Policy Horizons Canada | Horizons de politiques Canada

Reflections

The potential impacts of digital technologies on the economy

Canada

Canada has historically prospered despite economic turbulence brought on by technological change. This prosperity, however, is less certain in the transition to the Next Digital Economy. The scale and pace of change affecting the global economy exceeds previous experience.

This series of reflections on the potential impacts of digital technologies on the economy were developed in collaboration with Armine Yalnizyan, the Atkinson Foundation's Fellow on the Future of Workers. These reflections complement insights in Policy Horizons' previous reports *The Next Digital Economy* and *The Future of Work: Five Game Changers*.

These reflections are not predictions; they are possible scenarios that may arise in the transition to the digital economy.

The content for this series was produced between November 2017 and June 2019.

Table of Contents

1: Growth or “slowth”

How digital technologies may impact GDP

Two plausible global economic futures may emerge depending on how digital technologies impact wages, consumption, production, investment, and trade. A growth scenario follows historical norms as measured by gross domestic product (GDP). In an alternative future, a slowth scenario, we still benefit from GDP growth, but the rate slows over time. Although one future may prevail at a global level, the impacts of digital technologies may be uneven over time and across regions: some countries may experience growth, while others enter a prolonged period of slowth.

Digital Technologies

Eight digital technologies[1] are maturing and combining to change the economy:

- The Internet of Things
- Artificial intelligence (AI)
- Robotics
- Advanced telepresence
- Virtual reality
- Advanced materials
- Decentralized production technologies
- Blockchain technologies

A growth scenario

Assumptions

This scenario assumes that digital technologies will lead to a rise in global purchasing power and consumption, a reduction in production costs, and increased and more widely distributed production of goods and services.

Purchasing power

Globally, incomes increase for many people as low-skilled and lower-paying jobs are further automated.[2] The result is a continued trend towards an upward shift in labour skill sets and associated wages. For those who rely on low-skilled labour, work continues to become scarce and wages continue to decline.

The rise of online tasking platforms creates a global labour market leading to international wage convergence. High-wage workers in advanced economies like Canada may increasingly face competition from workers in emerging economies who can provide the same service at a lower cost since they live in regions with lower costs of living. This leads to global wage convergence for similar tasks. Although workers in advanced economies may face declining wages, many more workers in emerging and less developed economies could see significant wage increases as they enter international labour markets through digital platforms. Wage losses in developed economies are more than offset by increases elsewhere. This leads to a net increase in global purchasing power, which creates additional demand for goods and services and increases global GDP.

Consumption

Digital technologies reduce the marginal costs of production for many goods and services, sometimes significantly.[3] It is assumed that competitive markets allow the reductions, in the form of savings, to pass on to consumers as lower prices.

The effect of lower prices will vary for regions that have experienced increased purchasing power versus those that have not. In regions with increased wages, lower per-unit prices may be offset by growth in sales volume, resulting in increased GDP. Conversely, consumption may not increase as significantly in economies that have seen reductions in purchasing power due to international wage convergence. At a macro level, in a growth scenario, in economies where purchasing power is growing, increases in sales to consumers and firms will offset the reduced revenues in regions that may contract.

Production

Greater demand for goods and services requires more production, leading to increased spending on equipment, facilities, and labour. Some production jobs may be lost to automation and some intermediaries in the value chain might be replaced by digital technologies. However, in the growth scenario, there is a net increase in employment. This includes new jobs that directly or indirectly support the process of automation and digitization of work that was previously performed by humans. Expenditures on capital and labour further increase global GDP.

Investment

Digital technologies reduce costs of production and open up new investment channels. The new channels enable increased access to capital, including for small start-ups and emerging economies. Investment in larger, younger, and faster-growing emerging markets may also accelerate. In addition, crowdfunding opportunities reduce barriers to new and peripheral producers, creating a larger ecosystem of accessible investment capital. More venture capital

opportunities create breakthrough products and services with high potential for uptake. At a macro level, in the growth scenario, the developments in investment channels result in increased valuations and downward pressure on interest rates.

Trade

Innovations in digital technologies lead to increased local production of goods in both rich and poor countries alike. Even with an increase in competitive local production, digital technologies allow supply chains to become more fluid and geographically diverse. This expands global markets, especially for services and non-material goods. The rise in globally integrated production of services and the reshoring of goods production increases the size of both global and local markets.

A “slowth” scenario

Assumptions

This scenario assumes that digital technologies reduce global purchasing power by eliminating jobs, slow investment in production, and lead to lower corporate profits overall. At the same time, these technologies create significant imbalances in corporate income and market control.

Purchasing power

Digital technologies such as automation and artificial intelligence (AI) replace a significant amount of low, medium, and high-skilled work. Automation and AI are task- and skill-specific rather than sector-specific. Consequently, in the slowth scenario, employment declines simultaneously or in rapid succession across all sectors with similar skill requirements. Many displaced workers are unable to transfer skills to other sectors and must retrain for new work or accept work at lower skill and wage levels. Retraining is costly and not widely available to those who may most benefit.

The continued unbundling of jobs into tasks and micro tasks deskills remaining work, including for many professionals. This, combined with an expanded use of global online tasking platforms, increases the number of workers who can bid on tasks. In the slowth scenario, increased competition drives wages down globally.

The rise of global labour markets, which increasingly include professionals, broadens global wage convergence. Income loss in developed economies is not offset by income gains in emerging economies. Therefore, while some areas may experience gains, global purchasing power decreases.

The move from full-time jobs to individual tasks breaks traditional employer-employee relationships. The resulting uncertainty of household income and benefits suppresses consumer spending and demand. In developed economies, high-wage professions that were previously insulated from global competition are hit particularly hard. This, in turn, lowers spending in secondary economies.

Demographic growth may support a modest increase in GDP, but a global decline in wages coupled with increased income insecurity reduces average household spending on goods and services, which slows GDP growth.

Consumption

Digital technologies reduce the marginal costs of production for many goods and services, sometimes dramatically. In contrast to the growth scenario, wage declines and income insecurity suppress demand in developed and emerging economies. While there may be some growth in sales at the lower price, lower per-unit prices are not offset by increased sales volume. As a result, GDP growth slows.

Production

Digital economies allow for the production of many goods or services at a near limitless scale, reducing marginal production costs towards zero. In the slowth scenario, the share of labour in production continues to decrease as more goods and services become digital in nature. Although companies may buy more equipment and facilities, technology rather than labour drives the production of digital goods. Investment is diverted from incomes to capital in the form of technology and machinery.

