RESEARCH ON THE EVOLUTION OF COSTS ASSOCIATED WITH COVID-19 OF A COMPANY FROM THE AUTOMOTIVE INDUSTRY

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Abstract: The automotive industry is considered to be a remarkable industrial and economic power. Representing one of the most grown economic sectors, it contributes to several important national dimensions by generating government revenue, creating economic development and supporting research & development and innovation. This paper presents aspects of the automotive industry in the context of COVID-19 pandemic, materializing through a study on the evolution of costs related to COVID-19 and forecasting their future behaviour in a company from automotive industry.

JEL Classification: M21, C10, M40

Key words: automotive industry, costs, COVID-19

1. INTRODUCTION

The competitive environment, in which companies operate, can be seen as a constant struggle in which they try to maintain competitiveness in an increasingly demanding market, encountering obstacles such as uncertainty and lack of information.

Therefore, in order to guarantee the profits and obtain the needed information, the cost forecasting and the development of the methods for costs management have become some of the most important factors in the industry.

The automotive industry, including some other related industries, constitutes a major booster of economic growth and technological prosperity, supporting the global economy. Consisting of all companies and activities involved in the manufacture of vehicles, the automotive industry has a diminished historical archive than other industries.

It has an exceptional interest due to its impact on the history of the 20th century. Although the automobile appeared in Europe at the end of the 19th century, the United States dominated the world industry in the first half of the 20th century, with the invention of mass production. In the second half of the century, the situation changed spontaneously, as Western European countries and Japan became major suppliers and exporters.

The first self-propelled road vehicle was a military tractor designed by engineer Nicolas Joseph Cugnot in 1769 using a steam engine to power his vehicle built under his command at the Paris Arsenal. Romania was among the first countries in the world, which introduced the car in traffic, since the beginning of its construction. The first steam engine appeared in 1838 at the mining operations in Zlatna and at a timber factory in Bucharest. 1

The semiconductor crisis induced by the COVID-19 pandemic was exacerbated by natural disasters, such as a fire at a major semiconductor plant, severe weather and drought in Taiwan. The origin of this lack of semiconductors dates back to the beginning of year 2020 when Covid-19 caused the shuttering of factories. Once factories closed, semiconductor suppliers redirected parts to other sectors, such as consumer electronics, which have seen a tremendous increase in demand due to working from home and moving education in online mode.

2. Research methodology

This paper contributes to the knowledge of the evolution of automotive industry during COVI-19, materialized using a statistical forecasting model based on the associated costs with COVID-19 within a company in the automotive industry.

The research methods used for the elaboration of this paper are: the review of the specialized literature, the method of structuring the research, the documentation, the analysis and the chronological study, the comparison and the case study. We used these methods by consulting specialized papers, various articles and publications, databases, as well as direct documentation that requires knowledge of the practical reality of a multinational company.

3. Automotive industry in the context of COVID-19 pandemic

The outbreak of COVID in Wuhan, prompted the World Health Organization to declare a global health emergency in late January 2020. A catastrophic evolution observed during the COVID-19 pandemic is the growing number of collaborations. The need to address pandemic disorders and public health issues has put companies, governments and non-governmental organizations in situations that require astonishing interdependence and coordination. For example, these collaborations have grown exponentially in 2020 to address the lack of medical and protective equipment, to facilitate vaccine research partnerships, and to systematize the safe reopening of local economies.

This pandemic has also had a significant impact on the automotive industry and parts suppliers are still not reaching its maximum production capacity. Subsequent delivery delays have affected the market on several levels since the delayed launch of new car models, broken supply chains and lower vehicle sales in the first half of 2020.

The impact of COVID-19 on the automotive sector was swift and significant. Initial concerns about a disruption in exports of Chinese parts quickly turned into large-

[1] Biblioteca Națională a României - expoziție virtuală Septembrie 2020 (bibnat.ro)

scale production disruptions across Europe. In the US, assembly plant closures have added to intense pressure on an increasingly difficult global supply base.2

According to Michael Wayland, "the coronavirus pandemic has increased car sales and buying a car will never be the same. Car dealers and manufacturers are changing their business strategies and investing in new digital sales tools as consumers demand more online and personalized services".[3]

COVID-19 has triggered social and economic unrest around the world. A pandemic of such magnitude and severity has not been seen since the Spanish flu in 1918.[4] The global transformation of industries, supply chains, labor, communications and institutional frameworks has suggested the entering in a period of change in which the future cannot be universalized based on the past. The impact of the COVID-19 pandemic has also led to new opportunities created on other lines of mobility, such as shared mobility, electric vehicles, connectivity solutions, the exchange market and vehicle rental.

