Analytical Studies: Methods and References

Multi-year Consolidated Plan for Research, Modelling and Data Development, 2021 to 2023

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Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Multi-year Consolidated Plan for Research, Modelling and Data Development, 2021 to 2023

Prepared by the Analytical Studies and Modelling Branch, Statistics Canada

Analytical Studies: Methods and References

Papers in this series provide background discussions of the methods used to develop data for economic, health, and social analytical studies at Statistics Canada. They are intended to provide readers with information on the statistical methods, standards and definitions used to develop databases for research purposes. All papers in this series have undergone peer and institutional review to ensure that they conform to Statistics Canada's mandate and adhere to generally accepted standards of good professional practice.

The papers can be downloaded free at www.statcan.gc.ca.

We invite users to provide feedback on the consolidated plan as it is designed to respond to evolving issues and research needs (statcan.analyticalstudies-etudesanalytiques.statcan@canada.ca).

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Foreword

As Canada's national statistical agency, our mission is to serve Canada with high-quality statistical information that matters. Statistics Canada produces statistics that help Canadians better understand their country—its population, resources, economy, society and culture. We do this in a variety of ways. These include releasing regular social and economic indicators, accompanied by analysis to provide relevant context, and conducting in-depth research and modelling to better understand relevant policy issues and identify driving factors and possible future scenarios. Applied research and modelling are essential functions of an effective statistical organization, allowing us to remain—and become more—relevant. These efforts help us both provide valuable data to decision makers, and Canadians more broadly, and identify data gaps that we can work to fill by developing new data sources.

The ***Multi-year Consolidated Plan for Research, Modelling and Data Development*** outlines our research and modelling priorities over the next two years. The implementation of the plan will be led by our Analytical Studies and Modelling Branch. While this research program builds on a wide body of work and the varied expertise of our researchers, it focuses on the medium-term and potential long-term impacts of the COVID-19 pandemic on the health and the social and economic lives of Canadians. Researchers aim to apply a diversity and inclusion lens to ensure that, as an agency, we continue to highlight how the pandemic has affected diverse population groups, such as immigrants and racialized communities, in different ways. These efforts will be enabled by the disaggregated data the agency is committed to producing as part of the Disaggregated Data Action Plan, supported by the 2021 federal budget. This research and modelling program will also continue to inform, strengthen and expand our core social and economic programs through the development of new integrated data sources, new indicators and new modelling methods.

The themes outlined in the plan were developed in consultation with our many external partners and stakeholders, including federal government agencies and departments; provincial, territorial and municipal governments; non-governmental organizations; and academic researchers. Their input has been instrumental in shaping this research and model development program and ensuring its relevance.

As our world and the issues we face continue to change, so too must our work. As a result, we view this plan as evergreen, and I invite you to provide feedback by emailing statcan.analyticalstudies-etudesanalytiques.statcan@canada.ca.

Thank you in advance for your input.

Anil Arora, Chief Statistician of Canada

Executive summary

Since March 2020, the COVID-19 pandemic has reinforced the need for high-quality data and insights to guide decision making. The agency has responded and continues to respond to this need by leveraging it analytical capacity to produce research insights, health and economic modelling, and new economic indicators that directly address the information needs of departments across the Government of Canada, external stakeholders, and the Canadian public. The role of research and modelling in a national statistical agency is critical for adding value to data, developing new measures and informing and addressing data gaps. Moving forward, the research and modeling efforts of the agency will be guided in part by the needs for new research and indicators to identify and track potential structural economic and social changes—to help inform whether Canada will be a more resilient, inclusive and sustainable country following the pandemic. The agency will focus on applying a diversity and inclusion lens ensuring the creation and leveraging of new disaggregated data, where appropriate.

This ***Multi-year Consolidated Plan for Research, Modelling and Data Development*** outlines the research and modelling priorities for the agency over the next two years. The Analytical Studies and Modelling Branch (ASMB), the research arm of Statistics Canada, will lead the implementation of the plan. ASMB strategically makes use of expert knowledge and a broad range of data sources and modelling techniques to address the information needs of a broad range of government, academic and public sector partners and stakeholders through **analysis and research**, **modeling and predictive analytics,** and **data development**. The branch strives to deliver relevant, high-quality, timely, **comprehensive**, **horizontal** and **integrated** research and to enable the use of its research through capacity building and strategic dissemination to meet the user needs of policy makers, academics and the general public. Whereas other areas of the agency are also involved in modelling and research, this comprehensive plan reflects priorities of the agency that the ASMB will be addressing.

The plan is organized around the following key themes: **economic**, **social**, **health and multi-disciplinary** (inter-sectoral) themes. Within the **economic program**, research, data development and modelling will focus on **innovation and the new economy,** such as digitalization. Projects will be undertaken with the goal of better understanding the wide-ranging impacts of technology adoption and complementary activities on firms and workers, and their macroeconomic consequences. Research will also focus on **global competitiveness,** exploring the links between competition, innovation and productivity, and structural factors and policy that play an important role in helping shape the competitive landscape. Finally, the onset of the COVID-19 pandemic has accentuated the need to study **business dynamism and economic adaptability.** Using new measures of the openings and closures of firms, work in this area will focus on understanding how businesses of different ownership (e.g., women-, immigrant- or youth-owned businesses) have been impacted by the pandemic, the consequences of these impacts on the allocation of resources, productivity and growth, and the role government supports have played.

The program of **social** research will focus primarily on labour- and job-related themes. Work will continue being done to understand the vital role of **immigrants** in Canada's labour force, including the effectiveness and impacts of the economic immigration selection system in predicting labour market outcomes and the overall impacts of the pandemic on new and current immigrants, particularly those working in sectors hardest hit. Research will also focus on the economic outcomes of immigrants educated in science, technology, engineering and mathematics, the integration of refugees, and the social and political integration of immigrants more broadly. Research and data development on **jobs and employment** will focus on structural changes in the labour market, including the creation of new more-timely measures of the gig economy, the slow growth in median real hourly wages (relative to productivity growth), and the impact of automation and teleworking, including changes in job tasks. **Financial well-being** will be

explored, including the financial vulnerability of marginalized groups most impacted by the pandemic, savings behaviours related to key programs (e.g. registered retirement savings plans, child-related tax benefits), and income replacement among older workers transitioning into retirement. Finally, lockdown measures due to COVID-19 have created many uncertainties for students at all levels. Research related to **education, training and skills** will focus on enrolment of international students in Canadian universities; the long-term job impacts for postsecondary students; and the factors associated with pursuing a postsecondary education more broadly, using new linked data that integrates postsecondary enrolment records, taxation files, census data and kindergarten to grade 12 school records.

The program of health research will focus on **nutrition and physical health** examining the short- and long-term effects of pandemic strategies (e.g., lockdowns) on Canadians' food intake, physical activity and sedentary behaviors, as well as the inter-relationships between kids and parents. Research related to the impacts of the pandemic on **mental health** and **substance use** more broadly will be examined. A specific focus on **child and youth health** will be linked to national and international collaborations around indicator development for children and youth, including the Canadian index of child well-being, impacts of the pandemic on child and youth health and parents, and the availability and use of child care services as parents return to work. Finally, research efforts will also focus on the other end of the life cycle, **aging,** with a look both at health states and service needs of the elderly, including the transition to formal care and residential institutions, the met and unmet needs for formal home care, hospitalization use at the end of life, and the development of microsimulation models related to Alzheimer's and other dementias in response to the Canada's national dementia strategy.

Given the breadth of subject matter expertise, the branch is uniquely positioned to take a multi-disciplinary approach to address broader issues that directly align with key federal government priorities including **well-being (quality of life)**, **diversity and inclusion**, **early learning and child care,** and the **environment**. The COVID-19 pandemic has had unprecedented impacts on many key aspects of **quality of life**, including health, social connections, mobility, employment and incomes. Research will focus on the use of new data sources to quantify the impacts on life satisfaction among recent immigrants, youth and women, and the factors that contributed to or detracted from life satisfaction. While the branch will apply a **diversity and inclusion** lens to all research, where appropriate, specific attention will be paid to understanding the experiences of the most vulnerable groups hit hardest by the pandemic (i.e., less-educated individuals, lower-income families, recent immigrants) examining the intersectionality of their socio-economic health susceptibility, during and after the pandemic. In response to Canada's Anti-Racism Strategy, studies on social and economic experiences of ethno-cultural and visible minority groups will paint a fuller picture of different aspects of employment and income trajectories, social participation, health, and well-being for Canada's diverse population groups. The importance of **early learning and child care** have been marked by recent investments by the federal government. In support of the Multilateral Early Learning and Child Care Framework, the branch is leading a comprehensive program of data development and collection, research and analysis, and dissemination to address topics such as child care use and the impacts on parental earnings, employment decisions, and child outcomes, as well as child care use before, during, and after the COVID-19 pandemic.

