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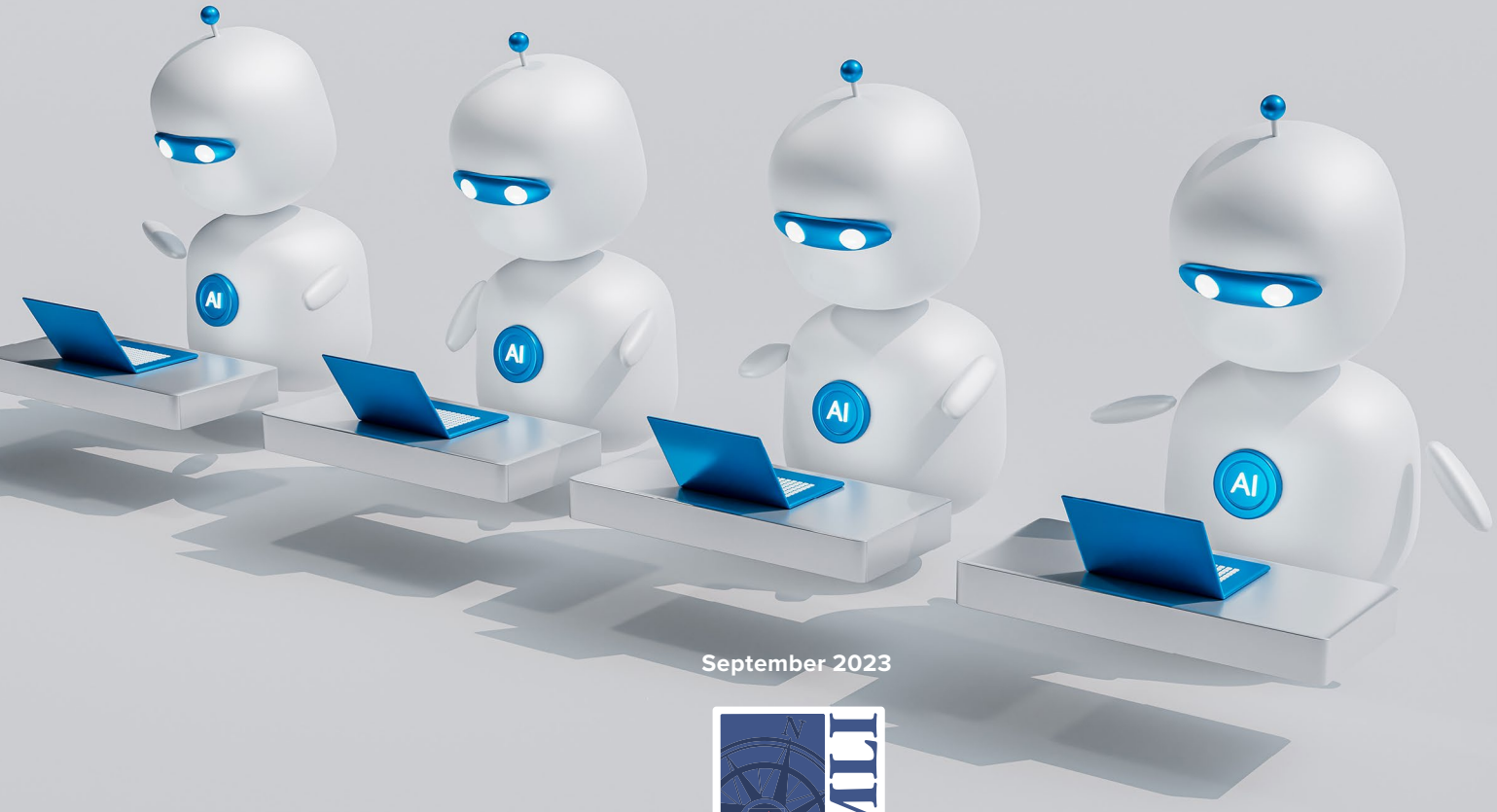
ARTIFICIAL INTELLIGENCE

A threat to middle-class, white-collar jobs?



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Artificial intelligence (AI) is emerging as the most discussed technological, social, and economic phenomenon of 2023. But many people are concerned that if it proves to be an improvement over human intelligence, AI will significantly reduce the demand for labour, especially for middle-class jobs.

This paper looks at the possible economic impacts of AI. It makes no attempt to forecast how AI will evolve and does not address broader concerns about whether the capabilities of AI will outrun the ability of humans to understand and manage this technology. Rather, it examines the economic impact of AI so far and compares its evolution with past forecasts of how technological change would affect workers. It cautions against a rush to increase government regulations and spending based on as yet unfounded concerns about the impact of AI on jobs.

Machine automation has been feared for its impact on human jobs since the Industrial Revolution began. Earlier eras of automation disrupted employment patterns in farming and factories, but overall job growth actually accelerated as higher incomes drove the expansion of other industries. Despite that experience, there are numerous forecasts that the deployment of AI will lead to widespread job losses.

Compounding the anxiety of potential job losses is the fear that AI will displace middle-class jobs and that the rewards from the widespread deployment of AI will accrue to a small number of people who own the capital and will thereby increase inequality. The reality is that recent developments in the labour market are the exact opposite of these gloomy predictions. Employment rates are at an all-time high. The main difficulty of employers is finding workers in a labour market where unemployment is near historic lows. While AI technology was predicted to be a unique threat to white collar jobs, white collar employment in Canada, the US, and Britain continues to increase steadily. This raises the possibility that AI will be deployed to help workers do their jobs better – not to get rid of employees.

There is a long history of erroneous predictions about new technologies leading to massive job losses for workers. While every recession in the past century has been at least partly blamed on automation, these pessimistic forecasts were all incorrect because

of what economists call “the Luddite fallacy,” which ignores the fact that productivity gains from technological innovation always have immediately or eventually generated more income and jobs. Over the last two centuries job losses on farms and factories that resulted from new technologies were balanced by workers upgrading their skills and moving to new occupations where demand was rising due to higher incomes generated by productivity gains. Few of the lost jobs were missed as most of the work replaced during the early Industrial Revolution was repetitive, routine, and often dangerous. While economists and pundits worried for decades that robots and automation would destroy millions of jobs, outside of cyclical recessions employment rates have risen steadily, to record highs.

