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ECONOMIC VIEWPOINT

Propelling Canada into the Future with Disruptive Innovation

By Kari Norman, Economics Document Production Specialist, Randall Bartlett, Senior Director of Canadian Economics and Mirela Pirlea, Lead Partnerships Innovation and Entrepreneurship

Highlights

▶ In this second in a series of three notes on innovation in Canada, we highlight five disruptive innovations at the forefront of revolutionizing how Canadians go about their daily lives. Featured at the 2023 Collision Conference, these include generative AI, clean technology, 5G, the Internet of Things and blockchain-related technologies.

▶ At a societal level, advances in these and other areas have the potential to address myriad global challenges, such as climate change, healthcare accessibility and outcomes, food insecurity as well as the quality of life for all Canadians.

▶ Disruptive innovation creates fundamental changes in the marketplace, such as new products, services and production processes. It can topple established companies as emerging market leaders sell their products to a wider customer base, often at a lower cost. Nationally, this can lead to more jobs, higher incomes, greater international trade and improved productivity.

▶ But there are barriers to disruptive innovation that must be addressed. These include the fear of change, insufficient resources to scale up or adopt new technologies, and legal or regulatory issues.

From the agricultural and industrial revolutions to the technological revolution that ushered in the age of the internet, disruptive technology has changed the course of history. And now society is at the forefront of rapid change again, as new disruptive innovations are developed and adopted at an accelerating pace. Our previous report in this series examined how Canada can improve public policies to support greater innovation by leveraging international best practices, with the goal of boosting Canadians' standard of living through higher productivity. In this note, we discuss what disruptive innovation is, look at five disruptive technologies that took centre stage at the 2023 Collision Conference in Toronto and highlight some homegrown success stories in these areas.

Disruptive Innovation

Most new businesses attempt to find their place in the current local market, with varying degrees of success. However, disruptive innovation refers to a fundamental, revolutionary change in the market landscape. This can take several forms, from improving or creating a new product or service, like the Apple iPod or digital downloadable music, to inventing a new production process, such as Henry Ford's assembly line, which significantly increased productivity. Perhaps it's a change in organizational practices, like Google in its early years encouraging employees to dedicate 20% of their work time to exploring their own ideas, or marketing in an entirely new way à la Amazon e-commerce. All of these companies revolutionized their respective industries. Often disruptive innovations make products accessible and affordable to a much wider—and at times previously untapped—audience. Established firms in the industry frequently discount the potential of such innovations and ultimately risk being displaced.

Desjardins Economic Studies: 514-281-2336 or 1-866-866-7000, ext. 5552336 • desjardins.economics@desjardins.com • desjardins.com/economics

Why Is Disruptive Innovation Important?

Disruptive innovation benefits a company by ultimately positioning it as a market leader, even if it isn't the most profitable at the start. It transforms industries, creates new market opportunities, drives progress and promotes competition. Customers also benefit from disruptive innovation because many get access to goods and services that were formerly unavailable to them, are able to acquire products or services at a much lower price or have an improved customer experience. Many types of innovation lead to increases in productivity. At a national level, this can boost employment, incomes, domestic demand and international trade.
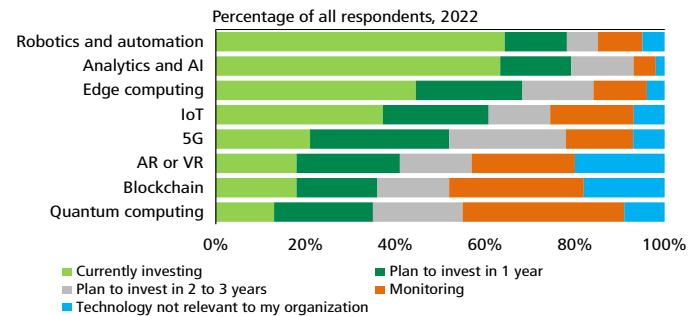
As an example, take one measure of innovation, intellectual property (IP) rights. Canadian small- and medium-sized enterprises (SMEs) that hold IP rights are 3 times more likely to have expanded domestically and 4.3 times more likely to have expanded internationally as compared to other SMEs. And their future plans include even more expansion, both domestically (3.8 times) and abroad (5.4 times) (Innovation, Science and Economic Development Canada, 2019).