Investment

In the slowth scenario, reduced demand results in narrower profit margins. This may cause a cyclical effect, whereby investment is reduced and growth is further suppressed. If declining income is geographically concentrated, the resulting lower demand could make it more difficult for those areas to attract investment. This would further slow their potential for growth.

Conversely, dominant firms may use investments to suppress competition and reduce labour costs, further increasing their market power. In this future, there is more money invested in mergers and acquisitions than in the development of new products or services.

Trade

As more goods and services shift to digital forms of delivery, the need for trade to manufacture physical goods declines.[4] Many digital technologies make reshoring and localizing production of

physical goods more feasible. This is true, even if all other aspects of product development can be sourced offshore.

There are fewer long-term supply chain contracts, leading to more volatile trade patterns. Employment and income streams, particularly for transportation and distribution intermediaries, are lower and less predictable. Some may be eliminated in their entirety. Many aspects of digital production blur borders. This makes them hard to tax or capture by trade rules or in trade statistics.

Growth and slowth?

The two scenarios presented reflect two aggregate global outcomes. However, the global economy is not homogeneous, and there will be variations in the nature and extent to which the scenarios play out across the world. One or the other scenario will likely prevail at regional or trading block levels, at individual country-economy levels, and within sectors at national levels.

Many factors influencing which scenario prevails within a country can be outside its control, forcing nations to be scenario takers rather than makers. What can be managed to some degree is how to react. In both scenarios, some gain ground and others lose, potentially leading to significant inequity. How a country addresses income and wealth redistribution can ease or exacerbate the transition and significantly influence economic and societal outcomes.

Endnotes

[1] "The Next Digital Economy," Policy Horizons Canada, accessed August 2020, https://horizons.gc.ca/en/2019/06/20/the-next-digital-economy.

[2] McKinsey Global Institute, "How will automation affect jobs, skills, and wages?", McKinsey & Company, accessed August 2020, https://www.mckinsey.com/featured-insights/future-of-work/how-will-automation-affect-jobs-skills-and-wages.

[3] "World Development Report: Digital Dividends," United Nations, accessed August 2020, https://www.un.org/ecosoc/sites/www.un.org.ecosoc/files/files/en/integration/WDR-Key-Messages.pdf.

[4] "Trends in the Information Technology Sector," Brookings Institution, accessed 2020 https://www.brookings.edu/research/trends-in-the-information-technology-sector/.

2: Digital technology is transforming production and labour

The current wave of technological innovations is changing how goods and services are produced and delivered. Mass consumption can happen without mass production, mass transportation, or mass warehousing; likely compress supply chains; and improve performance in many industries. Technology-enabled global competitive labour markets displace labour across worker categories, including white-collar and professional workers, and cause wage convergence. At a global scale, relocation of key production and labour inputs due to digital technologies could reduce the level of global aggregate demand, measured in gross domestic product (GDP).

Production

Repurposable, on-demand production platforms such as local 3D printing have become more sophisticated. Advanced 3D-printing technologies have led to lower costs, a greater range of material inputs, and greater ease of use. 3D printing can now produce prosthetics, homes, aircraft parts, bridges, organs for transplantation, and even food.[1]

Technological advances create the possibility of mass consumption without mass production, mass transportation, or mass warehousing. More products with custom specifications could be made on demand locally, at costs that rival those of mass-market goods made in low-wage economies. Algorithms can immediately identify the cheapest price point for intellectual or physical inputs to production. Blockchain technologies enable secure, trusted, low-cost digital transactions between humans and machines who do not know each other. These advances will likely compress supply chains and improve performance in many industries.

Labour

Some digital platform technologies deepen local markets by expanding access to local goods and services. For example, Uber provides a platform for local drivers to earn income from vehicles that would otherwise be underutilized. Airbnb provides a similar function for housing, and platforms such as Deliveroo[2] and TaskRabbit[3] facilitate on-demand discovery of, and access to, local labour.

"The Internet is enabling a new kind of poorly paid hell"

A comprehensive 2017 study of 3.8 million tasks conducted on Amazon's Mechanical Turk platform by 2,676 workers found a median hourly wage of around US$2.00, with 96% earning less than $7.25/hour (i.e. the current minimum wage in the U.S.).8

It is uncertain to what extent digital technology adds or destroys work, but it is shifting work from one location to another. The increase of digital technologies is having a marked impact on labour. In one future scenario, digital technology contributes to the input of work both regrading production and labour, while in another it may destroy it. Work, however, is definitely shifting from one location to another. Global task-based platforms such as Upwork[4] or freelancer.com[5] help create new global labour markets. They facilitate employers unbundling jobs into tasks and microtasks that can be open for bids by skilled workers anywhere in the world.

Taylorism

Taylorism: a factory management system developed in the late 19th century to increase efficiency. It evaluates every step in the manufacturing process and breaks down production into specialized repetitive tasks (Merriam-Webster).

In this case, Taylorism moves from the shop floor to personal and business services that perform both physical and cognitive tasks in a highly specialized way. Mass production, previously considered as "efficient," is superseded by even greater efficiencies that result from the application of digital technologies to both production and labour.

Complementary digital technologies enable remote workers to participate fully and directly in local work—from knowledge work to front-line on-call expertise. Examples include telepresence robots such as Double[6] and mixed reality telepresence glasses like Microsoft's HoloLens.[7] More work will likely be done in lower-pay jurisdictions. This could trigger an era of rapid global wage convergence.

Such labour displacement enabled by technology will affect workers across the wage spectrum. Wages could rise in less developed economies, where lower living costs allow workers to undercut and still live reasonably well due to gains in purchasing power. At the same time, wages could fall in developed economies like Canada.

White-collar and professional workers are soon expected to face global labour markets for the first time. In the past, they have been relatively immune to global competition in labour markets and the price competition that results. Historically, work displacement has affected

mainly blue-collar workers. However, the ongoing technological change will also impact professions such as accountants, lawyers, architects, engineers, software developers, editors, and auditors.

In light of a future that results in a global marketplace for white-collar and professional services, high-paying jobs are no longer connected to particular geographic locations. Historically, the supply of a large number of good, high-paying jobs was rooted to where the demand occurred, particularly in relation to services. For example, financial, insurance, and real estate jobs are concentrated in large metropolitan centres.

Possible futures that transform production and labour

Digital technologies enable sophisticated online platforms that allow tasks to be performed from any location, provided the worker's competencies fit the employer's needs. As a result, an increase in demand for a service may no longer result in local growth for services in this sector. This is true even in location-dependent sectors such as real estate. For example, Task Network[9] is a platform-based agency that provides clerical and professional services to Canada, the U.S., and Australia through its fulfillment office in the Philippines. Its Toronto offices say it can cut labour costs by 50-70 percent. Back-office services are billed below Ontario's minimum wage (C$6.40/hr versus $14/hr). Job postings for workers in Manila offer ₱30,000/month (C$733), a high wage in the Philippines. The service is used by the real estate industry, a highly profitable sector that has seen remarkable growth and profitability in home sales in recent years.