> *There is a long history of erroneous predictions about new technologies leading to massive job losses for workers.*

Much of the difficulty of forecasting the impact of technology on the labour market stems from the challenge of predicting how technology itself will evolve. Overall, AI is likely to make workers more productive and therefore more desirable to employers. Furthermore, the implementation of AI technology is likely to roll out slowly, which will help employers and workers adapt to its use. Past history shows even the most transformative technologies, such as electricity or the internal combustion engine, require decades to be widely diffused. A prolonged period of adaptation seems to be inevitable for AI.

While the potential capabilities of AI are often exaggerated, human abilities are routinely underrated. Humans retain key abilities that machines cannot duplicate or replace. Even in highly technical fields such as machine learning, artificial intelligence, and cloud computing, human beings are underrated. Machines may replace some jobs, but humans are too intelligent, creative, versatile, and adaptable to not find interesting work to do. **MLI**

L'intelligence artificielle (IA) est en passe de devenir le phénomène technologique, social et économique le plus évoqué en 2023. Cependant, nombreux sont ceux qui craignent que l'IA ne réduise considérablement la demande de main-d'œuvre, en particulier pour la classe moyenne, si elle élargit l'intelligence humaine.

Ce document porte sur les retombées économiques potentielles de l'IA. Il ne comprend ni de prévision sur l'évolution de l'IA ni de réponse à la question plus générale des capacités de l'IA à dépasser l'aptitude humaine à comprendre et à gérer cette technologie. Il traite plutôt des retombées de l'IA jusqu'à présent en comparant leur progression aux prévisions passées de l'effet des changements technologiques sur les travailleurs. Il fait valoir qu'on doit éviter de renforcer précipitamment les réglementations et d'accroître les dépenses publiques en réaction aux inquiétudes encore infondées quant aux conséquences de l'IA sur l'emploi.

L'automatisation de la production est redoutée pour son impact sur l'emploi depuis le début de la révolution industrielle. Si à ses premiers stades, elle a déréglé les modèles d'emploi dans l'agriculture et les usines, il reste que l'emploi s'est accéléré dans l'ensemble en raison de l'effet de revenu sur le développement d'autres industries. Malgré cette réussite, selon de nombreuses prévisions, le déploiement de l'IA entraînera des pertes d'emplois généralisées.

À l'angoisse des licenciements potentiels s'ajoute la crainte que l'IA ne supplante les emplois de la classe moyenne et que les bénéfices de son déploiement généralisé ne reviennent qu'au petit nombre de propriétaires du capital, ce qui aura pour effet d'accroître les inégalités. Or, le fait est que l'évolution récente du marché du travail est aux antipodes de ces sombres prédictions. Les taux d'emploi n'ont jamais été aussi élevés. La difficulté principale des employeurs tient à l'embauche dans un marché où le taux de chômage avoisine un creux historique. Bien qu'on ait prédit que l'IA serait une menace jamais vue pour les emplois de cols blancs, ce segment n'a cessé de croitre au Canada, aux États-Unis et en Grande-Bretagne. Cela soulève donc la possibilité que l'IA soit déployée pour aider les travailleurs à mieux accomplir leur travail – et non pas pour licencier des employés.

Depuis très longtemps, on prédit à tort que les nouvelles technologies entraînent des pertes d'emplois massives pour les travailleurs. Toutes les récessions survenues dans l'intervalle du siècle dernier ont été imputées au moins partiellement à l'automatisation, une prédiction pessimiste invariablement erronée en raison de ce que les économistes appellent le « sophisme luddite », raisonnement qui écarte l'indéniable effet d'entraînement immédiat ou à terme sur la croissance des revenus et de l'emploi des gains de productivité attribuables à l'innovation technologique. Au cours des deux derniers siècles, les pertes d'emplois agricoles et manufacturiers dues aux nouvelles technologies ont été contrebalancées par l'amélioration des compétences des travailleurs et leur transfert vers de nouvelles professions en forte demande en raison des revenus élevés générés par les gains de productivité. Peu d'emplois perdus ont constitué une

perte, car la plupart des tâches remplacées à l'avènement de la révolution industrielle étaient répétitives, routinières et souvent dangereuses. Les économistes et les prétendus experts ont craint pendant des décennies que les robots et l'automatisation ne détruisent des millions d'emplois. Or, en dehors des récessions cycliques, les taux d'emploi n'ont cessé d'augmenter pour atteindre des niveaux record.

> *Depuis très longtemps, on prédit à tort que les nouvelles technologies entraînent des pertes d'emplois massives pour les travailleurs.*

La difficulté de prévoir l'impact de la technologie sur le marché du travail tient en grande partie à celle de prédire l'évolution de la technologie elle-même. L'IA est généralement susceptible de rendre les travailleurs plus productifs et donc plus attirants pour les employeurs. En outre, la mise en œuvre de l'IA se déroulera probablement petit à petit, ce qui facilitera l'adaptation des employeurs et des travailleurs. L'histoire montre que même les technologies les plus transformatrices, telles que l'électricité ou le moteur à combustion interne d'autrefois, ont besoin de décennies pour être largement diffusées. Une longue période d'adaptation semble inévitable pour l'IA.

Si les capacités potentielles de l'IA sont souvent exagérées, les aptitudes humaines sont régulièrement sous-estimées. On parle ici d'aptitudes essentielles qui ne peuvent pas être reproduites ou remplacées par des machines. Il en est ainsi même dans les domaines hautement techniques tels que l'apprentissage automatique, l'intelligence artificielle et l'infonuagique. Les machines peuvent remplacer certains emplois, mais les êtres humains sont trop intelligents, créatifs, polyvalents et adaptables pour ne pas trouver de travail intéressant. **MLI**

Introduction

Artificial intelligence (AI) is easily the most discussed technological, social, and economic phenomenon of 2023. Pundits express wonder at its technical capabilities while also worrying about the implications for job losses and even human extinction. The hype surrounding AI is encapsulated by the surge in stock market prices for technology companies investing heavily in AI, such as Nvidia. However, soaring stock prices for AI companies also capture concerns that AI will lead to capital investments that significantly reduce the demand for labour, especially for middle-class jobs, leading to a sharp increase in inequality in our society. Unlike previous machines that mostly replaced or automated routine and low-skill tasks, some fear that AI will displace white collar jobs if it proves to be an improvement over human intelligence.

