The Influence of Business Cycles on the European Chemical Industry

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The article assesses how the chemical sector responds to oscillations in the economic cycle, given that industries do not react in the same way under the influence of macroeconomic frictions. The basic hypothesis is that the chemical industry, which is part of the sector of medium-high technology industries, was affected by the 2008-2011 crisis differently, compared to the rest of the industries. Since it has a higher labour productivity, it is expected that its decline was less visible than that of the European economy, taken as a whole. Our study analyses data from a sample that covers the 28 states of the European Union, and the analysed period is from the year 2000 to 2014.

Keywords: Chemical industry, production, economic crisis, technology

According to Business Cycles Theories, economies in general and industries in particular are subject to cyclic oscillations due to a series of factors. Schumpeter [1] argued that innovation is the most important determiner of cyclicity. Representatives of the Austrian School [2, 3] considered that credit expansion is to blame for the overheating of economies and the emergence of crises. Keynes [4] set the weight pole in the realm of actual demand. More recent theories considered that aggregated stocks are to blame [5], since they lead to different output variations under the effect of the same stimuli. When we refer to unrelated industries, certain factors such as the higher price that one has to pay for credit, will lead to the relocation of some production factors such as labour, from industries of relatively decreasing productivity to industries of increasing productivity. Thus, although all economic sectors will be affected, some of them will undergo slower output decreases than others [6]. However, according to other authors [7-9], industries move together over the business cycle, although at different paces. This is the so-called co-movements phenomenon, defined by [5, 10].

The chemical industry is of the largest manufacturing sectors of the European economy, covering approximately 7% of the total industrial production. Consequently, it plays an important role in achieving European competitiveness, especially since a high degree of technology incorporation and innovation are specific to it. The production of the chemical industry covers petrochemicals, polymers, basic inorganics, specialties, and consumer chemicals. This means that the more than 28,330 companies in the field achieve a production of approximately 500 billion dollars (2014) and sales of more than 530 billion dollars, which stands for more than 17% of world sales [11]. The chemical industry ensures approximately 1.1% of the EU GDP and generates a trade surplus of more than 50 billion euros. Created jobs are at a significant level (it provides 1.15 million direct highly-skilled jobs, that is 0.9% of the total employees in non-financial business economy and 3.9% of the manufacturing workforce) and the labour productivity ratio is very high. In 2010, it was Euro 95.3 thousand per person employed, approximately twice higher than the European average for the whole industry. If we refer to the relation between the gross operating surplus and turnover, known as gross operating rate, then it is approximately 10.5%, more than 1.5 per cent above the manufacturing average.

Experimental part
Research hypotheses
H1: Although the 2008-2009 crisis affected the European chemical industry sector, in a co-movement effect, the evolution of chemical production was less sensitive to specific macroeconomic frictions.

The explanation is grounded in Lucas' theory [5], according to which sectors with high yield production factors (such as the chemical sector) will undergo smaller variations in response to the shocks of the economic cycle.

H2: Depending on the phases of the economic cycle, the evolution of production from sectors of less advanced technology had a significant and differentiated influence on the chemical sector.

The hypothesis is based on Mitchell theory [10], according to which among the economy's sectors there was a driving effect under the influence of oscillations in the economic cycle, but the amplitude of variations differs.

Sample and data: the analysed sample comprises the 28 states of the European Union, and it was structured depending on the variables presented below. The study was conducted at the level of the period 2000-2015, on a quarterly basis.

Variables: for the validation of the proposed work hypotheses, the study considered the following variables:
- (VIP_Chim): Volume index of production corresponding to the sector Manufacture of chemicals and chemical products;
- (VIP_Ltech): Volume index of production corresponding to the sector Low-technology manufacturing;

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-(VIP_MLtech): *Volume index of production corresponding to the sector Medium low-technology manufacturing.*

According to the Eurostat methodology, it was considered that the chemical industry is part of the Medium High Technology sector. The other two sectors considered were the Low Technology sector and the Medium Low Technology sector, according to the same methodology. In order to establish the phases of the economic cycle we considered the following periods: BC – before crisis (2000-2008Q2); C – crisis (2008Q3-2009Q3); AC – after crisis (2009Q4-2015Q3). The data were collected on a quarterly basis from the EUROSTAT, and missing data were replaced by resorting to the expectation maximization algorithm [12].

Data analysis methods: in order to analyse data and estimate differences between the mean values of the analysed variables, in different phases of the economic cycle, we used the ANOVA procedure and post hoc (LSD) tests [13].

