Training and Skills Development Policy Options for the Changing World of Work

Key words: skills, training, disruptive technologies, active labour market policy, Canada.
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Abstract

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This article offers a critical assessment of empirical knowledge regarding labour market training and skills development in an era of technological disruption. While we do not know exactly which skills and jobs will become obsolete, technology may cause unemployment to spike and increase the need for retraining. In order to move towards understanding what policy interventions will be needed in response, this paper assesses the current state of knowledge about Canada's active labour market policies. We argue that before creating new programs, we need to learn from existing policy attempts to address labour market disruptions. By analyzing the most recent ESDC evaluations, we find that there is a lack of quality data and analyses regarding the effectiveness of these programs. The paper concludes that there is a need for research in this area before policymakers are able to develop responses to technological disruption.

Introduction

Academic literature and policy reports on work in the age of disruptive technologies are large and expanding almost by the day, demonstrating both the interest in and urgency of the topic in the minds of researchers and policy makers. Since 2006, the year some researchers suggest marks the start of the "second machine age" (Brynjolfsson and McAfee 2014), at least eighty government, international organization, think tank and global consultancy reports have been written on disruptive technologies and their impacts on skills and work (see appendix 3 for more information). Approximately half of these reports have been published since January 2017. In addition to this "grey" literature, a great deal of academic "futurist" work has been generated that offers some predictions about expected macro changes in the workforce, including polarization of jobs, job destruction, and the scope and depth of anticipated disruption in both the global North and global South (Autor 2015a; Autor 2015b; Brynjolfsson and McAfee 2011; Frey and Osborne 2013; Schwab 2016; Susskind and Susskind 2015). Much of this futurist work focuses on analyzing what tasks can be automated and what percentage of the labour market faces disruption. Very little empirical literature exists on the policy responses that have been taken to support training and skills development of workers in the face of disruptive technologies including machine learning and mobile robotics, the track record of success of existing programs, or the broader social and employment policy implications of a new world of work – particularly in the Canadian context.

It is noteworthy that while artificial intelligence (AI) and other disruptive technologies now dominate contemporary policy discussions, a scan of federal and Ontario government

parliamentary and legislative speeches, as well as budget documents and party manifestos reveal barely a mention of the topic until the past few years. In other words, AI and other disruptive technologies have moved up the policy agenda incredibly rapidly. The recency of attention paid to this issue raises serious concerns about governments' readiness to prepare for and respond to the changing nature of work due to disruptive technologies.

This article offers a first step towards a critical assessment of government capacity to anticipate and respond to the new world of work in an age of disruptive technologies, focusing on Canada in particular. The article begins by reviewing the current state of empirical knowledge regarding disruptive technologies' anticipated impact on the world of work. This literature suggests that while we do not know exactly which skills and jobs will become obsolete, it is likely that technology may cause unemployment to rise in some sectors in the short term and increase the need for retraining to improve both technical and "non-cognitive skills" of those who are displaced. In order for governments to respond to these changes, we first need to know whether current policy responses to labour market disruption offer a potential platform from which to build new programs. We then summarize the state of knowledge regarding training programs that have been shown to be most effective in the past, before assessing the state of knowledge about training program effectiveness in Canada in particular. By analyzing the most recent set of evaluations of nation-wide programs, we find that there is a need for better information on changing labour market demand to inform the development and provision of services in this area in Canada. We conclude by outlining a tripartite research agenda for both

academics and policymakers to pursue in order to identify how to respond to technological disruption of the labour market.

Background:

The Rise of the "Fourth Industrial Revolution" and its Labour Market Impacts

The rate and characteristics of technological change in the 21st century are remarkable. While computing began to reshape work in the 1960s, continuing and increasingly rapid advances in machine learning and mobile robotics mean that computers can now undertake much more complex and less routine tasks. Many researchers and policy makers believe we are witnessing the "fourth industrial revolution," on par with previous technological advances such as steam engines and other forms of mechanical production, the electric age and mass production, and the electronics and information technology age that led to automation of production (Schwab 2016). It is difficult to determine when this new age of artificial intelligence, communications, and mobile robotics-based innovation began. One way to identify a specific "starting point" for these recent changes in technological capabilities is to focus on Moore's Law: in 1965, Gerald Moore (of Intel) hypothesized that semiconductor capabilities would grow exponentially as the number of transistors in one chip would double every two years. Brynjolffson and McAfee (2014) argue that if the beginning of computing's effect on the economy is taken as 1958, the year that "information technology" was added to the US Bureau of Economic Affairs' categories, then the technological tipping point (where computers became "staggeringly" powerful) occurred in 2006. After 2006, supercomputers, factory robots and self-driving cars began to appear. In 2007, the first iPhone appeared on the market.

The pace of change is particularly remarkable. Many researchers support identifying the 2000s as the first decade of this most recent and sustained technological shift: between 1999 and 2000, Internet usage in Canada jumped from just over 36 per cent to over 50 per cent. By 2009, over 80 per cent of Canadians used the Internet (World Bank 2018). Technology started to be able to take on non-routine tasks from roughly the year 2007. In 2010, Google successfully piloted a completely autonomous vehicle, and, in January 2011, IBM announced it had succeeded in achieving automated translation. In 2011, people began referring to the reconfiguration of manufacturing as "Industry 4.0," where production occurs in "smart factories" in which virtual and physical systems cooperate (Schwab 2016, 11).

Digitization, artificial intelligence, big data, automation, and the rise of disruptive information and communication technologies are now created and implemented at a rapid rate. As McAfee and Brynjolfsson (2017, 98) note, "the combination of cheap raw materials, mass global markets, intense competition, and large manufacturing scale economies is essentially a guarantee of sustained cheap price declines and performance improvements" in technologies such as robots, drones and autonomous vehicles and attendant software and algorithms, altering the need for human labour in producing various goods and services. While job disruption as a result of automation has been underway for at least two decades, advances in machine learning, microchip technology and platform innovation are occurring very rapidly. The previous wave of global factory job displacements as a result of automation was massive: an estimated 31 million factory jobs disappeared between 1995 and 2002 in the 20 largest

economies (Rifkin 2004). While occupations in the service category experienced growth in this period, these jobs are now also facing the threat of automation (Rifkin 2004). In addition, technological advances have opened up new platforms that enable direct communication between clients and service providers. Applications such as Uber and Airbnb that match workers directly with customers have quickly created what has been described as the "gig economy," which has far reaching implications for the state of employment. Work is performed on an on-demand basis and is, depending on the jurisdiction, considered only loosely connected to the firms that produce the algorithms that match workers with consumers of their services (Kenney and Zysman 2016; Zysman and Kenney 2017).

The anticipated future job displacement globally is much larger. Researchers at the OECD recently forecast that nine per cent of jobs on average are completely automatable across OECD countries (Arntz, Gregory and Zierahn 2016, 25). A 2017 McKinsey study estimates that "as many as 375 million workers globally (14 per cent of the global workforce) will likely need to transition to new occupational categories and learn new skills, in the event of rapid automation adoption" (Manyika et al. 2017, 1). Other estimates run much higher (Frey and Osborne 2013). These global job trends are mirrored to some extent in Canada where the number of standard full-time jobs (jobs that do not involve self-employment, or temporary employment) declined significantly in the 1990s and the proportion of standard full-time jobs has fluctuated between just under 0.5 and 0.625 per cent since (Green and Townsend 2013, 69-70). While it is difficult to provide accurate estimates of future job loss, these disruptions are anticipated to be

massive. The breadth and depth of anticipated change raise a call for action in the form of evidence-based interventions that can support workers and their families in the future.

What Do We Know about Potential Implications for Employment?

Analyses of the impact of new technology on employment take two main forms: work that draws on historical trends to predict the effect of general-purpose technologies on the organization of production, and work that analyzes the tasks new technologies such as mobile robotics can take on to predict which jobs are likely to be disrupted. These analyses offer a range of predictions about exactly what tasks and occupations will remain the terrain of human workers. They suggest that there will be ongoing demand not just for technical skills such as engineering, but also for "non-cognitive" skills including empathy and creativity. These predictions, however, give only a general sense of what forms of training might support those who struggle in the labour market as a result of technological change.

Historical Trends

One set of literature draws on historical labour market trends and the experience of past technological disruptions to help analyze and contextualize the breadth and depth of change currently underway. Studies of changes to work highlight the rise and decline of "good jobs" over the course of the 20th century. After World War II, the introduction of Taylorist production processes combined with union labour law victories from the New Deal era gave rise to the "good" job standard: full-time, 40 hour per week employment with some protection from dismissal, health and safety regulations, health insurance, and eligibility for unemployment

insurance (Wartzman 2017) – mostly available to white men. Over time, reorganization of production as part of globalization processes, combined with intentional cost-saving measures, have continued to contribute to the pool of non-standard work. Sub-contracting allows firms to sidestep the costs of labour regulation and insurance entitlements and bring in workers on a temporary basis (Wartzman 2017; Hyman 2018).