This paper looks at the possible economic impacts of AI. It makes no attempt to forecast how AI will evolve. As such, it does not address broader concerns about whether the capabilities of AI will outrun the ability of humans to understand and manage this technology, potentially risking catastrophic effects, up to and including human extinction.[1] Instead, this paper examines the economic impact of AI so far and compares its evolution to date with past forecasts of how technological change would affect workers.

In most instances, the macroeconomic impact of AI is barely discernible—in fact, more labour-saving technology would be welcome in today's labour market, which is characterized by widespread shortages, rising costs, and an aging labour force. This contradicts past predictions by many AI proponents that by 2023 the technology would already be having a significant impact.

Prediction errors about technology's impact on the labour market have a long history, especially about the time required to adopt a new technology. Besides regularly exaggerating the capabilities of AI, forecasters often under-

rate the abilities and adaptability of humans. This supports the conclusion that "fear about computer superintelligence is a long-standing topic within tech circles—but so is the tendency to vastly overstate the capabilities of whatever technology is the subject of the latest hype cycle" such as virtual reality, augmented reality, and the blockchain (*Business Week* 2023).

What is Artificial Intelligence?

Despite the widespread references to AI in recent public discussions, it is often not clear what AI refers to. Whole books have been written about AI and the menace it represents to our society (such as *The Artificial Intelligence Contagion* by Daniel and David Barnhizer) without the authors clearly stating what they mean by AI. Some define it strictly as a technological process: a machine-learning technology that creates content based on a vast array of data and information inputs. Others frame AI as having a "single, but potentially, transformative purpose: namely, it significantly lowers the cost of prediction" (Meredith 2020, 42). Through its powers of predicting what a human would do, AI could replace human intervention in everything from investment advice to driving a vehicle (Meredith 2020, 43).

How AI is framed is closely correlated with whether an author treats AI as an existential threat to workers and even human existence, or something more benign that can be harnessed by humans to improve our society and standard of living. People who emphasize AI as a process of self-learning and prediction almost always extrapolate that it will evolve in a way that is harmful to the workplace and even our whole society. Analysts who see AI as a useful but not an all-powerful technology emphasize that it will remain a tool that needs human intervention to be useful.

Apocalyptic scenarios about AI's impact are usually coupled with calls for more government regulations and government income support (such as a guaranteed annual income to offset massive job losses). Writing in the *Wall Street Journal*, Baker (2023) notes that whether it is the threat of pandemics, nuclear weapons, climate change, or AI, "the remedies are always, strikingly, the same:

more government; more control over free markets and private decisions, more borderless bureaucracy." This paper cautions against a rush to increase government regulations and spending based on as yet unfounded concerns about the impact of AI on jobs.

Many forecast widespread job losses due to AI

Machine automation has been feared for its impact on human jobs since the Industrial Revolution began. Davenport and Kirby (2016, 2) outline three eras of automation. The first involved machines relieving humans of "work that was manually exhausting and mentally enervating." After this replacement of work that was dirty and dangerous, the second era of automation involved doing work that was repetitious and dull, such as some secretarial and clerical work. We're now early in the third era, which sees automation gaining in intelligence and replacing work that requires some decision-making capacity.

The first two eras of automation disrupted employment patterns in farming and factories, but overall job growth actually accelerated as higher incomes drove the expansion of other industries. Despite that experience, there are numerous forecasts that the deployment of AI will lead to widespread job losses. University of Oxford scholars Frey and Osborne, for example, speculate that up to 47 percent of all jobs in the US could disappear by 2030 (cited in Ridley 2020, 290). In 2013, Oxford's Martin School concluded that nearly 50 percent of jobs were susceptible to full machine automation (Ford 2015, 119). Another report said in 2014 that "50 percent of US jobs will disappear by 2030" (quoted in Barnhizer and Barnhizer 2019, 20). In 2016 the World Economic Forum predicted that five million jobs could disappear by 2020 due to automation in developed nations (cited in Barnhizer and Barnhizer 2019, 19). In Canada, a study from Ryerson University in 2016 concluded that "nearly 42 per cent of the employed Canadian labour force is at high risk of being affected by automation over the next 20 years" (Lambe, quoted in Doern, Stoney, and Hilton 2021, 61).

Most Canadians have shared the belief that automation leads to job losses. A Statistics Canada survey in 1989 found that 52 percent of Canadians felt that computers and automation would eliminate more jobs than they create, while only 33 percent believed the number of jobs would increase (15 percent had no opinion) (Morissette 2020, 2). In actual fact, Morissette's 2020 report noted that employment in Canada grew from 13.0 million in 1989 to 19.1 million in 2019.

Most Canadians have shared the belief that automation leads to job losses.

Compounding the anxiety of potential job losses is the fear that AI will displace middle-class jobs, not just low-skill jobs such as those in the warehousing or fast food industries. Some fear "labour displacement among many white-collar jobs is likely to be a painful casualty of the shift" (Rosenberg and Wendling 2023). Kevin Kelly predicted that "the rote tasks of any information-intensive job can be automated. It doesn't matter if you are a doctor, translator, editor, lawyer, architect, reporter, or even programmer. The robot takeover will be epic" (Kelly 2016, 51).

A further concern is that the rewards from widespread deployment of AI will accrue to a small number of people who own the capital. This builds upon Thomas Piketty's thesis that the rate of return on capital will outstrip overall economic growth (as summarized by his famous equation $r > g$, where r is the rate of return and g is the rate of economic growth) and increase inequality. In this scenario, many ordinary people will lose their jobs while incomes at the top end of society will explode, leading to unbearable social tensions.