Finally, the program of research on the **environment will be expanded** through several inter-related projects. The Government of Canada has identified a wide range of collaborative initiatives in the Pan-Canadian Framework on Clean Growth and Climate Change to meet emissions reduction targets, grow the economy and build resilience to a changing climate. This program of research will support the development of a body of knowledge and assess intended outcomes. It will include developing productivity measures that incorporate environmental impacts, developing consumption-based estimates of greenhouse gas (GHG) emissions, measuring the contribution of clean energy to the energy efficiency of the economy, measuring inter-sectoral shifts in employment and skill requirements in the context of Canada's transition

towards a low-carbon economy, and analyzing the effects of the COVID-19 shutdown on economic behaviour and environmental impacts. The pandemic has also altered the patterns of the work and home lives of Canadians. These impacts will be captured in research focusing on related GHG emissions and the impacts of air pollution and in new work on the impacts of the built environment on health, including the association between neighbourhood greenness and indicators of physical activity.

This program of research is supported by innovative **modelling and predictive analytics and data development.** As Statistics Canada's lead, ASMB develops microsimulation models and epidemiologic models, including the Population Health Model (POHEM), OncoSim, the COVID-19 compartmental model and the Social Policy Simulation Database/Model (SPSD/M), to project the potential short- and long-term impacts of health and social policies. These models are currently used by various federal departments and other stakeholders to inform their decision making. These models have been and will continue to be used to assess the economic and health impacts of the pandemic, including new federal income support benefits for individuals and families (SPSD/M) and long-term impacts on cancer incidence and mortality (OncoSim). The branch will continue to move toward greater use of predictive analytics, including artificial intelligence and machine learning, to leverage the power of new integrated data sources and overcome challenges with traditional regression analyses. For example, in the case of intersectionality, predictive analytics could be used to better measure the impact of experiencing multiple dimensions of quality of life and inequality and to better understand the characteristics of high-growth firms and their environments, enabling real-time predictions of firms over the next three years.

Statistics Canada's researchers will continue to develop new and innovative integrated data to support programs of research to address complex policy questions by bringing together economic, social, health and census data. In addition to maintaining and updating existing linked data files (e.g., Canadian Census Health and Environment Cohorts, Canadian Employer-Employee Dynamics Database, Longitudinal Worker File, Intergenerational Income Database), new linkages will include the integration of new data sources leveraged from external partners such as the Temporary Foreign Worker Program, the National Pollutant Release Inventory and the Greenhouse Gas Reporting Program to Statistics Canada's National Accounts Longitudinal Microdata File. These new and existing data sources will be used to facilitate research focused on understanding the interaction of the economy and the environment. These linked databases are made available to the wider academic and policy community to support a range of research initiatives through the Research Data Centre programs (https://www.statcan.gc.ca/eng/microdata/data-centres).

Mandate

The Analytical Studies and Modelling Branch (ASMB) is the main research arm of Statistics Canada mandated to provide high-quality, relevant and timely information on economic, health and social issues that are important to Canadians. The branch strategically makes use of expert knowledge and a broad range of data and methods to describe, draw inferences, and make objective and scientifically supported deductions about the evolving nature of the Canadian economy and society. Research questions are identified through consultations with a broad range of government, academic and public sector partners and stakeholders. Their knowledge of the research landscape and policy needs puts ASMB researchers in an advantageous position to identify both information and data gaps and translate them into research questions. These questions are addressed through a **comprehensive program of research** using **modelling and predictive analytics** and **innovative data development** that leverages the agency's administrative and survey data to enable interdisciplinary and horizontal research to address complex issues. To support greater access, ASMB integrated data and analytic results are made available to external researchers and policy makers to further support evidence-based decision making at national, provincial and local levels of government.

The branch disseminates research results by applying knowledge translation practices using a range of products (e.g., research papers, infographics, videos, and blogs) to meet user needs. The branch delivers a comprehensive training program to build data and analytical capacity both within the agency and among external stakeholders to better enable their use of data and statistical information. Branch researchers are called upon to provide expert advice, input, feedback and quality assurance to a wide range of programs within Statistics Canada. The branch is well-positioned to make substantial contributions in multi-disciplinary programs of research.

Vision

ASMB aims to ensure Canadians have the key information on Canada's economy, society and environment that they require to function effectively as citizens and decision makers. It does this through the delivery of relevant, high-quality, timely, **comprehensive**, **horizontal** and **integrated** research, using knowledge translation and capacity building, with emphasis on the following qualities:

- *Comprehensive*: providing in-depth insights on a range of current and emerging issues related to the economy, society, health and the environment

- *Horizontal*: leveraging and integrating traditional and alternative sources of data on individuals, institutions and firms from across and outside the agency that portray interdependencies across various sectors enabling insights from different lenses (i.e. social, economic);

- *Integrated*: adopting multi- and inter-disciplinary approaches to integrate data and research to address complex issues.

Partnerships and collaborations

Researchers implementing this plan work with a broad range of external and internal collaborators to ensure that its research and data development activities address policy-relevant issues and meet the needs of users. External partners include:

- **Federal government agencies and departments** (Bank of Canada, Immigration, Refugees and Citizenship Canada, Employment and Social Development Canada,

Treasury Board Secretariat, Department of Finance Canada, Privy Council Office, Canada Revenue Agency, Natural Resources Canada, Canada Mortgage and Housing Corporation, Health Canada, Crown–Indigenous Relations and Northern Affairs Canada, Innovation, Science and Economic Development Canada, Global Affairs Canada, Public Health Agency of Canada, Transport Canada, Environment and Climate Change Canada, Agriculture and Agri-Food Canada, Canada School of Public Service, Parliamentary Budget Officer, Department for Women and Gender Equality, Canadian Heritage, Veterans Affairs Canada, and regional development agencies), and **Parliamentary committees**

- **Provincial and territorial governments and organizations** (Newfoundland and Labrador, Nova Scotia, New Brunswick, Prince Edward Island, Ontario, Alberta, British Columbia, Northwest Territories, Yukon, Atlantic Workforce Partnership), **municipal governments and organizations** (City of Surrey, Fraser Health Authority, Surrey Fire Department)

- **Non-governmental organizations** (Canadian Apprenticeship Forum, Business Development Bank of Canada, Canadian Partnership Against Cancer, Canadian Institute for Health Information, Canadian Institutes for Health Research, C.D. Howe Institute, Canadian Centre for Policy Alternatives, Export Development Canada, Fraser Institute, Canadian Economics Association, Institute of Fiscal Studies and Democracy, Mitacs, Higher Education Quality Council of Ontario, Institute for Research on Public Policy, Centre for the Study of Living Standards, Canadian Association for Business Economics, National Bureau of Economic Research, Canadian Research Data Centre Network, Future Skill Centre, Public Policy Forum)

- **Academic researchers** (Simon Fraser University, University of Toronto, McGill University, University of Waterloo, McMaster University, Université de Montréal, University of Ottawa, University of British Columbia, Carleton University, Memorial University, Université du Québec à Montréal, Université Laval, Lakehead University, University of Guelph, Royal Military College, HEC Montréal, Columbia University, Research Institute of Industrial Economics, National Tsing Hua University, New York University Stern School of Business, State University of New York, University of California Los Angeles, Oregon State University, Osaka Medical College, London School of Hygiene & Tropical Medicine)

- **International organizations** (International Population Data Linkage Network, Organisation for Economic Co-operation and Development, International Monetary Fund, World Bank, Washington Group on Disability Statistics, United Nations Economic Commission for Europe, UNICEF, the European Union, United Kingdom Office for National Statistics and Economic Statistics Centre of Excellence)

Program of research, modelling and data development

This plan outlines activities to be undertaken in three broad and inter-related areas: analysis and research, modelling and predictive analytics, and innovative data development – by the Economic Analysis Division, Health Analysis Division, Social Analysis and Modelling Division, and the Strategic Analysis, Publications and Training Division of ASMB.

Analysis and research

This plan proposes to engage in an ambitious program of research on economic, health and social issues, as well as the interplay between them. The research is rooted in expert knowledge of diverse fields of study, such as economics, sociology, labour, psychology, epidemiology,

business, mathematics and statistics. The research program serves the current information needs of federal and provincial policy makers, the academic community and other stakeholders, and it identifies future information needs. It also highlights the value and potential of Statistics Canada's administrative, linked and survey data to the broader research and policy communities. ASMB also leads programs of research that cut across disciplinary and organizational boundaries, drawing on subject matter expertise across the branch and data across the agency. This strategy has been particularly useful in ASMB's involvement in providing COVID-19 insights, analyses, modelling, innovative indicators and timely dissemination.

Modelling and predictive analytics

This plan proposes to engage in multiple activities in the domain of modelling and predictive analytics. This ranges from classic regression models to predictive algorithms and machine learning. Microsimulation models are a cornerstone of the branch's work, with over 30 years of experience in building models that support evidence-based policy making and enable users to conduct what-if scenarios to better understand the short- and long-term impacts of policy options. Recently, the branch has been exploring the creation and dissemination of interactive tools developed as part of research, making these available to users to provide more customized, actionable and timely information. In addition, building models and supporting partners in the modelling of infectious diseases has been a COVID-19 priority. Furthermore, the branch is exploring the development of models that would leverage the increasingly detailed information produced at Statistics Canada on the structure of the economy and society, and the businesses and individuals that operate within it. These models will enable analysis on the relationship between changes in the aggregate statistics with the changes and impacts on cities and regions, businesses, and individuals.