Barriers to Disruptive Innovation

There are several potential barriers to fundamental change, starting with resistance to change itself by the companies who could potentially create it. Their suppliers or purchasers up and down the value chain could be unable or unwilling to adapt to technological advances. End-user customers may be loyal to existing brands and skeptical of new products or services. And companies that could adopt technologies may be averse to risk, hesitant to invest in unproven ideas. Even if they aren't cautious, they may be unable to access sufficient financial resources or talent to move forward. Company decision-makers may have a poor understanding of how new technologies can benefit their processes, and even if they consider adopting them, they may have a lack of knowledge of the supplier ecosystem. New technologies may come with an unknown or prohibitively complex process of integrating with existing systems. Regulatory compliance may add costs and time delays. And there can be legal obstacles such as obtaining licences and protecting intellectual property rights (as was the case in the early days of Uber). For innovators, even if the new product, service or business model does get off the ground, it might not be easily scaled with the resources available to the company.

A recent survey by EY showed that robotics and automation are broadly adopted, while most other disruptive technologies are not (graph 1). A whopping 96% of survey respondents believe that emerging technologies can play a vital or largely positive role in accelerating sustainability (EY, 2023). In fact, they note that environmental, social and governance (ESG) factors are a major consideration when investing in emerging technologies, particularly 5G, the internet of things (IoT), and artificial intelligence (AI) and analytics. Respondents also have concerns

GRAPH 1
Disruptive Technologies Are Not Yet Widely Adopted

Percentage of all respondents, 2022

Legend: Currently investing · Plan to invest in 1 year · Plan to invest in 2 to 3 years · Monitoring · Technology not relevant to my organization

AR or VR: Augmented reality or virtual reality
Sources: EY and Desjardins Economic Studies

about technology adoption, including an increased vulnerability to cybersecurity threats, but also some that may be misguided, such as worries about the health impacts of 5G equipment.

Disruptive Innovations Shaping Canada's Future

Against this backdrop, there are numerous innovations at the cusp of transforming their respective industries. Here are just a few examples that drew a lot of attention at this year's Collision Conference in Toronto.

Generative AI

Generative AI—artificial intelligence—is the transformational tool of this generation, in the same way that electricity, calculators and personal computers were in the past. AI can automate and perform tasks faster and often with greater accuracy than people can, leading to higher productivity. AI will free up workers to spend less time on rote tasks and more time on higher-level thinking activities. Examples of tasks where AI could excel include cybersecurity and fraud detection, smart buildings, predictive maintenance, supply chain optimization, automated customer service and other predictive analytics.

While some may be concerned that AI will put people out of work, that is unlikely to be the case. AI will not replace jobs—it will replace tasks. This is nothing new. In 2023, organizations estimated that 34% of all business-related tasks are already performed by machines. They predicted that this would increase to 42% by 2027. AI cannot replace human creativity. People can take advantage of this by recognizing that jobs will go to those who know how to use AI effectively. Moreover, the predictive power of AI works best when current and future conditions are similar to the past. Human thought excels during times of disruption and in fields requiring emotional intelligence.

The Government of Canada has taken a particular interest in supporting the development and scaling of AI. For instance, it has committed up to $248 million in funding for the

Montreal-based Scale AI cluster to apply AI to building intelligent supply chains. While the size and scope of the potential economic benefits are disputed, Scale AI has invested in over 70 projects with hundreds of partners since receiving funding in 2018. In a 2023 report, Scale AI concluded that reliable public funding and pioneering government programs have helped Canada to develop leading AI R&D institutions and attract top talent from around the world. As a result, Canada is a strong launchpad for AI start-ups, incubators and accelerators. However, start-ups struggle to survive and grow in Canada due to weak domestic demand for AI and intense competition with large technology companies.