However, the view that AI will lead to a precipitous fall in employment is far from unanimous, although readers can be forgiven for holding that view based on recent press reports. A recent Pew survey of 1,986 experts asked whether AI and robotics would displace more jobs than they created. The results found respondents were almost evenly split, with optimists edging out pessimists by 52 percent to 48 percent (cited in Davenport and Kirby 2016, 226).

Labour shortages, not job losses, characterize today's labour market

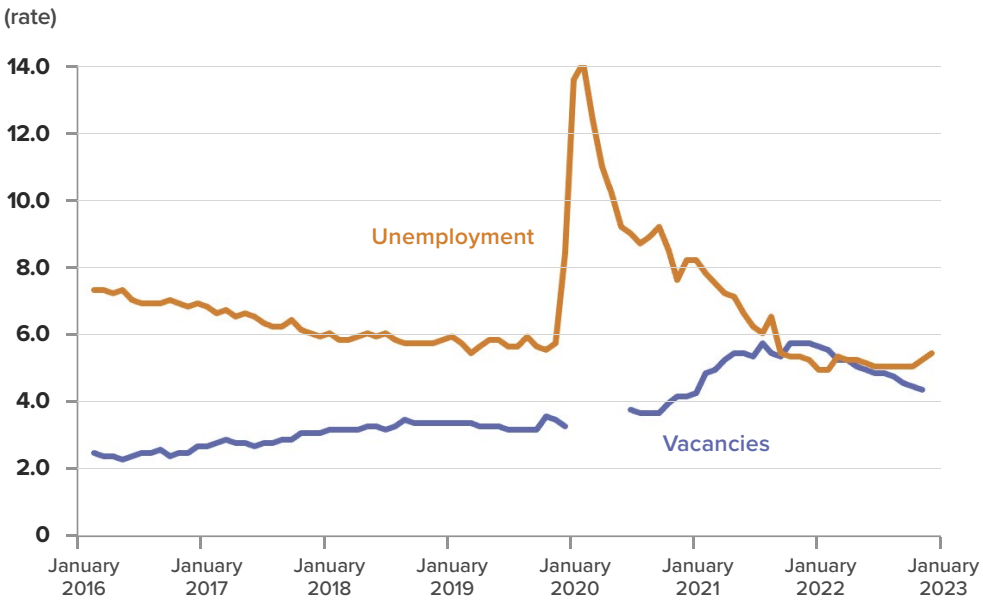
The reality is that recent developments in the labour market are the exact opposite of these gloomy predictions. Employment rates are at an all-time high and unemployment reached a record low of 4.9 percent in 2022. Today in 2023 we are quickly approaching 2030—the date by which Frey and Osborne said nearly half of US jobs would have disappeared—and the main difficulty of US employers is finding workers in a labour market where unemployment is below 4 percent. Labour shortages also are dominating labour markets in Canada. Our unemployment rate remains near historical lows while the 4 percent job vacancy rate remains well above its pre-pandemic levels (see Figure 1. The gap in vacancy data between April 2020 and September 2020 is due to the suspension of data collection during the pandemic).

The aggregate data on productivity reflect that there has been no significant deployment of labour-saving technology. Labour productivity is defined as output per person-hour of work. Any significant displacement of labour inputs by machines, including AI, would be evident in much higher labour productivity. Instead, Canada's greatest challenge is to address its steadily slowing productivity growth (see Figure 2). Labour productivity rose by a total of 14.9 percent in the eight years between 1998 and 2006 (an average of 1.9 percent a year); in the following eight years it gained 8.1 percent (an annual average of 1.0 percent); in the eight years from 2014 to 2022 it increased a total of only 4.4 percent, or 0.6 percent a year.

Nor is there evidence that automation is leading to job losses for any broad occupational group. Between 1987 and 2018 Statistics Canada reported that job growth was fastest in the managerial, professional, and technical occupations and non-routine service occupations (Frank, Yang, and Frenette 2021, 11). But employment also rose in absolute terms in the sales, clerical, and administrative support group and in the production, craft, repair, and operative occupations, with gains of about 70 percent and 14 percent respectively.

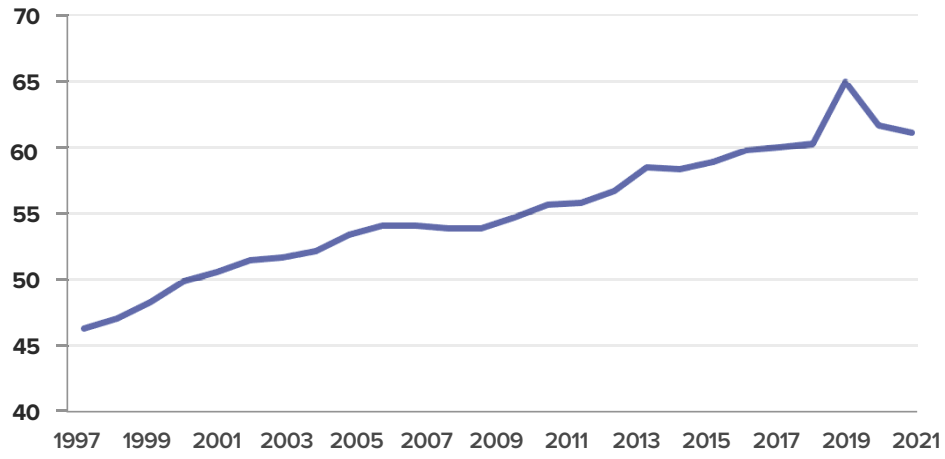
Predictions that AI would lead to widespread job losses for truckdrivers are a good example of how forecasts of the rapid deployment of new computer-driven technologies remain speculative, and may never materialize. For

FIGURE 1: JOB VACANCY AND UNEMPLOYMENT RATE IN CANADA



Sources: Statistics Canada, tables 14-10-0406-01 and 14-10-0287-01.