Data development

This plan proposes to engage in a range of activities designed to strengthen and expand Statistics Canada's data holdings and, more broadly, Canada's statistical infrastructure. Such activities include data integration of both individual and firm-level data through record linkage and microsimulation, as well as integration of contextual data such as environmental information using geographic location. The branch plays a leading role in training and providing subject matter expertise to other divisions for survey development, including content, frame development and innovations using administrative and linked files. New data sources resulting from these activities are made available to policy and academic researchers through the Research Data Centres in universities across the country.

The following narratives provide an overview of the main programs of research within the broad economic, social and health themes.

1 Analysis and research

1.1 Economic

1.1.1 Innovation and the new economy

Digitalization is fundamentally changing the way goods and services are produced and delivered to individuals. The opportunities and flexibility afforded by digitalization have been underscored by the COVID-19 pandemic. Businesses that were already engaged in e-commerce, or had already invested in technology to permit work from home, were better equipped to adapt to social distancing restrictions. It is important that the digital transformation is reflected in the way that we measure the economy and is included in our analysis of what underlies the movements in aggregate statistics.

At the aggregate level, expanding the measure of intangible capital to include asset types of growing importance, such as the **value of data and databases**, is important for understanding the contribution of digitalization to economic growth. Measuring the **intensity of digitalization** at the industry level will provide insights into its impact on patterns of firm entry and survival, firm productivity, and productivity distributions. Combining measures of digital intensity and the potential for workers by occupation to work from home will facilitate analysis of the relationship between **telework and productivity** at a more detailed industry level.

At the firm level, studies on the productivity and employment consequences of **robot adoption** will be followed up by other studies that investigate the **impact of technology adoption** on growth, productivity and firm entry. The **role of patents** in explaining firm growth and firm dynamics will be examined. Measures of the **use of artificial intelligence** by firms will be developed to better understand its effect on firm outcomes. Leveraging ASMB's employer–employee databases, the **links between technology adoption, firm performance, individual employment earnings, jobs losses and gains, and job quality** will continue to be studied. These studies will delve into the diversity and inclusiveness of technology adoption.

While robot and technology adoption will likely lead to increases in productivity, they will likely also cause the displacement of workers in certain occupations and with certain skills. These displaced workers may experience interruptions in their employment, require upgrading of their skill sets or experience changes in their career paths. It is important to understand the impact of technology adoption and automation on workers' well-being by type of worker so that any negative impacts can be mitigated.

1.1.2 Global competitiveness

As a small open economy, Canada's economic performance is greatly affected by external factors and trading and investment relationships with key partners. While competition is said to spur innovation and productivity in general, the links between competition, innovation and productivity are not fully understood. For example, there are questions about the impact of foreign investment on research and development, intellectual property, and innovation in Canada. There are also questions about why Canada's strong record of scientific innovation is not translating into improved productivity performance. Moreover, the effect of changes in the competitive environment are not equal across regions, firms and individuals, and the strategies that enable certain types of firms to succeed may not be the same for other firms. Finally, not only do trade and investment dollars flow across countries, workers do as well. Immigrants to Canada bring in knowledge about markets in their home countries and may also play a role in trade creation, innovation and technological diffusion.

Understanding Canada's global competitiveness requires cross-country comparisons. Productivity is an important measure of competitiveness, both at the country and firm level. **Productivity growth leads to higher living standards and enables firms to compete** with other firms selling similar goods and services. Studies will be undertaken to examine **how productive Canada's firms are relative to the most productive firms in the world**. Recent studies, which have excluded Canada, have found evidence of a widening gap between the most productive firms and all other firms. This study will examine where Canadian firms are situated relative to global firms operating in the same industries.

However, the competitiveness of a business is not measured solely by its productivity. The ability of a company to attract investment and consumers may be **increasingly dependent on its sustainability and societal impact**. Factors such as family-friendly policies that foster an inclusive workplace can aid in the retention of workers and improve innovativeness, and a business' environmental footprint may be considered along with its profitability by investors. Studies in this area will examine the importance of these factors for a firm's competitiveness.

The **competitiveness of an economic environment** can be measured in a number of ways. Examples include **concentration ratios, market share turnover rates, firm entry and exit rates, job creation and destruction rates, and measures of market power**. A comprehensive study in this area looks at these measures individually and then creates a composite index of these measures. It will also highlight how competitiveness and competition may have changed because of the COVID-19 pandemic. The impact of the changing competitive environment on investment, productivity and wages are also examined.

Structural factors and policy also play an important role in helping shape the competitive landscape. In this area, **the regulatory competitiveness** of Canada will be studied. This may include an examination of inter-provincial barriers to trade and the construction of a composite index using World Economic Forum data on labour market and financial system competitiveness, World Bank data on the ease of doing business and Organisation for Economic Co-operation and Development (OECD) data on product market regulation. Past work on the role of industry structure, capacity utilization and firm size distribution on Canada's productivity performance will continue to be updated and expanded.

The integration of domestic industries in Canada in **global value chains have been an important source of competitiveness** for Canadian firms that find it advantageous to source more of their inputs globally. The **high degree of integration of Canadian industries in global value chains** may also **pose risks to firms during periods of rising trade tensions, and more recently, the COVID-19 pandemic**. There is ongoing work with international organizations such as OECD, the Asia-Pacific Economic Cooperation and statistical agencies in the United States and Mexico to understand the extent to which firms and industries are integrated with global value chains. The work is planned to monitor recent trends in global value chains and to examine if the firms are moving up the value chain and becoming more specialized in knowledge-intensive, high value-added activities. Specialization in more traditional cost-based industries and activities is no longer a viable option for most developed countries.

Digitization has allowed services trade to grow. In Canada, services trade as a share of total trade has expanded rapidly over the past two decades. New research will examine **the role multinational enterprises play in services trade**, compare the **contributions of men- and women-owned businesses to the services trade**, and study **the impact of COVID-19 on services trade.**

1.1.3 Dynamism and economic adaptability

The onset of the COVID-19 pandemic has accentuated the need to study business dynamism in and out of recessions. Using the newly created monthly statistics on the openings and closures

of firms, studies will be undertaken to examine the **characteristics of businesses that have closed and exited**, the potential **contribution of new businesses to economic recovery**, and changes in the location choices of businesses as a result of the pandemic.

The path of the economic recovery from the COVID-19 pandemic can also be informed by examining the dynamics of previous recessions. Studies in this area will examine whether **business start-ups during recessions fare worse** than start-ups during other periods; whether these differences can be accounted for by industry, entry size, financial constraints, or demand conditions; and what the **potential contribution of start-ups to jobs and export growth** is after the pandemic. Where appropriate, and to the extent possible, a diversity lens will be applied to determine **if women-, immigrant-, youth-, Indigenous-, disabled-, Black-, other visible minority- or same-sex couple-owned businesses are affected differently**.

Government policies have supported, and will continue to support, Canadian businesses through the pandemic and the economic recovery phase, respectively. Two of the largest direct support measures in the COVID-19 Economic Response Plan are the Canada Emergency Response Benefit and the Canada Emergency Wage Subsidy (CEWS). Both programs ultimately provide support to workers, but the **CEWS has the additional benefit of enabling workers to maintain ties with their firms**. Studies will examine the **utilization rate of the CEWS**, explore whether differences by industry, geography, firm size, gender of owner and immigrant status of owner exist, and the underlying factors that may account for these differences. The **potential implications of CEWS utilization for the economic recovery path** will also be modelled.

Understanding business dynamism and its long-run decline is important because the entry of new firms is a significant channel through which innovation, new ideas and new products enter into the market. Moreover, **reallocation of resources from exiting and declining firms to entering and growing firms is an important source of aggregate productivity and trade growth**. Evidence from other countries has suggested that low interest rates have enabled weaker firms to survive, thereby inhibiting the reallocation of resources to more productive uses. Programs such as the CEWS may also have the unintended consequence of supporting weak firms and inhibiting reallocation. A study in this area will examine the characteristics of firms that file for insolvency, how these characteristics have changed overtime, the size of the population of firms that have characteristics similar to those that file for insolvency, and the fraction of those applying for support under the COVID-19 Economic Response Plan. Work will also continue on documenting and understanding the long-run decline in business dynamism in Canada.

1.2 Social

1.2.1 Immigration

Immigration continues to play a vital role in Canada's society and economy. It is projected that, by 2031, one-third of the Canadian labour force will be foreign-born. Immigration levels and selection criteria continue to be centre stage in policy discussions, and the economic, social and health outcomes and contributions of immigrants continue to be important metrics of settlement and inclusion. These discussions are taking on added importance during and after the COVID-19 pandemic, which has significantly disrupted both the inflow and socio-economic landscapes of immigrants.