Analyzing the globally production of motor vehicles in the period 2019-2020, we can observe that in 2020 there was a production in the amount of 77.7 million motor vehicles, which is a decrease of 15.8% compared to 2019.

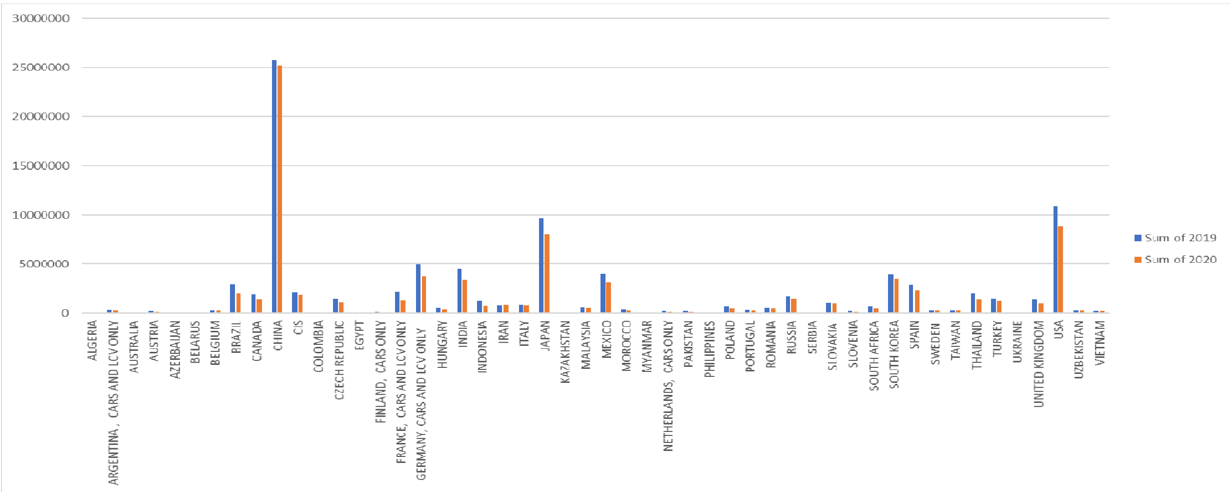

Fig.1 Production of motor vehicles 2019-2020

Source: Own processing based on Production Statistics | www.oica.net5

The largest global vehicle manufacturer for the period analyzed is China with a production of 26 million vehicles in 2019 and in 2020 with a decrease of only 2% compared to the previous year. It is followed in second place by the United States with a production volume of about 11 million vehicles in 2019, and in 2020 with 19% fewer vehicles produced.

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[2] Understanding COVID-19's impact on the automotive sector | Deloitte Global

[3] The coronavirus pandemic has upended auto sales and buying a car will never be the same (cnbc.com)

[4] North, D. (1999). 'Dealing with a non-ergodic world: Institutional economics, property rights, and the global environment'. Duke Environmental Law & Policy Forum, 10, 1–12

[5] Production Statistics | www.oica.net

Analyzing from another perspective, namely by groups of states, we can observe that the first place remains occupied by the group of states called Asia - Pacific with a production volume of about 49 million vehicles and the second place belongs to Europe, with a production volume of 22 million vehicles in 2019, registering in 2020 a decrease of 21.6% compared to the previous year.

As we can see, Germany is the largest European producer, followed by Spain, France and Russia. Analyzing the data related with Romania, we can observe a registered decrease of 10.7% in the production of motor vehicles in 2020 compared to 2019.

The countries that recorded the largest negative change in 2020 compared to 2019 were Algeria, registering a decrease in motor vehicle production of -98.7%, followed by Indonesia (which had a decrease of -46.3%), Austria (with a decrease of -41.7%) and France (which recorded a decrease of -39.5%).

In other words, the countries that registered a positive change related to vehicle production in 2020 were Kazakhstan, which registered an increase of 51.5% compared to the reference year; followed by Egypt, which had an increase of 28.4% in motor vehicle production in 2020 compared to the previous year 2019.

Driven by global initiatives such as the Paris Agreement, several countries around the world have begun to adopt stricter emission controls on the new vehicle prototypes. As such, car manufacturers have started to grow their business in the electric mobility sector.

