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Sectoral structure of the Romanian economy

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Abstract: *The paper analyzes the input-output structure of Romanian economy and the diffusion mechanisms of economic effects in 2010, being the most recent year for which the national symmetric input-output table* (*SIOT) was available in Eurostat databases. The input-output models for the network of sectoral activities assess the direct and indirect impact on the economy. The shocks such as changes of final demand, changes of production or of input-output technological inter-linkages of sectoral production levels, during the propagation processes influences the impact throughout the economy. The complexity of linkages between economic sectors can be understood with the input-output analyses. This input-output method can show the relevance of diffusion mechanisms in the future behavior of sectors. Knowing the future behavior at macroeconomic level could be useful for the economic policies of different sectors and for keeping the desired equilibrium.*

Key-words: *input-output tables, input and output coefficients, output multipliers, backward linkage, forward linkage*

1. Introduction

The input-output table shows the production and consumption structures of an economy. The input-output table is a matrix whose columns are the economic activities: the production sectors and the categories of final demand and the rows are the corresponding inputs of these activities: products of the sectors, in the same order, and primary inputs (wages, capital etc.). The cost structure may be determined based on the columns. The rows show the revenues of a sector from all the corresponding other sectors.

The four quadrants of the input-output table refer to the requirements for *intermediate inputs* in production, in quadrant I, the final use of goods and services for consumption and investment, as *final demand*, in quadrant II, the requirements for *primary inputs*: labor, capital, land - for each sector, in quadrant III and quadrant IV, normally is empty, yet some transactions could, albeit rarely, be reported.

The input-output analyses are based on the input-output tables and the purpose is to describe the flows between all sectors of an economy over a period of

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time. These analyses provide information about the input flows used in production: intermediates, labor, capital, and land.

The NACE classifications for industries and CPA for products are used in the matrices which describe the production processes and products' transactions in Supply and Use tables.

The Supply table shows the supply of goods and services of domestic industries and imports. The Use table shows the goods and services by type of use: the intermediate consumption – quadrant I and final consumption, gross capital formation or exports – quadrant II. The components of gross value added: compensation of employees, other taxes except for subsidies on production, net mixed income, net operating surplus and consumption of fixed capital are presented in quadrant III.

Supply and Use tables are interlinked by the identities:

- by industry: *output = intermediate consumption + value added*
- by product: *output + imports = intermediate consumption + final consumption + gross capital formation + exports*.

Based on the information of Supply and Use tables there can be analyzed: the structure of production costs, the structure of value added in the production process, the flows of goods and services produced within a national economy and the transactions with the Rest of the World. A national symmetric input-output table (SIOT) is a matrix which contains both Supply and Use table in a single table with the same classification of products or industries both in rows and columns.

The method of using input-output framework can be used also to analyze the value added chains in interdependent markets when there are considered the production processes of interconnected economies in a global approach.

2. Input-output table of the Romanian economy, in 2010

According to ESA 2010, the product-by-product approach is the most important for symmetric input-output table. This kind of table was used here to analyze the Romanian economy. Using the SIOT for Romania in 2010, the last year introduced in Eurostat databases, after some summing operations of CPA levels, there were obtained the data from Table 1, for six aggregate branches, defined as specified in *Eurostat Manual of Supply, Use and Input-Output Tables* (2008, p. 480).

Based on Classification of Products by Activity (CPA) in Table 1, the structure of the Romanian economy for the following six sectors is presented in a condensed form:

– Agriculture: Products of agriculture, forestry, fisheries and aquaculture;
– Manufacturing: Products of mining and quarrying, manufactured products and energy products;
– Construction: Constructions and construction works;

– Trade: Wholesale and retail trade, repair services, hotel and restaurant services, transport and communication services;
– Business services: Financial intermediation services, real estate, renting and business services;
– Other services.

This structure is similar to the structure of the European Union's economic activity characterized in the Supply and Use Tables at basic prices of EU27 for the year 2000 at current prices, in millions of euro. (http://ec.europa.eu/eurostat/cache/metadata/Annexes/naio_esms_an1.pdf).

The Romanian indicators in Table 1 are at current prices in millions of euro and were obtained based on the tables extracted from the archive of files for Romania (http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/data/ workbooks).

The Romanian GDP, valued at market prices can be determined in the three ways, based on the data from Table 1 (http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/methodology/supply-use-tables):

- according to the production approach, as:

GDP = Output at basic prices - Intermediate consumption at purchasers' prices + Taxes less subsidies on products = 244608 – 133882 + 13602 = 124328 *(mill. euro), more exactly* 124327.736 *mill. euro*

or

GDP = Output at basic prices – (Domestic products + Imported products for intermediates) + Taxes less subsidies on products for final uses = 244608 – 99038 – 27542 + 6300 = 124328 *(mill. euro)*

- according to the income approach, as:

GDP = (Compensation of employees + Other net taxes on production + Operating surplus, gross) + Taxes less subsidies on products =Value added at basic prices + Taxes less subsidies on products

GDP = (45057 + 55 + 65613) +13602 = 110725 + 13602 = 124328 *(mill. euro)*

- according to the expenditure approach, as:

GDP = Final Uses – Imports = [(Private consumption + Government consumption) + (Gross fixed capital formation + Changes in inventories and valuables) + Exports] – Imports = Final consumption expenditure + Gross capital formation + (Exports – Imports) = Final consumption expenditure + Gross capital formation - Net Exports.

