The Impact of the Market Concentration Ratio on the Productivity Romanian chemical industry

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In this article we enlarge upon the market concentration ratio of all the companies in the chemical industry (divided into 16 areas of activity, according to the NACE code: The National Classification of Economic Activities), but also of the most important 50 companies in this sector, depending on the turnover. Throughout the paper, we deal with the correlation between the market concentration and profitability, determined by taking into consideration the net profit, ROA, ROE and the profit margin. The research results point to the existence of a weak correlation between the concentration ratio as an independent variable, and ROA and the profit margin as dependent variables. However, the correlation is direct and strong if connected to the net profit and ROE. For these two variables, there are patters of linear regression that have been brought together.

Keywords: market structure, Gini-Struck coefficient, Herfindhal-Hirschman index, Theil index, profitability

The companies' profitability is influenced by numerous factors. The researchers who have dealt with this problem, have identified numerous factors, both internal, as well as external, and have come up with an explanation regarding the mechanisms used to pass on this influence. One of the factors is the market concentration ratio. Although the studies that have been conducted so far have reached different conclusions, one thing is for sure: the market concentration influences the companies' profitability, more or less, even though the conveyance mechanism is not always known. Starting from these premises, we intend to analyze the market concentration ratio of the Romanian chemical products and the way it affects the companies' profitability.

The Romanian chemical industry has traditionally had a considerable impact on the GDP. But after 1990, the lack of investments in a new technologization had led to the closing of a lot of companies which were no longer the top companies they once were because of the high amounts of natural gases consumed, that have a considerable proportion in the production costs [1]. The consequence was the explosion of the imports of petrochemical and chemical products (approximately 8 billion euros each year), whereas the exports raise only 2 billion euros per year. The recent changes from the chemical industry are the result of the National Strategy for the Sustainable Development [2], whose main purposes are to reduce the emission of chemical pollutants.

Nowadays, there are approximately 1000 companies active in the chemical industry. In this industry there are greater or smaller operators, determining a certain degree of market concentration. Market competition and the companies' size are susceptible to influence the profitability of the area of activity and the companies' market behaviour. For the purpose of this research paper, the companies have been divided into 16 areas of activity that correspond to the 16 NACE codes and cumulate a turnover in the amount of 9,536.6 mil. lei in 2016.

The first aim of this paper was determining the concentration ratio of the 16 groups of companies by taking into account the turnover and the profit. The second

aim was analyzing the concentration ratio of the first 50 companies belonging to this industry (taking into consideration the turnover) and the correlation between this issue and the companies' profitability.

Joe S. Bain was among the first to study the impact of markets on the business performance. He analysed the market concentration in relation to market power and profitability. Bain developed the structure-conductperformance (SCP) paradigm of Edward Chamberlin and Joan Robinson, by which he explained the causal relationship between market environment, market structure, business conduct and its performance. Bain's study and findings became a reference for many years, even later his theory (part of Industrial Organizations) has been criticised and other paradigms occurred [3].

F. Leon in *Measuring competition in banking: A critical review of methods* analysed the factors of competition in the banking industry. He reviewed the main theories, from the structural approach developed by Bain till non-structural approaches later developed. The non-structural methods represent a second major stream in analysing the competition, also called New Empirical Industrial Organization. Among the most important measures developed with this stream are the Lerner index, the conjectural variation model, the Panzar-Rosse model and the Boone indicator [4].

Stanciulescu G. C. and Molnar E. I. start from the industrial economic theory and use SCP paradigm and game theory to analyse the price strategy of tourism companies on a competitive market. The two authors show how the decision of a company to advertise influences a competitor's decision to advertise and what the impact on the sales is [5].

Abraao Luis Silva makes a complex study on Chamberlin's works, emphasizing the main specific features of his paradigm, the influences of Marshall on his theory, the strong and weak points of his paradigm, and the link with J. Robinson's findings. Silva performs his research starting with the types of competition on the market, the relationship between competitors, on one hand, and the relationship between companies and consumers,

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on the other hand. The market structure influences hereby the actions and the perceptions of the competitors and of the customers and their behaviour [6].

