The Analysis of the Correlation Regarding the Chemical Industry Main Results in Romania

Experimental study

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The implications of the chemical industry in the economy can be seen in almost all the products we use in everyday life, through the chemical processing of natural raw materials from the soil, water and air. Starting from this, this research paper analysed the statistical correlation between the industrial production of the chemical industry in Romania and its main variables. We applied statistical tools for a period of 15 years. The results were analysed in the context of relevant international statistics, as well as compared to those obtained in Romania before 1990.

Keywords: chemical industry, macroeconomic variables, statistical correlations

The connection between the chemical industry and the economy can be seen by transforming natural raw materials from the soil, water and air in the products we use in our daily lives, such as food, clothing (fibres, dyes), health care products (medicines), cosmetics, computer technology, non-polluting energy sources, transport fuels, plastics, fertilizers, and any other product of modern life that depends on the chemical sector of the economy.

The main raw materials for the chemical industry are: coal, alcohols, air, cellulose, oil, minerals, animal fats, natural gas, aromatics, water, fats (oils), monomers, fatty acids and wood. Most of the basic chemical production, approximately 90%, is produced from oil, natural gas, coal and oil shale, water and air. To manufacture chemicals, other raw materials are also used, such as ores, which is feedstock for the manufacture of metals and non-metallic products; raw materials of animal and vegetable - fat, wool, cotton, wood, etc.; and biomass, such as the waste from agriculture, food and wood industry. Biomass represents a new source of raw materials required by the resource crisis for the chemical industry.

In this paper we test 4 sets of hypotheses to verify whether or not there is a correlation between the industrial production of the chemical industry, as a dependent variable, and 6 independent variables that characterize the main results of the chemical industry in Romania. The results are analysed in the context of relevant international statistics and compared to those obtained in Romania before 1990. To carry out the present research, we applied the statistical tool for selected variables over a period of 15 years.

The paper is organized as follows: a separate section is the presentation of the experimental part in which we described the data and methodology used. Then, there is a section of results and discussions, interpreted amid international results, but also compared to those obtained in Romania before 1990. In the last part of the paper we presented the findings of our research.

Experimental part

Database and methodology

In Romania, according to the classification of national economy sectors, the chemical industry can be found in the Statistical Yearbook as *the manufacturing of chemicals and chemical products* and is part of the manufacturing industry [1].

According to the codes of the Classification of Activities of National Economy (CANE) in 2016 [2,3], the branch *the manufacturing of chemicals and chemical products* (group 20) comprises the following industry groups: the manufacturing of basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms; the manufacture of pesticides and other agrochemicals, paints, varnishes, printing ink and mastics, soaps, detergents and maintenance products, cosmetics and perfumery, of synthetic and artificial fibres and manufacture of other chemicals, such as explosives, glues and others.

According to the Statistical Yearbook of Romania, at the level of 2014, 880 companies were active in the industry of the manufacturing of chemicals and chemical products [1]. Out of 880 companies, the top 10 companies, classified according to their turnover, are presented in table 1.

Thus, of the 10 companies with the highest turnover in Romania, in the year 2014, only 4 recorded a net profit while the others made a loss. The four companies that made a net profit at the end of 2014 are, in order, the following: Azomures SA, having as main activity the manufacture of fertilizers and nitrogen compounds; Linde Gaz Romania SRL having as object of activity the manufacture of other basic organic products; Redox SRL, dealing with the manufacture of pesticides and other agrochemicals; and Egger and Technology Ltd, having as main activity the manufacture of other basic organic products.

Figure 1 shows the return on assets and the return on equity for the 10 companies. Thus, we can see that Oltchim SA recorded a negative return on assets of over 50%, which means that its gross loss accounts for half of total assets. The highest rate of return on assets is obtained by Redoxim SRL, approximately 19%, followed by Linde Gaz Romania SRL, with over 12%. The largest contribution of net profit in the equity of companies, measured by the financial rate of return, of more than 68%, is recorded at Bio Fuel Energy SRL, which activated in manufacturing other basic organic products. Assets efficiency values range from 0.13% for

