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IMPACTS OF INNOVATION ON LABOR MARKET: DESCRIPTIVE ANALYSIS

Iskandar Mammadzada[1], Narmin Eynizada[2]

[1]SABAH faculty
Azerbaijan State University of Economics
Baku, AZERBAIJAN

[2]International School of Economics
Azerbaijan State University of Economics
Baku, AZERBAIJAN

ABSTRACT

This paper examines the effects of innovation on the labor market, more clearly employment dynamics by analyzing the relationship between different measures of innovation and unemployment rate. It reviews existing literature on the link between these two variables and analyzes the argument for and against the adverse effects of innovation. Taking into account that there are different types of measures of innovation, firstly, the author tries to find the most relevant one of them.

Paper concludes that there is no evidence to believe that innovation increases unemployment rates. By contrast, it is observed that the unemployment rate is almost always around its natural level in countries with a high innovation level. However, it is not true to state that innovation decreases the unemployment rate. To get more reliable results, one should distinguish between high-skilled and low-skilled labor, because innovation and new technologies affect them differently. Additionally, a high innovation level is mainly observed in developed countries, which means that the low unemployment rate may be the result of other economic variables, not innovation.

Keywords: innovation, technology, patent, R&D, unemployment, labor market.

1. Introduction

The analysis of the link between technological improvements and employment levels is a complicated issue. The improvement of the technologies, in the last decades, based on ICTs, resulted, again, as the emergence of the old arguments about the possible effects of innovation on employment. Of course, as everybody knows, labor has always been in the fear of being unemployed as a result of technological improvements. The dynamics of unemployment in national and international level is linked with technological improvements even now. But it is important to not only considering the effects of innovation on employment and do not giving a sufficient level of attention to other factors. For example, short-term analysis of prices – wages and interest rates – and institutions and regulations in the labor market are also important determinants of employment dynamics in the labor market. But not analyzing the relationship between innovation and employment will result in an incomplete study of the employment dynamics. This has ever been a contradicting problem in economic theory. A well-organized structure is needed to understand whether high innovation levels benefit or worsen employment dynamics in a society. By taking into account that different types of technological changes have different effects on the employment level in the labor market, some economists started to change the nature of this simple question. New perspectives have asked the new question of "about what type of technological changes are analysts concerning?". Another new question is considering different structural, demand and institutional factors that may impact the creation or dispose of jobs. It is also important to take into account not only quantitative changes in employment. So, qualitative aspects of the technological improvements have received careful attention recently.

The question for this issue is concerned about the types of jobs that are created or destroyed by technological improvements. Looking from this perspective to the research is often associated with disequilibrium view of the functioning of the labor market. This perspective has two main directions: Firstly, as innovations occur, how the composition of the skills of the available labor in the market changes, and, by taking into account the changing structure of the skills in the labor market, the changes in the wage rates also are a growing concern for these types of analysis. All of these new types of questions lead to an emergence of large literature and studies of skill biases of technical changes.

Our analysis examines, firstly, the different pieces of evidence from an empirical analysis of the considerable number of economists from different periods. But choosing from different alternatives, we linked technological improvements and employment level by considering the Research and development (R&D) expenditures. R&D means undertaking creative work systematically, to increase the level of knowledge. By saying the level of knowledge, we mean, the knowledge of men, culture, and society. R&D policies also concern about the use of this acquired knowledge to improve the technological level of society.

In our analysis, we, firstly, examined different articles regarding the same issue by taking into account different types of innovation and different ways of responses by the labor market in different periods. Also, the analysis of the existence of different types of labor regarding their skills is given attention. Second, by analyzing the R&D expenditure dynamics and unemployment rate dynamics over the world we would find a link between innovation and unemployment, which was started in the studies of earlier economists. Finally, in conclusion, we described the acquired results of the analysis by giving the evidence.

2. Literature Review

Debates regarding the impacts of technological changes – innovation – on the labor force were growing concerns of economists since from the origins of the economic thought. From the origins of economics, different attempts were taken to identify the possible negative effects of technological changes. At the beginning of the nineteenth-century economists developed different theories, which were called as the "compensation theory" by Karl Marx (Marx, 1961). According to this theory, different market compensation mechanisms are available. These compensation mechanisms are created by technological changes itself and decrease the labor-saving effects of new technologies (Vivarelli, 1995; Vivarelli and Pianta, 2000; Pianta, 2004). Labor-saving effects of the same technological improvements in labor-intensive industries are balanced by the creation of the new jobs in the capital-intensive industry, in which these technologically improved machines are produced. Because of the technological improvements, on the one hand, the displacement of employees between industries occurs. But, on the other hand, these technological changes cause a lower cost of production. So, in a competitive market, because of this, it results in a decrease in prices. Lower prices stimulate consumer demand for products. Also, this additional demand leads to additional production and employment in the industry. This mechanism was known even at the beginning of the economic thought (Steuart, 1966).

When there is a gap between the decrease in the costs and a decrease in the price levels, because of the technological changes, innovative business owners may capture extra profits from this situation. Then these innovative business owners may invest these extra profits and new technological improvements may take place further (Ricardo, 1951). As Ricardo explained, the fear of being unemployed because of the growing numbers of new technologies was an important characteristic of the "working-class opinion". Although the academic – also, political – debate over this issue was mostly included the confidence because of the ex-ante analysis of economists about the market compensation for the unemployed workers because of the technological changes (Ricardo, 1951).

