OECD SME and Entrepreneurship Papers

The Geography of Higher Education of Newfoundland and Labrador, Canada

Assessing the role of Memorial University within its regional innovation ecosystem

This paper analyses Memorial University's contribution to the economic development of the province of Newfoundland and Labrador in Canada, specifically focusing on the university's contributions to the provincial ocean economy. It analyses the university's public engagement, entrepreneurship, and collaboration strategies, programs, and relationships to understand Memorial's regional impact.

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Executive Summary

Higher Education Institutions (HEIs) are increasingly producing broader societal and economic value for their surrounding communities. HEIs now commonly engage in collaborations with external stakeholders and provide support, including through their teaching and research activities, to entrepreneurs, contributing to growth and well-being, especially in the regions in which they are located. The present report investigates the contribution of Memorial University to the economic development of the province of Newfoundland and Labrador, in Canada, through education, research, and collaboration with stakeholders. The report studies the role of the university in delivering on these goals through a spatial; lens that recognises it operates in a sparsely populated province that possesses an abundance of natural resources (e.g., renewable energy sources, petroleum) and is home to several ocean-based industries including marine transportation fisheries, offshore oil and gas exploration and production. Against this backdrop, Memorial University plays a pivotal role in diversifying and modernising the province's economy, not least given Newfoundland and Labrador's exposure to shifts in global commodity prices (oil in particular), a declining and ageing population, and a business ecosystem dominated by large foreign-based corporations that focus on natural-resource extraction.

As the only university in Newfoundland and Labrador, since its foundation in 1949, Memorial has complied with its "special obligation" to the people of the province, as enshrined in its vision and core values, to contribute to the socioeconomic development of the province. To fulfil this obligation, Memorial has geared its missions and activities to serve the needs of the community including by enhancing its physical presence via several new campuses across the province specialised in areas of regional interest and strength. As of 2022, the University had five campuses across the island of Newfoundland, including a campus in Grenfell, in the more rural west coast, specialised in art and environmental studies, and a new campus in Labrador specialised in Artic and Sub Artic studies, food, and agriculture. Across its campuses, the University has oriented its teaching, research, and engagement activities to mirror the economic fabric of Newfoundland and Labrador, training the labour force with skills needed by industry and undertaking research for the oil and gas industry, and ocean-based industries. As a case in point, one of the campuses, the Marine Institute, specialised in marine science and technology, has a dedicated hub on ocean innovation; "The Launch," in the town of Holyrood on Conception Bay. Memorial has also established the Centre for Cold Oceans Research (C-CORE), a separately incorporated entity providing research and consulting services to the oil and gas industry, shipping, and aerospace, which has helped these industries develop activities in the province, for instance by providing technology solutions for risk-mitigation in ice and iceberg prone waters.

Memorial is also engaging with new industries in addition to resource-based activities. For instance, the University cooperates with the nascent ICT sector, conducting research, but also supporting aspiring technology entrepreneurs. Importantly, Memorial promotes entrepreneurship in the province by providing learning opportunities to help students, faculty, and staff discover new growth opportunities, develop and implement their own ideas, and move their research to the market. Genesis, Memorial's St. John's incubator, is open to students and start-ups that want to develop their technology-based ventures. Genesis supports technology start-ups from idea creation all the way to scaling-up. Since its opening in 1997, Genesis has incubated over 70 start-up companies and created 2 500 jobs. Memorial is home to two other

incubation facilities, the Centre for Social Enterprise providing dedicated programming related to not-for-profit entrepreneurship and social enterprise, in St. John's, and Navigate, which offers learning opportunities in entrepreneurship and supports start-ups at the Grenfell Campus. Memorial also partners with a health innovation incubator, the Bounce Labs, housed on the St. John's Campus, and has strengthened its ties with the federal cluster on Ocean Science; the Ocean Supercluster through the "Ocean Start-up Project". In particular, the aim of the collaboration with the Ocean Supercluster is to deliver mentoring and incubation for ocean tech start-ups inside the University, in collaboration with private and public partners across the sector.

To support its engagement activities with external stakeholders, Memorial has created policies and structures dedicated to public engagement. It has developed a Senate-approved, public engagement strategy. Following this strategy, public engagement units have been created to facilitate collaboration between partners outside the University, especially public authorities, NGOs, and SMEs. For example, the Leslie Harris Centre of Regional Policy and Development brings together different stakeholders, including government agencies, SMEs, municipalities, and NGOs.