GDP = 176044 – 51716 = *[(*79266 + 20285) + (30725 + 1063) + 44705] – 51716 = [99551 + 31788 + 44705] – 51716 = 99551 + 31788 + (-7011) = 124328 *(mill. eur*

		Intermediate Consumption, j							**Final Uses**										***Total use***
	Production sectors, i	***Agricul-ture***	***Manu-factur--ing***	***Con-struc-tion***	***Trade***	***Business services***	***Other services***	***Total***	***Private consump-tion***	***Gov-ernment con-sumption***	***Gross fixed capital formation***	***Chan ges in inven-tories***	***Gross capital forma-tion***	***Exports intra EU FOB***	***Exports extra EU FOB***	***Exports FOB***	***Final uses***	
No		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Agriculture	5165	7930	162	28	0	32	13317	3081	562	103	427	530	1140	875	2015	6188	19505
2	Manufacturing	1327	13517	6992	6278	1084	3158	32356	20927	968	1479	-460	1019	20320	8231	28551	51465	83821
3	Construction	148	1829	3239	2519	372	1633	9738	3231	0	17447	758	18205	168	346	514	21950	31688
4	Trade	1247	8851	3015	6436	787	2791	23127	12069	3342	1017	332	1349	4745	1803	6548	23307	46434
5	Business serv.	130	1461	409	2365	1055	1173	6593	4358	111	841	4	845	1132	486	1618	6931	13525
6	Other services	517	2774	874	4407	1277	4056	13906	18182	15302	485	2	487	1292	465	1757	35728	49635
7	Domestic prod.	8534	36362	14691	22032	4574	12844	99038	61847	20285	21373	1063	22435	28798	12206	41003	145571	244608
8	Agriculture	331	1494	56	2	0	4	1887	757		0		0	0	0	0	757	2644
9	Manufacturing	1082	9791	4183	4501	1259	1776	22591	10067		7926		7926	3192	486	3677	21671	44262
10	Construction	4	53	64	79	11	65	276	54		39		39	0	0	0	92	368
11	Trade	7	32	18	62	18	46	183	957		0		0	0	0	0	957	1140
12	Business serv.	23	262	77	452	223	248	1286	160		0		0	0	0	0	160	1446
13	Other services	33	231	43	352	102	559	1319	512		0		0	11	13	24	537	1856
14	Imported prod.	1480	11863	4441	5448	1612	2699	27542	12507		7965		7965	3203	499	3702	24174	51716
15	Taxes less subsidies prod.	340	2230	1008	2397	316	1011	7303	4912		1388		1388		0		6300	13602
16	Total intermed./ Final use	10354	50455	20140	29877	6502	16554	133882	79266	20285	30725	1063	31788	32000	12704	44705	176044	309927
17	Compensation of employees	4404	10927	2808	9117	2989	14812	45057										
18	Wages,salaries	3576	9379	2432	7745	2508	11639	37279										
19	Other net taxes on production	-569	352	31	81	87	73	55										
20	Operating surplus, gross	5315	21930	8500	7359	3926	18583	65613										
21	- Mixed income, gross	5475	4718	4049	2436	494	2223	19396										
22	Value added at basic prices	9151	33209	11339	16557	7002	33468	110725										
23	Output at basic prices	19505	83663	31479	46434	13504	50022	244608										

Table 1. *Input-output table at basic prices, for Romanian economy, in 2010 (Mill. euro, current prices)*

The calculated value of GDP on the basis of Table 1 is just the same as that for Romania's GDP at market prices, in millions of euro, which appears in Eurostat databases (http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do).

3. Input-output analyses for Romanian economy

The indicators from Table 1, in quadrant I, x_{ij} represent inter-sectoral flows of goods and services from the row producer sector *i*, to the column consumer sector *j*, are called intermediates.

The structural coefficients can be calculated for describing the structure of the production activity of each sector and the relationships between the absorbed inputs and the produced outputs. The input coefficients and output coefficients allow one to determine the forward and respective the backward linkages of a branch to other industries or sectors within the complex system of economic interdependences. The input coefficients represent shares of costs for goods and services, and primary inputs in total output of the corresponding branches. Many input-output models are using input coefficients.

There are also input-output models based on output coefficients. The output coefficients represent market shares of different sectors, referring to the output distribution.

The interdependences among the sectors can be described by a set of linear equations to balance total input and output of each sector, in the Leontief input-output model.

In order to analyze the interdependences among the six sectors of Table 1, the values of column 17 of *Total use* should be the same as the *Output at basic prices* from row 23. As it can be noticed there is equality only for two sectors: *Agriculture* and *Trade*. For the other four sectors, as it is mentioned in the Romanian tables transmitted at Eurostat, in the "*Footnotes: the difference between output by row and by column for several industries are due to redistribution of market output of non-market institutional sectors*" and "*they do not affect the total output (the sum of differences is: zero*".
(Romania_suiot_131108_eur_cur.xls,http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do). Being conformant to reality, the results of our analysis can be affected by these facts.

3.1. Input coefficients of the Romanian economy, in 2010

The calculation of *input coefficients* consists in dividing each entry of the rows in the input-output table by the corresponding column total.

Table 2, corresponding to quadrant I of input-output table, shows the input coefficients for domestic intermediates of each sector, defined as: $a_{ij} = x_{ij}/x_j$, where:

a_{ij} = input coefficient for domestic goods and services of sector *j* from sector *i* (i=1, 6; j=1, 6)
x_{ij} = flow of domestic commodity *i* to sector *j*
x_j = output of sector *j*

The value of products of sector *i* used in order to produce one unit of output of industry *j* equals the value of *input coefficient*, a_{ij}.
Input coefficients are related to the production functions or cost structures of sectors.