As an example, English workers in the eighteenth century were in riots to destroy new technologies (mainly, threshing machines). In the newly industrialized areas, they were led by Ned Ludd, and, however, in the countryside Captain Swing led to them (Hobsbawm, 1968; Hobsbawm and Rudé, 1969). Others looked at from different – macroeconomic - points of view, so to analyze correctly the labor market effects of technological changes the amount of labor-saving effect of the process innovation and the labor-intensive impact of product innovation have to be compared. And the differing effects of income and price mechanisms, operating at the firm, sectoral and intersectoral levels have to be taken into account for this comparison. From this perspective, innovation and new technologies permit to decrease prices. It is also increasing incomes (profits and wages) of employees. According to Freimane and Balina (2016) increased R&D spending increases GDP per capita employed. Hence, these effects would lead to the increased demand for labor and more employment (Vivarelli, 1995; Spiezia et al., 2002).

Early analysis of the relationship between innovation and the labor market at the firm level requires the analysis of a more general and strict measure of innovations and technological changes. In doing so, the investigation of the effects of the different forms of innovations on the employment of the labor force directly, and testing if a given way of technological change decreases the level of labor required or not is crucial. Earlier microeconomic analysis of this issue has taken into account mainly the innovation and labor market dynamics of more tech-

nologically advanced countries which mostly rely on the R&D expenditures. As an example, Entorf and Pohlmeier (1990) found a positive correlation between employment and product innovation. In their study, both of these variables were measured as dummy variables. In 1984 they analyzed a cross-sectional data of 2,276 firms in the Western Germany firms. The positive relationship between employment and product innovation in Western Germany firms confirmed by Smolny (1998). However, he used a panel data regarding 2,405 firms in the same region for the period between 1980-1992. By using a cross-sectional data of 859 Dutch firms, Brouwer et al. (1993) analyzed the link between technological changes and employment. An aggregate negative relationship between aggregate R&D expenditures of those Dutch firms and the employment level of the labor market is discovered by him. However, the positive impact was found when he considered only product innovation, and not considered process innovation. Although Doms et al. (1997) conducted his study, not for the analysis of the relationship between innovation and employment, they found an implication of this relationship. So, as the foundation, innovative technological changes, which were measured as dummy variables, caused the growth of employment by higher rates in USA firms during the period between 1987-1991.

But the conclusions of the analysis of Klette and Førre (1998) were surprising and contradicting. Their analysis' database consisted of 4,333 Norwegian manufacturing firms during the period between 1982-1992. Although the results of the earlier analysis, these authors did not find that much strict positive link between employment creation and the dynamics of R&D expenditures of the analyzed firms. Pianta (2005) explained that it is important to distinguish between product innovation and process innovation for the analysis of the relationship between innovation and the labor market. Product innovation has a positive employment effect, but process innovation has negative effects on employment. And there are skill bias effects, which means that the number of unskilled labor either declining in some countries or growing at a very small rate in other countries. But, in most countries, the number of jobs for skilled labor with education increases (Autor & Acemoglu, 2011). So, the demand for unskilled labor decreases, while it increases for skilled labor. The author also stated that the impact of technological changes on employment depends on the macroeconomic conditions. The results of technological changes depend on the conditions and institutions of the labor market. So, the way the supply of labor matches the required skills is also important to take into account. Meriküll (2008) found that both types of innovation (product and process) contribute positively to employment. According to Blechinger et al. (1998) product innovation contribute to job creation if this innovation does not eliminate other products.

One of the related studies is conducted in the United Kingdom. Blanchflower et al. (1991) analyzed 948 firms in 1984. These authors found a strong positive employment impact of new technologies in their analysis. They took workplace characteristics such as demand, union density and organizational change as fixed variables. Vivarelli (2007) suggested that relationship between innovation and employment dynamics is a complex problem and can not be found with empirical generalization.

3. Measures of Innovation

Before analyzing the impact of innovation on the labor market we should find a relevant measure of innovation for our analysis. Historically, several measures have been suggested by different authors. Morck et al. (2000) identified three main quantitive measures of innovation. The first one of them is Research and Development spending. It is the most widely used measure of innovation because the data is easily achievable from different sources. However, there are

shortcomings in using R&D spending as a measure of innovation. According to Lhuillery et al (2015) money spent on innovation is perceived as R&D spending if this money is intentionally used to invent something. Therefore, money spend on unintentional innovations can not be included in R&D spending and, consequently, because of this reason using R&D spending to measure innovation becomes irrelevant. The next shortcoming of R&D spending as a measure of innovation is that it is an input of the innovation process. Some of the money spend on different projects to invent a new product or process may generate nothing for the company. As a result of these unsuccessful projects, the amount of money allocated to R&D is not an accurate measure of innovation (Morck et al., 2000).

The next measure of innovation identified by these authors is a patent which are the outputs of the innovation process. Measuring outputs of any process is more accurate than measuring inputs. However, there are demerits of using patents as a measure of innovation to consider. The most important consideration is that the majority of innovations are not patented by innovators. Fontana et al. (2009) analyzed the winners of the "R&D 100 Awards" competition. According to their analysis, only about 10% of innovations which won this competition between 1977 and 2004 were patented. This means the number of patents as a measure of innovation overlooks the actual level of innovation.

Finally, the authors mentioned innovation counts as the third most used measure of innovation. Innovation counts are simply the numbers of innovations made by a company or a nation over some time. These numbers are collected through large surveys. Taking into account that in most countries innovation counts do not exist, it is not always relevant to use innovation counts to measure innovation.

