ROBOTICS AND THE LABOUR MARKET

Shahab Sharfaei

Abstract

Technological advances change the capital–labour ratio in the workplace and can sometimes completely alter the composition of the workforce in a fundamental way. These technological breakthroughs can often lead to a big increase in the amounts of products and services, and even employment in the affected industries. Technological advances can also automate a lot of routine work which reduces the reliance on some workers. The goal of this paper is to identify research gaps in order to expand the understanding of the impact of robot adoption on the economy. Namely, whether robot adoption has a positive or a negative effect on employment, and productivity. Moreover, whether increased robot use has a different impact on the economy in the long run and the short run in the context of these theoretical aspects. This comparison facilitates the assessment of the various patterns of influence to help with making informed policy decisions. Finally, the paper suggests a methodological approach based on the literature to address this issue.

Keywords: Robot Adoption, Employment, Productivity, Labour Market

JEL Code: E24, F62, J01

Introduction

During the 1930s, the prominent economist Keynes predicted an era when machines would create "technological unemployment" (Keynes, 1930). He believed businesses will become less reliant on workers, and machines will replace labour. The implications of that taking place at current times is worth considering. The current era is experiencing the expansion of a new technological landscape through automation. The fast-paced advances in robot technology in recent times can potentially alter the way we live and work (McKinsey Global Institute, 2017). An important component in this environment is the labour market which must adapt to these changes. The new generation of robots are increasingly becoming more advanced in doing complicated tasks than the robots in the past. As such, the human capital is currently confronted with the limitless processing power of computers, AI, and robotics, which indicates a significant workforce displacement on the horizon. This has raised some concern in certain quarters regarding the possible downsides of robot technology on the labour market while

acknowledging the benefits that it may carry in terms of productivity and raising the standard of living. Some studies have suggested that the destruction of certain jobs and a widening income inequality could be the consequence of these advances (e.g., Graetz & Michaels, 2018). These fears of robot technology highlights the need for understanding their effect on different segments of the labour market, standard of living, and on economic growth.

Based on previous studies, the different perspectives when it comes to the impact of increased robot use are twofold, which consist of the displacement effect and the productivity effect. The former implies that robots can impact employment as well as income through the direct displacement of labor since robots will be able to do those jobs more efficiently. The other perspective however favors the productivity effect. The productivity effect implies that there could be new jobs and even whole new sectors created due to the increased robot use which could in turn lead to higher demand for workers. The eventual impact of increased robot use on employment is contingent on whether the displacement effect or the productivity effect has a bigger influence on the labor market (Acemoglu & Restrepo, 2020; Fu et al., 2020).

Based on the literature on the impact of robots on the labor market and economic growth, we can observe that the relationship is far from conclusive. Dauth et al. (2021) observed that industrial robots altered the composition of the workforce but did not influence nominal employment numbers, since the fall in manufacturing jobs was entirely counterbalanced by a surge in the service sector jobs while simultaneously increasing labor productivity. Additionally, the study found that robot adoption was responsible for a nominal drop in workers' share of income but did not raise nor reduce wages. According to Jäger, et al. (2016), although European manufacturers achieved higher worker productivity levels as a result of using robots, they nevertheless had no impact on firm-level employment. Likewise, other studies have also concluded that robot adoption has led to a considerable rise in worker productivity (Graetz & Michaels, 2018). However, other studies reached a different conclusion. For example, some studies found that robots led to a considerable decline in employment as well as salaries in the United States in the 1990-2007 period (Acemoglu & Restrepo, 2020). Chiacchio et al. (2018) also observed that industrial robots caused a considerable increase in unemployment, however, it did not have a commensurate effect on workers' income.

The literature has mainly considered a small sample of countries over a relatively short period of time. Nonetheless, the impact of technological advances is likely not to be

instantaneous. Specifically, there can be a lag between the adoption of technology and the effect on employment. This lag could be due to the time it takes for firms to make the transition from labor to technology. There could be a further lag between the time it takes between the adoption of robots and the spill-over effect. Thus, the effect of robots on aggregate employment is likely to take time. It is evident from previous studies that the short-term versus the long-term effects of technology on employment are unclear.