Further, a significant portion of the AI-related intellectual property developed in Canada is owned by foreign companies (graph 2). Consequently, there is a substantial gap that remains to be closed between AI R&D and commercialization in Canada. As Canada is a leading country in AI R&D, closing the gap between R&D, AI IP rights and AI IP commercialization will help to accelerate Canada's leadership in AI and make it more competitive relative to the global leaders in the space. Leading AI institutes in Canada—Vector Institute (Ontario), Mila (Quebec),

GRAPH 2
Almost Half of AI Patents on Inventions by Canadians Are Foreign-Owned

AI patents, 2015–2017

Sources: Scale AI and Desjardins Economic Studies

Box 1: A Canadian AI Success Story

Montreal-based Hopper was named the number one most innovative company in travel in 2020. It uses big data paired with AI machine learning to predict price drops and help travellers determine the optimal time to book a flight or accommodation by analyzing over 30 billion price points every day. Founded in 2007, Hopper began by aggregating content from travel blogs to generate travel recommendations. It shifted its business model in 2014 to a data-driven website. Now it's the number one most downloaded travel app in North America, selling over $6 billion of travel every year. It has raised over $750 million in private capital and is backed by some of the world's largest banks.

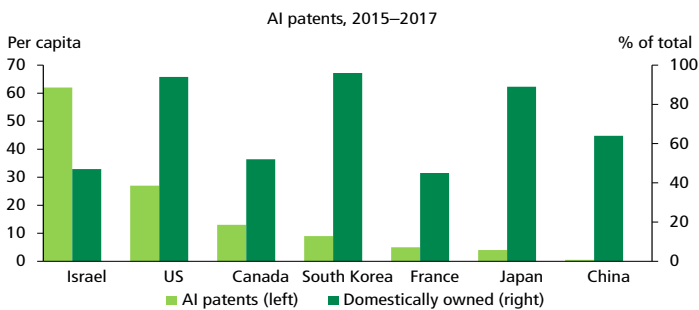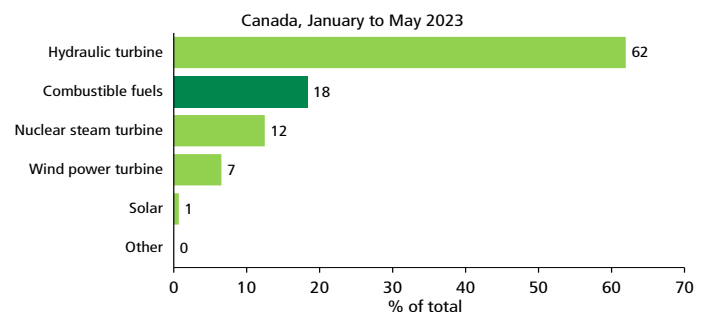AMII (Alberta) and university research centres—are playing a significant role in closing this gap.

Clean Tech

Canada has committed to reducing its emissions by 40% to 45% below 2005 levels by 2030 and achieving net-zero by 2050. In 2021, Clean Energy Canada predicted that the number of jobs in this sector will grow nearly 50% to almost 640,000 jobs by 2030.

At the forefront of the push to Net Zero 2050 is the shift towards electric vehicles (EVs). This will require significantly more power generation along with upgrades to our aging power grid. On the other hand, while EVs are a drain on the grid, their batteries are also a significant store of electricity that can be drawn on when vehicles are not in use. Individuals could actively manage the transfer of electricity from their vehicle to their house at peak load times, then recharge their car overnight when rates are at their lowest. Managed bi-directional charging could also be used during brief power disruptions. On a larger scale, a parking lot full of electric school buses could add their remaining store of electricity to the grid during the peak late afternoon period and recharge overnight when demand for power is low. Opportunities in clean tech will also be found in industries ranging from agrifood to construction and mining to manufacturing. The demand for inputs of critical minerals, from nickel and copper to more exotic rare earth elements, will also be substantial in the development of clean tech. Canada has the potential to become a major global player in these commodities and support the development of other elements of the clean tech value chain (Government of Canada, 2023).