Technological change, including improvements in information and communications technologies, fragmented production processes and led to manufacturing moving offshore (Breznitz and Zysman 2013), decreasing union density and the availability of well-paid jobs for those without high levels of formal education. In Europe and Canada, similar changes also decreased demand for manufacturing workers and changes to social policy in parts of Europe increased the size of the non-standard workforce (Hall and Soskice 2001; Häusermann, Kurer and Schwander 2015; Iversen and Soskice 2009; Iversen and Stephens 2008; Rueda 2007; Emmenegger et al. 2012). Partisan policy making and policy stasis or drift also contributed to this process (Banting and Myles 2013; Hacker, Pierson, and Thelen 2015). Labour markets in Germany, Sweden, and beyond have dualized, split between those workers in protected, stable and full-time employment, covered by social insurance and other benefits, and those subject to increasing precarity and risk as a result of previous rounds of disruptive innovation such as automation (Emmenegger et al. 2011; Ibsen and Thelen 2017; Iversen and Soskice 2015). This dualization trend sets the stage for coming technological disruption; the interaction between these phenomena, while beyond the scope of this paper, is certainly worthy of further research.

Closer studies of the effects of computing on employment indicate that technology has hollowed out middle class jobs. Autor and Dorn (2013) argue that US employment and wages have polarized between 1980 and 2005 because of both consumer preferences and the falling cost of automating routine jobs. The same pattern applies to other countries (Goos, Manning and Salomons 2014). That said, Autor (2015a) acknowledges that these trends are specific to both the type of technological disruption that occurred and to the broader political-economic context in which they occur. These trends indicate that technological change can significantly reorganize production in ways that go beyond a simple one to one replacement of human labour with technology. For example, Bessen (2015, 110) argues that technologies can alter but not simply destroy work, using the example of ATMs: the number of bank tellers increased with the introduction of ATMs, but the tasks they completed shifted.

Scholars including Autor (2015b) have acknowledged that studies of the effect of basic computing in the twentieth century are unlikely to facilitate useful predictions about the impact of machine learning and mobile robotics because these advances allow machines to be used for a much wider range of tasks and so will reshape work in fundamentally different ways. Knowledge about the potential for future employment shocks must be treated cautiously by scholars and policymakers alike.

The Futurists

A second body of literature comprises a range of expert forecasts regarding the possible effects of recent technological disruption. Machine learning and mobile robotics, the foundational technology increasing the ability of technology to produce goods and services, are most likely to be able to undertake routine tasks that are somewhat simple, repetitive, and involve interfacing with other machines that help make processes regularized (Frey and Osborne 2013). Tasks and occupations that involve non-routine processes, very fine motor skills, creativity, and empathy remain outside of technology's grasp.

Presently, predictions about the future demand for human labour are built from analysing the abilities of technologies currently in development, including artificial intelligence or machine learning. By mapping the abilities of new technologies against the tasks lists that constitute many occupations (according to the US Dictionary of Occupations), Frey and Osborne (2013) find that service work, administrative tasks, sales, transportation, and production are all likely to see human workers displaced by technology. Using a similar methodology but focusing on tasks rather than occupations, a study by the McKinsey Institute (Manyika et al. 2017) estimates that low-wage earners in jobs involving physical labour or administration are the most likely to be automated, while technology continues to struggle with contextualizing knowledge, creativity, understanding non-literal ideas and following social or emotional queues, or with evaluation.

When it comes to identifying which forms of work humans are likely to continue to undertake,

analyses converge on several main themes. Some researchers (e.g. Autor 2015a) Neuberger-Fernandez and Barton 2017) have stressed that adaptability is a crucial human skill in a time of technological change, not only because of the need to be able to work with new technologies but also because more people are likely going to need to manage multiple jobs, both at the time and throughout their working lives. Learning will increasingly be a lifelong commitment (Lowe & Graves 2016). Other researchers note that non-routine skills such as problem solving, creativity, and skills related to empathy and social interaction are likely to continue to be in demand (National Research Council, 2012; Deming 2017). And, as noted, demand for non-routine cognitive and manual tasks has increased since the 1960s (Autor, Levy, & Murnane 2003). We are of course also likely to see increasing demand for technological skills including engineering, data processing, coding and other skills related to the rising use of machine learning and mobile robotics (Manyika et al. 2017; World Economic Forum and Manpower Group 2017). Bughin et al. (2018) find that the strongest anticipated growth in demand, across the six countries they study is likely to be for technological skills.

The effects of these new technologies may eventually lead to the growth of high-wage work – but they also might continue to deepen inequalities. While no consensus exists, the more optimistic labour market researchers argue that technological advancement leads to *skill-biased technological change* (SBTC), which has the long-run effect of improving job quality in areas such as cloud computing, big data and so on (Autor, Levy and Murnane 2003; Brynjolffson and McAfee 2011 2014). For example, in Canada, demand for ICT skills exceeded supply at the beginning of the 21st century but wage adjustments, alongside immigration, improved the

supply of skilled workers able to meet this demand. In this case, policy interventions that make tertiary education accessible and encourage skilled migration help to rematch supply and demand (Thomson, Veall, and Sweetman 2018; Finnie, Mueller, and Sweetman 2018). In the short term, however, researchers are concerned that technological change will lead to upticks in unemployment (Feldmann 2013). As technology continues to replace low-skilled human labour, wages for jobs with these skills will also be driven lower (Brynjolfsson and McAfee 2014). At the same time, technological change is anticipated to increase demand for high-skilled workers because it creates demand for "more abstract and data-driven reasoning" (Brynjolfsson and McAfee 2014: chapter 9), which may well be remunerated highly.

A more pessimistic forecast focuses on the relationship between the introduction of new technologies and skills polarization, predicted to further fuel both income inequality (within the workforce) and wealth inequality. Autor (2015b) argues that technological advances are increasing the share of productivity gains that go to capital, because of the need for less labour in high-growth production. Frey and Osborne (2013) also give some support to the polarization thesis. They argue that the (thus far) limited ability of machines to do fine-grained manual work means that technological change has in fact led to an "increasingly polarised labour market, with growing employment in high-income cognitive jobs and low-income manual occupations, accompanied by a hollowing-out of middle-income routine jobs" (Frey and Osborne 2013: 12). This concern has also been expressed in Canada, where the Advisory Council on Economic Growth has observed that automation decreases middle-income professions (Advisory Council on Economic Growth, 2017). A study of Canadian cities also found a relationship between

higher levels of innovation and wage inequality (Breau et al. 2014). Degradations to the quality of work contribute to polarization when lower income jobs are also jobs that are temporary and lack benefits (Aronowitz and DiFazio 2010; Weil 2014).

The reconfiguration (and attendant degradation) of work can also be seen in the rise of labour-market platforms and micro-work. Zysman and Kenney (2017, 1) argue that these platforms are "fundamental features of the present phase of the digital revolution." Digital platforms use algorithms and an abundance of data to match products or services with consumers (Kenney and Zysman 2016, 5). Platforms that match human labour with consumption, such as Uber, UpWork and Mechanical Turk effectively create micro-contracts between workers and consumers for agreed-upon services, with quite varying rates of remuneration (Barzilay and Ben-David 2017). These platforms additionally raise a host of questions regarding both consumer protection, labour regulation and growing inequality, or rather, policies that affect the distribution of gains from productivity (Kenney and Zysman 2016; Zysman and Kenney 2017, 3-7). For example, those who sell labour through labour market platforms tend not to be considered standard employees (Stanford 2017).

In sum, in order to keep up, workers need to be able to quickly adapt to new demands; their ability to do so depends on a worker's skill level and wage level at the time at which automation affects their job (Autor 2015a), as well as the workers' and firms' willingness to pay for retraining for new jobs. Can investments in training help with combating labour market disruptions caused by technological change? Answering this question involves first

understanding whether existing interventions help people into the labour market and then considering how such programs need to be adapted in order to provide people with skills that will continue to be in-demand as we move farther along in the 21st century.

What Training and Skills Development Interventions Are Possible in Response to Workforce Displacements caused by Technological Disruption?

Given that it is anticipated new technologies will continue to alter demand for various skills and talents on the labour market, any policy response will need to involve significant attention paid to the provision of skills and training to three groups: new entrants to the labour market, those in work already who are at-risk of displacement, and those who are displaced from work. Currently, people who are displaced or struggling to join the labour market can access support in the form of active labour market policies (ALMPs), which establish programs designed to reskill and reallocate workers into expanding sectors. These programs contrast with passive income maintenance policies which generally provide income replacement to eligible individuals. These programs support both new entrants to the labour market and displaced workers who do not self-select into available forms of higher education. Further research should indeed address the role wider education systems play in supporting these groups of people, but here we focus on the role of the state outside the traditional educational system.

Literature evaluating ALMPs has made significant progress in the last 20 years and can be used to generate lessons about how governments can adjust training provision to better support future displaced workers. Card, Kluve, and Weber (2017) provide a comprehensive meta-analysis of ALMPs and conclude that the average impacts of these programs are close to zero in

the short run but often become more positive in the medium to long-run (two to three years post-program), with effect size estimates of between 0.035 and 0.064. They find that there are significant differences in impact by type of program: programs that emphasize the accumulation of human capital have the largest effect, while programs that assist with a job search have less payoff in the long-term. Significant heterogeneity is found among participants with respect to the effect of these programs; for example, women and individuals who have recently been in a long spell of unemployment have been found to benefit the most. It should be noted that the effectiveness of government programs needs to be considered in light of the high degree of occupation-switching that they facilitate. Such switches have in the past meant the effectiveness of ALMPs relative to employer-sponsored training has been understated (Kambourov, Manovskii, and Plesca forthcoming). Finally, ALMPs have been found to have the greatest impact during times of economic hardship such as during a recession. As noted by Heckman, LaLonde and Smith (1999), however, many ALMPs do not pass a cost-benefit test. Even when they are cost effective, they are rarely associated with large-scale skills improvements.

