Romanian IO Tables: Updated Series 1989-2018 in Twenty-Sectoral Structure

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ABSTRACT

The INS extended input-output tables were organized into twenty-sectoral structure, which allows a deeper investigation of the Romanian economy in its evolution from the centrally planned system to market mechanisms. Integral statistical series 1989-2018 are compacted into three annexes: i) the sectoral shares of output and of gross value added (Appendix 1); ii) the technical coefficients at current prices (Appendix 2); and iii) the Leontief coefficients at current prices (Appendix 3). Methodological problems discussed in the previous fourteen-sectoral structure (Romanian Statistical Review 3/2019) remain valid and are not repeated. As an illustration of the analytical insights offered by these statistical series, the present paper examines from a dynamical perspective the temporal intensity of sectoral changes, their interdependences, the main relocations of the output multipliers, structural impulses for changing the ratio of gross value added to output.

Key-words: *sectoral structure, I-O coefficients, stationarity tests, Granger causality, output multiplers*

JEL Classification: *C12, C67*

ROMANIAN IO TABLES: UPDATED SERIES 1989-2018 IN TWENTY-SECTORAL STRUCTURE

The previous similar analyses (Dobrescu and Gaftea 2017, 2019) were built on a fourteen sectoral structure: three sectors from the primary mega-field of economic activities, five from the secondary, four from tertiary and two from the quaternary ones.

1. The present study extends the number of sectors to 20, diminishing the informational losses induced by the aggregative operations. The sectors belonging to primary and secondary mega-fields of economic activities, respectively the sectors 1-8 are identical in both classifications. The other 6 sectors of the previous structure are reorganized into 12 in the new one, *obtaining a more representative specification of the tertiary and quaternary mega-fields, which are characterized by a special dynamism under the modern civilization. The following table describes account correspondence between twenty-sector and fourteen-sector structures.*

Comparative structures used in aggregation of the Romanian IO tables

Table 1

Twenty-sector structure	Fourteen-sector structure
● Agriculture, forestry, hunting and fishing (1);	● Agriculture, forestry, hunting and fishing (1);
● Mining and quarrying (2);	● Mining and quarrying (2);
● Production and distribution of electric and thermal power (3);	● Production and distribution of electric and thermal power (3);
● Food, beverages and tobacco (4)	● Food, beverages and tobacco (4)
● Textiles, leather, pulp and paper, furniture (5);	● Textiles, leather, pulp and paper, furniture (5);
● Machinery and equipment, transport means, other metal products (6);	● Machinery and equipment, transport means, other metal products (6);
● Other manufacturing industries (7);	● Other manufacturing industries (7);
● Constructions (8);	● Constructions (8);
**************************************	**************************************
● Wholesale and retail trade; repair of motor vehicles, and personal and household goods (9)	● Transports, post and telecommunications (9);
● Transport and storage (10)	● Trading services (10);
● Hotels and restaurants (11)	● Financial services, real estate transactions (11);
● Communications (12)	● Social services (12);
● Information (13)	● Creative services (13); and
●Financial intermediary and insurance (14)	● Professional services (mainly businesses) (14)
● Real estate transactions (15).	
● Professional and scientific-technic activities, administrative and support services (16)	
● Public administration and defense, public system of the social security (17)	
● Education (18)	
● Health and social assistance (19)	
● Cultural and recreational activities, spectacles and other services (20)	

The twenty-sector structure of economy can be easily converted into four mega-fields classification: the primary mega-field includes sectors (1+2+3); the secondary (4+5+6+7+8); the tertiary (9+10+11+12+14+15+17+19); and the quaternary (13+16+18+20).

The three annexes detail the statistical series (current prices) for the entire period 1989-2019 in this new sectoral structure: the sectoral shares in output and gross domestic value added (Appendix 1), the technical coefficients (Appendix 2), and the Leontief matrix (Appendix 3). In this way, a large palette of empirical studies can be developed.

The present study presents only several characteristics of the structural changes of Romanian economy during its historical transition from centrally planned system to market mechanisms. Particularly, the following questions will be especially commented:

- temporal intensity of the sectoral changes;
- their dynamical interdependences;
- the main relocations of the output multipliers;
- the structural impulses for changing the ratio of gross value added to output.

