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IMPACT OF ROBOT INSTALLATIONS ON EMPLOYMENT AND LABOUR PRODUCTIVITY IN AUTOMOTIVE INDUSTRY

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Abstract

The automotive industry is regarded as one of the most robotized sectors of the manufacturing industry. The topic of robotization is currently intensely debated as part of the Fourth Industrial Revolution or Industry 4.0. In this study, we focus on automobile manufacturers operating in selected countries of the European Union and analyse the level of labour productivity and employment in the period 2002-2021. Specifically, we investigate whether the annual installation of robots and the total number of robots in the automotive industry have a negative impact on labour demand. The collected data are evaluated using empirical analysis. Our estimations show that the installation of robots in the automotive industry has a positive effect on labour demand. At the same time, however, it is found that labour productivity tends to decrease as the number of robots increases. A possible explanation for these results is that major manufacturing activities in this sector are being replaced with machines at the expense of human labour.

Implications for Central European audience: Theoretical implications of the article arise from primary literature, which investigates the implications of industry robotization on the labour market. The practical implications stem from our empirical analysis, which investigates the impact of robotization on labour demand and productivity in automobile industries across the EU.

Keywords: Automation; automotive industry; robotization

JEL Classification: J21

Introduction

In recent years, as a result of the ongoing Fourth Industrial Revolution or Industry 4.0, impacts on the labour market and productivity can be observed with increasing automation, robotization and digitization. With the global market starting to face extensive robotization, it can be expected that fewer people will work in the future due to the replacement of human labour with robots. This will then result in rising unemployment and, at the same time, a reduction in government budget revenues. We perform an assessment of impacts of robots on employment, especially in the automotive industry, in order to extract valuable conclusions regarding the effects of robotization in this industry.

There are two different views on the impact of robotization on employment. Some leading economists argue that increasing numbers of robots in use may reduce both employment and wages (Acemoglu & Restrepo, 2020). However, Smids et al. (2020), for example, argued that the increased use of industrial robots might benefit workers or at least not affect them significantly, mainly due to potential collaboration between robots and workers or the possibility of workers getting into a supervisory position.

This study focuses on the impact of robotics on employment and labour productivity in the automotive sector. The main objective is to investigate whether the annual installation of robots and the total number of robots in the automotive manufacturing sector negatively affect the demand for human labour and overall labour productivity. The aim is to investigate whether the current pace of robotization leads to harmful effects on particular industries.

An empirical analysis was conducted using publicly available data from the International Organization of Motor Vehicle Manufacturers/Organisation Internationale des Constructeurs d'Automobiles (OICA, 2023) and Eurostat (2022) on the total number of employees and output in the automotive industry in each country for the period 2002-2021. Based on the estimates made, it was then possible to evaluate the effects of the installed robots in automotive production on employment and labour productivity.

The introductory part of the paper is devoted to the literature review, while the next part presents the objectives and methodology for the evaluation of the data obtained. The final part is then devoted to the evaluation and presentation of the analysis results.

1 Literature Review

The Fourth Industrial Revolution (Industry 4.0) affects not only the functioning of human society but also the concept of industrial production and service delivery. Long-established business processes are being transformed and companies are investing much more in modernization, innovations and streamlining of production processes and procedures in order to sustain their competitive advantage (Leigh et al., 2022). Another important component is decision-making about the use of resources. Companies are seeking to use resources as efficiently and cost-effectively as possible and evaluate potential alternatives more carefully (Wu et al., 2022). One of the alternative options may be outsourcing (Gunasekaran et al., 2015), which can help companies streamline those business processes for which they do not have suitable and sufficient equipment[1] or enough suitable employees or lack know-how[2] (Suharmono et al., 2022).

Due to globalization, it is possible to move some of the processes from one continent to another, which has become an important issue in corporate decision-making and business management even in the current energy crisis. For example, some companies in Europe are considering relocating their business to lower-cost destinations (Alkousaa et al., 2022). This practice is being opposed by governmental and non-governmental organizations, which are trying to persuade companies to rationalize their behaviour to avoid placing an unnecessary burden on the environment and minimise carbon dioxide emissions while moving their products and semi-finished products in an attempt to maximise their profits (Baloch et al., 2020; Hanif et al., 2019; Ministry of the Environment of the Czech Republic, 2020).

