

STRUCTURAL CHANGES IN THE MANUFACTURING INDUSTRY IN ROMANIA IN THE CONTEXT OF THE ENERGY SHOCK INDUCED BY THE WAR IN UKRAINE

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Abstract. *The war in Ukraine had a notable impact on the Romanian economy and the broader European economy, in which Romania is strongly integrated. The inflationary shock generated by the economic and geopolitical consequences of the war in Ukraine impacted the cost structure of industry, affecting its competitiveness. The manufacturing industry remains a crucial driver of economic development, as evidenced by the strong correlation between manufacturing production dynamics and gross domestic product growth. In light of these circumstances, the present study focuses on examining the structural changes within the manufacturing industry and identifying the activities that are particularly susceptible to energy shocks based on energy consumption and efficiency. To investigate the impact of energy price shocks on the most vulnerable sectors of the manufacturing industry, a VAR model is employed. The findings indicate that the energy intensive sectors were negatively affected by the price shock except for Manufacture of coke and refined petroleum products which benefited directly from the energy price rises.*

Keywords: *manufacturing industry, energy intensive activities, exogenous shock, VAR model, impulse response function.*

1. Introduction

The manufacturing industry continues to play a strategic role in the economy as an engine of economic development in the context of a significant correlation between the dynamics of the manufacturing industry production and the GDP growth. Recent studies show that increases in gross domestic product per capita are positively correlated with increases in the share of manufacturing added value and employment in the total

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economy (Gabriel and De Santana 2019, Haraguchi et al. 2019, Su and Yao 2017).

The double economic shock generated by the pandemic and the war in Ukraine had a significant impact on the Romanian economy and on the European economy in which Romania is strongly integrated. Industrial activity registered a strong contraction against the background of a constellation of factors, among which we list the impact of global value chains, the sharp increases in raw material prices, the increased volatility of domestic and foreign demand.

The inflationary shock generated by the economic and geopolitical consequences of the war in Ukraine impacted the cost structure of the industry, affecting its competitiveness. In this respect, the increases in industrial production prices were higher than those of the consumer price index in both Romania and EU27 overall, pointing to the high pressures on the cost structure in the context of the surges in energy prices (Eurostat 2023).

Additional pressures on industry are exerted by the strategic priorities of the European Union in the context of the European Ecological Pact. "Energy efficiency first" is a strategic priority and one of the key principles of the European Green Deal (European Commission 2019).

The manufacturing industry represents 25% of total energy consumption in the European Union (Eurostat 2023), which is why increasing energy efficiency in this sector can have major positive effects in reducing emissions.

In this context, the present analysis examines whether the structural transformations specific to the Romanian manufacturing industry have led to a more energy efficient structure and investigates the second-round impact of the energy price shock on the most energy intensive manufacturing activities through a VAR model. The model analyzes the impact of the energy shock on the manufacturing industry by examining the secondary effects reflected in producer prices. This approach aims to understand how the energy price shock influenced the cost structure of the manufacturing sector and, subsequently, its impact on output.

2. Methodology

In economics, autoregressive models are commonly employed to examine the effects of economic shocks (Sims 1980, Hamilton 1994, Castellini 2020, Bobeica and Hartwig 2021). Specifically, vector autoregression (VAR) models are statistical tools used to study the

interrelationships among economic variables, without making predetermined assumptions about the causal links between these variables. Mathematically, the model is described below:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + e_t, \quad (1)$$

where Y is a vector of the analyzed variables, t is the number of lags used, e is a vector of errors of mean 0 and finite variation.

VAR models are designed to capture the underlying structural relationships within an economy, without imposing any assumptions about the causal structure of the data being analyzed. The effects of the shocks are typically quantified using the impulse response function. In this study, an autoregressive vector model was utilized to estimate the impact of the energy price shock on the manufacturing activities that consume the most energy and stand to be the most affected by the energy shock.

3. Structural transformations of the Romanian manufacturing industry. Did the structural changes lead to a more energy efficient structure?

Romania went through an extensive transition process that led to a strong contraction of production in the manufacturing industry, especially in the period 1990-1994, a period in which the contraction was approximately 45%. The most affected activities were the Manufacture of rubber and plastic products and the Manufacture of chemicals and chemical products, where production contractions of 60% and 55% respectively were recorded. The tendency to lose productive capacity reflected the negative dynamics of the gross domestic product in the first part of the transition.