Samuel Fosu conducts a research in order to analyse the relationship between capital structure, corporate performance and industry competition. His survey comprised 257 South African companies analysed between 1998 and 2009. His main objective was to point out the impact of leverage on the performance, but he also introduced the market competition as a variable into this process. In order to measure the competition, Fosu used the Boone indicator. He found that the indebtedness has a positive and major impact on the performance and that the degree of competition increases the effect of leverage [7].

Diana Heger and Kornelius Kraft analysed the correlation between the barriers to entry the market, the firm profitability and the number of firms on the market. They considered the hypothesis that high returns result in new competitors entering the market and they will cut from the leading company's share, especially if the barriers to entry are low. This will further lead to profit adjustments as a result of higher competition. The two researchers found that return on sales is negatively and significantly determined by the degree of competition and as well by the size of competitors. The higher the competition pressure, the lower the profit margins [8].

Concepts and methodology

The market concentration ratio [9] has been analyzed at first empirically by using the Pareto diagram and then the Gini-Struck coefficient (G), the Herfindal-Hirschman Index (HHI) and the Theil index (T). The calculation relationships between the coefficients used are the following:

$$G = \sqrt{\frac{n * \sum g i^2 - 1}{n - 1}} [10]$$
 (1)

where:

n - the number of variables taken into consideration

gi- the structure of the indicator whose concentration ratio is calculated;

$$IHH = \sum gi^2 [10] \tag{2}$$

and the Theil index: $T = \frac{1}{n} * \sum_{i=1}^{n} \left[\frac{x_i}{\bar{x}} * (\ln x_i - \ln \bar{x}) \right] =$ $= \frac{1}{n} * \sum_{i=1}^{n} \left(\frac{x_i}{\bar{x}} * \ln \frac{x_i}{\bar{x}} \right) [11] \quad (3)$

where:

n - the number of elements

xi - the total value of the x variable

 \boldsymbol{x} - the average value of the variables included in the total.

In order to be able to interpret the results, we have taken into account the coefficients' reference range, therefore for Gini-Struck the reference range is [0;1], for the Herfindal-Hirschman Index is[1/n; 1], and for the Theil Index $[0; \ln(n)]$. When the values are close to 0 and 1/n there is a relatively uniform distribution, and when they tend to reach 1 and $\ln(n)$, the distribution focuses on some elements belonging to the analyzed indicator or variable.

The profitability ratios borne in mind when it comes to establishing the level of correlation with the market concentration ratio have been determined the following way:

$$ROA = \frac{GP}{A} * 100$$
⁽⁴⁾

$$ROE = \frac{NP}{E} * 100$$

$$NPM = \frac{NP}{T} * 100$$

(6)

where:

ROA - return on assets ROE - return on equity NPM - net profit margin GP, NP - gross profit, net profit A - total assets E- owner's capital

TRN-turnover.

The selection of the profitability indicators has been conducted also by bearing in mind the significance of the constructive elements of these indicators, the elements being familiar also when it comes to determining the size of the Romanian companies; the turnover, the total assets and the number of employees [12].

In order to reach the purposes of this research, i.e. identifying the impact of the market concentration ratio in what the chemical products are concerned on the profitability, we have come up with the following series of research hypotheses:

H1: There is a statistically significant correlation between the market concentration ratio and the net profit (NP) gained by the Romanian companies from the chemical industry;

H2: There is a statistically significant correlation between the market concentration ratio and the return on assets (ROA) of the Romanian companies in the chemical industry;

H3: There is a statistically significant correlation between the market concentration ratio and the return on equity (ROE) of the Romanian companies in the chemical industry.

H4: There is a statistically significant correlation between the market correlation ratio and the net profit margin (NPM) obtained by the Romanian companies in the chemical industry;

In order to prove that these hypotheses are valid/ invalid, we will use the software app Statistical Package for the Social Sciences (SPSS), with the help of which we will calculate the Pearson correlation coefficient between the structure of the turnover for the Top-50 companies in this industry (gi) and the profitability indicators: NP, ROA, ROE and NPM. If there is a statistically significant dependence between these variables, the research will be continued with the help of the linear regression from the selected variables.

