

Robot and Automation. Which are the Impact on the Productivity, Jobs and Inequality of the Countries?

Jose Ignacio Lopez -Sanchez, Jose Luis Arroyo-Barriguete

Date: Pre-Print January 2022

Lopez-Sanchez, J. I., & Arroyo-Barriguete, J. L. (2022). Robot and Automation. Which are the Impacts on the Productivity, Jobs and Inequality of the Countries? In *Biosystems and Biorobotics*, Vol. 30, pp.73-79 https://doi.org/10.1007/978-3-031-04305-5_13

Abstract—First, analysing the evolution of robots in the world in order to draw initial conclusions regarding the behaviour of some countries, then verify if countries with a higher density of robots per worker are countries whose jobs have a lower risk of being replaced by automation and are more competitive. Jobs requiring physical and manual skills, and basic cognitive skills will be the first to be automated; while the most demanding jobs will require social, emotional and technological skills. All the countries analysed need more new jobs than the ones they are going to lose. Also, we have observed that higher levels of automation lead to a reduction in inequality in the medium term

I. INTRODUCTION

ACCORDING Lopez-Sanchez et al [1] the term **automation anxiety**, which is, the fear of being replaced by a robot in the workplace, while it may seem something typical of our time, is far from being a novel concept. On the contrary, it is a cyclical phenomenon, Bassett and Roberts, [2], that emerges periodically in public debate. In fact, we can go back to the early 19th century, when the Luddites, a group led mainly by textile workers, opposed the mechanization of their industry on the grounds that it threatened their jobs.

Automation is a reality. Many jobs disappear because they will be replaced by machines (ICT, Robots, Artificial Intelligence, among others). Companies must be prepared to face this challenge and remain competitive. If SMEs are not able to adapt to the new competitive environment they may disappear. For this reason, it is necessary that they incorporate this technology as a source of external knowledge.

The present contribution is intended to answer the next three questions:

1. Are countries with a high density of robots per worker more competitive? Is there a relationship between the risk of job automation and worker productivity, and what is the relationship with

This study was supported by the H2020 Topic ICT 28-2017, Inclusive Robotics for a better Society (INBOTs CSA EU project 780073)
J.I.L.S, Professor of Management Complutense University of Madrid, Spain. Head of GIPTIC-UCM. (corresponding author: jilopez@ucm.es)

unemployment?

2. Will more jobs be created or destroyed in 2030?
3. Does automation increase or reduce inequality in countries?

II. ROBOT DENSITY, PRODUCTIVITY AND UNEMPLOYMENT

Automation itself is not bad. In fact, countries with a higher density of robots per worker are countries whose jobs have a lower risk of being replaced by automation. Hawksworth et al [3] show a negative correlation between the potential jobs at high risk of automation, adjusted to account for industry composition, against the density of industrial robots in the country (as shown in Fig. 1).

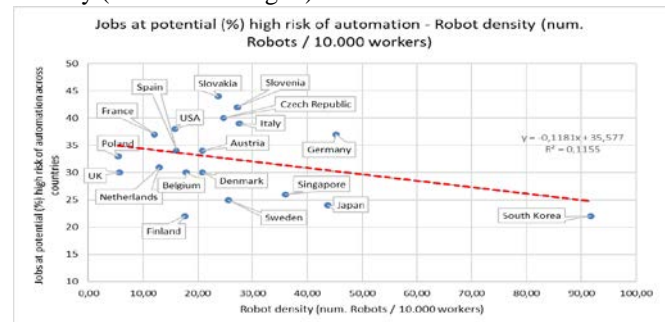


Fig. 1. Jobs at potential (%) high risk of automation across countries [3]- Robot density (num. Robots / 10.000 workers).

From a first analysis Lopez-Sanchez et al [4] do not see a clear relationship between robotization and unemployment increase. However, we can observe (Fig. 2) that those countries that have a higher density of robots, per worker, generally have a lower unemployment rate. In this case, we have considered the robot density rate, as the number of robots (all operational stock) per 10,000 workers currently working (source ILO), these data have been obtained from the International Federation on Robotics.

J.L.A.B, Research GIPTIC-UCM, Professor of Quantitative Methods Comillas Pontifical University, Spain (email: jlarroyo@icade.comillas.edu).

