

The impact of industrial robots on the EU economy

Headlines

- New JRC evidence confirms that, for 1995-2015, industrial robot use is linked to a small but significant increase in employment. However, when the period is separated in two different decades, this research yields a more mixed picture: the impact of robots on employment is generally small but slightly negative in 1995-2005 and slightly positive in 2005-2015.
- Robots do not seem to reduce the share of low-skill workers or produce job polarisation in Europe: instead, robotisation has a positive effect in terms of employment on middle-wage jobs.
- The intensified use of industrial robots has contributed to the growth of labour productivity.
- Convergence of robot use in the manufacturing industries across Europe occurred over the period from 1995 to 2015. Since industrial robot use boosts productivity, this process might have also led to EU Member State convergence in terms of productivity.
- In sum, the impact of industrial robots in the EU economy is rather small, but positive effects seem to prevail. We thus suggest to introduce a cautious note into the debate on the destructive potential of industrial robots. Nevertheless, knowledge about the transformative impact of novel technologies such as robots enhanced by A.I. is rather limited and additional research is necessary to fully assess their impact on the economy.

How are new technologies affecting our daily life? Are they going to transform our routines at work? What is going to be their socio-economic impact? These questions have been present for centuries and remain highly topical: the digital transformation is causing significant changes in the world of work in the EU ([González Vázquez et al. 2019](#)). Some jobs are at risk of being lost to machines. Others are being transformed and new ones are being created. This brief summarises new evidence on the effects of technological progress on the EU economy, focusing on industrial robots, a form of technology widely used in the EU industry. This brief is a follow-up to [a previous brief that synthesized the first JRC evidence on the impact of industrial robots on employment](#). Here we aim to complement those findings with new data on the same topic, but we also offer a more comprehensive overview on the impact of robots on the EU economy by shedding some light on their effect in terms of job polarisation and labour productivity.

Characteristics, applications, and distribution of industrial robots in Europe

Industrial robots have been around for a long time, but their deployment intensified from the nineties: the number of robots in the EU-28 in 2015 was four times higher than in 1995. The scope of current industrial robots in terms of applications is very limited: their use is concentrated in repetitive manual tasks such as handling, welding and molding. Furthermore, half of all EU robots are installed in the automotive sector, and 73% of all robots are deployed in only three sectors: automotive, rubber and plastic and metal products (see Figure 1). Industrial robot use is also concentrated in few countries, especially Germany, but also Italy and France. As a result, 27% of all EU robots are concentrated in German car



