Input-Output Coefficients of the Romanian Economy

- Annual Data 1989-2016, Current Prices -

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ABSTRACT

Using the INS comprehensive input-output tables, the present work re-estimates data for a fourteen sectoral structure of the Romanian economy. With simple additional computations, this structure can be transformed into four mega-fields classification: primary, secondary, tertiary, and quaternary. The main results are the following statistical series 1989-2016 for:

i) the sectoral shares of output and gross value added (Appendix 1 – Sectoral shares in output and in gross value added);

ii) the technical coefficients at current prices (Appendix 2 - A-matrix); and

iii) the Leontief coefficients at current prices (Appendix 3 - L-matrix).

As a preponderantly explicative text, the note insists on the methodological framework in which the fourteen sectoral I-O tables were built. Some dynamic features of the estimated structure and of the I-O matrices (A and L) during the transition of the country from a centrally planned system to a market mechanisms are also described. The note ends with a short set of conclusions, with special emphasis on further desirable research.

Key-words: *sectoral structure, I-O coefficients*

JEL Classification: *C67*

I. INTRODUCTION

1. The pioneering attempts to assimilate the Input-Output (I-O) technique by the official Romanian statistics started at the end of the sixties. The main source of knowledge was the US experience, obviously adapted to conform to the accounting system of material production. Two professional Seminars with American experts have been organized in Bucharest (1969) and in Washington-Boston (1970, with participation of Wassily Leontief). The I-O tables of USA at that time were extensively described in (Dobrescu, 1970).

The first Romanian I-O tables were therefore built on a set of complete recorded data (not just a selected sample) concerning inter-sectoral flows for the year 1970. The obtained information, especially the resulted matrices of technical and Leontief coefficients, were used in planning simulations for the 1970th. (Dobrescu, 1976, 1979).

2. Unfortunately, this beneficial start was abandoned during the eighties, but was revived after 1989, at the beginning of the transition in Romania – similarly to other Central and East-European countries - from the centrally planned economy to the market mechanisms. Naturally, this time the statistical background was provided by the fully adopted new national accounting system.

Since then the Romanian National Institute of Statistics (INS) has estimated yearly input-output tables, using special surveys for a representative sample of enterprises, information corroborated with other available sources.

The data were systematized initially on the basis of NACE Rev.1, according to ESA 79 methodology, and more recently ESA 2010 NACE Rev. 2 (Commission Regulation EU - No 715/2010), which is the current European System of Regional and National Accounts. Our present analysis involves the homogenized series for the 1989-2016 interval, structured by ESA 2010 for 88 branches.

3. Some researchers within the Centre of the Macroeconomic Modelling (National Institute for Economic Research of the Romanian Academy) tried to merge - into a coherent set of equations - the input-output equilibrium identities with the macroeconomic behavioural relationships (for global output, employment, main labour and capital revenues, taxation, public budget expenditures, consumption, investments, foreign trade, monetary variables). With aim not to overcomplicate such a system, the I-O block has been configured in a consolidated sectoral structure.

Thus, the 2005 version of the Romanian macromodel (Dobrescu, 2006a, 2006b) has aggregated the data into six sectors, this classification being used until 2011, when it was augmented to ten sectors (Dobrescu 2013). In order to extend the analytical and forecasting potential of the macromodel, its 2018 version (Dobrescu 2018) organized the I-O tables into a fourteen sectoral structure (the numerical codes are in brackets):

- Agriculture, forestry, hunting and fishing (1);
- Mining and quarrying (2);
- Production and distribution of electric and thermal power (3);
- Food, beverages and tobacco (4);

- Textiles, leather, pulp and paper, furniture (5);
- Machinery and equipment, transport means, other metal products (6);
- Other manufacturing industries (7);
- Constructions (8);
- Transports, post and telecommunications (9);
- Trading services (10);
- Financial services and real estate transactions (11);
- Social services (12);
- Creative services (13); and
- Professional services (mainly businesses) (14).

Note that through several additional operations, this structure is easily transformed into the modern four mega-fields classification: primary (1+2+3); secondary (4+5+6+7+8); tertiary (9+10+11+12); and quaternary (13+14).