2. Through new sectoral classification, the intensity of structural changes can be more realistically approximated. For such a purpose, we shall use (as in the paper from 2019) two measures:

i) moving sectoral structural coefficient

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

ii) referential sectoral structural coefficient

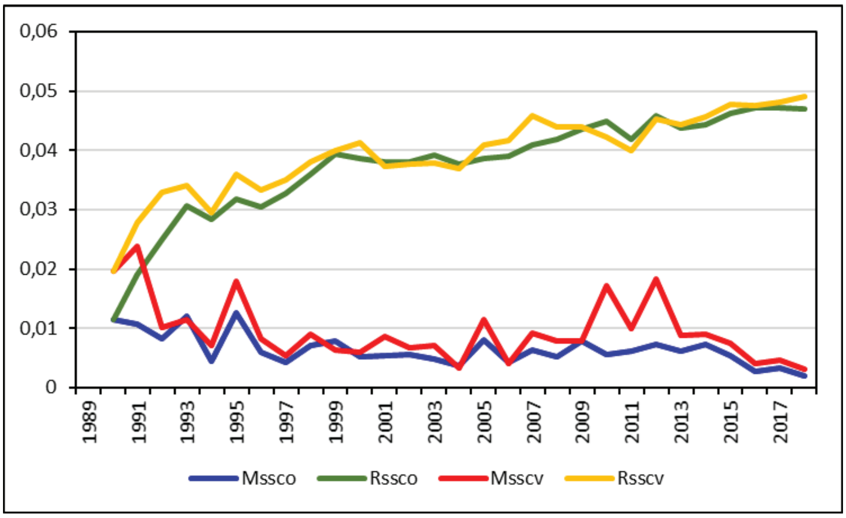
$Rssc_t=((1/m)*\sum(sh_{it}-rsh_i)^2)^{0.5}$ (1a),

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).

2.1. Recomputed for twenty-sectoral structure and for years 1990-2018, the coefficients (1) and (1a) concerning the productive sphere of economy - sectoral shares in the output (suffix o) and in the gross value added (suffix v) - maintain broadly the dynamical picture identified by fourteen- sectoral structure.

Moving and referential sectoral structural coefficients for output (suffix o) and gross value added (suffix v), during the 1990-2018 period

Figure 1



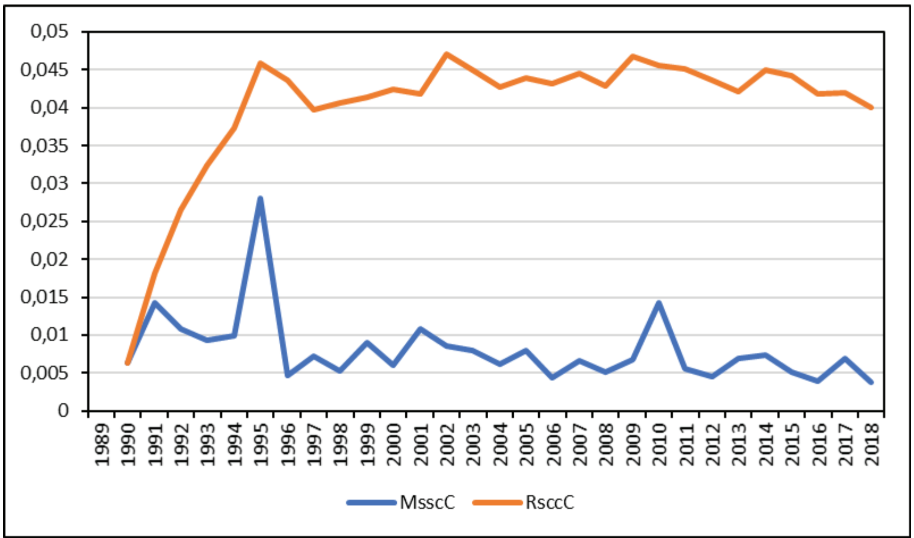
The accentuated structural turbulence during the first part of interval (signaled already in the previous paper) appears also clearly enough in the new IO tables. This came from a major peculiarity of the Romanian transition, when large previous industrial, agricultural and other types of productive infrastructure sectors were abandoned. The subsequent calmer, from this point of view, evolution coincided with the implementation of the preliminary institutional and socio-economic reforms required by the integration of Romania into European Union. Global financial crisis 2008-2010 and its consequences re-intensified the structural shifts, mainly regarding the sectoral ratios of value added to output. The relatively low levels registered during last years by Mssc are probable temporary, taking into account the expectable new structural mutations induced by Covid19 pandemic and by the implementation of EU climatological programs.

2.2. As expected, the supply-side structural changes of Romanian economy were accompanied by notable modifications concerning also the utilization of goods and services.