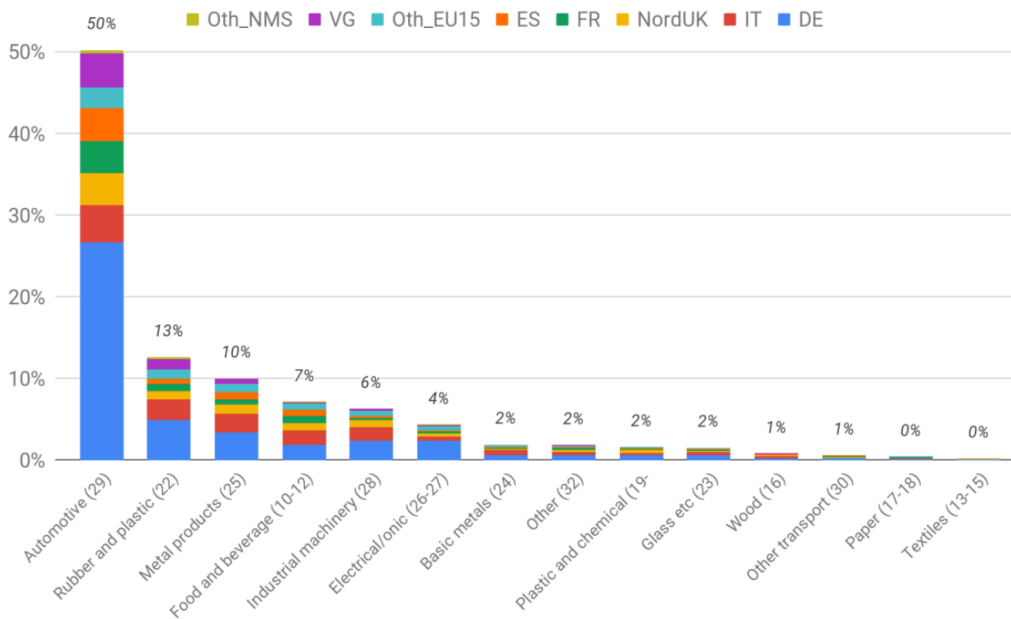


Figure 1
Distribution of industrial robot stocks by sector and country, EU 2016

Source: *International Federation of Robots (IFR)*

manufacturing, a sector that accounts for less than 1% of total employment in the EU today ([Fernández-Macías et al. 2020](#)). **This concentration limits significantly the potential role that robots may have played in recent economic and employment trends in Europe.**

Do robots really destroy jobs?

Industrial robots have been deployed at a large scale while most EU countries were facing a process of deindustrialisation. For this reason, robots have often been blamed for the job losses some economies have suffered as a result of deindustrialisation. But is there really a negative relationship between robot use and employment? In [a previous brief](#), a significant positive association between robot use and total employment for the period 1995-2015 was reported ([Klenert et al. 2020](#)). 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 EU manufacturing employment. These results stand in contrast to some previous literature and to the widespread notion that robots crowd out workers in general.

New JRC research on the topic ([Antón et al. 2020](#))¹ confirms the positive association between robot use and total employment for the period 1995-2015. But these new findings introduce some nuances into the debate, as they differ over time: according to their estimates, the effect tends to be small and negative during 1995-2005 and positive during 2005-2015 for the overwhelming majority of model specifications and assumptions. These new estimates seem to confirm **that industrial robots are not producing a disruptive effect in the labour market.** Instead, the effects of industrial robots on employment

tend to be small and not particularly robust, appearing to change in different periods.

These results have some qualifications: 1) we cannot generalise these results to non-manufacturing sectors because the use of robots outside manufacturing is anecdotal and has limited economic significance; 2) the effect of robots on employment is small compared to other trends over the same period (such as the financial crisis, European economic integration, or globalisation), as most of the literature indicates; 3) small differences in the data and the sample, in particular regarding the different time periods, can change the sign of the correlation or render it insignificant. For these reasons, we cannot expect a huge variation in terms of employment caused for the adoption of industrial robots.

In consequence, **the evidence we describe does not concur with the popular narrative of robots destroying jobs at a large scale, but it should neither be understood as proof that robot adoption is causally linked to employment growth.** On the contrary, it invites to be sceptical with claims about the disruptive effect of this technology in the labour market.

Do robots produce job polarisation? The impact of industrial robots in the employment structure

There is evidence that technological change contributes to transforming the occupational structure of employment ([Hurley et al. 2019](#)). [Klenert et al. \(2020\)](#) explore this relationship by examining the link between industrial robot use and low-skilled employment, but **they do not find evidence of robots reducing the share of low-skilled workers across Europe.**

This effort to unravel the effect of industrial robots on employment by looking at the impact by skill level has been complemented by [Antón et al. \(2020\)](#), who analyse their impact on occupational structures. According to their numbers, **there is no evidence of robots producing job polarisation in 1995-2015**. On the contrary, this pattern appears to be reversed: they find a pattern of mid-upgrading, i.e. a positive effect of robotisation that is slightly more pronounced for middle-wage jobs. They have also analysed the effects on the employment structure in different decades,² and for all analysed sub-periods the statistical significance depends strongly on the model specifications. Consequently, these results should be interpreted with additional caution. More research is still needed to accumulate evidence and fill the remaining knowledge gaps, but for the moment **these results question the role of industrial robots as a key driver of job polarisation in recent decades**.

In summary, with the data available **we cannot confirm that the use of industrial robots has negative implications for the labour market, not even when looking at their effect on low-skilled employment or their impact in terms of job polarisation**.

Do robots boost labour productivity?

Technological change is expected to boost productivity by directly increasing total factor productivity. Every increase in value added that is not explained by growth in production factors—that is to say, capital and labour—can be interpreted as due to technological progress. However, not every increase in investment is followed by productivity growth. Some economists observed that, in the nineties, a sharp increase in ICT investment did not correspond with an increase in productivity growth—the so-called Solow paradox—. Has robotisation created a similar paradox in the last decades? Or, on the contrary, is industrial robot adoption associated with an increase in labour productivity?

