Will Robots Take Our Jobs?: The Effects of Artificial Intelligence on High-Skilled Canadians

by

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Abstract

With the forthcoming Artificial Intelligence (AI) revolution estimated to cause millions in job losses throughout all sectors of the economy it is important to consider the broader societal impact that worker displacement and worker transition will have. Several studies have investigated the projected experience of low-skilled workers and the impact automation is predicted to have on their employment prospects, however, very few have focused on the effects on high-skilled workers. This paper attempts to fill this gap by evaluating policies for mitigating the expected negative impact of automation and AI-based technologies on Canada's high-skilled workforce. Three policy options are presented which focus on retraining, portable benefits schemes, and maintaining the status quo. As AI is an ever-changing field of technology with capabilities not yet fully achieved this paper and the policy options presented within attempt to create proactive policies that will effectively address the negative labour market outcomes regardless of technological advances.

Keywords: Artificial Intelligence; Automation; Labour Market; Technological Unemployment

Table of Contents

List of Figures

List of Tables

Chapter 1.

Introduction

With the forthcoming Artificial Intelligence (AI) revolution estimated to cause millions in job losses throughout all sectors of the economy in both the short and long term it is important to consider the broader societal impact that worker displacement and work transition will have. According to experts within the fields of AI and labour policy, there are differing estimates as to what the extent of the problem will be with some claiming numbers as high as 50% of the labour force, while others claim only a mere 9% will face displacement (Morgan et al., 2019).

Jobs that were previously considered safe, such as those jobs with a heavy reliance on knowledge have been projected to be negatively affected. The McKinsey Global Institute has estimated that with ever-sophisticated algorithms, approximately 149 million full time knowledge workers could face possible displacement (MGI, 2013). One of the main objectives of this research, focusing particularly on high-skilled workers, is to fill a gap in the literature in which the impact of automation is often not discussed on this group as much. There is abundant literature on the effects of automation on low-skilled workers, but not high-skilled workers, even though high-skilled workers will still feel the effects of automation as this paper looks to discuss.

Within the literature surrounding the extent to which artificial intelligence will impact the labour market whether this be a positive or negative impact, the experts are roughly divided into two separate camps. According to a recent Pew Research Center report, the experts in the field of AI are divided into two separate groupings; the first being the optimists and the second being the optimists with respect to the future of AI (Pew Research Center, 2018). The optimists view AI as being able to create unimagined new jobs, increase productivity, raise incomes, and provide historically unparalleled freedoms for workers to choose multiple leisure opportunities. On the other side of the argument the pessimists view AI as being wholly different than any other previous technological revolutions wherein it will replace cognitive tasks and thus render much of current human occupations redundant leading to mass unemployment (Furman, 2016).

As the pre-existing literature notes, it is difficult to foresee what the future holds, whether the impact of AI will be positive or negative for workers within the market. This paper takes a more pessimistic approach with respect to the impact of AI for two reasons. Firstly, due to the value high-skilled workers derive from their occupations and the negative effect displacement would have on their self-worth and well-being. Lastly, it is important to take a more pessimistic approach with this subject matter and err on the side of caution so as to develop proactive policy options for the possibility of such a large-scale, transformative labour market shift.

The paper proceeds with an introduction of the two main arguments for and against AI, followed by an introduction of the implications of these technologies, specifically the economic and labour implications. Following this literature review, the two main methodologies are introduced with the primary and secondary findings being reviewed in chapter five. The portion of the paper following this introduces the. Policy options and the criteria by which they will be evaluated by, followed by the in-depth evaluation of each particular option. The three policy options presented within the paper are; retraining programs, portable social benefits, and the maintenance of the status quo. Lastly, there is a recommendation section which comprises of a recommended course of action in both the short and long-term for governments to undertake with respect to this particular policy issue.

Chapter 2.

Implications of AI

2.1. The Techno-Optimists vs. Techno-Pessimists

Regarding the impact of AI on the labour market, the discussion has been roughly divided into two separate camps on the future of work. The first camp has become known as the techno-optimists. The optimists see AI as creating unimagined new jobs, increasing productivity, in turn increasing real wages, and providing historically unparalleled freedoms to pursue alternative leisure activities (Furman, 2016; Goolsbee, 2018; CD Howe, 2017; Merchant et al., 2014). Two from the mentioned literatures, provide a much more nuanced perspective on the matter however, noting two important aspects that ought to be considered within the techno-optimists perspective. For Furman (2016), that while technology brings large benefits to the economy, at this point in time it ought to raise some concerns. Specifically, points are to the increasing income inequality across developed countries as well as the decline in labour force participation rate and the troubling slowdown in productivity growth as compounding on top of any potential negative implications the increased adoption of AI may have on a society. As the paper delves deeper into argument, there is the slowdown in labour productivity growth as troublesome as it then leads to lagging wage growth and when these factors are compounded on top of the potential labour displacement due to AI, societal unrest may prove to be a further issue for policy experts. Similarly, Merchant et al. (2014) presents a grey outlook similar as the capabilities of AI and robotics continue to progress, there will be fewer and fewer jobs that will be safe in the long run. As noted with the real possibility of widespread technological unemployment on the horizon, the adoption of AI technologies have the possibility to result in unacceptable individual and societal instability. However, these technologies also have the large positive benefit of enriching citizens' lives through the freedom from work that was previously not automatable.

On the other side of the debate are the techno-pessimists, who in summary, believe that AI is wholly different than any other previous technological revolutions. As seen through previous technological revolutions, cognitive tasks were not replaced, but in the AI-pessimist scenario these tasks are replaced and thus rendering much of current human occupations redundant leading to mass technologically induced unemployment. Many of the techno-pessimists are prominent leaders within the technology field such as Elon Musk (CEO of Tesla), Bill Gates (founder of Microsoft), and Stephen Hawking (theoretical physicist), with also many, many academic researchers in the field of AI and policy, tending to err on the side of caution when addressing AI issues as it is important to plan for the worst case scenario with respect to a technology of this scope (Morgan et al., 2019; Stiglitz & Korinek, 2017; Bruun & Dubka, 2018; Peters, 2017; Brynjolfsson & McAfee, 2011; Chui, 2016; Acemoglu & Restrepo, 2018; McNeal, 2015). Researchers within the field see AI as having the likely possibility of transforming almost all occupations to at least some degree. Moore's Law, which states that technology doubles every two years, the future outlook for AI's capabilities is positive within the technology field but is negative for workers who may have previously thought they were considered 'safe' from automation/computerisation (Morgan et al., 2019). Morgan et al., has estimated that the US labour market impacts, dependent on the specific scenario and rate of adoption of AI technologies range from approximately 9% to 50% of the US labour market. In nations other than the US, findings have been fairly similar with estimates from the German labour market finding that 59% of German jobs may be highly susceptible to automation (Brzeski & Burk, 2015). In the case of Finland, it was found that approximately 35.7% of Finnish jobs are at a high risk to automation (Pajarinen & Rouvinen, 2014).

One of the central concerns of the pessimists surrounds the issue of the rate at which jobs are displaced relative to how they are created. Historically speaking, when steam engines replaced horse drawn carriages, multiple jobs were created in the new industries that arose from the production of steam engines, operators of steam engines, etc. However, it remains to be seen whether this time will be wholly different or if it will follow the historical trends of job creation outweighing job displacement. Goolsbee (2018) is optimist by specific points to the historical track record job creation versus job displacement and the data from the previous 100 years that shows, that while yes, there has been significant displacement, structural unemployment has remained unchanged. As a counterpoint Bruun and Dubka (2018) views AI's rate of change as wholly different from previous General-Purpose Technologies (GPTs) because they were not subject to the same level of continuous progress as the field of AI is currently experiencing.

For companies, the choice on whether to implement algorithms, software, or any other labour-saving AI technology is clear. To begin, the price decline in the cost of computing over time has gone down significantly and has begun to create vast economic incentives for employers to begin to substitute it into their business model (Frey & Osborne, 2017). The same papers note that computers will hold a competitive advantage to human labour when there is a problem that can be easily specified, wherein the criteria for success is quantifiable and measurable and can be inputted/developed by a computer programmer (Frey & Osborne, 2017). Another large-scale benefit of AI relative to human labour is the inherent ability of software, algorithms, etc., to be able to work 24/7, don't require sick days, workers compensation, etc., and thus hold a comparative advantage in currently automatable professions (Merchant et al., 2014).

Furthermore, computerisation of professions hold two more benefits relative to their human counterparts. The first is the sheer scalability of AI relative to human labour. The second is, the absence of some human biases within software which is especially important within some occupations. In areas that are already implementing AI technology with the high-skilled professions such as fraud detection, software is able to 100% automate these jobs as they are able to comb through massive data set trends and provide an impartial lens by which to identify and flag possible fraud (Frey & Osborne, 2017). In the field of health care, AI software has assisted in diagnostics as it is able to compile massive data sets and algorithms on patient's history, family history, etc., to determine the best treatment plan for any given patient (Frey & Osborne, 2017). Lastly, another important implementation of current AI technology in the high-skill sector is within the legal field. In law firms, AI algorithms currently have an effect with respect to paralegals and lawyers wherein algorithms are able to scan thousands of law documents, identify patterns, and key words that are then able to be easily sorted through by humans to identify the necessary information. These three current examples highlight further the importance of AI within the domain of high-skilled labour and while it is currently not displacing workers to the extent that is predicted, it is augmenting and saving labour hours for workers to put towards non-computerizable tasks.

