

How Will the Adoption of Industrial Robots Influence Employment and Wage? Factors Behind Different Effects

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Abstract: This paper explains the effect of adopting industrial robots in developed and developing countries. By reviewing prior researchers' conclusion, result has been found that either negative and positive relationship may appear in developed and developing countries. Then this paper states the possible factors of the emerge of different conclusions. Diminishing productivity returns and the offset of demand scale effect and displacement effect can be the attributors.

1. Introduction

The recent technological advances and innovation cause certain automation, robots, and artificial intelligence to have the ability to take the place of humans in some tasks (Brynjolfsson and McAfee, 2014; Ford, 2015; Artuc, E., Bastos, P., & Rijkers, B, 2020 [1]). According to Cali & Presidente (2022 [2]), "industrial robots are defined by the International Standards Organization 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". Specifically, industrial robots can be set to do simple repetitive work with lower costs and higher productivity than humans, thus being increasingly adopted in industrial productions. Since industrial robots seem to deprive people's jobs but raise productivity at the same time, specific concerns may appear about whether industrial robots do good to society or not. Recent research drew different conclusions based on the countries they have been researched. Developed countries and developing countries are believed to have different impacts of robotization, but conclusions are different among developed countries as well. What are the impacts of industrial robots on economies? Specifically, this paper intends to apply employment rate and wages to examine the degree of impact. By doing so, different conclusions are compared, and reasons for different conclusions drawn by prior researchers may be explained, which can be used for developed and developing countries to better implement robots and automation in the future.

2. Background

2.1 Negative Relationship between Industrial Robots and Economy in Developed Countries

Adoption of industrial robots has been a concerned to reduce the overall employment rate for a long time. John Maynard Keynes estimated that the introduction of automation technologies would rapidly cost technological unemployment in 1929 (Keynes, 1931; Acemoglu, Daron, & Pascual, 2020 [3]). Some researchers concluded that the relationship between industrial robot adoption and the employment rate is negative in developed countries. In fact, the adoption of industrial robots reduces the labor share as robots are cheaper than laborers at the firm-level. Industrial robots at the same time increase productivity and therefore increase the operations and employment of those companies. However, the expansion cost the situation of their competitors to deteriorate. Employment of the competitors experienced a decline significantly, which is more than just offsetting the impact (Acemoglu, D., Lelarge, C., & Restrepo, P., 2020 [4]). The research conducted by Acemoglu, D., Lelarge, C., & Restrepo, P. (2020 [4]) found that, in France, the gross effect of adopting industrial robots is negative at the market level and examines that every 20-percentage point increase in adopting industrial robots leads to a 3.2 percent decline in the employment.

Overall, employment may increase at the firm level, but the displacement effect outweighs the benefits such as productivity brought by adopting industrial robots at the market level. In the US, the same conclusion has been found that the introduction of industrial robots contributes to a negative impact on US local labor market (Acemoglu, D., Lelarge, C., & Restrepo, P., 2020 [4]).

Another study completed by Chiacchio, F., Petropoulos, G., & Pichler, D. (2018 [5]) supported the idea as well. In their study, they researched the impact of industrial robots on employment and wage in six EU countries, applying a local labor market equilibrium approach designed by AR. They analyzed that 1 industrial robot increase per thousand laborers causes a 0.16-0.20 percentage points decrease in the employment rate. Therefore, the displacement effect largely outweighs the advantage industrial robots bring, especially for middle-education young men. Additionally, there are no significant results that industrial robots lead to wage growth (Chiacchio, F., Petropoulos, G., & Pichler, D., 2018 [5]).

2.2 Positive Relationship between Industrial Robots and Economy in Developed Countries

However, recent researchers raised contradicting ideas and indicated the positive effects of robotization in developed countries. In a paper written by Artuc, E., Bastos, P., & Rijkers, B. (2020 [1]), the authors build a Ricardian model with intermediate and final stages of goods during production and trade sections between the North and South. North, in the paper, is referred to as a developed country. Wages and welfare are used to be two key factors to examine the effect of robotization.

For the North, the labor wages are relatively high. According to Artuc, E., Bastos, P., & Rijkers, B. (2020 [1]), the decline in robot cost leads to robotization in the North and thus replacing labor. Consequently, the wages will decrease initially. But at the same time, robotization contributes to higher exports. The increased production and lower prices outweigh the effects of lower income, and therefore will result in an increase in welfare. In the long term, the adoption of robotization progressed in the North continually expanding production and increasing the task demand for other technologically non-replaceable areas. Eventually, the employment share of labor expands, leading to higher wages. Therefore, robotization will contribute to a positive result for developed countries.

The conclusion is also supported by Adachi, D., Kawaguchi, D., & Saito, Y. (2020 [6]). Their research is based on the context of robot adoption in Japan from 1978 to 2017. By applying a cost-based identification method, they study the effect of robotization on employment in Japan. Their industry-level analysis concluded specific data on the relationship between robotization and wages and employment. They found out that robots and labor are actually a gross complement. According to them [6], every one-percent decrease in the price of robots causes a 0.44 percent increase in labor demand. Every one percent increase in robot adoption due to the reduction of robot prices increases 0.28 percent in employment. Furthermore, every-one robot per thousand workers increases results in a 2 percent reduction in working hours and a 4 percent increase in hourly labor wages (Adachi, D., Kawaguchi, D., & Saito, Y., 2020 [6]). This means that laborers can work fewer hours with higher wages per hour. In conclusion, the evidence perfectly supported the idea that robotization resulted in an increase in both wages and welfare in developed countries.