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Table 1

THE FIRST TEN COMPANIES IN THE CHEMICAL INDUSTRY IN ROMANIA, ACCORDING TO THEIR TURNOVER, IN 2014

No.	Name of company	Town/ County	Turnover (thousand lei)	Total assets (thousand lei)	Equity (thousand lei)	Gross profit (thousand lei)	Net profit (thousand lei)	Employees	Return on equity (%)	Return on assets (%)	Assets efficiency	Labour productivity (thousand lei/employee)
1.	Azomureș SA	Târgu Mureș/ Mureș	1,681,092	1,822,749	1,250,849	143,941	122,830	1729	7.90	9.82	0.92	972
2.	Oltchim SA	Râmnicu Vâlcea/ Vâlcea	627,531	908,105	-2,836,744	-459,320	-459,320	2267	-50.58	16.19	0.69	277
3.	Linde Gaz Romania SRL	Timișoara/ Timiș	507,874	837,375	573,978	104,171	86,319	424	12.44	15.04	0.61	1,198
4.	Greenfiber International SA	Buzău/ Buzău	332,230	182,726	74,883	15,919	-13,932	626	8.71	-18.61	1.82	531
5.	Uzinele Sodice Govora – Ciech Chemical Group SA	Râmnicu Vâlcea/ Vâlcea	284,340	309,598	-412,625	-313	-313	609	-0.10	0.08	0.92	467
6.	Egger Technologia SRL	Rădăuți/ Suceava	284,039	269,191	116,570	12,904	11,593	49	4.79	9.94	1.06	5,797
7.	Bio Fuel Energy SRL	Zimnicea/ Teleorman	254,135	362,776	-21,461	-14,624	-14,624	256	-4.03	68.14	0.70	993
8.	Redoxim SRL	Ghiroda/ Timiș	252,277	142,086	100,045	26,936	21,393	177	18.96	21.38	1.78	1,425
9.	Regia Autonomă pentru Activități Nucleare RA	Drobeta-Turnu Severin/Mehedinți	225,980	1,736,335	262,280	-86,071	-86,071	2427	-4.96	-32.82	0.13	93
10.	Prio Biocombustibil SRL	București	216,263	132,897	20,039	-11,513	-11,513	50	-8.66	-57.45	1.63	4,325

Source: Source: data synthesized and calculated by authors using the site of the Ministry of Public Finance, http://www.mfinante.gov.ro/obiee.html?pagina=domenii

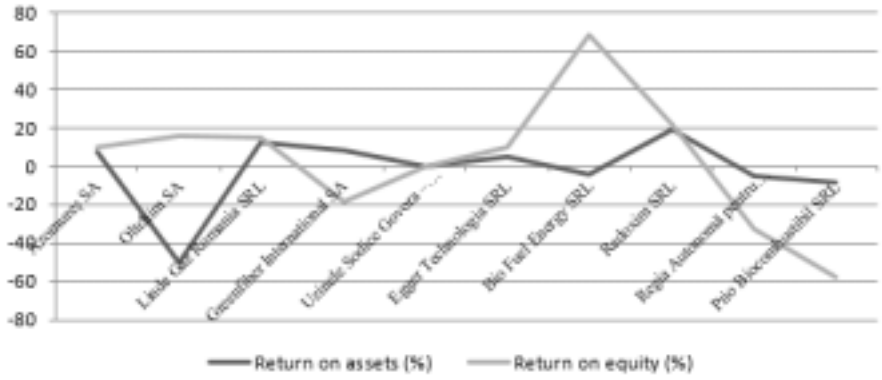

Fig. 1. The return on assets and return on equity for the first ten companies from chemical industry in Romania, year 2014

Source: authors calculation based on the financial indicators of the companies [4]

the Autonomous Administration for Nuclear Activities and 1.82% for Greenfiber International SA (table 1).

To test what the causality is between the chemical industry production in Romania and its main influencing factors, we analysed the correlation among the variables identified using statistical tools.