The goal of this paper is to identify research gaps in order to expand the understanding of the impact of robot adoption on the economy. Namely, whether robot adoption has a positive or a negative effect on employment and productivity. These aspects have been studied in past studies, however, to the best of my knowledge, there has not been research on whether increased robot use has a different impact on the economy in the long run and the short run in the context of these theoretical aspects. This comparison facilitates the assessment of the various patterns of influence to help with making informed policy decisions. Finally, this paper suggests a methodological approach based on the literature to address this issue.

1 Literature Review

This study identifies the gaps in the literature on the effect of robotics on economic growth from two aspects, namely employment and productivity.

1.1 Robots and Productivity

Graetz and Michaels (2018) examine robot use in production across industries in 17 developed economies between 1993 and 2007. They suggest that a lower robot price could result in a higher robot density. Consequently, this leads to a lower price for goods and an increase in output. Moreover, this significantly improved labour productivity. Similarly, Jäger, et al. (2016) found that manufacturing firms increase labour productivity by using robots. Fu et al. (2020), found a positive relationship between the usage of robots by companies and worker productivity. Dauth et al. (2021) also believe that there is a significant and positive link between the usage of robots by firms and increased productivity of workers since robots can do certain functions in a more efficient way than even humans in some cases, which leads to a higher productivity.

Overall, if the productivity effect has a larger influence on employment, there might even be more benefits for lower-skilled workers as they will be able to integrate their work with the robots, thereby, closing the skills gap with the high-skilled workers (Aghion, 2017). Vivarelli (2014) also found that technological advancements and product innovation through firm-level investment in research and development has a substantial labor-enhancing effect,

at least for European companies.

1.2 Robots and Employment

While there are still major limitations in robot capabilities, rapid improvements are underway, with the new generation being more autonomous and efficient at performing tasks. They can undertake a range of routine physical activities, such as assembling and using tools in the production line. In addition, they are more and more able to perform tasks that need cognitive abilities (Sousa & Rocha, 2019). With the continual improvements in robot capabilities, along with the declining unit costs, businesses are investing in robotization more than ever before (Acemoglu & Restrepo, 2020). As a result, there have been some concern about their possible consequences on the job market, while acknowledging their upsides, such as improving productivity and the standard of living. Mass unemployment and growing inequality might be some of the outcomes of using these technologies (Edwards, et al. 2017; Graetz & Michaels, 2018).

Whether the bleak view on employment is actually realized depends on which effect is bigger, productivity or displacement. If the productivity effect has a bigger influence on employment, increased robot use will not automatically lower the overall number of jobs. But in case the displacement has a larger effect, robot adoption can lower employment as well as income since the number of new jobs created will be less than the ones eliminated. These two hypotheses culminated in a study done by the National Bureau of Economic Research. According to their findings, industrial robots could increase unemployment and reduce wages in the United States as the number of robots is projected to triple by the year 2025 from its current level at around a million and a half in the economy (Acemoglu & Restrepo, 2020).

2 Methods

The different influences of increased robot use on economic growth can be measured by examining the data on robotics from the sample. Data from international federation of robotics (IFR) is the most comprehensive dataset typically used in this type of research (eg., Graetz & Michaels, 2018). To address potential reverse causation concerns linked to different measures of economic growth, this study follows Fu et al. (2020) and use lagged values of robot stocks as a robustness check. The panel data model, which is adopted from a study done by Fu et al. (2020), is as below:

$$Y_{i,t} = \alpha + \beta * LNROBOT_{i,t} + \delta * CVi,t + \rho_i + \rho_t + \varepsilon_{i,t} \quad (1)$$

Y in this model signifies one of the two aspects of economic growth chosen for this study. These two aspects include employment rate and worker productivity. Moreover, in the

above model, *LNROBOT* signifies the number of robots. The logarithm for the robot stock is considered in order to address heteroscedasticity issues. *CV* signifies a range of control variables which differs based on the dependent variable being measured. In addition, we control for the country in order to consider the time-invariant factors. This is signified by *Pi*. Furthermore, the year fixed effects is signified by *Pt*. In the above formula, country is *i* and time is *t*. To measure the difference in the long term and the short-term effects of robot adoption on the two dimensions, we will consider the effects based on 2 time periods, from 1980 to 2000, and from 1980 to 2020. This will enable us to identify any anomalies in the impacts of increased robot use in the short run and the long run.