FIGURE 2: LABOUR PRODUCTIVITY IN CANADA, CHAINED (2012) DOLLARS PER HOUR



Source: Statistics Canada table 36-10-0480-01.

over a decade, pundits confidently predicted that in the trucking industry, currently the largest employer of men in North America, truck drivers would be made obsolete by autonomous self-driving vehicles. For example, one analyst maintained that by 2010 Google already had successfully introduced a fully automated car capable of driving in traffic and that self-driving vehicles would be having a major impact between 2020 and 2025 (Ford 2015, xiii and 186). Instead, as of 2023, the deployment of driverless technology has not gained more than a niche footing because of the difficulty machines have in handling situations that are routine for humans.

One problem is that "AI learns to drive by predicting what a human driver would do given specific road conditions" (Agrawal, Gans, and Goldfarb 2018, 15). Unfortunately for AI, driving has proven to be quite unpredictable and people retain an advantage because "humans are sometimes extremely good at prediction with little data" (Agrawal, Gans, and Goldfarb 2018, 56). The conclusion is that "the self-driving car doesn't really work" except in ideal, highly-controlled situations (Broussard 2018, 142). Meanwhile, pay rates for truck drivers have soared, with UPS recently agreeing to increase the average annual pay for its drivers to $170,000.

> *This raises the possibility that AI will be deployed to help workers do their jobs better – not to get rid of employees.*

Another reason driverless vehicles remain mostly sidelined is that driving is not the only function of the person at the wheel. School bus drivers, for example, also exercise discipline inside the bus and ensure the safety of the children (Agrawal, Gans, and Goldfarb 2018, 149). Long-range truck drivers do more than just drive: they also prevent the theft of the truck's contents (Agrawal, Gans, and Goldfarb 2018, 150).

Beyond the unfounded threat to truck drivers, AI technology was predicted to be a unique threat to white collar jobs. Yet white collar employment

FIGURE 3: LABOUR PRODUCTIVITY IN CANADA,CHAINED (2012) DOLLARS PER HOUR

Source: Statistics Canada table 14-10-0310-01

in Canada, the US, and Britain continues to increase steadily. This raises the possibility that AI will be deployed to help workers do their jobs better – not to get rid of employees (Lindblad 2023). For example, more than half of employers in Britain "expect AI technologies to have a positive impact on their headcount over the next two years" (*The Economist*, 2023c). In Canada, before the pandemic struck, white collar jobs had risen at a steady 2.0 percent yearly clip between January 2016 and January 2020. Since the pandemic, white collar jobs rose at an annual rate of 1.7 percent; the large job losses during the pandemic were quickly recouped. In the last 12 months ending in June 2023, white collar jobs returned to their trend rate of growth with a 2.1 percent gain (see Figure 3).

Past forecasts of technological unemployment were unfounded

Ridley observed that "the idea that innovation destroys jobs comes around in every generation. So far it has proved wrong" (2020, 290). There is a long history of erroneous predictions about new technologies leading to massive job losses for workers. Robert Shiller devotes two chapters in his book *Narrative Economics* to the history of jobs being threatened by labour-saving machinery, automation, and artificial intelligence. In his *Iliad,* written in eighth century BCE, Homer coined the phrase "automatic" to describe a driverless vehicle that navigates on its own (Shiller 2019, 174). The original narrative of machines replacing men that Homer articulated in ancient Greek has been regularly refreshed. In 1821 David Ricardo expressed a deep concern that technological progress would create mass unemployment (Mokyr 2016, 278). The word "robot" entered our language in 1922 from a play that tells the story of a scientist who invents a robot and a businessman who starts manufacturing them and who ultimately faces a revolt from robots "who have developed minds of their own" (Shiller 2019, 182). This revolt presages today's same fears about AI.

In his 1930 essay "Economic Possibilities for our Grandchildren," economist J.M. Keynes introduced into the lexicon the term "technological unemployment," which he defined as "unemployment due to our discovery of means of economizing the use of labor outrunning the pace at which we can find uses for labor" and which he blamed for the mass unemployment in 1930 (quoted in Brynjolfsson and McAfee 2014, 174).

Every recession in the past century has been at least partly blamed on automation. Labour-saving inventions were singled out as the cause of the depressions of 1873-79 and the 1890s (Shiller 2019, 176-9). Andrew Pollack of the *New York Times* summarized the despair about the advance of technology in 1982 when he wrote, "I don't know where we can run to this time" (quoted in Shiller 2019, 204). Stuart Chase, who coined the term "New Deal," warned in 1929 of an impending wave of technological unemployment, a diagnosis of the Great Depression that Keynes initially shared, though later he shifted his explanation to under-consumption (Shiller 2019, 185). After the war, the 1957-58 downturn was dubbed "the automation recession" in the *Washington Post* (Shiller 2019, 201). During the devastating 1982 recession, a "new auto-

mation" was expected to threaten office jobs as word processors replaced typing pools and filing clerks (Shiller 2019, 204).

These pessimistic forecasts were all incorrect because of what economists call "the Luddite fallacy," which ignores the fact that productivity gains from technological innovation always have immediately or eventually generated more income and jobs (Davenport and Kirby 2016, 1). What happened over the last two centuries is that job losses on farms and factories brought about by new technologies were balanced by workers upgrading their skills and moving to new occupations where demand was rising due to higher incomes generated by productivity gains.

Few of the lost jobs were missed as most of the work replaced during the early Industrial Revolution was repetitive, routine, and often dangerous. This era of automation addressed Henry Ford's famous complaint about humans: "Why is it every time I ask for a pair of hands, they come with a brain attached?" (Colvin 2015, 54). Even the capabilities of computers were limited to "arithmetic and nothing more. The advent and commercialization of computers made arithmetic cheap... Computers still cannot think, so thought isn't about to become cheap" (Agrawal, Gans and Goldfarb 2018, 12-13).

