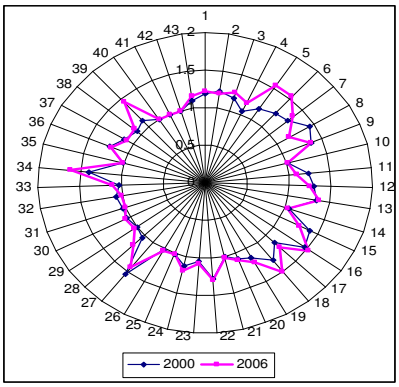
In 2006, the second largest output backward linkage coefficient is for Manufacture of Chemicals and Chemical Products (3.332), followed by the Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (3.254). The lowest values of the output backward linkage coefficients were in: Telecommunications (1.086); Post and Courier Activities (1.743); Education (1.731); Public Administration and Defence, Compulsory Social Assistance (1.632).

Comparing the output multipliers for both years, it is important to note that most sectors have recorded an increase, the most significant being: Oil and Natural Gas Extraction (+0.676); Professional, Scientific and Technical Activities (+0.599); Metallurgy (+0.531). In contrast, other branches registered decreases such as: Manufacture of Beverages and Tobacco Products (-0.468); Forestry, Fishing and Fish Farming (-0.303).

In the case of output forward linkage coefficients (see Fig. 11), in 2000 the first three places were occupied by: Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (8.20), Oil and Natural Gas Extraction (5.48), Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products (4.52). In 2006 the first two places remained the same: Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning (7.52), Oil and Natural Gas Extraction (7.01), but on the third place is Professional, Scientific and Technical Activities (6.48).

According to the main diagonal values of Leontief inverse matrix in 2000, on the first place was Production and Supply of Electricity, Steam, Gas, Hot Water and Air Condition-

ing (1.551), second place Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products (1.463), third place Manufacture of Beverages and Tobacco Products (1.453).



Source: [authors own calculations]

Figure no. 12 Main diagonal of Leontief inverse matrix

In 2006, Ancillary and Auxiliary Transport Activities, Activities of Travel Agencies and Tourism Assistance (1.620) is on first place, Mining of Metal Ores, Other Mining Activities and Mining Related Services (1.554) is on second place, and third place is represented by Oil and Natural Gas Extraction (1.554).

Table no. 4 - Classification of industries based on main diagonal coefficients of Leontief inverse matrix, 2000 and 2006

		Between 1.0 and 1.1 (including)	**Between 1.1 and 1.2 (including)**	**Between 1.2 and 1.3 (including)**
Branches	2000	40, 41, 42, 29, 35, 10, 21, 26, 25, 33, 31, 28, 4, 30, 23, 38, 14, 32, 20	39, 43, 37, 19, 24, 17, 3, 5, 1	11, 2, 36, 6, 22, 7, 12
	2006	40, 42, 41, 31, 25, 35, 10, 32, 21, 26, 14, 29, 30, 23, 37, 11	33, 20, 38, 8, 4, 43, 28, 2	24, 19, 1, 36, 17, 12, 3, 15, 22
		Between 1.3 and 1.4 (including)	**Between 1.4 and 1.5 (including)**	**Over 1.5**
	2000	18, 13, 9, 34	15, 8, 16	27
	2006	9, 13, 7	27, 39, 18	16, 5, 6, 34

Source: [authors own calculations]

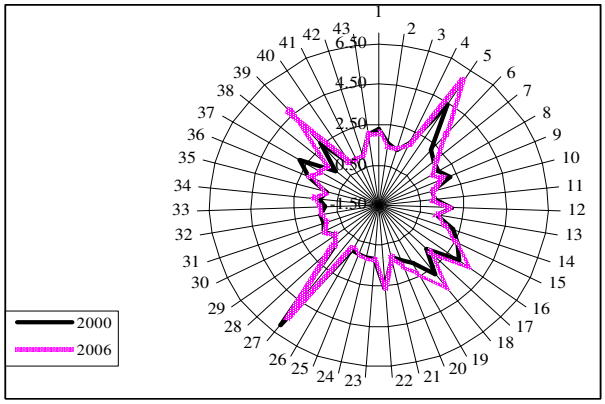
The difference between the output multiplier and the values on the main diagonal from the total requirements matrix indicates the indirect impact and the ability of each industry to increase the output in other branches' economy.