The input coefficients reflect the direct requirements for domestic intermediates for one unit of final demand, for each sector. The input coefficients contribute to the identification of stable cost components and reflect technical input relations between sectors, being called "technical" coefficients.

matrix A		**Agriculture**	**Manufacturing**	**Construction**	**Trade**	**Business services**	**Other services**
1	Agriculture	0.2648	0.0948	0.0052	0.0006	0.0000	0.0006
2	Manufacturing	0.0681	0.1616	0.2221	0.1352	0.0803	0.0631
3	Construction	0.0076	0.0219	0.1029	0.0542	0.0275	0.0326
4	Trade	0.0639	0.1058	0.0958	0.1386	0.0583	0.0558
5	Business services	0.0067	0.0175	0.0130	0.0509	0.0781	0.0235
6	Other services	0.0265	0.0332	0.0278	0.0949	0.0946	0.0811
total		0.4375	0.4346	0.4667	0.4745	0.3387	0.2568

Table 2. *Input coefficients for domestic intermediates – technological matrix A*

On the diagonal of input coefficients' matrix there are the domestic intermediates produced by the row sectors and consumed within the column sectors, meaning the direct effects of intermediates, signifying the intra-sectoral consumption.

In *Agriculture* a proportion of 26.5% of its output is produced to be used within itself, 9.5% for *Manufacturing*, and less than 1% for the other sectors.
Manufacturing sector produced around 22% for *Construction* sector, followed by 16% for its own consumption. *Construction* sector produced for itself around 10%.

The coefficients on the diagonal of matrix show the proportions of the sectors for internal intermediary consumption from their own production. As a conclusion, the domestic intermediate consumption of Romanian *Agriculture* was the greatest, followed by the *Manufacturing* sector, especially by the *Construction* sector.

The cost structure of commodities of sectors can be read on the column of each sector. For *Construction*, the cost structure was 22% for the industries of *Manufacturing* sector and 9-10% from its own production and from *Trade*. The cost of *Trade* commodity was in close proportions of 13% from *Manufacturing* sector and *Trade*, of 9% from *Other services* and of mostly equal proportions of 5% from *Construction* and *Business services*.

The sum of input coefficients shows for each sector, the cost proportion of domestic goods and services, as effect *of direct input requirements*. *Trade* had in its cost more than 47% of the domestic production cost. The direct effects of domestic intermediates of the Romanian sectors were encountered in a *Trade* - oriented economy. *Construction* followed with 46%, *Agriculture* and *Manufacturing* with about 43%.

3.2. Output multipliers of the Romanian economy, in 2010

The matrix of input coefficients, *A*, is called *technology matrix*. Using the unit matrix, I, with ones on the diagonal, meaning one unit of final demand of each sector, and zeros for all the other elements, the matrix *(I - A)* is called the Leontief matrix. On the diagonal of the Leontief matrix, there are the proportions of net output for all the other sectors, having positive sign and the meaning of revenues for the considered sector; all the other coefficients are negative, meaning costs for the input requirements.

The Leontief matrix *(I - A)* of the Romanian economy for 2010, shows the input direct requirements for domestic intermediates in Table 3.

If the input coefficient of *Agriculture* for its own consumption was of 26.5%, then the net output of Romanian agriculture for all the other sectors represented less than 73.5%, the difference as compared to 100%, as in Table 3, on the diagonal of matrix *(I - A)*.

Leontief matrix *(I-A)*	**Agriculture**	**Manufacturing**	**Construction**	**Trade**	**Business services**	**Other services**
Agriculture	0.7352	-0.0948	-0.0052	-0.0006	0.0000	-0.0006
Manufacturing	-0.0681	0.8384	-0.2221	-0.1352	-0.0803	-0.0631
Construction	-0.0076	-0.0219	0.8971	-0.0542	-0.0275	-0.0326
Trade	-0.0639	-0.1058	-0.0958	0.8614	-0.0583	-0.0558
Business services	-0.0067	-0.0175	-0.0130	-0.0509	0.9219	-0.0235
Other services	-0.0265	-0.0332	-0.0278	-0.0949	-0.0946	0.9189

Table 3. *Matrix of direct requirements for domestic intermediates, in 2010*

Comparing the values on the diagonal with the direct requirements of input coefficients of the input-output table of Germany in 1990 ("Eurostat Manual of Supply, Use and Input-Output Tables", Eurostat, 2008 Edition, p. 480, 481-485, 497, http://ec.europa.eu/eurostat), it can be seen that German *Agriculture* had its own input requirement of 2.6% of output and the net output was below 97.4%. The productivity of Romanian agriculture in 2010 was ten times less than that of German agriculture, ten years before, in 1990.

The net outputs for the sectors *Business services* and *Other services* were obtained in the greatest proportions, more than 90%, followed closely by the *Construction* sector, *Trade*, *Manufacturing* – with over 80% and by *Agriculture* with less over 70%.

The inverse matrix $(I - A)^{-1}$ is the Leontief inverse and it reflects the direct and indirect requirements of intermediates. The *direct input requirements* are defined by matrix *A*. The power matrices of A show *the indirect effects* from the previous stages of production. The inverse Leontief matrix, $(I - A)^{-1}$, can be also expressed by the sum of power series of *A* matrices, as: $(I - A)^{-1} = I + A + A^2 + A^3 + ... + A^n$.