Results and discussions

The concentration ratio of the chemical products has been analyzed by taking into account the level of the turnover and of the net profit, in two cases:

a) The areas of activity according to the NACE classification. There have been identified 16 areas of activity in which the chemical industry has been divided, as they can been seen in Annex 1 [13];

b)The companies that are relevant for this industry. For the study there have been selected the first 50 companies in this industry, based on the level of the turnover in the year 2016, which together account for 83% of the industry's turnover.

The most important position is owned by the sector *The* making of fertilizers and nitrous products with 16.78% out of the total turnover, completely different from the sector *The* making of adhesives with only 0.45% out of the total turnover of the chemical industry [14].

For the analysis of the concentration ratio of each area of activity's turnover, we have used the Pareto diagram

(5)

and have thus divided the 16 areas of activity in three sectors:

-sector A, having three areas: the making of fertilizers and nitrous products; the making of paints and lacquer and the making of other chemical organic products, which together generate 45% of the total turnover in the chemical industry;

-*sector B* is made out of five areas of activity, with a total percentage of almost 40% of the turnover in the chemical industry;

-sector C enhances the other eight areas of activity, which have a total percentage in the industry's turnover in an amount of 15%.

The graphical representation of the three sectors can be seen in the figure 1.



The *linear* level reflects the case when we are dealing with the highest diversification of the activity, because the turnover can be equally distributed among the 16 areas of activity, whereas the *theoretical* level reflects the general case introduced by Pareto, according to whom 80% of the turnover is generated by 20% of the sectors.

When it comes to the chemical industry, the graphic curve is halfway between the two limits, which means that the turnover concentration ratio is low, and that the most important areas (belonging to sector A) have gained less than 50% of the market.

The turnover concentration ratio of each area of activity has been analyzed afterwards with the help of the Gini-Struck coefficient, of the Herfindal-Hirschman index and of the Theil index, these values being presented in the table 1.

The values of these indicators confirm the conclusion we have reached by using the Pareto diagram because they point to a low turnover concentration ratio in what the areas of activity are concerned.

The concentration ratio can also be analyzed by taking into consideration the **profit** that each area registers. There is a possibility that a certain area of activity may own a profit level that dominates the sector, although the sales have proven to be relatively uniform. The structure of the

Name of the indicator	Fluctuation range	Value
The Herfindhal-Hirschman index	(0.0625; 1)	0.1064
The Gini-Struck coefficient	(0; 1)	0.2164
Theil Index	(0; 2.77)	0.3707

Name of the indicator	Fluctuation range	Value
The Herfindhal-Hirschman index	(0.0625; 1)	0.1200
The Gini-Struck coefficient	(0; 1)	0.2476
Theil Index	(0; 2.77)	0.4419

profit made in the chemical industry in each area of activity can be seen in the Annex 1. What can be noticed is that the three areas of activity belonging to sector A own 45% of the turnover and 50% of the profit. Sector B owns 40% of the turnover and 36% of the profit, and sector C has 15% of the turnover and 14% of the profit. Therefore, sector A owns a larger percentage of the profit than of the turnover, the situation being different when referring to sectors B and C. This means that the companies belonging to the sectors with a higher percentage of the turnover have a higher profitability ratio than the companies belonging to the sectors with a lower percentage of the turnover.

With the help of the same indicators it has been analyzed also the profit concentration ratio of each area of activity. Their level can be spotted in the table 2:

There is a slight increase of the level of the coefficients compared to the ones obtained after having analyzed the turnover, which reflects an increase of the concentration ratio by confirming the fact that the areas with a higher turnover have registered a higher profitability, but the differences are not very significant.

In order to point out the correlation between the market concentration ratio and profitability we have continued to conduct the analysis *among the companies which are relevant for this industry*. Therefore, we have identified the first 50 companies in the chemical industry based on the turnover from the year 2016 [15], their situation can be found in the Annex 2.