The transfer and relocation of services in this regard are more environmentally friendly and, attributable to the development of technology, even much easier. It is not uncommon for companies to use outsourced bookkeeping and accounting services. For example, they have their bookkeeping and accounting services done in a country other than where they normally do their business (Egiyi & Alio, 2020). The purpose of doing this is not only to streamline the chosen processes but also to cut labour costs. It is still true that there are regional differences in wages. In the past, it was also common for companies to relocate their factories to areas where there was no such strict control over compliance with occupational health and safety regulations.

The motivation for companies was to find cheap labour because this ultimately meant higher earnings before interest and taxes (EBIT) and higher dividends for shareholders. It is the shareholders who can put pressure on managers to take every opportunity to increase the company's wealth. Due to media coverage of cases that should act as deterrents, conditions are improving even in developing countries, but this gradually leads to an increase in labour costs. With their growth combined with the shortage of workers in some sectors and activities, it is becoming (or starting to become) interesting for companies to invest in modern technologies (Carbonero et al., 2020). These can implement predefined forms of behaviour through automation and thus reduce the requirements for the amounts of human resources. As long as there are relatively low unemployment rates on the market and labour supply exceeds labour demand, at first glance, this does not pose any risk to human society. We also know some past cases where the introduction of machines brought progress and prosperity to human society. We also witnessed a massive increase in the introduction of modern technology into the operation of firms and companies during the COVID-19 pandemic (Miller, 2020).

The main goal of companies was to adapt to negative circumstances, but they also found that it was possible to make human labour more efficient (e.g., save money on travel allowances). However, the question is how this experience will affect their future decision-making. Earlier, it was difficult for small companies to invest in modern technology because of the high

[1] For example, they do not have to purchase completely new manufacturing equipment for small orders, which could be unprofitable, but they can hire another business to do this work for them.
[2] An example of outsourcing could be, e.g., outsourcing of accounting and bookkeeping, which means hiring an external accounting firm to manage accounts, or possibly provide tax and finance advice.

purchase price (Mironkina et al., 2020). However, the acquisition costs are gradually decreasing, and new technologies are thus becoming more affordable. A problem that may very soon affect the human population is that some jobs may entirely disappear (Paluch et al., 2021). In general, it is anticipated that this will only involve the transfer of employees between manufacturing activities (usually those that cannot yet be completely replaced with robots). However, it is necessary to address the question of whether human society will be able and, more importantly, willing to retrain for new jobs. It is much more likely that a large part of the human population will be replaced with robots and that it will be difficult to effectively utilize these human resources (Meitner, 2022).

According to Oxford Economics (2019), the number of robots in use has tripled globally to 2.25 million over the past 20 years; and it is expected that their number will grow even faster over the next two decades. As seen by trends, there will even be as many as 20 million robots worldwide as early as 2030, and approximately the same number of jobs will be lost. It was found that each newly installed robot will replace 1.6 manufacturing workers (Oxford Economics, 2019). These figures suggest that up to 8.5% of the global human workforce may be replaced with robots (Tappe, 2019). Even today, in some industries, employees can be completely replaced with machines and technologies. These are the main industries where employees' jobs are repetitive manual tasks without much added value. It is difficult for these people to find another job in their field, and they often remain without any income (Delaney, 2018). It is clear that without the assistance of the state, many of these workers would immediately face existential difficulties. Their current support is part of the state's social policy, but in the long run, with the increase in the numbers of people receiving financial support from the state, the situation would be unsustainable.

Not only do the unemployed not pay income tax, but more importantly, they do not contribute to the social and health insurance system (West, 2015). A drop on the personal income tax side might not be such a big problem as low-income groups do not pay any income taxes while taking advantage of tax credits. However, a significant problem will be caused by a drop in social security and health insurance collections. For example, in the Czech Republic in 2022, compulsory social insurance contributions should account for 38.8% of the state budget revenues, whereas personal income tax is 6.7% (Ministry of Finance of the Czech Republic, 2022). Clearly, they are a significant part of public revenues. If they dropped dramatically, this would have a negative impact on social transfers (e.g., old-age pensions and unemployment benefits).