However, the timeline of these expected impacts have varied among experts in the field. Following a conference of experts surrounding the topic of AGI most of those surveyed foresee AGI as being available prior to 2030 (43%), with another quarter of respondents foreseeing it occurring sometime prior to 2049 (Makridakis, 2017).

Currently, there is a lack of existing literature on what exactly a technological revolution would do within the Canadian context. However, a recent Brookfield Institute research paper explored that question exactly and while it is not directly applicable to this analysis due to it incorporating all occupations (both low and high-skilled), it is interesting to note the facts and findings contained within it. The researchers find that the occupations with the highest risk of being affected by automation are retail salespersons, administrative assistants, food counter attendants, cashiers, and transport truck drivers (Brookfield Institute, 2016). Each of these occupations have an automation probability of 92, 96, 92, 97, and 79 percent chance of being automated, totalling nearly 1.7 million employees across Canada (Brookfield, 2016). On the opposite end of the spectrum, the top five occupations with the lowest risk of being automated are retail and wholesale trade managers, registered nurses, elementary/kindergarten teachers, early childhood educators/assistants, and secondary school teachers (Brookfield, 2016). As has been discussed already, the current technology makes jobs that are heavily rooted in non-routine cognitive tasks are much less likely to be automated than those focused on routine jobs that are easily broken down into distinct, repetitive tasks that are able to be replaced.

As discussed throughout this section there are two main differences within the literature with respect to the future implications AI will have on labour. The first camp, the techno-optimists focus on the positive impacts that AI will bring for high-skilled labour such as labour-efficiency, higher wages, and other general improvements within the workplace. On the other hand, the techno-pessimists focus on the negative impacts that are expected to be caused by AI such as labour displacement, increased wage disparity in the marketplace, and other negative socioeconomic consequences.

2.2. Implications of AI

The following sections will look to explore the implications that will coincide with the continual increase in adoption of AI technologies in the public and private sectors. The two main streams in which AI is expected to impact society is economically and more importantly, the labour force. The economic implications are expected to occur at both a micro and macro level. At the micro level, households can expect an increase in the quality of goods, ease of service, and a general lowering of costs of goods and services. At the macro level, national economies can be expected to achieve high levels of growth occurring due to the transition away from more labour-intensive processes towards more technologically focused production. Depending on the makeup of each nation's labour force, GDP growth may vary as will be explored in detail in the subsequent chapter.

With respect to the impact of AI on labour, there are two main effects that AI can be expected to have both positively and negatively, as will be discussed in detail later. As noted in the economic implications section, the impact on labour will vary across nations due to the differing makeup of the labour force within each nation. Those nations with a large number of low-skilled workers, will face greater displacement in the coming years and those with more high-skilled workers will face a relatively lower level of displacement. For Canada's high-skilled workforce, the effect will be lesser than for the lower skilled workers. However, these effects will largely depend on the rate of adoption of new technologies as well as how quickly technological advances will occur in the AI field. The following two sub-sections will look to explore in greater detail both the economic and labour implications that will result from artificial intelligence.

2.3. Economic Implications

The following section will further explore the implications of AI within the context of this research, specifically the economic implications that the advent of AI will bring to high-skilled labour. This section will look at how and why the use of AI has increased significantly in recent years as well as the global economic impact and the distribution of this impact across differing regions of the globe.

The economic implications of AI technologies are a major factor when discussing the extent of the impact that they will have on the future of nearly all global economies. The recent explosion in the advancements of AI technologies is due to three related developments: (1) an extreme drop in the costs of computing and the ability to store large amounts of data easily, (2) the widespread adoption and development of the internet and digital communications that has allowed for the creation of large data sets, and (3) a significant drop in capital costs for start-ups making the development of new technologies much less costly (Ernst, et al., 2018). The convergence of these three factors in the development of AI technologies has led to a significant increase in AI patent applications across the globe and the continual development of AI technologies across nearly all industries. AI patents have been on the rise worldwide with a 6 percent average yearly growth between 2010 and 2015, which is higher than any other patent categories measured which further highlights the importance that is being placed on researching and developing these technologies for the market (Szczepanski, 2019).

The majority of current research has indicated that AI will have significant effects on the economy. As indicated, in 12 developed economies, it has been estimated that AI could double annual global economic growth rates (Szczepanski, 2019). The claim that Ai could double annual global economic growth rates is supported by three main reasons. Firstly, AI will provide for a strong increase in labour productivity due to its increases in providing on the job efficiency. Secondly, it will create an AI workforce so to speak, that will be capable of solving problems on its own while simultaneously having the capability to self-learn. Lastly, there will be benefits reaped from the "diffusion of innovation, which will affect different sectors and create new revenue streams." (Szczepanski, 2019, p. 3).

On a global level it has been estimated that GDP could increase by nearly 14 percent in 2030 due to the effects of AI, which in dollar terms is equivalent to approximately $15.7 trillion (PwC, 2018). The substantial potential impact that AI is expected to have on the global economy can be mainly attributed to labour productivity improvements (~50% of GDP increase) which will increase sharply in the short-term and then begin to slowly plateau over the years modelled (PwC, 2018). The majority of the increase is from labour productivity gains followed by product personalisation, time savings, and increase in product qualities.

The impact of AI on GDP varies across geographical area as well, mainly attributable to national economic output and the differences in labour force composition (skilled vs unskilled). The two regions that will experience the greatest growth in GDP are China and North America (Canada and USA) who will experience gains of $7 trillion and $3.7 trillion, respectively (PwC, 2018). In explaining the significant effect on both the US and Canada, the main, positive factors associated with the high growth rate is due to both "advanced technological and consumer readiness for AI...enabling a faster effect of AI on productivity and overall larger effect by 2030." (PwC, 2018, p. 48).

The economic effects of AI discussed throughout this section highlight the largely positive effects on macroeconomic growth, however, it ignores the micro-level effects the adoption of AI will have on the workers within these countries. The following section will look to explore the specific effects on labour that have been predicted thus far on a more general level. The specific case of Canada's high-skilled workforce which this paper looks to explore in detail will be shown in the results section of the analysis.

2.4. Labour Implications of AI

This section will look to review some of the pre-existing literature on the matter and outline the labour implications that AI is expected to bring.

When it comes to the impact of AI on labour or technological innovations more broadly, there are two main ways in which it can affect employment. The first being known as the "displacement effect" (Petropoulos, 2018) in which workers are directly displaced by technology that they had previously been doing. The second main effect that technological innovation can affect workers is known as the "productivity effect", which is a much more positive effect that innovation can have on labour in which there is an increased demand for labour in particular industries due to a change in the process spurred by technology (Petropoulos, 2018). The main concern within this research is with respect to the displacement effect as worker displacement has profound societal and economic implications that ought to be address through policy solutions. It has been observed that in past industrial revolutions in the "short run the displacement effect may dominate. But in the longer run, when markets and society are fully adapted to major automation shocks, the productivity effect can dominate and have a positive impact on employment." (Petropoulos, 2018, p. 121). However, the main concern as has been discussed earlier within this paper is that this AI revolution may be highly different than the ones previously observed in the late 18th and early 19th centuries as the pace of change and scale of the technology is wholly different than those that have come prior. The McKinsey Global Institute has compared the rate of change of the AI revolution to that of the Industrial Revolution and has estimated that the changes occurring in present day are occurring at a rate ten times faster and at three hundred times the scale of the

Industrial Revolution, signaling profound implications for the labour market (Dobbs, Manyika, & Woetzel, 2015).

The European Union (EU) conducted a study recently in which they also studied the patterns of previous industrial revolutions and found that job destruction is much more likely in the short and medium term, however, in the long-term job creation will be of greater likelihood (Szczepanski, 2019). One important caveat of note is that the job destruction and creation does have the potential to “increase inequality, push down wages, and shrink the tax base” (Szczepanski, 2019, p. 1). The potential for wage decreases in conjunction with increased inequality for workers is cause for concern by governments. Governments have already been grappling with rising socioeconomic inequality and with the potential for AI to compound upon this effect in the short and medium terms, there ought to be ever more careful policy solutions crafted to alleviate any issues that the increased adoption of AI-technologies may bring to the labour force. The increased inequality that may be brought by the onset of ever-greater adoption of AI technologies has the possibility to lead to what is known as the ‘paradox of plenty’. The paradox of plenty is a scenario in which “society would be far richer overall, but for many individuals, communities and regions, technological change would only reinforce inequalities.” (Szczepanski. 2019, p. 7). This paradox will be caused by both the productivity effect and the displacement effect mentioned earlier within this section in which workers are more productive due to technological advancements, however a large swath of workers are also displaced due to technology. In the international context, these impacts will not be distributed equally across nations, with the World Bank estimating that developing countries are at a high risk of displacement with 69% of jobs in India, 72% in Thailand, 77% in China, and 85% in Ethiopia (Ernst et al., 2018, p. 3). Shifting the focus back to the Western world, the changes in skill sets required and the future preparedness of nations for technological change will largely depend on the policies implemented within these nations. Between 2016 and 2030, there will be a large shift in skill sets for both the United States and Western Europe (Ernst et al., 2018, p. 19). There will be a significant increase in demand for technological skills, which will be an important point to note within the development of policy options later within this paper.