The total turnover in the chemical industry in 2016 was 9536.6 million lei, out of which 7962.5 million lei were obtained by the first 50 companies, which means that the industry's most important 5% of the companies have gathered 83.5% of the total turnover. That is why we regard the study conducted in the case of the 50 selected companies as being a relevant one, and the results can be extended to the whole industry.

What can be also noticed is that in the chemical industry's case the concentration ratio is high. Taking into consideration the relevance of the Top 50 companies, we will further proceed to analyzing them. In order to stress out the market concentration ratio of the chemical products, we have used in the first phase the Pareto diagram in what the Top 50 companies are concerned:



Fig. 2. Pareto diagram - the companies' turnover conentration

 Table 1

 THE TURNOVER CONCENTRATION RATIO OF

 EACH AREA OF ACTIVITY

Table 2THE PROFIT CONCENTRATION RATIO OF EACH AREAOF ACTIVITY

Name of the indicator	Fluctuation range	Value
The Herfindhal-Hirschman index	(0.02; 1)	0.06446
The Gini-Struck coefficient	(0; 1)	0.21301
Theil Index	(0; 3.91)	0.61456

Table 3 THE COMPANIES' TURNOVER CONCENTRATION RATIO

		Struct_CA	NP	ROA	ROE	NPM
	PearsonCorrelation (R)	1	,703"	,123	,369**	,136
Struct_TRN	Sig. (2-tailed)		,000	,396	,008	,347
_	N	50	50	50	50	50

Table 4 THE CORRELATION BETWEEN THE MARKET CONCENTRATION RATIO AND THE PROFITABILITY INDICATORS

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

Compared to the turnover concentration of each area of activity, it can be noticed that the graphic is more similar to the theoretical curve suggested by Pareto, which means that the turnover concentration ratio of the companies is higher compared to the areas of activity. Sector A, including this industry's most important 9 companies, owns a percentage of 57.8% of the turnover registered by the Top 50 companies, sector B with 15 companies, owns 27.7% of the total turnover, and sector C, where there are 26 companies, has 14.5% of the total turnover.

We came to a clearer picture of the market concentration ratio with the help of the Gini-Struck coefficient, the Herfindhal-Hirschman index and the Theil index. The values of these indicators for the 50 companies are shown in the table 3.

The values of the three indicators are placed in the first part of the interval, which means that in what the 50 companies that have been analyzed are concerned the concentration ratio is moderate, even though it is higher than the concentration ratio of the areas of activity.

In order to determine the profitability of the 50 companies under analysis, we have used the following indicators: net profit, RÖA, ROE and NPM. Their level has been calculated starting from the data published on the website of the Ministry of Public Finance. Out of the 50 companies, 40 have had a profit and 10 have dealt with losses, counting with a total profit of 334.8 million lei. From the companies that have dealt with losses, 8 belong to sector C and only one to each of the sectors A and B. By adding also the profitability ratios to this study, we have come to the conclusion that the level of ROA and NPM has been higher in what the companies from sector A are concerned and lower in the case of the companies belonging to the sector C, consequently the level of profitability has been higher when referring to the companies with a higher turnover compared to the small companies.

In order to analyze the correlation between the market concentration ratio of the chemical products and the profitability, we have used the software app Statistical Package for Social Sciences (SPSS), with the help of which we have calculated the Pearson correlation coefficient [16] between the structure of the turnover for the Top 50 companies (gi) and the profitability indicators: NP, ROA, ROE, and NPM. The values we have reached are to be found in the table 4.

Between the market concentration ratio of the chemical products and the companies' net profit there is a pretty strong direct correlation, where the correlation coefficient (R) has a high value (R = 0.703). The Sig. (2-tailed) coefficient is low, lower than the first significance line (0.01), which means that the connection we have come to is important statistically speaking.

The same remarks can also be applied to the dependence between the market concentration ratio and the level of ROE, but it should be borne in mind the fact that the value of the Pearson correlation coefficient is much lower (R = 0.369), this suggesting the existence of a medium direct correlation which has a certain significance statistically speaking (Sig. = 0.08).