With the introduction of the Express Entry (EE) system and subsequent modifications, Canada has significantly altered the selection of economic immigrants. ASMB provided data analysis and release for the design of EE Comprehensive Ranking System. In collaboration with Immigration, Refugees and Citizenship Canada, ASMB continues to examine and monitor **the effectiveness of selection criteria** in predicting labour market outcomes of economic immigrants and to provide analytical insights for the consideration of immigration selection policies.

The **role that temporary residents (TRs) play in the Canadian economy,** particularly in addressing **short-term labour and skill shortages,** continues to be an important issue. ASMB is refining measurement in this area and documenting the extent to which TRs are contributing to industries with labour shortages (e.g., the Canadian food supply chain, which relies significantly on temporary foreign workers). **TRs are also an increasingly important pool from which permanent residents (PRs) are selected**. In the wake of the COVID-19 pandemic, some potential risks associated with this two-step immigration selection are exacerbated. A series of studies are reviewing the advantages and risks of the economic immigration selection systems, including recent trends in pathways of TR to PR transition and labour market outcomes. A special lens will be on international students as sources of labour supply and how the pandemic may reshape the prospects of this group of TRs and postsecondary institutions.

Immigrants are over-represented in certain industries, some of which are hard hit by the COVID-19 pandemic. Moreover, some groups of immigrants have been more vulnerable to past economic downturns, such as recent immigrants and refugees. In this context, research on PRs continues to examine **economic and social outcomes in the years after landing**, with a particular focus on short-term and persistent impacts of the pandemic, including labour market trajectories when the economy recovers and in the years to come after the COVID-19 pandemic. The economic outcomes of immigrants are also being studied in terms of trends in **wage gaps between immigrants and Canadian-born individuals** and how the wage gaps are distributed between and within firms.

Immigrants comprise a large share of labour force participants with university degrees, particularly in science, technology, engineering and mathematics (STEM) fields, and hence offer capacity to contribute to an innovative and dynamic economy. Studies in this area are investigating **Canada–United States differences in economic outcomes of STEM-educated immigrants**, **innovation in immigrant-owned firms**, and the role that supply and demand factors play in education–job match among recent immigrants and youth in Canada. A particular research focus is on the long-term labour market outcomes of university-educated immigrants who could not find skilled jobs in the initial years after immigration. Gender differences in the skill–job match among recent immigrants are also being investigated.

Refugee intake and settlement have been centre stage for many Western democracies in recent years, and a policy focus in Canada. An overview of asylum claimant outcomes looks at recent trends for asylum seekers. Several studies compare various economic and social integration outcomes (e.g., employment, earnings, use of social assistance, poverty rates and sense of belonging to Canada) across refugee programs (i.e., government-assisted refugees, privately sponsored refugees, and asylum claimants) and between refugees and other immigrants.

Ongoing research examines the **social and political participation of immigrants**. Research projects include Canadian citizenship acquisition, voting in federal and provincial elections, civic engagement, sense of belonging, and subjective well-being. Using several cycles of the General Social Survey on victimization, a study examines group differences in domestic violence against immigrant women.

Research on **immigrant health** will examine different health outcomes, including use of health services, based on individual characteristics such as type of immigrant, world region of origin, time since immigration and location of landing. The record linkage between immigration and health administrative data sources has increased the research possibilities, enabling researchers to have a deeper look at these topics, including issues such as mental health among immigrants, health outcomes and hospitalizations for temporary residents.

1.2.2 Jobs and employment

The Canadian labour market experiences various shocks on an ongoing basis, including the current COVID-19 disruptions. **Technological changes and movements in international trade** affect employers' demand for labour and potentially alter the nature of work and employer–employee relationships. New types of firm–worker relationships, such as those embedded in the 'gig economy,' may change **job quality,** while providing flexible work arrangements for both workers and firms. Because **digital innovation** allows firms to produce new products and processes based on software code and data at a low marginal cost, it may give rise to 'winner-take-all' market structures. Such market structures may change the wage bargaining power of firms in local labour markets and affect wage growth. Increases in computing power allow for the automation of a growing number of tasks previously performed by workers. Along with labour demand shocks, **population aging** introduces labour supply movements into the labour market. Assessing the changing nature of work in light of these changes is a priority.

The **implications of the 'gig economy' for the employment prospects** and longer-term evolvement of gig employment in the aftermath of the COVID-19 pandemic will depend on the speed and intensity of the post-COVID-19 overall economic recovery. Continuous efforts will be focusing on improving the methodology and timeliness of measuring the gig economy in Canada and assessing the financial well-being of gig workers and their families.

Even though labour productivity is substantially higher today than it was in the early 1980s, median real hourly wages have grown little since the early 1980s. Research will examine the extent to which this **slow growth in median real hourly wages** (relative to productivity growth) can be accounted for by declines in the labour share of gross domestic product, changes in employer social contributions, movements in the terms of trade and changes in wage inequality. To inform discussions about the **middle class**, research will also document, for families in various segments of the earnings distribution, the degree to which hourly wages and annual hours of work of spouses have increased at a faster (or slower) pace than they did nationwide from 1980 onwards.

As computer-based technologies allow for the automation of a growing number of tasks, the task content of jobs in various occupations change. Similarly, internet technology may facilitate working from home for workers who are able to do so. The COVID-19 pandemic may accelerate such ongoing trends in telework and automation. To document the movements in task content of jobs, information on job tasks drawn from the US Bureau of Labor Statistics' O*Net files in the 2010s are being appended to the Labour Force Survey over those years. They will be used to assess potential changes in occupational task content in Canada during a period of major advances in automation technology. Of course, not every worker will be affected equally by technology. While some may experience negative outcomes (such as job loss), others may be in high demand because of the complementarity of their skills and the new technology. Ongoing work will investigate the degree to which worker characteristics are associated with the risk of **job transformation due to automation**.

Research will also examine the relationship between **telework feasibility** and the degree to which tasks are automatable. Workers whose jobs can be carried out from home and have a low risk of being automated are likely to be in a favourable position in the labour market in coming years. Since employees who work at home might trade off earnings growth for the possibility of working at home, analyses will also assess whether employees who work at home at a given point in time experience lower subsequent earnings growth and more unstable employment trajectories than other workers.

Committed to a gender-based analysis plus focus, a gender lens will be placed on technology and its impact on workers. This will include an analysis of gender difference in the susceptibility of workers to automation technology and a portrait of the **digital skills** of women and men in the workplace and at home.

Other aspects of employment among **women and youth** are also being investigated. This includes studies looking into educational and work experiences of women with disabilities; short- and long-term consequences of the COVID-19 pandemic for youth employment, learning, and psycho-social well-being; the employment trajectories of men and women during and after COVID-19, taking into consideration of the role of family responsibilities and occupation characteristics; and gender differences in employment during school and subsequent employer–employee job matches.

Every year, thousands of Canadian workers lose their job or suffer a major health shock. The financial **impacts of disruptions to employment** due to layoffs or health events and the roles that public and private insurance programs play in offsetting such impacts are important to policy makers and Canadians. This will continue to be a growing area of interest with respect to the impact of COVID-19 and post-COVID-19 recovery. Research will investigate how workers laid off during the pandemic compare and how they have fared economically, relative to their counterparts who were laid off during the three previous recessions. Analyses conducted at the family level will allow for an assessment of the degree to which lower-income families have been relatively more affected during the pandemic-induced labour market downturn than during the 2008-2009 recession.

A new and groundbreaking program of research using linked tax and health administrative data is underway, documenting the impacts of various 'health shocks' on the employment and earnings of Canadians and their families. Building on methods developed to study the impacts of cardiovascular events (e.g., strokes), similar methods will be applied to study the impact of severe trauma and various forms of cancer. Related work is documenting the extent to which earnings losses associated with hospitalization are offset by public programs and the tax system and the roles that various health conditions play in transitions into non-employment and early retirement among older workers.

1.2.3   Financial well-being

Financial decision making and savings behaviours are important issues in the context of population aging, increasing life expectancy and historically high levels of household debt. Forthcoming studies will examine various aspects of savings and labour supply behaviours, including the extent to which: a) registered retirement savings plan (RRSP) withdrawals differ based on tax filers' financial literacy; b) RRSP contributions are more common when tax filers owe a final balance to the CRA; c) child-related tax benefits impact labour market outcomes, health characteristics and poverty rates of Canadian families with children; and d) tax incentives are adequate for encouraging Canadians with low levels of savings to prepare financially for retirement.

In addition, the employment of **older workers** and **transitions into retirement** will be a focus of research. Of particular interest are inter-cohort differences in the **income replacement rates** of seniors, joint retirement decisions among spouses and variations in labour supply decisions of older workers with different socio-economic characteristics.

COVID-19 and associated economic closures have impacted Canadian families unevenly. Research will be looking at **financial vulnerability** before, during and after the COVID-19 pandemic and identifying the groups most impacted by the work stoppage resulting from the pandemic and those that are more susceptible to economic and financial shocks of COVID-19.