Chapter 3.

Policy Problem and Stakeholders

The chosen policy problem is, given the rise and expected future adoption of AI related technologies expected to severely disrupt the labour market, it is incumbent upon policy researchers to develop and analyze policy options that will effectively alleviate the projected displacement workers may face. In both the short and long term it is important to consider the broader societal impact that worker displacement and work transition will have on employees across all occupations, in this case specifically, those in high-skill occupations. Furthermore, as discussed previously, AI will largely have a two-pronged effect with the first focusing on the economic effects and the second focusing on the labour market impacts. As discussed in the preceding sections, the economic impact is largely expected to be positive as technological progress historically brings about greater productivity growth, real wage increases, and overall GDP growth. However, the negatives arise when discussing at what expense these gains occur, specifically with the displacement of workers who are replaced by AI. Besides causing unemployment, possibly large-scale unemployment at the hands of AI will have broader, negative societal impacts that are associated with higher levels of unemployment such as crime and a greater burden on the social programs provided by the government.

The most important stakeholders within this policy problem are the private citizens/workers who will be negatively affected by the further advancement of AI technologies within the workplace. It will be of the utmost importance to attempt to determine both the short and long-term possibilities of technological unemployment with respect to these high-skill workers.

Likewise, the firms who purchase and implement AI-related technologies will be an important stakeholder to consider within the analysis as they will be one of the main drivers impacting the scope and nature of AI-induced unemployment.

Lastly, Employment and Social Development Canada (ESDC) will be another important stakeholder to consider within the analysis. With many of the policies that will be considered throughout this analysis relying heavily on an involvement of social welfare programs. Furthermore, ESDC may be negatively impacted if the expected labour displacement is large in the short-term as they will be overloaded with demands to assist in alleviating the possibly large labour market disruption. As they will be the lead agency to handle any negative impacts associated with the disruptive nature of AI technologies, it is necessary to consider them as an important stakeholder within this analysis.

Chapter 4.

Methodology

In this research two methodologies are employed to first develop results of the effect of automation on Canada's high-skilled workforce, and secondly to confirm the findings of the primary methodology by drawing on studies conducted in comparable jurisdictions. The information sources for this methodology are Frey and Osborne (Frey & Osborne, 2017) and all the indications given by the authors' names in 4.1 are from this reference. Frey and Osborne developed this blueprint through the use of an algorithm to assign estimates of the risk of automation on a scale from 0.0 to 1.0 (0% risk of automation to 100% risk of automation). This methodology is further explained through section 4.1, with the list of high-skilled jobs, their risk of automation, the number of Canadians currently employed, and their average annual salary fully listed in appendix a. The secondary methodology seeks to support the findings of the primary methodology's results through the use of an analysis conducted in similar jurisdictions to Canada to provide a confirmation of the primary findings for Canada.

4.1. Primary Methodology: Automation Risk Analysis

The primary methodology being used within this research employs a previous blueprint developed by Oxford academics Frey and Osborne who established an algorithm in which they calculated the probability of an extensive list of occupations to be automated in the next ten to twenty years. Frey and Osborne's initial blueprint was employed in an analysis of the USA's labour market to assess its risk of automation and has subsequently been employed by academics and researchers in other nations to estimate the effects of automation. When it comes to the work done by Frey and Osborne, there are a few factors when it comes to discussing the risk probability of the given jobs. Firstly, there are three main bottlenecks that current automation cannot overcome, in which the technology is not readily able to automate such as perception and manipulation, creative intelligence, and social intelligence. For each of the jobs listed, they assessed how it involved any of the three given bottlenecks and scored the risk probability as such. In addition to the previous approach, there was also a subjective scoring of a portion of these occupations judged based off of job descriptions and task compositions of the given occupations in cooperation with machine learning researchers who are experts within this field. Within this study in particular, there are some pre-requisite steps required to effectively employ this initial blueprint for Canada's high-skilled workers. As there was already a set of occupations with their respective American job classifications codes, known as a Standard Occupational Classification (SOC) codes one of the first steps was transferring this to a Canadian context. The first step in developing a proper data set to estimate for Canada, was transferring all of the occupations and their SOC codes to Canada's job codes known as National Occupation Classification (NOC) codes. As not each SOC code could be transferred 1:1 with an NOC code it was required to find the NOC code that best fit the pre-established SOC code. After transferring each job to their NOC code, multiple sources were drawn from the Statistics Canada database, as the dataset could now be effectively employed. The Statistics Canada information that was required to be drawn from was, first, the NOC list of occupations with their respective current employment numbers for Canada as well as their respective average annual salary to get a rough estimate of what jobs were affected in terms of pay. Furthermore, as this research is focused specifically on the impact on high-skilled workers, it was necessary to sort out the occupations that were not considered high-skilled under the NOC database. According to the Government of Canada's five different skill level classifications, three of the five were considered to be high-skilled. Skill level 0, A, and B, all of these classifications exclude jobs that require a basic high school education or formal on the job training.

With respect to the use of Statistics Canada data as well as Frey and Osborne's likelihood of computerisation of occupations data, the numbers presented within the findings may present an over-estimation or possibly an under-estimation of real-world results. Due to the nature of the field of AI being ever-changing, the results of the research may be inaccurate in the long-term as new developments occur. However, the data availability and findings will provide a useful estimation of impacts in the development of policy options.

4.2. Secondary Methodology: Jurisdictional Analysis

The secondary methodology of this research is focused on attempting to confirm the findings of the primary methodology through the analysis of estimates in academic research that occur within similar jurisdictions. After reviewing the results that have been observed in similar jurisdictions, a greater perspective on the extent to which automation will affect the labour market will be established. The two countries that will be looked at for confirmation of the primary findings is the United Kingdom and the United States. These two countries are excellent representatives for Canada’s circumstance as they both have fairly similar economic makeups and close social and economic ties. While the USA and UK differ with Canada on the basis of the size of their economy and size of their population, they still provide for a useful estimation to provide a rough confirmation or disconfirmation of findings. Each of the results for the UK and the US will draw from more than one study so as to provide greater validation of the findings for each country observed.

Chapter 5.

Findings

5.1. Automation Risk Analysis Findings

As noted within section four in the overview of the methodology, the primary analysis of this research is based on Frey and Osborne's (2017) research in which they calculated the risk probability of automation for nearly 700 occupations. The work with respect to the risk probability of these 700 jobs are for the next 10+ years which allows for short term and long-term impacts of AI technology on high-skilled jobs. The job list used within these findings is drawn from Frey and Osborne's list, with the non-high skilled jobs filtered out of the list and applied within the Canadian context. Furthermore, the average salary, and number of jobs currently at risk is drawn from the Statistics Canada publicly available database.

When attempting to ascertain which jobs from the Frey and Osborne list were high-skilled and which ones were not, the Statistics Canada NOC system for job classifications is consulted. Due to the Frey and Osborne listing originating in the United States, the first step is converting the Standard Occupational Classification (SOC) codes to the Canadian classification system so data on salary, employment, and skill type could be developed more efficiently.

The approach Statistics Canada takes for classifying jobs within the NOC system is fairly straightforward. As NOCs are composed of four digits, the first digit of the entry corresponds with the skill type category such as management occupations, health occupations, occupations in manufacturing, etc., from 0 to 9. The second digit of the four digit sequence corresponds with the skill level category which is divided into four separate skill categories: skill level A, B, C, or D. Skill level A is composed of 0 or 1 as the second digit, skill level B is composed of 2 or 3, so on and so forth. For the purposes of this analysis, skill levels A and B were the only ones that were applicable for high-skilled workers. Skill level A represents professional jobs that require a University degree at minimum. Skill level B are defined as technical jobs or trades that require a college diploma or sometimes, apprenticeships. Out of the initial 709 jobs and their corresponding risk probabilities of automation, over half (453 jobs) met the criteria, providing a solid foundation for analysis of the Canadian job markets transformation that can be expected over the next 20 to 30 years.

The 443 jobs compiled range from Financial Managers to Pharmacists and Insurance Underwriters. When assessing briefly some descriptive statistics for this set of jobs, on average they have a 0.436 risk probability (43.6% chance) of AI-induced job displacement. This may seem high as the range in values of risk probability are quite extreme across the job set with the lowest risk probability provided for Recreational therapists who have a corresponding value of 0.0028. On the other end of the spectrum however, Insurance underwriters, mathematical technicians, amongst a handful of other professions have a 0.99 risk probability of automation, all but ensuring job loss for those employed in these professions. Furthermore, the skewness of this risk probability data is merely 0.14 representing a fairly normal distribution of risk probability for the high-skilled jobs measured. As well, the kurtosis contains a value of -1.62 implying that the distribution of these probabilities is a fairly flatter distribution than that of a normal distribution.