2.2.1. The final consumption characterized by the following temporal intensity of structural changes (Figure 2).

Moving and referential sectoral structural coefficients for final consumption (suffix C), during the period 1990-2018

Figure 2

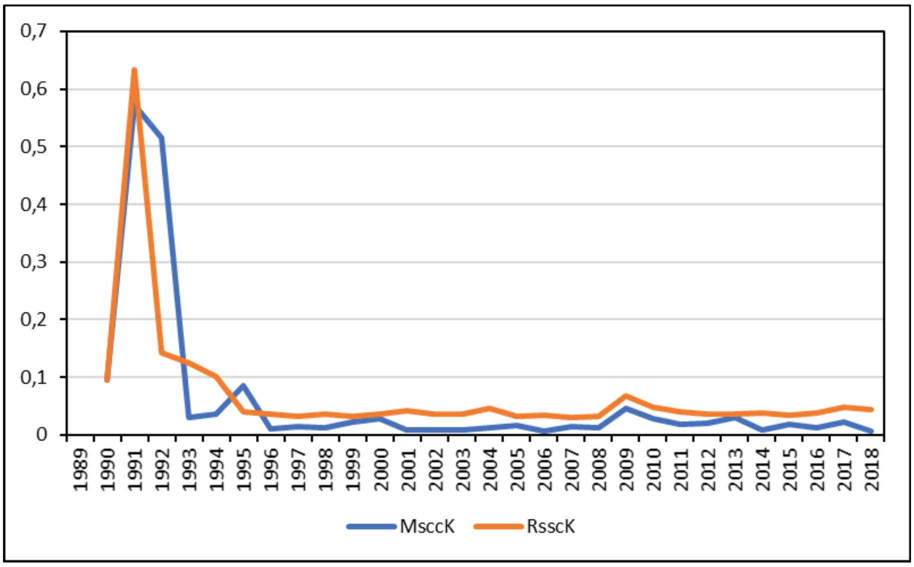


Apart from some shocks registered at the beginning of transition and along the previous global financial crisis, the moving coefficients oscillate within a restrained enough band. Compared to the starting point, the structural changes were however considerable (RsscC).

2.2.3. The gross capital formation shows a different picture from this point of view. (Figure 3).

Moving and referential sectoral structural coefficients for gross capital formation (suffix K), during period 1990-2018

Figure 3

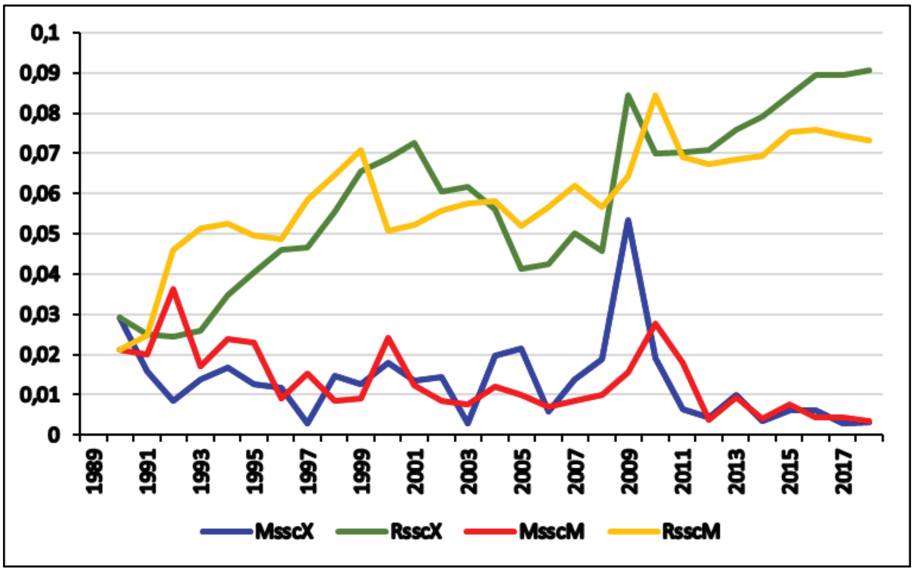


The spectacular breaks induced by the initial transformational processes of the transition to market economy were followed, therefore, by a stable enough sectoral structure of the investment programs.

2.3. The export (X) and import (M) of Romania also knew profound structural changes (Figure 3).

Moving and referential sectoral structural coefficients for export (suffix X) and import (M), during period 1990-2018

Figure 4



Two global features were dominant. On one hand, the external openness of Romanian economy amplified substantially: as ratio to output, the foreign trade (sum of export and import) increased from 15-17% during the first years of transition, to 25% in 2000 and to 46% in 2018. On the other hand, this trend was associated with important deficits of the foreign trade balance.

3. Treated themselves as time series, the coefficients Mssc allow to identify some dynamic interdependences among the structural change intensities in different spheres of economic activity. In our case, of great interest are such possible connections between the production and utilization of goods and services, respectively between Mssco, and the corresponding indicators for final consumption, gross capital formation, export and import. With this aim, it will be used the Granger causality test (Granger 1969), whose application is conditioned by the stationarity of the examined series.