At the beginning of the 2000s, Romania's economy experienced a revival reflected in the positive dynamics of production in the analyzed industrial activities. This was due to some positive changes in the national economy, among which we mention: the completion of some structural reforms, the partial liberalization of administered prices, the strengthening of macroeconomic policies, the development of the private environment and the change in the share of state-owned enterprises in the sectors of the national economy. Some of the traditional branches in Romania experienced a period of sustained development and increased investment, including foreign direct investment. Among the main winners we mention the Manufacture of road transport vehicles, trailers, and semi-trailers; the manufacture of other means of transport in which production tripled in

2019 compared to 1990. Among the main losers we mention the Manufacture of basic pharmaceutical products and pharmaceutical preparations and the Manufacture of chemicals and chemical products in which production experienced a decrease of 70% and 40% respectively in the same period mentioned.

Manufacturing of food products; beverages and tobacco products has remained the main activity in the manufacturing industry for the last 30 years. The activity Manufacturing road transport vehicles, trailers and semi-trailers, manufacturing other means of transport has seen spectacular growth in the last 20 years. To these was added Manufacture of coke and refined petroleum products which benefited from international developments, especially the spectacular increases in energy prices. Together the three activities generate approximately 50% of the gross added value of the manufacturing industry (see Figure 1). A phenomenon of weight reset can also be observed. The most visible from this point of view is the case of the Manufacture of textile products, which faced competition from the international market, especially from China, and the migration of an important part of the workforce, its share dropping significantly from 22.6% in 1990 to 6.3 % in 2021.

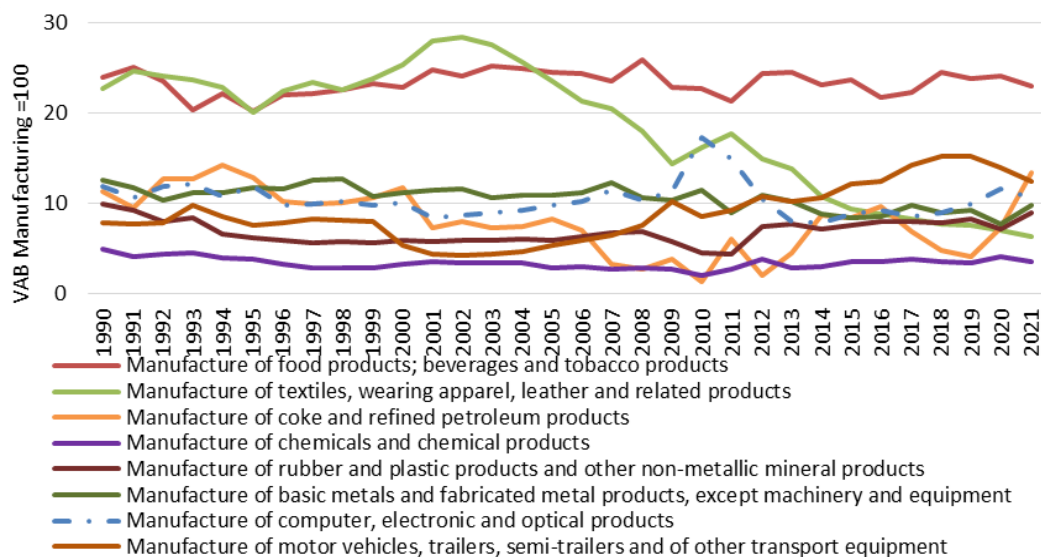


Figure 1. Structural developments of main activities in the manufacturing industry (VAB Manufacturing industry = 100).

Source: National Institute of Statistics, Eurostat.

The analysis of the relationship between the manufacturing activities output and energy consumption reveals a noteworthy decline in the relative importance of activities characterized by high energy usage (see Table 1). Specifically, significant reductions were observed for Metal constructions and metal products industry, exclusively machines, equipment and installations and Manufacturing of substances and chemical products which recorded significant reductions in their relative importance in terms of output. These changes played an important role in decreasing the energy intensity of manufacturing output with a positive impact on the energy intensity of GDP. Progress can be made for activities such as Manufacture of chemicals and chemical products which is characterized by significantly higher energy intensity compared to other activities. For this cases, targeted investments could lead to a reduction in energy consumption with a positive impact on competitiveness and further reduction in the energy intensity of GDP.

