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# THE INFLUENCE OF MACROECONOMIC FACTORS ON THE AUTOMOBILE INDUSTRY IN THE EU

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**Abstract**

The aim of this paper is to examine whether macroeconomic factors affect the automotive market. The difficult situation on the global market, a result of the numerous disruptions caused by the Covid-19 pandemic, has once again brought to the fore the issue of interruptions in supply chains and their vulnerability. Supply chains in the automotive industry are in a particularly difficult situation because their members are often very geographically dislocated, and the problems that arise in the present are very complex. For the authors of this paper, such a situation was the main driver of looking at the context and looking for potential solutions on the way to reducing negative effects. The main idea of this paper is to look at macroeconomic factors and their connection with supply chains in the automotive industry in the context of their impact on one of the most important performance factors – sales. Based on the panel analysis conducted as part of the research, it is possible to observe three very important macroeconomic factors that affect the automobile market, namely the inflation rate, GDP, and household income. The analysis of all factors indicated the existence of the influence of these variables on sales in the automotive industry.

**Key words**: automobile industry, supply chains, macroeconomic factors, EU.

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# УТИЦАЈ МАКРОЕКОНОМСКИХ ФАКТОРА НА АУТОМОБИЛСКУ ИНДУСТРИЈУ У ЕУ

**Апстракт**

Циљ овог рада је испитати да ли макроекономски фактори утичу на аутомобилско тржиште. Тешка ситуација на глобалном тржишту, због бројних поремећаја изазваних пандемијом *Covid*-19, поново је у први план ставила питање прекида у ланцима снабдевања и њихове рањивости. Ланци снабдевања у аутомобилској индустрији су посебно у тешкој ситуацији јер су њихови чланови често веома географски дислоцирани, а проблеми који се јављају у садашњости су врло сложени. За ауторе овог рада оваква ситуација је била главни покретач сагледавања контекста и тражења потенцијалних решења на путу смањења негативних ефеката. Основна идеја овог рада је да се сагледају макроекономски фактори и њихова повезаност са ланцима снабдевања у аутомобилској индустрији, у контексту њиховог утицаја на један од најважнијих фактора перформанси – продају. На основу панел анализе спроведене у оквиру истраживања, могуће је уочити три веома важна макроекономска фактора који утичу на тржиште аутомобила, а то су стопа инфлације, БДП и приходи становништва. Анализа свих фактора указала је на постојање утицаја ових варијабли на продају у аутомобилској индустрији.

**Кључне речи**: аутомобилска индустрија, ланци снабдевања, макроекономски фактори, ЕУ.

## *INTRODUCTION*

Macroeconomic factors represent very important indicators, whose impact is often examined by creating economic models. A particularly important research question refers to the examination of the relationship between numerous macroeconomic indicators and the results achieved by members of supply chains in the automotive industry. Due to its specificity, which is reflected in a large number of members and complex collaborative relationships, supply chains in the automotive industry are often the subject of numerous scientific works. The author Vychytilova and her collaborators examined the influence of macroeconomic factors on the automobile industry in a study that analysed 39 manufacturers in 11 countries. In their work, they investigated the factors that influence the stock prices of car manufacturers. They concluded that there is a relationship between prices and GDP, unemployment, and inflation measured by the index of industrial prices. Authors Patra and Rao (2017) analysed the impact of macroeconomic factors on the automobile industry in India. In their research, they concluded that GDP has a positive impact on car sales. In his research, author Saeed (2012) looked at the impact of macroeconomic factors on the automotive industry, stating that the interest rate has a negative and statistically significant impact on revenues in the automotive industry. Money supply, industrial production, and the exchange rate also have a negative, but significant relationship with income in the automotive industry. Oil prices have a positive effect on income, but the influence of prices is not

statistically significant. In his work, the author Khoury (2015) also examined how macroeconomic variables affect the automotive industry. With his research, he summarised and monitored the impact of macroeconomic variables on the revenues of companies in the automotive industry, particularly highlighting the following conclusions. Inflation and the Euribor interest rate, as well as exports, have the greatest impact on income. In their study, Fic and colleagues (2022) examined the influence of macroeconomic factors on premium German automobile brands in the Malaysian market. Through the application of PESTEL analysis and multiple regression methods, they analysed the impact of macroeconomic variables on sales and concluded that there is no direct correlation. Given that the research focused exclusively on premium models, the results might differ if the full range of vehicles were taken into account.