4. SEMICONDUCTOR CRISIS

Subsequently, the COVID-19 pandemic also led to a semiconductor crisis in many industries, including the automotive sector. In early 2020, the global semiconductor industry expected this increase in demand to trigger the launch of 5G on mobile devices and specialists predicted an increasing demand for the growing need to use semiconductors beyond smartphones, such as automotive and industrial applications. With COVID-19, this has changed, impacting the global semiconductor supply. The initial disruption was seen in China and Taiwan, dominant semiconductor-producing regions, where factories were forced to close when the pandemic first struck.

However, although production has recovered and semiconductor revenues increased in 2020, new increases in demand, such as those caused by changing consumer habits, along with challenges in allocating semiconductors, have led to a significant and general lack of semiconductors in 2021.

The car market and automotive industry were significantly affected by the COVID-19 pandemic. Decreased vehicle sales and the closure of production plants have led companies to reduce their semiconductor orders. The fall in vehicle sales and the total or partial closure of production plants led as well to a reduction in semiconductor orders. This reduction in demand from the automotive sector has induced the consumer electronics suppliers to quickly seize this opportunity, driven by work from home and online school. There was also a growing demand from telecom providers who needed to meet the needs of online work and entertainment. When demand for new vehicles finally returned, carmakers failed to get enough semiconductors, forcing them to once again obstruct the production.

Initially focused on the automotive industry, the global shortage of semiconductors has affected other sectors, such as consumer electronics, home appliances and entertainment electronics. As the demand for electronic devices continued to increase, the pressure on semiconductor manufacturers to meet their supply commitments raised.

According to Ondrej Burkacky, "in the first month of 2021, global semiconductor sales amounted to more than 40 billion $, an increase of 13% compared to the same month in 2020. Increased demand, semiconductors storage in due to geopolitical tensions such as those between the US and China and extreme weather events, have fueled the global semiconductors deficit seen in 2021."[6]

5. CASE STUDY

The costs associated with COVID-19 were highlighted separately by type of cost element, for each department. Examples of costs associated with COVID-19 at company level are: costs with the purchase of surgical masks, rapid test Antigen COVID-19, cardboard boxes for medical waste, epidemiological services, medical office on site, thermometers, hand sanitizer and for surfaces, etc.

Currently, the analized company is placed in the top of Romanian companies with the same object of activity being part of a group of the most premium car manufacturers and the world's largest vehicle manufacturer.

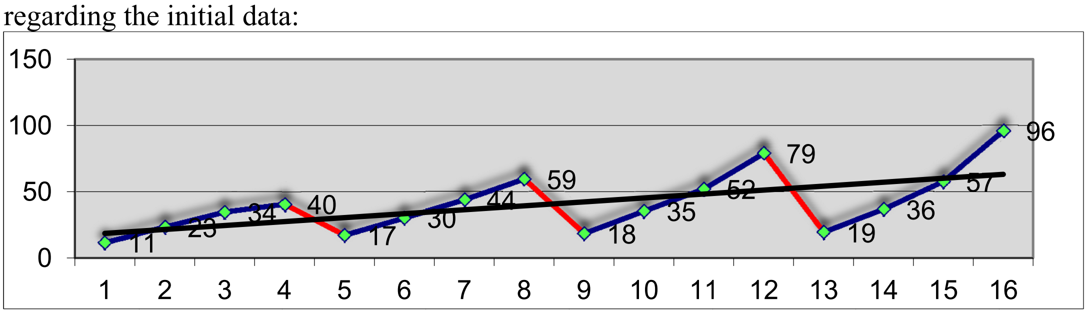
In carrying out their activity, managers are often placed in a position to anticipate the future, and then to make decisions accordingly. In this case study we aimed to observe the evolution of COVID-19 associated costs at company level and to obtain a model that optimally describes the evolution of the phenomenon followed over time and that helps us to forecast its future behavior, the sample being made up of a series consisting of 16 moments of time.

In the first step, the deseasonalization of the series and the calculation of the moving averages, initially we note the indicator that we study (expressed in thousands of RON), in a series on moments of time as follows:

Y:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
	11	23	34	40	17	30	44	59	18	35	52	79	19	36	57	96

Fig. 2 COVID-19 associated costs
Source: Own processing

To assume the trend of the previous series, we insert the line-type diagram regarding the initial data:



6 Ondrej Burkacky, Stephanie Lingemann, Klaus Pototzky, Coping with the auto-semiconductor shortage: Strategies for success, 2021, The semiconductor shortage in autos: Strategies for success | McKinsey

Fig. 3 The evolution of costs associated with COVID-19

Source: Own processing

Observing the graphic above, we can state the increasing trend for the studied period of the costs related to COVID-19.