Conclusion

To conclude, the effect of increased robot use on economic expansion depends on several factors. Whether robot usage is a benefit or a detriment to employment and productivity is not only contingent on the extent of robot use by companies, but also whether the displacement or the productivity effect has a more significant role. Moreover, the outcome of increased robot use on the two theoretical dimensions might vary if it enables the displacement and the productivity effects in the short run and the long run. Some segment of workers may lose their job in the short run due to adoption of robots, however, more jobs might be created in other part of the economy in the long run which did not exist before. These new jobs may require a different skillset, which implies a major displacement effect. Therefore, it is vital to study the impact of robots in the long run and compare it with the short run in order to have a more clear understanding of their effects. Hence, this paper calls for more studies on how increased robot usage impacts the labor market. Specifically, if there is displacement or productivity effect in terms of employment in the long run.

Acknowledgement

This article is provided as one of the outputs of the IGA research project The Effect of Robotics on Employment, Productivity, and Workers' Share of GDP in the European Union IG307022, financed by the Faculty of Business Administration, Prague University of Economics and Business.

References

Acemoglu, D., & Restrepo, P. (2020). Robots and jobs: Evidence from US labor markets. *Journal of Political Economy,* 128(6), 2188-2244.

Aghion, P., Jones, B. E., & Jones, C. I. (2017). Artificial intelligence and economic growth. *NBER Working Paper,* No. 23928.

Dauth, W., Findeisen, S., Suedekum, J., & Woessner, N. (2021). The Adjustment of Labor Markets to Robots. *Journal of the European Economic Association.* 10.1093/jeea/jvab

Edwards, D. J., Pärn, E., Love, P. E. D., & El-Gohary, H. (2017). Research note: Machinery, manumission, and economic machinations. *Journal of Business Research, 70*, 391–394.

Fu, X., Qun Bao, Q., Xie, H., Fu, X. (2020). Diffusion of industrial robotics and inclusive growth: Labour market evidence from cross country data. *Journal of Business Research.* https://doi.org/10.1016/j.jbusres.2020.05.051

Graetz, G., & Michaels, G. (2018). Robots at work. *The Review of Economics and Statistics, 100,* 753–768.

Jäger, A., Moll, C., & Lerch, C. (2016). *Analysis of the impact of robotic systems on employment in the European Union – 2012 Data Update*. Fraunhofer ISI. DOI: 10.2759/176994

Keynes, J.M. (1930). *Economic possibilities for our grandchildren in Essays in Persuasion.* New York: W.W. Norton & Co., 1963, pp. 358–373.

McKinsey Global Institute (2017). *Jobs lost, jobs Gained: Workforce Transitions in a time of Automation.* McKinsey & Company.

Piva, M; Vivarelli. M. (2018). Is innovation destroying jobs? Firm-level evidence from the EU. *Sustainability* 10(4):1279. https://doi.org/10.3390/su10041279.

Sousa, M., & Rocha, Á. (2019). Skills for disruptive digital business. *Journal of Business Research*. 94. 257-263. 10.1016/j.jbusres.2017.12.051.

Vivarelli, M. (2014). Innovation, employment and skills in advanced and developing countries: A survey of economic literature. *Journal of Economic Issues,* 48(1): 123–154

Contact

Shahab Sharfaei

Prague University of Economics and Business, Faculty of Business Administration

nám. Winstona Churchilla 1938/4, 130 67 Praha 3-Žižkov

Shahab.sharfaei11@gmail.com