Based on the theoretical dependence of the variables analysed, but also on the records of the previous research found in the technical literature, we formulated the following hypotheses:

H1: *There is a significant positive association between the value of production and the investment in tangible fixed assets in the chemical industry;*

H2: *There is a significant positive association between the value of production, the gross value added and the value of exports in the chemical industry;*

H3: *There is a significant positive association between the value of production and the number of companies operating in the chemical industry;*

H4: *There is a significant positive association between the value of production and the number of employees working in the chemical industry.*

For the analysis, we used data that characterize the manufacturing industry for the branch of the manufacture of chemicals and chemical products, taken from the Statistical Yearbook of Romania for the period 2000 - 2014 [1], presented below. The variables used for testing the statistical correlations are: production, denoted by P, as the dependent variable; the gross value added (VA); the number of enterprises (NE); the average number of employees (ANE); net investments (NI); tangible fixed assets (TFA) and export FOB (EX), as independent variables, analysed within each set of hypotheses.

Thus, the net investments made in this sector increased from 244.6 million Lei current prices in 2000 to 1207.6 mil. Lei in 2011, following a decline to 438.4 mil. Lei in current prices in 2012, followed by a growth to 863 million lei in 2014. As such, the allocation of direct investment in this sector, the chemical industry, would be a branch of the economy that Romania might count on for development in the coming years.

As can be seen in figure 2, the evolution of investment in tangible fixed assets showed approximately the same trend as the evolution of the industrial production.

Overall in economy, the number of companies in this sector increased between 2000-2004, from 1,026 companies to 1,221, followed by a downward trend during 2004-2012, from 1,221 to 824 companies, followed then by an increase between 2012 and 2014 to 880 companies. The average number of employees decreased almost 3 times in the analysed period, 2000-2014, from 72,647 employees in 2000 to 25,748 employees in 2014.

However, the production of companies in the branch of the manufacture of chemicals and chemical products

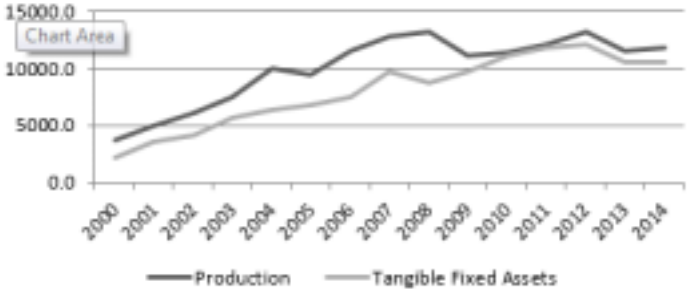

Fig. 2. The evolution of production and tangible fixed assets for chemical industry in Romania (expressed in milion RON current prices), period 2000-2014, [1] section 12. Investments and Tangible Fixed Assets

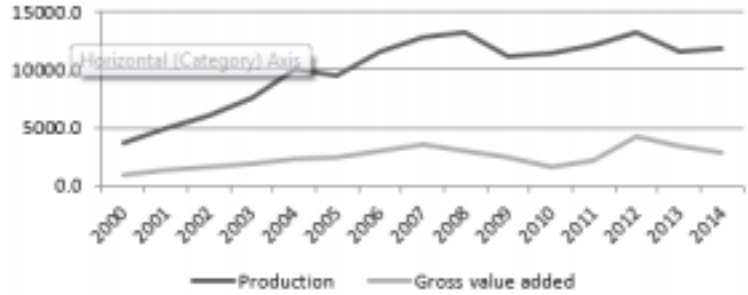

Fig. 3. The evolution of production and gross value added for chemical industry in Romania, period 2000-2014, [1] Section 11. National Accounts

recorded an economic recovery trend between 2000 and 2004, increasing then from 3,727.3 million Lei current prices, to 10,052 Lei in 2004, followed by a decrease in 2005 to 9,452 million Lei. There followed three distinct periods of growth, 2005-2008, 2009-2012 and 2013-2014, as shown in figure 3, where the evolution of the gross value added is presented, with approximately the same trend as the industrial production.

FOB exports registered a growth trend between 2000 and 2008, from 687 million EUR to 1,848 million Euros, followed then by a slight decrease in 2009, to 1,045 million Euros. During 2010, 2012 exports rose again, reaching a maximum in the last 15 years, of 2,187 million Euros in 2012. Later, from 2013, exports have started to fall again, reaching 1,837 million Euros at the end of 2014.