For the analysis of the influence of the production growth index in the medium low technology (*VIP_MLtech*) sector on the production growth index in the chemical sector, the following model is proposed, which also considers fixed time effects, as well as cross effects among countries [14]:

$$VIP\_Chim = \beta_0 + \beta_1 . IP\_MLtech + \beta_2 . Before\_crisis + \beta_3 . Crisis + \beta_4 . Before\_crisis . VIP\_MLtech + \beta_5 . Crisis . VIP\_MLtech + Year\ fixed\ effects + Country\ fixed\ effects + \varepsilon \quad (1)$$

where β measures the influence of each factor included in the analysis on *VIP_Chim*; *Before crisis* and *Crisis* are *dummy* variables that take the value 1 for the case in which the analysed period corresponds to the periods BC – before crisis (2000-2008Q2) and C – crisis (2008Q3-2009Q3), and 0 for AC – after crisis (2009q4-2015), the reference period.

The data were processed and analysed via SPSS 20.0.

Results and discussions

The evolution of production in the three sectors considered was pro-cyclical, as one can notice in the graphical representation of production indices and GDP variation.

In addition, the amplitude of the variation was bigger in all three analysed sectors, and even at a descriptive level there was a co-movement phenomenon. Yet there are significant differences in amplitude.

The chemical sector had the most pregnant oscillations, at least beginning with the third quarter of the year 2008, followed by the medium low tech sector. The low tech
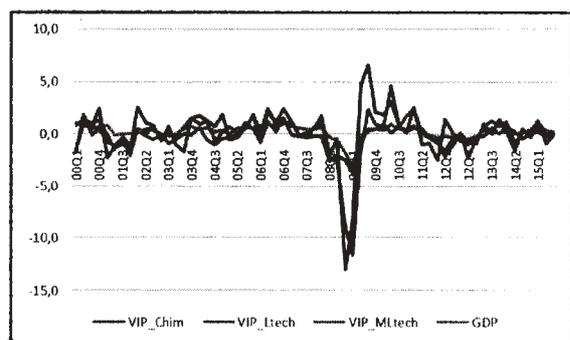
sector had modest evolutions both in growth and decline phases.

Table 1 features descriptive statistics at the level of the entire analysed sample, in terms of the mean value and the standard deviation during the three phases of the economic cycle and over the entire analysed period. In the Table, one can also see that the lowest values were registered, for all analysed indicators, during the crisis period (2008Q3-2009Q3) as a result of the generalised decrease of production caused by the drop in global demand and of domestic demand on the European market.

For the analysed indicators, table 2 features differences between averages registered at the level of each period of the economic cycle. Based on the presented data, one can notice that there are significant differences in what the values of *VIP_Ltech* and *VIP_MLtech* are concerned, in all phases of the economic cycle, but for *VIP_Chim* one can notice significant differences only between the values recorded before the crisis (BC) and those from during the crisis (C). The lack of significant differences can be accounted for by the fact that the post-crisis evolution of the chemical industry was extremely slow and oscillating, as the data presented in figure 1 show. As for the low tech sector (VIP_Ltech), differences registered between the evolutions of production indices are much smaller than in the medium low tech sector. Table 3 shows that the three

Table 1
DESCRIPTIVE STATISTICS

Variable		N	Mean	Std. Deviation
(VIP_Chim)	BC	952	0.97	5.31
	C	140	-1.55	11.02
	AC	672	0.72	5.30
	Total	1764	0.67	5.99
(VIP_Ltech)	BC	952	0.27	2.43
	C	140	-1.70	3.09
	AC	672	0.28	1.74
	Total	1764	0.12	2.32
(VIP_MLtec)	BC	952	0.98	3.02
	C	140	-3.92	5.43
	AC	672	0.59	2.82
	Total	1764	0.44	3.46

(Source: own processing in SPSS 20.0)

Table 2
AVERAGE DIFFERENCES REGISTERED IN DIFFERENT PHASES OF THE ECONOMIC CYCLE

Dependent Variable	(I) Economic Cycle	(J) Economic Cycle	Mean Difference (I-J)	Sig.
(VIP_Chim)	C	BC	-2.51	0.08
		AC	-2.27	0.41
(VIP_Ltec)	C	BC	-1.97	0.00
		AC	-1.98	0.00
(VIP_MLtech)	C	BC	-4.90	0.00
		AC	-4.51	0.00

Post hoc test: LSD
(Source: own processing in SPSS 20.0)

(Source: Eurostat database)

Fig. 1. Volume index of production (EU 28)