3.1. Taking into account the diversity of the cognitive specificities belonging to statistical procedures conceived in this field, there will be used a set of unit root tests (Dickey and Fuller 1981, Phillips and Perron 1988, Kwiatkowski et al. 1992, Ng and Perron 1994, Gujarati and Porter 2009, Patterson 2011, Patterson 2012). We used: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), DF-GLS (developed by Elliott-Rothenberg-Stock), Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Elliott-Rothenberg-Stock point optimal (ERS), Ng-Perron (NgP) in four variants (MZa, MZt, MSB, MPT), and Breakpoint. Table 2 synthetizes the null hypothesis probabilities obtained for all five mentioned time-series.

Stationarity tests for the moving sectoral structural coefficients of output and utilization of goods and services - Probability of the null hypothesis

Table 2

Statistic test	Null hypothesis	Mssco	MsscC	MsscK	MsscX	MsscM
Augmented Dickey-Fuller	Series has a unit root	0.0032	0.0004	0.0731	0.0054	0.0446
Phillips-Perron	Series has a unit root	0.003	0.0004	0.0986	0.0059	0.0566
Elliott-Rothenberg-Stock DF-GLS	Series has a unit root	under 0.01	under 0.01	under 0.01	under 0.01	under 0.01
Kwiatkowski-Phillips-Schmidt-Shin	Series is stationary	0.01-0.05	0.01-0.05	0.01-0.05	0.01-0.05	0.01-0.05
Elliott-Rothenberg-Stock	Series has a unit root	over 0.1	under 0.01	0.01-0.05	over 0.1	0.05-0.1
Ng-Perron	Series has a unit root					
Variant	MZa	0.01-0.05	under 0.01	0.01-0.05	0.01-0.05	0.01-0.05
Variant	MZt	0.01-0.05	under 0.01	0.01-0.05	0.01-0.05	0.01-0.05
Variant	MSB	0.01-0.05	under 0.01	0.01-0.05	0.01-0.05	0.01-0.05
Variant	MPT	0.01-0.05	under 0.01	0.01-0.05	0.01-0.05	0.01-0.05
Breakpoint	Series has a unit root	under 0.01	under 0.01	under 0.01	under 0.01	0.0448

Therefore, the probability of null hypothesis does not reject the stationarity of the respective series in 8 applications for Mssco, 9 for MsscC, 7 for MsscK, 8 for MsscX, and 7 for MsscM. Such a proportion justifies, in our opinion, the utilization of Granger causality test in its standard version.

3.2. Applied on the relationship between output and its main destinations – domestic absorption and foreign trade - the results of Granger causality test for one and two lags are presented in Table 3.

Granger causality test, sample 1989-2018, for one and two lags

Table 3

	Lags 1			Lags: 2		
Null Hypothesis:	Obs	F-Statistic	Prob.	Obs	F-Statistic	Prob.
Mssco does not Granger Cause MsscC	28	0.24274	0.6265	27	5.68776	0.0102
MsscC does not Granger Cause Mssco		0.00534	0.9424		1.00846	0.381
Mssco does not Granger Cause MSCCK	28	3.42541	0.0761	27	3.04465	0.068
MSCCK does not Granger Cause Mssco		5.5223	0.027		1.38847	0.2705
Mssco does not Granger Cause MsscX	28	0.13288	0.7185	27	0.0398	0.9611
MsscX does not Granger Cause Mssco		0.6277	0.4357		0.26696	0.7682
Mssco does not Granger Cause MsscM	28	4.23263	0.0502	27	6.16053	0.0075
MsscM does not Granger Cause Mssco		14.9554	0.0007		4.17151	0.0291

These results do not confirm the tempter impression that structural changes intensity of output could come from the final consumption or export impulses. Stronger appears to be the connection of output with gross capital formation. What has to be especially outlined is the bilateral interdependence between output and import.

4. Among powerful analytical tools offered by the IO tables, the output multipliers (scL_i) have a special role. Approximating the global output generated by the entire economy for ensuring an increase by unity of the final resources of given sector i, these are equal to sum-columns of the Leontief matrix (L_{ij}):