The move away from fossil fuels will increase Canada's need for clean electricity generation. Canada already has one of the cleanest electricity profiles in the world due to its vast hydroelectric generation network and, to a lesser extent, its nuclear power infrastructure (graph 3). Solar and wind power have both expanded in recent years, but still comprise a small

GRAPH 3
Canada Is a Powerful Force in Green Electricity Generation

Canada, January to May 2023

Sources: Statistics Canada and Desjardins Economic Studies

Box 2: A Canadian Clean Tech Success Story

In 2023, 12 Canadian firms were included in the Global Cleantech 100. The director of cleantech ecosystems at MaRS "attributes Canada's success to earlier government investment in cleantech R&D, which is now paying off." For example, the cement industry is one of the largest emitters of carbon dioxide. Calgary-based Carbon Upcycling addresses this problem head on. Its innovative technology traps CO_2 inside a cement-alternative material made with local industrial waste and natural materials. It also reduces the amount of cement required to make concrete by up to 20%. Moreover, it increases the durability of concrete by up to 60% and its strength by up to 40%.

GRAPH 4
Canada's Mobile Operators Paid the Most for Internet

Price paid by mobile network operators at principal assignment for 3.4GHz to 4.2GHz band
US$/MHz/population

Sources: Analysys Mason and Desjardins Economic Studies

share of total power generation. The future of clean electricity will include new technologies, such as tidal power, small modular reactors and hydrogen, as well as improvements to the power-generating capacity of existing green technologies.

5G – The Fifth Generation of Mobile Networks

5G mobile networks provide faster data speeds, lower latency and greater capacity. While at first glance this may seem to be just an improvement on existing networks, it opens up a vast array of possibilities. For example, it makes telemedicine and remote healthcare services possible, improving patient outcomes and reducing costs. 5G's high speeds and reduced latency are also essential to developing a network of autonomous vehicles and smart cities. And 5G will generate productivity and efficiency gains in manufacturing, supply chain management and telework and improve the customer experience. Virtual reality, augmented reality and gaming will also see significant advancements with 5G.

5G first rolled out in Canada in 2020. Today, the three largest networks plus several regional carriers together provide 5G coverage that reaches over 70% of Canadians. The federal government has recently announced a new framework for improved connectivity to expand 5G access, in particular to rural, remote and Indigenous communities. Broad access is essential to provide a level playing field for all Canadians. While 6G technology isn't expected to roll out until about 2030, the groundwork required to take us there is being laid now.