Of the large number of studies (207 impact evaluations) included in Card, Kluve and Weber (2017), only one study from Canada met their criteria for inclusion in their evaluation. The inclusion criteria were that the focus of the study needed to be on an ALMP, the manuscript had to be well documented, it needed to include individual level micro-data, and it needed to incorporate a counterfactual/control group design or a form of selection correction. The one study examining Canada—Connolly and Gottschalk (2009)—evaluated the Canadian Self-

Sufficiency Project earnings subsidy. This subsidy was a demonstration project in the provinces of New Brunswick and British Columbia from 1993 to 1995 in which a random sample of single parents who had been on long-term income assistance were able to collect monetary supplements. Other studies of Canadian policies have been completed but have been of poor quality and were focused on specific groups of workers or specific industries. The evaluations of these programs were not encouraging (Riddell 2013, Park et al. 1996).

The dearth of evaluations is surprising given the existence of strong scholarship focused on Canada and on worker displacement, skills, and education more generally. Studies of improvements to human capital and the uptake of computing found that in Canada, there is a positive association between IT and upskilling (Kim 2002; Riddell and Song 2017). These same investments in human capital did generate income returns for workers from the 1980s, but these effects were much greater for men than women (Fortin et al 2012). Studies focusing on retraining specifically are much more uncommon. The inclusion of only one Canadian study in Card, Kluve, and Weber (2017) highlights the overall lack of academic research related to specific ALMPs in the Canadian context. However, some work in the non-academic world has evaluated ALMPs in Canada. For example, the Social Research and Demonstration Corporation (SRDC), a non-profit Canadian research group, works in partnership with federal and provincial governments as well as other for-profit and non-profit organizations to create, pilot, inform and assess ALMPs (SRDC 2013, SRDC 2018, SRDC 2019). Its work includes upcoming assessments of some of Canada's largest ALMPs, suggesting that Canada will have more technical evaluation material to draw on when making policy decisions in the future (SRDC 2018). Employment and

Social Development Canada has also undertaken evaluations of federal and provincial ALMPs, which we discuss in detail in the following section. These evaluations combine qualitative and quantitative data drawn from a series of technical studies (see Table 1 and below for a description of each of these studies). The federal government has also invested in a Future Skills Centre, tasked with evaluating ALMPs specifically with an eye to changing labour market demands. Other non-government organizations like the Mowat Centre have also contributed to this body of knowledge: a 2011 report on Employment Insurance and the future of work expresses support for continuing to focus on active labour market policy in support of flexibility to changing labour market demand (Gunderson 2011).

The findings in the ALMP literature are relevant to the current economic climate as they highlight that Canadian policy makers generally do not have a clear picture of how to mitigate unemployment and other labour market failures. Governments in many advanced industrial countries have developed a significant number of ALMPs, among other measures, to try to respond to disruption and labour market displacement. And while partisan politics do affect skills policy development – particularly at the provincial level in Canada (Haddow and Klassen 2006) – labour market disruption should be a cross-partisan issue. The question is the extent to which past practices and initiatives can be retooled for the new world of work.

Evaluating the Canadian Training and Skills Development Policy Landscape

In order to develop policy interventions that mitigate technological disruptions to the labour market, we first need to understand the existing state of Canada's active labour market

policies. Are programs effective in improving people's labour market outcomes? Part of the problem with answering this question is the lack of high-quality data and empirical evidence. In this section we undertake a critical analysis of what is currently known about the effectiveness of Canada's active labour market programs and outline what data are needed to provide a more useful analysis of the status quo.

Before discussing specific programs, it is worth setting out the current state of Canada's active labour market policies generally. We focus on government policies and programs that provide training and job search assistance to unemployed people managed both federally and provincially. While other programs in Canada touch on skills development, such as programs for new immigrants and secondary school students, those run by organizations not contracted with the government, or private companies' internal reskilling initiatives, these programs are outside the scope of our evaluation as we focus primarily on government interventions targeting displaced workers.

Immediately striking is the level of complexity that exists among them from a policy making perspective. Policy incoherence can create confusion for users (May, Sapotichne and Workman 2006; Schneider and Ingram 1997) – but further research is needed to analyze whether this is the case for users of Canadian ALMPs. Figure 1 depicts the sheer number and type of programs that currently exist. A number of programs are managed at the federal level, while provincial governments took on responsibility for managing labour market programs for people receiving Employment Insurance in the 1990s as part of reorganizing relationships and resources

between Canada's federal and provincial governments in the context of budget cuts (Graefe 2006; Simmons & Graefe 2013). These programs are funded through federal transfers and governed by Labour Market Development Agreements (LMDAs). They are then managed and delivered by provincial governments and contracted service providers (some of which are not-for-profit).

The federal government and provincial governments also share some responsibility for ALMPs funded outside of the federal Employment Insurance program. From 2007 to 2014, provinces received federal transfers for these programs, governed by federal-provincial Labour Market Agreements. In 2014, however, the Canada Job Fund largely replaced these programs (Morden 2016). They were reorganized again with the introduction of the Workforce Development Agreements in 2017 (Morneau 2017).

[Insert Figure 1 here]

The complex array of programs may restrict provinces' abilities to update programming in response to labour market changes (Morden 2016). Morden (2016, 38) argues, for example, that the complexity of ALMP provision potentially creates barriers for those seeking support, in part because people may struggle to understand what assistance they are entitled to and who is responsible for facilitating their access to retraining or job search support. However, splitting responsibility between different levels of government may also facilitate flexibility in service provision, allowing training arrangements to be tailored to local needs. More research is

needed to determine whether these complex governing arrangements support or inhibit the ability of ALMPs to offer people relevant, up-to-date skills training.

Canada's expenditure on active labour market policies also suggests there is room for improvement. Canada sits well below the OECD average when spending is measured as a per centage of GDP (including expenditure on administration costs), but firmly within the range of what liberal market economies tend to spend (OECD 2019b) (see Figures 2 and 3). Spending rose slightly following the global financial crisis but was reasonably stable at between 0.24 and 0.26 per cent of GDP from 2011 to 2016. Since 2016, the Trudeau Government has pledged to increase transfers for ALMPs. Federal budgets indicate that the $1.95 billion yearly LMDA transfers were topped up by $125 million for the 2016-2017 financial year. From 2017, an additional $2.7 billion over six years was pledged for Labour Market Transfer Agreements, which cover both the LMDAs and Workforce Development Agreements. The 2018 federal budget also indicates additional funds were earmarked for federal ALMPs, including the Youth Employment Strategy, as well as for the development of a Future Skills organization (later renamed as a Future Skills Centre) tasked with testing and developing training interventions that will align the labour force with demand (Morneau 2018). The 2019 Federal Budget reaffirms many of these commitments, and outlines the Canada Training Credit, a two-pronged program that supports individuals to access training while both in and out of work (Morneau 2019).

[Insert Figures 2 and 3 here]

In order to evaluate the state of knowledge about Canada's existing active labour market programs, we analyze the most recent set of nation-wide program evaluations: the ESDC's evaluations of federal and provincial programs that are funded through the Employment Insurance Act. Next, we discuss the strengths and limitations of these evaluations. These evaluations indicate that in order to respond to technological change, Canada first needs to improve upon its understanding of how effective existing programs are at helping people into work for which there is labour market demand.

Federal Programs

Evaluations of federally managed ALMPs indicate that both the effectiveness of these programs and the methods of evaluation they are subject to could be strengthened. There are three main federal active labour market programs: The Youth Employment Skills Strategy; the Indigenous Skills, Employment, and Training Strategy, and the Canada Job Bank. All three are available to Canadians regardless of whether they are eligible for Employment Insurance (see row two of table one), and the main interventions target groups deemed to be marginalized from the labour market. Some federal initiatives have not been the subject of evaluations, including the Canada Job Bank, which is available to anyone looking for work in Canada and serves as a bank of employment opportunities throughout the country. It matches employment opportunities with jobseekers' self-created profiles. It also contains career planning tools and labour market information. This tool is difficult to evaluate, as data does not exist for non-users who would be comparable to the users of the platform.

Another branch of federal programs permits access to extended retraining in the form of apprenticeships, diplomas, or degrees while in receipt of Employment Insurance. Since 2018, that has been located under the Canada Student Grant and Skills Boost pilot (Employment and Social Development Canada 2018a). These are complemented by the 2019 announcement of the Canada Training Support Benefit and Canada Training Credit, which provide income support and funding for individuals who take time off work to undergo training (Morneau 2019). Undertaking more in-depth retraining may help Canadians better access quality, long-term jobs depending in the areas in which people choose to train. However, there is little available data on the success of these programs. While this is understandable for the newer programs, a commitment to thorough program evaluation should be accompanying new ALMPs. The recently announced EI Training Support Benefit offers unemployed workers further flexibility to seek short-term training if they are eligible for Employment Insurance (Morneau 2019, 37). There is some evidence that those without income security are less likely to complete retraining (Heckman and Smith 2004), suggesting that the federal Liberal government's decision to extend EI eligibility to people in tertiary education is likely to mean more people are able to retrain.[1] Whether people use this assistance effectively to upskill in areas of high demand is another question worth further investigation once the ability to receive EI while in tertiary education has been in place for three to five years, given that program effectiveness for ALMPs is best evaluated over the medium-to-long term (Card, Kluve, and Weber 2017).