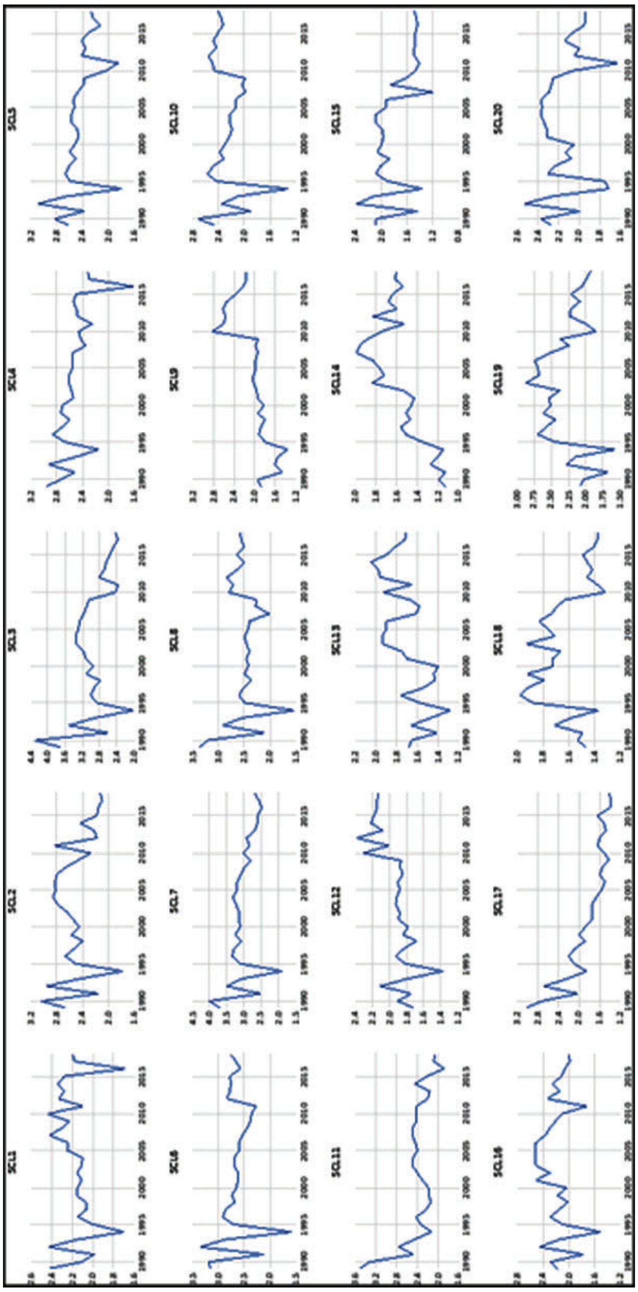
$scL_i=\sum_j L_{ij}$ (j=1, 2,…, n) (2)

Economically, therefore, the output multipliers reflect not only the direct, but also the propagated inter-branches productive flows (Dobrescu 1970, Leontief 1974, Leontief 1986, Okuyama et al. 2004, Pilat and Wölfl 2005, Eurostat, European Commission 2008, Hall 2009, Miller and Blair 2009, D'Hernoncourt et al. 2011, Bess and Ambargis 2011, Lazarov and Kocovski 2016, Hughes 2018, The Scottish Government 2020).

4.1. Figure 5 displays an overview about dynamics of output-multipliers scL_i in Romanian economy.

Output-multipliers (scLi) during the period 1989-2018

Figure 5

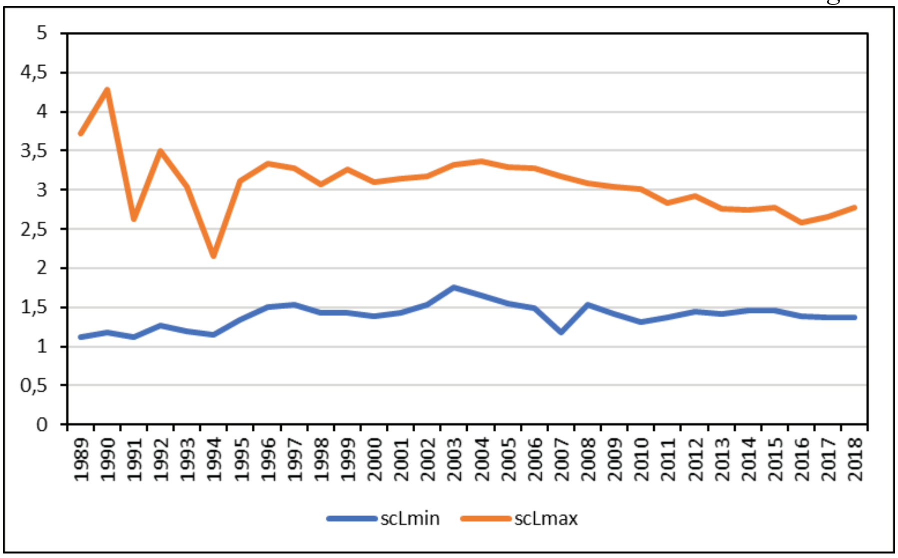


The rather turbulent evolution of output-multipliers should come as no surprise since they cumulate an extremely large spectrum of transformations – institutional and technologic-managerial, not avoiding the operational behaviors of economic agents and even accounting systems. Despite this “whirling” picture, some tendential features have to be noted.