Table 1.
Manufacturing activities with high energy consumption vs change in the output share

	Energy consumption, % manufacturing 2021	Energy intensity, Terajoule per mil. Euro 2021	Output, % manufacturing 1990	Output, % manufacturing 2021
Manufacture of coke and refined petroleum products	23.1	35.3	10.5	7.7
Manufacture of basic metals and fabricated metal products, except machinery and equipment	18.9	27.1	21.8	11.1
Manufacture of chemicals and chemical products	18.8	51.2	10.9	4.3
Manufacture of rubber and plastic products and other non-metallic mineral products	16.9	26.1	14.2	8.8

Source: Author calculation based on data from National Institute of Statistics and Eurostat

4. Econometric analysis of the impact of the COVID-19 shock on low-technology activities

A VAR model was constructed, incorporating the variables: (a) production dynamics within the manufacturing industry; (b) producer prices within the manufacturing sector.² The analysis focuses on the shock generated by the producer prices in manufacturing to better capture the impact of the energy price shock on the cost structure and its impact on output. The estimation of these models utilized monthly data spanning from January 2019 to April 2023. The VAR model included the manufacturing activities that exhibited heightened susceptibility to the energy shock, as indicated in Table 1.

To ensure the reliability of the findings, a series of specific tests were conducted. The stationarity of the variables was examined using the Dickey-Fuller (ADF) test. The production dynamics series exhibited stationarity in levels, while the price index displayed stationarity in the first difference. The optimal number of lags was determined by employing five criteria available in Eviews. These criteria suggested lag 2 as optimal for the model. The stationarity of the system was assessed using the AR root table, which revealed that all roots of the VAR system resided within the unit circle. To investigate potential residual serial correlation in the model, the LM test of autocorrelation was employed. The test results indicated the absence of first-order autocorrelation. Additionally, the F-test yielded statistically significant results at a 5% level of significance for the VAR models employed in the analysis of the impulse response functions.

$$\begin{aligned} \text{MCHEM} = & - 0.14*\text{MCHEM}(-1) - 0.25*\text{MCHEM}(-2) - 0.05*\text{MCOKE}(-1) + \\ & 0.03*\text{MCOKE}(-2) - 0.43*\text{MRUB}(-1) + 1.16*\text{MRUB}(-2) - 0.49*\text{MMET}(-1) - \\ & 0.45*\text{MMET}(-2) + 0.56*\text{M}(-1) - 0.94*\text{M}(-2) + 2.45*\text{MPR}(-1) - 4.06*\text{MPR}(-2) \\ & + 0.78 \\ & [\text{F-statistic} = 1.95] \end{aligned} \quad (1)$$

$$\begin{aligned} \text{MCOKE} = & - 0.01*\text{MCHEM}(-1) - 0.62*\text{MCHEM}(-2) - 0.122*\text{MCOKE}(-1) - \\ & 0.12*\text{MCOKE}(-2) + 0.13*\text{MRUB}(-1) + 0.71*\text{MRUB}(-2) - 0.75*\text{MMET}(-1) - \end{aligned}$$

² M – production dynamics in manufacturing; MCHEM - production dynamics in Manufacture of chemicals and chemical products; MCOKE – production dynamics in Manufacture of coke and refined petroleum products; MRUB – production dynamics in Manufacture of rubber and plastic products and other non-metallic mineral products; MMET – production dynamics in Manufacture of basic metals and fabricated metal products, except machinery and equipment; MPR – producer prices in manufacturing.

$$0.38*MMET(-2) + 0.33*M(-1) + 0.09*M(-2) - 1.72*MPR(-1) + 2.32*MPR(-2) - 0.02$$

$$[F\text{-statistic} = 1.72] \quad (2)$$

$$MRUB = 0.07*MCHEM(-1) - 0.14*MCHEM(-2) - 0.08*MCOKE(-1) + 0.08*MCOKE(-2) - 1.01*MRUB(-1) + 0.07*MRUB(-2) - 0.47*MMET(-1) - 0.11*MMET(-2) + 1.22*M(-1) - 0.15*M(-2) + 1.91*MPR(-1) - 2.27*MPR(-2) + 0.15$$

$$[F\text{-statistic} = 2.68] \quad (3)$$

$$MMET = - 0.157*MCHEM(-1) - 0.06*MCHEM(-2) + 0.1*MCOKE(-1) - 0.03*MCOKE(-2) - 0.41*MRUB(-1) + 0.07*MRUB(-2) - 0.67*MMET(-1) + 0.03*MMET(-2) + 0.85*M(-1) - 0.02*M(-2) + 0.85*MPR(-1) - 1.76*MPR(-2) + 0.35$$

$$[F\text{-statistic} = 2.33] \quad (4)$$

The statistical data analysis revealed a substantial impact of the pandemic shock on the selected activities. The econometric results align with the historical data, demonstrating that the production shock had a greater effect on the Manufacture of chemicals and chemical products, as well as the Manufacture of basic metals and fabricated metal products (excluding machinery and equipment). This finding is consistent with the significant decline in demand due to pandemic restrictions and the disruption of global value chains. Furthermore, Figure 2 illustrates that as disruptions in global value chains intensified, the impact on the aforementioned activities became more pronounced. The response of the activity Manufacture of coke and refined petroleum products to a price shock captured by the producer prices in manufacturing was initially negative, but the cumulative response was positive as the activity benefited directly from the energy price rises.