1.2.4 Education, training and skills

The COVID-19 pandemic and subsequent lockdown have created many uncertainties for students at all levels. Physical distancing requirements have led to a sudden and massive shift to online learning. At the primary and secondary school levels, this raises issues about **online preparedness**. To actively participate in the new educational delivery mode, schoolchildren must have access to home internet, and there must also be enough devices in the home to accommodate increased demand from siblings and parents who are often also learning or working from home. In addition, personal computers (desktops and laptops) are preferred over mobile devices since the latter are amenable only to receiving, not producing, educational information. Access may differ by level of parental income, which is the basis of comparisons in new research in this area.

At the postsecondary level, the prospect of online learning raises concerns about the future, particularly for international students who may reconsider their enrolment in Canadian universities and colleges. This is also a concern for institutions because international students have been an increasingly large source of overall revenue (i.e., international enrolment has increased substantially over the last decade, and institutions charge international students much higher tuition fees compared with domestic students). Current work conducted in collaboration with the Canadian Centre for Education Statistics is highlighting these vulnerabilities by mapping out pre-COVID-19 international enrolment by level, field of study and source country.

Longer-term, postsecondary students are concerned about future job prospects given the extent of the economic downturn, which has disproportionately affected youth. To this end, ongoing research is simulating **the impact of the downturn on the labour market outcomes of the class of 2020** over the next five years. As students transition to the labour market, they will no doubt seek every advantage they can to improve their chances of landing a well-paying job. One strategy is to build a solid job résumé before graduating, which might become challenging if the economic downturn persists. One way to build a résumé is to acquire human capital with a specific employer. This reduces the uncertainty of hiring a new employee since the employer has already had an opportunity to observe the job candidate. On the other hand, remaining with the same firm may simply signal an inability to find a better job, which may critically depend on the industry of the original employer. For example, remaining in a low-wage fast food job may not help students in their career; in contrast, maintaining employment in a large multinational firm with plenty of room for advancement may be beneficial. New research will be asking if the strategy of landing a job after graduation with the same employer the individual worked for as a student results in more favourable labour market outcomes (i.e., earnings).

Parents may also be concerned about the educational prospects of their children in light of the stock market volatility and job losses, both of which could reduce the total value of educational savings (e.g., Registered Education Savings Plan accounts [RESPs]). Future research will estimate the impact of the pandemic on two parental characteristics that could have ramifications for their children: expectations about their children's educational attainment and savings behaviour. These research questions will be addressed by comparing responses on the 2020 Survey of Approaches to Educational Planning (SAEP), which was in data collection both before and after the lockdown. As such, this work will also inform data users about the relevance of pre-COVID-19 pandemic responses in the dataset in a post-COVID-19 world. Results will be disseminated jointly with the release of the 2020 SAEP data, in collaboration with the Canadian Centre for Education Statistics. Of course, parental savings are not solely determined by wealth and a steady income—some families may not invest due to the complexity of the rules and forms that they are required to fill out. Current research is investigating **the role of literacy, numeracy, and financial literacy, as well as wealth and education in explaining the gap in RESP participation** between families in the top and bottom of the income distribution.

The decision to pursue a postsecondary education may also be influenced by various other factors such as parental income and education, and academic performance of the children. It is well-documented that youth from lower-income families are less likely to attend college or university than their higher-incomes counterparts. To help bridge this gap, the federal and provincial governments generally offer more financial aid (e.g., loans and non-repayable grants) to students with lower resources (e.g., parental income). However, older research within ASMB found that most of the gap in university attendance between high- and low-income youth could be explained by differences in academic performance and parental education (i.e., only about 16% of the total gap could not be explained by differences in observed characteristics). Whether the situation has improved or worsened is unknown, since no data sources have enabled follow-up analysis, until now. Newly available data combining postsecondary enrolment records, taxation files, census, and kindergarten to grade 12 school records will be used to track the role of parental income in determining postsecondary access over the last decade. The same data source will be used to investigate **the role of parental income in determining the field of study choice** once in college or university, which is another important factor in labour market success.

Finally, postsecondary education is not the exclusive domain of youth. **Lifelong learning** is a key component of labour market success, particularly as technology evolves, or as job restructuring takes place. **Returning to school following job loss** is an important decision to consider, as displaced workers may have the time and the incentives to re-invest in themselves. Beyond the decision to re-train, displaced workers also have to decide what field to specialize in. Pursuing further studies in one's main area of specialization is one option ('fine tuning'), while another is to explore a new area completely ('re-skilling'). Future research will estimate the frequency and benefits of these two very different re-training strategies.

1.3   Health

The program of research in health uses a comprehensive approach focusing on health determinants and outcomes across the lifespan, from birth to end-of-life. Health determinants include the physical, environment and socio-economic conditions, as well as health behaviours such as nutrition, physical activity and substance use, while health outcomes include chronic conditions, mental health, cancer, morbidity, hospitalizations and mortality. A substantial focus will now include infectious diseases to contribute to our understanding of COVID-19 and impacts of associated policies such as social isolation. When appropriate, a diversity lens is also incorporated to examine health differences and health inequalities by characteristics such as disability, gender or immigrant status, as well as a focus on vulnerable populations, including children and youth, those living in poverty, Indigenous people, and the aging population.

1.3.1   Health post-COVID-19

A research framework and program will be developed to examine how structural changes in how we live, work and play will impact initial and long-term health behaviours and health outcomes. This program will align with changes identified in other areas of analysis such as telework or rural–urban population distribution.

1.3.2   Nutrition and physical measures

Nutrition and physical activity are important and modifiable health behaviours that influence both mental and physical health, including obesity, diabetes and cardiovascular disease. Our work will examine the **fitness levels of Canadian children and adults** and associations between parent and preschooler physical activity levels.

With the publication of the revised Canada's Food Guide, Statistics Canada's unique food intake data, based on 24-hour recall methodology in the Canadian Community Health Survey - Nutrition focus, offers research opportunities to examine differences in how Canadians have met the old

and the new food guidelines and how a **healthy diet** score can be built by incorporating the new recommendations. For example, the consumption of ultra-processed food, fruit and vegetables, sugar intake, and changes over time will be a focus in coming years. Innovative work in nutrition will look into bringing food environment into the research and developing new ways to analyze data at the sub-provincial level.

Important new survey content and physical accelerometer data will offer unique opportunities to use the Canadian Health Measures Survey to quantify sleep duration and patterns of movement over a 24-hour period and to gain insights into the relationship between patterns of measured sleep, sedentary and active behaviors, and associations with obesity and chronic health conditions.

Special populations, such as the elderly or those struggling with certain chronic conditions, will be the target of new research on movement behaviour, and innovative work in physical measures will look into using physical activity tracking data (e.g., Fitbit) shared by respondents.

In terms of COVID-19 and social isolation, new data will be used to examine the short- and long-term effects on Canadians' food intake, physical activity and sedentary behaviours. For example, food insecurity and the use of food banks, change in behaviours in regards to screen time, and indoor and outdoor activities during and after the several lockdowns will be explored. Shared data from the activity tracker will be an innovative way to explore the short-term behavioural impacts of the COVID-19 pandemic.

1.3.3   Child and youth health

The early years are a critical time for **child development** that have a long-lasting impact on future health, social and economic conditions. Initiatives in this area are linked to national and international collaborations around indicator development. Work with the Public Health Agency of Canada and Employment and Social Development Canada will focus on indicators for children and youth in relation to early interventions for the most vulnerable, and learning and child care for all, in line with an upcoming national child care strategy. Statistics Canada is collaborating with international partners such as the United Nations Economic Commission for Europe to support an international survey and recommendations for the collection of child and youth statistics and UNICEF to support the development of measures for reporting on sustainable development goals, a **Canadian index of child well-being**, and **the youth-focused U-Report polling data**. Another initiative includes working with the international Washington Group measure of **child disability** being collected in the Canadian Health Survey on Children and Youth. Additional work related to COVID-19 will focus on the family, parental concerns during the pandemic, and impacts on child and youth health and mental health. The availability and use of child care services as parents return to work will also be studied.

Indigenous children are among the most vulnerable in Canada, with many community-level programs in place to foster the healthy development of Indigenous children and their families. A set of projects will contribute information necessary for federal program evaluation, including geospatial mapping to enhance the understanding of nutrition, developmental and school readiness program locations across the nation; characteristics of the municipalities where programs are situated; and the identification of vulnerable communities and program needs.

Maternal behaviours and physical and mental health are important parts of a child's or youth's environment that influence their own health and well-being. Maternal employment behaviours will be explored using linked data to inform the interplay between family policy, child care choices and parental outcomes, including earnings, the gender wage gap and maternal labour force participation. This will include the impact on child mental health and economic outcomes over time. A particular focus will be on child care choices and labour force participation of parents after the COVID-19 pandemic.

1.3.4 Substance use

Substance use behaviours are intricately linked to physical and mental health. With the legalization of cannabis and the growing awareness of the impact of opioid-related overdoses and deaths, substance use is a priority for health policy (also see next section on multi-disciplinary research themes).

In addition to updating previous estimates of cannabis consumption, long-term trends of daily or near-daily **cannabis consumption** will be examined. Trends using pre- and post-legalization estimates will inform the impact of changes in access to cannabis. Special attention will be given to those aged 45 or older, as they account for the majority of cannabis consumed in the country. In addition, the impact of the COVID-19 pandemic and related social isolation on substance use behaviours will be considered, including opioid, tobacco, alcohol, and cannabis use.