The two targeted programs, outlined in Table 1 below, are evaluated by Employment and Social Development Canada, which draws on administrative data and interviews with bureaucrats in

order to assess the impact of such programs on participants. Canada's Federal Youth Employment Strategy aims to assist Canadians aged 15-30 who face barriers to employment and is delivered by Service Canada. The three main programs under this strategy (Career Focus, Skills Link, and Summer Work Experience, outlined in columns two to four of table one) mainly provide short-term employment experience accompanied by some mentoring to Canadians aged 15-30 who face barriers to employment (see row two of table one). The latest evaluation, undertaken in 2015, takes the form of a non-experimental incremental impact study, explained in row five of table one, which compares participants' outcomes to people in the same age range who received some support in the form of Employment Assistance Programs provided by provinces.

Career Focus, detailed in column two of table one, provides financial assistance to employers who create professional development opportunities that promote the skills and knowledge necessary to participate in current and future modes of work (Government of Canada 2016c). The 2015 evaluation of Career Focus found that the program also has positive effects on participants' future earnings and that approximately one of five participants returned to school or further training after completion of the program (Employment and Social Development Canada 2015b). Positive effects were slightly higher for male participants, though both groups made gains to income in the six-year period following participation (Employment and Social Development Canad, 2015b) – confirming the trend that ALMP evaluations must consider impacts in the long-term (Card, Kluve, and Weber 2017).

Skills Link, outlined in column three of table one, appears to be less successful than Career Focus in improving participants' outcomes. Participants' earnings five years after completion were in fact lower than control group members' earnings (Employment and Social Development Canada 2015b). Skills Link targets support to young people who face significant barriers to employment – particularly basic literacy – so improving this program is likely to be essential to ensuring marginalized young people are not left even further behind if mobile robotics and machine learning decrease demand for routine non-cognitive tasks (Autor, Levy, & Murnane 2003; Manyika et al. 2018).

The Summer Jobs component, of the Youth Employment Strategy aims to help young people connect with employment, outlined in column four of table one. The program provides funding to employers who create youth job opportunities and preference is given to employers that support STEM-related work, particularly for women (Government of Canada 2015b). Program participants have reported learning both technical skills and non-cognitive skills, which the literature on the future of work indicates is highly desirable (Autor, Levy, & Murnane 2003; Deming 2017; Lowe and Graves 2016; National Research Council 2012). An incremental impact evaluation of the Summer Work Program has not been completed, creating a clear gap in our knowledge about the effectiveness of this program.

This set of programs may help young people begin their careers and adapt to changing labour market demands – but we are limited in our ability to assess these due in part to the lack of detail about participants' outcomes. Future analyses of the Youth Employment Strategy should

consider how these impacts vary in relation to participants' previous levels of education, as well as reporting findings on industries and occupations that participants are connected to.

[Insert Table 1 here]

There are even more significant limits to current knowledge regarding the effectiveness of the Indigenous Skills and Employment Training (ISET) program (see column five of table one), which is particularly concerning given the continued labour market disadvantages First Nations, Métis and Inuit workers experience (Hu, Daley and Warman 2019). The previously named Aboriginal Skills and Employment Training Strategy (ASET) focuses on increasing employment for First Nations, Inuit, Métis, and status and non-status Indigenous peoples in Canada by providing multi-year funding to indigenous organizations. It is complemented by the Skills and Partnership Fund, which is similar but provides short-term training and skills development projects. By drawing on interviews with those responsible for program delivery, ESDC concluded that ASETS programs were generally able to provide participants with skills relevant to their local labour markets (Employment and Social Development Canada 2015a). However, more granular evaluation detail is needed to help with assessing whether these programs offer building blocks towards responding to technological disruption.

The combination of these policies indicates that federally, there is a significant lack of data and evaluations of active labour market programs. Before any policy changes are made to respond to technological disruption, a more thorough interrogation of existing program effectiveness is

needed. It may be that programs expanding access to tertiary education are effective – but this is worthy of careful investigation. While there is concern about qualification inflation and misalignment between qualifications pursued and demand (Fuller and Raman 2017; Grant 2016), completion of a tertiary degree still carries an earnings premium and facilitates intergenerational mobility (Corak 2013). Basic literacy and numeracy continue to have positive income effects (Charette and Meng 1998; Ferrer, Green, and Riddell 2006; Hu et al. 2019), though there is also room for changes to Canada's education policy to better support human capital development (Corak 2018). Furthermore, qualification misalignment may be overstated once transition changes are accounted for (Edge, Martin, & McKean 2018). Alternatively, problems of mismatch may be the result of declining employer investment in training rather than with the supply of graduates (Lowe & Graves 2016). Whether the Canada Training Benefit can help to encourage training for those already in work will be worthy of investigation once it has been in place for a number of years. Regardless, planning to collect data in order to evaluate the impacts of these federal programs on people's future employment and earnings is vital.

Provincial Initiatives

Provinces are likely to also be involved in any future programs designed to combat technological disruption of the labour force. In this section, we analyze the state of knowledge regarding the main ALMPs delivered by Canada's provincial governments. The three main forms of ALMPs consistent across the provinces are skills development and employment assistance programs, self-employment assistance, and partnerships with employers (the Labour Market

Agreements for People with Disabilities expired in 2018 and will be combined into the next Workforce Development Agreements). In this section, we focus on training governed by the LMDAs, as these programs have been in-place long enough for government evaluations to occur. The findings of these evaluations are likely to also speak to the strengths and weaknesses of training governed by the Workforce Development Agreements, as these agreements, introduced in 2017, are supposed to align training for those not eligible for EI more closely to training offered under the LMDAs.

Taken together, the ESDC evaluations indicate that there is room for improvement in both the evaluation and delivery of these provincial ALMPs. Table 2, below, summarizes the completed ESDC evaluations of the territories and provinces in 2018. As with the federal-level evaluations, the ESDC reports draw on administrative data to generate incremental impact analyses rather than randomized control trials. The reports do not specify sample size or the precise matching criteria used to build control groups. Data on outcomes for Yukon and the Northwest Territories are also missing. In general, the data available suggests that skills development and job creation programs have the greatest impact on future earnings and likelihood of employment. In contrast, targeted wage subsidies and employment assistance have negative effects on the likelihood of being employed alongside smaller wage effects.

[Insert Table 2 here]

Skills development programs, outlined in column two of table two, are provided throughout

Canada and do increase a participant's likelihood of being employed relative to a non-participant across the provinces and territories (for provincial data, see Appendix 1). That said, the impact is a lot more significant in Alberta (an increase of 9.6 per cent) than in Nunavut (two per cent increase). Report commentary derived from interviews with bureaucrats and program delivery professionals indicate that linking training decisions to information about labour market demand is part of the program's success (Employment and Social Development Canada 2018b). Nunavut's process of organizing access to training also involves factoring in labour market demand (Employment and Social Development Canada 2018d) and the report suggests the lower success rate is more to do with limits to employment opportunities.

Employment assistance services tend to have smaller effects on participants' probabilities of being employed, in part because these services support people who are further from the labour market (as outlined in column two of table two). This aligns with the findings in academic studies of ALMPs which indicate that job search programs have more consistent but less significant effects on future employment and income (Card, Kluve, and Weber 2017). Employment assistance impacts also vary, producing earnings differentials of $4855 on average in Alberta and $12,531 on average in Newfoundland and Labrador. Furthermore, the reports suggest that people have trouble accessing these services, partially because they are not aware that they exist and partially because of a lack of administrative capacity, noted in Alberta and Ontario especially (Employment and Social Development Canada 2018f). For Canada to be prepared for the future of work, supporting those who need the most help with skills development is likely to be important if employment growth is to include those most-

marginalized from the workforce – especially given that those with lower educations have been found less likely to have access to adult education (OECD 2019a). People in need of this support are likely to struggle to participate in lifelong learning if they are not supported to undertake basic skills acquisition.

It is reassuring that skills development and employment assistance programs receive the bulk of LMDA funding as systematic evaluations of ALMPs indicate that human-capital focused programs tend to have positive impacts on participants' employment rates (Card, Kluve, and Weber 2017). For 2014-2015, 86 per cent of funding under the LMDAs nationally went to these programs, with 51 per cent directed to skills development (Employment and Social Development Canada 2017b). These programs fund training costs or provide services that support people with counselling and job searches, the latter of which are also available to people who are not eligible for Employment Insurance. Provinces and territories tend to spend more on training services than employment assistance services, with the exception of Ontario, the Northwest Territories, and Nunavut.

While training services are reasonably strong, apprenticeships are not faring as well. Apprenticeships involve vocational training and secure the certification needed to work in skilled trades such as carpentry, heavy equipment operation, iron work, and machining (Employment and Social Development Canada 2017a). Those who complete Red Seal trade apprenticeships are then licensed to work across Canada's provinces in their given area. The LMDA portion of Canada's apprenticeship system has worryingly high drop-out rates in all

provinces and territories. The evaluations of provincial and territorial programs suggest that time-lags in receiving EI are a major reason for non-completion (Coe 2013; Employment and Social Development Canada 2018b-j) – an issue that should clearly be prioritized. Furthermore, the population of skilled tradespeople in Canada is aging (Lehmann 2012), indicating that there might be unmet demand in jobs for which apprenticeships are able to provide a skilled workforce.