Then, in order to eliminate the seasonal component in order to highlight the trend, the "moving averages" must be calculated using the formula:

$$y_t' = \frac{0,5y_{t-k} + y_{t-k+1} + ... + y_t + ... + y_{t+k-1} + 0,5y_{t+k}}{2k}$$

Following the calculation, through the graphical representation of the new values of the moving averages, (12 moments) we can observe that we eliminated the seasonal component with the help of this procedure:

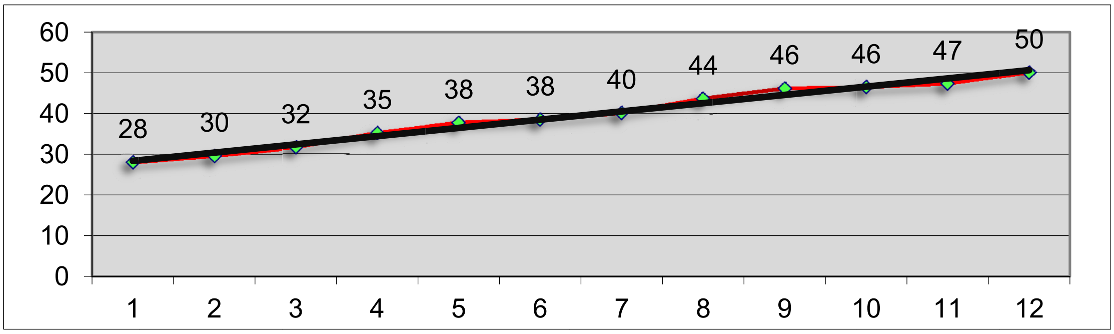


Fig. 4 Seasonally adjusted values

Source: Own processing

The intensity with which seasonal factors act is highlighted numerically by coefficients of seasonality. Therefore, a calculation of the seasonality coefficients is needed in order to correct the forecasted value based on the trend taking into account their influence. They are calculated using the following formula:

$$K_{ts} = \frac{Y_{ts}}{Y_{ts}'} \cdot 100$$

	I	II	III	IV
seasonality coefficients			1,2252628	1,3653298
	0,5397008	0,8562102	1,1588617	1,5405235
	0,4554258	0,8074638	1,1240250	1,6992538
	0,4038926	0,7273331		
Coef..average	0,4663398	0,7970024	1,1693832	1,5350357

* <1 influences by decreasing

** >1 influences by increasing

Analyzing the above results, we can observe that the phenomenon affects season I and II by decreasing the costs related to COVID, and season III and IV are influenced by their increase (if the average coefficient of seasonality is> 100 => influences by increase, and in contrary case, by decreasing).

The calculation for next step called "establishing the trend and calculating the variation between the differences, calculating the average, the linear average deviation and the coefficient of variation for each hypothesis" can be found in the following figure:

t	y	lny	ty	Dy	mod	Dy(2)	mod	Dlny	mod	Dty	mod	
1	28	3,3328	28									
2	30	3,3879	59	2	2			0,0552	0,0552	31	31	
3	32	3,4550	95	2	2	0	0	0,0671	0,0671	36	36	
4	35	3,5606	141	4	4	1	1	0,1056	0,1056	46	46	
5	38	3,6294	188	3	3	-1	1	0,0688	0,0688	48	48	
6	38	3,6501	231	1	1	-2	2	0,0207	0,0207	42	42	
7	40	3,6924	281	2	2	1	1	0,0424	0,0424	50	50	
8	44	3,7756	349	3	3	2	2	0,0831	0,0831	68	68	
9	46	3,8324	416	3	3	-1	1	0,0569	0,0569	67	67	
10	46	3,8378	464	0	0	-2	2	0,0054	0,0054	49	49	
11	47	3,8557	520	1	1	1	1	0,0179	0,0179	56	56	
12	50	3,9135	601	3	3	2	2	0,0578	0,0578	81	81	
					Dy				Dlny		Dty	
				Average	2		1		0,052793		52	
				Deviation	1		1		0,022699		11	
				Coeficient	0,444020		0,410533		0,429955		0,219555	

Fig. 6 Results for average, deviation, coefficient of variation calculation

Source: Own processing in Microsoft Excel

$$T = a + \frac{b}{t}$$

Using the MIN function in Microsoft Excel, we have as a result: Dty = 0.219555, which means the case of the hyperbolic tendency and its equation is in the form:

For the linearization of the tendency, the substitution can be used $\frac{1}{t} = k$, therefore $T(k) = a + bk$ obtaining:

$$a = M(y(t))$$

$$b = \frac{M[y(t)k']}{M[(k')^2]}$$

Using the formula, obtained by the substitution used for linearizing the trend, we can calculate points a and b and the result will be: b=-22 and a=45.