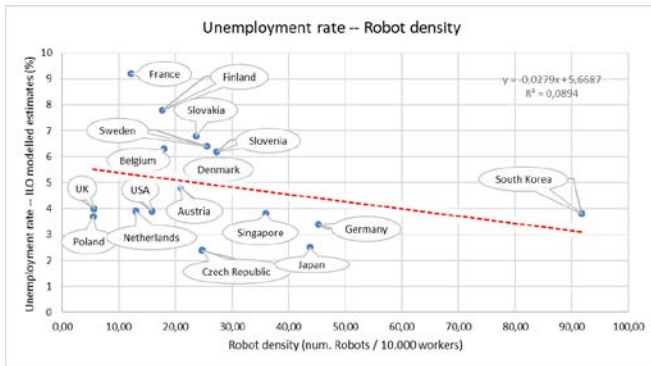


Fig. 2. Robot density (num. Robots / 10.000 workers) and Unemployment rate -- ILO modelled estimates (%)

Similarly, in Fig 3 and 4, those countries whose workers are more productive present a lower risk of automation of their jobs and higher robot density. As previously mentioned, countries with a higher productivity per worker are countries whose jobs have a lower risk of being replaced by automation.

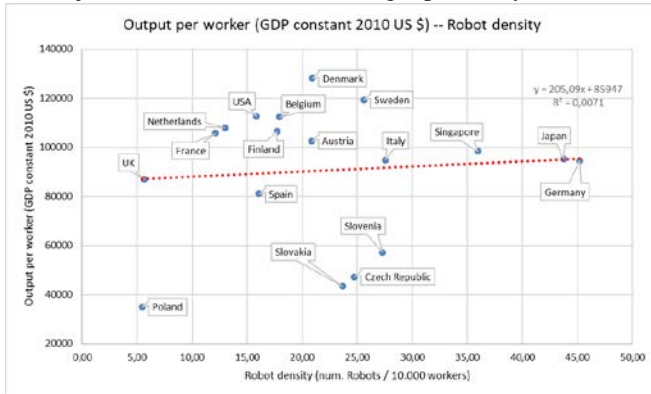


Fig. 3. Output per worker (GDP constant 2010 US \$) - Robot density (num. Robots / 10.000 workers).

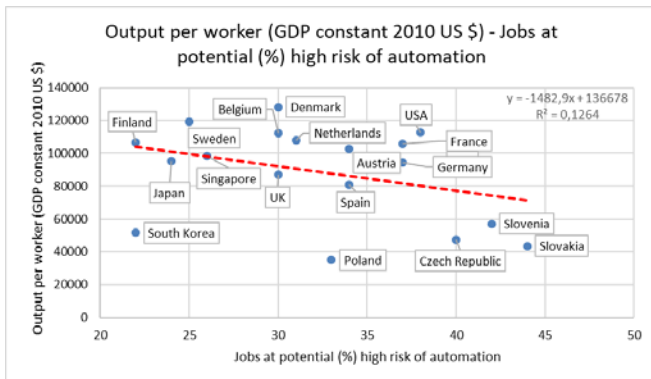


Fig. 4. Jobs at potential (%) high risk of automation across countries [3]- Output per worker (GDP constant 2010 US \$).

III. JOB LOSS OR JOB CREATION?

We will use the data obtained by Bughin et al [5] as well as the 25 skills that they study and that have been contested through other research:

A. Physical and manual skills: General equipment operation

and navigation (Drivers, assembly line workers); General equipment repair and mechanical skills (Car and truck mechanics); Craft and technician skills (Stonemasons, roofers, electricians); Fine motor skills (Nurses, food preparation workers); Gross motor skills and strength (Machine feeders, cleaners, packers); Inspecting and monitoring skills (Security guards, quality control)

- B. Basic cognitive skills: Basic literacy, numeracy, and communication (Cashiers), Basic data input and processing (Typists, data entry, accounting clerks)
- C. Higher cognitive skills: Advanced literacy and writing (Editors, paralegals, writers), Quantitative and statistical skills (Financial analysts, accountants); Critical thinking and decision making (Doctors, insurance underwriters); Project management (Purchasing agents, front-line supervisors); Complex information processing and interpretation (Market research analysts, lawyers); Creativity (PR specialists, music composers)
- D. Social and emotional skills: Advanced communication and negotiation skills (Sales representatives, real estate agents); Interpersonal skills and empathy (Counselors, social workers, therapists); Leadership and managing others (Managers, executives); Entrepreneurship and initiative-taking (Business development, strategists); Adaptability and continuous learning (Emergency responders, programmers); Teaching and training others (Teachers, instructors, trainers)
- E. Technological skills: Basic digital skills (Administrative assistants, desktop publishers); Advanced IT skills and programming (Software development, network administrators); Advanced data analysis and mathematical skills (Statisticians, research analysts); Technology design, engineering, and maintenance (Engineers, robotics experts, product designers); Scientific research and development (Scientists)

We can see (Fig 5) that the United States would lose 9,730,337 jobs but would need 21,179,775 new jobs (Higher cognitive skills, Social and emotional skills, and Technological skills). The net balance would be an increase of 11,449,438 jobs [4].