Subject matter expertise in the area of substance use will contribute to the development of predictive models and trajectories for **alcohol consumption** that could be integrated into microsimulation tools.

1.3.5 Aging

The **aging of the population** is a major demographic shift that will impact all facets of the Canadian economy and society, and thus remains an important pillar of health research. Research in this area has focused on the impacts of chronic conditions, disability, social isolation, frailty and hearing loss on health-related quality of life, service use and general health and mental health. The research program will look both at health states and at the service needs of the elderly. This is particularly pertinent with respect to the COVID-19 pandemic and its impact on seniors, because of the severity of the condition and consequences for this particular age group. Going forward, the program will focus on continuing to understand the current and future care needs of seniors, including the transition to formal care and residential institutions, the met and unmet needs for formal home care, and hospitalization use at the end of life. In the absence of an institutional survey, innovative methodology examining transitions to institutions will need to be used.

Health states of seniors will be studied using global measures such as the Health Utilities Index and health-adjusted life expectancy and through specific health conditions. Responding to the Canada's national dementia strategy, the Population Health Model microsimulation tool will be updated to include the projection of **Alzheimer's and other dementias** by using the newest findings about determinants of dementia incidence and age of onset. The impact of social determinants such as education on **cognitive functioning** over the life trajectory will also be studied.

1.4 Multidisciplinary programs of research

Complex social and economic policy issues sometimes require a more comprehensive, multi-disciplinary approach. Given the range of subject matter expertise and knowledge of a broad range of data sources, the branch is uniquely positioned to lead these types of programs of research.

1.4.1 Well-being and quality of life

The **digital transformation** continues to reshape the lives of individuals, communities and societies. The need for data development and research on the social aspects of digital transformation, including its **impacts on well-being**, have been underscored by both the Conference of European Statisticians and OECD. ASMB is contributing to the evidence base in this area, drawing on the Canadian Internet Use Surveys being fielded in 2018, 2020 and 2022

and other data sources. Of central interest are the following: how Canadians are engaging in and adapting to the rapidly changing digital environment, the degree to which their digital skills allow them to capitalize on opportunities and mitigate risks encountered in the digital environment, and the impacts that their online activities and digital skills have on their well-being. These issues take on added relevance in the context of COVID-19 and the increased scope of online activity it has brought about.

ASMB continues to respond to demands for data and analysis on the **quality of life** and well-being of Canadians. **Subjective well-being**, and specifically, **life satisfaction**, is an important dimension of this. ASMB recently provided the first estimate of the decline in life satisfaction in Canada during the first wave of the COVID-19 pandemic. This work will continue as ASMB uses various household surveys to track life satisfaction from pre-pandemic levels in late 2019 through successive phases of the pandemic, as measured over the course of 2020 and 2021. The magnitudes of the decline in life satisfaction observed across population groups such as recent immigrants, youth and women will be documented, and the factors that contributed to or detracted from the life satisfaction of these groups through the pandemic will also be documented. The COVID-19 pandemic has had unprecedented impacts on many key aspects of life, including health, social connections, mobility, employment and incomes. Life satisfaction provides the best available umbrella measure of the combined effects of these changes on the well-being of Canadians.

Research on **inequalities** in emerging **job quality** measures, such as the feasibility of working from home, risks of job transformation by automation, work–life balance and pay and benefits, as well as in the levels of **life satisfaction** and overall **well-being** will take on added importance in the post-COVID-19 era and a **digital economy**. These multi-dimensional research projects are expected to contribute to the development of Canada's **quality of life** framework.

Stakeholder demand for information on housing, neighbourhoods and communities continues to be high. ASMB is working closely with external stakeholders in support of Canada's National Housing Strategy. Continued projects are being undertaken to identify dwelling and neighbourhood characteristics associated with positive (and negative) outcomes among residents. More broadly, ASMB work will continue to harness information from diverse sources, including the new Canadian Housing Survey, census data, administrative data and open data, to shed new light on Canadians' satisfaction with their homes and neighbourhoods, the factors that contribute to (or detract from) their assessments, and the role that these factors play in individual outcomes such as health and life satisfaction.

1.4.2   Diversity and inequality

The Canadian society and economy have experienced important changes over the last decades, including technological advancements and digital transformation, shifts in industrial compositions, international trade, and increased diversity of Canadian population. Impacts of those changes are not felt equally across various groups. The COVID-19 pandemic—a combination of social, economic and health stressors—has further affected different populations unevenly. Less-educated individuals, lower-income families and recent immigrants are among the hardest hit. ASMB will pay particular attention to **vulnerable populations,** examining the intersectionality of their socio-economic health susceptibility, during and after the pandemic. Health conditions before the pandemic will also be studied as a potential source of inequalities.

In response to Canada's **Anti-Racism** Strategy, forthcoming studies on social and economic experiences of ethno-cultural and visible minority groups will paint a fuller picture of different aspects of employment and income trajectories, social participation, health, and well-being of Canada's diverse population groups, using new General Social Survey (GSS) data on social identity, the Labour Force Survey and linked administrative data.

The interactions of gender, employment and health are the focus of several new projects. ASMB is participating in a nationally funded Social Sciences and Humanities Research Council team grant with multiple Canadian universities and stakeholders, led by the University of Ottawa. This research will examine data from the Canadian Community Health Survey to look at the **role of different professions, work stress and mental health, using a gender lens**. An additional theme related to women and the workforce will explore parental leave, child care, and maternal employment decisions and earnings using administrative and newly linked data.

There is a long history of reporting birth, death and cancer outcomes for the Canadian population by age, sex and province. With the recent creation of a series of Census-to-Vital Statistics linked datasets, it is now possible to examine **inequalities in these health outcomes** for populations such as Indigenous people and immigrants and **across socio-economic strata, including education and income**. Moreover, these linked datasets will allow for an examination of trends over time. For example, recent studies using these data have found an increase in relative income-related mortality inequalities between 1991 and 2011, a more pronounced 'healthy migrant' effect on perinatal health among more recent migrants, a greater relative risk of thyroid cancer in the immigrant population and certain ethnic groups, and significant gains in life expectancy among members of First Nations, Métis, and Inuit since 1996. Over the next couple of years, these linked datasets will continue to be used to inform policy that aims to reduce health inequalities in Canada. Death registers (2020) linked to census data will also be explored as a tool to study excess death as a result of the COVID-19 pandemic by socio-economic characteristics.

Finally, people are ultimately the backbone of the economy. The health of the economy will depend on the health and composition of its workforce. A study is planned to examine how health contributes to Canada's human capital stock via longer working lives and effectiveness on the job. Furthermore, diversity is often cited as a potential source of strength for the economy. Studies are planned to examine this at both the aggregate and firm levels. These studies will investigate the contribution of women to the gross domestic product, women to trade, and composition of a firm's workforce to its competitiveness.

1.4.3   Early learning and child care

In support of the Multilateral Early Learning and Child Care Framework, Statistics Canada has convened teams to fulfill a variety of information needs. The work has capitalized on the expertise of various divisions in the areas of data development and collection, research and analysis, and dissemination. Feedback is obtained through collaborations with a team of national stakeholders including federal, provincial and territorial representatives; academics; policy makers; and an expert group. Currently, there is a wealth of information that can be obtained from existing census, survey (e.g., GSS, Longitudinal and International Study of Adults), administrative (Business Register, Canadian System of Macroeconomic Accounts, government sector general ledger files), and linked data to produce indicators of child care use, supply, cost, and characteristics of the child care workforce. For example, research will examine child care use and the impacts on parental earnings, employment decisions and child outcomes. These sources will be complemented by new data collection vehicles (e.g., Rapid Stats surveys for parents of children aged 0 to 5 and parents of school-age children, a national child care provider survey) to inform both indicators and research. This will allow for an examination of child care use before, during and after the COVID-19 pandemic to provide policy makers with specific information related to their particular needs.

1.4.4   Environment, clean technology, growth and health

The Government of Canada has identified a wide range of collaborative initiatives in the Pan-Canadian Framework on Clean Growth and Climate Change to meet our emissions reduction

targets, grow the economy and build resilience to a changing climate. ASMB's research can support the development of a body of knowledge and assess the intended outcomes.

Estimates of productivity growth should take account of all inputs and outputs associated with a production process. However, productivity growth is often measured without taking into account the effects on the environment. The purpose of research undertaken under this broad theme is **to develop productivity measures that incorporate environmental impacts** and to apply them to some of the more significant environmental issues facing Canada such as greenhouse gas (GHG) emissions, thereby providing a more appropriate representation of sustainability aspects and more adequate measures of productivity growth. While productivity is one point of entry into analysis linking the economy to the environment, another is **understanding how the COVID-19 shutdown and expected recovery may affect long-term demand for energy and its associated GHG emissions**, as governments continue to look for clean growth. Projects related to this theme will develop the data and methodological foundations for this type of analysis.