4. Using the INS comprehensive input-output tables which were computed. for the above aggregated fourteen sectoral structure, the following statistical series were obtained for the years 1989-2016:

i) the sectoral shares of the output and gross value added (Appendix 1);
ii) the technical coefficients at current prices (Appendix 2); and
iii) the Leontief coefficients at current prices (Appendix 3).

5. The present note continues with a synthetical characterization of the methodological framework used to build the fourteen sectoral I-O tables (second chapter). Some dynamic features of the thus estimated structure (the sectoral shares, the evolution of A and L matrices) are revealed in the third chapter. As usually, our work ends by a short set of conclusions, with accent on further desirable research.

II. METHODOLOGICAL FRAMEWORK

The accounting relationships and the coefficient matrices follow, as much as possible, the standard methodology of the input-output analysis (see Leontief, 1936, 1970, 1986; Ghosh, 1958; Stone, 1961; United Nations, 1999; Pilat and Wölfl, 2005; Robles and Sanjuán 2005; Horowitz and Planting 2006; Wixted et al., 2006; Reis and Rua 2006; Ritzmann, editor, 2008; Eurostat, European Commission 2008; Miller and Blair, 2009; Guerra, and Sancho 2010; Manresa and Sancho 2012; McLennan. 2016; Dobrescu and Gaftea 2017). Some specific solutions were, however, adopted which take into account the available data and the need to interpret I-O information with leading macroeconomic variables.

1. The basic I-O tables are defined at current prices. The intra and inter-sectoral flows are expressed as monetary values of transactions in both directions, as supplied (R) and used (U) resources.

1.1. The main components of the supplied resources are:

$$R=Q+NIT+M \quad (1)$$

where Q - is output (production exclusively of resident units) at producer prices; NIT – net indirect taxes; and M – imports (competitive and non-competitive) of goods and services, at purchaser prices.

In counterpart, the used resources comprise:

$$U=Z+AD+X \quad (2)$$

where Z – is intermediate consumption (inputs in sector j from sector i), at mixed prices (domestic entries at producer prices and imports at purchaser ones); AD – domestic absorption, including consumption of households, public consumption (financed by the general consolidated budget), gross fixed capital formation, inventory change, all at purchaser prices, and diverse balancing corrections; X – is export of goods and services, at purchaser prices.

For i=j the equality R=U is axiomatically admitted.

1.2. The difference between producer prices and purchaser ones is due to many concrete components. Our paper groups all of them into a cumulative indicator - net indirect taxes (value added tax, excises, custom duties, subsidies on product, other similar add-ons).

1.3. The gross value added (GVA) is not separated into its components (labor revenues, capital depreciation, taxes included in production costs, operating surplus). Consequently, the output appears as a sum of intermediate consumption on column and gross value added.

1.4. The technical coefficients (a_{ij}) - respectively the A matrix - are calculated by dividing the elements of the Z matrix by the corresponding outputs (Q), containing therefore the productive inputs from both domestic and external sources.

1.5. The Leontief matrix (L). - incorporating not only direct, but also propagated effects of intersectoral connections - is computed as usual by the inverse matrix operation, respectively $L=(I-A)^{-1}$.

2. The fourteen sectoral tables are built on the equality of supplied and used resources, either for each sector as a separate entity or, correspondingly, for the national economy as a whole. This fundamental accounting assumption (identities (1) and (2) at macro-level) is translated in sectoral profile by the relationships (1a) and (2a):

$$R_j=Q_j+NIT_j+M_j=\sum_j z_{ij}+GVA_j+NIT_j+M_j \quad (j=fix;\ i,j=1, 2,\ldots, m) \qquad (1a)$$

$$U_i=\sum_i z_{ij}+DA_i+X_i \ (i=fix) \qquad (2a)$$

where: i,j – numerical code for the sector as rows (i) and columns (j) of I-O table; m – number of sectors; Q_j - sectoral output; z_{ij} – intermediate consumption of resources provided by sector i for obtaining the output of sector j; DA_i – resources of sector i allocated to the domestic absorption.

