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Do robots really destroy jobs?*

Headlines

- New JRC research discusses the effect of the deployment of industrial robots on employment in the EU. It finds that, even though the share of low-skilled workers declined over the analysed period (1995-2015), there is no evidence that industrial robots contributed to this trend.
- Instead, there is a significant positive association between robot use and total employment. This correlation is most pronounced in the manufacturing sectors but still holds when non-manufacturing sectors are included.
- This suggests that robot-adopting industries have so far been comparatively more resistant to the long-term downward trend in the employment shares of European manufacturing sectors.
- These results stand in contrast to some previous literature and to the widespread notion that robots crowd out workers in general, and low-skilled workers in particular.
- These findings, based on current industrial robot technologies only, cast doubt on the effectiveness of policies such as taxes on robots, which could have unintended negative effects on technical progress and few benefits for workers.

In a recent Eurobarometer survey, 72% of respondents agreed with the statement 'robots and artificial intelligence steal peoples' jobs' [1]. Since not all jobs are equally exposed to automation, there are additional concerns about the impact of such trends on income inequality and social cohesion [2,3]. There have even been calls for a tax on companies' use of robots, for instance by Microsoft founder Bill Gates [4]. This policy brief summarises the main findings from a JRC study that analyses the effect of industrial robots on total employment and the employment shares of low-skilled households. It then sets the findings of the JRC study in a policy context.

Industrial robots in Europe

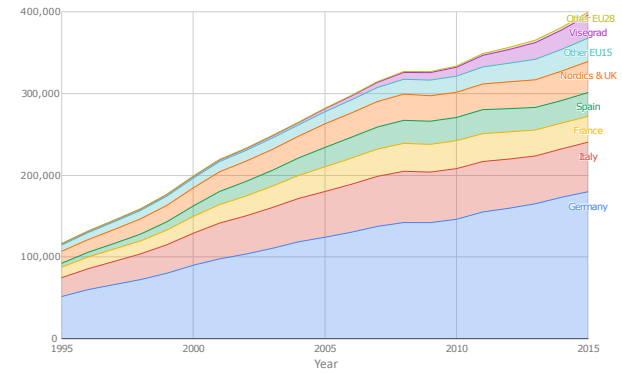
Industrial robots can mostly be pictured as more or less stationary reprogrammable robotic 'arms' that perform manual tasks such as handling, welding and molding, and which are far from humanoid robots in any sense.[1] They have been around since the 1980s but have been deployed more broadly over the past two and a half decades (see Figure 1). Almost all industrial robots are used in manufacturing, with the automotive sector accounting for roughly half of all robots (see Figure 2). These characteristics clearly distinguish industrial robots from other advanced technologies such as artificial intelligence.

*This policy brief has been prepared by David Klenert, Enrique Fernández-Macías and Robert Marschinski. It is based on the JRC Working Paper: Klenert, D., Fernández-Macías, E., Antón, J., Do robots really destroy jobs? Evidence from Europe, EUR. Seville: European Commission, 2020, JRC118393. Available at: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/do-robots-really-destroy-jobs-evidence-europe.

This brief can be downloaded from https://ec.europa.eu/jrc/en/research/crosscutting-activities/fairness.

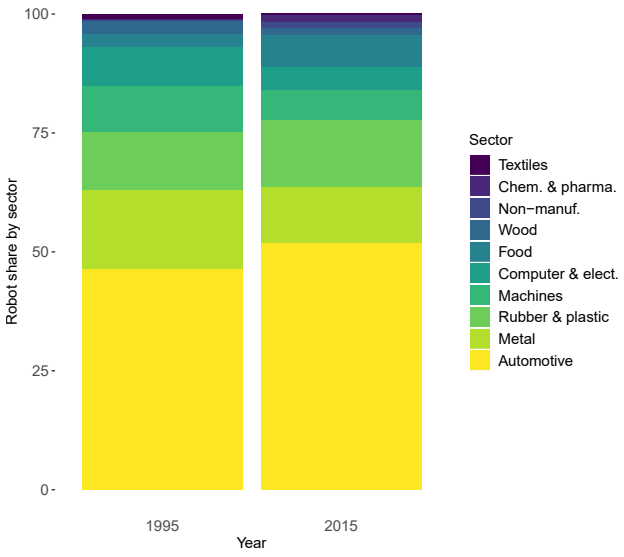
[1]The International Organisation for Standardisation defines an industrial robot as 'an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications' (ISO 8373:2012).