Regarding the share of chemical production in the total production, at the end of 2011 [1], the chemical industry generated 3% of all industrial production, registering a downward trend between 2000 and 2011, from 7% of the total industrial production.

Results and discussions

In order to deepen the analysis of the correlation between the value of chemical industry production and the identified variables, we used Pearson correlation coefficient, calculated using SPSS software. The values of this coefficient, which allows the illustration of the possible correlations among all variables considered in this analysis, as well as the level of their significance, are shown in table 2.

After having analysed the Pearson coefficient values, we observed that the value of production in the chemical industry is strongly correlated with most variables analysed. Thus, the highest value for the Pearson coefficient was registered in the dependence between the production value and the value of fixed tangible assets (0.910). In addition, the value of Sig is equal to 0, which means that the positive dependency signalled is significant. High values were also registered for other variables: net investments (0.751), exports (0.876) and gross value added (0.821).

The number of enterprises does not have a significant influence on the value of production, the Pearson correlation coefficient recording the value of -0.354, with a Sig significance level 0.195 times higher than the limit of 0.05, making this value not significant.

Surprisingly, between the value of production and the average number of employees a negative Pearson correlation coefficient (-0.880) was registered, with a Sig significance level of 0.000. Under these circumstances, increased production is explained by the rise in labour productivity, while the average number of employees decreased.

The analysis of the identified correlations for each independent variable analysed is also based on the results of the analysis of the dependency among them.

Thus, the gross value added is positively correlated with the value of exports (Pearson correlation coefficient = 0.784 and Sig = 0.001) and the value of tangible fixed assets (Pearson correlation coefficient = 0.702 and Sig = 0.004), whereas the correlation with the average number of employees is negative (Pearson correlation coefficient = -0.650 and Sig = 0.009). The three correlations are strong and significant because Sig is less than 0.05.

Net investments are positively correlated with exports (0.580) and the value of tangible fixed assets (0.632) and negatively correlated with the average number of employees (-0.641). The number of enterprises significantly correlated only with the average number of employees (0.686), and negatively correlated with other variables, the correlation being more often than not insignificant.

Thus, in terms of testing the four hypotheses, following the analysis carried out, we can draw the following conclusions:

- there is a positive, extremely strong association between the value of production and the investment in tangible fixed assets in the chemical industry, which means that *the research hypothesis H1 is accepted*;
- there is a positive, very strong association between the value of production, the gross value added and the value of exports in the chemical industry, which means that *the research hypothesis H2 is accepted*;
- there is not a significant positive association between the value of production and the number of companies operating in the chemical industry, which means that *the research hypothesis H3 is rejected*;
- there is not a significant positive association between the value of production and the number of employees working for the chemical industry, which means that *the research hypothesis H4 is rejected*;

In conclusion, two of the four hypotheses tested (H1 and H2) were accepted, the other two (H3 and H4) were rejected.

		P	VA	NE	ANE	NI	TFA	EX
P	Pearson Correlation	1	0.821**	-0.354	-0.880**	0.751**	0.910**	0.876**
	Sig. (2-tailed)		0.000	0.195	0.000	0.001	0.000	0.000
	N	15	15	15	15	15	15	15
VA	Pearson Correlation	0.821**	1	-0.224	-0.650**	0.323	0.702**	0.784**
	Sig. (2-tailed)	0.000		0.423	0.009	0.240	0.004	0.001
	N	15	15	15	15	15	15	15
NE	Pearson Correlation	-0.354	-0.224	1	0.686**	-0.199	-0.631*	-0.617*
	Sig. (2-tailed)	0.195	0.423		0.005	0,.477	0.012	0.014
	N	15	15	15	15	15	15	15
ANE	Pearson Correlation	-0.880**	-0.650**	0.686**	1	-0.641*	-0.959**	-0.859**
	Sig. (2-tailed)	0.000	0.009	0.005		0.010	0.000	0.000
	N	15	15	15	15	15	15	15
NI	Pearson Correlation	0.751**	0.323	-0.199	-0.641*	1	0.632*	0.580*
	Sig. (2-tailed)	0.001	0.240	0.477	0.010		0.011	0.023
	N	15	15	15	15	15	15	15
TFA	Pearson Correlation	0.910**	0.702**	-0.631*	-0.959**	0.632*	1	0.890**
	Sig. (2-tailed)	0.000	0.004	0.012	0.000	0.011		0.000
	N	15	15	15	15	15	15	15
EX	Pearson Correlation	0.876**	0.784**	-0.617*	-0.859**	0.580*	0.890**	1
	Sig. (2-tailed)	0.000	0.001	0.014	0.000	0.023	0.000	
	N	15	15	15	15	15	15	15