Another much smaller form of support offered to displaced workers is self-employment assistance. Provinces spend between one and eight per cent of their LMDA funding on self-employment support programs. These programs provide people interested in self-employment with formal teaching, coaching, and assistance with business plans. As a result, people may enhance their problem-solving skills and adaptability. People also receive EI and financial support with start-up costs. These programs are not widely used, and some provinces struggle with finding the data to evaluate them (Employment and Social Development Canadas 2018c, 2018e, 2018f, 2018g, 2018h, 2018i). Of concern as well is the lack of knowledge about how these programs are delivered across the provinces reported in the ESDC evaluations. Whether self-employment offers a pathway to quality work is particularly difficult to measure. While self-employed Canadians tend to report low earnings, some draw low salaries and keep money within their businesses (LaRochelle-Côté and Uppal 2011).

A final strand of support links assistance with employment in the form of employer partnerships and targeted wage subsidies, outlined in column four of table two. These

programs partially cover employers' costs of hiring participants. Provincial governments tend to spend between one and eight per cent of LMDA funding on these initiatives (save for Nunavut, which spends 17 per cent) and all provincial evaluations report declining use of targeted wage subsidies in particular. These programs were historically quite successful at converting work experience into permanent employment, in line with what international ALMP evaluations find when it comes to employment placement programs (Card, Kluve, and Weber 2017). Presently, both tend to improve on future earnings, but targeted wage subsidies on average actually decrease participants' likelihood of being employed due to particularly negative impacts in Nunavut and the Northwest territories (see table 3). Provinces report issues with employers' knowledge of or willingness to take part in the program, administrative burdens, or employer expectations (Employment and Social Development Canada 2018c, 2018e, 2018g, 2018i, 2018j). Provincial evaluations also say little about the occupations in which people are placed.

All provinces report a need for better labour-market information and better administration. Only Ontario and Prince Edward Island are using LMDA funding for research and innovation. The ability of provinces to ensure their programs support people in finding work depends on the quality of the labour market information they can access. Across the board, provinces report concerns about people's access to such information and report that they need better access to both labour market information and to information about participants' specific needs. The Federal Advisory Council on Economic Growth (2017) reports several initiatives that need to be linked through to provincial ALMP efforts. In general, then, Canada's employment assistance services are improving people's chances of success in the labour market. These

programs need to be supported, however, with better labour market data and data about trends in long-term demand, alongside data about the types of employment outcomes participants achieve to assess whether people are being placed in sustainable occupations. Along with data issues, provinces need to address these issues in order to first fully understand the effectiveness of existing ALMPs before preparing to make changes in order to respond to technological disruption of the labour market.

Discussion and Conclusion

While research has begun to tackle the question of what is to be done in an era of large-scale technological disruption – especially for displaced workers – it generally suggests that the focus be on retraining. However, the current state of knowledge regarding interventions for displaced workers is incomplete. There remains a need to systematically evaluate what we know about future demands for core skills and competencies – a challenge this research team is tackling. Research would benefit from a much wider multidisciplinary scholarly lens and empirically grounded research on the experiences of workers and the kinds of education and training that complement these technological changes. Our review of ALMP effectiveness in Canada suggests that there is a need for more data both to inform program decisions and to evaluate their outcomes. While current evaluations are able to document effects on earnings post-participation, we call for more data on the occupations that participants train for and end up in. We need systematic, independent academic evaluations that utilize randomized control trials, alongside work that analyzes how people find out about and gain access to ALMPs to ensure people are able to participate in quality retraining that supports them in the labour market.

Insights from historical institutional scholarship emphasize the challenges governments face in significantly veering from path dependent approaches to policy (Thelen 2004). To date, in Canada, there has been no paradigmatic shift in response to rising concerns about technological disruption of the workforce (Jansen and Robbins 2019), despite these concerns having been raised some time ago (Muszynski & Wolfe 1989). This shift may indeed be coming: the federal Future Skills Centre may be able to provide sufficient data and new programs, which would strengthen Canada's ability to ensure interventions are relevant in the context of a changing labour market. Others have called for a wider review of Canada's training systems, citing a "growing need for flexible and on-demand training" delivered by tertiary institutions and business alike (Anani 2018). The Canadian government's response to date has been to improve access to income support in the form of EI while undertaking retraining through the 2018 introduction of the Skills Boost pilot and the 2019 announcement of the Canada Training Credit and EI Training Support Benefit (Morneau 2019).

Added to the policy-making challenges is the fact that these technological changes are occurring in the context of widening income and wealth inequality, particularly in liberal market economies such as the United States, Great Britain and Canada (Corak 2013; Fortin et al. 2012). The social policy implications of a new world of work where more and more people are responsible not only for their own employment but also for the attendant risks such as sickness, job loss and underemployment are considerable (Hacker 2004; Johal and Thirgood 2016; Bajwa et al. 2018). Exposure to these risks also varies by gender, race and migration status—at least in

Canada and likely elsewhere as well (Vosko and Clark 2009). Some research notes the link between technological change and the reorganization of productive value to rising inequality. So far in Canada, workers' general ability to achieve eligibility for Employment Insurance, and entitlement supplementary forms of health insurance, sick leave and maternity leave do not appear to be part of the discussion about responding to technological disruption—despite acknowledgement that technological disruption will deepen the current trend toward contract work over employment. Instead, the gap in access to state support between people who can access employment insurance and those who cannot remains in place. Contractors on low incomes (and especially micro-contractors—see Bajwa et al. 2018) lack access to employer-sponsored training and to a swathe of active labour market programs for which access depends on having employment insurance.

How does the social safety net need to respond to a "fissured workplace" (Weil 2014) where employers and firms are shedding responsibility for providing workplace benefits? As employees morph into individual "entrepreneurs" and firms take less responsibility for providing employee benefits, who should take on the responsibility for providing those benefits? To put it more bluntly, in an era of TaskRabbit, who is responsible for social policy benefits? Such a concern applies to any jurisdiction in which some benefits are tied to employment status. One option would be to alter the work requirements for eligibility to Employment Insurance, while a more radical option would be to merge provincial social assistance and Employment Insurance together. These options are worthy of more in-depth analysis. Governments will have to make trade-offs about efficiencies and equity when deciding

which groups to prioritize for retraining in light of anticipated disruptions. Evaluations that traced the impact of different programs for different groups (those with and without extensive work histories and those with specific skills profiles for example) would provide better information for governments to manage these trade-offs. Research is needed that both provides this form of evaluation and that draws on it to consider the kinds of trade-offs governments can make when responding to technological disruption.

Before governments design responses to technological disruption of the workforce, they need sound information about both the effectiveness of retraining programs and which skills are likely to be in high demand. Existing research suggests that demand for non-cognitive skills that involve empathy and creativity is likely to increase, though these terms are not sufficiently specified to build new training interventions around. Further, knowledge regarding the effectiveness of existing training programs for people not in work is imperfect – particularly in Canada. The most recent government evaluations indicate that there is great variation in program effectiveness, alongside significant gaps in what is known about their effectiveness, for different groups of workers. Policy makers need a much more solid knowledge base regarding both changing demand for skills and existing program effectiveness before they can develop robust policy responses to the technological disruption of labour.