Godin (2001) found out that output indicators are more important and reliable for innovation measurement than input indicators. However, non of them can be used as separate perfect measure of innovation (Rogers, 1998).

According to Phan K. (2013), several new products, revenue generated from new products, sales of new products and et cetera are other output measures of innovations that are used by different scholars throughout history. Rammer C. (2016) innovation output data help firms to better understand impacts of innovation of firm performance. Piva and Vivarelli (2005) used innovation investment as a measure of innovation and found posistive relationship between innovation and employment.

In our analysis we will not focus on innovation and employment at the business level, rather we will analyze the effects of innovation on labor market by analyzing worldwide data, Additionally, we will use nation-level innovation measures and employment measures to exemplify our analysis.

To analyze innovation within a nation or political unit scholars use an aggregate indices approach. By this approach, scholars use different indicators that affect the innovation within a nation or other political units. To exemplify, European Innovation Scoreboard uses different indicators – such as, new patents issued, early-stage venture capital, employment in high technology industries and et cetera – to rank the European nations' innovativeness.

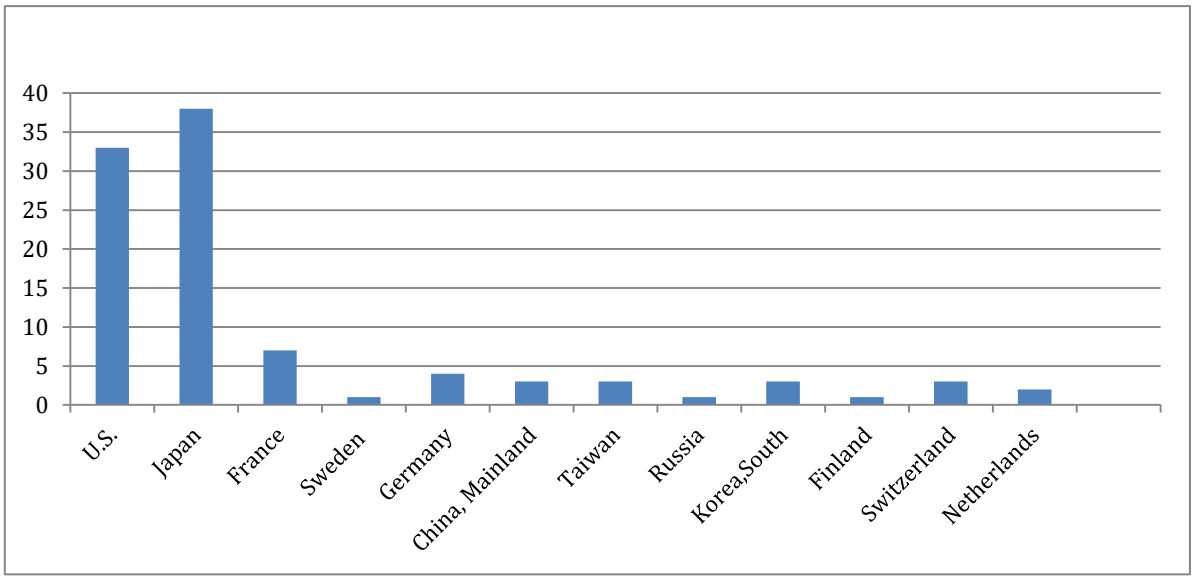
Within this analysis, we will use R&D spending (an input measure of innovation) and several patents issued (an output measure of innovation) as a measure of innovation to analyze labor market effects of innovation.

4. Unemployment dynamics in the homeland of 100 most innovative firms

As discussed previously in this article, historically different indicators were used to measure innovation. However, none of those indicators are perfect to analyze the level of innovation.

Since 2011, Clarivate Analytics (USA based analytics company) has been presenting the list of the most innovative firms in the world. In order to measure the level of innovation in different companies Clarivate Analytics uses 4 criteria based on indexes provided by Derwent which is a Clarivate Analytics company and maintain different patent data sources. The graph below shows the homeland of the most innovative firms according to "Derwent 100 Top Innovators Report 2018-19" of Clarivate Analytics.

Figure 1: Number of Innovator Firms from "Derwent 100 Top Innovators Report 2018-19"



According to the figure above it is evident that the most innovative firms are mainly originated from developed countries with high living standards and technological progress. Only two of these countries are developing countries – China, Mainland and Taiwan.

Figure 2 graphs the level of unemployment in the homeland of these 100 most innovative companies. Almost for all of those seven countries – except France – unemployment rate is around the natural rate of unemployment (around 5-6%) after 2015.