Jobs lost and gained United States (Estimation 2016-2030)						
Source: Own elaboration from the data provided by MGI in Bughin et al (2018); International Labour Organization (2019); OECD (2019)						
United States, all sectors (1.780 hours/worker)						
Skills	Hours worked 2016 (billions)	Change in hours worked by 2030 (%)	Hours worked 2030 (billions)	Change in hours worked by 2030	Change in Worker by 2030	
Physical and manual skills	90	-11,00	80,1	-9,90	-5.561.798	
Basic cognitive skills	53	-14,00	45,58	-7,42	-4.168.539	-9.730.337
Higher cognitive skills	62	9,00	67,58	5,58	3.134.831	
Social and emotional skills	52	26,00	65,52	13,52	7.595.506	
Technological skills	31	60,00	49,6	18,60	10.449.438	21.179.775
TOTAL	286		308,38	20,38	11.449.438	

Fig. 5. Jobs lost and gained United States (Estimation 2016-2030). Source: Own elaboration from the data provided by MCI in Bughin et al (2018); International Labour Organization (2019); OECD (2019) [4].

Western Europe (Fig 6) would lose 18,792,969 jobs but would need 27,605,046 new jobs. The net balance would be

an increase of 8,812,077 jobs. Western Europe would lose many more jobs than the United States, and would not recover them in the same proportion [4].

Jobs lost and gained Western Europe (Estimation 2016-2030)					
Source: Own elaboration from the data provided by MGI in Bughin et al (2018); International Labour Organization (2019); ODCE (2019)					
Western Europe, all sectors (1.522,91 hours/worker)					
Skills	Hours worked 2016 (billions)	Change in hours worked by 2030 (%)	Hours worked 2030 (billions)	Change in hours worked by 2030	Change in Worker by 2030
Physical and manual skills	113	-16,00	94,92	-18,08	-11.872.008
Basic cognitive skills	62	-17,00	51,46	-10,54	-6.920.961
Higher cognitive skills	78	7,00	83,46	5,46	3.585.241
Social and emotional skills	67	22,00	81,74	14,74	9.678.839
Technological skills	42	52,00	63,84	21,84	14.340.966
TOTAL	362		375,42	13,42	8.812.077

Western Europe (Countries analysed): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Numbers may not sum due to rounding

Fig. 6. Jobs lost and gained Western Europe (Estimation 2016-2030). Source: Own elaboration from the data provided by MGI in Bughin et al (2018); International Labour Organization (2019); ODCE (2019) [4].

From the MGI data analysed we can make a more exhaustive analysis of five European countries with the largest working population: Germany, United Kingdom, France, Italy and Spain (Fig. 8) [4].

Jobs lost and gained by Skills per Country (Estimation 2016-2030)								
Source: Own elaboration from the data provided by Bughin et al (2018); International Labour Organization (2019); ODCE (2019)								
Skills: (A) Physical and manual skills; (B) Basic cognitive skills; (C) Higher cognitive skills; (D) Social and emotional skills; (E) Technological skills								
Country	A	B	C	D	E	TOTAL	Lost	Gained
Spain	-1.164.548	-455.624	294.295	786.182	1.212.046	672.351	-1.620.172	2.292.523
Italy	-1.214.632	-922.420	409.382	925.188	1.374.856	572.374	-2.137.052	2.709.426
Germany	-2.609.844	-1.478.912	593.906	3.505.168	2.467.422	2.477.740	-4.088.756	6.566.496
France	-983.794	-961.706	512.164	1.306.704	1.694.221	1.567.589	-1.945.500	3.513.090
UK	-704.940	-536.051	920.330	1.882.568	1.142.280	2.704.188	-1.240.991	3.945.179

Fig. 8. Jobs lost and gained (Estimation 2016-2030). Source: Own elaboration from the data provided by MGI in Bughin et al (2018); International Labour Organization (2019); ODCE (2019) [4].

We can see (Fig. 8) the jobs lost and won, in each of the skills, for each of the countries. All the countries analysed need more new jobs than the ones they are going to lose. This allows us to conclude that automation (robots and Artificial Intelligence) will not have a negative impact on jobs. Another issue is that countries may have workers with the skills required for the new jobs.

IV. DOES AUTOMATION INCREASE OR REDUCE INEQUALITY IN COUNTRIES?

Lopez-Sanchez et al [1] using a sample of 33 European countries in the period 2000-2016, analyze the relationship between economic inequality, measured by the Gini index, and the automation level, evaluated according to the number of robots per 10,000 workers. Using a panel data approach, the conclusion is that higher levels of automation lead to a reduction in inequality in the medium term. The explanation for this phenomenon can be found in the fact that automation increases wealth in the country, which can be used by governments to reduce inequality through redistributive policies. However, it does give us an indication that the

relationship between inequality and the level of automation is far from obvious.