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Figures and Tables

Figure 1: Map of ALMPs and Apprenticeships in Canada

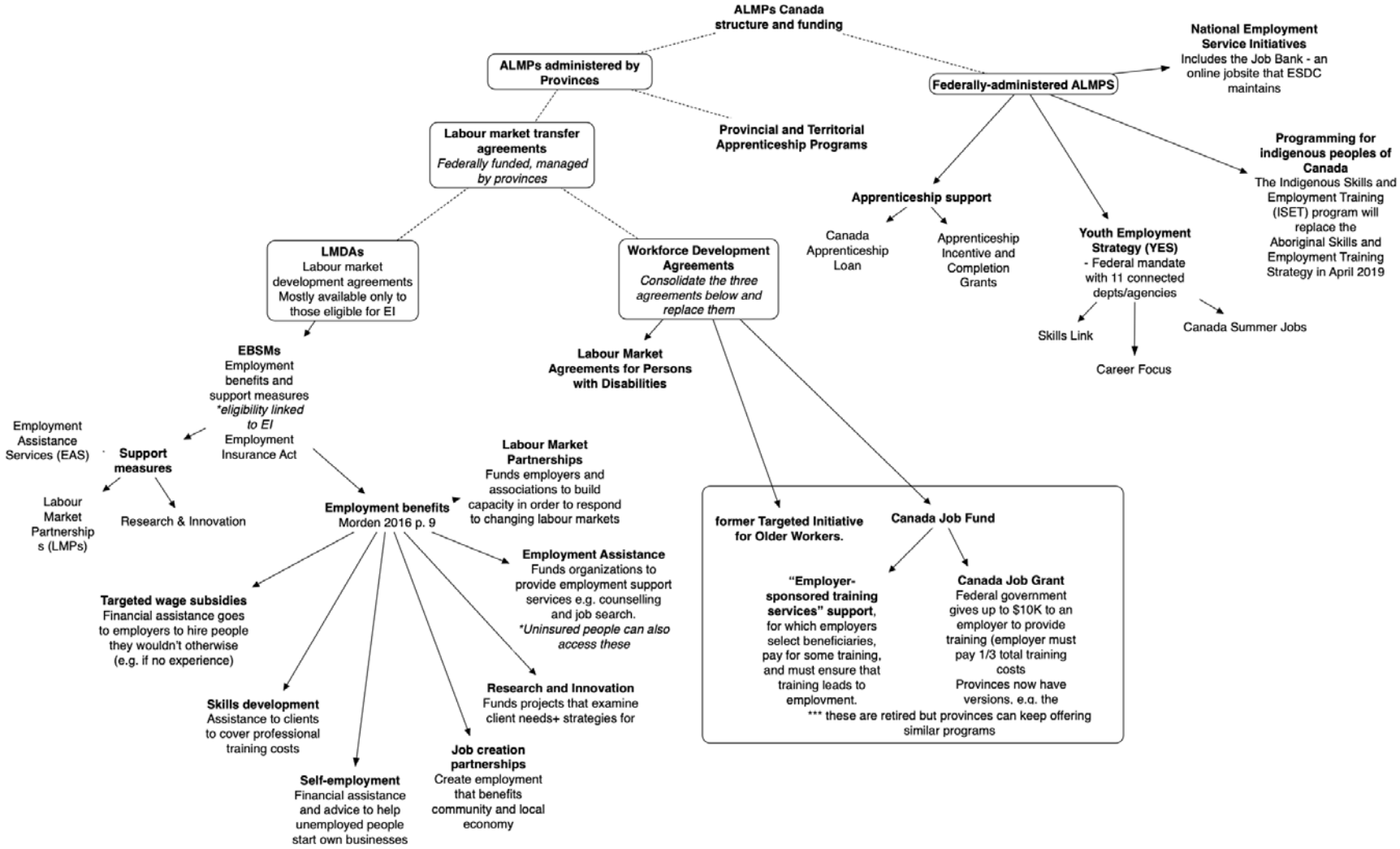
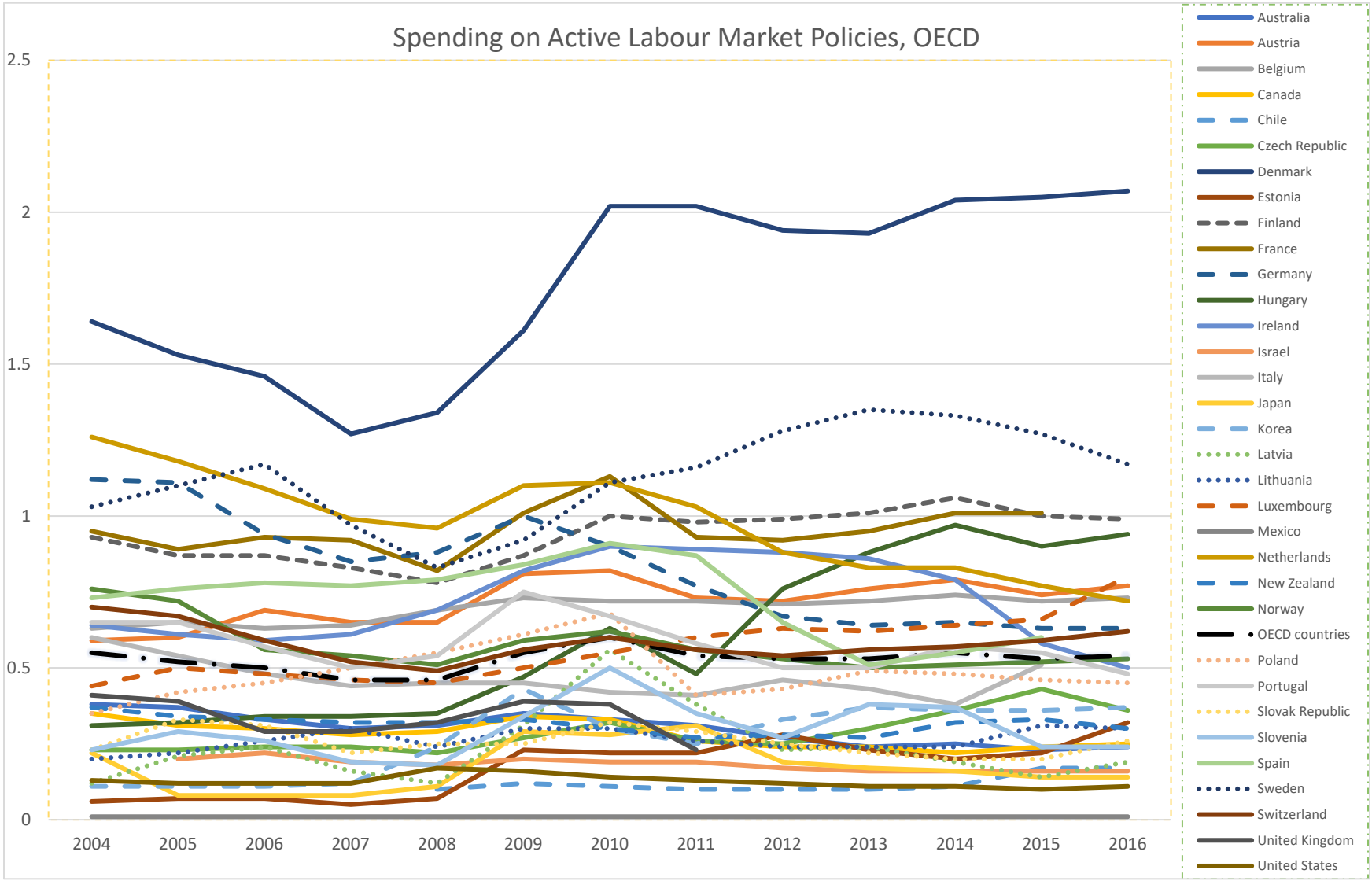


Figure 2: ALMP Expenditure as % of GDP (OECD 2019b)



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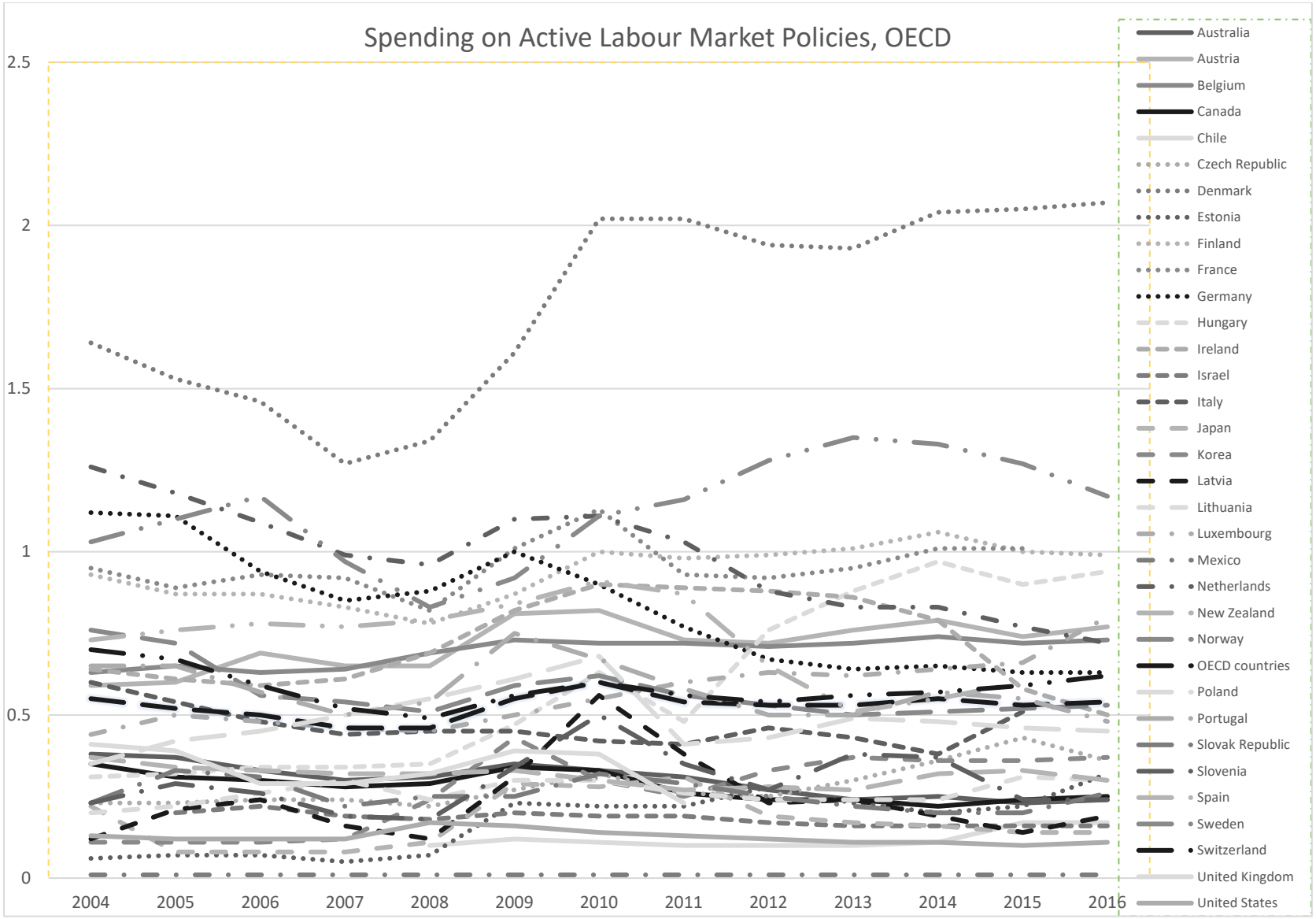