Futures are affected from both the digital relocation of work and the global distribution of demand given that providers of the work are in geographically less concentrated regions. Incomes and demand could decrease significantly in regions that have lost work due to digital relocation. This is particularly so if substituted workers cannot find new employment that provides the same level of income. Conversely, for regions that have gained work due to digital relocation, the opposite may occur: incomes and demand could increase.

It remains unclear whether growth in on-demand online labour, algorithmic management, and telework creates a net increase in spending, but it clearly adds new sources of supply. The net effects on pay rates and the volatility of earnings are unlikely to contribute to GDP growth in developed countries. However, the lines between personal and work lives will likely continue to be blurred. More people will spend longer hours working at their screens, increasing social isolation and stress. This may increase demand for, and expenditures on, healthcare.

At a global scale, relocation of key production and labour inputs due to digital technologies could reduce the level of global aggregate demand, measured in GDP. This may occur if the purchasing power in the original location stops growing or declines, and the growth in purchasing power in the new location does not match the loss or is slow to accommodate changes in spending behaviour.

Endnotes

[1] John Hauer, "3D Printing in the Food Industry," Get3DSmart, accessed May 2019, https://get3dsmart.com/2019/06/03/3d-printing-in-the-food-industry/.

[2] Deliveroo, last accessed May 2020, https://deliveroo.co.uk/.

[3] TaskRabbit, last accessed May 2020, https://www.taskrabbit.com/.

[4] Upwork, last accessed May 2020, https://www.upwork.com/.

[5] Freelancer.com, last accessed May 2020, https://www.freelancer.com/.

[6] Double Robotics, last accessed May 2020, https://www.doublerobotics.com/.

[7] "HoloLens 2," Microsoft, last accessed May 2020, https://www.microsoft.com/en-us/hololens/hardware.

[8] Alana Semuels, "The Internet is Enabling a New Kind of Poorly Paid Hell," The Atlantic, accessed January 23, 2018, https://www.theatlantic.com/business/archive/2018/01/amazon-mechanical-turk/551192/.

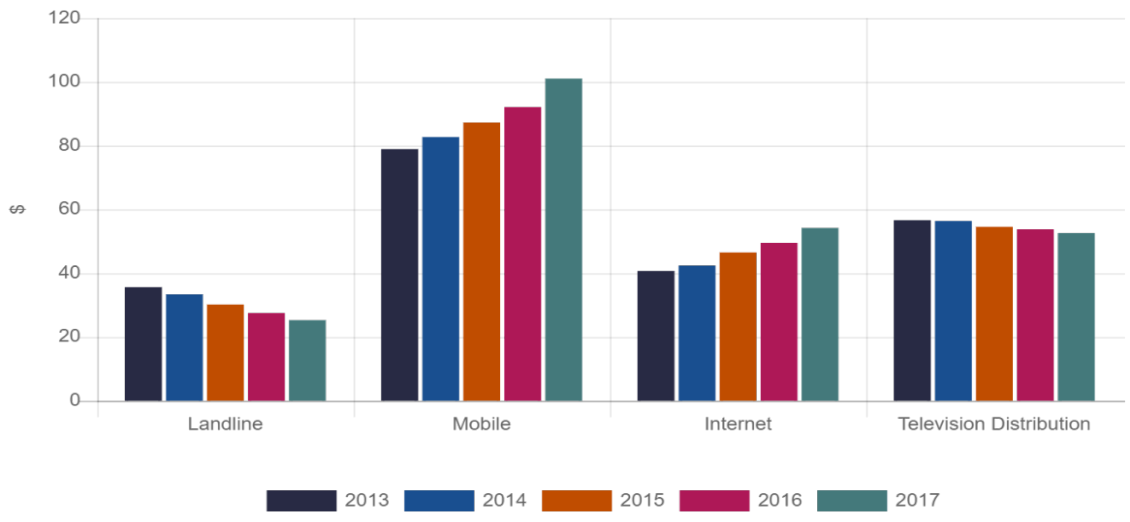
[9] Task Network, last accessed May 2020, http://tasknetwork.ca/.

3: Digital technology is transforming consumption

Digital technology continues to advance at an unprecedented rate. The effect of the technological advances on consumption results in various scenarios. Current market trends, supporting increased consumer demands, balloon. Goods and services are cheap to produce and demand is insatiable. Technological advances have added value to existing products and services and enabled the creation of new ones, thereby also increasing consumption. These trends serve to increase gross domestic product (GDP). Alternatively, advances in digital technology consumption may decrease if new technology replaces an existing product or service at a lower cost, if consumers can repurpose durable goods or if consumers delay purchases. Consumer welfare could improve even as GDP declines.

Between 2013 and 2017, Canadian spending on mobile and Internet services increased by approximately 27 percent and 33 percent, respectively.[1] During the same period, combined spending on landline and television distribution services decreased by approximately eight percent.

Average monthly household communications services spending, 2013-2017[2]



Increasing household consumption

The single largest economic driver of GDP is generated through household consumption, accounting for 58 percent in 2018 in Canada. Consequently, changes to household consumption by digital technologies is particularly interesting to examine. Technological changes may affect consumption patterns, perhaps increasing or decreasing those patterns through their impact on utility, investment, and job creation. These changes may expand opportunities that were previously non-existent or generate more variable and uncertain incomes. The result of the uncertain or enhanced investment and job creation opportunities may serve to either increase or decrease GDP.

Enhancing utility

Digital technology allows people to earn income from assets that were previously difficult to market by reducing transactional friction. For example, spare rooms can be rented out via Airbnb, and idle automobiles can generate income for drivers through Uber or Lyft. This reduced transactional friction enhances the utility of existing assets and serves to expand markets by reducing costs and improving access. However, it is unclear whether this new demand would result in a net increase to GDP. As a secondary effect, new entrants may reduce previous spending on hotels, taxis, and delivery services. This would force these providers to lower their prices. People affected by these markets may experience ups and downs in terms of both how much they earn, and how often they earn it. The uncertainty around purchasing and investment decisions, be it perceived or real, will have a negative impact on GDP.

Shifting from physical to digital

Digital technology allows the delivery of some goods and services to shift from physical to digital form. Digital delivery of everything from music and journalism to movies brings the cost of providing an additional unit to, or near to, zero.