According to [Jungmittag and Pesole \(2019\)](#), **in the period 1993-2015 the intensified use of robots contributed to the growth of labour productivity in the European industry**. They find that an increase by one standard deviation³ of the relative number of robots with respect non-ICT capital input would increase its labour productivity by 3.3%. The authors have carried out the

same analysis for different sub-periods, finding that the positive impact of robot use on productivity increased from 1995-2007 to 2008-2015. These results suggest that robots have to reach a certain critical mass in order to achieve their full beneficial impact on labour productivity.

As expected, the positive effect of robots on productivity varies considerably across industries (Figure 2), being more prominent in the industries with the highest average robot density: *transport equipment*;⁴ *rubber and plastic products, metals and metal products* and *machinery and equipment*. On the contrary, the effect is small—equal or below 1%—in the other sub-sectors.

The results of [Jungmittag and Pesole \(2019\)](#) are in line with previous studies which also establish a significant positive effect of robot adoption on productivity. In consequence, this evidence complements the previous findings, focused on the impact of robots on employment, and reinforces the idea of robots having an overall positive impact on both the labour market and the economy. In this light, we can also anticipate that **the convergence in robot densities that has been documented in this sector in the last decades in the period from 1995 to 2015 ([Jungmittag 2020](#))⁵ should have contributed to cross EU convergence in terms of productivity in the industries concerned**. In any case, this idea reinforces the positive consequences that robot adoption could have for the European industries and offers some clues for the design of industrial and cohesion policies for EU countries and regions.

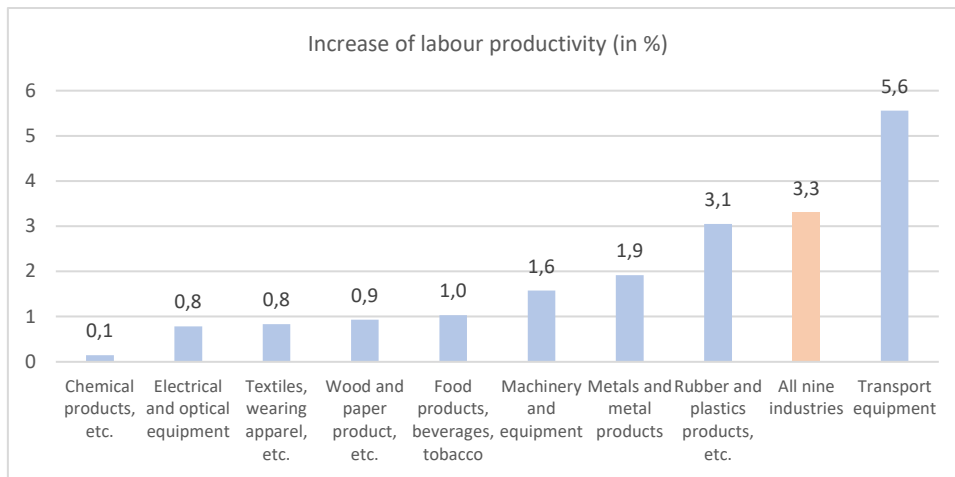


Figure 2

The impact of a one standard deviation increase of robots (per 1 million Euro no-ICT capital input) on labour productivity

Source: Jungmittag & Pesole (2019) with data from IFR (2017) and EUKLEMS (2017)

Conclusions and policy implications

Taken together, these findings suggest that **the use of industrial robots is likely to generate net benefits**. We are not assessing the impact other technologies might have, so our results cannot be generalised to other sectors and automation technologies. We do not exclude the possibility of other new technological developments having a disruptive effect, but concerning existing industrial robots this is just a possibility, not an observable fact. What seems clear is that so far **industrial robots are not having a major disruptive impact in the labour market and the economy**.