> *While economists and pundits worried for decades that robots and automation would destroy millions of jobs,(...) employment rates have risen steadily (...).*

While economists and pundits worried for decades that robots and automation would destroy millions of jobs, outside of cyclical recessions employment rates have risen steadily, to record highs. The combination of rapid growth in new service industries and rising education overcame the negative impact of automation in farming and manufacturing. Furthermore, "few of the doom-mongers have a good explanation for why countries with the highest rates of tech usage around the globe, such as Japan, Singapore and South Korea, consistently have among the lowest rates of unemployment" (*The Economist*, 2023c).

The turmoil in the publishing industry shows how rapid gains in one part of an industry can offset large losses in another. Between 2000 and 2016, employment in US newspapers plummeted from 425,000 to 174,000 as readership and advertising revenues nose-dived. However, the number of jobs in Internet publishing at online news sites such as the *Huffington Post* and *Buzzfeed* offset most of the losses in newspapers, rising from 29,000 to 206,000 over the same period (Meredith 2020, 18).

Every recent decade has weathered one panic or another over technology causing widespread job losses. The perceived threat in the late 1990s was from globalization and offshoring. A survey by economists Alan Blinder and Alan Krueger of Princeton University estimated that one-quarter of American workers (30 to 40 million people) were at risk of seeing their jobs move to low-wage countries (Ford 2015, 119). Blinder predicted that "We have so far barely seen the tip of the offshoring iceberg, the eventual dimensions of which may be staggering" (quoted in Ford 2015, 118).

Instead, globalization peaked in 2008 after trade as a share of global GDP nearly doubled from 17 percent in 1986 to 30 percent in 2008 (Antràs 2020, 8). Since 2008 the share of trade in global GDP has fallen slightly, mostly because there is less trade in inputs into the production process as firms and nations moved to shorten and secure supply chains (Antràs 2020, 9). This process accelerated during the COVID pandemic due to the shortage of key products ranging from semiconductor chips to facemasks. The hand-wringing over globalization was followed in the early 2000s by fears of job losses due to the internet and robots. Instead, a whole slew of jobs was created around the customization of information. McKinsey reports that the internet "so far created 2.4 jobs for every one that was lost" (Smith and Free 2016, 163). Even university teachers were supposedly under threat from massive open online courses (MOOCS). Instead, students shunned MOOCS (Ford 2015, 134).

Much of the difficulty of forecasting the impact of technology on the labour market stems from the challenge of predicting how technology itself will evolve. Kevin Kelly conducted a review of the expectations of experts in the 1980s and found that none predicted innovations such as the internet, social media, on-line shopping, search engines, or 3D manufacturing (Kelly 2016, 20). Other highly touted predictions about particular technologies being adopted also have failed spectacularly. Ray Kurzweil, one of the leading advocates

of the superiority of computers over human intelligence, maintained in 1999 that "people [would] routinely use three-dimensional displays built into their glasses or contact lenses" (p. 202). In reality, Google glasses were a flop and were withdrawn from the marketplace. Recent technologies such as the internet, the smartphone, and cloud computing all had impacts that were significant, but hardly revolutionary.

The difficulty of anticipating how technology will evolve was demonstrated when Bill Clinton, in the aftermath of his election in 1992, had the "finest minds in the country assembled in Little Rock to discuss how to get the economy moving again. Having spent twelve years in the wilderness, the Democratic policy elite was plotting a return to greatness. There was talk about education and trade policy, hours of discussion and thousands of papers, much posturing and bloviating. In all the papers, Summers[2] recalls, one term was conspicuously absent: the Internet" (Gross 2012, 26).

AI can help workers become more productive, not obsolete

It is rash to assume that AI technology will lead to massive job losses for workers. It is as likely that AI will make workers more productive and therefore more desirable to employers. Academic studies show an increase of three percentage points in the labour productivity of firms adopting the technology, hardly a revolutionary trend (*The Economist*, 2023b). For example, even in a relatively routine task like customer service, combining customer support agents with support from AI made workers 13.8 percent more efficient in handling complaints (NBER Digest, 2023). This is because "the AI tool based its suggestions on the work style and outputs of the company's most productive agents and therefore spread their pattern of behavior to newer and less skilled workers" (NBER Digest, 2023).

Rather than robots leading to job losses, Statistics Canada found that "firms that invested in robots from 1996 to 2017 employ more, not fewer, workers" (2020). Moreover, robot use was associated "with firms focussing more

on increasing product and service quality, and not on reducing labour costs" (Statistics Canada 2020).

Intelligent machines have advantages over humans, such as lower costs and greater reliability. However, "coupling them with intelligent people [is] a better bet for the long run" (Davenport and Kirby 2016, 206). Scientist and policy analyst Vaclav Smil sees AI as a very useful tool in "amplifying and optimizing our abilities and ushering in an age of plenty and unprecedented blessings arising from deeply learned neural networks" (Smil 2023, 159). Jobs that involve nonroutine tasks such as carpentry, truck driving, cleaning, and being a security guard have not been hurt by computers, while jobs involving problem-solving and complex communications tasks such as in science, engineering, and marketing "have actually been made more productive by computers" according to *The New Geography of Jobs* (Moretti 2013, 41). In 2016, a Harvard/MIT team of researchers won a cancer diagnosing contest by combining human and machine predictions (Agrawal, Gans, and Goldfarb 2018, 65). The best chess player is one in which "a centaur player will listen to the moves suggested by the AI but will occasionally override them" (Kelly, 2016, 41). Pill-dispensing robots will free pharmacists to focus on patient counselling, while ATMs are already allowing bank tellers to shift to financial advising. Much of the work done by robots and automation will be tasks that humans cannot do, such as searching for a particular page or face, and therefore will involve no job loss.

Humans help machines be more accurate

Just as machines enable people to become more productive, human collaboration helps machines avoid erroneous and even bizarre outcomes. One famous example is a bank's computerized rejection of former chair of the Federal Reserve Board Ben Bernanke's application to refinance his mortgage, because he had recently left his job and had a history of changing jobs (Davenport and Kirby 2016, 28). Bernanke himself had once stated that "the real service performed by the banking system is the differentiation between good and bad borrowers" (quoted in Rework America 2017, 109). University of Chicago professor Amir

Sufi pointed out that the Bernanke refinancing rejection episode illustrated that "banks are bad at the job that is supposedly their main source of value" (Rework America 2017, 109). More broadly, breaking the link between local bank managers and their knowledge of the credit-worthiness of borrowers led to the "robotic" decisions made in 2007 and 2008 that precipitated the global financial crisis and then the 2010 "flash crash" on US stock markets (Carr 2014, 77). More human collaboration could have avoided each of these situations.