But Canada needs to be more strategic about rolling out 5G and in the future 6G faster and at a lower price. According to research by Analysys Mason, Canadian mobile network operators not only paid the most for 3.4GHz to 4.2GHz band internet (graph 4), but Canada was four years behind the country with the earliest principal assignment to secure this radio spectrum.
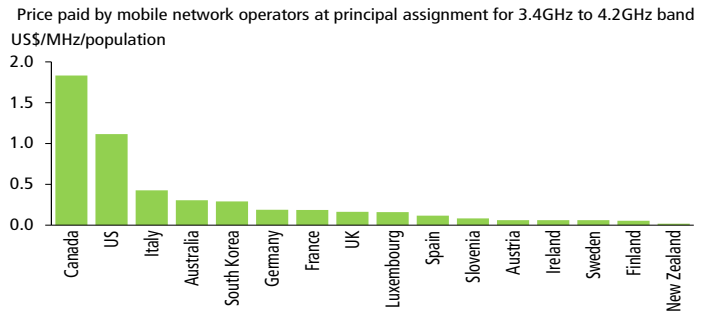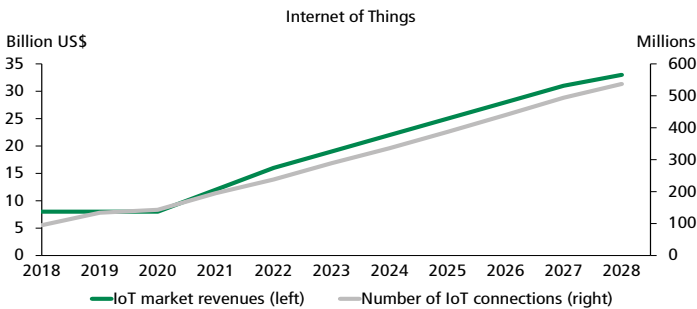
Box 3: A Canadian 5G Success Story

ENCQOR 5G (Evolution of Networked Services through a Corridor in Quebec and Ontario for Research and Innovation) is an example of a collaborative ecosystem in the 5G sector. Its objective is to give SMEs, researchers and academia access to 5G networks for the purpose of driving long-term economic growth in the Ontario–Quebec region. It's made up of several large anchor partner corporations and connects over 800 SMEs from a broad cross-section of industries. The Ontario Centre of Innovation estimates that the Ontario portion of this program has generated $2 billion in GDP, more than 23,000 jobs and over $800 million in federal and provincial tax revenues.

The Internet of Things

On the back of 5G networks comes the Internet of Things (IoT). The IoT is a network of connected devices and sensors that collect and exchange data, then use that data to automate and control a variety of processes. An example in the consumer sector is smart home devices. The IoT can improve energy efficiency and convenience by automating lighting, temperature and home security. In industrial settings, sensors can provide real-time data on the health of machinery and prevent equipment failure by optimizing maintenance schedules. This reduces downtime and improves quality control. In the agricultural space, crop yields can be maximized by gathering data on things like soil moisture that influence plant growth to optimize irrigation and other factors of production. The IoT plays a role in other sectors as well, including smart finance, healthcare, smart cities and automotive.

In Canada, revenue in the IoT market is expected to total C$26 billion in 2023 and rise to C$43 billion by 2028 (graph 5 on page 5). Today, the industrial and automotive sectors dominate the IoT market. IoT applications can detect and address quality issues in vehicles through predictive analytics and predictive

GRAPH 5
Canada's Internet of Things Market Is Expected to Double Over the Next 6 Years

Internet of Things

IoT: Internet of Things
Sources: Statistica and Desjardins Economic Studies

Box 4: A Canadian IoT Success Story

Telus Corporation was founded in 1990 as a telecommunications firm to privatize the Alberta Government Telephones crown corporation. Over the following three decades, it has not only expanded its reach across the country, but also branched into additional telecoms-related services including home security monitoring, health technology services, agribusiness, animal agriculture and integrated consumer goods systems. Telus is a great example of how disruptive innovations combine to create powerful results. For example, using the IoT on a 5G network, companies in the agrifood space can automate routine tasks and mine data insights to drive more efficient processes, leading to a smaller environmental footprint and greater sustainability.

maintenance. This helps owners avoid inconvenient and costly breakdowns and gives automakers data that will help them optimize software upgrades and design vehicles that are more efficient. For example, IoT sensors can monitor and analyze vibrations to detect deviations from the baseline.

Blockchain and Other Distributed Ledger Technologies

Blockchain is a well-known example of distributed ledger technology (DLT). Traditional databases are a centralized store of data. In a DLT system, transaction details are recorded in multiple places at the same time, with each node processing and verifying every item. Data is stored over multiple locations, allowing access only to authorized users. DLT provides a high level of trust and virtually eliminates the opportunity for tampering or fraud. The Bank of Canada has shown significant leadership in this regard with Project Jasper, which is a collaborative DLT research initiative between the central bank and the private sector—the first of its kind in the world. Launched in early 2017, it led to the Bank holding public consultations on a digital dollar in 2023, the results of which will be released soon.