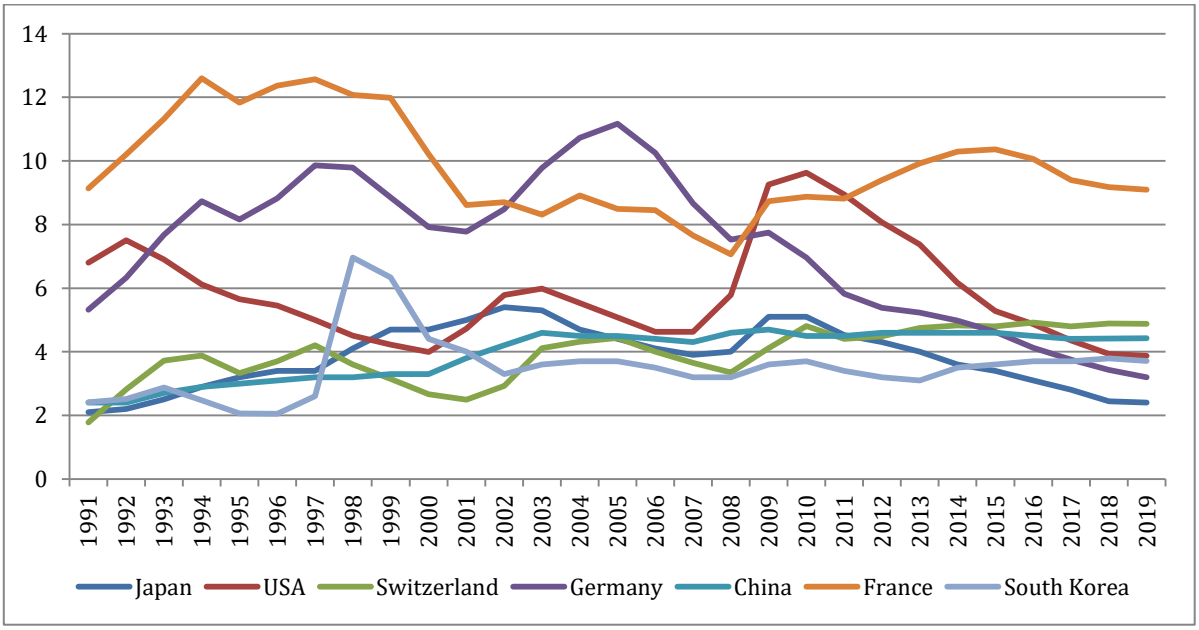
According to Global Innovation Index 2019, which is provided by World Intellectual Property Organization, the top performers were high-income countries and only exception for this was China – a middle-income country. This result is the same as what is suggested by Derwent 100 Top Innovators Report 2018-19".

Balanced unemployment rate and high level of innovation in developed high-income countries may be the outcome of "compensation theory". According to Vivarelli (2014) this theory consists of 6 mechanisms which compensate the decreased employment level as a result of innovation:

1) While innovations may lead to the lay-off of workers in the traditional industries, new employment opportunities are provided in the new industries in capital markets where these new technologies are produced (Vivarelli, 2014).

2) Decreased employment levels can be compensated by increased demand for products. Because when a process innovation occurs the cost of production decreases and, consequently, price of the products decreases. Lower prices mean higher demand, and to satisfy this demand, firms must supply more which means firms must hire additional labor to meet the demand in the market (Pianta, 2018).

Figure 2: Unemployment rates (%) in 7 most innovative countries



Source: World Bank, World Development Indicators.

3) If profitability expectations of innovators are favourable and they realized their expected profits, these companies will invest its profits for further innovation and development, which means increased production capacity and more jobs.

4) According to the neoclassical view, as technological innovation occurs, wages of labor will fall and employers will hire more labor because of the decline in the cost of labor.

5) In contrast with the decreased wage as a compensation mechanism, there is other view which suggests that innovation increases the income of labor. If because of the new technologies cost of production declines, then more as any member of society workers should also get their portions from this increased welfare. As a result of increased incomes of workers, both demand and employment will increase which in turn compensate the initial effect of innovation on unemployment level (Boyer, 1990).

6) Last compensation mechanism of innovation for decreased employment level is about the product innovation – while in process innovation new and more efficient way of producing a product is developed, in product innovation completely new product is produced (UNESCO Institute for Statistics, 2015). Production of new goods in any company requires more workers to hire. So, product innovations impact on employment increase is evident. According to Vivarelli (2014), even the strictest critics of compensation theory accepts the positive impacts of product innovations on employment level.

Pianta (2018) suggests that compensation theory is less relevant to emerging countries than developed countries. It means negative effects of innovation on labor market are more common in developing economies in which market imperfections and structural problems exist.

5. Analysis of the link between research and development expenditures and unemployment dynamics

Research and Development plays an important role for the overall well-being of society. Impact of R&D on health, education, manufacturing is evident. As a result, not only governments, but also other institutions such as universities, private entities, non-governmental institutions invest in Research and Developmet around the world. In a modern world, largest portion of R&D spending is made by private firms (Weil, 2013).

For their empirical analysis on R&D expenditures and employment Piva & Vivarelli (2017) and Bogliacino & Vivarelli (2010) used R&D expenditures as a measure of technological change and innovation and they found a positive relationship between employment and innovation.

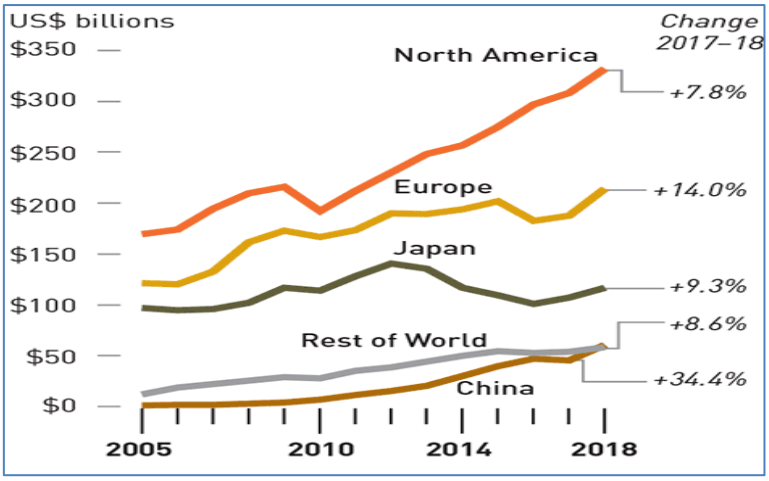
Ciarli et al. (2018) touches a very recent topic – modern types of employment. According to their analysis, as firms increase their R&D expenditures, these firms tend to hire more employees for complementary tasks. Authors also points out the self-employment opportunities for unemployed people which is actually a result of the long innovation process (Selim, 2013).