The net effect of this shift on GDP is unclear and results in various futures.

In one scenario, within competitive markets, new entrants will contribute additional supply and lower per-unit prices, which will further encourage consumption. The new entrants will provide a net increase to jobs. The job growth leading to potential increase in purchasing power due to lower prices may increase consumption and therefore GDP.

In another scenario, if the market is already saturated, no additional entrants will join. And although per-unit prices may fall, without the associated job growth, consumption will not change. GDP could still fall as people buy cheaper substitutes within the digital space. However, in the absence of a competitive market, the benefits from cheaper production might not be passed on to consumers as lower prices. In this future, wages may go down, but prices do not, leading to stagnant or falling GDP.

Beyond these two futures, the following trends emerge:

- New market models may shift demand without producing clear pricing signals that are associated with the shift. A service may be offered in exchange for something that is not priced, such as digital data. A company uses data to deepen and broaden markets, whereas governments can use data to make public services more efficient or accessible. Whether digital data encourages or discourages demand as measured by GDP depends on how insights from data are used.
- Digital technology is transforming public service provision and use. For example, the City of Innisfil, Ontario (population 36,000) partnered with Uber[3] to provide more public transit to its residents.

Public-private technology partnerships can increase demand in many ways. These range from shifting demand from a non-profit to a for-profit market structure, to enhancing provision of affordable high-quality public services. It is also unknown whether these developments will increase or decrease the base cost of service. Prices are a function of the contracts negotiated on behalf of consumers, citizens, and residents.

Repurposing durable goods

Durables such as smart appliances and automobiles can increasingly be "repurposed" without replacing hardware. A digitally controlled physical item, such as a smartphone, can be repurposed to perform the functions of multiple pieces of hardware. Simply changing its software, for example, could turn the smartphone into a compass, a map, a camera, a television, a typewriter, and a keyboard. Other examples include reprogrammable assembly robots and 3D printers.

More repurposing may reduce consumer spending, which in turn would reduce GDP. Buying one smartphone or robot can eliminate the need to buy several other products. Manufacturers of multi-purpose products can still create new demand. However, a world in which consumers need fewer items, repurposing, or upgrading them, and keeping them for longer, would likely result in a negative impact on GDP. This is true even if people consume the same, or more, things.

Delaying consumption

Consumers may put off purchases as they wait for the next "smart" product to become available. For example, consumers would traditionally choose to buy or replace a conventional internal combustion engine car reaching the end of its lifespan. However, electric vehicles are poised to become cheaper to buy and operate. As a result, consumers may delay buying a vehicle until they can compare the merits of both types.

More smart features may not drive new sales. As smart devices include more features, the marginal utility of additional products tends to diminish. This dampens demand for replacement items. Free upgrades through new software may become more widely available, making it easier or more intuitive to enhance current capacity.

Endnotes

[1] Statistics Canada Survey of Household Spending, accessed April 29, 2020, https://crtc.gc.ca/eng/publications/reports/policyMonitoring/2019/cmr1.htm.
[2] "Canada: Household consumption, percent of GDP, " The Global Economy, accessed March 2020, https://www.theglobaleconomy.com/Canada/household_consumption/.

[3] Laura Bliss, "Uber was Supposed to be Our Public Transit," Citilab, last accessed April 29, 2018, https://www.bloomberg.com/news/articles/2019-04-29/when-a-town-takes-uber-instead-of-public-transit.

4: Digital technology is transforming trade

The latest advances in digital technologies—particularly 3D printing, artificial intelligence, the Internet of Things, and robotics—could impact trade flows and gross domestic product (GDP) by enabling a rise in both local and global production. For instance, as goods and services are produced on-demand, and in localized markets, current net exporters may see exports decrease. Conversely, current net importers may be able to produce more goods and services within their own jurisdictions. Regarding international collaboration, trade agreements are evolving to incorporate key digital elements such as data localization and storage. Digital technology continues to inform future trade negotiations.

From mass production to tailor-made

Traditionally, businesses have subscribed to classic price/quantity models, aiming to lower costs in order to deliver more goods to more consumers. For decades, the constraints on purchasing power in the developed world have pressured businesses to find more cost-cutting ways to deliver goods. To date, businesses have responded to the demands of mass consumption with complex global supply chains to sustain low-cost, high-volume mass production. These supply chains also required mass shipping and warehousing.

Looking to the future, digital technologies, such as 3D printing, artificial intelligence, the Internet of Things, and robotics, could facilitate low-cost, local, and on-demand mass production of both goods and services. These goods and services, which could be created at a smaller scale, may cater to tailored demands for a smaller and more localized market. Algorithms can optimize design and input sourcing from anywhere in the world based on price and performance objectives. Meanwhile, 3D printing increasingly supports near-instantaneous production at or near the point of consumption. Custom ordering and tailor-made products are becoming possible at mass production prices.

Expansion of this new model could change trade flows. In recent years, competition has shortened the length of supply chain contracts for most merchandise trade. Now, digital technologies will make them even more fluid by increasing options and competition globally, while reducing contract lot size.

Reshoring goods and services

Future scenarios for reshoring goods and services could increase domestic production for jurisdictions that are the net beneficiary, or decrease domestic production for those that are the net benefactor. Factors such as geopolitics, a pandemic, extreme climate events, and rising wages in previously low-wage jurisdictions could favour local production of physical goods despite global networks. Reshoring could have the same effect as offshoring once did: regions to which economic activity is transferred have historically increased their production and consumption, adding to global demand as measured by GDP. For example, increased imports of low-cost Japanese cars into Canada and the United States in the 1970s cut into the market share of the Big Three North American auto manufacturers. Global GDP still grew due to increased consumption in Japan. The broad adoption of online platforms and telepresence could diminish this effect. It could allow many aspects of reshored production to continue occurring outside the country. Only a small amount of work would be needed at the point of final production.

Reshoring/onshoring (Oxford Dictionary)

The practice of transferring a business operation that was moved overseas back to the country from which it was originally relocated.

"Reshoring can help us rebalance our economy, create new jobs and cut our trade deficit."

New products and services

Digital technology creates new, and enables existing, products and services that can be "traded" at a global level. Additional products in the market do not guarantee more aggregate demand as measured by GDP. This is because a new product or service, such as Netflix and other on-demand entertainment, can substitute a more costly one that is broadly consumed, such as cable TV. In scenarios where new technologies replace older, higher-costing products and services, GDP may, in fact, decline. In scenarios where cost savings are used to purchase other goods and services, there may be net growth.