The payment of social and health insurance is not only a deduction from the employee's gross wages, but it also concerns the employer, who contributes to the social and health insurance system. The employer's contribution accounts for about one-quarter of the wage costs. If employees are massively replaced with technologies[3] and cannot be effectively utilized any more, the state would have to subsidise the social and health systems from other public sources. This is, however, just a short-term solution. It is necessary to consider the need to support unemployed or unemployable people so that they might reach some sort of socially acceptable living standard. From this point of view, the only feasible option seems to be to impose taxes on production so that the amount of money collected could compensate for the shortfalls in state budgets, thus reducing the gap between the income previously paid

[3] *Technology is to be understood in a broader sense not only as an asset but also, e.g., as software.*

in employment and the income that the unemployed will receive from the state when they cannot be employed. It is not our intention to support the voluntarily unemployed and socially maladjusted, but their lives are also (co-)financed from public funds. Regardless of whether people are unemployed voluntarily or involuntarily, it is necessary to find ways to ensure at least basic living standards for the population and to ensure at least the basic functions of states. Failure to do so could result in social disintegration. We believe that this catastrophic scenario need not happen. However, it is absolutely inevitable to develop rules on how to effectively evaluate and subsequently tax the continuous introduction of technology in corporate processes at the expense of employees as pointed out by Costinot and Werning (2018).

However, two conditions must be met at the same time, namely:

(*i*) The level of taxation should not be demotivating for companies, as it could lead to a reduction in human activity and in searching for technological innovations that may have a lower impact on the environment and work safety;

(*ii*) The rules for taxation must be applicable globally. If the level of taxation were chosen by each state without any concept (harmonisation), this could be associated with tax optimization practices such as shifting production to areas without this form of taxation or violating transfer pricing rules between related entities. In extreme cases, there could be tax evasion, such as carousel fraud (VAT fraud) or smuggling (excise tax fraud). As each sector is rather different and changes in technology adoption can be made with different intensity and speed, we focused on the automotive industry. Another reason is the fact that this is a traditional industry, global in nature (Sturgeon et al., 2009) and highly competitive. Changes in technology cannot be ignored by individual companies because they could cause existential problems to them.

Hawksworth et al. (2018) estimated that, by 2030, robot adoption can increase global GDP growth by up to 14%. However, the authors also estimated that by replacing human labour with machines, as many as 37% of employees may lose their jobs. Of industry sectors, the transport sector is the most at risk and has the highest potential for automation in the long run, up to 50% after 2030. The overall impact on individual countries will be different, depending on their industrial structure. A relatively high share of total employment in easily automated industries (e.g., manufacturing and transport) is in Eastern European[4] countries, whereas Nordic countries such as Finland or Asian countries such as South Korea have a share of potentially automated occupations around 22% (Hawksworth et al., 2018). The latest paper to have estimated the impact of robots on employment is Acemoglu and Restrepo (2020). The authors performed an empirical analysis of 50 world countries between 1993-2014. They concluded that the introduction of robots has a negative impact on employment and wages across analysed countries.

2 Objective and Methodology

The main objective of the paper is to evaluate the impact of robot installations on employment and labour productivity in the automotive industry. Our objective is to determine whether the

[4] *For example, Slovakia 44%, Slovenia 42%, Czech Republic 40%.*

annual robot installations and the total number of robots in the automotive manufacturing sector have a negative effect on labour demand and labour productivity. Considering the latest findings of Acemoglu and Restrepo (2020), we also add control variables to our model in order to include the effects of other exogenous factors on employment and labour productivity, such as gross domestic product (GDP), total population as well as average annual wages, which represent the main incentive for our dependent variables.

The data for our empirical analysis were obtained from the International Federation of Robotics (IFR, @2011-2021) and cover the period between 2002 and 2021. Time series data were collected at a country level, focusing on the main car manufacturing countries of the European Union, namely Germany, Finland, Hungary, Italy, Poland, the Czech Republic, Slovakia, Spain and Sweden. From the Eurostat database, data were obtained on the number of employees in the automotive industry in each country during the period under consideration. Data on car production were obtained from the database of the International Organisation of Motor Vehicle Manufacturers (OICA, 2023).

