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ECON 4670 Paper - Automation and gender gap in the labor market

Introduction

Autor (2015) clarifies the myth that automation will create a laborless economy, but also introduces the idea that automation will lead to job polarization: routine and codifiable jobs will be replaced, severely reducing the demand for middle-skilled workers, while there will be greater need for high skilled labor in abstract tasks. The increase in productivity with automation would increase people's income in general and therefore, consumption which will indirectly increase the demand for low-skilled labor especially in the service industry, such as food and catering, travelling and etc. (Autor, 2015) Yet, as there will be occupational segregation by gender (Aramburu and Goicoechea, 2021), which means there might be more men in technical field and women in services industry and working different mixes of routine and cognitive tasks, automation might impact women and men differently as automation substitutes on particular tasks. Hence, this paper will study the effect of automation on women and men so as to understand if automation will widen the gender gap in the labor market.

Understanding the effect of automation on gender could help us better design and allocate resources to alleviate the cost brought by automation. It could help economies unlock potential productivity and labor forces by realizing the difference in genders and how it can complement with technologies.

Through reviewing various works of literature on related topics, this paper will first provide a brief summary of the current labor market and gender gaps, following by some possible reasons for occupational segregation. Then, there will be discussion on the effect of automation on males and females and attempts to explain whether the wage gap will be widened due to automation. This paper will end with a summary on the implications of the above analysis and

how authorities and institutions can better design their strategies to maximize their gains amid the automation and a better preparation for the next technological wave.

Discussion

I. *A review of current labor market*

Female labor force participation has been relatively steady in general, with an increasing trend for some high-income regions; but for low-income regions, such as India, there is a decreasing trend. (Figure 1) While some suggested that the female labor force participation rate has increased due to the increase in women's education level for some countries (Aramburu and Goicoechea, 2021; World Bank 2011), there is still an obvious gender gap in terms of employment, wage, and education. Many have argued that women remain in the low-pay and low productivity occupations while men are more dominant in technical or skilled jobs. For example, the World Bank's gender assessment report in India (2020) shows that women have a dominant presence in the low productivity sector, such as restaurants and other services sectors while men remain dominant in finance and business services sectors. Hence, we could see an overrepresentation of males in technical and skillful sectors; while in service sectors, there is an overrepresentation of females. Apart from the differences in jobs, it is found that women are less likely to be in the managerial position than males, resulting in a lower pay for females in general (Brussevich, Dabla-Norris, and Khalid, 2019). The differences in levels of roles could lead to the gender wage gap. A study from United Nations (2016) also asserts that women are paid less than men in general, even they deliver the same work with equal value through observing the ILO data[1]. To conclude, it appears that occupational differences result

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[1] The ILO (International Labor Organization) data is collected through household and labor force survey carried out by national statistics offices around the world.

in a gender wage gap and even employment differences, as women are less likely to enter male-dominated industries with better benefits.

II. Reasons accounting for the occupation segregation by gender

After recognizing there is indeed an occupational difference even before automation, it is important to understand why there will be such a difference so to help us better analyse if automation would further reinforce the differences or alleviate the segregation. The first possible reason could be differences in education received and skills developed. While female may outnumber males in obtaining higher education in the United States (Brussevich et al, 2018), they are underrepresented in STEM industries which help students build up stronger technical and mathematical skills. According to the OECD's research (2017), only 35% of the tertiary graduates in natural sciences or engineering were women. The share of women in tertiary graduates in computer was even worse, with only 20%. (ibid) Hence, women are unlikely to benefit from new job opportunities in engineering and tasks that involve advanced computer and mathematical skills which makes them more disadvantaged in the world of automation.

Scholars argue that stereotyping could be one of the reasons of occupational segregation. A study of UNESCO (2013) shows that people will genderise subjects, for example, STEM fields as masculine and human services as feminine. The gendered job idea reflects the traditional gender roles and perceptions which men's jobs are usually more technical and skilled which physical strengths are needed, women's jobs are considered as providing caring services or retail services which are also less skilled jobs. Jensen's research (2010) confirms the argument with her finding which women are more preferred in the services industry as such industries do not require physical strength and female has a comparative advantage in mental tasks.