The effect of substituting more costly traditional products and services with cheaper new ones, e.g. on-demand entertainment, could impact advanced markets like Canada more than emerging markets. It is assumed that the emerging market has previously consumed less of the original product or service. In other words, the market may simply jump to the new technology without ever having had the older one, such as the case of cell phones in Africa. Emerging markets are likely to see expenditures from digital technologies as net additions to spending, for example, rather than replacements.

Trade agreements

"Free" trade agreements explicitly incorporate and protect intellectual property (IP) and data ownership, shaping the trajectory of economic development. IP shapes the world's economic and social potential. Access to patented antiretroviral drugs to treat HIV/AIDS, for example, was embedded in the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights. In this case, IP protections were ultimately overridden.[1] As economies and societies become more data-driven, and as more processes and platforms become proprietary, emerging and developed economies alike will face multiple challenges. They will need to gain access to the data collectively generated through the consumption and use of a wide range of digital goods and services to develop public life, as well as markets.[2]

Data Localization and CUSMA

One new provision in the Canada-United States–Mexico Agreement (CUSMA) prevents Mexico, the U.S., and Canada from imposing data-localization requirements.

Data localization or data residency law requires that data about a nation's citizens or residents be collected, processed, and/or stored inside their country. Data localization requirements, which previously existed in Canada and remain in effect in Nova Scotia and British Columbia, limit cross-border data flows from leaving local data centres to, for example, cloud computing.

This matters for global e-commerce vendors, for instance, who often need to transfer customer and commercial data across borders to keep track of orders and products.[3]

Endnotes

[1] Nicol, Dianne and Olasupo Owoeye. "Using TRIPS Flexibilities to Facilitate Access to Medicines." *Bulletin of the World Health Organization* 91 (April 18, 2013): 533–39. https://www.who.int/bulletin/volumes/91/7/12-115865/en/.

[2] Curiak, Dan and Maria Ptashinka. "Leveraging the Digital Transformation for Development: A Global South Strategy for the Data-driven Economy." *CIGI Policy Brief* 148 (April 3, 2019). https://www.cigionline.org/publications/leveraging-digital-transformation-development-global-south-strategy-data-driven.

[3] Shah, Agam and Jared Council. "USMCA Formalizes Free Flow of Data, Other Tech Issues." *Wall Street Journal*, January 29, 2020. https://www.wsj.com/articles/cios-businesses-to-benefit-from-new-trade-deal-11580340128.

5: Digital technology is transforming the nature of ownership and expectations of value generation

The way businesses and consumers share the value created from ownership of technology and data determines whether there is demand destruction or demand creation. Regarding the nature of ownership and its virtue, there are looming questions surrounding how digital technology is created, stored, analyzed, and redistributed. Expectations for how we derive value from data, and the composite big data, are questions for all stakeholders, including the individuals who freely supply the source materials.

Transforming the nature of ownership

Digital technologies enable the creation of new, intangible forms of ownership. The nature of ownership is transforming uses of proceeds and capital. New forms of ownership include intellectual property like patents, data, algorithms, and branding, and network effects such as licensing agreements and platform reach. How digital technologies will shape economic growth is increasingly the product of who owns, or can access, data.[1] That, in turn, is affected by corporate scale, market concentration, and regulations.

It is unclear whether the impact of paying for user data would increase or decrease demand. Users subsidize the cost of providing many digital services through use of their data. User data is the core input for businesses that offer "free" digital services (such as social media), and is the

Large firms both develop and buy technological innovations, thereby concentrating the ownership of technology.[2] These firms may deliver a variety of returns to different market participants. Shareholders could receive capital gains and dividends. Labour could receive executive compensation and/or staff pay. Government could benefit from taxes and tariffs. Finally, consumers could benefit from lower prices and/or new or better quality products or services.

Over time, economic power and demand creation could increasingly shift from consumers and governments to a small number of globally dominant firms. The largest tech firms decide how technological benefits are returned and to whom. Their global reach allows them to set up corporate locations in areas with relatively more favourable tax laws, reducing returns to governments in taxes.[3] These lowered returns to individuals and governments increase these corporations' wealth, as well as their ability to control the ownership of new and existing technology. Due to their market dominance, these large technology firms often set prices. They may feel minimal pressure to pass on returns from technology ownership to consumers in the form of lower prices.

Challenging the virtue of ownership

Data ownership is perhaps the most challenging aspect of digital technologies. As an asset class, data is highly valuable in the short run. Unlike other assets that decline in value as supply increases, data does not become less valuable as more of it becomes available. Troves of individual-level data are harvested from public sources and proprietary corporate channels, and are aggregated and analyzed for different objectives. It can be difficult to assert exclusive ownership of data when it comes from many sources. The proliferation of sensors and apps means data is available through millions of overlapping data sets. This disrupts the ownership model, because it is difficult to control developments in the use of the data. Similarly, the availability of open-source coding for artificial intelligence versus proprietary algorithms to process big data makes the ownership of useful insights contestable.

Data sales help cover costs of production and generate profits. Smart devices and Internet of Things sensors provide a wealth of personal user data—arguably the most important factor of production—without payment. While users may receive some services in return for their data, no monetary payment could stimulate demand for other goods and services. It is unclear whether paying consumers for their data would have a net increase on purchasing, offset by having them pay for "free" services.

Expectations for return on investment

Data can be viewed as a tradeable commodity or as a public utility. Digital technology blurs the line between public and private investments and interests when it comes to data. Corporate objectives for data ownership centre on broadening and deepening markets to maximize revenues and profits. For their part, civil society and government objectives centre on increasing the efficiency, reach, and affordability of public services.

It is unclear how tension over objectives will play out in the market, partly because the value of the asset changes depending on context. Individuals, corporations, and governments could own and extract value from data if it were viewed as a tradeable commodity (such as oil). However, big data could be viewed simply as an ever-changing reflection of each user and their interactions, constantly collated and reformatted. In that case, data would be more like water than oil, a public utility to be regulated with regard to access and quality, in the public interest.

Regarding cryptocurrencies, prices for these financial products may increase significantly, but this may not drive demand growth. Many purchasers of cryptocurrencies see them as highly speculative investments rather than a currency. Due to the fluctuating value of cryptocurrencies, a price increase may not directly increase demand for other goods or services in the economy, unless more transactions are initiated in formal, legal markets.