4.2. Evolution of the output multipliers takes place between some limits, as revealed by Figure 6.

Limits of variation of scl_i produced during 1989-2018

Figure 6



Statistical analysis discloses some notable aspects. As time series, scLmax is clearly stationary: it is confirmed by 9 tests (ADF, PP, ERSDF-GLS, KPSS, NgP all four variants, Breakpoint); only ERS is negative). The case of scLmin is somehow different: ERS, NgP, and breakpoint tests do not accredit the stationarity; it is however accepted by ERSDF-GLS and KPSS, and at limit by ADF (0.0673 - null hypothesis probability) an PP (0.0717). The autocorrelation analysis signals a certain interdependence among data scLmax and scLmin series (Table 4).

Autocorrelation of scLmax and scLmin series

Table 4

	scLmax				scLmin			
Lags	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.253	0.253	2.1142	0.146	0.607	0.607	12.201	0
2	0.121	0.061	2.6132	0.271	0.381	0.019	17.174	0
3	0.268	0.24	5.1586	0.161	0.215	-0.037	18.818	0
4	-0.122	-0.276	5.71	0.222	0.097	-0.038	19.169	0.001
5	-0.092	-0.03	6.0357	0.303	0.083	0.07	19.431	0.002
6	0.089	0.093	6.351	0.385	0.038	-0.039	19.488	0.003
7	0.113	0.224	6.8847	0.441	-0.03	-0.079	19.525	0.007
8	-0.031	-0.154	6.9271	0.545	-0.115	-0.106	20.106	0.01

BDS test (Broock et al. 1996) enforces the conclusion that both series scLmax and scLmjn are not independent identically distributed (iid) series.

BDS test applied on scLmax and scLmin series

Table 5

Dimension	scLmax			scLmin		
	BDS Statistic	Norm. Prob.	Bootstrap Prob.	BDS Statistic	Norm Prob.	Bootstrap Prob.
	Fraction of pairs					
2	0.065307	0.0001	0.0148	0.081954	0	0.0012
3	0.128987	0	0.0052	0.132149	0	0.0016
4	0.168815	0	0.0024	0.156251	0	0.0022
5	0.228047	0	0.0006	0.15622	0	0.0054
6	0.251139	0	0.0002	0.145564	0	0.009
	Standard deviations					
2	0.129814	0	0	0.088276	0	0
3	0.186813	0	0	0.091553	0	0.001
4	0.213276	0	0	0.077932	0	0.002
5	0.218998	0	0	0.050943	0	0.0044
6	0.215737	0	0	0.03226	0	0.0092
	Fraction of range					
2	0.129814	0	0	0.013589	0	0.1266
3	0.186813	0	0	0.030327	0	0.1004
4	0.213276	0	0	0.050535	0	0.0872
5	0.218998	0	0	0.074534	0	0.0748
6	0.215737	0	0	0.102629	0	0.0624

There exist, therefore, enough reason for treating both scLmax and scLmin series as auto-regressive processes. With this end, for the series scLmax and scLmin there was selected a VAR system with as high as possible number of lags in order to take into account peculiarities of the sample data under stability VAR restriction. The following equations were retained:

scLmax = 0.739275*scLmax(-1) + 0.352509*scLmax(-2) -
0.176618*scLmax(-3) + 0.063871*scLmax(-4) - 0.095537*scLmax(-5)
- 0.060627*scLmax(-6) - 0.02749*scLmax(-7) - 0.120791*scLmax(-8) +
0.200991*scLmin(-1) - 0.053133*scLmin(-2) - 0.042201*scLmin(-3) +
0.134704*scLmin(-4) - 0.329895*scLmin(-5) + 0.307413*scLmin(-6) +
0.184198*scLmin(-7) - 0.242667*scLmin(-8) + 0.755140 (3a)