The projects outlined here address one or both of these two broad agendas. These will include developing **consumption-based estimates of GHG emissions** that account for the total amount of GHG emissions produced along the production chain and measuring the **contribution of clean energy to the energy efficiency of the economy**.

Projects will also be aimed at examining the **effect of technological advancement in pollution abatement such as clean technology on firm dynamics and performance**. Projects will study the relationship between innovation in production and innovation in pollution abatement; study the effects of carbon pricing on firm-level employment, earnings and job turnover; and measure digitalization in the energy sector and assess its impact on firms and workers.

In an effort to derive more granular and locally relevant information, a number of projects will examine how the aforementioned changes, and others, are impacting **regional and sectoral economic and labour market performance** and the potential impact on the volatility of various measures of economic performance.

In collaboration with Natural Resources Canada and Environment and Climate Change Canada, ASMB has established a new research program focusing on inter-sectoral shifts in **employment and skill requirements in the context of Canada's transition towards a low-carbon economy**. Analyses have looked at worker displacement and job profiles, as pertaining to various energy-producing industries, including both traditional sectors such as coal mining, oil and gas extraction, and fossil fuel electric power generation, and emerging clean technology industries such as alternative sources of electric power generation (e.g., wind and solar). This information is critical to inform discussions regarding the potential impact of inter-sectoral employment shifts on workers' economic well-being. Further work is planned to examine the post-displacement educational and training strategies workers displaced from the energy sector use and the employment outcomes associated with these strategies.

Behavioural changes of individuals in choosing electric cars and telework, in particular during and after the COVID-19 pandemic, will in turn have an impact on GHG emissions. Two projects will investigate the implications of those new trends for GHG reductions.

The **physical environment** is a well-established determinant of health. Geospatial data identify the geographic location of features and boundaries on Earth that can be used to derive information about the physical environment. Associations between health and characteristics of the physical environment, such as the proximity of homes to highways and major roads, air pollution, industrial emissions, road network density and green space, have been demonstrated. A longstanding research partnership with Health Canada and a network of air pollution researchers will continue to develop methods and datasets to better understand these relationships. In addition, a research

program has been initiated to better understand the impact of climate change on human health, with an emphasis on social infrastructure.

The influence of the **built environment** on health behaviours such as nutrition and physical activity has also emerged as an important area of research. The coming year will see new work on the association between neighbourhood greenness and indicators of physical activity. In an effort to meet users' needs for more granular-level data, this year will see the completion of a feasibility study on creating a food environment dataset created from the Business Register.

2 Modelling and predictive analytics

This plan intends to advance the use of modelling and predictive analytics including microsimulation and exploring the applications of advanced methods such as artificial intelligence (AI) and machine learning (ML) in the context of analysis and research and data integration. The transformation within the branch from the exclusive use of survey data to the development and use of large administrative linked and integrated data to address complex policy issues also opens the possibilities of applying new advanced and leading-edge methods. New this year will be the dissemination of interactive models developed in the course of research that will allow users to customize their queries to more directly meet their needs in a timely manner.

2.1 Microsimulation models

Microsimulation models are powerful tools for integrating and using data from diverse sources and enabling the establishment of what-if scenarios to assess the impact of policy options on Canadians in the immediate and long term. Building on a long history, ASMB continues to play a central role in the agency in the ongoing innovation and development of microsimulation models, including the areas of population health, distributional impacts of tax and transfers, and retirement adequacy.

The **Population Health Model (POHEM)** is a microsimulation tool that uses the Canadian Community Health Survey as its starting population and provides future projections for a range of health outcomes, including prevalence of risk factors and disease, costs and economic indicators, health status, life expectancy, and health-adjusted life expectancy. POHEM has been used by federal health planners, for example, to estimate the impact of reducing obesity and increasing physical activity on the future rate of diabetes. New updates to POHEM will include the implementation of various multivariate predictive models including the **Cardiovascular Disease Population Risk Tool**, the **Dementia Population Risk Tool**, and the **Mortality Population Risk Tool.** These additions will enable decision makers to evaluate the impact of changing risk factor exposures on future cardiovascular disease outcomes, dementia incidence and mortality.

OncoSim is a web-enabled microsimulation tool developed at Statistics Canada, in partnership with the Canadian Partnership Against Cancer. OncoSim is currently used by health care planners across the country to evaluate the impact of cancer control strategies, specifically of screening programs, on future cancer incidence, mortality, resource demands, and costs and cost-effectiveness. OncoSim includes highly sophisticated models of breast, cervical, lung and colorectal cancer and dynamic risk factor models of smoking, radon, hormone replacement therapy, breast density, family history and transmission of human papilloma virus. In response to the COVID-19 pandemic and the resulting halt of cancer screening programs, OncoSim is being used to evaluate the impact of paused cancer screening on future cancer incidence and scenarios under which the backlog of screening tests could be resolved.

The **Social Policy Simulation Database/Model (SPSD/M)** is a static model used by federal and provincial governments and researchers to assess the distributional impacts of changes to tax

and transfer policy on Canadian households. The model is updated annually to reflect policy and tax changes announced in the federal and provincial budgets. In addition to adding any tax and transfer changes that will be announced in the 2020-2021 budgets, new developments of the SPSD/M include **creating COVID-19 versions of the model** that allow users to model the large-scale changes in the labour market, as seen in 2020 because of the pandemic. New federal income support benefits for individuals and families announced in Canada's COVID-19 Economic Response Plan are also incorporated. A new version of the model built using administrative data is also being planned. The model would allow impacts of policy changes on smaller populations, such as on smaller levels of geographies (e.g., census metropolitan areas/census agglomeration) or on the top 1% of earners to be examined.

Our experts have also been working with Employment and Social Development Canada and a consortium of academics to develop a **new dynamic microsimulation model** that would allow users to explore the impacts of policy changes over the life course. This model is being designed to model public pensions and income security including the Canada Pension Plan (CPP), registered pension plans (RPPs), registered retirement savings plans, tax-free savings accounts, housing, and other forms of savings. The development of this model will take multiple years. Once built, the model will be able to estimate the impact of changes to retirement income policies (e.g., a change to CPP rules) and changes to various socio-economic trends (e.g., changes in RPP enrolment) on future retirement cohorts.

2.2   Predictive analytics, artificial intelligence and machine learning

We have been experimenting with the use of ML on a range of fronts, including statistical matching to create new synthetic data sources to integrate in existing microsimulation models and comparing these new approaches to conventional statistical matching techniques. ML techniques are being used to overcome challenges with traditional regression analyses in the case, for example, of intersectionality to better measure the impact of experiencing multiple dimensions of inequality (i.e., gender, socio-economic, Indigenous identity) on the risk of mortality. Another recent example is the use of ML to integrate thousands of data series to produce monthly economic activity indexes for the provinces and territories. Over the next year, further applications of AI and ML in both the health and economic programs will be explored. ML techniques will be used to classify and predict opioid overdoses and deaths, and associations of birth characteristics with later outcomes. Similarly, a range of supervised ML techniques (e.g., logit, decision trees, neural networks) will be applied to better understand the characteristics of high-growth firms and their environment to build a predictive model enabling real-time predictions of firms that are candidates to grow rapidly over the next three years. Furthermore, a project will explore the use of microdata to forecast macroeconomic aggregates. ASMB researchers working in these areas are members of the Data Science Centre of Excellence at Statistics Canada established to ensure the appropriate application of these techniques. Learnings from these ML projects will advance our understanding of the possible applications of these techniques to other areas and programs of research.

2.3   Interactive models and tools

Research produces a range of products including peer-reviewed and accelerated publications, data tables and models. We are committed to continuing to make available the results of the programs of research through open publications and open data. In addition to these products, ASMB is leading the production of interactive tools, taking complex models generated through the research process and transforming them into interactive tools that can produce customizable and actionable insights that more directly meet our users' needs in a timely way.

ASMB, in collaboration with the Business Development Bank of Canada, created a business performance tool that allows firms to compare their performance with that of their peers in the

same industry. In the 9-month period after its launch in 2016, over 17,000 firms accessed the tool. A similar tool was developed for the Survey of Innovation and Business Strategies to provide respondents with immediate enterprise-specific feedback on firm performance, focusing on the impacts of innovation and business strategies. This tool results in a range of program benefits, including increased response rates, improved data quality and lower response burden. This initiative provides a model that could be applied to a range of surveys to better meet user needs by providing customizable and actionable information in a timely manner.

New interactive models to be developed include one applied to the multifactor productivity dataset produced by ASMB which will allow users to examine relationships in the productivity data and to provide customized outputs by changing parameters of interest (e.g., time periods, base years, variables, industries, etc.), to build simple regression models, produce heat maps and make distributional comparisons. With this tool, users will be able to address a range of questions, including what industries and provinces are contributing the most to aggregate productivity growth and which source of output growth is the most important (e.g., productivity, capital accumulation, hours worked, capacity utilization, labour quality). This project will serve to better understand how this tool can be modified to use alternative data to provide near-term forecasts and now-casts, or to introduce any analytical tool necessary. Importantly, as an open-source project, the code can be published and more technical clients could then customize the tool to their purposes or contribute directly to its evolution.