The debate surrounding ownership of products and services generated by digital technologies will remain. Questions are emerging surrounding ownership of big data, particularly in public-private partnerships that attempt to use it to build smart cities. There are also questions about data ownership that uses tools both to stimulate innovation and advance manufacturing. Finally, other data ownership questions are rapidly surfacing as more accessible and transparent markets for cryptocurrencies are further developed.[4]

Can data collected through broadly used digital technologies be owned? Can the anonymity of trading in cryptocurrencies be better tracked? The answers could strongly influence the degree to which technology companies invest in the development of digital technologies. This, in turn, could affect production and pricing decisions. Significant spillover effects on the market would influence aggregate demand, consumer welfare, and economic growth.

Endnotes

[1] Haskel, Jonathan and Stian Westlake. *Capitalism without Capital: The Rise of the Intangible Economy*. Princetown: Princeton University Press, 2017.

[2] Wu, Tim and Stuart A. Thompson. "The Roots of Big Tech Run Disturbingly Deep." *The New York Times*, June 7, 2019. https://www.nytimes.com/interactive/2019/06/07/opinion/google-facebook-mergers-acquisitions-antitrust.html.

[3] "Paradise Papers: Apple's secret tax bolthole revealed." *BBC News* , November 6, 2017. https://www.bbc.com/news/world-us-canada-41889787.

[4] Wylie, Bianca. "Searching for the Smart City's Democratic Future", CIGI Online, August 13, 2018. https://www.cigionline.org/articles/searching-smart-citys-democratic-future.

6: Digital technologies impact financial market behaviours

Digital technologies will motivate change in financial market behaviours across many channels and spark a range of activities that can affect market volatility. Speed will be a key driver for price discovery, either for many market participants or a select few. This will either level the playing field or create further schisms—even by milliseconds—between those who have information and those still waiting for it. Digital technologies may continue to privilege large, incumbent firms, such as through high-frequency trading. Conversely, quickly evolving technologies may trickle through to smaller players, thereby creating "fairness" in the timing of financial trading. Finally, traditional credit-providing vehicles may become disrupted, resulting in a disconnect between borrowers and lenders.

Market stability and volatility reexamined

Digital technologies such as artificial intelligence and data analytics could either exacerbate the advantages enjoyed by large, incumbent firms, or level the playing field by allowing all investors to identify and accurately price risk at the same speed. In one scenario, digital technologies could amplify volatility and system risk, destabilizing markets. Robo-trading, high-frequency trading,[1] and automated platforms for wealth management could lead to bubbles and "flash" crashes that rapidly create and destroy value. For example, the volatile fluctuation in the value of Bitcoin could only have occurred with digital technologies. Automated systems make up to 80 percent of all Bitcoin trades, allowing arbitrage trading across multiple platforms at near-zero transactional cost.[2] Technology that continues to favour high-frequency trading can create even larger moves in market values. It provides an advantage to big players with the means to develop those technologies. Financial volatility may produce

higher returns, but can also erase value. The net result could be more unequal or irregular growth of gross domestic product, which itself could reduce long-term growth.

In another scenario, digital technologies could contribute to enhanced market stability and efficiency, reducing the high-frequency trader advantage. Enhanced market stability could help investors gain certainty about asset valuation and make more informed decisions about those investments. The transparency surrounding better-performing investments could increase demand through corporate reinvestment or the increased purchasing power of shareholders. Conversely, sustained volatility and increased transparency could serve to lower prices for assets that had previously been inflated.

Digital technologies affect credit underwriting and availability

Digital technologies are increasingly used to evaluate credit extended to borrowers, replacing the traditional "know your customer" metrics. A protracted period of low interest rates has resulted in lower savings rates and riskier investments as people and firms seek more risk in search of higher returns. The "know your customer" metrics have been designed to help lenders better evaluate credit risk to borrowers. Individuals and corporations find higher returns in riskier equities and inflated housing markets. Easier access to credit through new digital platforms increases borrowing and reduces accountability. This, along with historically low rates, has led to new levels of household debt in Canada.[3]

In one scenario, digital platforms erode the connection between borrowers and lenders and provide easier access to equity markets through discount online brokerages that do not provide any advisory services to a trader using them. These digital technologies further elevate credit risk by increasing the volume of inexperienced traders.

In another scenario, the availability of credit secured by digital currencies and other cryptocurrencies provides enhanced transactional security between entities that do not know each other in transparent markets. The underlying distributed ledger provides members with a platform to form their own community, removed from the traditional regulated financial institution. The role of existing trusted intermediary is transferred from institutions such as banks to the distributed membership that makes up the blockchain.

In either scenario, the arrival of a single digital provider such as Apple into financial markets could transform credit markets. The company's 1.4 billion active users are poised to benefit from instantaneous access to credit with no fees and low-interest lending rates, online financial planning, and cash back on purchases.[4] This "bank of the future" may shake up credit markets. It would effectively integrate ownership, from device to capital, so that cash can be recycled within an Apple ecosystem.

Digital technologies and financial transaction execution

Technological innovations are reshaping wholesale trade, which is based on discovery and trust in tight delivery windows. In one scenario, blockchains and their associated distributed ledger technology could make the cost of transactional trust plummet, saving billions of dollars in transactional fees. Blockchain is being used to track the chain of custody and delivery for shipments of physical goods. In the process, it eliminates many broker functions in the distribution elements of the supply chain. Demand could be reduced from intermediaries that are eliminated from payment and custody channels.

In another scenario, public blockchains, such as Bitcoin, may have difficulty gaining mainstream appeal. However, existing intermediaries could adopt private blockchains that reduce their internal costs as they continue to extract high rents in transaction fees charged to investors. Consequently, the savings in transaction fees may not be passed on to consumers.

Sources of innovation

The demand-destroying or demand-creating potential of investments as sources of innovation depends on the rate of creation and market acceptance of new enterprises, which depends to some degree on corporate innovation and concentration in the marketplace. While technological innovation can still start at a small scale from the periphery, corporate giants drive research and development (R&D) and shape economic potential. The capacity of corporate giants to invest in technology development has increased significantly. Fewer than 10 percent of the world's public companies account for more than 80 percent of global profit.[5] They effectively decide how to allocate the vast majority of the global surplus.

Eight tech firms alone spent US$96.5 billion on R&D in 2018. This outstrips R&D investments in any other industrial sector, including pharma (US$66.3 billion) and autos (US$61.2 billion).

For the start-ups, digital technology can develop new markets and transactional systems by democratizing access to capital through crowdfunding platforms. Crowdfunding may simply inflate market bubbles rather than act as an alternative mechanism for financing new products and services. Crowdfunding has grown rapidly—its global volume in 2017 was estimated at US$34 billion.[6] However, it is vastly eclipsed by traditional capital markets—global equity trades were approximately US$21.7 trillion in the fourth quarter of 2017.[7]

The integration of digital technologies into emerging markets has increased capital flows, raising both supply and demand in these markets. For example, M-pesa allows quick and cheap transfers of money from abroad (e.g. remittances) through mobile phones to communities in Kenya, Tanzania, and South Africa. Such transactions were previously inconceivable given the lack of banking infrastructure. These transfers have accelerated economic development in Africa, particularly among women—a clear example of demand creation through technology.