Another reason why women would not consider joining certain industries is women's disproportionate share in family care responsibility that makes them inflexible at work. Schomer and Hammond (2020) found that one of the reasons why women leave the infrastructure jobs is the inflexible working hours which makes it hard for them to balance work and family obligations. Hence, we can see that the inflexibility could even drive women out of the labor force. A McKinsey's survey (2018) also shows that 42 percent of senior-level US women are unwilling to be top executive as they do not want to sacrifice their time in family care to work, compared with 35 percent of men, addressing the abovementioned situation which women are found less represented in the managerial roles. To conclude, the differences in skills and education, stereotyping and the inflexibility of women help explain the occupational segregation.

III.   _Effects on automation on gender_

a. _Employment_

As mentioned in the introduction, the literature suggests that automation will replace labor in routine and codifiable tasks. As a result, World Bank (2019) has estimated that automation will take over thousands of routine tasks and eliminate low-skill jobs. Hawksworth, Berriman, and Goel (2017), through their own automation algorithm which is built on top of the Frey and Osborne's study (2013)[2] to estimate how likely a job will be replaced by automation, also argue that low-skill workers, such as machine operators and assemblers, would be at least 60% of chances to be replaced by automation while more highly skilled workers, such as professionals, only face the possibility of being replaced of about 10%, further illustrating how automation targets low-skilled codifiable tasks. As women and men are segregated in different fields and

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[2] Frey and Osborn designed a methodology to study how likely a job will be replaced by automation by asking machine-learning experts at Oxford University to hand-labelled whether the tasks performed in a particular occupation could be automatable or not. Having a set of labelled features of an occupation, they can run a machine-learning algorithm to estimate and predict the possibility of the occupation being fully automated.

tasks, this paper argues that the two parties are affected differently. Yet, it is undeniable that both sexes will face the risk of automation and substitution. When it comes to women, the less educated women are likely to be replaced as they are usually employed in jobs concentrated in codifiable tasks that require low levels of education. (Brussevich et al, 2018; Brussevich, Dabla-Norris and Khalid, 2019). For example, Martinho-Truswell (2019) claim that in the United States, 94% of secretaries and administrative assistants who perform simple data-entry tasks and are considered as one of the riskiest groups, are female. On the other hand, males also face the risk of automation as automation takes place in male-dominated industries. One of the key benefits of automation is that it could replace human in performing tasks that are risky and require physical strength while these tasks are usually found in male-dominated fields, such as production, transportation, and construction (Frenette and Frank, 2020) Similar to women, low-skilled male workers are likely to be replaced. According to Hawksworth Berriman, and Goel (2017), men with low education levels would face an increased risk of being replaced by automation of 52%, which is even higher than that of the low-educated women (29%), mostly due to the types of occupations they are in, as men are most likely to be found in machine operators work and women are in service industries, such as cleaning.. In general, we could conclude that both men and women face the risk of automation. Yet, there has been a lot of discussion on whether males or females will suffer more from automation.

Apart from replacing jobs, automation also creates new jobs, for example, jobs like Artificial Intelligence and Machine Learning specialists do not exist before automation. Also, as suggested in Introduction, automation also creates the labor demand for service industry. Yet, statistics from World Economic Forum (2017) show that although women may face fewer job losses, they may also benefit less from the job gains compared to men, arguing that women will face a higher risk than men in general. Frenette and Frank's research (2020) also draws the

same conclusion: they argue that 44 percent of women in the paid workforce will face a moderate to high risk of automation-related job transformation compared with only 38.4 percent of the male when controlling for factors like characteristics, age, education level, and industry. Brussevich and his co-authors (2018) agree but state that different economies and sectors may have a slight difference. Reasons used to explain why women would face a higher risk are indeed similar to the reasons resulting in occupational segregation, for example, women work in more substitutable low productivity jobs than men. Roberts et al (2019) found that jobs with routine work, such as clerical support could account for 52 percent of women's jobs that have high automation risks in the United States and 5 European countries. As introduced in Section II, women have less technical skills and education in STEM fields. This indeed is a key factor that makes women more disadvantaged in the wave of automation. While automation creates more new job opportunities in fields related to STEM, these jobs will mainly go to men as women are not capable of handling these tasks due to the gender gap in education. World Bank (2020) warns with the example in Indonesia which Indonesian women are less likely to utilize technology than men as they lack knowledge. Furthermore, women lack flexibility with heavy family care responsibilities as illustrated above. Madgavakar et al (2019) estimated that about 40 to 160 million women might need to transit across jobs to maintain the current share of employment. Even though women do not have to change their occupations, they will still face a change in tasks performed due to the "partial automation" as automation replaces certain tasks within the occupation (Hegewisch, Childers, and Hartmann, 2019; Madgavkar et al, 2019; Madgavkar, Krishnann and Ellingrud, 2019). Yet, women may be unable to obtain training because of their inflexibility which may include heavy childcare responsibility. Cho et al. (2013) argue that women would find attending reskilling programs more challenging than men because of their family commitment. Another research also reported that women find family responsibility makes them less mobile and flexible in reskilling and changing occupations.