3. At a sectoral level, the equilibrium between supplied and used resources, for i=j, means:

$$\sum_j z_{ji}+GVA_j+NIT_j=\sum_i z_{ij}+DA_i+NX_i \qquad (3)$$

where NX_i – is net export (difference between export and import) at sectoral level.

A useful simplification may be obtained by introducing the concept of net inter-sectoral flows (NIF) defined as the difference between total intermediate consumption on row, and the same indicator on column, that is:

$$NIF_i=\sum_i z_{ij}-\sum_j z_{ji} \qquad (3a)$$

Hence, the relationship (3) can be rewritten as:

$$GVA_j+NIT_j=NIF_i+DA_i+NX_i \qquad (3b)$$

This formula has a clear economic sense. It shows that – in a maximally compressed expression – the net output (gross output minus own intermediate consumption) of each sector has a triple possible destination:

- as productive usage in other sectors,
- as domestic final demand, and
- for external final demand (net export).

Evidently, the sums of all inter-sectoral transactions on rows and columns are identical. This explains why at the macro-level, respectively when the gross domestic product is determined, neither NIF nor any other equivalent indicator appear.

4. The sectoral contribution to gross domestic product (noted G) can be therefore expressed at the supply side as:

$G_j=GVA_j+NIT_j$ (4),

and at the demand side as:

$G_i=NIF_i+DA_i+NX_i$ (4a),

both estimations (4) and (4a) being equal for i=j.

5. The main objective of the present work is to obtain the technical and Leontief coefficients of the Romanian I-O tables as continuous yearly series for the period 1989-2016. As it is known, the analytical valorisation of A and L matrices is complex, needing further research of interested specialists.

For the moment, we comment only on some dynamic characteristics of the I-O tables of Romania during its historical way from the centrally planned economy to the modern market system.

III. ROMANIAN ECONOMY EVOLUTION IN THE LIGHT OF I-O TABLES

The I-O tables for the entire period 1989-2016 provide a rich statistical information about almost three decades of the development of the Romanian's economy. The scope of our presentation is only the discussion of some structural tendencies registered in this pluri-dimensional socio-economic and cultural process.

From a sectoral structure perspective, until now we could distinguish three phases of the post-socialist evolution of Romania.

● The first decade (1990-1999) was characterized by the dismantling not only of the centrally planned mechanism, but also of the inherited large industries, transporting networks, agrarian exploitations.

● In 2000 Romania officially adopted – with large support from political parties, civic organizations, scientific centres, and public opinion – the National Program for Integration into European Union. Its implementation and the institutional changes induced by the negotiations with the European Commission represented favourable premises for the recovery of the Romanian economy.

● This process has been intensified after 2007, when Romania became a full member of the European Union.

1. A striking result of this historical transformation was a significant change of the sectoral structure of the economy.

1.1. Based on I-O tables for 1989-2016, two structural change coefficients were computed: one (named moving and noted Mscc) refers to

the yearly modifications, and another (referential one - Rscc) evaluates them in comparison with a given fixed year:

$$Mssc_t=((1/m)*\sum(sh_{it}-sh_{i(t-1)})^2)^{0.5} \quad (5)$$

and

$$Rssc_t=((1/m)*\sum(sh_{it}-rsh_i)^2)^{0.5} \quad (5a)$$

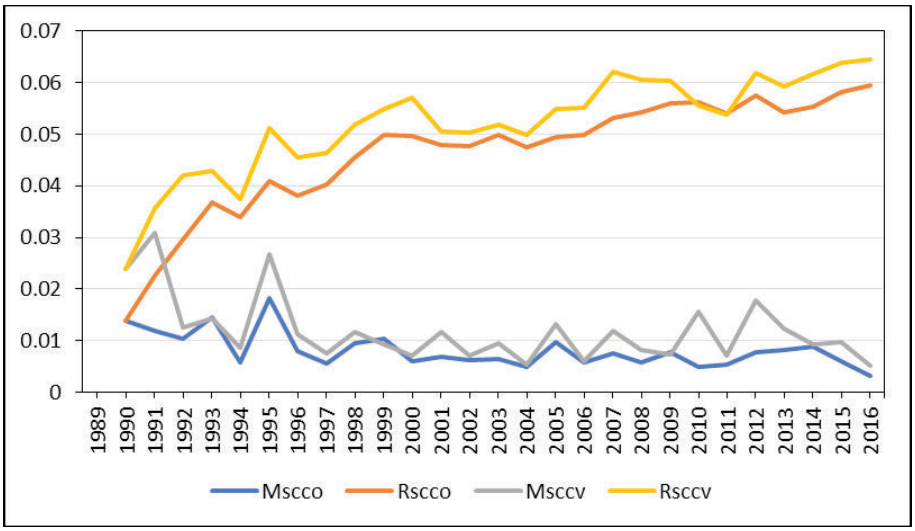
where m – is the number of sectors, sh_{it} - sectoral shares at time t, and rsh_i - sectoral shares adopted as a benchmark (1989 as the last year of the socialist regime).

Both coefficients (5) and (5a) are computed distinctly for the sectoral shares in output (suffix o). and for the sectoral shares in gross value added (suffix v).

1.2. The Figure 1 presents the dynamics of the so estimated structural change coefficients during the entire period 1990-2016.

Structural change coefficient during 1990-2016

Figure 1



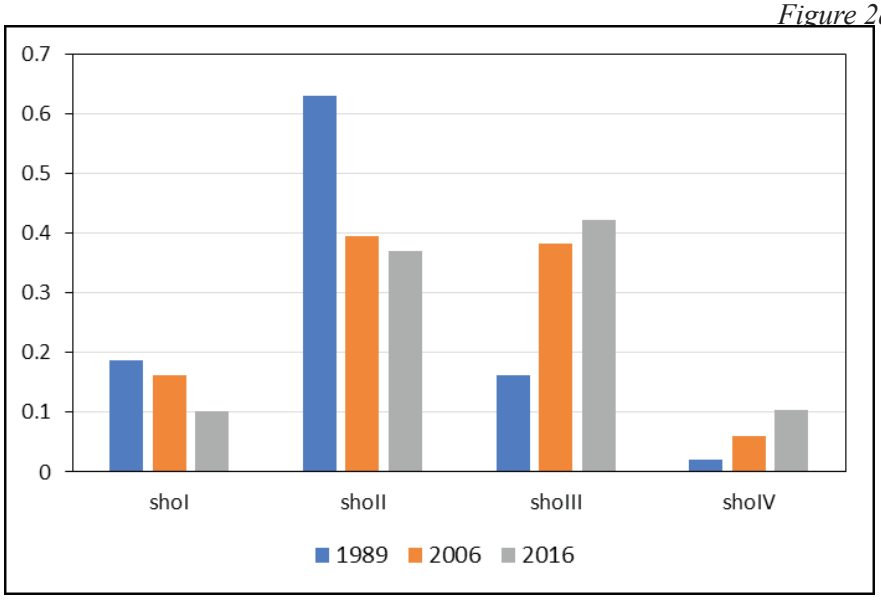
After the first part of transition, characterized by frequent and sometimes sudden changes, the sectoral shares volatility notably has mitigated. The trend stabilized, however, at a significantly different structure comparatively to 1989 (see Rscco and Rsccv in Figure 1).

2. A more informative image is offered by the mega-field aggregation.

At the three key-moments of the examined interval (1989, 2006 as pre-accession to EU year, and 2016), the four mega-fields classification (I–primary mega-field, II-secondary, III-tertiary, and IV-quaternary) is the following:

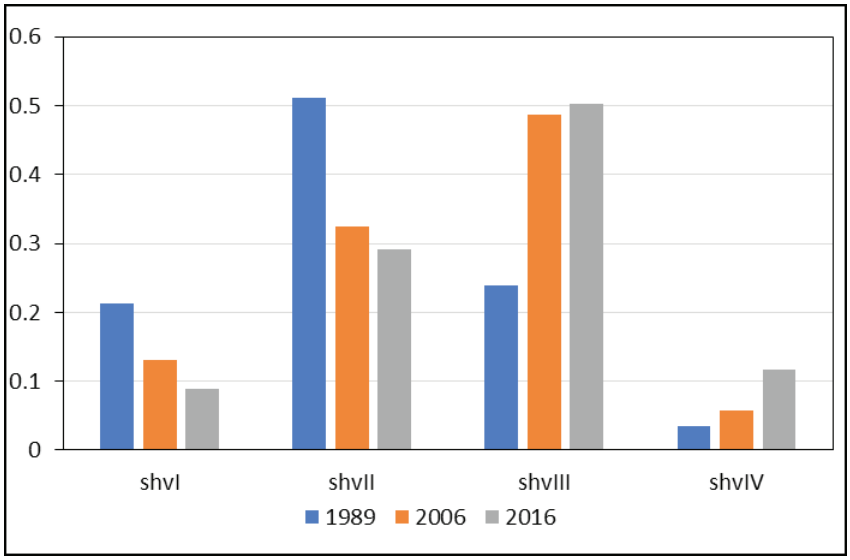
Mega-fields shares in output

Figure 2a



Mega-fields shares in gross value added

Figure 2b



Both Figures 2 and 2a outline that the Romanian economy unambiguously incorporated the dominant modernization trends.

3. Naturally, the structural changes have had ample repercussions on intra and inter-sectoral productive flows. In order to obtain a global image of this process, we computed a synthetizing indicator of all the changes in the technical coefficients (=m^2):

$$ca_t=(\sum_{ij}(a_{ijt}-a_{ij(t-1)})^2/m^2)^{0.5} \quad (6)$$

In this expression, the individual changes are aggregated with an uniform weighting factor (=$1/m^2$).

We also computed two weighted coefficients with weights defined according to the methodology described in (Dobrescu 2019).

In one case (noted coa), the weights were deduced from the sectoral shares in the global output of the economy:

$$coa_t=(\sum o_{it}*(a_{ijt}-a_{ij(t-1)})^2)^{0.5} \quad (6a)$$

were o_{it} are the weights based on the sectoral shares in output ($\sum o_i=1$)

In the other (noted cva) the weights resulted from the sectoral shares in the total gross value added:

$$cva_t=(\sum v_{it}*(a_{ijt}-a_{ij(t-1)})^2)^{0.5} \quad (6b)$$

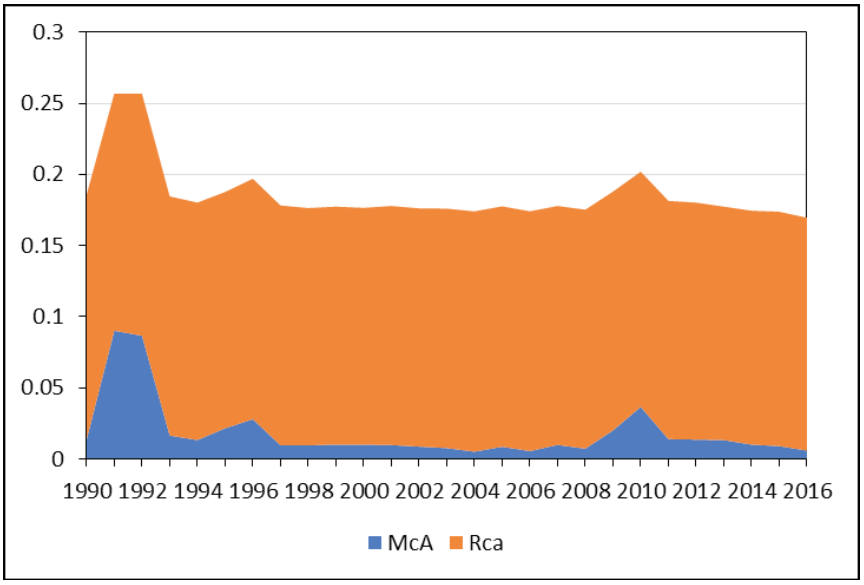
were v_{it} are the weights based on the sectoral shares in gross value added ($\sum v_i=1$).