The examination of the inflationary shock's influence encompasses the deflationary effect of the pandemic on prices, as well as the substantial inflationary impact caused by the war. In the initial periods, the statistical confidence interval encompasses the value of 0. This suggests a diminished statistical confidence in the positive response of the activities under analysis. This outcome reflects the heightened volatility observed in the manufacturing activities being studied. Similar patterns of large statistical confidence intervals are observed as the pandemic was followed by a second shock induced by the war in Ukraine which added to the volatility and uncertainty (see Figure 2).

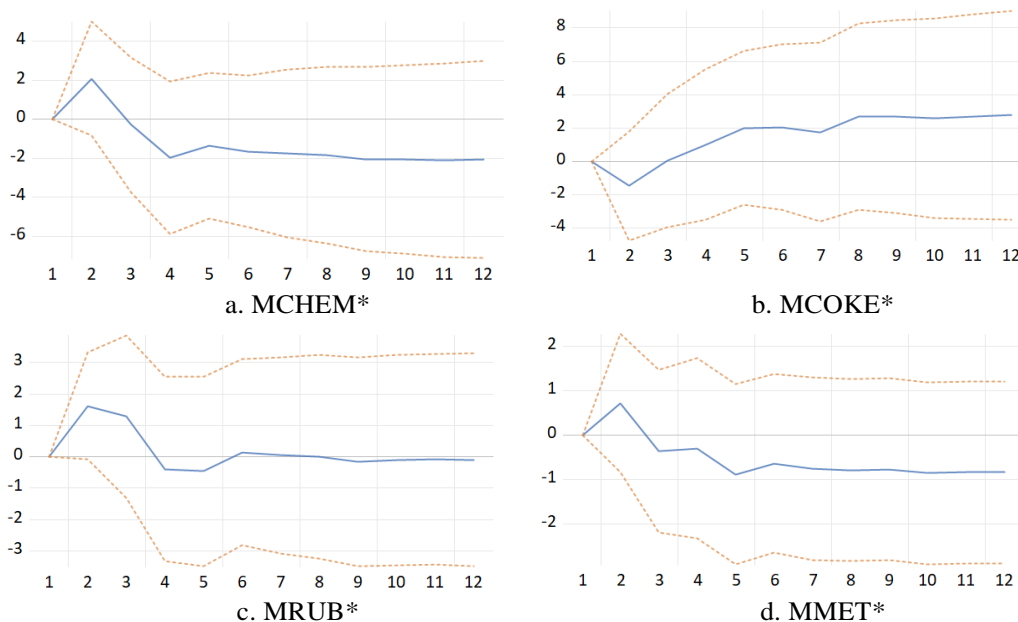


Figure 2. *The response of medium technology activities to a shock in the Producer prices in manufacturing.*

Source: Author's calculations using Eviews 12

Note: The shock response function measures the impact of a shock equal to a standard deviation of the residues of the regression equation specific to the manufacturing industry. The shock response is monitored for 12 periods equivalent to 12 months. * See footnote 1 for the acronyms.

The deflationary shock experienced during the pandemic exhibited a positive correlation with the decline in output. As the economy began to recover and aggregate demand increased, there was a subsequent rise in prices. The cumulative impact of the price increases on output was negative with the exception of Manufacture of coke and refined petroleum products where a simultaneous increase in production and prices was observed. However, in order to better understand the impact of the inflationary shock resulting from the war, a longer time period following the outbreak of the conflict in Ukraine is required for more accurate analysis and identification of its effects.

5. Conclusions

The examination of the relationship between the production of specific activities within the manufacturing industry and energy

consumption reveals a notable decline in the structural weights associated with activities characterized by high energy consumption. Particularly noteworthy are the activities of Manufacture of basic metals and fabricated metal products, except machinery and equipment, and Manufacture of chemicals and chemical products, which have experienced significant reductions in their production share within the overall manufacturing industry.

The analysis of the inflationary shock encompasses the deflationary impact observed during the pandemic and the significant inflationary impact resulting from the war. The deflationary pressures experienced during the pandemic showed a positive correlation with the decline in production, while the subsequent economic recovery and resurgence of aggregate demand were roughly synchronized with price increases. The full propagation of the inflationary shock on aggregate demand has not yet been realized. To better understand the impact of the inflationary shock, it is necessary to observe a longer period since the onset of the war in Ukraine. This highlights the potential usefulness of conducting further econometric analysis in future studies to identify and assess the effects of the inflationary shock more accurately.

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