The Impact of Automation on Employment and Relevant Economic Solutions

I Introduction

In Greek mythology, Prometheus stole fire from the gods and restored it to humanity. This enraged Zeus to send Pandora, who later opened the box of evils, to live with humanity. Indeed, this myth of fire and box is remarkably close to the modern view of technology (Simon, 1981). Over the past half-century, machines have replaced a considerable number of manufacturing and transaction jobs, including secretaries, typists and switchboard operators (McKinsey Global Institute [MGI], 2013). With the emergence of big data and artificial intelligence, it is foreseeable that numerous mental tasks will be subject to automation gradually (Rifkin, 2005). Quantitatively, Frey and Osborne (2013) suggested that around 47 percent of US employment will be potentially automated within two decades. However, while technological unemployment in the short run may be undeniable, its result remains indeterminate in the long run, mainly because of insufficient economic data and specialized literature in modern automation (Leontief & Duchin, 1986; Scientific American, 2014). Is technology stealing fire from the gods, or opening the Pandora's Box? This paper will first delve into the major economic consequences of automation on labour employment in the short run and the long run respectively, followed by exploring some feasible solutions to reduce the negative consequences.

II Automation and Employment in the Short Run

In the short run, a higher degree of automation will inevitably lead to an increasing level of unemployment. To begin with, let Q, L and K be the quantity of output, total cost of labour and capital respectively. The necessary condition for a higher degree of automation is given by $\frac{\partial L}{\partial Q} > \frac{\partial K}{\partial Q}$. In the case of technological advancement, $\frac{\partial K}{\partial Q}$ decreases while $\frac{\partial L}{\partial Q}$

remains unchanged, leading to a reduction in the actual price level P_a. Thus, based on the new classical imperfect information model $u = u_n - a(P_a - P_e)$ (Lucas, 1973), unemployment rate u increases as technology advances. However, consider the aforementioned necessary condition for automation, it follows that the rate of change of technology and unemployment are non-synchronized since producers will not employ machinery if its operating cost is higher than labour cost (Ricardo, 1821).

When labour cost exceeds machinery operating cost, the first direct consequence is frictional unemployment (Keynes, 2003). For instance, a great improvement in speech recognition has caused the job of telephone operators to be completely computerized. Since this change is unanticipated in the short run, these unemployed people will enter the labour market and start to search for new jobs. They are likely to spend a considerable amount of time on reading advertisements, writing cover letters and attending interviews. Even in a communist economy, the government has to spend time on re-evaluating her central plan. The time period required to transit between jobs, i.e. frictional unemployment, is unavoidable to any individuals in any economy (Keynes, 2003).

Meanwhile, structural unemployment may develop as the second direct consequence (Orlandi, 2012). As the reduction in actual price level P_a implies a growth in the real wage $\frac{W}{P_a}$, there is a labour surplus in the traditional market, whereas a labour shortage appears in the emerging market. To restore the equilibrium, the nominal wage W has to adjust downward in the traditional market, leading to an increase in the relative wage in the emerging market. Nonetheless, according to the sticky wage theory (Keynes, 2003), workers are reluctant to accept any decline in nominal wages. Without any adjustment in nominal wages or government policy, the labour surplus will develop into structural unemployment probably.

III Automation and Employment in the Long Run

In contrast, it is doubtful whether automation will cause persistent unemployment in the long run. Firstly, it may be a fallacy, namely Luddite fallacy, to associate technology and employment in the long run (Krugman, 2013). As Simon (1981) stated, "The level of employment in a society has nothing to do with that society's level of productivity" (p. 70), and he supported his view by the fact that economists generally agree on the correlation between employment and business cycle (Faria, 2012; Keynes, 2003; Simon, 1981). Consider Hong Kong as an example – the unemployment rate remained stable at around 2.5 percent from 1981 to 1995 (Trading Economics, 2016), despite the mass relocation of domestic factories to the Mainland. On the other hand, the unemployment rate stayed high at around 6.5 percent from 2000 to 2005 (Trading Economics, 2016), which coincides with the period of the early 2000s recession.

Secondly, with a higher degree of automation, the compensation effects will operate in the long run (Humphrey, 2004). For example, automation requires a growth in capital stock, which leads to an increase in demand for maintenance service and brings about new jobs. Even though technology companies employ fewer workers directly as compared with dominant companies in the last century, they create a new ecosystem that generates jobs indirectly (Edwards, 2015). The advertisers on Facebook and sellers on eBay (Edwards, 2015) prove that existing jobs are not vanishing but being replaced by new forms of employment. In addition, automation increases human possibilities by lowering resource requirements. For instance, Brozen (1963) highlighted the possibility of a reduction in travelling time through the application of big data in traffic management. This will increase the amount of free resources, which can enlarge both sublime and mundane activities (Brozen, 1963).

Last but not least, the free market can probably adjust its short run supply to attain long run equilibrium. Since nominal prices and wages are fully flexible in the long run, the

invisible hand (Smith, 2013) may guide the traditional market to adjust the nominal wage W downward. This will lead to a redistribution of workers from the traditional market to the emerging market, which is likely to reduce structural unemployment. Furthermore, people will adjust their price expectations P_e downward to arrive at the long run equilibrium $P_a = P_e$. According to the aforementioned imperfect information model $u = u_n - a(P_a - P_e)$ (Lucas, 1973), the unemployment rate u will diminish to the natural rate of unemployment u_n. The economy has probably achieved full employment as unemployment rate cannot be zero due to the inevitability of frictional unemployment.