## *THE AUTOMOTIVE SECTOR IN THE EU*

Car production is one of the most important bases of the European Union's Economy (Lazlo, 2020). The automotive sector absorbs more than six percent of employees and generates more than seven percent of the EU's gross domestic product. There are about 17,000 small and medium-sized companies in the EU, which are mainly specialised in the production of cars with traditional gearboxes and internal combustion engines. A significant risk these companies face stems from their lack of preparation to compete with rivals in the electric vehicle market. The high dependence of these companies on large competitors outside the EU that produce batteries for driving electric vehicles represents a significant threat to the development of electromobility in Europe. The last world economic crisis led to a significant decline in the global production of motor vehicles (Figure 1). During 2009, 61.76 million vehicles were produced, which is about 14% less than the previous year. After this crisis, there was a recovery in the global production of motor vehicles.

The Covid-19 pandemic halted the long-term growth of global trade, and production volume and real GDP (Milovanović, Milanović, Radisavljević; 2020). The pandemic has forced governments and the largest world economies to demand from their citizens to stay at home, to close shops, factories and other facilities in order to suppress the spread of the Coronavirus (Milovanović, Anđelković, Popović, 2021). Covid-19 has wreaked havoc on supply chains around the globe. This is particularly true for producers of cars, as they struggled to bounce back amid the Covid-19 outbreak (Anđelković, Stanković, Janković Milić, 2024). In 2019, 91.78 million motor vehicles were produced in the world, but in 2020, due to the outbreak of the Covid-19 pandemic, their production decreased by nearly 16%. The largest producers of cars and commercial vehicles in 2020 were China, Japan, and Germany.

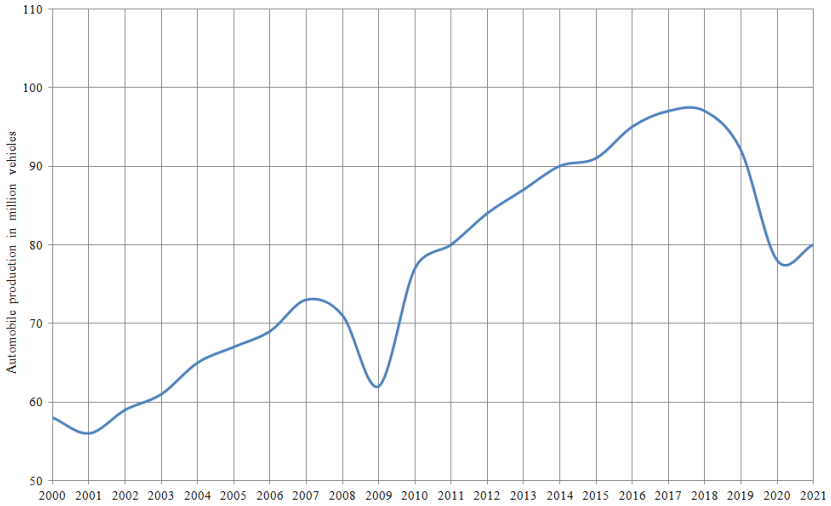


*Figure 1. Estimated world production of motor vehicles (cars and commercial vehicles) from 2000 to 2021 (in millions of vehicles)*
*Source:* https://www.statista.com/statistics/262747/worldwide-automobile-production-since-2000/

After the last global economic crisis, there was an increase in the number of registered passenger cars in the EU - from 11.9 million in 2013 to 15.3 million in 2019. From 2010 to 2019, the number of registered new passenger vehicles in the EU mainly reflected the growth of the GDP of the members of this integration (Figure 2).