Figure 3: Labour Market Policy Expenditure and GDP Per Capita, OECD Countries 2016 (OECD 2019b; OECD 2019c)

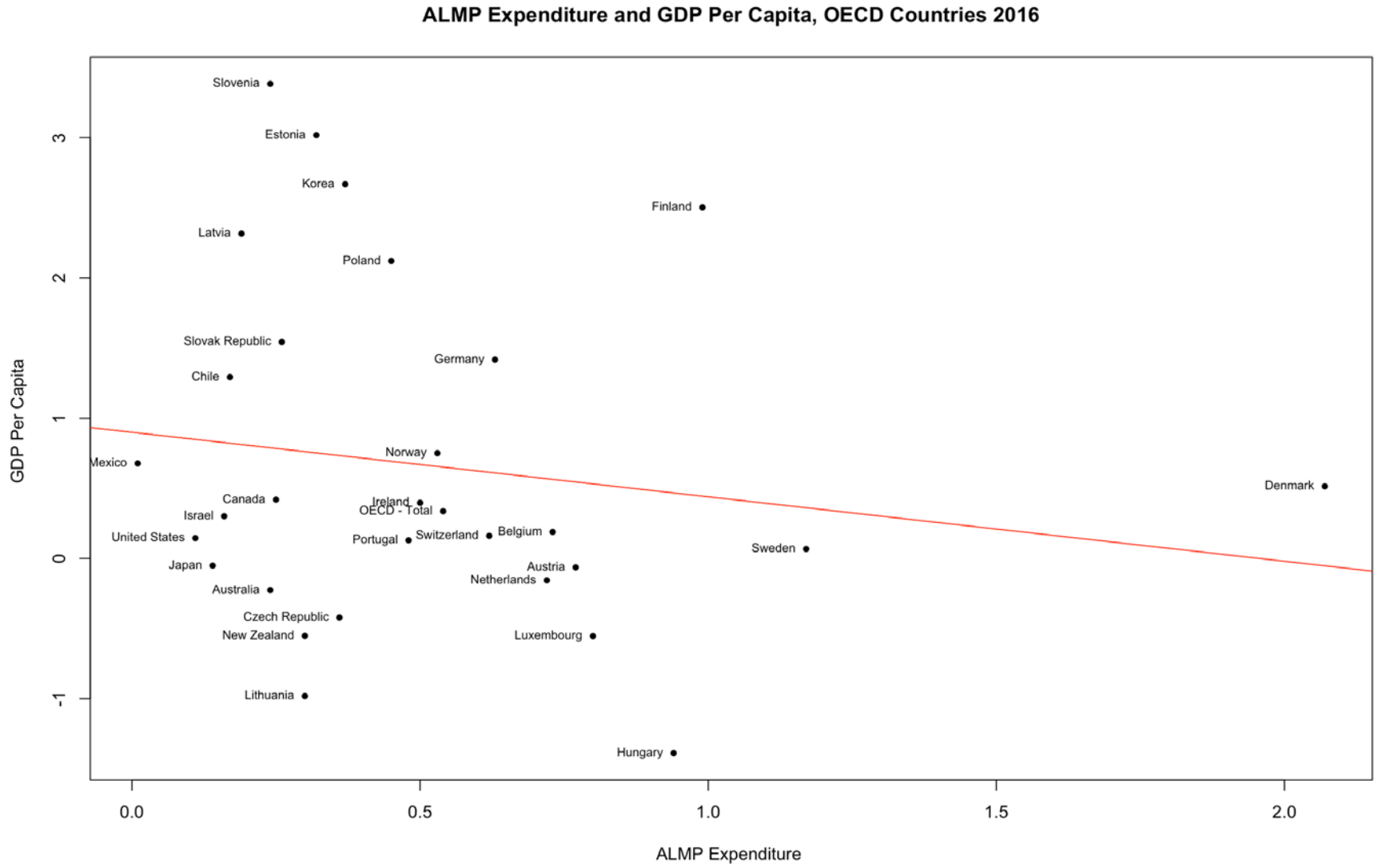

Table 1: Summary of Federal ALMP ESDC Evaluations

	Federal			
	Youth Employment Skills Strategy			**Indigenous Skills and Employment Training Strategy**
	Career Focus	*Canada Summer Work Experience*	*Skills Link*	
Program	Provides skills training, work experience, supports self-employment.	Help youth secure employment experience by funding employers, provide job search services and labour market support through coaching.	Provides work experience, mentoring, skills development (including "employability skills"), supports self-employment, assistance with career and skills planning.	Skills development, training, and employment for First Nations, Inuit, Métis, and non-status Indigenous peoples delivered through contribution agreements with Indigenous organizations.
Eligible population	Citizens, permanent residents, or those with refugee protection aged 15-30 with barriers to employment (including early school leavers, recent migrants, visible minority youth, youth living with disabilities, single parents, youth in low-income households, experiencing homelessness, or living in remote areas). Career Focus is not available for those eligible for EI.			First Nations, Inuit, Métis, and non-status Indigenous peoples. Eligibility for EI not required.
Treatment	Mentoring and skills training, often in the form of wage-subsidized internship opportunities.	Mentoring and subsidized employment.	Short-term subsidized employment experience.	Interventions vary across organizations delivering support.
Outcomes measured	*Earnings*: Gain of $40,488 in annual employment earnings over six years *Cost-benefit analysis*: benefit is 4.74 times average costs *Future EI Use*: x	Not included in incremental impact study, though participants reported that work experience allowed them to earn income to support their further education.	*Earnings*: no statistically significant impact on employment earnings over comparison group, though effects vary by age. *Cost-benefit analysis*: cost-neutral for those who completed university education. Full data for all participants unavailable. *Future EI Use*: 24% participants in receipt of benefits after participating	*Earnings*: $1621 increase in average annual earnings for participants Employment: five percentage point improvement in incidence of employment *Future EI Use*: increased by three percentage points (indicates attachment to labour market, per EI eligibility).
Methodology used	Non-experimental incremental impact study. Comparison of treatment and control (non-random assignment), who received limited treatment under Employment Assistance. Cost-benefit analysis. Interviews.			Non-comparative. Data collected: survey of 250 educational or employer partners, 8- interviews, and document and file review. Administrative data used but limited for the years 2011-2013.

Table 2: Summary of Provincial ALMP ESDC Evaluations

	Provincial		
	Skills development	**Employment assistance**	**Partnerships with employers**
Program	*Skills development*: financial assistance for classroom-based training. The apprenticeship stream provides additional financial support to apprentices eligible for EI.	Job search support, career counselling, job placement services, labour market information dissemination, and case management.	*Job creation partnerships*: funding supports the creation of community-project based employment. *Targeted wage subsidies*: funds work experience opportunities by subsidizing wages.
Eligible population	Requires eligibility for Employment Insurance - must have worked sufficient hours in insurable employment and have not worked in at least seven days through no fault of their own – and be available for and actively seeking work.		
Treatment	Skills training completed varies by province, availability, and selection.	Interventions vary across organizations delivering support.	Form of training and employment varies.
Outcomes measured	Average across provinces Employment: 2.86 (change in probability of being employed relative to non-participants for active claimants) *Earnings*: $19,203 average cumulative earnings over 5 years relative to non-participants (active claimants) *Cost-benefit analysis*: 4.69 years until benefits exceed program costs for active claimants	Average across provinces Employment: -1.15 (change in probability of being employed relative to non-participants for active claimants) *Earnings*: $3858 average cumulative earnings over 5 years relative to non-participants (active claimants) *Cost-benefit analysis*: 2.66 years until benefits exceed program costs for active claimants	Average across provinces **Targeted Wage Subsidies**: Employment: -1.04 (change in probability of being employed relative to non-participants for active claimants) *Earnings*: $9573 average cumulative earnings over 5 years relative to non-participants (active claimants) *Cost-benefit analysis*: 3.58 years until benefits exceed program costs for active claimants **Job creation partnerships** Employment: 5.33 (change in probability of being employed relative to non-participants for active claimants) Earnings: $12,284 average cumulative earnings over 5 years relative to non-participants (active claimants) Cost-benefit analysis: 12.18 years until benefits exceed program costs for active claimants.
Methodology used	Incremental impacts analysis using administrative data, measuring earnings, EI or social assistance use, and incidence of employment. Comparison of participants versus non-participants matched using 75 socio-demographic and labour market variables, with a five-year observation window.		