(Madgavkar, Krishnan, and Ellingrud, 2019). Being unable to obtain skills needed in the market makes women more vulnerable to automation.

While there are various evidence and claims in women facing a higher automation risk, some argued that men are in fact the party at risk. Sattar (2012) used the example in Europe and Central Asia which shows that the contractions in manufacturing sectors had more severe effects on men than women as men are more overrepresented in these sectors and women are benefited from the expansion in service sectors happening at the same time. Reasons supporting the argument can be categorized into 2 main aspects, occupational differences and skill differences. Looking at the occupational differences, male-dominated industries, such as construction, manufacturing, and transportation, are argued to be replaced dominantly while female-dominated occupations are growing in demand with the increase in income. (Hawksworth, Berriman and Goel, 2017) Meanwhile, women have largely benefited from the growing service sectors (Weinstein, 2017; Madgavkar and et al, 2019) such as education and health services. (Brussevich and et al, 2018) Considering the skill differences, men are generally less educated (Brussevich et al, 2018) and has lower skill level which makes them more substitutable in automation as highly educated workers are believed to associate with better abstract skills and hence, more productive and flexible to change jobs. (Frenette and Frank 2020; Hawksworth, Berriman and Goel, 2017) Apart from the educational differences, women are believed to have a comparative advantage in socio-behavioral skills, such as negotiating and empathizing, which will be in a high demand in the labor market after automation and hence makes women more preferred in labor market. (Guy and Newman, 2004) Moreover, the overrepresentation of women in education and healthcare also reflects that women are constantly involved in the roles that require emotional intelligence, communication skills, and relationship management. (Martinho-Truswell, 2019). These socio-behavorial skills

and interpersonal tasks are associated with the female-dominated roles which are also roles that automation technology finds hard to replace. (Frenette and Frank, 2020; Autor, 2015)

All in all, it is difficult to conclude which gender will face a higher risk of being replaced as we have seen that there are both increase and decrease in demand for male-dominated and female-dominated industries. Yet, we could see that both low-skilled male and female workers are facing a higher risk of being replaced. Moreover, while women are benefited from the growth of the low-skill yet socio-behavorial skills-intensive industries, such as healthcare, they may find difficulty in capturing the growth in need of the high-pay and technical-focused technology sectors, such as STEM fields due to their inflexibility in reskilling for the demanded skillset.

b. Wage

Combined with the above findings, this paper argues that there will be a widening gender wage gap because of the automation. We could see that most women gain in the low-pay works, such as the education field, while men are gaining higher income as they are more likely than women to enter the technical and abstract skill-based industries with their skillset and flexibility. In fact, the gender pay gap has long been explained by the occupational and sectoral differences, which these differences account for nearly half the gender pay gap in the United States. (Blau and Kahn, 2017) Hegewisch, Childers, and Hartmann (2019) also stated that while women may gain in the overall rates of employment, these employments mainly come from the low-quality and low-pay services works. At the same time, women will have trouble entering the male-dominated 'high pay high tech' jobs which are expected to grow under automation (ibid) The inflexibility of women which makes them difficult to obtain training and transition to new jobs could also deepen the existing wage gaps (Roberts, Parkes, Statham and Rankin, 2019). Hence,

it is argued that women, in general, will enjoy less in terms of earning than men under automation and hence widening the existing gender gap.

Implications and conclusion

From the above analysis, we can see that while there may not be obvious gender differences in terms of overall employment, the gender wage gap is very likely to be widened due to automation. While comparing the factors causing higher automation risks to the factors causing occupational segregation, we could find that the factors are mostly the same. As occupational aggregation takes place even before automation, it comes to the questions on whether occupational segregation results in differences in effects of automation on gender and if solving the problem of occupational segregation, in which women are overrepresented in the services industry while men are overrepresented in technical and labor-intensive fields, can help eliminate the effect of automation done on the gender gap in the labor market.