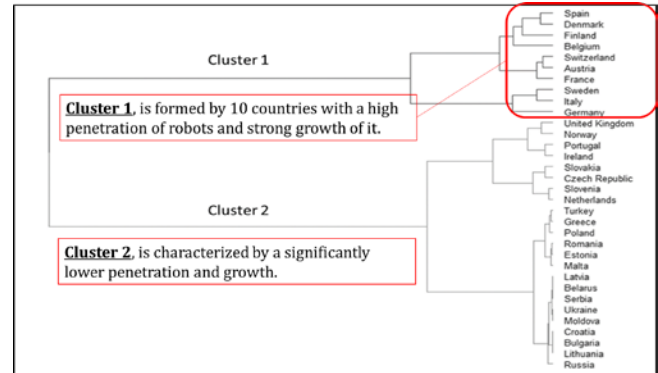


Fig. 9. Dendrogram for the time series of robot density [1]

We can identify two very different groups of countries, the first one (cluster 1), in which Germany, France, Italy, Spain are located, is formed by 10 countries with a high penetration of robots and strong growth of it (Fig 9). The second group (cluster 2) is characterized by a significantly lower penetration and growth. [1]. Countries corresponding to cluster 1 (high automation level) do not seem to be those with the most serious inequality problems. In fact, drawing the boxplot for both groups of countries (Fig 10) shows the opposite: while inequality before taxes and transfers (gini_mkt) seems slightly higher in cluster 1 countries, once we consider inequality after taxes and transfers (gini_disp), this group of countries seems to have lower levels of income inequality. This is a first indication that, in line with the majority opinion of the IGM panel of experts, high levels of robotization generate benefits that can be used by governments precisely to reduce inequality.

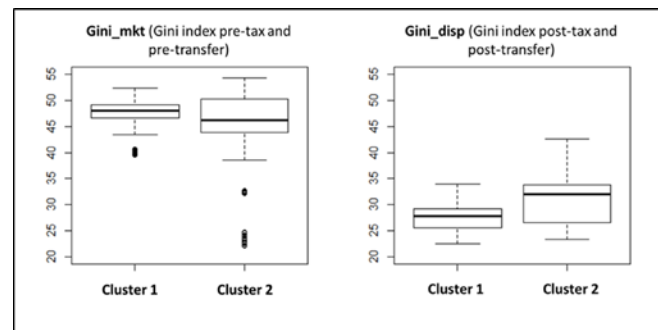


Fig. 10. boxplot for the Gini indices, distinguishing between cluster 1 and cluster 2.J [1].

V. CONCLUSION

From a first analysis we do not see a clear relationship between robotization and unemployment increase. However, we can observe empirical evidence that those countries that have a higher density of robots, per worker, generally have a lower unemployment rate. Similarly, we can observe empirical evidence that those countries whose workers are more productive present a lower risk of automation of their

jobs. Countries with a higher productivity per worker are countries whose jobs have a lower risk of being replaced by automation.

We also have made a first approximation of the jobs that could be destroyed, but also that will be created. This allows us to conclude that automation (robots and Artificial Intelligence) will not have a negative impact on jobs. Another issue is that countries may have workers with the skills required for the new jobs. Also, we have observed that higher levels of automation lead to a reduction in inequality in the medium term. Automation increases wealth in the country, which can be used by governments to reduce inequality through redistributive policies.

REFERENCES

- [1] J. I. López-Sánchez, J. L. Arroyo-Barrigüete, and T. Curto-González, "Automation and inequality", *UCJC Business and Society Review*, vol. 17, no. 4, pp. 148-176, Dec. 2020.
- [2] C. Bassett, and B. Roberts. "Automation now and then: automation fevers, anxieties and utopias". *New Formations*, 98, 9-28. 2019
- [3] J. Hawksworth, R. Berriman, and S. Goel, S. "Will robots really steal our jobs? An international analysis of the potential long term impact of automation". Price Waterhouse Coopers Report. 2018
- [4] J.I. Lopez-Sanchez, A. Grau, and Y. Sánchez-Urán,"The impact of robotics and computerization on the labour market: Inclusive insight from a Law and Economics perspective". *Digital Law and Innovation Review*, núm3, Julio-Septiembre 2019, Editorial Wolters
- [5] J. Bughin; E. Hazan; S. Lund; P. Dahlström; A. Wiesinger and A. Subramaniam. "Skill Shift Automation and The Future Of The Workforce", McKinsey Global Institute, may 2018.
<https://www.mckinsey.com/featured-insights/future-of-work/skill-shift-automation-and-the-future-of-the-workforce>