Although we rely on publicly available data, predominantly data on the numbers of robots provided by the IFR, some of the missing data within the time series had to be imputed. Therefore, we used the following regression equations for the ordinary least squares (OLS) method:

$$ogempl = \beta_0(\alpha) + \beta_1(logind_{robot}) + \beta_2(logprod_{car}) + \beta_3(logGDP) + \beta_4(logpopulation) + \beta_5(average\_salary) + \varepsilon \quad (1)$$

$$logempl = \beta_0(\alpha) + \beta_1(logyearly_{inst}) + \beta_2(logprod_{car}) + \beta_3(logGDP) + \beta_4(logpopulation) + \beta_5(average\_salary) + \varepsilon \quad (2)$$

$$logLPI = \beta_0(\alpha) + \beta_1(logind_{robot}) + \beta_2(logprod_{car}) + \beta_3(logGDP) + \beta_4(logpopulation) + \beta_5(average\_salary) + \varepsilon \quad (3)$$

$$logLPI = \beta_0(\alpha) + \beta_1(logyearly_{inst}) + \beta_2(logprod_{car}) + \beta_3(logGDP) + \beta_4(logpopulation) + \beta_5(logaverage\_salary) + \varepsilon \quad (4)$$

where $logempl$ represents the logarithm of the total number of employees in the automotive industry; $logind_{robot}$ is the first main independent variable and represents the logarithm of the total number of robots in use in the automotive industry; $logyearly_{inst}$ is then the second independent variable and represents the logarithm of the number of annual robot installations in the automotive industry; $logprod_{car}$ is the total number of cars produced per year in logarithms. The control variable $logGDP$ represents the GDP, $logpopulation$ represents the total population of the analysed countries on an annual basis, and $logaverage\_salary$ represents the annual average salary.

The labour productivity index $logLPI$ is calculated as the ratio between total output (i.e., the total number of cars produced per year) and the total number of employees, converted to logarithms. The terms α and ε then represent the constant and the error term.

3 Trends in Automotive Industry

The automotive industry as such falls under the engineering industry and is concerned with the development, manufacture and sale of motor vehicles. The automotive industry includes all companies and activities involved in the manufacture of motor vehicles, including their components – engines, bodies, etc. From an economic point of view, the automotive industry has become a key element of the economy of industrialised countries. Motor vehicle manufacturing also has a significant effect on other industries (OECD, 2010). Apart from the metallurgical industry producing steel and sheet metal, the automotive industry is a customer of many other industries that are part of the manufacturing sector. Specifically, these are the chemical, electrical or glass industries.

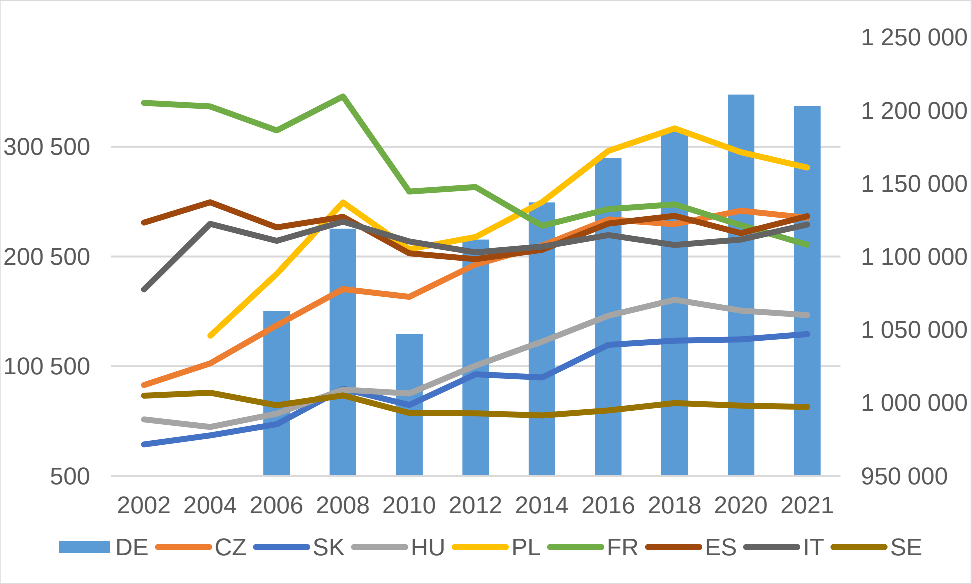
A significant dependence of the economy on the automotive industry can also be observed in the Czech Republic, as demonstrated by the analysis carried out by Marek et al. (2019), which showed that the relocation of the automotive industry outside the Czech Republic would cause a decline in GDP and an increase in unemployment of 25%.