As shown in Figure 3, growth rate of R&D expenditures was highest for China and Europe with approximately 35% and 14% respectively. From Figure 4 it is evident that in all of those regions where R&D expenditure growth is high unemployment rate is about in its natural level (for European Union it is slightly more that natural rate of unemployment).

So far, we made attempts to analyze the impact of R&D expenditures on labor market by its "indirect" effects. Actually, increased R&D expenditures means more R&D specialist, analyists, and other relevant personnel will be hired to use convert these expenditures into productive outcomes (Westholm et al. 2003). Which will in turn create new job opportunities and decrease unemployment level.

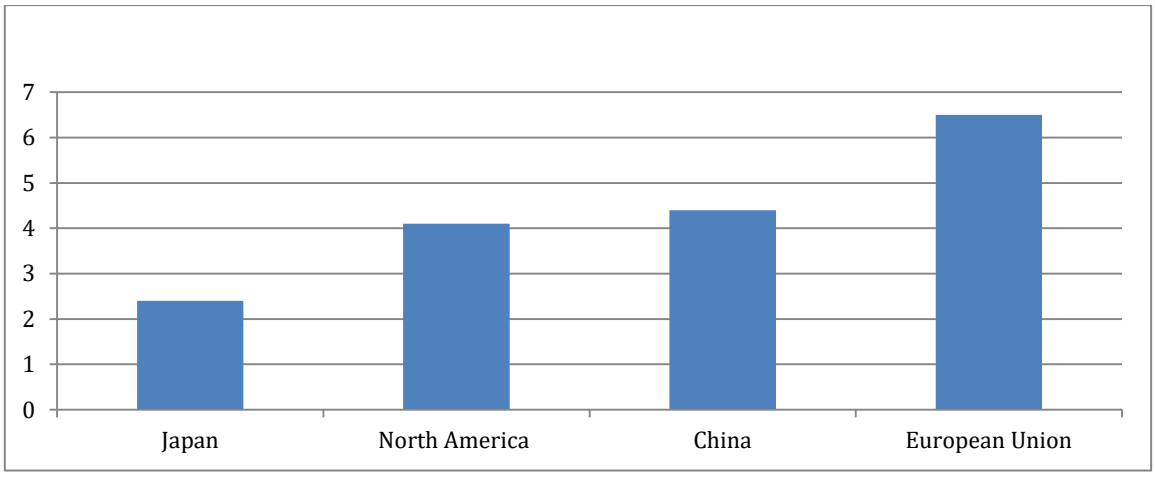
USA is one of the countries which allocates a considerable portion of its budget on Research and Development. Most of the influential innovations were made by US firms historically. The only reason for lower level of R&D expenditure growth in North America in Figure 3 is that the level of R&D expenditures is already very high. While the additional money invested in research and development is huge in nominal terms, it because of the already high levels growth rate is relatively lower than other regions.

Figure 3: Growth Rate of R&D Expenditures by Region



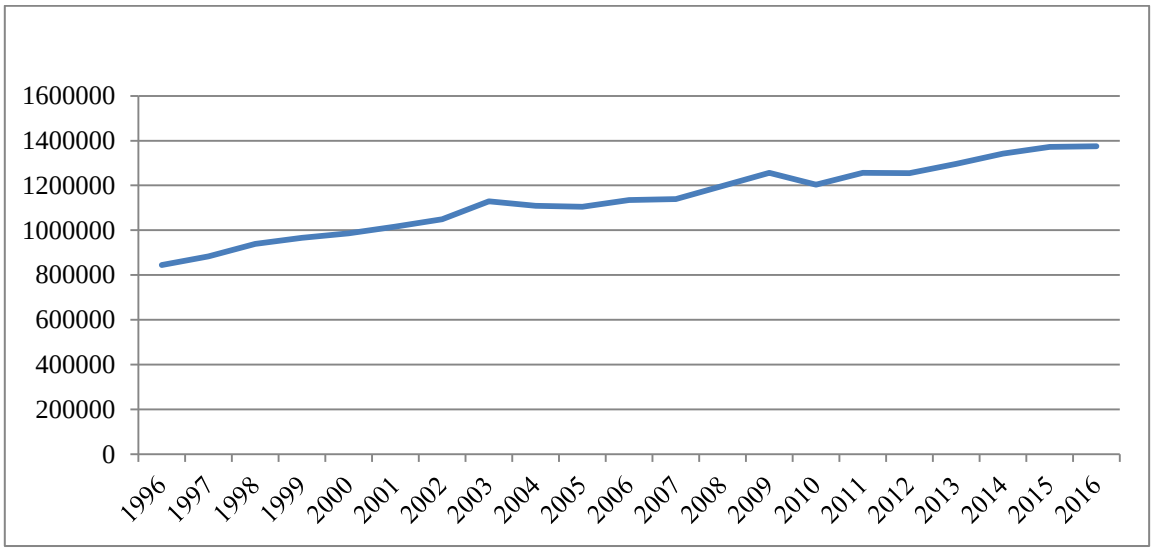
Source: Jaruzelski, Chwalik and Goehle (2018)

Figure 4: Unemployment Rate of Top Performers in R&D Growth



Source: World Bank, World Development Indicators.