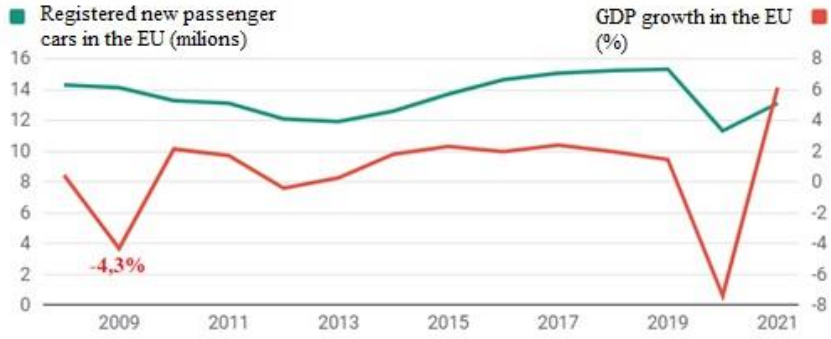


*Figure 2. Number of registered new passenger cars and annual GDP growth in the EU*
*Source:* https://www.acea.auto/figure/vehicle-sales-mirror-economic-growth-2008-2021-trend/

The demand for new passenger cars is mainly based on anticipating GDP trends since their purchase is often influenced by consumer confidence. The number of registered commercial vehicles followed GDP growth more than the number of registered new passenger vehicles, given that the demand for road transport services is directly related to the state of national economies. The Covid-19 pandemic has caused disruptions in the global supply chains of automotive companies (for example, disruptions in the supply of semiconductors), but it has also increased the demand for electric vehicles and, thus, the need for electrification, digitisation and measures to increase the resilience of global supply chains. However, intensifying disruptions in supply chains, especially with new members located outside the EU, threaten the jobs and viability of many EU car companies. The EU automotive industry will develop more in the next decade than it did in the entire previous century. Although companies in this industry are leading in terms of research and development intensity, they need to increase investment in the digitisation of supply chains. Electrification, smart and shared mobility represent the EU's big steps towards environmental sustainability and efficient transport, which is largely made possible by digitisation. The EU needs to regain leadership in key technologies, especially in the connected and autonomous vehicle segment. A major challenge for automotive companies in the EU is the improvement of the double digital and green transition (Eng. 'tween' transition) at a time when their interests are threatened by new and existing competitors from the Asia-Pacific region and North America. The 'dual transition' strategy allows leaders to combine digitisation plans and sustainability plans to prepare their companies for the future. However, such a transition will hardly be able to bypass the paradox that is reflected in obtaining electricity from dirty fuels (coal, fuel oil, gasoline engines...) for its accumulation in car batteries.

## *SUPPLY CHAINS IN THE AUTOMOTIVE INDUSTRY*

The global market is characterised by permanent changes, which require the reorganisation of the business model. Business actors in such an environment must show a high level of flexibility. Adapting to constant changes is a big challenge, which business entities often cannot realise on their own. Joining and creating different forms of business is one of the ways to overcome challenges. Supply chains are the dominant form in which the subjects realise their business.

Supply chains can be defined as an integrated network of facilities, various transportation options, and operations such as procurement, production, storage, and distribution of materials and products (Garcia & You, 2015). The aforementioned definition indicates the basic processes in supply chains, but also the importance of the connection between members, which is reflected in the level of integration achieved. Authors Stevens and

Johnson (2016) view supply chain integration as the alignment, linking, and coordination of people, processes, information, knowledge, and strategies across the supply chain to facilitate efficient and effective flows of materials, money, information, and knowledge in response to customer needs. With their definition, the aforementioned authors made a contribution to the research of supply chains, pointing out how important it is to coordinate with all entities and elements not only within but also outside the boundaries of supply chains. Looking at the external dimension in the business of supply chains is very important for achieving the set goals of supply chains. The global business context is a common dimension for all entities in creating their practices and goals. In the existing literature, it is possible to encounter the term global capitalism, in the function of which supply chains are increasingly being observed.