The sum total of jobs that are included within this high-skilled category is 8,118,730. While these 8 million jobs are not all affected in the same manner, this number provides a rough estimate to further highlight that this impact is far-reaching across the Canadian high-skilled labour market. This number represents approximately 40% of Canada's total labour force of just over 19 million total, encompassing a wide-range of occupations across all different sectors of the economy. Table 1 helps to further highlight the diversity of jobs affected and the wide-ranging 'safety' of jobs from AI ranked from greatest risk probability to lowest.

Table 1. Job Occupation Risk

Risk Probability	Occupation(s)
0.90+	Insurance Underwriters, Mathematical Technicians, Title Examiners
0.70-0.79	Carpenters, Broadcast Technicians, Civil Engineering Technicians
0.50-0.59	Court Reporters, Commercial Pilots, Personal Finance Advisors

0.40-0.49	Economists, Judicial Law Clerks, Physical Scientists
0.30-0.39	Upholsterers, Surveyors, Surgical Technologists
0.20-0.29	Financial Analysts, Statisticians, Epidemiologists
0.0028-0.19	Nuclear Engineers, Mathematicians, Civil Engineers

Across the 400+ jobs measured within the data set, another factor taken into account is the income groups across the ones measured. For the sake of convenience, the jobs were divided into three income sub-groups representing low, middle, and high-income groupings. As these are high-skilled workers, the income groupings were adjusted to reflect the high-income nature of these occupations and as such the groupings are as follows: Low-income <$49,999, Middle income $50,000-$99,999, and High income >$100,000. As figure 1 shows, the majority (57%) of jobs are grouped into the middle-income category, a third in the low-income category (33%) and only 10% of jobs are contained in the high-income category.

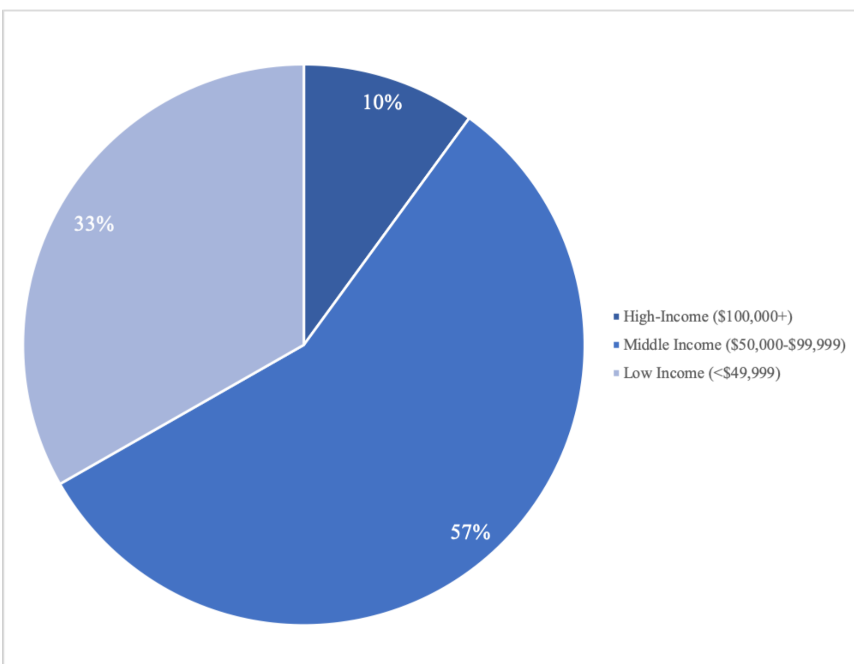

Figure 1. Income Bracket Make Up of High-Skilled Workers
Source: Statistics Canada (2016) & Author's Calculations

It is important to note that these results are for the average income for the respective occupations, and not representative of the upper or lower quintile salary of these positions. When computing the descriptive statistics for the incomes across the 400+ occupations, the mean salary is $63,424. The lowest average salary for all the high-skilled positions contained within this job set is $10,275 whereas the highest average earners earn an average yearly salary of $228,412. The minimum and maximum average salaries represent sports officials and Judges (magistrate judges and magistrates included), respectively.

In figure 2, many of the jobs included within the analysis face a much lower risk. However, the distribution of at-risk occupations is much higher with many jobs facing greater than a 50% chance of automation.

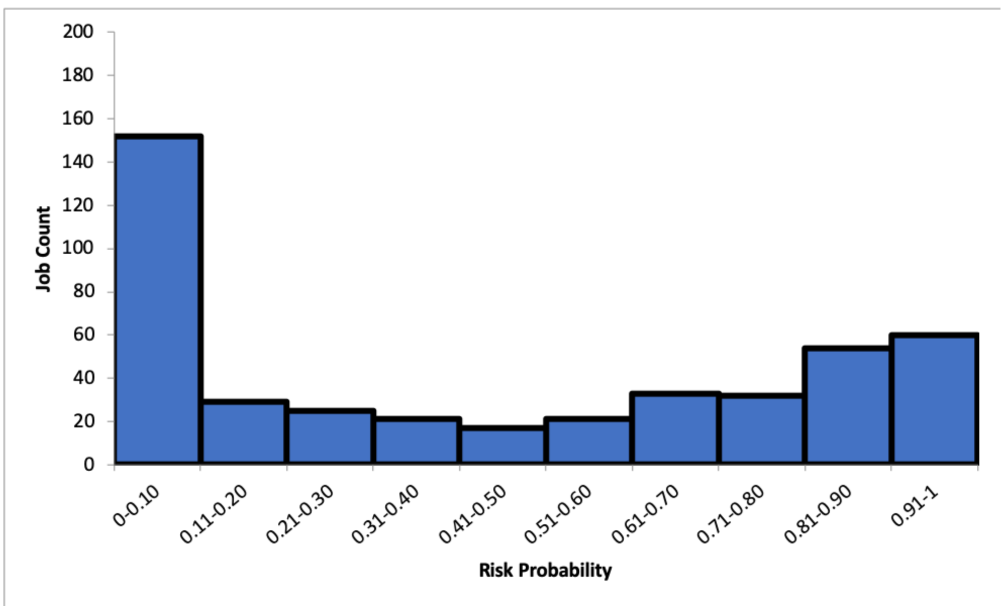

Figure 2. Occupational Risk Probability
Source: Author’s Calculations

As shown in figure 2, many of these occupations face a much lower risk of complete automation, than some at the higher end of the spectrum, however, this does not mean that some of their current occupational responsibilities will not be automated. As automation and AI-based technologies continue to develop and expand, more and more of these occupations will face a greater risk of having the majority of their tasks automated. As this risk probability only estimates the likelihood of complete job automation, and not a percentage of tasks performed within the workplace, some of the workers on the lower end of figure 4 may still feel the effects of AI technologies in the coming years.

Throughout the analysis of these findings it has been shown that a wide range of occupations are at risk of automation across a range of salary levels for high-skilled. While there is a fairly significant amount of workers who face a much lower risk, it is important to reiterate that the model adopted here for the Canadian context is an occupation-based risk framework in which the risk probability represents the likelihood of an entire job being automated, not a particular task, which does lead to some variance in results relative to task-based risk analysis in other jurisdictions' literature. These preliminary findings however do present a strong argument that even for high-skilled Canadians, the negative effects of automation ought to be addressed through proactive policy solutions to combat any negative socioeconomic effects that may arise from large-scale technological unemployment.

5.2. Secondary Methodology Findings

This section provides an overview of analysis of the effects of automation on the labour market within the United Kingdom and the United States, in order to fully emphasize the negative effects, the potential for automation has in comparable jurisdictions.

5.2.1. Projected Impact on the United Kingdom

The following section looks to explore the recently introduced plans by the government of the United Kingdom (UK) to address the rising threat of automation. As has been discussed throughout this paper, the threat of automation is an issue that ought to be addressed due to the socioeconomic impacts it will have at the micro and macro level. For workers, the effects will be felt most harshly as they derive value from their careers. Specifically, when high-skilled workers such as the ones analyzed throughout this paper spend a large portion of time and money training for their careers, the value they place on their jobs is high.