The research also shows the importance of placing female workers in quality work, as we can see that even women are employed, they may not be better off as there may be wage reduction in low-skilled work (Autor, 2015). In order to solve the problem, it is important to enable each side to acquire the skills needed. For example, encouraging and incentivizing women to enter the STEM field could solve the problem of skill differences. One possible solution could be ensuring females can get access to the information about STEM fields, such as the return of the skills, the networks, and job security. In Mexico, when girls were provided with related information, they showed a higher tendency to switch into male-dominated fields, including STEM (Schomer and Hammond, 2020). Jensen's research (2010) also shows once the perceived return on certain skills increased, women became more willing to acquire that skill. Moreover, women have been found to be increasingly opting into occupations that are more

insulated from automation risk (Brussevich, Dabla-Norris, and Khalid, 2019), proving the women's responsiveness to better job prospects. On top of that, it is essential to help women enjoy higher flexibility as it is the major hurdle for women to perform job transition from the low-pay job to a higher-pay job under automation. This is indeed an opportunity that comes along with automation, since technological advancements have enabled more flexible working arrangements. (Madgavkar et al, 2019). For example, the introduction of software, like Zoom meeting allows workers to work from home, taking care of both family responsibility and work. Yet not all jobs can be benefited from the abovementioned example. Manual jobs like catering services and cleaning services would not allow the "work-from-home" practices. Hence, other methods to enhance women's flexibility are needed, such as helping women ease the burden of childcare could make women more flexible too. The gig economy which offers a more flexible kind of work created with technological advancement also enables more women to participate in the labor force. (World Bank, 2019). Yet, better design and controls on these informal jobs are needed, such as the job security and benefits, to ensure women are participating in quality work.

Last but not least, while some argue that automation will eventually slow down as there is a bottleneck for developing new technology, there is reasonable concern about how far technology can go, as we are slowly seeing automation replacing simple cognitive tasks. (Frey and Osborne, 2013; Autor, 2015). In other words, more tasks could be substitutable and the demand for creative, abstract, and technical skills will keep increasing. It is of utmost importance to prepare the workforce with digital literacy in order to fully enjoy the benefits brought by automation.
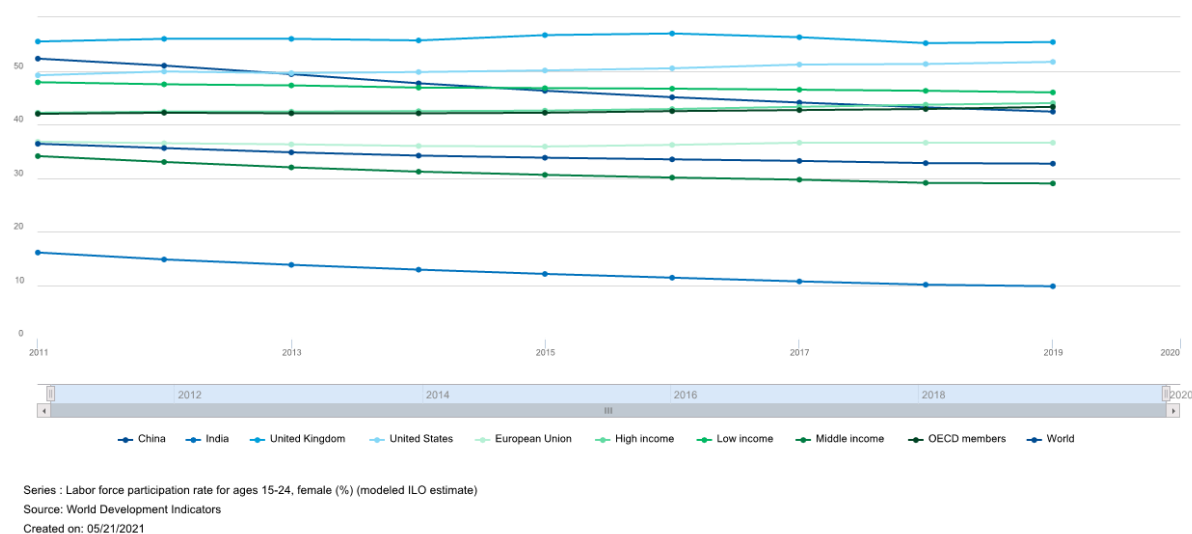
Appendix

Series : Labor force participation rate for ages 15-24, female (%) (modeled ILO estimate)
Source: World Development Indicators
Created on: 05/21/2021

Figure 1 – Labor Force participation rate, female (2000 – 2019). The World Bank Group.

World Development Indicator . (2021)

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