IV Solutions to Alleviate Technological Unemployment

Regardless of the duration of technological unemployment, the government is expected to alleviate this threat as continuous high unemployment will lead to a reduction in human capital. Apart from the traditional fiscal stimulus, one possible solution, which specifically targets technological unemployment, is the work-time reduction (Danaher, 2016; Gans, 2013). As technological advancement increases the real wage $\frac{W}{P_a}$, people can work for fewer hours while maintaining the same standard of living. Although workers may be unwilling to accept a decline in total wage, this problem can be lessened by distributing short term cash subsidy using the unemployment benefits which otherwise would have been paid (Gans, 2013). Also, people are generally risk averse and sympathetic, so they are likely to accept work-time reduction for no dismissal (Gans, 2013). Rifkin (2005) highlighted that the 35-hour work week law in France has created more jobs successfully.

While work-time reduction primarily creates jobs in the short run, the basic income (Gans, 2014; Danaher, 2016) focuses on a wider time horizon. In the long run, technological advancement will commonly result in an increase in aggregate output. The desire for economic growth is satisfied, and thus, the problem left will be the distributional problem

(Danaher, 2016). With the basic income, which is unconditionally distributed to all people on an individual basis (Gans, 2014), the distributional problem can be partially solved. Furthermore, as the basic income guarantees a basic standard of living, the wage is no longer the most important concern of people. Hence, people can choose from a wider range of occupations, which increases aggregate output and creates employment. Currently, no government has implemented a basic income scheme completely (Gans, 2014), but several similar welfare policies in different countries such as India still are worth the government's attention.

V **Conclusion**

Technology is similar to the Pandora's Box (Simon, 1981). Since the first industrial revolution, the possibility of technological unemployment has been a great concern among scholars and governments. Indeed, major improvement in technology, which increases the degree of automation, will inevitably lead to a higher level of unemployment in the short run, namely frictional unemployment and structural unemployment. However, through market adjustment and operation of compensation effect, automation probably cannot cause persistent unemployment in the long run. Nevertheless, to take out hope from the Pandora's Box quickly, the government should explore different possible policies to alleviate this threat. For this pragmatic reason, we need to conduct more research focusing on the impact of different policies on technological unemployment.

References

Brozen, Y. (1963). Automation, the impact of technological change. Retrieved from http://files.eric.ed.gov/fulltext/ED021995.pdf

Danaher, J. (2016). Will life be worth living in a world without work? Technological unemployment and the meaning of life. *Science and Engineering Ethics,* 1-24. Retrieved from http://philpapers.org/archive/DANWLB.pdf

Edwards, J. (2015, June 5). This idea that technology destroys jobs is garbage. *Business Insider UK.* Retrieved from http://uk.businessinsider.com/new-technology-does-not-destroy-jobs-or-create-unemplyoment-2015-6

Faria, J. R. (2012). Entrepreneurship and business cycles: Technological innovations and unemployment. Retrieved from http://academics.utep.edu/Portals/1890/wp3-2012%20Entrepreneurship%20and%20cycles.pdf

Frey, C. B., & Osborne, M. A. (2013). The future of employment: How susceptible are jobs to computerization. Retrieved from http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Gans, H. J. (2013). Work-Time reduction: Possibilities and problems. *Challenge, 56*(5), 62-73. doi: 10.2753/0577-5132560503

Gans, H. J. (2014). Basic income. *Challenge, 57*(2), 80-90. doi: 10.2753/0577-5132570206

Humphrey, T. M. (2004). Ricardo versus Wicksell on job losses and technological change. *Economic Quarterly - Federal Reserve Bank of Richmond, 90*(4), 5-24. Retrieved from https://fraser.stlouisfed.org/docs/publications/frbrichreview/rev_frbrich200404.pdf

Keynes, J. M. (2003). The general theory of employment interest and money. Retrieved from http://cas.umkc.edu/economics/people/facultypages/kregel/courses/econ645/winter2

011/generaltheory.pdf

Krugman, P. (2013, June 13). Sympathy for the luddites. *The New York Times.* Retrieved from http://www.nytimes.com/2013/06/14/opinion/krugman-sympathy-for-the-luddites.html

Leontief, W., & Duchin, F. (1986). The impacts of automation on employment, 1963-2000. Retrieved from http://files.eric.ed.gov/fulltext/ED241743.pdf

Lucas, R. E. (1973). Some international evidence on output-inflation tradeoffs. *American Economic Review, 63*(3), *326–334.* Retrieved from https://assets.aeaweb.org/assets/production/journals/aer/top20/63.3.326-334.pdf

McKinsey Global Institute (2013). Disruptive technologies: Advances that will transform life, business, and the global economy. Retrieved from http://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Business%20Technology/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx

Orlandi, F. (2012). Structural unemployment and its determinants in the EU countries. *Economic Papers, 455.* doi: 10.2765/26367

Ricardo, D. (1821). On the principles of political economy and taxation. Retrieved from http://www.econlib.org/library/Ricardo/ricP.html

Rifkin, J. (2005, August 3). Jeremy Rifkin on Europe's uncertain future: The end of work. *Spiegel Online.* Retrieved from http://www.spiegel.de/international/jeremy-rifkin-on-europe-s-uncertain-future-the-end-of-work-a-368155.html

Scientific American. (2014). Will work for machines. *Scientific American, 311*(2), 10. doi: 10.1038/scientificamerican0814-10

Simon, H. A. (1981). Special feature: Prometheus or Pandora: The influence of automation

on society. *Computer, 14*(11), 69-74. doi: 10.1109/C-M.1981.220253

Smith, A. (2013). An inquiry into the nature and causes of the wealth of nations. Retrieved from https://www.gutenberg.org/files/3300/3300-h/3300-h.htm

Trading Economics. (2016, April 28). Hong Kong unemployment rate 1981-2016. Retrieved from http://www.tradingeconomics.com/hong-kong/unemployment-rate