Anna Tsing (2009), who looked at the role of supply chains in the achievement of goals in global capitalism, examined this connection. She pointed out that supply chains are not the only modern form of global capitalism. In her work, she concludes that in addition to supply chains, there are other models of global capitalism, but she also points out that supply chains are not a new form of business. It is a form that corresponds to the current conditions on the market, but with the change of context, there must also be changes in the business model. In her work, she even uses the term supply chain capitalism, which only confirms the dominance of this business form. There are numerous variations of this business form on the market.

Author Carter and his collaborators researched the basic types of supply chains. According to their understanding there are physical supply chains and support supply chains (Carter et al., 2015). Physical supply chains actually resemble traditional chains, because they are dominated by production as the core activity. In addition to it, traditional supply chains also contain numerous logistics functions in order for the processes to be carried out efficiently. Support supply chains involve the involvement of members who usually perform some specialised functions such as brokers, financial consultants, or logistics service providers. The global context of business certainly imposes the need for support supply chains because factors in the international market are more complex, and specialised intermediaries are crucial in the organisation of an efficient business. The automotive sector affects the economy not only via its magnitude and export share but also via ties with the other sectors and supply chains (Mareš & Janičko, 2022).

Looking at the efficiency of supply chains is a very important task. By looking at macroeconomic indicators and analysing them, it is possible to examine the connection between the global context and the business results of supply chains. Macroeconomic indicators can contain leading information about the context, such as changing global economic conditions (Sagaert et al., 2018). By looking at the connection between macroeconomic indicators and supply chain operations, it is possible to recognise

trends in the economy. One of the results of such an analysis can be a recommendation for the redesign of supply chains, so that the chains follow changes at the macroeconomic level to a greater extent. The subject of this paper is the analysis of the impact of macroeconomic factors on car sales in the EU market. By looking at the connection between supply chains in the automotive industry and the movement of macroeconomic factors, the authors will try to determine and propose possible changes in the organisation of supply chains based on a ten-year analysis. Supply chains in the automotive industry are characterised by their complex structure, which, in addition to traditional participants in supply chains, include a large number of specialised intermediaries. According to their structure, supply chains in the automotive industry can be classified as support supply chains. The sales and distribution network in the automotive industry has a divergent structure, consisting of numerous participants, such as a central sales department, manufacturers, salespeople who may be responsible for different regions of the world, sales companies in different countries or local areas, and a fairly high number of downstream retailers and a few sales subsidiaries (Meyr, 2004). A large number of suppliers, which are organised on several levels, also makes supply chains in the automotive industry more complex. More complex relationships between members, as well as their number, impose different challenges in the management of supply chains in the automotive industry.

## *RESEARCH METHODOLOGY*

### *Data and Econometric Models*

The research carried out in this paper is of a deductive-implicative type, given that the research is based on the results of previous studies and theoretical frameworks, and it will be concluded whether the observed set of independent variables affects the sale of cars in the EU based on the obtained research results. In other words, the research is based on the assumption that panel models of time series can identify factors that significantly affect the sale of cars in the EU market. The research covers 28 EU countries. Realised car sales in the 2010-2020 period were monitored, so the sample consists of 308 observations. The stated sample size is sufficient for conducting quantitative research of this type and for obtaining valid results. The list of used indicators is given in the following table.

*Table 1. Indicator used in the study*

| Indicator | |
|---|---|
| SAL | Realized car sales |
| INF | Inflation rate |
| GDPR | GDP change rate |
| INC | Household income |

*Source: Authors*

The data necessary for the analysis of the impact of the identified factors on the achieved car sales in the EU countries was obtained via download from the Carsales and Eurostat databases. Data quality is ensured by analysing the data and adding missing values to the average values for the given countries in the observed value period. Panel time series analysis and testing of results were conducted using EViews 10 statistical software. Panel econometric models combine comparative and time-series data, meaning that each panel observation has a spatial and temporal dimension. Panel data can be graphically described as data related to units of observation in different time periods. Based on the limitations related to regression coefficients, the following regression models are most often used in panel research:

- model with constant parameters (pooled OLS model),
- fixed-effects model,
- model with stochastic effects (random-effects model).