According the United Kingdom's Office for National Statistics (ONS), the effects of automation are, as this paper has argued, expected to be profound and widespread across the labour market. A recent report published by the ONS highlights the importance of action and further reinforces the findings put forward by the findings in the primary methodology with approximately 25% of jobs requiring a degree or above to have a medium risk of automation (ONS, 2019). Furthermore, many of the findings of this report by the ONS align with what has been discussed throughout this paper, namely, that it is not just low-skilled workers that will be negatively impacted by the expansion of AI-related and automation technologies. While the probability of automation for high-skilled jobs in the report highlight the disperse nature to which jobs will be affected, the negative impact is strong for certain jobs. While jobs that focus on computer programming skills, scientific research and development, and related fields will be relatively safe according to the ONS's predictions, other jobs may not be. A common theme throughout this recent report and throughout this paper is that jobs that heavily involve critical thinking and human interaction will be much more secure than those that centre around repetitive processes such as data entry. While skill and education are both important facets of this discussion surrounding the impact of automation, another factor that plays a role according to the report is age. The ONS report breaks down the probability of automation across age groupings with younger workers having a much higher risk of automation than older workers. The workers who are in their prime working age (20-40 years old) have a much higher risk of automation (medium to high risk) than those above that age range. The report notes that this could possibly stem from workers learning more skills and abilities as they are on the workforce longer, however it is not entirely clear (ONS, 2019). Further supporting the ONS's findings with respect to the UK, is a report also published in 2019 by Deloitte which highlights the negative impact of automation on the UK labour force. This report also supports the findings that those even with higher education are not entirely safe from automation, however, this is highly dependent on the skill sets that these educated workers have. Specifically, those with digital know-how, creativity, and problem-solving skills are much safer than those who have not developed these critical thinking skills that are presently safe from automation (Deloitte, 2019). The combination of the reports by the ONS and Deloitte further emphasize the importance of taking steps to address the negative impacts automation pose to the labour market and as further described in the following paragraphs, the UK Government's steps they are taking to proactively address the issue.

As part of the 2018 autumn budget, the UK government announced £100 million for the development and deployment of their national retraining scheme that aims to retrain adult workers, particularly for those negatively affected by automation. The £100 million initially announced is intended to further the testing phase, the first part of the scheme, and to assist in retraining, in six specific areas across the UK. The scheme is part of the government's broader strategy to increase productivity across the UK.

This particular scheme that the UK government has developed currently has four specific criteria by which to initially support adults as it is rolled out across the country and further developed. The adults who are displaced from their jobs must meet the following four criteria: already in work, aged 24 or above, do not have a degree, and are paid below a certain wage threshold (the current threshold is being tested with lower to medium wage people as the program develops) (UK Government, 2018). The government of the UK has targeted this particular group first as they "have comparatively less access to existing government support and are most in need of adapting their skills so they can take advantage of new opportunities" (UK Government, 2018). While the reasoning behind the targeting of this particular group differs from the aim of this paper (low skill vs high skill workers), this program can be easily adapted to expand its scope and target groupings to include all workers who are affected by automation, and thus be applicable to the policy problem presented throughout this research.

The national retraining scheme has three main objectives that they have identified as being of the greatest priority: 1, to support people already working to transition into better jobs through training and support, 2, to complement existing programs, and 3, to encourage people to be resilient in the new economy and take advantage of opportunities presented to them. The government in the UK recognizes the future issues that will be associated with the continued advancement and implementation of automation and AI-related technologies and thus has begun to roll out the program across the country. Furthermore, the government recognizes the need for workers to be multi-skilled to adjust to the new and emerging jobs, and to adapt to the new opportunities that the future will hold in the economy.

At the time of the announcement, the government had also considered many other challenges that currently face workers in the labour market. Some of these issues include the barriers to retraining, whether that be the financial cost, the mismatch between training at the jobs that will be available, and previous experience in receiving education that had been negative. Not only did they consider issues with previous retraining initiatives, they also considered that at this point in time, people will tend to have longer lives in the labour market and will need to be able to upskill or transition out of jobs dependent on labour market trends and the impact of automation. The UK has also experienced low productivity growth within their economy, which the new retraining scheme seeks to address through the improvement of skills, and having workers and businesses alike work alongside new and emerging technologies instead of merely being displaced by them.

When these workers engage with the UK's national retraining scheme, they will experience a digital service that will allow workers to understand what their skills are at the present and what some alternative avenues they make take to transition to different occupations as well as present them with the appropriate opportunities to develop these skills. Furthermore, in conjunction with this they will receive support from advisors who will assist them in their new career path and provide guidance and understanding of how best to use the new program.

While this program is currently specifically targeted at low-skilled adults, the applicability to Canada's high-skilled (and low-skilled) workforce is there, as it would allow for Canada to be a leader in retraining programs, specifically targeting the negative effects brought about by automation. Furthermore, the program in the UK involves multiple agencies as well as business organizations to develop a strong, comprehensive partnership. This partnership includes the Department for Education, the Treasury, the Confederation of British Industry, and the Trades Union Congress. The involvement of all these agencies and groups allows for a comprehensive plan that recognizes the needs of businesses while balancing that with the needs of workers to create an effective program that will plan for the future

The development of this strategy in the UK aligns with the primary methodology's findings that the threat of automation is in fact real and ought to be addressed. It ought to be addressed so that workers are not displaced in mass without a new job to transition into, are not unemployed for sustained periods of time with no skills for the future economy, and do not simply abstain from being an active member of the labour market. Of course this is not simply an economic argument that workers should simply be employed, it is also a social argument insofar that when society experiences high levels of unemployment, social programs, health programs, and the police are all strained due to the negative externalities associated with high levels of unemployment.

5.2.2. Projected Impact on the United States

Canada's proximity to the USA and highly connected economies provide an excellent comparable example as to the impact automation will have on the labour market. Thus, studying the estimates of automation on the US labour market will further support the findings discovered in the primary methodology for Canada's high-skilled labour market.

A recent study by the Brookings Institution, an American think tank estimated that a quarter of current US employment (or 36 million people) are estimated to face high exposure to automation in the coming decade (Brookings Institution, 2017, p. 31). As each particular occupation is made up of a particular set of tasks, the report came up with an estimate for how much of the current task content is at risk of substitution by currently available technologies and they found that greater than 70% of the current task content is at risk with currently available technologies (Brookings, 2017, p. 31). When looking at jobs that are ranked as having a medium level of exposure to automation, the numbers are, as expected, more significant with 36% of current US jobs (or 52 million people) subject to automation by 2030 (Brookings, 2017, p. 31).

Subject to greater importance and relevancy with this papers focus is the impact on more highly skilled workers, particularly those workers with advanced education whether it be a Bachelor's degree or above. With respect to the American job market, those workers who currently have a Bachelor's degree or higher, face a minimum automation exposure level of 29% (Brookings, 2017, p.35). While this number is lower than the overall level discussed earlier within this section, for those with a University degree who are typically facing a lower exposure, this number is fairly significant. When taking a deeper dive into the relationship between educational attainment and the automation potential of particular jobs it appears that those with some college face a greater exposure (45%), those with a Bachelor's degree face less (31%), and those with a graduate or professional degree face much less, at a rate of 25%. As expected, it appears that as one increases their educational attainment the rate of exposure to automation slowly decreases. This result is similar to the findings presented earlier within the primary methodology, as well one particular example of occupation presented within the Brookings' findings is that legal occupations, a profession centred around years of training and a highly professional atmosphere face nearly a 40% risk of automation for all legal occupations (Brookings, 2017, p. 34). This is similar to the results presented in earlier sections wherein, high paying jobs such as those found in the field of law, face a high risk of automation, regardless of their educational attainment. This is interesting to note as an exception to the upwards linear relationship regarding education and occupational safety, as not all jobs and fields follow a similar trajectory as noted here.

Another report, as McKinsey (2017) further emphasizes the findings presented by the Brookings Institution as well as the primary methodology findings of this research. It is estimated on a global scale that as many as 375 million people or 14% of the entire global workforce would likely need to transition to different occupations. Furthermore, 50% of current working activities are automatable with approximately six out of ten jobs having at least 30% of their activities that are able to be automated with current technologies. Within the US in particular, the McKinsey's midpoint estimation scenario has approximately 25% of its total workforce activities able to be automated at this point in time, a slightly lower estimate than the Brookings approach, however, it is only a midpoint scenario estimate. For high-skill workers, it is found that they engaged in activities such as software engineering and electrical engineering will be relatively safe due to two main factors. The first factor is that these positions in particular are safe from current automation technologies and secondly are occupations that will work most closely in the development, deployment, and maintenance of current and future automation technologies. One important facet to note that this report discusses and has been a common theme/issue throughout this research is that with the displacement possibilities, if the transition to new jobs is slow, unemployment will more than likely continue to rise and dampen wage growth that is typically associated with technological advancement.

As discussed throughout this chapter, the United Kingdom, the USA, and Canada all share fairly similar negative projected impacts on the labour market arising from automation. All three of these jurisdictions have somewhat differing results due to their differing labour market compositions. However, all three are similar insofar that they are projected to have automation impact all levels of the workforce from low-skilled workers to high-skilled. The following chapters will look to present three policy options for Canada to address the negative impacts of automation including; portable social benefits, retraining programs, and the status quo alternative. All three of these policy options will be presented and explained in detail with a critical evaluation of these options to follow.

Chapter 6.

Policy Objectives, Criteria, and Options

6.1. Policy Objectives

The long-term policy goal is to reduce the number of unemployed high-skilled Canadians that are negatively affected by the advent of AI within the workplace causing unemployment. The short-term policy goal is to ensure adequate transition support and to minimize the negative effects that will occur due to AI in the next 20 to 30 years as discussed within the primary methodology findings. The focus of the policy analysis is to fill in the gaps currently existing at the Federal government level in which there are currently no long-term government plans in place (that could be found) to ease the transition and prevent high rates of technology-based unemployment.