The inverse Leontief matrix for the Romanian economy, in 2010 is presented in Table 4 and shows the *direct and indirect input requirements of the economy* for one unit of final demand.

The column sums signify the *output multipliers* of sectors. The output multiplier *j* is the sum of productions in all sectors of the economy, necessary at all stages of production for producing one unit of final demand *j*.

For 1 million euro of final demand in *Agriculture*, the total effect induced in the Romanian economy was 1.763 million euro - the output multiplier of *Agriculture*. The direct and indirect requirements represented the internal greatest value of 1.379 million euro, own revenues - induced effect in *Agriculture*, and 0.384 million euro, the sum of the coefficients from the first column of Table 4 – indirect induced effect in the other economic sectors.

Inverse Leontief matrix	**Agriculture**	**Manufacturing**	**Construction**	**Trade**	**Business services**	**Other services**
Agriculture	1.3793	0.1625	0.0524	0.0327	0.0195	0.0165
Manufacturing	0.1463	1.2562	0.3433	0.2404	0.1468	0.1170
Construction	0.0259	0.0466	1.1380	0.0874	0.0487	0.0502
Trade	0.1287	0.1788	0.1795	1.2172	0.1076	0.0954
Business services	0.0218	0.0374	0.0346	0.0770	1.0976	0.0365
Other services	0.0614	0.0737	0.0704	0.1459	0.1314	1.1081
output multiplier	1.7633	1.7553	1.8182	1.8007	1.5517	1.4236

Table 4. *Direct and indirect requirements for domestic intermediates, in 2010*

The output multiplier signifies the cumulative revenues of each sector, meaning one unit of final demand and the direct and indirect requirements for domestic intermediates.

The previous stages' effects can be established when using the inverse Leontief matrix, as sum of power matrices of A. For *Agriculture* sector the internal effects of the previous six stages were: 1.3793 = 1 + 0.2648 + 0.0767 + 0.0243 + 0.0084 + 0.0031 + 0.0012, where: 1 is the unit of final demand of 2010, 0.2648

direct effects of agriculture in 2010, 0.0767 - indirect effects of agriculture in previous stage, 0.0243 - indirect effects of two stages ago, 0.0084 - of three stages ago, 0.0031 - of four stages ago, 0.0012 - of five stages ago and close to 0 six stages ago. Starting with the third production stage, the indirect influence was only 0.84%, so less than 1% for the three stages before the third stage.

For the Romanian economy, the *Construction* and *Trade* sectors were the most efficient, because they induced the greatest revenues in the economy: at every 1 million of final demand increase, there should be obtained 1.8 million euro in the whole economy. The direct and indirect effects of *Construction* were the greatest. If the final demand for *Construction* should increase by 1 million Euros, the cumulative revenues of 1.818 million Euros would be induced in the economy. The *Construction* sector had the best output multiplier in Romania, in 2010. The investments in *Construction* have had the greatest impact, generating the greatest value of cumulative revenues throughout the economy.

3.3. Applications of Leontief input-output model for the Romanian economy

The Leontief input-output model is based on the Leontief equation system. This system has a set of equations for all sectors, where for each sector *i,* the sum of intermediates x_{ij}, and the final demand for commodity of this sector *i*, gives the output of the same sector, *j*.

The assumption that all sectors produce with linear Leontief production functions means that the proportions of inputs (intermediates, capital, labor, land) in relation to output are fixed, meaning that the technical input coefficients are the same.

The Leontief equation system considers the final demand as an exogenous variable, *y*, on the right side of the Eq. 2; the matrix product of technology matrix *A* and the vector of outputs *x* – represents the requirements for intermediates; the net output (without intra-sectoral consumption) *x - Ax*, is given by the Leontief matrix *(I - A)* multiplied by *x*, which become final demand in Eq. 3. In the Leontief matrix, the outputs will have positive sign, meaning revenues and being on its diagonal and the inputs will have negative sign, meaning costs to other sectors.

$$Ax + y = x \quad (1)$$
$$x - Ax = y \quad (2)$$
$$(I - A)\,x = y \quad (3)$$
$$x = (I - A)^{-1}y \quad (4)$$

The Leontief equation system can be used when the vector of final demand and the technical coefficients are known and the output levels are unknown. If the inverse Leontief matrix is multiplied by the established vector of final demand *y*, the output levels, *x* can be estimated. This is the static model, in Eq. 4.

In other words, the levels of different industries can be sized for a given level of final demand. So the changes of sectoral final demand, can easily conduct to the required levels of productions for each sector, knowing that the technical coefficients which show the inter-sectoral relationships, remain constant for longer periods. The technology matrix A for the Romanian economy in 2010 is presented in Table 2.

In a deeper analysis the input coefficients for intermediates, could be considered together with those for primary inputs: capital and labor. Macroeconomic models with some sectoral disaggregation could stay at the basis of labor and fiscal policies. *The central model of input-output analysis* has the central equation system: $Z = B(I - A)^{-1}Y$, where:

B = vector of input coefficients for a certain variable: intermediates, labor, capital, energy or emissions;

I = unit matrix;

A = matrix of input coefficients for intermediates;

Y = diagonal matrix for exogenous final demand for goods and services;

Z = matrix with results for *direct and indirect influences* for the studied variable of intermediates, labor, capital, energy or emissions.

The multipliers are the column sums of coefficients of the matrix product $B(I - A)^{-1}$ and the values of the analyzed type of input is the matrix product Z.

3.3.1 Primary input content for products of final demand in Romania, in 2010

In order to establish the direct and indirect requirements of *Domestic intermediates*, the vector B consists of the input coefficients, presented in the last row of Table 2, as the sums of input coefficients of sectors, showing their direct effects on the economy.