Each of these three models gives different results in terms of the values of the regression coefficients and the statistical significance of the results themselves. In order to establish which of the models best describes the reactions of the dependent variable to the variations of the independent variables, appropriate tests are necessary. In the analysis of empirical data, a choice was made between the fixed-effects model (FEM) and the random-effects model (REM). Also, balanced panel data was used, which implies an equal number of observations for each observation unit (cross-section) over time. The choice between the fixed effect model and the random effect model was made using the Hausman test. With this test, we test the null hypothesis that the effects are random against the alternative hypothesis that the individual effects are fixed. The considered models can be presented as follows (Brooks, 2008):

$$y_{ij} = \alpha + \beta x_{it} + u_{it}$$

where $y_{ij}$ is the dependent variable, $\alpha$ is the intercept term, $\beta$is $k \times 1$vector of parameters to be estimated on the explanatory variables, and $x_{it}$ is $1 \times k$ vector of observations on the explanatory variables, $t = 1,2, \dots . , T; i = 1,2, \dots , N$.

Before the selected variables were entered into the model, the data related to the dependent variable was logarithmised. The selected model, after entering the variables, can be displayed as follows:

$$logSAL_{it} = \beta_0 + \beta_1 INFL_{it} + \beta_2 INC_{it} + \beta_3 GDPR_{it} + \omega_{it},$$

$$\omega_{it} = e_i + \nu_{it}$$

where $e_i$ is cross-sectional error term, and $\nu_{it}$ is individual observation error term.

### *Descriptive Statistical Analysis of Data*

In order to better understand the nature of the observed phenomena, as well as the first quality of the data that will be used for the formulation of the model, descriptive measures were determined for the given variables. In this sense, the minimum, maximum, and mean values of the given indicators, their standard deviation, and the corresponding measures of the layout form were determined. An overview of these descriptive indicators is given in Table 2.

*Table 2. Descriptive statistics*

| | Min | Max | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| SAL | 5157.00 | 3912223.00 | 541448.20 | 885328.85 | 2.08 | 3.22 |
| INF | -1.60 | 6.10 | 1.4205 | 1.41934 | 0.40 | 0.04 |
| GDPR | -11.30 | 24.40 | 1.63 | 3.45 | 0.09 | 2.45 |
| INC | 2.02 | 37.84 | 14.67 | 8.59 | 0.39 | -0.83 |

*Source: Authors*

### *Results of Panel Analysis*

The effect of the influence of independent variables (inflation rate, household income, and GDP growth rate) on car sales in EU countries in the 2010-2020 period was assessed using panel data analysis. Regression coefficients were evaluated using the fixed and random-effects model, in order to determine which of these two models is more adequate. The evaluation of the coefficients of the variables was carried out using the random-effects model, given that the value of the Hausman test is $chi^2(6) = 5.799345$ with the probability Prob > $chi^2 = 0.1218$. The validity and stability of the overall regression model are identified using the F test and its probability. In this sense, the F test has a value of F (58.24234) with probability Prob > F = 0.0000, which shows that the variation in the dependent variable (logSAL) is the result of the influence of the independent variables in the model. On the other hand, the value of $R^2$ shows that the measure of explained variability – the adjusted coefficient of determination is 0.358716, that is, 35.87% of the changes in the dependent variable is explained by the independent variables used in the model. Based on the data in Table 3, it can be concluded that an increase in the inflation rate leads to an increase in car sales (the regression coefficient has a value of 0.019994 and is statistically significant Prob. =0.0152). The same applies to the impact of household income. An increase in household income (measured by mean and median) leads to an increase in car sales in EU countries (the regression coefficient is 8.34E-05 and is statistically significant Prob. =0.0000). Finally, there is a direct impact of the growth rate GDP on realised car sales in the EU – the higher the GDP growth rate, the higher the car sales (the coefficient has a value of 0.035395, and the significance is Prob. =0.0000).