Long Term Objective

With respect to the extent of the possible large-scale displacement effect that AI will have on labour as highlighted within the primary methodology findings, it appears that the effect on high-skilled labour will affect nearly 40% of Canada's total labour force to differing extents. As such, the main long-term objective of the policy options presented within this analysis will focus on alleviating the displacement effect AI will have. This will be achieved through developing policy that is equitable and fair to all members of the high-skilled group being analyzed. In ensuring equitable and fair policy, the main long-term policy objective ought to ensure that all occupations are treated equally and that the policy options presented are broad in scope and targeted in objectives so as to directly target the problem but also ensuring applications across all industries and occupations. All of the policy objectives presented here seek to keep technological unemployment low and worker displacement to a minimum.

Short Term Objectives

In the short-term there are three main considerations that ought to be taken into account. The first is stakeholder acceptance as there are many diverse stakeholder groups. First and foremost, the workers that are directly affected, ESDC, and the firms implementing the AI-based technology. All of these stakeholders ought to be accepting of the options presented here. Stakeholder acceptance in the short-term will allow for a future in which workers, firms, and ESDC are working seamlessly in maintaining both long-term macroeconomic growth as well as low rates of unemployment.

The second short-term policy objective that is taken into account, is the cost to stakeholders. As some of the policy options presented may cost firms, ESDC, or even the workers it is important to minimize these costs to support the previously discussed short-term objective, stakeholder acceptance. In keeping costs low, stakeholders will be more likely to accept the policies in both the short and long run facilitating a smoother transition.

6.2. Chosen Evaluation Criteria

Criteria are used to evaluate the three policy options presented to identify the best one for improving the labour market displacement effects brought about by automation. The focus of the evaluation is on high-skilled workers within Canada who are expected to be displaced by automation within the short and medium term as discussed within the primary methodology. The criteria take into account are: equity, cost, administrative complexity, economic efficiency, and stakeholder acceptance. The measures for the criteria have an index between 1 and 3, with 1 the lowest score, 2 the middle, and 3 for the highest. Three is the best score that any of the given three policies could possibly receive and thus the policy option that has the highest overall score will the final recommended policy after all scores are tabulated. Economic efficiency has two separate score measures, the first being the impact on businesses as some policies may negatively impact their willingness to adopt technologies and the second measure estimates the effect on the broader Canadian economy.

Table 2. Criteria and Measures Matrix

Criteria	Definition	Measure	Score
Equity	Does the policy provide equitable outcomes?	Targeted group	Fully assisted=3 Some support=2 Not assisted=1
Equity (*2) **Equity score multiplied by two due to its significance**			
Cost	Cost to stakeholders if policy is adopted	Estimated cost of policy option to firms	Low cost=3 Medium cost=2 High cost=1
		Estimated cost of policy option to employees	Low cost=3 Medium cost=2 High cost=1
		Estimated cost of policy to government	Low cost=3 Medium cost=2 High cost=1
Cost Total (/3)			
Administrative Complexity	Ease of implementation/administration including the number of actors that need to be engaged in process	Expected Level of Involvement	High level=3 Medium level=2 Low level=1
Economic Efficiency	Will the policy option impact positively or negatively economic efficiency at both the micro and macro level	Expected burden on business	Low burden=3 Medium burden=2 High burden=1
		Expected burden on Canadian economy	Low to none=3 Medium=2 High=1
Economic Efficiency Total (/2)			
Stakeholder Acceptance	Would stakeholders be willing to accept the policy?	Amount of groups expected to accept	All accepting=3 Some accepting=2 None accepting=1

Equity

Equity, in this particular circumstance, is evaluated in the context of the three policy options on the basis of whether each particular policy treats the workers affected by automation equally. Ensuring equitable outcomes for displaced workers is of the utmost concern as the policies proposed ought to not benefit one specific group of workers over another or one specific industry more than the other. According to the scores presented in figure 3 previously, a score of 3 would represent that the given policy provides the greatest level of equitable outcomes. A score of 2, would provide a somewhat equitable outcome, and a score of 1 would be the least equitable outcome.

Stakeholder Acceptance

As this issue affects workers the most negatively as well as firms, albeit in a different manner than the workers, it is important that all relevant stakeholders accept the policy option. If all stakeholders are expected to positively accept the given policies, this criterion would receive a score of 3. As presented within the previous criterion, a score of 2 or 1 would represent somewhat of an expected level of acceptance and the least amount of expected acceptability, respectively.

Cost

Cost is measured in a form of estimated cost estimates as there are no direct pre-existing programs to draw upon for each of the costs. There are three distinct groups to which cost will matter. The first cost impact that will be estimated is the cost to firms, followed by the cost to workers, and then the cost to government if the policy is government initiated. For this criterion a score of 3 would again be the most ideal as it would signify the lowest cost possible, with a score of 1 on the opposite end of the spectrum representing a fairly high cost estimate.

Administrative Complexity

Administrative complexity involves the level of difficulty of policy administration and implementation. This is measured as an estimate of the projected involvement of the federal government in the administration and implementation of the given policy, if applicable. As was the case with the cost criterion, a score of 3 would be the ideal score as it would represent the lowest level of administrative complexity required for the implementation of the policy, with 1 representing the least ideal score and the highest level of administrative complexity.

Economic Efficiency

Economic efficiency is used to evaluate the projected effect that the proposed policy will have on two different groups, the first is businesses. As firms may or may not have their efficiency impacted via the possible hindrance on their willingness to adopt new technologies due to policy implementation. If firms are projected to not be interfered with, with respect to their economic efficiency the policy would receive a score of 3 for most ideal. The second economic efficiency that will be examined is the effect on the Canadian economy. This will be an estimate of whether or not the policy chosen is expected to have a positive or negative effect on the economy, with a score of 3, again, being the most ideal scenario.

6.3. Policy Options

In this section, three policy options derived from the analysis are provided. This includes retraining schemes, the expansion of the social safety net, and the status quo option that ought to be considered with respect to this policy issue.

Option 1: Retraining Program

The first policy option is a skills-based approach to alleviating the negative impact of automation on the labour force. In it, workers are provided with training free of charge to gain skills better suited to the changing labour market.

A centrally developed, federal government program in which workers who are displaced by automation or are at a high-risk to being displaced in the short-term can access this service to become better prepared for the future labour market. A program such as a retraining scheme would facilitate the development of a strong and adaptable labour force that would assist in alleviating the negative labour market impacts brought about by the increasing adoption of automation and AI-related technologies. The main objective of a program such as this is to transition workers into new skills and abilities within new positions of the same field. Ensuring workers stay in the fields they initially trained and were educated in ensures that the amount of retraining required is lower than if they were to transition into an entirely new discipline. For example, if a worker in the legal field is displaced and must transition into a scientific field, this is the scenario we ought to avoid ensuring low costs and low stress on the worker. Having a clear and precise objective with respect to the re-training program attempting to stay within their profession is of the utmost importance in the implementation of a program such as this.

An effective retraining program ought to include a wide range of services such as one on one support with a skills expert who can provide expert advice on in demand skills, career path guidance, and recommendations for skills training options to workers. Furthermore, removing the barrier of cost for these workers to access programs such as this would incentivize workers to access and use these programs to gain new job market opportunities that are considered ‘safer’ from automation. Recently, the United Kingdom has introduced a pilot program for a national retraining scheme in which they are targeting lower-skilled workers through providing functional skills, vocational training, tailored advice, amongst other things which they are looking to expand on in the future. In the context of Canada’s policy dilemma, a program such as this could easily be adapted and implemented to better suit Canada’s high-skilled workforce and introduce an effective program to better prepare Canada’s workforce and ensure Canada has a multiskilled workforce for the future of work.

Option 2: Portable Social Benefits

Portable social benefits involves expanding the general social safety net to further increase social assistance to citizens and more specifically to those workers that are expected to be displaced by automation and AI-related technologies.

This particular policy option involves the establishment of a unique portable social benefits account wherein employers, employees, and the federal government pay into an account that would then be able to be accessed by workers who are displaced due to technology. This account would provide access to health, dental, mental, child care and (most importantly for this policy) a retraining allowance to cover workers during their transitory period between occupations. This particular option is especially important as the nature of work is expected to undergo significant change, as has been discussed in detail throughout this paper. Temporary, part-time, and gig employment has increased in recent years and with the increased threat of automation looming even for high-skilled workers it is important to provide social benefits coverage for workers who are displaced.

One of the main advantages of adopting a program such as this with respect to the changing nature of work is that these benefits are attached directly to the employee and not the employer themselves. Therefore, employees who are negatively affected by automation are able to access necessary benefits even without being employed and provide at a basic level, some form of coverage.

A program such as this ideally would be developed and administered by the federal government as a centrally planned, tested, and administered program would allow for greater scale, and help to alleviate the possible differences between provinces, facilitating an equitable program for all high-skilled Canadians. While high-skilled workers tend to be those with the greatest level of coverage in their occupations and the highest amount of full-time positions, with the threat of automation, this will be an important option to consider as it would help to alleviate any issues or anxiety workers may face as a part of their transitory period.