The difference between output multipliers and the main diagonal of the Leontief inverse matrix for both years was calculated. In 2000, the largest differences are in the case of: Manufacture of Chemicals and Chemical Products (1.895); Metallurgy (1.890); Means of Road Transport (1.786). In 2006, the branches are: Metallurgy (2.234); Manufacture of Chemicals and Chemical Products (2.064); Manufacture of Coke Products and Products Derived from Oil Processing (2.033).

Another aspect analysed regards the sums on lines in k_{ij} matrix. Below are displayed the values of K_j for those two years of analysis, where:

$$K_j = \sum_{i=1}^{n} \Delta k_{ij} \tag{8}$$

Given the difference between b_{ij} and a_{ij} coefficients, branches that have a significant impact on others with which comes in contact are Oil and Natural Gas Extraction and also Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning for both years analyzed.



Source: [authors own calculations]

Figure no. 13 Sums on lines in k_{ij} matrix, 2000 and 2006

In addition, in 2006, the branch named Professional, Scientific and Technical Activities generates a more consistent spread effect in other economic sectors.

It is worth stressing the importance of some activities in the macroeconomic framework, such as IT and related activities, research – development, architecture activities, engineering activities and other technical services, other service activities for enterprises, having an incentive role on the growth of other sectors.

4. SOME FINAL REMARKS AND CONCLUSIONS

This research leads us to underline the following aspects:

- IO model applied to the national economy case in 2000 and 2006 gives us the possibility of analysis the changes of the national economy structures in a new way, by which can be addressed in new terms the strategies for sustainable development of

Romania, in terms of a more judicious correlation between the primary, secondary and tertiary sectors of the economy and in terms of removing the speculative "pseudo-tertiarization" effects;

- Unfortunately, the most important economic sectors ("enablers") don't include branches with generating and spreading effects of technological progress and enhancement effects of value added in the value chains;
- The establishment of some blocks of relatively independent branches through triangulation method provides the most powerful information and benchmarks to establish of some strategic priorities for sustainable growth in the Romanian socio-economic competitiveness;
- IO model is a tool for analysis and forecasting, on short and medium run, which can be used to support of some strategic management decisions at the micro, meso and macroeconomic levels, whose use and understanding requires a minimum professionalism level from the decision makers.

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Annexes

Annex no. 1 - Aggregation of the branches

No.	Branches aggregated	Branches
1	01 Crops	01 Crops
2	02-03 Livestock and Ancillary Services	02 Animal Husbandry, 03 Auxiliary Services
3	04-06 Forestry, Fishing and Fish Farming	04 Forestry and Hunting Economy, 05 Logging, 06 Fish Farming and Fishing
4	07 Coal Mining	07 Coal Mining and Coal Preparation (Including Shale Schist)
5	08-09 Oil and Natural Gas Extraction	08 Oil Extraction (Including Related Services Activities), 09 Natural Gas Extraction (Including Related Services Activities)
6	11-17 Mining of Metal Ores, Other Mining Activities and Mining Related Services	11 Mining and Preparation of Ferrous Ores, 12 Mining and Preparation of Non-Ferrous Ores, 13 Mining of the Ores for the Construction Materials Industry, 14 Sand and Clay Mining, 15 Mining and Preparation of Ores for Chemical Industry, 16 Salt Mining and Preparation, 17 Extraction and Preparation of Other Non-Metallic Ores
7	18-25 Food Industry	18 Production, Processing and Preserving of Meat, 19 Processing and Preserving of Fish and Fish Products 20 Processing and Preserving of Fruit and Vegetables, 21 Plant and Animal Oils and Fats Production, 22 Manufacture of Milk Products, 23 Manufacture of Milling Products, Starch and Starch Products, 24 Manufacture of Animal Food Products, 25 Manufacture of Other Food Products
8	26-27 Manufacture of Beverages and Tobacco Products	26 Manufacture of Beverages, 27 Tobacco Industry
9	28 Textile Industry and Textile Products	28 Textile Industry and Textile Products
10	29 Textile Clothing Industry	29 Manufacture of Textile Garments
11	30-31 Furs and Leather Garments Manufacture, Leather and Footwear	30 Furs and Leather Garments Manufacture, 31 Leather and Footwear Industry
12	32-33 Wood Processing Industry, Cellulose and Paper	32 Wood Processing Industry (Excluding Furniture Industry), 33 Cellulose, Paper, Cardboard and Other Items Industry
13	34 Publishing, Polygraph and Reproduction of the Recordings on Supports	34 Publishing, Polygraph and Recordings Reproduction on Supports
14	35-37 Manufacture of Coke Products and Products Derived from Oil Processing	35 Coke, 36 Oil Processing, 37 Processing of Nuclear Fuel
15	38-40 Manufacture of	38 Manufacture of Basic Chemicals, 39 Manufacture of Pesti-