Figure 1. Robots in operation in different EU countries



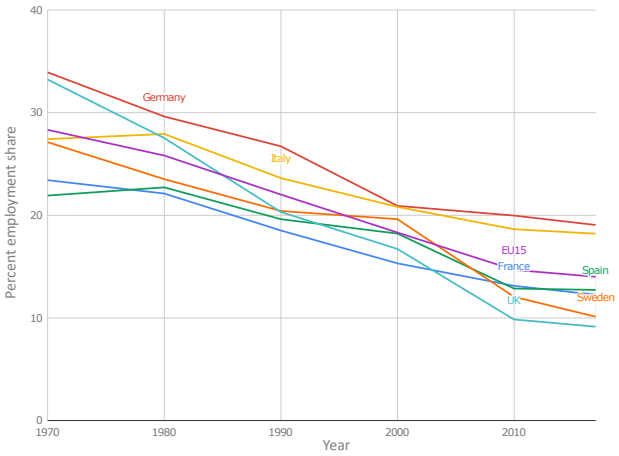
Notes: Countries are grouped as follows. Nordic countries: Denmark, Sweden, Finland, UK. Other EU15: Austria, Belgium, Greece, Ireland, Netherlands, Portugal. Other EU28: Bulgaria, Croatia, Estonia, Latvia, Lithuania, Malta, Romania, Slovenia. Visegrad: Hungary, Poland, Czech Republic and Slovakia. Luxembourg and Cyprus are not contained in the sample.

Figure 2. Distribution of robots by sector as a share of total robots in 28 EU countries



The employment share of European manufacturing sectors has been decreasing relative to other sectors since the 1970s (see Figure 3), while **the number of industrial robots** has been on the rise since the mid-1990s (Figure 1). This poses the question of **whether robots contributed to this trend** and, if so, to what extent. Answering this question requires a thorough econometric analysis, which takes into account the structural differences between different countries and economic sectors, as well as parallel trends in the formation of Information and Communications Technology (ICT) capital, the capital/labour ratio and other factors. This policy brief reports the results of such an analysis.

Figure 3. Employment shares of manufacturing in Europe



Links between robots and employment

The JRC study finds that in Europe, over the last couple of decades, **the use of industrial robots is positively correlated with total employment**. It is shown that one additional robot per 1,000 workers is associated with an increase in total employment of 1.3% in any given sector, country and year. Also in contrast to previous studies, the authors of the JRC study find **no evidence for a negative relationship between robot use and low-skilled employment**. These results are **very robust** across a wide range of assumptions, estimator choices, sector selections and time periods.

With regard to earlier findings, the JRC analysis is more in line with studies based on microeconomic data, which often find a neutral or positive relationship between robotisation and employment. Some results of the JRC study differ from studies using aggregate data –most importantly [3,5] –which is a consequence of the JRC study using different data sources covering eight (or, in some cases, more) additional years and relaxing some of the key assumptions of these studies.[2] The JRC study shows in detail which specific assumption leads to deviations from earlier studies.

What could explain this positive effect of robot use on employment, given that robots are deployed to increase labour productivity by helping to produce the same or a greater amount of output with relatively less labour input? Several factors are at play:

First, there are **demand effects** that can lead to employment growth, despite labour-saving robot technology.

[2]For example on how exactly the robot density in each economic sector is calculated.