The vector product between the vector B and the matrix $(I - A)^{-1}$ from Table 4, shows the direct and indirect effects in the entire economy of considering the technological matrix, A. These output multipliers of *domestic intermediates* are presented in Table 5, on the corresponding row.

In order to find the direct and indirect effects of all the inputs of production activities, the vectors of input coefficients B are multiplied by the inverse matrix Leontief $(I - A)$, using the equation $z = B(I - A)^{-1}$, where z is the vector of output multipliers.

The coefficients of *final demand*, on the first row of Table 5, are the ones, because the effects of inputs are calculated for obtaining one unit of final demand.

Continuing to apply the *model of input-output analysis*: $Z = B(I - A)^{-1}Y = zY$, by multiplying the vector of output multipliers with the diagonal matrix of *final demand*, the values of *domestic intermediates* are obtained, in Table 6.

Using input coefficients of ones for *Output*, the result of output multipliers will be just the values obtained by adding the sectoral output multipliers of the inverse Leontief matrix $(I - A)^{-1}$, on the last row of Table 4.

The output multipliers minus the unit of *final demand* show just the direct and indirect effects on the economy, in 2010, in Table 5.

Direct &indirect requirements for:	Agriculture	Manufacturing	Construction	Trade	Business services	Other services
	DOMESTIC PRODUCTION (millions of euro)					
Final demand	1	1	1	1	1	1
Domestic intermediates	0.7633	0.7553	0.8182	0.8007	0.5517	0.4236
Output	1.7633	1.7553	1.8182	1.8007	1.5517	1.4236
	IMPORT (millions of euro)					
Imported goods and services	0.1501	0.2265	0.2422	0.2088	0.1799	0.1003
	SUPPLY					
Taxes less subsidies on products	0.0372	0.0494	0.0580	0.0774	0.0397	0.0332
Intermediate consumption	0.9506	1.0311	1.1184	1.0869	0.7713	0.5571
	INCOME (millions of euro)					
Compensation of employees	0.3811	0.2701	0.2219	0.3458	0.3309	0.3784
From which: wages & salaries	0.3111	0.2281	0.1888	0.2910	0.2762	0.3005
Other net taxes on production	-0.0391	0.0013	0.0017	0.0030	0.0075	0.0021
Net operating surplus	0.4708	0.4527	0.4762	0.3650	0.4420	0.4861
Value added at basic prices	0.8128	0.7241	0.6998	0.7138	0.7804	0.8666
	GROSS CAPITAL FORMATION (GCF, millions of euro)					
Gross fixed capital formation	0.0290	0.0559	0.6438	0.0857	0.1017	0.0451
Changes in inventories	0.0309	-0.0009	0.0280	0.0102	0.0019	0.0016
Domestic Gross capital formation (GCF)	0.0600	0.0550	0.6718	0.0960	0.1036	0.0467
GFCF from import	0.0139	0.1190	0.0339	0.0229	0.0140	0.0111
Total GFCF	0.0429	0.1749	0.6778	0.1086	0.1157	0.0562
Total GCF	0.0739	0.1740	0.7056	0.1189	0.1176	0.0579

Table 5. *Output multipliers of input for production activities, in Romania, in 2010*

As already concluded, the *Construction* sector was the best to invest in, because for 1 million euro of final demand the effects were of 1.818 million euro in the entire economy.

The imported goods and services for 1 unit of final demand were the most efficient also in *Construction*.

The income of Romanian households, received for labor supply, in 2010, is emphasized by the direct and indirect requirements for *compensation of employees*, from which the *wages and salaries*, as primary input in order to produce one unit of final demand. *Agriculture* is the sector where for 1 million euro of *final demand*, the direct and indirect effects over wages in economy were the greatest.

The sum of output multipliers of *Final demand* and *Domestic intermediates* gives the multiplier of *Output* from each sector. This relation is also available for the calculated values of these indicators for a certain amount of final demand, from the diagonal matrix of *final demand*, and found in column 16 of Table 1, for the six sectors.

The sum of output multipliers of *Domestic intermediates*, *Imported goods and services* and *Taxes less subsidies on products*, gives the direct and indirect effects of *Intermediate consumption* of each sector, throughout the economy.

The sector *Other services* brought the lowest direct and indirect effects throughout the economy, with the lowest effects of *Imported goods and services* and having the lowest effects of *Intermediate consumption*. But, it can be appreciated that for each final demand of 1,000,000 euro in this sector, there was the greatest *Value added* of 866,600 euro, from which a *Net operating surplus* of 486,100 euro and with only 57,900 euro investment. For this sector the direct effects were the greatest as compared to the others, having the input coefficient of 0.6691. This means that from the direct and indirect effects for *Value added* of 866,600 euro, the value 669,100 euro represents direct effects.

Table 5 contains the multipliers for products which were delivered to final demand in 2010 and Table 6 contains the effects of these multipliers for the sectoral final demand. The content of primary inputs for the production activities, which correspond to the final demand of year 2010, is presented in Table 6.

There are some differences between the theoretical calculated values from Table 6 and the real values from Table 1. The sectoral differences between the theoretical and the effective distribution of indicators are founded on the reasons of practical and theoretical nature. The practical reasons refer to different conditions of productivity and efficiency of each sector.

The theoretical explanations for the practical production conditions are based on the production functions for each sector. The production functions have the assumption of constant returns to scale of inputs and an existence of fixed relations between sectors, described by the technical input coefficients which characterize the technology. In addition to the existence of the complex technologies for different products, there are also different required characteristics of labor.