Each of the indicators (ca_t. coa_t, and cva_t) were calculated as yearly changes (prefix M – moving), and against 1989 as the base year (R – referential).

During the period 1989-2016 the series ca_t. coa_t, and cva_t are plotted in Figures 3a, 3b, and 3c.

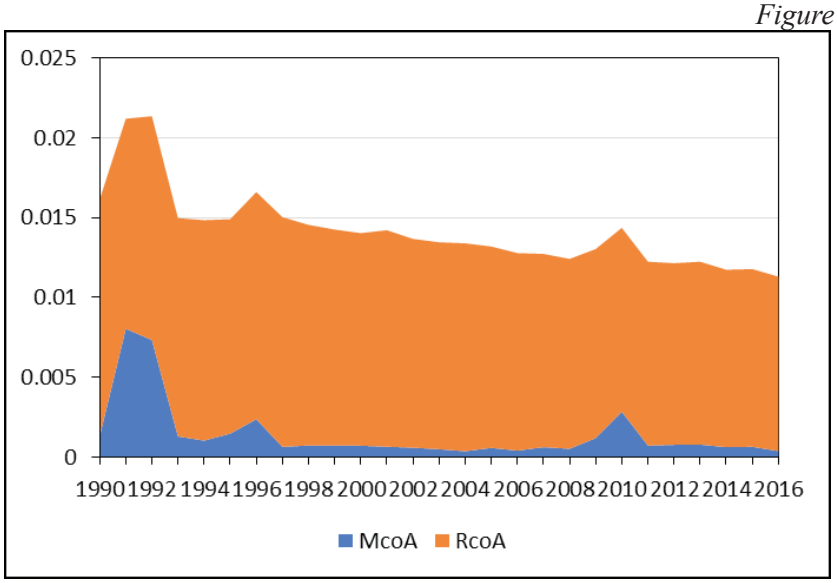
Moving and referential change of the technical coefficients

Figure 3a



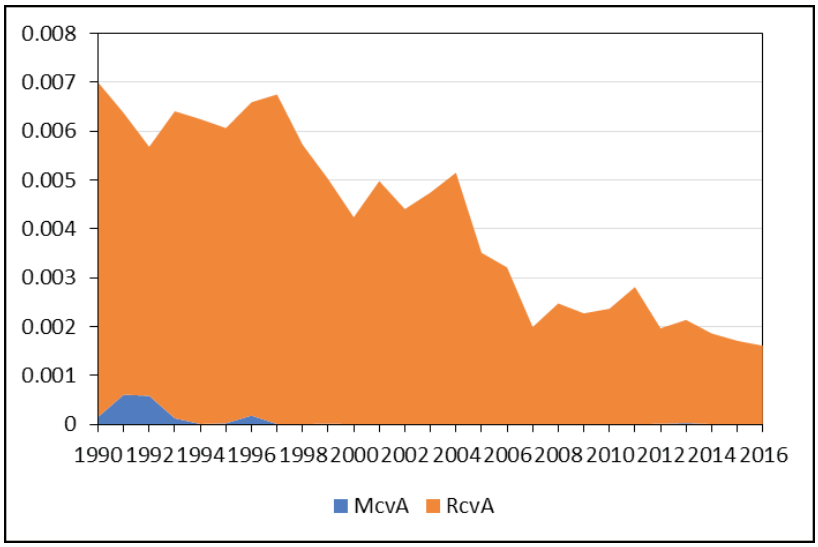
Moving and referential change (weighted by $w_{ij}O$) of the technical coefficients

Figure 3b



Moving and referential change (weighted by $w_{ij}V$) of the technical coefficients