Building on the very successful interactive data visualization of regional domestic trade flows (https://www150.statcan.gc.ca/n1/en/catalogue/11-627-M2016005) disseminated by ASMB in 2016, an econometric model is being developed to provide insights on Canada–United States cross-border trade flows, based on changes in the exchange rate, income, unemployment, costs of travel and border security measures.

ASMB also has advanced innovative approaches to disseminating complex information and data. Examples include recent developments in using interactive maps to present multi-dimensional income mixing and distribution at neighbourhood level. Further interactive tools are being developed for inter-jurisdictional employment data and the social inclusion index.

2.4   Other modelling activities

The COVID-19 pandemic has resulted in many changes to research conducted in ASMB, including several new initiatives. Analysts from the Health Analysis Division (HAD) have collaborated with analysts at the Public Health Agency of Canada (PHAC) to develop an age-structured deterministic compartmental model to project various aspects of the COVID-19 pandemic, including infections, hospitalizations and death. This work has been used extensively by PHAC in their monthly modelling reports published over the course of the COVID-19 pandemic. The model has also been described in a peer-reviewed manuscript, and the code and R package used have been made available to other researchers. This work will continue to be developed as additional aspects, such as vaccination rates, continue to develop and affect the course of the pandemic.

Statistics Canada has also engaged with Health Canada to undertake and implement a statistical program regarding the procurement and distribution of **personal protective equipment (PPE) called the PPE project**. The epidemiologic model within the PPE project—which is used to track and project the number of COVID-19 infections, hospitalizations, deaths and recoveries at various points during the pandemic—is being led by analysts in HAD. This work will leverage the knowledge developed as part of the aforementioned work to develop the deterministic compartmental model, but will also make use of additional data-science, epidemiologic and statistical expertise present within HAD and ASMB. The PPE project is a multi-year undertaking, and ASMB will be involved in various aspects of the work as the project evolves.

Furthermore, we are exploring the development of models that would leverage the increasingly detailed information produced at Statistics Canada on the structure of the economy and society, and the businesses and individuals that operate within it. Tables from the Macroeconomic Accounts that describe the structure of the economy have always been used to assess effects of exogenous shocks. As the detail available in the accounts expand, such as the Distributed Household Economic Accounts and gross domestic product by city, effects at finer levels can be analyzed. Building on these developments, the application of techniques, such as computable general equilibrium models and dynamic general equilibrium models, will enable analysis on the relationship between exogenous shocks, changes in behaviour and impacts on cities and regions, businesses and individuals.

3   Innovative data development

While Statistics Canada has been linking data for decades, ASMB researchers pioneered the use of linked and integrated data to support programs of research to address complex policy questions and derive new insights on the Canadian economy and society. As such, record linkage is a key element in ASMB's ambitious program of data development. This is informed by the deep subject matter expertise of our researchers and their knowledge of data holdings available across the agency, which allows them to identify early data development opportunities that will yield large analytical returns on investments over the medium term. These linked databases are made available to the wider academic and policy community to support a range of research initiatives through the Research Data Centre (RDC) programs (https://www.statcan.gc.ca/eng/microdata/data-centres).

The patent research database is a linked data file that brings together the European Patent Office's PATSTAT database on the worldwide patenting activities of Canadian inventors and firms and other Statistics Canada data holdings, including the Business Register and administrative data on firm performance and workers. This database will allow the study of topics, such as the impact of foreign direct investment on Canada's intellectual property, the importance of intellectual property to firm performance and knowledge diffusion through the movement of inventors. The economic program of research is supported by a range of linked data sources currently available to researchers through the RDCs, including the Longitudinal Employment Analysis Program (LEAP), T2-LEAP, environmentally adjusted multifactor productivity micro database, the National Accounts Longitudinal Microdata File, and the Canadian Longitudinal Census of Agriculture File.

Linking Environment and Climate Change Canada's National Pollutant Release Inventory (NPRI) and Greenhouse Gas Reporting Program to Statistics Canada's National Accounts Longitudinal Microdata File (NALMF) will facilitate research focused on understanding the interaction of the economy and the environment.

Data integration has focused on linkability and longitudinal consistency over time. Through regular annual processing and development of various core component files, including T1 Tax Files, T4 Tax Files, Records of Employment, and business-level data (e.g., T2 Corporate Tax Files, LEAP and NALMF), three linkage platforms have been developed over the years to support different research projects and analytical outputs. These linkage platforms include the following: 1) The Canadian Employer–Employee Dynamics Database (CEEDD), which contains matched employer–employee data from 2001 onwards that can be extracted from the core analytical files, and other component files, including the Longitudinal Immigration Database (IMDB), Temporary Residents File, T1 Family File (T1FF), Trade by Import Characteristics, and Trade by Export Characteristics ; 2) The Longitudinal Worker File (LWF), which contains matched employer–employee data from 1989 onwards from the core analytical files; and 3) The Intergenerational Income Database (IID), which contains matched children and parents data from T1 files.

In addition to maintaining these three linkage platforms, new linkages have been developed to bring in other survey or administrative information to the linkage platforms to facilitate research that requires more detailed information that can be collected only through survey or other linkage platforms. Some examples include linkages to the Census of Population, Labour Force Survey, Postsecondary Student Information System, Canadian Community Health Survey and the data from the Pediatric Oncology Group of Ontario.

Through a joint initiative with Employment and Social Development Canada (ESDC), the Temporary Foreign Worker Program administrative database from ESDC, which contains the business information for firms that hire TFWs, are brought over to Statistics Canada and have been recently linked to the CEEDD to support new research in this area during the 2020/2021 fiscal year.

The COVID-19 pandemic has highlighted the growing demand among policy makers for **measures of the social and economic characteristics of sub-provincial regions down to the neighbourhood level** to better inform how policies are designed, implemented and evaluated. This interest coincides with ongoing work in the agency aimed at combining traditional sources of neighbourhood-level socio-economic data from the census, with data developed from administrative sources (e.g., tax data) and measures of the built and natural environment derived often from non-traditional open data platforms. Geographic information systems provide an effective and efficient means to both combine these data from disparate sources and to apply spatial analytics and other analytical tools to address multiple questions (e.g., where investments might be located to best serve demand). ASMB is working both internally within Statistics Canada and across federal departments to develop these data and the analytical tools to better inform policy.

To help inform the public about the impact of COVID-19, ASMB has worked with the crowdsourcing team to develop crowdsource surveys to collect Canadians' social, economic and health perceptions during the pandemic.

New data sources, such as details on Canada's COVID-19Economic Response Plan and social distancing restrictions, are being integrated into existing and improved databases so that analyses on their impacts can be performed. For example, the existing payroll deductions files have been used to produce measures of monthly business opening and closures. These data are being linked to program and restrictions data to provide insights on how the pandemic has affected businesses.

To increase data access to the general research community, linked data and new linkage initiatives have been made available to the RDCs including the IID; the LWF (10% file); the Financial Capability, Employment and Income Database, which links the Canadian Financial Survey 2014 to T1 tax data; the Longitudinal Administrative Databank; and Discharge Abstract Database (DAD) linkage key, and the LWF—10% and Employment Insurance Status Vector linkage key (a pilot project).

New data development and integration opportunities are constantly explored and collaborated on with other teams across the agency. Work in this direction includes linkages to the Administrative Personal Income Masterfile (APIM) and the Longitudinal and International Study of Adults.

Research relating to health and the environment, and the study of health inequalities, have been made possible through the creation of the Canadian Census Health and Environment Cohorts, a series of nationally based census cohorts that follow the health outcomes of individuals (e.g., mortality, cancer, hospitalizations) over time. These linked datasets are continually being updated with new data and follow-up periods and are made available in the RDCs after validation and fitness of use assessments. Immigrant health research is supported by the IMDB linked to the DAD, first released to the RDCs in January 2019. Other linked databases used by the branch to

support health research include the Canadian Birth-Census Cohorts and the Montréal Longitudinal Experimental Study linked to T1FF.

4   Communicating our research

The Branch aspires to communicate the results of its research, modelling and data development to a broad range of stakeholders. Applying knowledge translation principles, we use a range of vehicles to disseminate our work. Detailed accounts of the research methods, data and findings are published in branch publications including *Health Reports*, *Economic and Social Reports*, Analytical Studies: Methods and References, and the Analytical Studies Branch Research Paper Series. Plain language summaries are also prepared to be used by policy makers and media is disseminated through *The Daily* and directly to senior government officials. Where appropriate, innovative data visualization techniques such as infographics are used to communicate research findings to the general public. The branch also plays a key role in taking a horizontal view and synthesizing analysis and research conducted across the agency to provide a more comprehensive picture on issues and questions of high relevancy. The most recent examples are "COVID-19 in Canada: A Six-month Update on Social and Economic Impacts," and "COVID-19 in Canada: A One-year Update on Social and Economic Impacts," which highlight the health, social and economic impacts of the COVID-19 pandemic on the lives of Canadians.

We invite users to provide feedback on the consolidated plan as it is designed to respond to evolving issues and research needs (statcan.analyticalstudies-etudesanalytiques.statcan@canada.ca).