At first glance, a dramatic loss of jobs may seem unrealistic in the foreseeable future, but if we look at the recent history of the European, Asian and American continents, we can find examples that disprove this optimistic belief (Berger, 2016):

- Between 2000 and 2014, US companies relocated their production to low-cost countries (e.g., Mexico and China), which led to the loss of 5 million jobs in the USA.
- French companies also benefitted from the relocation of production.
- In Japan, two million jobs were lost between 2010 and 2014.

Dramatic changes have also occurred in China, which wants to remain competitive at a time when demand for cheap products is falling. That is why it itself is introducing “Intelligent Manufacturing 2025” (Zhong et al., 2017). It can therefore be assumed that if one of the leading economics – China – starts to use advanced information and production technologies in its manufacturing, we will start to move towards the scenarios described in the introduction. Indeed, current advanced technologies can completely replace human labour in the Smart Factory mode (Bystronic, 2018; Cars Garage, 2016). These are automated predefined processes that are able not only to order the material needed but also flexibly adjust the quantities of production according to different priorities in orders; the systems themselves monitor all process activities and in the event of (oncoming) failure, they can order service. These automated processes are also used in the automotive industry.

Graph 1 | Development of numbers of employees in automotive industry in selected countries



Note: The horizontal lines represent the number of employees in each selected country, while the vertical lines represent the yearly average for the entire group of countries analysed.

Source: Authors' own work based on Eurostat (2022)

The automotive industry is one of the major employers, and according to the estimates of the European Commission (2022), it provides 14 million jobs in the European Union. In the Czech Republic alone, it employed 235,800 people in 2021 (Eurostat, 2022). Many supplier companies and downstream companies are also dependent on the automotive industry. They also have employees and also seek savings. The automotive industry (including the downstream industries) employs 500,000 people in the Czech Republic (AutoSAP, 2020), and their numbers have been increasing since the global economic crisis. From 2010 to 2019, the number of employees increased by 26.13% (Graph 1).

The automotive industry also appears to be an important employer in the other countries presented in Graph 1. Germany can be considered the leader in Europe, with over one million people employed in the automotive industry. However, a long-term decline in the number of employees in this sector can be observed in France, confirmed by the above-mentioned shift of production by French companies. The total number of employees in the automotive sector was reduced by 53,600 in 2009. This trend was visible in France in the following years except in the period of 2015-2017, when there was a slight increase in the number of employees.

Although a rather increasing trend in the total number of employees in the automotive industry can be seen in other countries, it cannot be ruled out that the number of employees will decrease in the coming years and in other economies as a result of technological change or a change in the employment structure.

The employment structure as a result of new technologies and automation is becoming polarized, with an increasing share of highly paid professionals and a decreasing share of employees in manufacturing (Cho & Kim, 2018).

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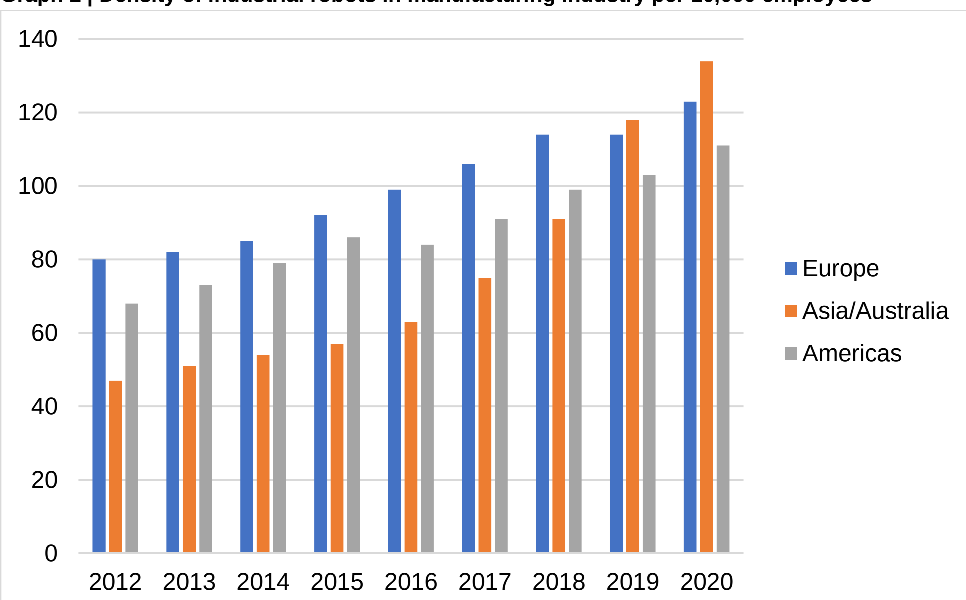
4 Robotization