2.3 Negative Relationship between Industrial Robots and Economy in Developing Countries

In developing countries, the situations may be slightly different from the in developed countries. As the industrial level in developing countries is less sophisticated than that in developed countries, corresponding risks will appear (Nagano, A., 2018 [7]). The opportunities for developing countries to turn from low-income countries to middle- or high-income countries may be taken over by the adoption of automation and digitalization technologies (Nagano, A., 2018 [7]). Also, they are riskier in terms of their economic background, as they lack technology background and information (Alcorta, L., 1999 [8]).

Accordingly, the impact of industrial robots may be stronger in developing countries than in developed countries. Comparing the impact on employment rate with developed countries, the influence of industrial robots is found to emerge detrimentally throughout the world, while it is 11 times stronger in developing countries (Carbonero, F., Ernst, E., & Weber, E., 2020 [9]).

Furthermore, the labor intensity is found unrelated to the impact of industrial robots on employment in developed countries, but there is a non-monotonic effect on employment in developing countries (Carbonero, F., Ernst, E., & Weber, E., 2020 [9]). Therefore, the adoption of industrial robots negatively affects the employment rate in developing countries, especially in those places with intense labor, and does more harm in developing countries than in developed countries.

Another reason that makes situations in developing countries worse is the trade effect of developed countries on developing countries. Since developing countries have relatively small local markets, their economy depends largely on trade with other countries, especially developed countries. The openness of developing countries is larger than developed countries, thus experiencing a larger effect on trade. In fact, the adoption of industrial robots in developed countries has a negative relationship with employment in developing countries (Carbonero, F., Ernst, E., & Weber, E., 2020 [9]).

2.4 Positive Relationship between Industrial Robots and Economy in Developing Countries

Contradict conclusions are also drawn on the topics of developing countries. The industries with high intensity of robots lead to an increase in imports and an even higher increase of exports to the same industries in less developed countries (Artuc, E., Bastos, P., & Rijkers, B., 2020 [1]). For the south, which is used to describe less developed countries, as Northern producers become more competitive, the demand for Southern inputs increases (Artuc, E., Bastos, P., & Rijkers, B., 2020 [1]). Moreover, according to Artuc, E., Bastos, P., & Rijkers, B. (2020 [1]), because of the increase in imports and exports, their wages and welfare will increase too, indicating lower consumer prices.

Furthermore, if robotization becomes possible in the South in the future, welfare could be more pronounced (Artuc, E., Bastos, P., & Rijkers, B., 2020 [1]). Similarly, Cali, M., & Presidente, G (2022 [2]) cast doubts on the trade-off between productivity and employment loss as well. Countries at the early stage of industrialization, such as Indonesia, are found to gain large benefits from adopting industrial robots (Cali, M., & Presidente, G, 2022 [2]). With the adoption of industrial robots, the two core kinds of jobs, machine operators and assemblers, in the developed countries appeared to a relatively intense growth and thus lead to an increase in employment (Maloney, W. F., & Molina, C, 2019 [10]). The benefits that industrial robots bring may be because of the diminishing productivity returns (Graetz, G., & Michaels, G, 2018 [11]).

3. Research Results

3.1 Factors between Developed and Developing Countries

Different conclusions have been made about the impact of industrial robots on both developed and developing countries. For the differences between developed and developing countries, it is firmly believed that developing countries may be more affected by the adoption of industrial robots, because of their unstable, less sophisticated economic environment, and the trade impact from developed countries. Noticeably, developing countries tend to have a less-negatively, or positive impact on industrial robots due to being the receiver side of off-shoring and robots (Maloney, W. F., & Molina, C, 2019 [10]).

3.2 Factors between Developed or Developing Countries

However, when explaining the reasons opposite conclusions have been drawn in developed or developing countries, the factors could be diminishing productivity returns and the offshoring between scale effects and displacement effects.

Attributor that diminishing productivity returns are explained by different stages of industrialization among the countries. The effect of industrial robots is believed to rely on the starting degree of robotization (Artuc, E. et al., 2022 [12]). In countries that are at the initial stages of adopting industrial robots, diminishing productivity returns can lead to an increase in labor demand, thus increasing employment (Graetz, G., & Michaels, G, 2018 [11]).

Another key factor is the offshoring of scale effect and displacement effect. In regard to the opposite result made by other literature, Adachi, D., Kawaguchi, D., & Saito, Y. (2020 [6]) mentioned a potential reason related to different demand scale effects. The demand scale effects depend on the scale of demand on the adoption of industrial robots. The displacement effect, or substitution effect, means the negative replacement of industrial robots with humans, which substantially explains the decrease in employment (Maloney, W. F., & Molina, C, 2019 [10]). If there is a strong demand for robot-intensive industries, robotization possibly arouses the scale effect, which can alleviate the displacement effect (Acemoglu and Restrepo, 2017; Adachi, D., Kawaguchi, D., & Saito, Y., 2020 [6]). They proposed that countries with a high demand for robotization are likely to have a positive effect of robotization on employment.

4. Summary

Industrial robots are adopted in production recently. While they tend to cost less and produce more compared to the laborers, they are replacing people by doing simple repetitive work. The effects of industrial robots on employment and wage are being studied. Both positive and negative relationships between industrial robots on employment rates and wages in developed and developing countries have been concluded by prior researchers. The common consensus is that impact in developing countries is related to domestic industrial robot adoption and international industrial robot adoption caused by trade. Also, developing countries face more risk in adopting industrial robots due to their less sophisticated economies. The factors that getting opposed conclusions in developed countries or developing countries could be the diminishing productivity returns of industrial robots, and the offset of demand scale effects and displacement effects.

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