Figure 3c



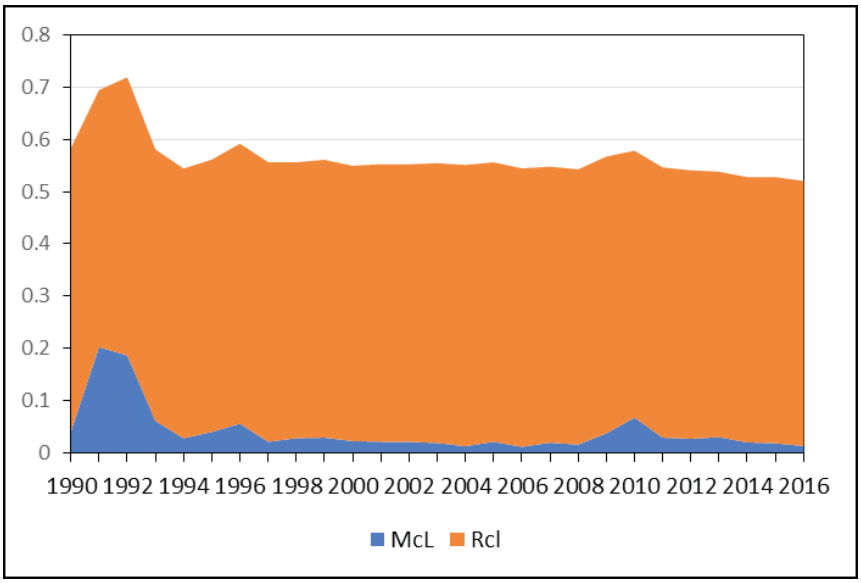
From the Figures 3a, 3b, and 3c it can be noticed that the changes in the technical coefficients were very important at the beginning of transition, afterwards they evolved around a relatively stabilizing trend. Generally, the technical coefficients have different dynamics during the three defined periods in time.

It is interesting to note also that the weighted coefficients produced more attenuated dynamics in comparison to the non-weighted ones. This may mean that the cluster of technical coefficients characterizing inter-flows among key-sectors (those with main shares in output, respectively in gross value added) evolved in narrower bands.

4. The same measures of dynamics have been applied to the matrix of the Leontief coefficients (noted by l instead of a). Figures 4a, 4b, and 4c present the corresponding moving and referential indicators.

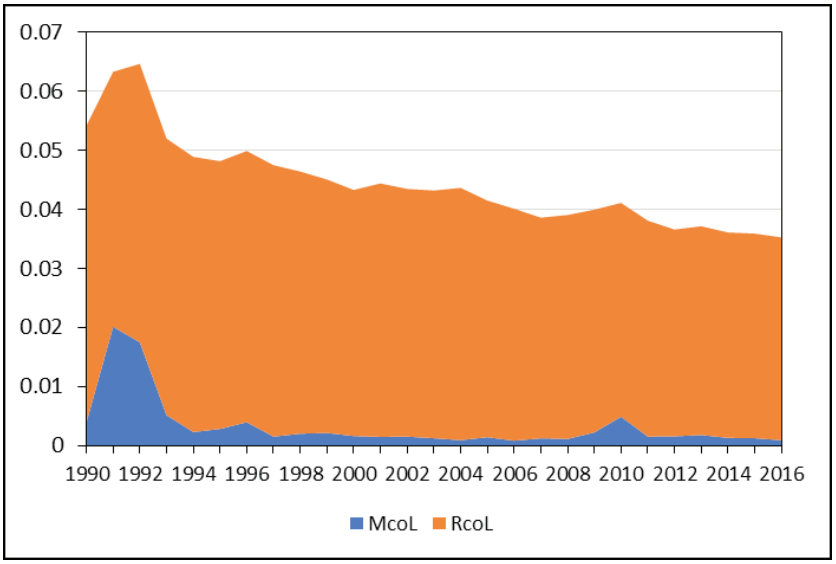
Moving and referential change in the Leontiev coefficients