Direct and indirect requirements	Agriculture	Manufacturing	Construction	Trade	Business services	Other services	Total
	DOMESTIC PRODUCTION (millions of euro)						
Final demand	6188	51465	21950	23307	6931	35728	145571
Domestic intermediates	4724	38870	17959	18663	3824	15135	99175
Output	10912	90335	39909	41970	10755	50864	244746
	IMPORT (millions of euro)						
Imported goods, services	929	11654	5316	4866	1247	3582	27594
	SUPPLY (millions of euro)						
Taxes less subsidies on products	230	2543	1273	1803	275	1186	7311
Intermediate consumption	5883	53067	24548	25332	5346	19903	134079
	INCOME (millions of euro)						
Compensation of employees	2359	13903	4872	8061	2294	13519	45007
From which: wages & salaries	1925	11741	4143	6782	1914	10738	37244
Other net taxes on production	-242	64	36	69	52	74	54
Net operating surplus	2913	23301	10453	8508	3063	17367	65605
Value added at basic prices	5030	37268	15361	16638	5409	30961	110666
	GROSS CAPITAL FORMATION (GCF, millions of euro)						
GFCF	180	2877	14131	1998	705	1611	21502
Changes in inventories	192	-49	614	237	13	58	1065
Domestic GCF	371	2829	14745	2238	718	1669	22570
GFCF import	86	6125	744	533	97	398	7983
Total GFCF	265	9002	14877	2532	802	2009	29487
Total GCF	457	8954	15489	2771	815	2067	30553

Table 6. *Direct and indirect effects of inputs for products, throughout the economy*

The function production describes the dependence of output on the intermediates and on the primary inputs: labor and capital: $x_j = f(x_{ij}, L_j, C_j)$, where:

x_j = output of sector j (products),
x_{ij} = flow of goods and services between sector i and j (intermediates),
L_j = required labor of sector j – number of employees is missing, but the *wages and salaries* describe the income of labor supply,
C_j = required capital of sector j, here is present by investments through domestic and from import *Gross Fixed Capital Formation, Changes in inventories*, giving *Gross Capital Formation*,
f = technology – described by matrix A, which contains the input coefficients of intermediates for products and of primary inputs.

The production processes should obtain maximum outputs with the used inputs. The theoretical constructions cannot reproduce exactly the reality, but they can offer a useful tool to understand the interrelations between the sectors of an economy.

3.3.2. Primary input content for final demand, by category of final use, in 2010

The output is formed by the intermediate production and the production for obtaining final demand. The production for the final destinations of consumption is presented in Table 7.

The values of consumption of output production by final uses are obtained using the same model: $Z = B(I - A)^{-1}Y = zY$, where:

B – input coefficients of the considered primary input,
$(I - A)^{-1}$ – inverse matrix Leontief of technological matrix A,
Y – the matrix of sectoral output by category of use, is presented in Table 7.

The z coefficients of direct and indirect effects of output multipliers are already calculated in Table 4. It remains only to consider them multiplying by matrix Y.

matrix *Y*	**Private consumption**	**Government consumption**	**GFCF**	**Changes in inventories**	**Exports**
Agriculture	3081	562	103	427	2015
Manufacturing	20927	968	1479	-460	28551
Construction	3231	0	17447	758	514
Trade	12069	3342	1017	332	6548
Business services	4358	111	841	4	1618
Other services	18182	15302	485	2	1757
Total by category of use	61848	20285	21372	1063	41003

Table 7. *Distribution of sectoral output for final demand, by category of use*

The totals obtained for each primary input, in the last column of Table 8, are just the same as those obtained in the analysis of primary input content of production activities of sectors for obtaining the final demand, in the last column of Table 6. The differences between the theoretical structure of output consumption by categories, from Table 8, and the effective distribution of production output for final demand, from Table 7, can be subject of debate for governmental policies.

The *private consumption* was too high and it should have had to decrease in favor of *government consumption*, which was underestimated. Also investments have had to increase for *GFCF*, from 30,725 millions of euro to 38,327 millions of euro and for *changes in inventories* from 1,063 million of euro to 1,930 millions of euro.

Direct and indirect effects by categories of final uses	**Private consumption**	**Government consumption**	**GFCF**	**Changes in inventories**	**Exports**	**Total**
	FINAL DEMAND and OUTPUT (millions of euro)					
Final demand	61847	20285	21373	1063	41003	145571
Domestic intermediates – th.	40571	10380	16955	867	30403	99175
Output theoretic	102418	30664	38327	1930	71406	244746
	IMPORT (millions of euro) – theoretic values					
Imported goods and services	11110	2555	4988	214	8727	27594
	SUPPLY (millions of euro) - theoretic values					
Intermediate consumption	54727	13774	23160	1144	41274	134079
	INCOME (millions of euro) - theoretic values					
Compensation of employees	20040	7458	5125	324	12060	45007
From which: wages & salaries	16522	5998	4337	269	10118	37244
Other net taxes on production	17	22	37	-15	-7	54
Net operating surplus	27633	9410	10005	478	18079	65605
Value added at basic prices	47691	16890	15167	786	30132	110666

Table 8. *Primary input content of production by categories of final demand*

The analysis could have been more interesting if the number of employees would have been recorded. The value added by exports could have been important, as seen in Table 8.