Paired Differences	Mean			
	BC	C	AC	Total
(VIP_Chim) – (VIP_Ltech)	**0.69** (Sig. 0.00)	0.15 (Sig. 0,86)	**0.44** (Sig. 0,04)	**0.55** (Sig. 0,00)
(VIP_Chim) – (VIP_MLtech)	-0.01 (Sig. 0.94)	**2.38** (Sig. 0.03)	0.13 (Sig. 0.53)	**0.23** (Sig. 0.10)

(Source: own processing in SPSS 20.0)

Parameters	Model (1)		Model (2)		Model (3)	
	β_i	Sig.	β_i	Sig.	β_i	Sig.
Intercept	-0.72	0.46	-0.81	0.39	-0.98	0.30
VIP_MLtech	-	-	0.43	0.00	0.45	0.00
BC	3.97	0.02	3.09	0.07	2.58	0.10
C	-1.84	0.16	-0.40	0.75	1.06	0.18
BC· VIP_MLtech	-	-	-	-	-0.25	0.02
C· VIP_MLtech	-	-	-	-	0.43	0.00
Year fixed effecs	Yes		Yes		Yes	
Country fixed effects	Yes		Yes		Yes	
Observations (N)	1764		1764		1764	
R^2	0.05		0.10		0.12	

*Dependent variable: VIP_Chim
**AC is the reference category
***Significant values for Sig ≤ 0.10
(Source: own processing in SPSS 20.0)

sectors evolved differently throughout the phases of the economic cycle, and the clearest difference was registered during the crisis between the chemical sector and the medium low tech sector. The direction of the result runs counter to our hypothesis. As it could be noticed from the trend evolution in figure 1, higher technology sectors have stronger oscillations than low technology sectors.

In what follows, we shall highlight the inter-dependencies between sectors of medium technology, respectively medium low tech and medium hi tech (chemical) throughout the three phases of the economic cycle. In order to highlight the influence of *VIP_MLtech* on *VIP_Chim*, table 4 features the estimations of the parameters of the regression models used to analyse the influence of *VIP_MLtech* on *VIP_Chim*, depending on the phases of the economic cycle.

The presented data show the following:
- Model 1: We analysed the variation *VIP_Chim* throughout the phases of the economic cycle, taking the after crisis stage as the reference period. We noticed that the *before crisis* stage had a significant influence on the evolution of *VIP_Chim*, compared to the other phases of the economic cycle. The data could also have been influenced by the fact that the series of time corresponding to the BC period is much longer, which made it possible to make a more precise and correct estimation of the connection.
- Model 2: irrespective of the phases of the economic cycle, *VIP_MLtech* has a significant influence on *VIP_Chim* variation, in parallel with the significant influence of the *before crisis* phase, compared to the other phases of the economic cycle.
- Model 3: *VIP_MLtech* has a significant influence on *VIP_Chim* variation, in all phases of the economic cycle: the *after crisis, crisis and before crisis* phases, although there are no significant differences between the *VIP_Chim* variations, registered in the *after crisis* and *crisis* phases.

Conclusions

The 2008 crisis started as a financial crisis, which implied the substantial increase of costs to finance current operations and, implicitly, the emergence of serious problems in running production-related activities. At the same time, the sudden decrease of consumption led to a drop in demand. The most affected were the developed markets, where consumption is oriented especially towards products of a certain higher level of incorporation of technology. Therefore, industries that produced such goods were the most affected and they registered the most severe drops. This explains that there was no adjustment period on production factors' markets, in which they could migrate from sectors of lower productivity towards those of higher productivity. The figures that we analysed have demonstrated precisely this.

The obtained results could have been influenced by the temporal dimension of the periods under investigation. We considered a long growth phase, given that from 2000 up to 2008, at the level of the European economy, there were no major and generalised oscillations of the economic activity that would require the segmentation of the period. On the other hand, the crisis stage was short and the recovery stage was unclear from the point of view of sustainability. At the same time, the time series had lacking values that had to be approximated, which could deform the results to a certain acceptable extent.

The European chemical industry was one of the most affected branches that suffered the effects of the economic crisis which started in Europe in 2008. Just like the other sectors of the European economy, the chemical sector underwent significant output drops. Thus, we can state that our first hypothesis was validated. On the other hand, according to Lucas' theory, it was expected that the amplitude of the decrease would be smaller, given that the chemical industry is one of advanced technology and high yields. Our analysis has shown that, on the contrary, output drops were more abrupt than in all other analysed

sectors, which led to the rejection of the hypothesis that in periods of macroeconomic frictions, production factors of high productivity migrate towards medium and hi tech industries.

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