*Table 3. Random effect model results*

Dependent Variable: logSALE
Sample: 2010 2020
Periods included: 11
Cross-sections included: 28
Total panel (balanced) observations: 308

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 10.64852 | 0.303428 | 35.09404 | 0.0000 |
| INF | 0.019994 | 0.008191 | 2.440885 | 0.0152 |
| GDPR | 0.035395 | 0.003606 | 9.816848 | 0.0000 |
| INC | 8.34E-05 | 7.52E-06 | 11.09660 | 0.0000 |
| R-squared | 0364983 | | | |
| Adjusted R-squared | 0.358716 | | | |
| F-statistic | 58.24234 | | Prob(F-statistic) | 0.0000 |
| Hausman test | $Chi^2(3)$ | 5.799345 | Prob(Chi-Sq. Stat) | 0.1218 |

*Source: Authors*

## *CONCLUSION*

The aim of this paper was to determine the macroeconomic factors that affect the automotive market, as well as the direction of their action. Based on the Panel analysis, the authors concluded that when it comes to GDP, there is a direct impact, which indicates that an increase in GDP also increases car sales. The situation is identical with income, because its growth leads to the growth of car sales. In particular, the conclusion refers to the inflation rate, because the analysis showed that even there is a direct conflict in relation to it, that is, with the increase in the inflation rate, there is an increase in car sales. The authors believe that the contribution of this paper is reflected in the definition of the impact of certain macroeconomic factors on sales in the automotive industry. These conclusions can be the starting point for the creation of new strategies, which, among other things, would help to improve the current situation in the car market.

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# УТИЦАЈ МАКРОЕКОНОМСКИХ ФАКТОРА НА АУТОМОБИЛСКУ ИНДУСТРИЈУ У ЕУ

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**Резиме**

Макроекономски фактори представљају кључне показатеље чији се утицај често анализира кроз креирање економских модела. Овај рад истражује повезаност макроекономских индикатора са резултатима у ланцима снабдевања аутомобилске индустрије у Европској унији (ЕУ). Аутомобилска индустрија у ЕУ запошљава више од шест одсто радне снаге и генерише више од седам одсто бруто домаћег производа (БДП). Посебна пажња посвећена је анализирању тога како су макроекономски фактори, попут инфлације, прихода домаћинстава и стопе раста БДП-а, утицали на продају аутомобила у ЕУ у периоду од 2010. до 2020. године.

Рад се ослања на постојећа теоријска истраживања и резултате претходних студија, користећи панел анализу временских серија на узорку од 28 земаља ЕУ са 308 посматрања. Коришћени су модели са фиксним и случајним ефектима, а избор одговарајућег модела извршен је Хаусмановим тестом. Резултати показују да стопа инфлације има позитиван и статистички значајан утицај на продају аутомобила (коефицијент 0.019994, p = 0.0152), те приход домаћинстава директно доприноси повећању продаје аутомобила (коефицијент 8.34E-05, p = 0.0000), док стопа раста БДП-а има позитиван и значајан утицај на продају аутомобила (коефицијент 0.035395, p = 0.0000).

Комплексност ланаца снабдевања захтева прилагођавање глобалним економским променама кроз ефикаснију координацију и интеграцију. Закључци рада указују на потребу за редизајном ланаца снабдевања како би боље одговорили на промене макроекономског окружења и тиме унапредили пословне резултате. Дигитализација, електрификација и одрживост су кључни кораци за будући развој аутомобилске индустрије у ЕУ, док 'двострука транзиција' (дигитална и зелена) представља велику шансу, али и изазов за компаније у овом сектору.