3.4. Output coefficients of Romanian economy, in 2010

The *output coefficient*s are related to the market shares for commodities and primary inputs of sectors. The calculation of *output coefficients* consists in dividing each entry of the rows in the input-output table by the corresponding row total. Tables 9 and 10, corresponding to quadrant I and II of Input-Output table, show the output coefficients for domestic intermediates of each sector, defined as: $o_{ij} = x_{ij}/x_i$, where:

o_{ij} = output coefficient domestic goods, services of sector *i* from sector *j* (i=1,6; j=1,6)
x_{ij} = flow of domestic commodity *i* to sector *j*
x_i = output of sector *i*.

The proportion of *domestic products*, 40.5% was distributed for economic sectors: 3.5% for *Agriculture*, 15% for *Manufacturing*, 6% for *Construction*, 9% for *Trade*, 2% for *Business services* and 5% for *Other services*.

Output coefficients	**Agricul-ture**	**Manufac-turing**	**Construc-tion**	**Trade**	**Business services**	**Other services**	**Total**
Agriculture	0.265	0.407	0.008	0.001	0.000	0.002	0.683
Manufacturing	0.016	0.161	0.083	0.075	0.013	0.038	0.386
Construction	0.005	0.058	0.102	0.079	0.012	0.052	0.307
Trade	0.027	0.191	0.065	0.139	0.017	0.060	0.498
Business serv.	0.010	0.108	0.030	0.175	0.078	0.087	0.488
Other services	0.010	0.056	0.018	0.089	0.026	0.082	0.280
Domestic products	0.035	0.149	0.060	0.090	0.019	0.053	0.405
Agriculture	0.125	0.565	0.021	0.001	0.000	0.002	0.714
Manufacturing	0.024	0.221	0.095	0.102	0.028	0.040	0.510
Construction	0.011	0.143	0.174	0.215	0.029	0.177	0.749
Trade	0.006	0.028	0.016	0.055	0.016	0.041	0.161
Business services	0.016	0.181	0.053	0.313	0.154	0.172	0.889
Other services	0.018	0.124	0.023	0.189	0.055	0.301	0.711
Imported products	0.029	0.229	0.086	0.105	0.031	0.052	0.533
Taxes less subsidies	0.025	0.164	0.074	0.176	0.023	0.074	0.537
Total intermediates	0.033	0.163	0.065	0.096	0.021	0.053	0.432

Table 9. *Output coefficients for total intermediates, in Romania, in 2010*

The *Imported products* for the sectoral consumption represented 53.3% of *Imported products*, being distributed mainly for *Manufacturing*, in a proportion of 23% and around or less than 10% for the other sectors; the lowest proportion of imports was for the *Agriculture* sector. So, 43.2% of the *Total intermediates* were mainly distributed in *Manufacturing*, and less than 10% in all the other sectors.

In 2010, the domestic output was consumed in proportion of 40.5% by domestic needs of sectors and 59.5% was for *Final uses*. From the *final uses:* 33.6% was *final consumption* expenditure, from witch 25.3% was *private consumption* and 8.3% was *final consumption of government*, 9.2% was for investments (*Gross Capital Formation – GCF*) and 16.8% was the *export*.

Output coefficients	**Total**	**Private cons.**	**Final cons. govern-ment**	**Final cons. expendi-ture**	**GCF**	**Exports FOB**	**Final uses**	**Total use**
Agriculture	0.683	0.158	0.029	0.187	0.027	0.103	0.317	1.000
Manufacturing	0.386	0.250	0.012	0.261	0.012	0.341	0.614	1.000
Construction	0.307	0.102	0.000	0.102	0.574	0.016	0.693	1.000
Trade	0.498	0.260	0.072	0.332	0.029	0.141	0.502	1.000
Business serv.	0.488	0.322	0.008	0.330	0.062	0.120	0.512	1.000
Other services	0.280	0.366	0.308	0.675	0.010	0.035	0.720	1.000
Domestic prod.	0.405	0.253	0.083	0.336	0.092	0.168	0.595	1.000
Agriculture	0.714	0.286	0.000	0.286	0.000	0.000	0.286	1.000
Manufacturing	0.510	0.227	0.000	0.227	0.179	0.083	0.490	1.000
Construction	0.749	0.146	0.000	0.146	0.106	0.000	0.251	1.000
Trade	0.161	0.839	0.000	0.839	0.000	0.000	0.839	1.000
Business serv.	0.889	0.111	0.000	0.111	0.000	0.000	0.111	1.000
Other services	0.711	0.276	0.000	0.276	0.000	0.013	0.289	1.000
Imported prod.	***0.533***	***0.242***	***0.000***	***0.242***	***0.154***	0.072	***0.467***	1.000
Taxes less subs.	0.537	0.361	0.000	0.361	0.102	0.000	0.463	1.000
Final use p.p.	***0.432***	0.256	0.065	***0.321***	***0.103***	***0.144***	***0.568***	1.000

Table 10. *Output coefficients of total intermediates and final uses, in 2010*

A proportion of 46.7% from *imported products* was for *final uses*: 24% for *private consumption of population* and 15% for *investments*. The *output for final use* in purchasers' prices was 43% for the consumption of economic sectors and 56.8% was for *final uses*: 32.1% for *final consumption expenditure*, 10.3% for *GCF* and 14.4% for *export*.

3.5. Multipliers of production activities in Romanian economy, in 2010

The dynamism of economic activity captures the interconnections of a sector, in the two sides: the demand and the offer of the sector. Increasing the production of a sector *j* leads to an increase of inputs and intermediates required from other sectors –

being its demand. The term "*backward linkage*" characterizes the demand side of the sector, describing the interconnection of the sector with the other sectors from which the inputs are purchased. The increased output of sector *j* signifies an addition supply for other sectors such as supplementary inputs to be used by other sectors.