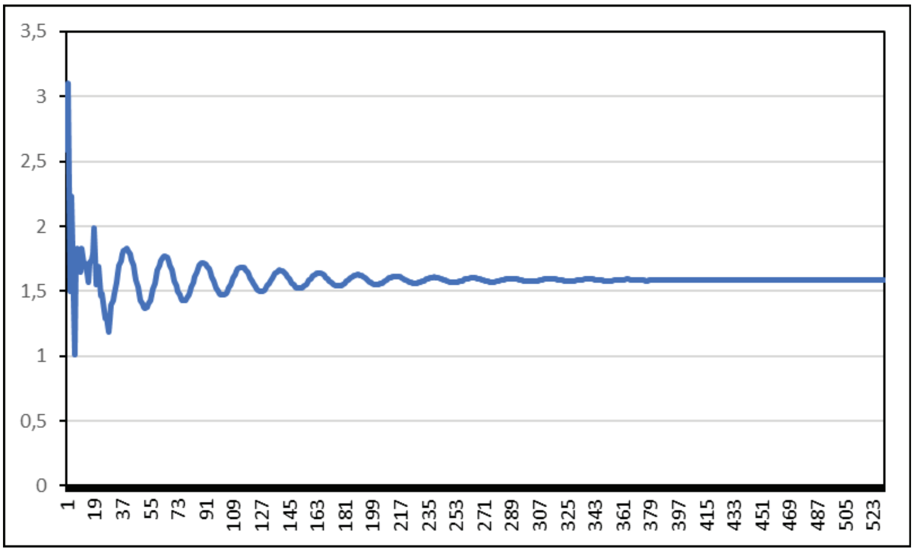
scLmin = 0.245675*scLmax(-1) - 0.167622*scLmax(-2) -
0.103779*scLmax(-3) + 0.148758*scLmax(-4) + 0.004381*scLmax(-5) +
0.093199*scLmax(-6) - 0.011095*scLmax(-7) - 0.055810*scLmax(-8) +
0.2316025*scLmin(-1) + 0.012499*scLmin(-2) + 0.075238*scLmin(-3)
- 0.281911*scLmin(-4) - 0.101835*scLmin(-5) + 0.157412*scLmin(-6) -
0.033316*scLmin(-7) - 0.12872*scLmin(-8) + 1.075381 (3b)

Observing the VAR stability condition, these equations were simulated by successive post-sample iterations. The resulted difference

dscL=scLmax-scLmin (4)
approximates the band within which the output multipliers are moving. Figure 7 plots the stabilizing tendency of this band in hypothetical absence of new shocks.

Estimated band (dscL=scLmax-scLmin) of the output multipliers evolution

Figure 7



4.3. As expected, such a dynamic process as transition involves a changing sectors hierarchy, depending on their output-multipliers size. Table 6 presents the number of observations in which the sector i (labeled on columns) places on rank j (on rows).

Number of observations in which the sector i places on rank j

Table 6

Rank / Sector	j																					Sum
I		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	1													4	10	2		7	7			30
	2									1				7	6	5		4	7			30
	3									2	1		3	4	3	5		5	6		1	30
	4									3			7	3	8	2		1	5		1	30
	5				1					6			9	9				1	3	1		30
	6	1								5	1			2	2	5		3	2	5	4	30
	7	2	1			1				4	2		3	1		10	3			1	2	30
	8	6	1			1					4	2	1		1	1	8	2		1	2	30
	9	6							2		5	3	1				7			3	3	30
	10	6	3				1					3	1				3	1		3	9	30
	11	1	1			1			3		1	7	3				3	2		2	6	30
	12	4	1		1	2	1		4	2	7	2	1				1	2		1	1	30
	13	3	2		1	5	2		6			4	1				4			1	1	30
	14		6	2	3	8	1		3	1	2	2					1			1		30
	15	1	4		9	5			1	1	2	1						1		5		30
	16		1		4	5	7		1	3	4	1						1		3		30
	17		2	4	8	2	3	2	3	1	1	2								2		30
	18		7	3	2		8	2	5			2								1		30
	19		1	11			1	13	2	1		1										30
	20			10	1		6	13														30
Sum		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	

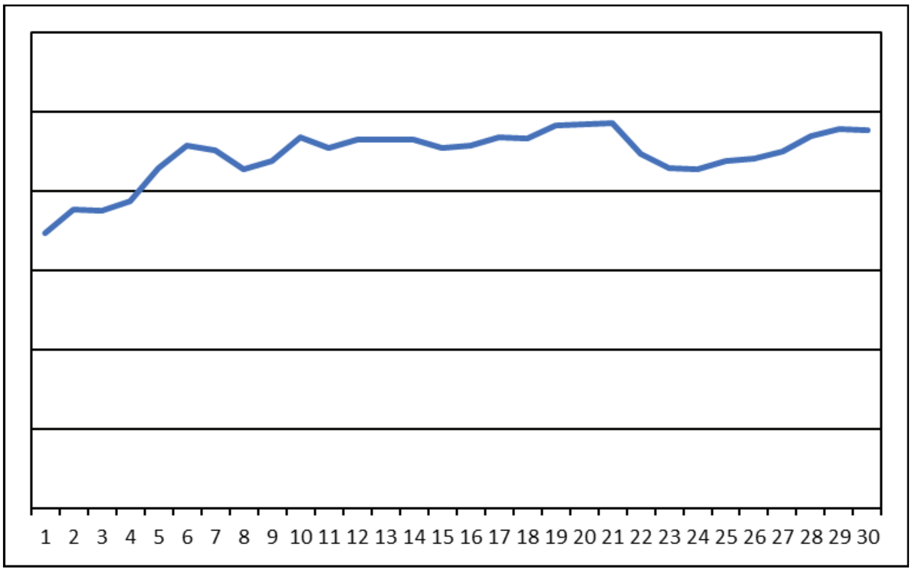
The greatest output multiplier (rank 1) belonged, therefore, ten years to sector 14, 7 to sector 17, and again 7 to sector 18. At opposite side, the lowest output multiplier (rank 20) was registered 13 times for sector 7, 10 for sector 3, and 6 for sector 6. Hierarchy of these sectoral output multipliers can be especially useful in the analysis and projection of the macroeconomic consequences of different structural changes.