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 2
CORRELATION COEFICIENTS OF THE ANALIZED VARIABLES

At a global level, the chemical industry, one of the largest and fastest growing industries, confirms its role as one of the key drivers of economic recovery.

However, starting from 2014, in April 2014, the global chemical production decrease registered a peak of 3.7% [5]. In September, American Chemistry Council, reported a decrease of 3% of chemical production in the major regions of the world, so [6]: in Asia, chemical production was halved from 6.4 to 3.2%; in Latin America, chemical production was negative, of -3.2%; in Western Europe, it decreased from 4.1 to 3.2%; in North America recorded a peak of 5.3% in February 2015, which was halved to 2.4%; only Central and Eastern Europe recorded a strong growth to 9.2%.

Compared with results obtained in the chemical industry before 1989, during the communist period, the chemical industry registered an impressive growth due to the significant reserves of oil and mining that Romania had.

Thus, if before the Second World War the chemical industry generated less than 3% of the total industrial production, by 1980 it produced between 10 and 20% of the total industrial production and it represented over 25% of export earnings [7].

The largest share of the chemical industry was owned by petrochemical branch, which produced approximately 50% of the total production of the chemical industry. After factories on sodium and chlorine were built in Turda, Tarnaveni, Govora and Ocna Mures, Romania became the biggest manufacturer of products based on sodium and chlorine in Comecon[1], after U.R.S.S. After 1985, Romania focused on the production of complex chemicals, such as particular plastic, synthetic rubber, fibres, plates, medicines, and detergents. The government's target was that by 1989, the amount of fertilizers and agricultural products manufactured in Romania would double.

Conclusions

The present analysis highlights the fact that the results of the production of the chemical industry in Romania are part of its overall trend in Central and Eastern Europe, but this growth is not very strong in Romania, as the average obtained in this region is. To do this, we must interfere with those variables that support its growth, such as investments in tangible fixed assets, exports and gross value added.

The number of employees and the number of enterprises in the chemical industry do not affect the industrial production. Moreover, as the results of the top 10 companies in the market, according to their turnover, show, only 4 of them made a net profit at the end of 2014, namely those companies with more employees than those which made a loss (table 1).

The results of the research done in the international technical literature regarding performance in the chemical industry [8] reveal the fact that the allocation of expenses for research and development for qualifying employees significantly increases the performance of companies, while companies that do not allocate financial funds for upgrading skills, do not obtain remarkable results.

Compared to the situation until 1990, of the 21 large petrochemical and chemical plants that operated in Romania in the late 90s, 15 of them have been bankrupted or closed in the last 15 years. Some of them have reached the scrap being dismantled, others were sold in parts, and currently operate under different names, with reduced number of staff [9].

All major Romanian refineries: Petromidia Rafo, Petrobrazi Petrotel-, Arpechim had petrochemical plants attached, which produced ethylene, propylene, polyethylene and other finished products or raw materials which were further processed in chemical plant such as Oltchim. Of these, only the petrochemicals in Petromidia

still operates today, while petrochemicals from Arpechim was taken by Oltchim, but it is off. Of the fertilizer chemicals, only Azomureº still operates, and is currently the largest producer in Romanian chemistry.

Oltchim is the second company in the chemical industry by turnover and the largest chemical plant in Romania, but with a loss representing three quarters of its turnover. Govora Soda Works is the largest producer of soda in Romania. The petrochemical plant of Petromidia Navodari refinery is the only one working. Viromet Victoria is one of the oldest chemical companies in Romania.

Amid this research, we emphasize the importance of the chemical industry in everyday life and its potential, which should also be supported by its contribution to all economic sectors. This could be achieved by allocating further investment in this sector, with an impact on industrial production and consequently on exports and gross value added.

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