Despite their limitations, these results could have important policy implications:

- **We should not see robots as the culprits of recent worrying developments in EU labour markets** -such as rising wage inequality or the polarisation of employment-. An excessive focus on automation as a potential source of problems could be deviating public attention away from other, more prominent causes of inequality, linked to regulatory or institutional factors. Since the impact of industrial robots on employment is small compared to the influence of other variables, **we cannot expect policies focused on robot adoption or regulation to have a significant impact on labour market dynamics**.
- The results summarised above suggest that **recent calls for a specific tax on robots would be misguided**. This measure would be rather ineffective since the impact of robots on employment is fairly small and employment dynamics are largely determined by other factors. Taxing robots might even have a negative impact on both employment and economic growth, given that robot use was shown to be associated with increased productivity and potentially, increased employment.
- In fact, given that the evidence of robot use associated with increased productivity is unambiguous, it would make more sense to promote

and facilitate the use of robots in manufacturing industries as a measure aimed to promote productivity growth. **The deployment of industrial robots in less developed Member States could contribute to a process of convergence in terms of labour productivity**. Support for robot adoption in manufacturing industries could be conceived as a good measure to promote productivity growth and cohesion between countries and regions.

- Automation technologies are able to perform specific tasks, not jobs. For this reason, technological change is more likely to produce changes in the task content and the organisation of work, rather than replacing workers. In this context, **education and training are key to create a more resilient and adaptable workforce**. Education is going to play a key role in a context of rapid change, in which labour demand is going to require constant reskilling and upskilling. Given that high-qualified workers are the ones with more capacity and opportunities for updating their skillsets, it is crucial to ensure that less qualified workers also benefit from these educational programs. Such policies would ensure that as many people as possible benefit from the ongoing technological transition without risking a slowdown at the technology front. If we do not tackle this challenge, we can expect the lack of opportunities to reinforce existing inequalities in the labour market.

Notes

¹ While [Klenert et al. \(2020\)](#) study the effect of robots on employment from a sector perspective, [Antón et al. \(2020\)](#) address the same question by looking at the regional distribution of robots.

² When they split the full period into two different decades, they obtain the following results: 1) For the period 1995-2005, they obtain weak evidence that robotization might have led to upgrading (a relative expansion of the top tercile). 2) For the period 2005-2015, they document a positive effect of robots on employment which is more or less equally distributed across all terciles. For this reason, the positive effect of robots on employment has a neutral effect in terms of inequality and polarization.

³ The standard deviation (SD) is as standardised measure of the amount of variation or dispersion of a set of values. A low SD indicates that the values tend to be close to the mean of the set, while a high standard deviation indicates that the values are spread out over a wider range.

⁴ A category that includes automotive and manufacture of other transport equipment.

⁵ This process was unconditional and more pronounced in the second half of the period-, with robot use increasing specially in some central -the Netherlands- and eastern countries -Hungary, Slovakia, and Czech Republic-.

References

- Antón, J. I., D. Klenert, E. Fernández-Macías, M. C. Uri Brancati and G. Alaveras (2020). *The labour market impact of robotization in Europe*. JRC Working Papers Series on Labour, Education and Technology.
- Fernández-Macías, E., J. I. Antón & D. Klenert (2020). *Not so disruptive yet? Characteristics, distribution, and determinants of robots in Europe*. JRC Working Papers Series on Labour, Education and Technology.
- González Vázquez, I., et al. (2019). *The changing nature of work and skills in the digital age*. Luxembourg, Publications Office of the EU.
- Hurley, J., E. Fernández-Macías, M. Bisello, C. Vacas and M. Fana (2019). *EJM 2019: Shifts in the employment structure at regional level*. Luxembourg, Eurofound and EU Joint Research Centre.
- Jungmittag, A. (2020). *Robotisation of the manufacturing industries in the EU: convergence or divergence?* The Journal of Technology Transfer.
- Jungmittag, A. and A. Pesole (2019). *The impact of robots on labour productivity: A panel data approach covering 9 industries and 12 countries*. JRC Working Papers Series on Labour, Education and Technology.
- Klenert, D., E. Fernández-Macías and J. I. Antón (2020). *Do robots really destroy jobs? Evidence from Europe*. JRC Working Papers Series on Labour, Education and Technology.

This policy brief has been prepared by Sergio Torrejón Pérez, David Klenert, Robert Marschinski, Enrique Fernández-Macías and Ignacio González Vázquez, and summarises the main results and policy implications that emerge from a series of papers published recently by researchers from the JRC (see references).

Contacts:

Sergio.TORREJON-PEREZ@ec.europa.eu

David.KLENERT@ec.europa.eu

Robert.MARSCHINSKI@ec.europa.eu

Enrique.FERNANDEZ-MACIAS@ec.europa.eu

Ignacio.GONZALEZ-VAZQUEZ@ec.europa.eu