In the case of a chronological series b point defines the direction of phenomenon evolution. Due to this, and because the prediction equation in the case of hyperbola is T=a+b*1/t; T=a+b*k it results that we have a decreasing evolution of the phenomenon; therefore, the costs related to COVID 19 evolve decreasing.

The next step is called determining the forecast for the following seasons. To begin with, we calculate in Microsoft Excel using the AVERAGE function, the average for each column:

t	k=1/t	k^2	y(t)=y(k)	y(t)*k
1	1,000000	1,000000	28	28
2	0,500000	0,250000	30	15
3	0,333333	0,111111	32	11
4	0,250000	0,062500	35	9
5	0,200000	0,040000	38	8
6	0,166667	0,027778	38	6
7	0,142857	0,020408	40	6
8	0,125000	0,015625	44	5
9	0,111111	0,012346	46	5
10	0,100000	0,010000	46	5
11	0,090909	0,008264	47	4
12	0,083333	0,006944	50	4
6,5	**0,258601**	**0,130415**	**40**	**9**

Fig. 7 Forecast for the following seasons
Source: Own processing in Microsoft Excel

Trend-based forecasting is the next step that is calculated using: T=a+b*k or the TREND function; first we calculate k for the four seasons for which we want to predict:

t	k=1/t	k^2
13	0,076923	0,005917
14	0,071429	0,005102
15	0,066667	0,004444
16	0,062500	0,003906

b	a
-22	45
T=a+b*1/t	***T=a+b*k***
Previziune	**sezoane**
t13=	43,6
t14=	43,7
t15=	43,8
t16=	43,9

Fig. 8 Trend-based forecasting
Source: Own processing in Microsoft Excel

The last stepe is called “the correction of the forecast by the coefficients of seasonality”. If the determination of the trend was made on the seasonally adjusted values, the influence of the season must be reintroduced in the model, according to the formula:

t	Initial forecasting	Average c
13	43,6	
14	43,7	
15	43,8	
16	43,9	

$$y^{p}(t+k)\cdot\overline{K_s}$$

Fig.9 Correction of the forecast by the coefficients of seasonality
Source: Own processing in Microsoft Excel

The series of time moments, including the corrected forecasts for the next 4 seasons, will be as follows:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
11	23	34	40	17	30	44	59	18	35	52	79	19	36	57	96	20	35	51	67

Fig. 9 COVID-19 associated costs including the forecasting for the following 4 months
Source: Own processing

Using this model developed in Microsoft Excel, we can anticipate for the next 4 months, the costs associated with COVID-19 related to the studied company. We can observe that in November the costs associated COVID-19 will be 20 thousand RON, in December will be 35 thousand RON, in January will be 51 thousand RON and in February will be 67 thousand RON.

6. CONCLUSION AND LIMITATION

Following the analysis of the literature and case study, it was possible to outline certain conclusions and limitation presented in the last part of this paper.

Worldwide, the automotive industry is a spark for regional development, contributing to several important dimensions by encouraging research and development, revenue generation and boosting economic development.

The automotive industry was severely affected by the Covid-19 pandemic and lockdown measures in early 2020 forced factories to close or partially operate at their normal capacity. Therefore, demand for cars has fallen and is likely to decline for a longer time, with the subsequent semiconductor crisis encouraging this decline.

Cost forecasting allows managers to boost the decision-making process, cost management and streamline the budgeting process. Therefore, predictions having a direct impact on company's effectiveness, constitute the reason why time and resources were invested to study and develop new methods of forecasting and cost analysis. These predictions should ensure as much accuracy as possible. Underestimation could result in subsequent cost increases, and overestimation could lead, for example, to the cancellation of the approval of certain projects.

Regarding the model used in our case study, using it we can describe the evolution based on the tendency of a phenomenon, in time or its connection with other phenomena. The evolution of a phenomenon requires analysis in order to understand the information contained in the data observed in a certain period of time, and also to predict the future behavior of the observed phenomenon.

Regarding the limitations of the model used in our case study, we can say that it is a simple one and with its help we can predict the costs only in a short period of time. Because this model cannot be used for long-term cost forecasting, we can conclude that it does not provide much certainty and accuracy.

Unfortunately, in practice, a number of companies persist in ignoring the principles of relevant costs and benefits in decision making. Therefore, this can distort decision-making and lead to wrong actions and poor management.

Consequently, understanding cost behavior and predicting its future is crucial for managers to ensure that they have sufficient information and that the data is accurate to make effective decisions for their companies.

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