> *The presence of humans helps people accept the intervention of intelligent machines.*

The presence of humans helps people accept the intervention of intelligent machines. Humans do not trust machines to make important decisions, especially potentially life and death decisions. Computers already make most of the decisions piloting airplanes during "all but seven minutes of a typical flight" (Kelly 2016, 54). However, most passengers would balk at getting on an airplane without human pilots ready to take control in the event of an emergency (such as occurred in 2009 when a flight out of New York hit a flock of birds and forced an emergency landing, an event later made into the movie *Sully*).[3] Similarly, patients do not trust computers alone to diagnose their medical condition, even if computers help technicians and doctors make better judgements. Homebuyers rely on real estate agents when making a home sale or purchase because they need human validation of what is likely the most important financial decision of their life. Most people need a human presence because people make decisions "both cognitively and viscerally... This element of human development is not easily understood or replicated and cannot therefore be programmed into a computer" (Gratton 2017, 190).

Adopting AI will take time

The implementation of AI technology is likely to roll out slowly, which will help employers and workers adapt to its use. Past history shows even the most transformative general purpose technologies,[4] such as electricity or the internal combustion engine, require decades to be widely diffused. Patricia Meredith observes that "the normal period for new technologies to be understood, adopted, and integrated into production is twenty to thirty years" (2020, 40). Robert Gordon in his book *The Rise and Fall of American Growth* notes that the internet and robots have not has as much of an impact as other general purpose technologies such as electricity, which "appeared in dribs and drabs as firms found clever new ways to deploy electricity" (Avent 2017, 81). For example, the forest products industry was worried about the so-called "paperless office" as early as the 1980s, but demand for paper did not begin to shrink until the mid-2000s (Meredith 2020, 18).

All technologies require time for firms to understand and adapt to their specific needs. This is because "technologies have surprisingly long gestation periods; they may seem to appear overnight, but they don't" (Standage 2017, 12). While the internet arrived in the early 1990s, it was not until the late 2000s that two-thirds of American firms even had a website. As innovation expert Jonathan Brill summarized, while people fantasize about sudden breakthrough innovations, in reality "it takes typically five or six years for a product or a business to get to scale. There's a ramp-up period to see if things are working, to adjust, and to optimize… What you're looking for is profit. That happens on the decade scale. That doesn't happen on the quarterly scale" (quoted in Clark 2021, 7).

A given technological innovation may be inevitable but still require a long time to transpire. As Paul Saffo said, "Never mistake a clear view for a short distance" (quoted in Davenport and Kirby 2016, 24). The delay between the arrival of a technology and its full exploitation "is mostly accounted for by the time needed to discover how best to use the new innovation and to rearrange the world accordingly" (Avent 2017, 81). A prolonged period of adaptation seems to be inevitable for AI. For example, a recent survey of firms in North America found that a third of small businesses had no plans to use AI over the next year because "replacing outdated systems can be costly, complicated and painful" (*The Economist*, 2023d).

There are other reasons to expect AI adoption to be slower than many expect. One is that AI is most likely to be used in heavily regulated industries such as teaching and policing where powerful public sector unions will resist its deployment at the expense of their members (*The Economist*, 2023b). Of course, these are also the sectors of the economy where prices have risen at an above-average rate for years, in contrast with falling prices for products such as TVs, cell phones, clothing, and computers where technology plays an integral role. A further brake on widespread adoption of AI in the workplace is concern about protecting confidential or sensitive data, which has led several large firms to ban the use of ChatGPT at work (*The Economist*, 2023a). Nor is reliability iron clad yet, as AI still produces plausible but incorrect information, partly because it bases so much of its calculations on data from the public domain which is inherently imperfect.

"The roll-out of AI also may be slower than anticipated because its proponents exaggerate its capabilities.

The roll-out of AI also may be slower than anticipated because its proponents exaggerate its capabilities. In his review of the hype and failure that has accompanied AI-based inventions and innovations, Vaclav Smil concluded that "no category of modern inventions and technical advances has been so poorly and unhelpfully covered as AI" (Smil 2023, 157). This is because AI's capabilities and goals are misunderstood, even by people working in the area. AI is capable of "working with human-level competence on low-level pattern recognition skills" but is "nowhere near advanced enough to start replacing our brains in reasoning, complex understanding of the real world, and social interactions" (Smil 2023, 158).

A lack of competitive pressures in much of Canada's economy is a reason to expect the adoption of new AI technology to lag in this economy. As noted in recent research for the Macdonald-Laurier Institute, government regulations and controls on foreign investment insulate large segments of our economy from competition (Cross 2023). Competitive pressures are an important spur

for firms to undertake the cost of reorganizing their business to include new technology because doing so requires "time, money and, crucially, a competitive drive" (*The Economist*, 2023f). A recent survey found that 40 percent of small businesses in the US are uninterested in AI (*The Economist*, 2023f).

According to Michael Jordan, a leading AI researcher, "people are getting confused about the meaning of AI in discussions of technology trends—that there is some kind of intelligent thought in computers that is responsible for the progress and which is competing with humans. We don't have that, but people are talking like we do" (quoted in Smil 2023, 158). Among AI's specific problems are that it performs poorly on general intelligence and is "prone to catastrophic forgetting, poor in quantifying uncertainty, lacking common sense, and, perhaps most surprising, is not so good at solving math problems, even those routinely mastered by high school competitors" (Smil 2023, 158). Smil concludes that the quest for AI "is an enormously complex, multifaceted process whose progress must be measured across decades and generations and whose impressive achievements on some relatively easy tasks coexist with the much larger realm of intelligence that remains beyond the capabilities of programmed machines" (Smil 2023, 159).