The key role in the changing structure of employment in industry, in general, is played by the development of automation and the robotization of production. So-called industrial robots often replace human labour in production, which reduces costs for companies. Industrial robots are, in fact, multi-purpose automated machines that fully meet the requirements of flexibly changing production while automating auxiliary manufacturing operations (Khoroshailo & Kozub, 2020).

The trend of automation and continuous technical innovation has been observed since 2010. Since that year, there has been a global increase in demand for industrial robots every year. The major markets for industrial robots are China, Japan, the USA, South Korea and Germany. These economies account for approximately 74% of robot installations worldwide (Tikhonova, 2020). It is therefore necessary to pay special attention to technologies and the implications of their use. As a result of the changes, even the existing social and labour relations must be changed and transformed. The automotive sector seems to be an ideal industry where discussions on transformation could be initiated. According to the data from the International Federation of Robotics and Tikhonova (2020), 30% of the total number of industrial robot installations were made in the automotive industry in 2018, which represents the largest proportion of installations in the manufacturing industry in general.

Graph 2 | Density of industrial robots in manufacturing industry per 10,000 employees



Source: Authors' own work based on IFR (@2011-2021)

In 2018, Europe was the region with the highest density of robots in the manufacturing industry, with an average of 114 robots per 10,000 employees. Graph 2 shows that there has been an upward trend in the numbers of robots since 2012, and not only in Europe. At the end of 2020, the density of robots was 123 in Europe, 111 in America, and the highest density was in Asia: 134 robots per 10,000 employees. It is also important to mention the current status of Industry 4.0 and potential future trends. As pointed out by Ortiz (2020), besides the growing presence of robots in manufacturing industries, the Fourth Industrial Revolution could lead to significant economic growth in future, which could translate into reduced production, logistic and management costs. Moreover, digitization, especially robotization, can help in reducing the negative effects of climate change and more efficient use of non-renewable resources. Umar et al. (2021) underlined that the increase of Industry 4.0 has a positive impact on both economic and environmental performance.

5 Results and Discussion

Table 1 shows the summary statistics from our empirical analysis. We used two main dependent variables, namely the *total number of employees* and the *labour productivity index (LPI).*

The annual number of robot installations and the total number of robots were our main independent variables, while the total number of cars produced was our control independent variable.

Table 2 presents OLS regression estimates of the effect of the total number of robots and annual robot installations on the total number of employees in the automotive industry.

Table 2 shows the total number of robots used in the automotive industry, and their annual installations have a positive impact on labour demand in this sector. To increase the robustness of our model, the total number of cars produced (*logprod_car*) was used as a control variable.

As expected, all the independent variables are statistically significant and have a positive impact on our dependent variable. Since Equations 1 and 2 are log-log estimates, the resulting coefficients can be interpreted as elasticities. Thus, a 1% increase in the total number of robots will increase total employment in the automotive industry by 0.123%, whereas a 1% increase in annual robot installations will increase total employment by 0.112%. An increase in labour demand associated with the adoption of industrial robots was also recorded in Japan. This finding was reported by Dekle (2020), who, in his study, used data on robots and employment in the Japanese industry.