5. An important problem concerns the impact of the sectoral distribution of output on the ratio of gross value added to output, named rgva. This approximates globally the adding value rate (to used productive inputs) of different economic activities, independent on sources inducing it: technological innovations, managerial improvements, relative prices modifications.

5.1. Figure 8 plots dynamics of rgva at level of entire Romanian economy,

Evolution of rgva during 1989-2018

Figure 8



The initial growth of rgva has resulted probably from the initial abrupt liberalization of economic activity, associated with the deep shifts in the relative intersectoral prices and a drastic compression of the mining and other primary branches. This first phasis is followed by another - long enough of slightly increasing and mainly stabilizing trend, interrupted by the global financial recession. The post-crisis recovery must be cautiously taken into consideration because the data do not comprise Covid19 pandemic years.

5.2. Sectoral $rgva_i$ have characterized by several evolutive patterns. Five of them (4, 5, 7, 15, 17) knew an ascending trend, while others - again five (1, 9, 12, 13, 14) registered a contrary trend; all the rest traversed more or less accentuated oscillations. As an average on the whole interval, the sectoral rgva are distributed as follows: the median group (rgva between 0.4-0.6) comprises 11 sectors (1, 2, 5, 8, 9, 10, 11, 12, 16, 19, 20), the lowest group (rgva under 0.4) comprises four sectors (3, 4, 6, 7), and the other five (13, 14, 15, 17, 18) belong to the superior one (rgva over 0,6).

5.3. Dynamically, the ratio of gross value added to output ($rgva_t$) can be interpreted as a function of impulses coming from the changes of the sectoral rates as such ($rgva_i$) and from modification of the sectoral distribution of output ($rgvaq_i$). The first type of influences is aggregated into rgvar, and the second one into rgvac. In what proportions the rgva evolution was determined by these two types of influences – it would be certainly a question of interest. Therefore:

$rgva_t=f(rgvar_t, rgvaq_t, resrq_t, u_t)$ (5)

$rgvar_t=\Sigma(rgva_{it}*shq_{i(t-1)})$ i=1, 2,…,n) (6)

$rgvaq_t=\Sigma(rgva_{i(t-1)}*shq_{it})$ i=1, 2,…,n) (7)

where i symbolizes the code of sector.

In accordance with the stated analytical purpose – that is the best possible approximation of proportion in which rgvar and rgvaq are influencing rgva – a strictly bifactorial linear specification of (5) would be preferable. The series rgva, rgvar, and rgvaq are not stationary in levels.

Regarding rgva, only PP and KPSS are accepting the stationarity in level, all the rest of the processed tests suggesting opposite conclusion. The situation is not significantly different nor for rgvar (with ADF, PP, and KPSS favorable) or for rgvaq (with PP and KPSS). The first order differences (prefix d) are, instead, undoubtedly stationary: ERS procedure is the only one ambiguous for drgva. Consequently, the relationship (5) was estimated in differences, with the following results:

Dependence ofd rgva on drgvar and drgvaq

Table 7

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.00052	0.001618	-0.32233	0.7499
drgvar	0.798022	0.090976	8.771832	0
drgvaq	0.191501	0.080164	2.388877	0.0248
R-squared	0.773947	Mean dependent var		0.003575
Adjusted R-squared	0.755863	S.D. dependent var		0.016521
S.E. of regression	0.008163	Akaike info criterion		-6.67745
Sum squared resid	0.001666	Schwarz criterion		-6.53471
Log likelihood	96.48425	Hannan-Quinn criter.		-6.63381
F-statistic	42.79676	Durbin-Watson stat		3.063668
Prob(F-statistic)	0			

Therefore, at the level of the entire economy, the variation of rgva is decisively conditioned by changes of its sectoral levels, and only subsidiarily by the modification of its sectoral distribution of output as such.

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