In addition to being used in cryptocurrencies, DLT has many important applications in finance, healthcare, supply chain management, energy and other areas. Smart Contracts are automated contracts that are impervious to tampering and modification, with a high degree of accountability and transparency. Ethereum is a well-known early example. DLT has also been used as the foundation for secure personal identification and identity fraud prevention. Since DLT offers secure, restricted access to data, it is ideal for storing sensitive data such as patient records that need to be shared among health providers while ensuring patient privacy. An example of this is A Ledger of Me. With this system, patients control their own health data, including who it's shared with.

The number of jobs in DLT has grown rapidly, with Toronto and Vancouver being Canada's hubs in this industry (graph 6). Cryptocurrency and finance/fintech each account for 22% of the Canadian DLT ecosystem, followed by blockchain consulting at 14% (Information and Communications Technology Council, 2019).

GRAPH 6
Toronto and Vancouver Dominate Canada's DLT Jobs Ecosystem

Unique blockchain job postings, Nov. 2017 to Aug. 2019
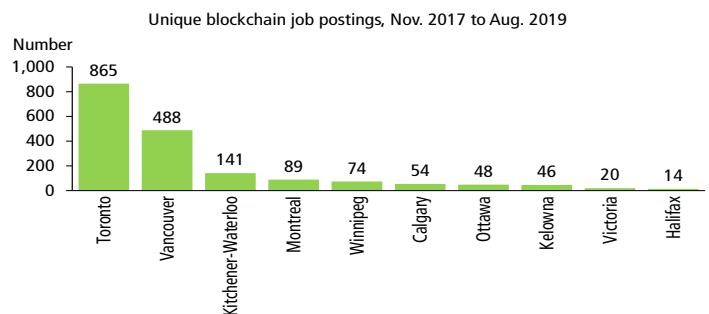
Sources: Information and Communications Technology Council and Desjardins Economic Studies

Box 5: A Canadian DLT Success Story

The Digital Aircraft Record System (DARS) consortium is led by TrustFlight in collaboration with Boeing, RaceRocks and the University of British Columbia. Its objective is to build a digital, industry-wide maintenance record of aircraft on a platform that uses blockchain technology. This trackable maintenance record will begin on the factory floor and continue through each aircraft's lifecycle, eliminating the paper records and recordkeeping gaps typical today. The consortium estimates that aircraft maintenance efficiencies could save $3.5 billion annually and improve airline maintenance productivity by up to 25%. DARS is an excellent example of private companies partnering with postsecondary education institutes. It came together in part due to the Canadian government's Digital Supercluster incubator.

Conclusion

Disruptive innovation such as 5G, IoT, AI, DLT and cleantech is of immense importance for Canada's future growth and productivity. Individually and collectively, these technologies—along with robotics, virtual reality, machine learning, 3D printing, quantum computing, nanotechnology and other advances—have the potential to revolutionize industries and sectors. 5G is empowering IoT technology, and generative AI can process and amplify the powerful data from the IoT that can then guide robots. Companies adopting these technologies can automate processes, streamline operations and make more informed decisions based on data analysis and insights. Businesses therefore stand to benefit from higher productivity, efficiency and competitiveness both at home and abroad to become leaders in their fields. At a societal level, disruptive innovation can address urgent global challenges, such as climate change, healthcare accessibility and outcomes, housing and urban planning, food insecurity, poverty and income disparity. And on an individual level, it offers convenience, connectivity, personalized customer experiences and improved access to information and services. Embracing these disruptive technologies will not only position Canada as a global leader, but also create new opportunities, drive economic growth and improve the quality of life for its citizens.