The term "*forward linkage*" characterizes the offer side of the economic activity of a sector and it refers to the relations between the supplying sector and the other sectors to which it sells its output.

For the Romanian economy, in 2010, the *backward linkage* of each sector is reflected by the column sum of input coefficients, showing the direct requirements for domestic intermediate production, which can be found in the last row of Table 2. The *Trade* sector is the most demanded for Romanian economy in 2010 with a *backward linkage* of 0.4745, as it was already discussed above.

The *backward linkages* are reflected in a more useful way by the column sums of the inverse Leontief matrix, which show the direct and indirect requirements of Romanian economic sectors, in the last row of Table 4, being the output multipliers. In this case, *Construction* sector had the highest level of required inputs from other sectors, its *backward linkage* being 1.8182.

The *forward linkages* are measured by the row totals of output coefficients, in the last column of Table 11, showing the direct effects of their output. The row sums of elements of inverse matrix $(I - A)^{-1}$ measure the forward linkage, in the last column of Table 11, showing the direct and indirect effects of their output through the final uses.

Inverse $(I-A)^{-1}$	**Agriculture**	**Manufacturing**	**Construction**	**Trade**	**Business services**	**Other services**	**total**
Agriculture	1.3793	0.6966	0.0844	0.0777	0.0134	0.0421	2.2936
Manufacturing	0.0340	1.2556	0.1288	0.1331	0.0236	0.0697	1.6448
Construction	0.0159	0.1230	1.1369	0.1280	0.0208	0.0792	1.5038
Trade	0.0540	0.3220	0.1215	1.2171	0.0313	0.1028	1.8488
Business serv	0.0314	0.2312	0.0805	0.2643	1.0975	0.1351	1.8399
Other serv.	0.0241	0.1243	0.0446	0.1365	0.0358	1.1090	1.4743

Table 11. *Direct and indirect effects of sectoral output throughout final uses*

In Romania, the *Agriculture* sector had the highest direct and indirect *forward linkages* of 2.2936. This value of *forward linkage* meant that 1 million euro of increased Agriculture output was directly and indirectly sold to other sectors with 2.2936 million of euro, from which directly the value of 683,000 euro, and from which 265,000 euro has been directly sold within this sector of *Agriculture*. To identify the sectors having higher multipliers, only domestic intermediates should be considered to assess the forward and backward linkages at national level.

The analysis of *inter-sectoral linkages* based on Table 12, shows that the *Construction* sector is more demand oriented having the greatest *backward linkage* of 1.8182 but it has a lower supply of 1.5038. This sector needs more from other sectors than it can offer to the others. This situation is also available for the *Manufacturing* sector.

Inter-sectoral Linkages	Effects	Agriculture	Manufacturing	Construction	Trade	Business services	Other services
Backward linkages	*Direct*	0.4375	0.4346	0.4667	0.4745	0.3387	*0.2568*
	Direct and indirect	1.7633	1.7553	***1.8182***	1.8007	1.5517	*1.4236*
Forward linkages	*Direct*	0.6827	0.3860	0.3073	0.4981	0.4875	*0.2802*
	Direct and indirect	***2.2936***	1.6448	1.5038	1.8488	1.8399	*1.4743*

Table 12. *Intersectoral linkages in Romanian economy, in 2010*

The *Other services* had the lowest values both for direct and indirect *backward linkages* and for direct and indirect *forward linkages* – in the last column of Table 12. Meanwhile, the *Agriculture* sector is the most supply-oriented, its output being sold into the entire national economy with a multiplier of 2.2936.

4. Conclusions

There are some differences between the uploaded data on Romania, in input-output tables and those updated in the second term of 2015, when the declared Romanian GDP for 2010 amounted to 126,746.4 million euro, instead of 124,328.7 million euro. The Romanian GDP in 2010, transmitted to Eurostat and considered in this paper, was calculated in compliance with ESA95. ESA 2010 has been applicable starting with 2014 ("GDP and main components (output, expenditure and income", nama_10_gdp, http://ec.europa.eu/eurostat/data/database).

The paper presents a short introduction into the input-output method.

The Romanian input-output table for 2010 is drawn here only for six sectors, based on the official data transmitted to Eurostat. The calculated structure on six branches is defined as the structure of the European Union's economic activity characterized by Eurostat by aggregating the national input-output tables of EU Member-states.

The Romanian GDP was calculated using the three methods of production, income and expenditure approaches.

Using the input-output table of the Romanian economy in 2010, with indicators in millions euro, current prices, the input and output coefficients were calculated for the economic sectors. Based on the input-output model the output multipliers were used to identify the relative and absolute direct and indirect effects of the economic activity of sectors. The input and output coefficients characterize the inter-sectoral backward and forward linkages and their direct and indirect effects.

The technical matrix of input coefficients allowed the analysis of the inputs of production activities and the primary input content of products for final demand in Romania, in 2010, and by category of final uses.

In 2010, *the agricultural profile of the Romanian economy* was identified, by its main role, having the greatest multiplier of forward linkages in the entire economy. The effects of the *Agriculture* sector for the future development of Romanian economy should be considered for European financing programs and for the investments policies in this sector.

Every change of taxes, of wages, of prices, of imports, of exports, of investments and others, can be tested with the input-output analysis to see in advance, what effects they can induce in the complex body of the national economy.

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