The market concentration ratio has no connection to the evolution of ROA and NPM, because the values of the Pearson correlation coefficient are very low. It can be concluded that the values we have come to validate the hypotheses H1 and H3, i.e. there is a statistically significant correlation between the market concentration ratio and the net profit, meaning ROE. Hypotheses H2 and H4 are rejected, because it has been proven that there is no validity in the existence of a correlation between the market concentration ratio and ROA, or NPM.

Considering the identified connections, we will proceed to the analysis of the dependence between them with the help of the linear regression.

a. The influence of the market concentration ratio on the net profit:

The coefficients of the linear regression pattern between these variables, which have been calculated with the help of the app SPSS, are to be found in the table 5.

The regression pattern we have come up with is the following:

$NP = -10.043 + 8.368 \times gi$

The negative value of the constant points to the fact that a company without a market quota will have to deal with losses, and the positive value of the regression coefficient associated with g_i points to the fact that there

Ν	/lodel		Unstandardized Coefficients		Standardized	t	Sig.	
					Coefficients			Table 5 THE DECRESSION DATTEDN
			В	Std. Error	Beta			BETWEEN THE MARKET
1		(Constant)	-10,043	4,385		-2,290	,026	CONCENTRATION RATIO AND THE NET PROFIT
		Struct_TRN	8,368	1,221	,703	6,853	,000	

a. Dependent Variable: NP

Model		Unstandardize	ed Coefficients	Standardized Coefficients	t	Sig.	
		В	Std. Error	Beta			
1	(Constant)	9,826	13,647		,720	,475	
	Struct_TRN	10,467	3,800	,369	2,754	,008	

Table 6THE REGRESSION PATTERNBETWEEN THE MARKETCONCENTRATION RATIO ANDROE

a. Dependent Variable: ROE

is a direct correlation between the two variables and that once the total turnover registers an increase of 1%, this should also lead to an increase of the net profit of 8.4 million lei. The high values for the *t* test and the low values for the Sig. coefficient take us to the conclusion that between the variables that have been analyzed there is a statistically significant connection.

b. The influence of the market concentration ratio on ROE:

The coefficients of the linear regression pattern between these variables, calculated with the help of the app SPSS, are to be found in the table 6.

The regression pattern we have come up with is the following:

$ROE = 9.826 + 10.467 \times gi$

This pattern confirms the direct connection between the market concentration ratio and the level of the financial profitability ratio, and the Romanian companies in the chemical industry with a higher market quota have registered a higher level of profitability than the small companies.

Conclusions

The study we have conducted had as a main purpose stressing out the correlation between the market concentration ratio and the profitability of the companies from the Romanian chemical industry. The concentration ratio has been analyzed considering both the areas of activity, as well as the number of companies in this industry. Starting from the distribution of the turnover over the areas of activity, we have noticed that in the structure of the chemical industry there are three sectors (the making of fertilizers; the making of paints and lacquer; the making of other chemical organic products) which own 45% of the industry's total turnover and 50% of the profit, the difference being an achievement of the other 13 sectors. By conducting a thorough analysis, we have concluded that the first 50 companies of this industry (Top 50), which are 5% of the total, have achieved 83.5% of the industry's turnover, this meaning a high market concentration ratio of the chemical products.

In what the profitability is concerned, we have noticed that its level is higher in what the companies with a higher turnover are concerned than it is in the case of the smaller companies. By studying the dependence between the market concentration ratio and the main profitability indicators of the Top 50 companies, it has been established that a higher percentage of the turnover achieved in the total turnover has a positive influence both on the level of the net profit, as well as on the level of the financial profitability ratio, thus confirming two of the four hypotheses of this research.

We have therefore come to the conclusion that J. Bain's paradigm partially complies with the Romanian chemical industry. The market's structure decisively influences the companies' profitability, because the larger companies have higher profits and a higher ROE. It does not comply though with ROA and the net profit margin. This research did not have as a purpose the analysis of the way this influence is passed on and neither the way in which the companies' behaviour influences the market's structure.