However, there are issues associated with this policy option. In particular, determining who pays, who qualifies, and what is covered are all important components to consider in the development and implementation of an option such as this. As this program does not have an example to drawn upon for analysis, these are all issues that would need to be sorted out prior to implementation of it across Canada. As AI continually rises in complexity and scope, it is important to have a benefits program that reflects the changing nature of work, however the transition to a new benefits scheme is highly complex and would require changing the existing models. With respect to the question of who pays, the sharing of costs between employers, employees, and government is important to ascertain as it would have bearing upon the level of acceptance to this new option stakeholders would have. The same goes for the other two aspects noted, as who qualifies and what is covered will impact the scores given to this option within the policy analysis portion of the paper.

Option 3: Status Quo and Accounting for Uncertainty

The third and final policy option considers that perhaps the best option for this policy problem is simply no solution at all and leaving the labour market to address its own changing nature.

As was discussed earlier within this research, a handful of experts within this field point towards the historical instances of extreme labour market change through the industrial and digital revolutions. In both of these circumstances in the broadest sense, the jobs that were displaced and replaced by machines and technology led to the creation of new employment possibilities. For example, as machines replaced humans in the factory with the introduction of machines replacing human-centred work, new jobs were created. Some of these new jobs included machine building, machine maintenance, among other positions that centred around the machines that initially replaced them. Another historical example is when the traditional horse and buggy was eventually replaced by automobiles. These automobiles replaced the need for drivers of the horse and buggy, however, new jobs were created in road development and maintenance as well as the many jobs required to create and keep cars on the road.

As described briefly above, all of the previous jobs that were destroyed due to the advent of new technologies were eventually replaced by new and better paying jobs spurred by the spread of these technologies. Furthermore, over the years real wages along with productivity have continually increased due to the spread of new technologies that make work easier and more efficient. While in the short term there was higher unemployment as these technologies displaced workers, in the long-run workers and society overall was made better off. When it comes to AI and automation technologies as has been noted throughout this paper, it is difficult to predict the spread and timing of the impact of these technologies and direct policy action may not be the best response to this problem. This particular policy option (or lack thereof), accounts for the uncertainty surrounding the impact automation will have and takes the views of the techno-pessimists who believe that the amount of new jobs that we aren't currently aware of at the moment will exceed the amount of jobs that will be replaced. In particular, workers in the high-skilled category are typically the most well-adjusted to disruptive technologies such as this and government intervention may not be necessary for them. This policy option is critically analyzed through the lens of the criteria and measures presented within this research to determine whether or not no action would be a proper response to this issue.

Chapter 7.

Evaluation of Policy Options

This section provides the evaluation of the policy options using the criteria presented earlier. Findings are based on the previous analysis as well as insights gained from the literature and similarly existing programs. A written analysis of the options' performance on the criteria is presented in the subsequent sub-sections. A summary of the results presented within this chapter is provided by table 3 at the end of the evaluation of option 3.

7.1. Evaluation of Option 1: Retraining Workers

Regarding equity, retraining schemes such as those observed in the UK as well as Job security councils observed in Sweden, are highly equitable to the workers who are negatively affected by technological displacement. Workers who become displaced must retrain and gain new skills so that they can effectively enter the workforce with ease. As observed in similar jurisdictions, policies such as these effectively handle the issue of equity, by ensuring the targeted groups of the policy are dealt with accordingly. In particular, the Swedish case of job security councils, 85% of workers who are released from their job whether it is attributed to technological displacement or other reasons, find a new occupation within a year of the prior displacement. These job security councils are a business-union agreement, unlike retraining schemes led by governments, however, they do provide the ultimate end goal of retraining workers for in demand positions With respect to evaluating the level of equity achieved with job security councils and retraining schemes, this option receives the highest score of 3

The second criterion is stakeholder acceptance. Workers are expected to positively react to programs such as this as it removes one of the major barriers to retraining/upskilling, namely, the cost of acquiring new skills. Providing, for free or minimal cost to the workers would be universally positively accepted, provided the program adopted shows demonstrable results for those involved within them. Insights gained from reviewed literature point to the fact that a large majority of acceptance from workers as well as participation within these programs hinges upon providing workers with demonstrated prior success and results that show that they are ‘worth their time’, so to speak. This factor receives the highest score of 3.

As for the cost criterion, this largely depends on how a possible program is funded, whether the majority of the funding comes from government or from firms who implement automation technologies or some combination of both. Workers would not be expected to fund programs such as this, due to the reasons noted earlier, that cost is one of the major barriers to workers engaging in retraining programs and thus, workers would be given the cost score of 3 since none of the burden would fall upon them. If the government funds the program in its entirety such as is occurring currently within the United Kingdom’s National Retraining Scheme, then the government cost score would receive a 1. Currently, the UK government is injecting £100 million for the first phase of a pilot retraining program which encompasses many aspects of retraining from consultation to direct retraining programs (UK Government). If firms were required to provide funding to the government when they adopted automation technology as some form of ‘robot tax’, so to speak, then they would also receive a score of 1 in the cost category. If the program is decided to be funded by some form of a combination of government and firms, then the score ought to be slightly higher than 1 between the two stakeholders. Therefore, overall since workers are the primary stakeholder within this analysis as they are the most negatively affected by automation, the cost score overall is a 2. The score of 2 takes into account the less positive cost scores of some of the secondary stakeholders while also recognizing the importance of a zero-cost option for workers. As there are three components for the burden of cost, the score is divided by three across the groups.

In terms of administrative complexity, the establishment of a national retraining program would require stakeholder engagement as well as a fairly high level of federal involvement. Much of the work in the development of this program would raise from the need to identify the future skills that would be in demand for the future labour market as well as what forms of supports would be best suited for high-skilled workers who need support in their transition. As was observed from the UK’s scheme, a smaller program ought to be developed first in the form of a pilot program focused on those most affected by automation to test its efficacy within the Canadian context and to continually improve and eventually expand the program to engage with a broader group of workers. For administrative complexity, this score ought to be given a 2 as it is not an impossible task that requires extensive and complex involvement from stakeholders, however, it is not as easy as simply adjusting a pre-existing program.

For economic efficiency at the business and broader Canadian economic level, this scheme ought to receive a score of 3. A retraining scheme would have no foreseeable negative impacts at the firm level, as businesses who lay off workers due to automation to increase productivity and profit maximization would not be hindered by a policy such as this one. On a Canadian macroeconomic level, the benefits of retraining workers would be positive as workers gaining new skills and transitioning to in demand jobs would increase Canada's overall economic health. Furthermore, having workers gain new skills and higher paying skills would have positive economic effects outside of a possible increase in salary for these workers. Jobs that pay better would increase overall economic spending, and greater investment in the economy.

7.2. Evaluation of Option 2: Portable Social Benefits

Regarding equity, the expansion of the social safety net, an important option for consideration that has been considered is the establishment of a portable benefits program that would better reflect the changing nature of work. While a program like this has not been undertaken within Canada historically, it is an idea that ought to be considered as the labour force undergoes changes such as more frequent periods between employment, more part-time work, and an overall increase in the digital gig economy. Historically, most of Canada's pre-existing programs focus on an employee and an employer providing benefits to the full-time worker covering health, dental, mental, skills training, etc. However, with the predicted shift in the labour market due to an increase in automation-based technologies, this may not be feasible for workers. Portable social benefits would alleviate the issues that automation present. While the details of a portable benefit scheme and the costs associated with it have not been explicitly calculated, a logical analysis of this system can be undertaken. Firstly, when accounting for the equitable nature of this policy option, a portable system such as this for high-skilled workers would be excellent as a universal program could be established federally that would facilitate coverage of workers of all skill types and in a broad swath of occupations. Due to this reasoning, this option would receive a score of 3 with respect to the equitable nature of this program.

As for stakeholder acceptance, this policy has not been tested before within Canada, it is difficult to ascertain for certain whether this policy would receive the highest possible score of 3, thus, it receives a score of 2. Employees would more than likely react positively to this option as it would facilitate the establishment of a reliable social net that could be withdrawn from regardless of employment status and for a broad swath of reasons. For firms, their level of acceptance would depend on the cost of this option to them and whether or not it would cost more than pre-existing programs they are legally required to pay in to. For ESDC, again, this would depend on cost and whether their contribution to the program is larger than currently existing social programs. Furthermore, a program such as this would be linked to the administrative complexity of such an undertaken and given this, ESDC's willingness to accept would depend on a multiplicity of factors. Given this, a score of 2 is best suited as it is difficult to ascertain one way or another whether it would be strongly received positively or negatively.

Cost, encompasses the costs to each of the three stakeholders, which was briefly touched upon in the discussion of the previous criteria. However, as has been a continuous theme throughout this particular analysis, the costs are indeterminate as there is no comparable program to base it off of. Therefore, the score I have chosen to assign to this option's criterion is 2. Assigning a moderate score in this scenario seems to be the most appropriate action as it will not score higher in the cost criterion relative to option 3 and may or may not be more expensive relative to the first policy option. Furthermore, as it is adjusting the current system of social welfare within Canada it can be expected that the policy will more than likely not greatly exceed the cost of the pre-existing policy Canada currently operates under.