	Chemicals and Chemical Products	cides and Other Agrochemical Products, 40 Manufacture of Paints and Varnishes
16	41-46 Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations, the Rubber and Plastic Products	41 Manufacture of Medicaments and Pharmaceuticals, 42 Manufacture of Soap, Detergents, Maintenance Products, Cosmetics, 43 Manufacture of Other Chemicals, 44 Manufacture of Fibre, of Synthetic or Artificial Yarn, 45 Rubber Articles Production, 46 Production of Plastic Articles
17	47-54 Manufacture of Other Non-Metallic Mineral Products	47 Manufacture of Glass and Glass Articles, 48 Manufacture of Ceramic Refractory and Non-Refractory Articles, 49 Manufacture of Ceramic Plates and Tiles, 50 Manufacture of Bricks, Tiles and Other Products 51 Manufacture of Cement, Lime, Plaster, 52 Manufacture of Concrete Elements, Cement and Plaster, 53 Cutting, Shaping and Stone Finishing, 54 Manufacture of Other Products from Non-Metallic Mineral
18	55-59 Metallurgy	55 Siderurgy and Production of Ferroalloys, 56 Production of Tubes, 57 Other Siderurgy Products, 58 Production of Precious Metals and Other Non-Ferrous Metals, 59 Foundry
19	60 Metallic Construction and Metal Products	60 Metallic Construction and Metal Products
20	61 Manufacturing of Equipment for the Production and use of Mechanical Energy	61 Manufacture of Equipment for the Production and use of Mechanical Energy
21	62-65 Manufacture of Machinery, Equipment, etc.	62 Manufacture of Machinery for General use, 63 Manufacture of Agricultural and Forestry Machinery, 64 Manufacture of Tools-Machine, 65 Manufacture of Other Machinery for Specific use
22	67-71 Manufacture of Computers, Electronic and Optic Products and Electrical Equipment	67 Manufacture of Machinery and Household Apparatus, 68 Industry of IT Means and Office Equipment, 69 Machinery and Electrical Apparatus Industry, 70 Equipment, Radio Apparatus, Television and Communication Industry, 71 Industry of Medical Instruments and Apparatus of Precision, Optical and Photographic, Clocks
23	72 Means of Road Transport	72 Means of Road Transport
24	73-76 Manufacture of other Transport Means	73 Naval Construction and Reparations, 74 Production and Repair of Rail Means and Rolling Stock, 75 Construction and Repair of Aircraft, 76 Production of Motorcycles, Bicycles and other Means of Transport
25	77 Furniture Production	77 Furniture Production
26	78 Other Industrial Activities	78 Other Industrial Activities
27	79-82 Production and Supply of Electricity, Steam, Gas, Hot Water and Air Conditioning	79 Production and Distribution of Electricity, 80 Gas Production and Distribution (Excluding Methane Extract), 81 Production and Distribution of Heat and Hot Water, 82 Collection, Treatment and Water Distribution
28	83 Constructions	83 Constructions
29	84 Wholesale and Retail	84 Wholesale and Retail

30	85-86 Hotels and Restaurants	85 Hotels, 86 Restaurants
31	87 Rail Transport	87 Rail Transport
32	88 Other Transport	88 Other Transport
33	89-91 Transport via Pipelines, on Water and on Air	89 Pipeline Transport, 90 Water Transport (Sea, Coast, Large River), 91 Air Transport
34	92-93 Ancillary and Auxiliary Transport Activities, Activities of Travel Agencies and Tourism Assistance	92 Ancillary and Auxiliary Transport Activities, Activities of Travel Agencies, 93 Activities of Travel Agencies and Tourism Assistance
35	94 Postal and Courier Activities	94 Postal and Courier Activities
36	95 Telecommunications	95 Telecommunications
37	96 Financial, Banking and Insurance Activities	96 Financial, Banking and Insurance Activities
38	97 Real Estate	97 Real Estate
39	98-101 Professional, Scientific and Technical Activities	98 IT and Related Activities, 99 Research - Development, 100 Architectural Activities, Engineering and Other Technical Services, 101 Other Services Activities for Enterprises
40	102 Public Administration and Defence, Compulsory Social Assistance	102 Public Administration and Defence, Compulsory Social Assistance
41	103 Education	103 Education
42	104 Health and Social Assistance	104 Health and Social Assistance
43	105 Other Collective Services, Social and Personal Activities	105 Other Collective Services Activities, Social and Personal