No.	Name of the sector	NACE code	TRN	NP	% TRN	% NP	Cate- gory
1.	The making of industrial gases	2011	849.8	124.4	8.91%	14.16 %	В
2.	The making of dyes and pigments	2012	154.3	10.6	1.62%	1.21%	С
3.	The making of other basic chemical inorganic products	2013	325.5	15.9	3.41%	1.81%	С
4.	The making of other basic organic products	2014	1200	155.5	12.58 %	17.71 %	А
5.	The making of fertilizers and nitrous products		1600	156.2	16.78 %	17.79 %	А
б.	The making of plastic materials in primary forms	2016	833.3	57.1	8.74%	6.50%	В
7.	The making of synthetic rubber in primary forms	2017	60.6	7.7	0.64%	0.88%	С
8.	The making of pesticides and other agrochemical products	2020	475.7	42.3	4.99%	4.82%	В
9.	The making of paints, lacquer, typographic ink and mastic	2030	1500	127.7	15.73 %	14.54 %	А
10.	The making of soaps, detergents and maintenance products	2041	898.5	44	9.42%	5.01%	В
11.	The making of perfumes and cosmetics	2042	420.6	35.5	4.41%	4.04%	С
12.	The making of explosives	2051	47.4	0.123	0.50%	0.01%	С
13.	The making of adhesives	2052	42.8	9.6	0.45%	1.09%	Ċ
14.	The making of essential oils	2053	77	13.2	0.81%	1.50%	С
15.	The making of other chemical products	2059	753.2	48.3	7.90%	5.50%	В
16.	The making of synthetic and artificial fibers	2060	297.9	30.1	3.12%	3.43%	C

Annex 1: The structure of the chemical industry according to each area of activity

		TRN -			TRN -
No.	Company name	mil.	No.	Company name	mil.
		RON			RON
1.	Azomures	1500	26.	Messer Romania Gaz SRL	72.0
2.	Oltchim SA	754.8	27.	Unilever Romania SA	65.8
3.	Linde Gaz Romania SRL	570.6	28.	Alchimex SA	64.3
4.	Dalli Production Romania	351.8	29.	Qualicaps Romania	60.7
5.	Redoxim SRL	335.9	30.	Air Liquide Romania SRL	59.2
6.	Kober SRL	289.7	31.	Viromet SA	57.4
7.	Greenfiber International SA	280.8	32.	Siad Romania SRL	50.1
8.	Egger Technologia SRL	266.7	33.	Fater Central Europe SRL	50.1
9.	Priob Biocombustibil SRL	255.7	34.	Papillon Laboratories	47.0
10.	Fabryo Corporation SRL	207.0	35.	Maxam Romania SRL	45.3
11.	Eurofoam SRL	204.4	36.	Hirsch Porozell SRL	44.6
12.	Farmec SA	196.8	37.	BioFuel Energy SRL	42.4
13.	Chimcomplex SA Borzesti	184.1	38.	PMG East SRL	42.4
14.	Vitafoam SRL	180.9	39.	Terpena	42.1
15.	Purolite SRL	174.8	40.	Marca Romania SRL	41.4
16.	Deutek SA	153.6	41.	Mer Invest Industries SRL	40.8
17.	Azur SA	135.6	42.	Chemgas Holding Corporation	39.8
18.	Interstar Chim SA	134.8	43.	Eftec Romania	39.5
19.	Heraeus	126.4	44.	Kemcristal SRL	33.5
20.	Policolor SA	120.1	45.	Aroma Rise SA	28.4
21.	SteraChemicals SRL	113.8	46.	Buse Gaz SRL	23.0
22.	Detergenti SA	95.3	47.	TelluriumChemical Co	23.0
23.	Combinatul de Ingrașăminte Chimice	92.6	48.	Melsprig Romania SRL	22.9
24.	Nubiola Romania SRL	83.9	49.	Regia Autonoma pt Activitati Nucleare	22.1
25.	HeraeusKulzer	74.1	50.	Multibond Sural	20.5

Annex 2: Top 50 companies in the chemical industry

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