Table 1 | Summary statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Total number of employees	2,156	243126	296372.5	6300	1211000
Labour productivity index	2,156	0.003117	0.001654	0.000183	0.008224
Annual number of robot installations	2,031	4811.039	5410.489	-7126.6	26723
Total number of robots	2,018	47471	-48238.6	33262.56	245908
Total number of cars produced	2,156	1418983	1584008	2631	6213460
GDP	2,156	875823.5	927694.1	26340.7	3601750
Population	2,156	3.25E+07	2.71E+07	5194901	8.32E+07
Average salary	2,156	24274.32	12273.53	4386	46934

Source: Authors' own compilation

Table 2 | OLS estimates of effect of total number of robots on employment in automotive industry

Variable	(1) logempl	(2) logempl
logind_robot	0.123***	
	(0.00990)	
logprod_car	0.493***	0.492***
	(0.0103)	(0.0103)
logGDP	2.135***	2.006***
	(0.120)	(0.124)
logpop	-1.566***	-1.446***
	(0.108)	(0.111)
logsalary	-2.301***	-2.172***
	(0.116)	(0.120)
logyearly_inst		0.112***
		(0.00935)
_cons	25.38***	24.17***
	(1.467)	(1.509)
N	1933	1842
R^2	0.908	0.907

*Note: Standard errors in parentheses, * p < 0.05, ** p < 0.01, *** p < 0.001.*

Source: Authors' own calculation

Our control variables have an opposite impact on employment in the automotive industry. While economic growth proxied by GDP has an overall positive impact on employment, as shown in Table 2, total population and average salary have a negative impact on employment. The negative impact of the two control variables can be explained by the fact that the automotive industry is in competition with other manufacturing industries. This means that skilled individuals can choose to work in different industries where the average wage is considerably higher than in the automotive industry.

Table 3 shows estimates obtained by replacing our main dependent variable, the total number of employees, with the labour productivity index. The purpose of this estimation is to determine the impact of robotization on labour productivity in the automotive industry.

In comparison with the estimates from the first model (Table 2), the total number of robots and their annual installations in the automotive industry have a negative impact on labour productivity. This means that a 1% increase in the total number of robots reduces labour productivity by 0.123%, and a 1% increase in annual robot installations in the automotive industry reduces labour productivity by 0.112%. As in Table 2, all the selected independent variables are statistically significant at the 1% significance level. The control variable, the total number of cars produced, has a positive effect on labour productivity.

Table 3 | OLS estimates of annual robot installations on labour productivity in automotive industry

Variable	(1) logLPI	(2) logLPI
logop_stock	-0.123***	
	(0.00990)	
logprod_car	0.507***	0.508***
	(0.0103)	(0.0103)
logGDP	-2.135***	-2.006***
	(0.120)	(0.124)
logpop	1.566***	1.446***
	(0.108)	(0.111)
logsalary	2.301***	2.172***
	(0.116)	(0.120)
logrobot_inst		-0.112***
		(0.00935)
_cons	-32.94***	-31.73***
	(1.467)	(1.509)
N	1933	1842
R^2	0.579	0.593

*Note: Standard errors in parentheses, * p < 0.05, ** p < 0.01, *** p < 0.001.*

Source: Authors' own calculation

A possible explanation for the somewhat contradictory results in Tables 2 and 3 could stem from the fact that although the number of robots installed in car factories increases the need for new employees, labour productivity tends to decline as major manufacturing activities are replaced with machines at the expense of human labour.

The negative impact of robots on employment was also confirmed by Carbonero et al. (2020), who found that the installation of robots reduces employment by 0.43% in developed countries and even by 11% in developing countries.

Conclusion

In this paper, we examined the impact of robot installation on employment and labour productivity in the automotive industry. Specifically, we investigated whether the annual installation of robots and the total number of robots in the car industry have a negative impact on employment. The analysis performed was based on data from selected European Union countries where the car industry is an important sector of the economy. The collected data were evaluated using empirical analysis. As we used publicly available data, it was also necessary to impute the missing data of time series. Subsequently, we set up four regression equations and made the necessary OLS estimations.

On the basis of the estimations, we found that robot installations in the automotive industry have a positive effect on employment. According to our results, a 1% increase in the number of robots increases total employment in this industry by 0.123%. With a 1% increase in the frequency of robot installations, total employment in the automotive industry increases by 0.112%. Moreover, our control variables have the expected statistical significance and effects on employment in the automotive industry.

When we focused on labour productivity, we found that when the total number of robots increases by one percentage point, labour productivity decreases by 0.123%. Additionally, economic growth has a negative impact on labour productivity in the automotive industry, while population and average salary tend to increase productivity as expected. The study produced somewhat contradictory conclusions. The number of robots installed in car factories increases the need for new employees, but at the same time, labour productivity tends to decline. A possible explanation for these contradictory results is that major manufacturing activities in this sector are being replaced with machines at the expense of human labour.

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