Endnotes

[1] Gregory Meyer, Nicole Bullock, and Joe Rennison, "How High-frequency Trading Hit a Speed Bump", January 1, 2018, *Financial Times*, https://www.ft.com/content/d81f96ea-d43c-11e7-a303-9060cb1e5f44.

[2] Benoit Tessier, "High-Speed Traders are Taking Over Bitcoin", January 16, 2017, *Globe and Mail*, https://www.theglobeandmail.com/globe-investor/investment-ideas/high-speed-traders-are-taking-over-bitcoin/article33637923/.

[3] Guy Gellatly and Elizabeth Richards, "Indebtedness and Wealth among Canadian Households", March 26, 2019, Statistics Canada, https://www150.statcan.gc.ca/n1/pub/11-626-x/11-626-x2019003-eng.htm.

[4] Kelly Fiveash, "Is Apple Card the Future of Finance or just a Fancy MasterCard?", March 28, 2019, *Wired*, https://www.wired.co.uk/article/apple-credit-card-uk.

[5] McKinsey Global Institute, McKinsey & Company, Playing to Win: The New Global Competition for Corporate Profits, September 2015, https://www.mckinsey.com/~/media/mckinsey/business%20functions/strategy%20and%20corporate%20finance/%20our%20insights/the%20new%20global%20competition%20for%20corporate%20profits/mgi%20global%20competition_full%20report_sep%202015.ashx.

[6] “Crowding Statistics”, Fundly, accessed April 2020, https://blog.fundly.com/crowdfunding-statistics/#general.

[7] Statista, 2019, “Value of Global Equity Trading Worldwide from 1st to 4th Quarter 2017”, Financial Instruments and Investments, Statista, https://www.statista.com/statistics/242745/volume-of-global-equity-trading/.

7: Digital technology blurs the interpretive function of key macroeconomic indicators

Digital technology has weakened the interpretative power of the main macroeconomic indicators—gross domestic product (GDP), the unemployment rate, and the Consumer Price Index (CPI). When any of these indicators rose or fell, the meaning used to be relatively clear. However, that is no longer the case.

Gross domestic product

Nominal GDP growth is a poor proxy for measuring human progress and wellbeing.[8] Declining or flat GDP could indicate that technology has destroyed purchasing power (earnings) or investment potential in a given jurisdiction, which would be a negative outcome. It could also reflect broad-based, technologically induced lower prices, indicating enhanced consumer welfare, which would be positive.

Unemployment rate

Traditionally, a low unemployment rate signalled full employment. It is a binary metric. Technology unbundles jobs into tasks, and employment becomes more unpredictable and precarious. As a result, the unemployment rate reveals less about employment and output gaps, both for individuals and for the economy as a whole. Low unemployment rates can mask slack in the labour market and underemployment. Therefore, they are no longer the indicator of economic strength they once were.

Consumer Price Index

The general price level that guides interest rate setting hinges on many factors. These include external supply shocks, institutional changes, market players that influence prices, and technology. Technological innovations (such as in medicine, defence, or aerospace) can

introduce new products and create new markets that drive prices up. But these innovations operate at the margins of the economy. The primary impact of digital technologies is lower unit prices through their ability to increase production indefinitely at low or no marginal cost. The more digital technologies are embedded in the economy, the more they will reduce prices, even as they expand the volume of goods and services.

What are the consequences of this new uncertainty for interpreting important macroeconomic indicators?

Here is one example using GDP: Digital technology lowers prices by creating abundance. Even though GDP falls, people are still better off, provided prices of goods and services fall faster than wages and incomes. Despite this, government revenues and expenditures would quickly be affected by falling GDP from nominal price deflation. Recessions, as indicated by falling GDP, lead to increased demands for public services even as revenues fall. Recessions usually last several quarters, but this new reality could last for years, putting stress on public support systems.

Endnotes

[1] Amit Kapoor and Bebek Debroy, “GDP is Not a Measure of Human Well-Being”, *Harvard Business Review*, October 4, 2019, https://hbr.org/2019/10/gdp-is-not-a-measure-of-human-well-being.

8: Digital technologies impact official data and macroeconomic policy tools

Reliable data is essential to economic forecasting. Digital technologies are challenging the certainty previously found in official statistics and macroeconomic models. There is an increasing need to examine whether economic trends are being accurately described or forecasted.

The rapidly expanding global labour market driven by digital platforms requires better ways of measuring how the job market is evolving, and at what pace. Digital platforms are accelerating the unbundling of services and professional jobs into discrete tasks, changing the meaning of both employment and unemployment. A growing range of tasks within a vast skill spectrum can be performed from anywhere in the world. The relationship between the time spent looking for paid work and the time spent doing the work is also changing as competition increases. Algorithmic management may reduce transactional costs of finding paid work, but increases the irregularity of work and rate of pay. Bidding for tasks and contracts also blurs the line between employment and unemployment. Workers are paid in various ways, including direct deposit, cash, trades, or gift cards. Not all earnings appear in tax files.

It is unclear how quickly this form of work is spreading globally. Statistical agencies struggle to measure the amount and growth of employment and self-employment on digital platforms. The extent of this phenomenon is critical, as the scale could affect unemployment and job growth measurements, both key metrics for macroeconomic policy.

The Oxford Internet Institute's Online Labour Index collects data daily from six widely used English-speaking sites that cover about 70 percent of this market. This index grew by 30 percent between June 2016 and March 2019.[1] Canada's share of this global market grew from 4.1 percent to 9.5 percent during this period. Canada is the fifth-largest user of on-demand labour on these sites (the U.S. and Europe are the biggest "employers") and the eighth-largest provider of workers completing tasks (India and Bangladesh are the two biggest). A Bank of Canada study estimated about 3.5 percent of the country's labour force was engaged in such work by the end of 2018. This represents about 70,000 full-time equivalent jobs not captured by official labour force statistics.[2]

Measurements of gross domestic product (GDP) may undercount the true volume of economic activity. Statistics Canada does not directly measure Canadian e-commerce on international platforms such as Amazon, Alibaba, or eBay, affecting the fidelity of statistical trends in both household consumption and trade. In addition, the use of cryptocurrencies is rising, both as a store of value and as a form of currency. The number of cryptocurrencies is also rising,[3] reminiscent of the process by which the U.S. transitioned to the U.S. dollar.[4] While much of this activity is intended for investment and speculation, some cryptocurrencies are the foundations for alternative commerce and trading zones, both legal and illegal. Because cryptocurrency use is not denominated in dollars, it is not included in systems of national accounts.