Figure 5: Number of Researchers in USA between 1996 and 2016



Source: World Bank, World Development Indicators

In Figure 5, it is obvious that number of researchers in the USA increased sharply since 1980s, as a result of increased investments in R&D which in turn contributes to higher level of employment. It should be mentioned that these are only the number of researchers, numbers of other research personnel are not included in this data. Even if, observed the effect on employment would be much stronger.

6. Skill-biased effects of innovation

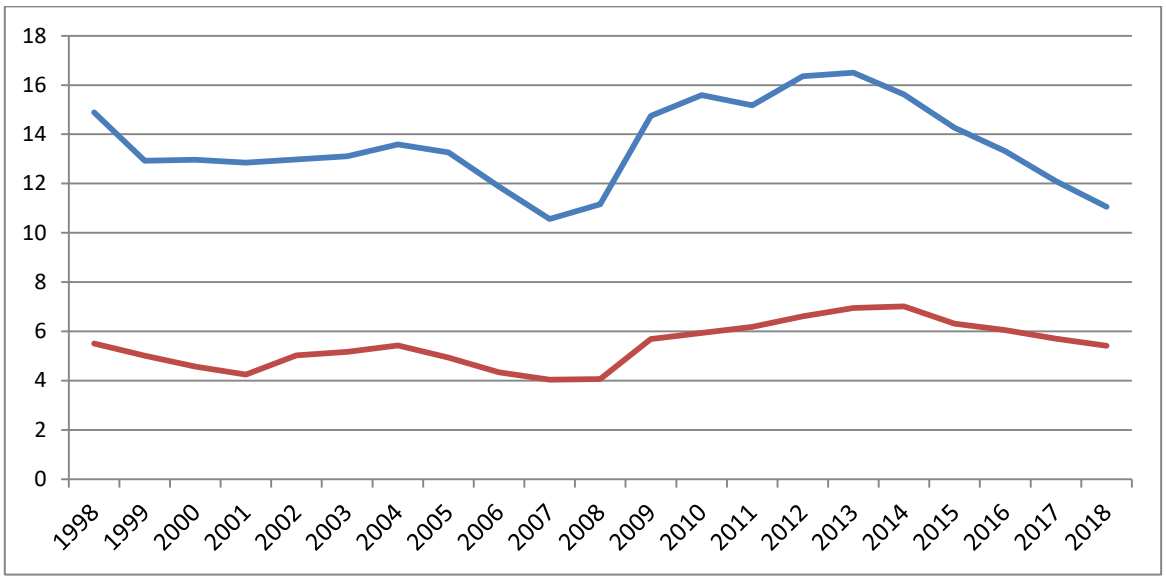
Throughout the text we assumed that innovation will affect both high-skilled and low-skilled labor in a same manner. However, it is obvious that, compared to historical data, technological development affected low-skilled labor in a more severe way.

What Acemoglu and Autor (2011) found is consistent with this idea, but has some interesting findings. According to the results of their analysis demand for medium-skilled jobs decreased because of their routine structure, while demand for low-skilled and high-skilled labor increased in USA.

Dachs (2017), Meschi et al. (2016) and Valdalbero (2010) concludes that innovation benefits high-skilled occupations, while it reduces empoyment opportunities in low-skilled occupations. Author suggests that low-skilled occupations are replaced by technology (ICT). However, high-skilled labor contribute the process of innovation because of their practical knowledge (Toner, 2009).

According to Weil (2013) human capital input of labor can be measured by his or her education level. Labor with high education level can be considered as high-skilled labor and vise-versa is true for labor with low education level. Figure 6 and figure 7 shows unemployment with basic education and advanced education in OECD member countries. While there are fluctuations in both indicators, unemployment rate is always higher than 10% for labor with basic education. Autor (2015) also suggests that workplace automation increases the demand for high-skilled labor.

Figure 7: "Unemployment with basic education" (as a percentage of total labor force with basic education, upper (blue) line) and "unemployment with advanced education" (as a percentage of total labor force with advanced education, lower (orange) line) in OECD Member Countries



Source: World Bank, World Development Indicators.

Van Roy et al. (2015) and Bhattacharya and Bloch (2004) concluded that the positive link between innovation and employment is true only in high-tech and medium-tech industries. Pompei and Pieroni (2008) suggests that the relationship is actually vice-versa, increased wages for high-skilled labor increase innovative activity. Some analysis show that increasing technological development can make men umployed but not women (ILO, 2018).

However, for the whole period shown in figure 7, unemployment rate among labor with advanced education was always around its natural level. This evidence suggests that innovation affect labor differently according to their human capital input. In a modern world, low-skilled occupations can easily be computerized, while to improve the production processes companies need more labor with advanced education.

Conclusion

There is a historical debate around the possible effects of innovation on the labor market. For analyzing the relationship between these two variables the appropriate measure for innovation

is required. While there are different ways to measure innovation level (R&D expenditures, number of patents, innovation counts and et cetera), none of them is perfect. This is the reason why Clarivate Analytics used an average of 4 different indexes to prepare the report on 100 most innovative firms. According to data from this report and statistics regarding the unemployment rate, there is no evidence to believe that a high level of innovation has adverse effects on employment in the homeland of those most innovative firms.

The reason why the traditional assumptions about the negative impact of innovation on labor market dynamics failed was explained through "compensation theory" by different researchers. According to this theory, type of innovation (process or product innovation), new industries created because of the innovation, profits from using new technologies and producing new products, decreased wages as a result of innovation, increased demand for new products because of the decline in production costs lead the way that innovation's positive impact on labor market.