Figure 4a



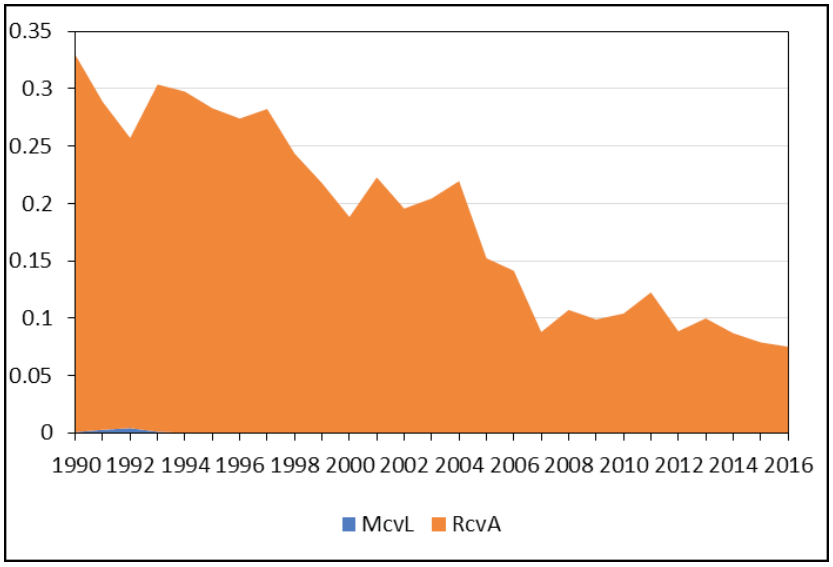
Moving and referential change (weighted by $w_{ij}O$) in the Leontiev coefficients

Figure 4b



Moving and referential change (weighted by $w_{ij}V$) in the Leontiev coefficients

Figure 4c



As was expected, the temporal features revealed examining the technical coefficients reverberate in the evolution of the Leontief ones.

IV. SOME CONCLUSION

As we already mentioned, the present text was intended as an explicative foreword for the Appendices which detail the matrices A and L of the Romanian economy during 1989-2016.

1. Obviously it is necessary to make important research efforts to adequately exploit all the cognitive and applicative opportunities offered by such long series of yearly I-O coefficients. Among these, the identification of backward and forward productive linkages, including I-O multipliers, must be especially mentioned. The triangulation of I-O tables also proved to be a powerful tool in the investigation of the intra- and inter-sectoral flows.

Many essential components of the economy's global efficiency - energy consumption, labour intensity, processing degree of raw materials etc. – could be more relevantly studied based on the technical and Leontief coefficients series.

Integrated into more complex models, the I-O information can be involved in the analysis of macroeconomic equilibria, international competitiveness, environmental problems. This enumeration could continue.

Besides the valorisation of the already existent I-O tables, it would be also an extension of the statistical support for application of this technique in Romanian economy. In our opinion, several ways are approachable even on short and medium term.

2. As a first step, it is necessary to complete the present computations in current prices with the corresponding estimations in constant ones.

This would allow to more specifically distinguish the determinants which induced the structural changes, respectively: i) the technological and managerial factors, and ii) the modifications in the relative prices of goods and services (sometimes with essential role). This way, the macroeconomic real-nominal binomial could be deeper deciphered.

3. The simulations showed that a fourteen sectoral structure represents a certain progress comparatively with previous more compact classification. This approach must be continued. It would be of great scientific and applicative interest to experiment other, maybe more disaggregated structures. The A and L matrices of increased dimensions would allow to reveal in a more detailed

manner the complexity of sectoral inter-dependences. The implications of the macroeconomic policies could be also better anticipated.

4. A serious challenge remains the assimilation of the input-output analysis in the territorial profile. Probably, the elaboration initially of the I-O tables for existent macro-regions would be a reasonable solution. With such an aim, a possible practical way could be the introduction – besides the present survey for inter-branch transactions - of a new special survey comprising the economic entities representative from an inter-regional flow perspective. Our opinion is to not reject the possibility to combine both nomenclatures, taking into account that a great number of companies are significant from both points of view.

5. The macroeconomic management requires a more and more projected A and L matrix, at least on short-medium run. Such a thematic is also highly interesting. On this issue the mainstream studies gravitate around the so named hybrid approaches. Depending on the available information and followed objectives, there are different possible procedures: econometric analysis, RAS algorithm, general equilibrium models. There are conditions, in our opinion, to develop such investigations for the Romanian economy as well.

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