Digital technology also makes it easier to swap goods directly without using currency.[5] This kind of trading is uncounted and uncountable, relative values being in the eye of the beholder.

The intermingling use of digital currencies and cash/credit promises in online games and digital platforms further blurs the distinctions between virtual and "real," as well as what is considered economic activity in our national accounting systems.[6] If these alternative trading systems continue to grow, economic activity will be increasingly difficult to capture through GDP.

The relationship between the statistics used and the underlying economic reality they are meant to depict is loosening. Information that drives macroeconomic decision making is reported annually, quarterly, or monthly. The time lag between surveying and reporting findings can be weeks, months, or even more than a year. Survey response rates are falling, and the quantity and type of digitized information bases are rising. As they do, governments and statistical agencies seek ways to incorporate more timely data from a variety of sources to improve their understanding of, and responsiveness to, emerging trends.[7] But in the fast-moving world of digital technology, gathering and analyzing data becomes increasingly complicated. Data from business systems can be proprietary and costly. In addition, businesses sometimes shield data from scrutiny or release it selectively.[8]

An increasing amount of data is being collected from a growing range of sources—public, private, administrative, social media, and sensors. This raises questions about the quality of that data, and how to best integrate its different types.

Price signals that guide macroeconomic analysis weaken if the data captures less labour market activity, fewer purchases of goods and services, and fewer financial transactions. This has an impact on fiscal and monetary policy decisions.

Digital technologies may also challenge macroeconomic model assumptions. Innovations that generate higher productivity (more output for the same or less input) lead to greater GDP growth. Digital innovations may become so widely adopted and generate such a multitude of efficiencies that they lead to generalized price disinflation, and stagnant or falling GDP (demand destruction).

Digital technologies could improve or weaken the robustness of data, reduce or increase uncertainty and volatility of the business cycle and household incomes, and reinforce or challenge basic assumptions of economics. This would reduce the reliability of macroeconomic forecasts, and challenge traditional business and government planning and growth. This, in turn, would weaken macroeconomic policy.

Endnotes

[1] "Introducing the iLabour Project", The iLabour Project Investigating the Construction of Labour Markets, Institutions and Movements on the Internet, accessed Month Day, 2020, http://ilabour.oii.ox.ac.uk/online-labour-index/.

[2] Olena Kostyshyna and Corinne Luu, 2019, "The Size and Characteristics of Informal ("Gig") Work in Canada, Bank of Canada, https://www.bankofcanada.ca/wp-content/uploads/2019/02/san2019-6.pdf.

[3] Bitcoin and Ethereum are the best known of 1,584 cryptocurrencies available, up from 1,565 at the end of 2017, accessed Month Day, 2020, https://coinmarketcap.com/all/views/all/.

[4] Clive Thompson, "What the Founding Fathers' Money Problems Can Teach Us About Bitcoin," *Smithsonian Magazine*, April 2018, https://www.smithsonianmag.com/innovation/founding-fathers-money-problems-bitcoin-180968393/.

John Szramiak, "The History of Money: A Brief Look at American Currency," *Business Insider*, June 18, 2016, http://www.businessinsider.com/the-history-of-american-money-2016-6.

[5] When one such trading platform became too heavily used, it gave way to a currency-based system. Michael Oliveira, "Bartering Community Bunz Launches Digital Currency in Move Some Say Goes Against its Original Purpose", April 9, 2018, *Financial Post*, http://business.financialpost.com/technology/blockchain/canadian-online-bartering-community-bunz-launches-digital-currency.

[6] Charlie Fink, "How Are People Making Money in VR… or Will They?", January 2, 2018, *Forbes,* https://www.forbes.com/sites/charliefink/2018/01/02/how-are-people-making-money-in-vr-or-when-will-they/#17fea27f75d7.

[7] Cornelia L. Hammer, et al. “Big Data: Potential, Challenges, and Statistical Implications,” *IMF Staff Discussion Note,* International Monetary Fund, September 2017, http://www.imf.org/~/media/Files/Publications/SDN/2017/sdn1706-bigdata.ashx.

As an early example in Canada, Statistics Canada announced it would supplement Labour Force Survey data with Kijiji job listings to assess bona fide labour shortages by the federal government during the temporary foreign worker controversy in 2014. Bill Curry and Tavia Grant, “Tories Defend Use of Kijiji Data in Face of Opposition Ridicule”, *Globe and Mail,* March 26, 2014, https://www.theglobeandmail.com/news/politics/tories-defend-use-of-kijiji-data-in-face-of-opposition-ridicule/article17690737/. The use of this source was subsequently dropped, and the job vacancy rate plunged. Bill Curry, “Job-Vacancy Rate Plunges as Tories Drop Kijiji Data”, May 5, 2014, https://www.theglobeandmail.com/report-on-business/economy/jobs/ottawa-adjust-labour-data-raising-questions-about-national-skills-shortage/article18457198/.

[8] Armine Yalnizyan, “Truth and Truthiness in Economic Statistics, *Behind the Numbers* (blog), June 9, 2015, http://behindthenumbers.ca/2015/06/09/truth-and-truthiness-in-economic-stats/.

Acknowledgements

Policy Horizons produced these reflections in collaboration with Armine Yalnizyan, the principal researcher of this work. Ms. Yalnizyan is an economist and the Atkinson Foundation's Fellow on the Future of Workers. She previously served as President of the Canadian Association for Business Economics, and Senior Economic Policy Advisor for the Deputy Minister at Employment and Social Development Canada.

We are deeply grateful for the expertise and input of a range of Canadian and international organizations and economists who were consulted in the development of this work, including but not limited to: Janine Berg, International Labour Organization; Stijn Broecke, Organization for Economic Cooperation and Development; Frances Donald, Manulife Investment Management; Rohinton Medhora, Centre for International Governance Innovation; Jonathan D. Ostry, International Monetary Fund; Eric Santor, Bank of Canada; Noah Smith, Bloomberg Opinion; and David West, the Financial Accountability Office of Ontario.

We would also like to acknowledge everyone at Policy Horizons who contributed to the publication of this work, especially: Maryam Alam, Marcus Ballinger, Steffen Christensen, Nelly Leonidis, Peter Padbury, Alain Piquette, Jessica Strauss, Kristel Van der Elst, and Nadia Zwierzchowska.