Appendix 1: Table of Provincial ALMP Impacts

Province	Measure	*Skills development*	*Targeted wage subsidies*	*Job creation partnerships*	*Employment assistance*
Alberta	Employment	9.6	7.3	10.8	2.2
	Earnings	$16,952	$12,700	$17,283	$2,485
	CBA	5.1	4.3	6.5	5.2
British Columbia	Employment	4.8	5.8	3.4	1.9
	Earnings	$18,819	$17,479	$10,675	$584
	CBA	6.7	3.2	23.6	9.4
Newfoundland and Labrador	Employment	1.8	2.7	2	0.4
	Earnings	$16,644	$13,639	$4,205	$12,531
	CBA	6	2.5	15.7	2.1
Northwest Territories	Employment	-3	-28		
	Earnings	$17,504	-$4,349		
	CBA				
Nova Scotia	Employment	4.9	5.1	5.1	1.4
	Earnings	$23,728	$13,617	$11,976	$5,287
	CBA	4.3	3.3	11.9	4.9
Ontario	Employment	4.4	7.2	6.4	16
	Earnings	$13,026	$17,239	$18,235	$714
	CBA	7.8	3.9	19.9	9.3
Prince Edward Island	Employment	2.4	4.4		0.8
	Earnings	$15,380	$14,499		$156
	CBA	5.1	3.9	8.9	
Saskatchewan	Employment	5.6	2		0.9
	Earnings	$31,770	-$1,702		$5,337
	CBA	3.2	Not recovered		3.8
Yukon	Employment	No data for active claimants available for Yukon			
	Earnings				
	CBA				
Nunavut	Employment				
	Earnings	$15,081			$2,528
	CBA	2			-12

Employment: change in probability of being employed relative to non-participants for active claimants
Earnings: average, cumulative over 5 years for active claimants relative to non-participants
Cost benefit analysis: number of years for benefits to exceed program costs for active claimants.

Appendix 2: Literature Review

This literature review includes the results of our search for literature that discusses education or training responses to technological disruption. Our research questions for this work were: what is the state of knowledge regarding technological disruption and its implications for skills and training across the lifespan of a worker? What are the main trends in speculation regarding the future of education and skills training given developing technological disruptions?

The review contains sources published during or after 2006. This is supplemented with Canadian sources published during or after 1980, to ensure the full extent of the Canadian literature was captured. We first entered key words based on recommendations from librarians and academic experts on automation and political economy and completed Google scholar searches using different combinations of these keywords. The keywords used in these searches are provided in the table below. Combinations of the terms in the table below were included. Additional terms in blue were added for the jurisdictional scan which will be described below.

Worker	Technological change	Education	Policy or program change	Displaced	Jurisdiction
Employ*	Technolog*	Training	Policy change	Displac*	Canada
Work*	Technological change	Vocational	Policy innovation	Disrupt*	Province (individually)
Labour force	SBTC	Occupational	Innovation	Unemploy*	
	Trends	Education	Change	Technological unemployment	
	Change	Retraining	Curriculum	Dislocated	
	Response	Apprentice			
	Innovation				

Sources were selected based on manual abstract scans and grouped into three categories: social/political disruption; education; and policy levers. This stage served to generate an impression of the existing literature and inform the process of narrowing the scope of the project.

We also undertook systematic database searches. Four databases were selected based on their relevance and on the interdisciplinary commitment of this project: ProQuest, EbscoHost (which includes Business Source Premier, Child Development and Adolescent Studies, EconLit, Education Source, Left Index), JStor and EconPapers. These databases were searched using the

same set of search terms outlined in the table above. Abstract or Boolean only searches were used when available. Searches were limited to full text, English-only texts published between January 2006 and 2018. Works that did not primarily focus on either education or technological change were excluded, in line with the focus of the research questions set out. In order to ensure the Canadian literature was captured, a second phase of searching Canadian journals and the publication records of key scholars was undertaken and these results are included in the literature review.

The literature review categorizes each entry under one of the following headings, based on the main theme in the literature. Note that there is significant thematic overlap between some of these folders. In this case, entries were categorized based on the entry's main focus.

***Education and training*:** One strand of literature focuses on the relationship between education and skills needed in the workforce. This literature has three main aspects. First, it discusses the role of different levels of education in training people to utilize new technologies in the workplace. Second, it sets out how education systems have responded to changing labour market demands driven by technological change. Finally, it analyzes the use of new technologies such as MOOCs and virtual reality as educational tools.

***Technology and displacement*:** A second strand of literature debates the impact of technology on changing demand for skills. Scholars debate whether automation is destroying low-, middle- or high-skilled work. The literature uses various estimation techniques to provide estimates of the impact of machine learning and mobile robotics that use task-based approaches. It also includes some discussions of the impact of technology on broader social phenomena, including redistribution.

***Skills and technological change*:** While there is some overlap with the previous two categories, literature in this area explicitly debates what skills are needed. Three main themes emerge: the need for "socio-emotional" and managerial skills to organize human labour to work with technology; the need for specialized knowledge of emerging technologies; and the need to "learn how to learn" in order to remain adaptable.

***Responses to the changing workforce within Canada*:** Sources that specifically discuss the impact of changing technology on employment and education in Canada explicitly are separated out from the other areas.

***Workforce displacement*:** Literature in this area discusses the implications of workforce displacement more broadly.

***Retraining after displacement*:** Given that workforce disruption is a wider phenomenon, literature that provides empirical discussions of retraining methods for displacement not necessarily caused by technological change is included in this category.

***Politics, public policy and disruption*:** Literature in this area outlines political and public policy-related responses and dynamics with respect to technological disruption that do not focus on education and training.

Displacement general: This literature surveys the more wide-ranging economic effects of work displacement.

Sources are cited in line with the APA guidelines. Please note that some sources may be behind a paywall and were accessed using the University of Toronto's library access.

Research questions and theses were drawn from scans of the sources included and have been provided to assist researchers with selecting relevant material for their own projects. Jurisdictions analyzed in the source material vary between the local, state/provincial and national level and include many cross-country comparisons. The main country of focus is noted in the jurisdiction column.

Appendix 3: Jurisdictional Scan

The jurisdictional scan is a targeted list of policy frameworks at both the federal and provincial levels of government that specifically address workforce disruption (actual or potential) caused by technological change. It also includes not-for-profit entities and collective agreements that address technological change on specific workforces or industries.

This scan was accomplished in two phases. Phase One consisted of a systemic search of media sources and government literature to locate government interventions intended to mitigate worker displacement caused by technological change. Two databases were selected based on their relevance to this project: EbscoHost and Proquest database (specifically Global Newsstream and Canadian Major Dailies). Database thesauruses were also used to narrow term selection. Searches were further limited to full text, newspaper articles, reports, academic articles, government or official documents, news releases, reference documents, statistics/data reports, all after 1 January 2006. Databases were searched using the following terms: **worker, technological change, education, policy change, program change, displace,** and **Canada.** The exploded search term option was selected when available. Searches were revised when over 400 results were returned to maximize efficiency.

Phase Two of the jurisdictional scan was conducted by combing through online government resources. Policies and initiatives were aggregated from federal and provincial websites and were selected based on their applicability to the search terms listed above and their relevance to the project. Provincial websites were reviewed individually to differentiate the inter-domestic response to technological disruption.

Search results were reviewed for relevance, entered into the search database, and organized according to relevance: from most relevant, where the article explicitly reported on changes to policy, education or training as a result of technological change; to least relevant where displacement or technological change are discussed but without linking to education, training or other policy.

Guide to Using the Jurisdictional Scan

Each initiative identified in the jurisdictional scan is divided into one of **seven** broad categories and then further organized at the individual program level (e.g. federal, provincial, not-for-profit).

Policies and programs are categorized as follows:

- **A: Worker Education/Training:** Education or training programs whose intervention is targeted at workers directly (whether it be current workers, prospective workers, laid-off workers, the un- or under-employed, etc.).

- **B: Youth Training and/or Apprenticeship:** Programs for secondary or post-secondary students that help develop skills and/or support hands-on experience through internships, apprenticeships, or co-ops. Many programs focus on emerging industries and allow participants to pair classroom studies with on-the-job training supervised by a skilled sector employee.

- **C: Employment Transition Program:** This highly targeted type of intervention focuses on transitional programming intended help workers in disrupted industries attain different occupational roles within their existing company, or to enter a new career path.

- **D: Employer/Provider Education and Training:** These programs are mostly government-run and provide support to employers and labour groups by helping them develop strategies to mitigate future workforce disruption, often caused by technological change. Assistance includes interventions in human resource management, access to experts for industry specific analysis, etc.

- **E: Grants/Direct Payment***:* Federal or provincial government programs that provide direct funds to education and training initiatives. Grant funding is also available through some not-for-profit organizations. The funding focuses on developing skills that are expected to be in-demand in workplaces of the future.

- **F: Development Initiative:** Government and not-for-profit strategies that may lead to the development of future education or training programs. This type of intervention largely involves partnerships between sectoral leaders and government or a cluster of industry stakeholders who convene to address sector-related concerns.

- **G: Collective Agreement:** This category focuses on collective agreements that explicitly put in place policies to address future technological change and its impact on workers.

Policy Intervention	Number of programs in Jurisdictional Scan of Canada
A: Worker Education/Training	8
B: Youth Training and/or Apprenticeships	17
C: Employment Transition Programs	3
D: Employer/Provider Education and Training	7
E: Grants/Direct Payments	40
F: Development Initiatives	6
G: Collective Agreements	3
Total	**84**