Analysis of R&D expenditure dynamics is the easiest way to measure innovation. We showed that regions with a high level of R&D expenditure growth also tend to have a lower unemployment rate. When analyzing the effects of innovation on the labor market, it is crucial to distinguish between modern and traditional types of employment. For instance, because of the new technologies, people can work remotely, as a type of self-employment. Direct employment-generating effects of R&D expenditures (through hiring more R&D personnel) are also pointed out in this analysis.

While no evidence of negative effects of innovation on the labor market is found, it is crucial to divide the labor market into high-skilled and low-skilled labor to get more reliable results. In this analysis, we used education as a measure of labor's skill level. According to the results, innovation decreases the demand for low-skilled labor because they can be replaced by new technologies. However, innovation increases the demand for labor with advanced education and high skills.

REFERENCES

1. Acemoglu, D. & Autor, D. (2011). *Skills, Tasks and Technologies: Implications for Employment and Earnings.* National Bureau of Economic Research, Inc, NBER Working Papers. 4.; Available at: https://economics.mit.edu/files/7006, 15.12.2019
2. Adriana P. & Ernesto S., (2018.) *Innovation, Employment and Skills.;* Available at: http://www.iariw.org/copenhagen/peluffo.pdf , 15.12.2019
3. Autor D. (2015). *Why Are There Still So Many Jobs? The History and Future of Workplace Automation;* Available at: https://economics.mit.edu/files/11563
4. Bhattacharya, M. & Bloch, H. (2004). Determinants of Innovation*. Small Business Economics. 22,* 155-162.
5. Blanchflower D., Millward N., & Oswald A. (1991*).* Unionisation and Employment Behaviour, *Economic Journal, 101(407), 815-834*
6. Blechinger, D. & Kleinknecht, A. & Licht, G. & Pfeiffer, F. (1998). *The Impacts of Innovation on Employment in Europe – an Analysis using CIS Data.;* Available at: https://www.researchgate.net/publication/46458209_The_Impacts_of_Innovation_on_Employment_in_Europe_-_an_Analysis_using_CIS_Data , 15.12.2019
7. Bogliacino F., Vivarelli M. (2010). *The Job Creation Effect of R&D Expenditures;* Available at: http://ftp.iza.org/dp4728.pdf , 15.12.2019
8. Brouwer E., & Kleinknecht A., (1993). Technology and A Firm's Export Intensity: A Need for Adequate Innovation Measurement*; Konjunkturpolitik, 39 (5), 315-325.*
9. Ciarli T., Marzucchi A., Salgado E & Savona M., (2018). *The Effect of R&D Growth on Employment and Self-Employment in Local Labour Markets,* SPRU Working Paper Series 2018-08, SPRU - Science Policy Research Unit, University of Sussex Business School.

10. Clarivate Analytics, (2018-2019). *Derwent Top 100 Global Innovators Report;* Available at: https://clarivate.com/derwent/campaigns/derwent-top-100-global-innovators-2018-19-report/, 15.12.2019
11. Dachs, B. (2017). *The impact of new technologies on the labour market and the social economy,* MPRA Paper No. 90519
12. Daria C., Pietro M. &Peter V. (2013). Innovation and Job Creation: A Sustainable Relation?; Eurasian Business Review, 6, 189-213.
13. Doms, M. & Dunne, T. & Troske, K. (1997). Workers, Wages, and Technology. *The Quarterly Journal of Economics,* 112, 253-90
14. Entorf, H., & Pohlmeier, W. (1990). *Innovation, employment and export activity: evidence from firm-level data.* Oxford, Blackwell;
15. Fontana, R., Nuvolari, A., & Shimizu, H., & Vezzulli, A. (2009). *The Nature of Inventive Activities: Evidence from a Data-Set of R&D Awards.* Institute of Innovation Research, Hitotsubashi University, IIR Working Paper.
16. Freimane R. & Balina S. (2016). *Research and Development Expenditures and Economic Growth in the EU: A Panel Data Analysis;* Available at: https://content.sciendo.com/view/journals/eb/29/1/article-p5.xml?lang=en , 15.12.2019
17. Godin B., (2002). *Measuring Output: When Economics Drive Science and Technology Measurements,* Montreal: OST;
18. Hobsbawm, E.J. (1968). *Industry and Empire: An Economic History of Britain since 1750;* London, Weidenfeld & Nicolson
19. Hobsbawm, E.J. and Rudé, G. (1969). Captain Swing, Pantheon Books, New York;
20. ILO, (2018). *Global Commision on the Future of Work, The impact of technology on the quality and quantity of jobs;* Available at:

    https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_618168.pdf , 15.12.2019
21. Jaruzelski B., Chwalik R., & Goehle B. (2018). *What the Top Innovators Get Right;* Available at: https://www.strategy-business.com/feature/What-the-Top-Innovators-Get-Right?gko=bdbc7 , 15.12.2019
22. Klette, T. J. and Førre, S. E. (1998). Innovation and Job Creation in a Small Open Economy - Evidence from Norvegian Manufacturing Plants 1982-92. *Economics of Innovation & New Technology,* 5, 247-272.
23. Lhuillery, S., Raffo, J. & Hamdan-Livramento, I. (2015). *Measurement of innovation;*Available at: https://www.researchgate.net/publication/283672126_Measurement_of_innovation , 15.12.2019
24. Marx, K. (1961). *Capital.* Moscow: Foreign Languages Publishing House, first edn 1867;
25. Meriküll, J. (2008). *The impact of innovation on employment: firm- and industry-level evidence from Estonia;* Available at: https://www.researchgate.net/publication/23525699_The_impact_of_innovation_on_employment_firm-_and_industry-level_evidence_from_Estonia , 15.12.2019
26. Meschi, E., Taymaz, E., & Vivarelli, M. (2016). Globalization, technological change and labor demand: a firm-level analysis for Turkey. *Review of World Economics*, *152*(4), 655-680.
27. Morck, R. & Yeung, B. & Distinguished, S., (2000). *The economic determinants of innovation.* Fourth Draft; Available at: https://www.researchgate.net/publication/228397191_The_economic_determinants_of_innovation , 15.12.2019
28. Phan K., (2013*). Innovation Measurement: a Decision Framework to Determine Innovativeness of a Company,* Dissertations and Theses; Available at: https://core.ac.uk/download/pdf/37767873.pdf , 15.12.2019
29. Pianta, M. (2004). The impact of innovation on jobs, skills and wages. *Economia e Lavoro*, *1*, 10-41.
30. Pianta, M. (2018). Technology and Employment: Twelve Stylised Facts for the Digital Age. *The Indian Journal of Labour Economics*, *61*(2), 189-225.
31. Piva, M., & Vivarelli, M. (2005). Innovation and employment: Evidence from Italian microdata. *Journal of Economics*, *86*(1), 65-83.
32. Pieroni, L., & Pompei, F. (2007). Evaluating innovation and labour market relationships: the case of Italy. *Cambridge Journal of Economics*, *32*(2), 325-347.
33. Rammer, C., (2016). *Measuring Output of Process Innovation at the Firm Level: Results from German Panel Data,* Blue Sky Conference; Available at: https://www.oecd.org/sti/127%20-%20Rammer_BlueSky2016_ProcessInnovationOutput.pdf , 15.12.2019
34. Ricardo, D. (1951). *The Works and Correspondence of David Ricardo;* Volume I, Cambridge University Press

35. Rogers, M. (1998), *The Definition and Measurement of Innovation,* Melbourne Institute Working Paper; Available at: https://melbourneinstitute.unimelb.edu.au/downloads/working_paper_series/wp1998n10.pdf , 15.12.2019
36. Selim N. (2013). *Innovation for Job Creation;*World Development Report; Available at: https://pdfs.semanticscholar.org/f0e4/14dccdcf4f2f65bebda5c7517d84cb607221.pdf , 15.12.2019
37. Smolny, W. (1998). Innovations, prices and employment: A theoretical model and an empirical application for West German manufacturing firms. *The Journal of Industrial Economics*, *46*(3), 359-381.
38. Spiezia, V., Vivarelli, M. & Piva, M. (2002). *Technological change and employment: a twofold theoretical critique and the empirical evidence.* Available at: https://www.researchgate.net/publication/254414522_Technological_change_and_employment_a_twofold_theoretical_critique_and_the_empirical_evidence , 15.12.2019
39. Steuart, J. (1966). *An Inquiry into the Principles of Political Economy,* first edn 1767. London: Routledge.
40. Toner, P. (2011). *Workforce Skills and Innovation: An Overview of Major Themes in the Literature.* Available at: https://www.researchgate.net/publication/241764313_Workforce_Skills_and_Innovation_An_Overview_of_Major_Themes_in_the_Literature , 15.12.2019
41. UNESCO Institute for Statistics, (2015). *Summary Report of the UIS Innovation Data Collection.* Available at: http://uis.unesco.org/sites/default/files/documents/ip37-summary-report-of-the-2015-uis-innovation-data-collection-2017-en.pdf , 15.12.2019
42. Valdalbero D.R. (2010). *Innovation: Creating Knowledge and Jobs.* Available at: https://ec.europa.eu/research/social-sciences/pdf/policy_reviews/innovation-creating-knowledge-and-jobs_en.pdf , 15.12.2019
43. Van R. V., Vertesy, D. & Vivarelli, M. (2015). *Innovation and Employment in Patenting Firms: Empirical Evidence from Europe;* Available at: https://www.researchgate.net/publication/280226886_Innovation_and_Employment_in_Patenting_Firms_Empirical_Evidence_from_Europe , 15.12.2019
44. Vivarelli, M. (1995). *The Economics of Technology and Employment: Theory and Empirical Evidence.* Aldershot, Elgar
45. Vivarelli, M., & Pianta, M. (Eds.). (2000). *The employment impact of innovation: evidence and policy* (pp. 1-216). London: Routledge.
46. Vivarelli, M. (2007). *Innovation and Employment: A Survey.* IZA DP No. 2621. Available at: http://anon-ftp.iza.org/dp2621.pdf , 15.12.2019
47. 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.
48. Weil D. N. (2013). *Economic Growth,* 3rd edition. Pearson Education Limited, England.
49. Westholm G., Bertrand T. & Tindemans P. (2003). *A statistical survey of R&D expenditure and research personnel worldwide.* Available at: https://unesdoc.unesco.org/ark:/48223/pf0000227217 , 15.12.2019

OTHER SOURCES

50. www.cepr.net, (n.d.). *Website of the Center for Economic and Policy Research;*
51. www.worldbank.org, (n.d.). *Website of the World Bank;*
52. www.oecd.org, (n.d.). *Website of the Organization for Economic Co-operation and Development;*
53. www.uis.unesco.org, (n.d.). *Website of the UNESCO Institute for Statistics.*