One reason the capabilities of AI are exaggerated is to attract investor and media interest. Sharma recounts that in the AI field, "if you say AI is coming in twenty years, you can get investors to fund your work; if you say five years they will remember and expect you to deliver, and if you say one hundred years they won't be interested" (2016, 55).

Human abilities are underrated

While the potential capabilities of AI are often exaggerated, human abilities are routinely underrated. Humans retain key abilities that machines cannot duplicate or replace. As Geoff Colvin observed in his book *Humans Are Underrated*, the nature of work is changing from "the technical, classroom-taught, left-brain skills" that has been required since economic growth took off in the Western world in the late 18th century. Now the skills most in demand are "the

abilities that literally define us as humans: sensing the thoughts and feelings of others, working productively in groups, building relationships, solving problems together, expressing ourselves with greater power than logic can ever achieve" (Colvin 2015, 4). This is because human intelligence is much more than rational thought and include language, interpersonal relations, music, and knowledge of the natural world around us (Davenport and Kirby 2016, 113). As former Bank of England Governor Mervyn King wrote, humans have an advantage over computers because we "make leaps of imagination… Most of my economist colleagues have had their deepest insights through the use of intuition, and have deployed logical mathematical proofs to demonstrate to others why that intuition is correct" (2016, 130).

Humans process three types of data that machines lack: our senses, judgement of preferences, and access to data that is confidential and therefore off-limits to machines.

Humans process three types of data that machines lack: our senses, judgement of preferences, and access to data that is confidential and therefore off-limits to machines (Agrawal, Gans, and Goldfarb 2018, 98). As a result, "humans and AIs are likely to work together; humans will provide complements to prediction, namely, data, judgement, or action. For example, as prediction becomes cheaper, the value of judgement rises… We can be confident that new jobs will arise within a few years and people will have something to do" although some job losses will occur during a transition period as occurred during the trend to offshoring in the 1990s (Agrawal, Gans, and Goldfarb 2018, 212). From this perspective, "the AI on the horizon looks more like Amazon Web Services – cheap, reliable, industrial-grade digital smartness running behind everything, and almost invisible except when it blinks off" (Kelly 2016, 33). Brynjolfsson and McAfee agree that "countless pieces of AI will be working on our behalf, often in the background" (2014, 91).

Instead of the workplace alienating people from their humanity, once AI has become widespread work will have the possibility of fulfilling human needs beyond money. In the words of neuroscientist Michael Gazzaniga, "our big brains are there primarily to deal with social matters, not to... cogitate about the second law of thermodynamics" (quoted in Colvin 2015, 37). Fulfilling work includes jobs such as artists, designers, musicians, photographers, therapists, and so on. Added to this are the "caring" professions such as nurses, therapists, and counselors, all of which require empathy as well as intelligence. As demand for these "interaction" jobs rises, demand will fall for "transaction" jobs such as bank tellers or checkout clerks. However, even as automated teller machines proliferated, the number of human tellers in US banks almost doubled between 1980 and 2010 partly because the number of bank branches expanded as their cost fell while the population grew (Sharma 2016, 55). The number of bank tellers in Canada also rose for the same reason (Frank, Yang, and Frenette 2021, 3). At the same time, the number of "relationship managers" in banks increased even faster (Raval 2017, 95). Similarly, when gas stations switched from full-service to self-service, total employment rose because workers were needed to staff the convenience stores now attached to gas stations (Raval 2017, 95).

A McKinsey report identified the skills that "future-proof" careers in an age of artificial intelligence, automation, and digital technologies. Most are related to communication in all its forms: "storytelling, public speaking, synthesizing and clarifying messages, translating information for different audiences and contexts, crafting an inspiring vision, developing relationships, and inspiring trust" (Gallo, 2022, 7). Communications skills, both written and verbal, are the most required skills employers are looking for (Gallo, 2022, 6). Even in highly technical fields such as machine learning, artificial intelligence, and cloud computing, LinkedIn CEO Jeff Weiner agrees that "human beings are underrated" (quoted in Gallo, 2022, 6).

Machines may replace some jobs, but venture capital investor Marc Andreessen makes the case: "To argue that huge numbers of people will be put out of work but we will find nothing for them—or us—to do is to short human creativity dramatically" (quoted in Smick 2017, 50). Humans are too intelligent, creative, versatile, and adaptable to not find interesting work to do.

Conclusion

Some of the hype surrounding AI this year is due to exaggerated claims made by people in the industry seeking to garner attention to a new product that most of the public has not yet understood. The spectre of mass unemployment always draws an attentive audience, as do the threats of human extinction which environmentalists have skillfully deployed to raise concern about climate change. This study has attempted to provide a more balanced and nuanced view of a technology that will mesh with human abilities to provide some improvement to our economy and the human condition. MLI

About the author

Philip Cross is a Munk Senior Fellow at the Macdonald-Laurier Institute. Prior to joining MLI, Mr. Cross spent 36 years at Statistics Canada specializing in macroeconomics. He was appointed Chief Economic Analyst in 2008 and was responsible for ensuring quality and coherency of all major economic statistics. During his career, he also wrote the "Current Economic Conditions" section of the Canadian Economic Observer, which provides Statistics Canada's view of the economy. He is a frequent commentator on the economy and interpreter of Statistics Canada reports for the media and general public. He is also a member of the CD Howe Business Cycle Dating Committee. MLI

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Endnotes

1 So-called "superforecasters" put the chances of a catastrophe that kills 10 percent of humans at 2.1 percent and the risk of extinction at 0.38 percent, much less than AI experts, who predict the chances of catastrophe at 12 percent and 3 percent respectively (The Economist 2023e). Superforecasters are a group with a record of making accurate predictions about events such as elections or wars (Tetlock and Gardner 2015).

2 This refers to Larry Summers, who became Clinton's Treasury Secretary.

3 People may just need a human presence to get used to a new technology; elevator operators helped assure passengers that elevators were safe when the technology was introduced in the 19th century, but are rarely used today.

4 General purpose technologies are innovations that transform businesses in a wide range of industries.

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