Administrative complexity is where this policy option tends to become a less desirable option. As this policy option requires the establishment of a new form/a modification of currently existing social benefits, it is more than likely to require a high level of centralised, federal government planning/development in its implementation and testing which is why this option receives a score of 1 in terms of administrative complexity. This option is not without its positives however, as a centralised approach to portable benefits developed by a federal government agency would lead to cost savings through the benefits of scale brought about by a federal program which would ease the burden on lower levels of governments and corporations. Intricacies such as the amount paid into by employers, employees, and the federal government (possibly) would lead to an increase in complexity as well as ascertaining what the scope of benefits would be. Simply due to the novel nature of this program and the scope of issues that would have to be dealt with in its development, this criterion receives a medium score even though there are positives associated with its development and implementation.

Economic efficiency, is again more difficult to ascertain as such a program is novel in nature and thus has no observable or historical results by which to go on in evaluating its micro and macro level economic effects. Thinking through the expected outcomes of this particular policy it could be expected that the micro level effects on businesses would be minor as their ability to maximize profits would not be hindered, as they could continually adopt new technologies that would increase their efficiency. The only expected drawback to this particular option is that they would be required to pay a yet-to-be determined amount into the portable social benefits account. On the macro level, the Canadian economy would more than likely feel overall positive benefits as workers who are displaced could use their portable accounts to pay for retraining/upskilling and childcare, among other benefits that would facilitate their re-entry into the labour market, thus boosting the Canadian economy, broadly speaking. Due to the projected minimal negative impact on businesses and the Canadian economy, this particular criterion ought to receive a score of three, representing the highest possible score for this particular criterion.

7.3. Evaluation of Option 3: Status Quo/Accounting for Uncertainty

With respect to option 3, in which we are trying to account for uncertainty of future technological progress in relation to automation, the status quo option was considered. In beginning with the evaluation of this option, the equitable nature of this policy option (or lack thereof) scores at the lowest ranking of 1. The reasoning for the status quo receiving the score 1 is attributed to the fact that maintaining the status quo of no policy action would not positively affect workers who are displaced by technological advances. Maintaining the status quo of no policy action would hinder the creation of worker transition programs and worker support mechanisms and would leave the burden of skills retraining, for example, on the workers themselves and not other institutional actors.

In terms of stakeholder acceptance, this has received a score of 2. As there are multiple stakeholders within the analysis, the level of acceptance across the three groups varies. Workers would be least likely to accept, ESDC more likely, and the firms are the most likely to accept. Workers are expected to be least likely to accept this option as they would receive no financial or occupational transition support if they were subject to technological unemployment, as expected. Firms and ESDC more likely to accept as they would not be burdened with having to be burdened by development, implementation, and administration of a policy. Firms are the most likely to positively react to the given policy option as their business would not be impeded upon with respect to this issue and thus could maximize their profits, as is the ultimate goal of business.

The cost of this policy option is nothing. There is no financial cost in the maintenance of the status quo and therefore, receives the highest score of 3, across all three stakeholder groups involved within this policy. Similarly, administrative complexity would receive the highest score of 3, as again, doing nothing and maintaining the status quo is the least complex option available, involving no development, implementation, or enforcement.

The final criterion, economic efficiency, again receives a high score of 3. The impact on businesses in terms of economic efficiency is expected to be largely positive as automation and AI-related technologies are expected to boost productivity and efficiency as more and more of these technologies are implemented. On a broader Canadian economic level, the maintenance of the status quo would again, be largely positive as, generally speaking, productivity gains often leads to better products and better standards of living overall. However, with the issue of large-scale unemployment there is the possibility of a negative impact on the overall Canadian economy.

Table 3. Policy Option Evaluation

Criteria	Option 1: Retraining Program	Option 2: Portable Social Benefits	Option 3: Status Quo
Equity (*2)	6	6	2
Stakeholder Acceptance	3	2	2
Cost			
Cost to Workers	3	2	3
Cost to Firms	2	2	3
Cost to Government	2	2	3
Total/3	2.3	2	3
Administrative Complexity	2	1	3
Economic Efficiency			
Impact on Firms	3	3	3
Impact on Canadian economy	3	3	3
Total/2	3	2	3
TOTAL	16.3	15	13

7.4. Recommended Course of Action

When considering the recommended course of action for addressing the issue of the negative effects of automation on high-skilled Canadians, the main policy response that ought to be implemented is the portable social benefits scheme discussed as option two in the previous sections. The portable social benefits scheme described in the previous sections would essentially be a transition away from the historical system of social benefits in which an employee is given particular benefits whether it be dental, health, mental, etc., towards a more portable scheme. Ensuring the portability of benefits in which an employer or the government or some combination of both pay into this portable benefit system in conjunction with the worker would allow for the worker to take these benefits that they have paid into with them as they transition to a new occupation or position. As has been discussed within this paper, it is expected that as automation and AI-related technologies increase in their prevalence across the economy occupations will become less permanent as they have in the past and people will transition between jobs more frequently. As such, a system that works for this changing nature of work will be necessary.

The implementation of such a program would also facilitate the inclusion of one of the secondary policy options that was presented in the previous section, namely the national retraining scheme which is why even though option 1 technically scores higher, option 2 is the recommended policy option. The inclusion of training benefits within these portable benefit accounts would help to address the major concern of this paper, specifically that occupations at a high risk of automation will be forced to transition to new occupations that they may or may not be trained for. Upskilling and retraining these workers for differing occupations and ensuring that they have an adequate amount of money to cover these programs will help to minimize the risk of large-scale unemployment. As was noted in prior sections, money is one of, if not the most important barrier to workers' willingness to engage in retraining programs, with the secondary impediment being the concern of not receiving an occupation post-education. If both of these issues can be resolved via the portable social benefits program, then this option ought to be the primary policy mechanism to be pursued.

In the long run, the government should focus on adjusting the overall education model in schools to better reflect the changing nature of the job market and ensure that students have the proper skills to protect from current automation potentials. This will require significant investment and research into analyzing job market trends and the technological capabilities of automation and AI technologies to ensure that workers are better protected from displacement.

Furthermore, analyzing jurisdictions in which portable social benefits have previously been implemented such as in Washington state, would allow the government to better understand and adopt best practices and methods by what to cover within the portable social benefits. Moreover, the government ought to continually analyze and adjust the program and retraining programs so that workers do not fear technological progress will take their jobs and if technology does augment some portion of their employment the ease of access and coverage of services to transition to new occupations is seamless and financially covered.

Chapter 8.

Conclusion

In this paper, I identified the negative labour market outcomes that high-skilled labour in Canada is expected to have in the coming decades due to the rise in automation and AI-related technologies. After determining the size of the effects, it appeared that while many jobs faced a high risk of occupation according to the occupation-based risk numbers, there was a significant degree of variation amongst the occupations. Many jobs that focused on routine-based tasks, data entry, and jobs that did not rely heavily on skills that are intrinsic to humans such as critical thinking and social skills. Furthermore, many of the jobs that are highly paid ($100,000 or more annually) were less at risk than those that make less. Intuitively, these results made sense as jobs that earn more often require a broader skill set with more University level education and thus more critical thinking skills that are currently safe from automation technologies. While it is true and is often the concern that low-skill jobs will be greatly affected by automation, there has been a significant lack of analysis on the impact of high-skilled workers within the literature. This paper has sought to expand on the research surrounding the effects of automation on high-skilled workers and determine just to what extent they are affected within the Canadian context.

First and foremost, the focus of the policy options was to ensure equitable outcomes for all affected workers, not focusing on a single industry or a single occupation and pursuing policies that would ensure the transitory period for displaced workers was minimized. Thus, the option of portable social benefits was recommended as it transitions away from the historical employer-employee benefits wherein workers receive benefits from their employers as long as they are in that specific posting. Transitioning away from this historical system is deemed as a necessary first step in alleviating the negative impacts of automation as it recognizes that as the level of automation increases within the economy occupations will become less permanent. With the rise of less permanent postings, a portable social account will become necessary as it will provide important services such as health coverage and more importantly, a skills training account that will allow for workers to be covered as they pursue skills retraining to transition to jobs that are considered safer from automation. Alleviating the financial burden and ensuring workers are covered equally during their transitory period is of the utmost importance and for that reason, was chosen as the preferred policy option.

As there is much uncertainty surrounding what the future of AI-based technologies will be capable of in terms of displacing workers, it is important that future research focuses on analyzing the capabilities and the extent to which workers will be affected in the coming years. Furthermore, governments ought to play a large role in ensuring the negative effects on workers are minimized as large-scale unemployment causes many negative socioeconomic externalities such as increased crime and general social discontent. While AI brings with it many fantastic opportunities such as increased productivity, real wage growth, and large-scale advances in all aspects of life, there are drawbacks that must be dealt with and handled with care so that AI benefits everyone in the long-run.

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