Quick Guide

The analysis combines annual data on robot installations in Europe from the International Federation of Robotics with data on aggregate employment and employment by skill level from the EU Labour Force Survey. Additional control variables are taken from EU KLEMS growth and productivity accounts. The resulting sample covers the years 1995 to 2015, 14 different sector aggregates and 14 EU countries.
In our benchmark analysis, we use estimations of the following form:
$X_{c,s,t} = \beta_1 + \beta_2 \text{robots}_{c,s,t} + \beta_3 \text{controls}_{c,s,t} + \epsilon_{c,s,t}$
Here, X is the variable of interest (total employment, low-skilled employment, low-skilled employment share of total employment, change in total employment compared with the initial year). robots is a measure of robotisation (robot stock, robot density, percentile of robot density) and controls includes a vector of covariates (capital/labour ratio, capital formation, ICT share of capital). The indices c, s and t stand for the country, sector and year, respectively. In the case of averages over several years, t refers to each time period.
There is significant variation between sectors, both within and between countries, which is the reason why we account for specific country-sector characteristics by including country-sector fixed effects. When these structural differences are not accounted for, we still find positive (and in most cases significant) correlations between total employment and robotisation, but the explanatory power is lower. Furthermore, to account for macroeconomic trends such as economic crises or a general downward trend in manufacturing jobs that affect all sectors to a similar extent, we control for time fixed effects that are not country or sector specific. If time trends are not controlled for, these general negative employment trends may be falsely attributed to robotisation, as this is the only case in which the correlation between employment and robotisation becomes negative. In general, these results are very robust with regard to the inclusion of additional control variables (such as the ICT capital share, capital accumulation and capital/labour share), the inclusion of non-manufacturing sectors, and the use of different time periods, calculations of the stock of robots, indicators for robotisation and estimators.

Second, **employment and investment in robots might move together**, as both might reflect some underlying variable such as the resilience, competitiveness or innovative capacity of some countries manufacturing industries.

Third, **robots might not replace jobs as a whole but only certain tasks**. This might not lead to job losses at the aggregate level but to a restructuring of the task content of different jobs, thus enhancing labour productivity and, potentially, employment.

There are three key points to keep in mind when interpreting these results:

First, these findings refer to recent and ongoing trends, but **cannot be generalised into the future**. The kinds of industrial robots analysed in the study have been around since the 1980s and should not be confused with more advanced technologies such as robots enhanced by artificial intelligence, which are not yet deployed at large scale. Once these technologies are used in mainstream manufacturing, they may have more disruptive potential.

Second, since the overwhelming majority of industrial robots is used in manufacturing sectors, these results do not necessarily apply to other sectors.

Third, the positive correlation between robotisation and employment is significant and robust but small compared with other variables.

Policy implications

In sum, we found no evidence that industrial robots have reduced the employment share of low-skilled workers in Europe in recent years. In fact, robot adoption tends to be positively associated with aggregate employment. Based on empirical data on the use of industrial robots **JRC research is not in line with the widespread notion that this technology has significant job-destroying potential**.

This has important implications for policy makers. Taken together with recent findings that industrial robots have increased productivity, these results suggest that **policies such as a tax on robots would do little to address the real drivers behind growing inequality**.

Related and future JRC work

Related work at the JRC looks at the distribution and the determinants of robotisation in Europe

(see Fernández-Macías, E., Antón, J., I. and Klenert, D. 2020, "The distribution and determinants of industrial robots in Europe", *forthcoming*.) and at the effect of robots on labour productivity (Jungmittag and Pesole 2019, "The impact of robots on labour productivity: A panel data approach covering nine industries and 12 countries" Seville: European Commission. *JRC Working Papers on Labour, Education and Technology*. JRC 118044). Future research should analyse the effects of artificial intelligence and service robots on employment structures. However, data on these are very limited at the time of writing.

This brief is one of a **series of 'science for policy' briefs** reporting on recent JRC research on various aspects of fairness. **A comprehensive report on fairness** will be published in 2020.

References

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