Key recommendations

All these activities have consolidated Memorial's role in the province's entrepreneurial ecosystem, by providing training and research to modernise the ocean-based industries, and by supporting entrepreneurship. However, to continue to support Newfoundland and Labrador's long-term growth, Memorial University should consider addressing some challenges related to entrepreneurship education, collaboration with industry and engagement with public authorities. This report offers some recommendations that Memorial could consider. In particular:

- Because of the importance of entrepreneurship and innovation in the Province, Memorial should step up its efforts to give centrality to such agendas. The University's new Innovation Strategy goes in the right direction by recognising entrepreneurial and innovation activities as positive factors in promotion, recruitment and retention decisions. These incentives can help mainstream these activities across faculties and campuses. The Innovation Strategy also offers more in-house collaboration opportunities to support entrepreneurship and research-driven innovation, favouring transdisciplinary activities. The Innovation Strategy should be carefully monitored and assessed to identify and scale up good practices.
- While Memorial excels in research and technology in ocean science and serves the needs of the industry, it should look beyond this constituency to foster partnerships abroad and enhance its presence internationally as a competitive institution in the fields of Ocean and Marine Science. To this aim, it can leverage the support of the federal government, such as Canada's new Ocean Supercluster, and gain international visibility to establish more research partnerships abroad. Such an outward oriented approach can contribute to attract more talent from abroad and mitigate declining enrolment rates.
- Memorial should continue to partner with provincial and local authorities to help them achieve the United Nations 2030 Sustainable Development Agenda and spur green and inclusive economic development. Industry stakeholders will be increasingly turning to Memorial to better understand the effects of climate change and to transition to carbon-neutral business models. Memorial is already working with the government and firms to develop sustainable products and should continue to invest in resources to support the green transition and the deployment of renewable energies. This collaboration should become more visible and strategic for Memorial University, notably through the Sustainable and Climate Action Office and the implementation of the University's strategic plan (2021-2026), as the University will play a valuable role in implementing the provincial priority to achieve carbon neutrality.

- Finally, and related to the structural transitions facing economies and societies, the University could work with the provincial government to establish forward-looking innovation priorities for Newfoundland and Labrador and create a coordination entity to push forward these priorities at the university-level. In this way, Memorial would affirm its role as a driver of innovation and entrepreneurship. Such an approach would catalyse Memorial's capacity to cooperate with the private sector not only by reflecting skills and innovation needs of resource-based industries, but also by supporting employers from the emerging ICT sector, who wish to upskill and reskill workers. Creating advanced digital training certificates can strengthen Memorial's role as a pioneering education institution in the province, and abroad.

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1 Reader's guide

The Entrepreneurial University: a new regional role

Over the past four decades, universities' roles in their surrounding ecosystems have changed. In connection with their teaching and research activities, HEIs collaborate with external stakeholders and support entrepreneurs, contributing to growth and well-being, especially in their own communities, and networks. The interconnections between HEIs and their stakeholders within such communities and networks may affect the performance and resilience of all components. We assume that physical proximity plays an important role connecting actors and aligning agendas. For this reason, it is possible to define these "spaces" as "entrepreneurial ecosystems" (or local ecosystems) and the HEIs as "entrepreneurial universities" (Kantis and Federico, 2020[1])

Etzkowitz defines the "entrepreneurial university" as one that carries out activities beyond teaching and research, to fulfil its third mission (Etzkowitz, 2013[2]). Concretely, third mission activities may refer to continuous education or lifelong learning, innovation, knowledge and technology transfer, social engagement (volunteer work, cultural programmes) and entrepreneurship programmes.

Gibb, Haskins and Robertson (2013[3]) further argue that entrepreneurial universities are dedicated to "creating public value via a process of open engagement, mutual learning, discovery and exchange with all stakeholders in society – local, national and international". Entrepreneurial universities have started to engage more with their ecosystem and some universities have turned into key drivers of economic development in their region.

These HEIs spur individuals with an entrepreneurial mindset, by teaching entrepreneurship, providing incubation facilities, and co-specialising their research activities. The University of Stanford in the Silicon Valley or Massachusetts Institute of Technology, United States, are famous examples of entrepreneurial university, producing talent, training a new generation of entrepreneurs, and liaising with local technological companies to produce pioneering research and technology (Bassett, 2003[4]). However, these should not be considered as absolute "benchmarks". There are many ways in which HEIs can be entrepreneurial by promoting transdisciplinary teaching activities and collaborating and co-creating with stakeholders, in their communities and networks.

To be successful, however, entrepreneurship HEIs need to strike a balance between supporting their regional communities and generating internationally relevant research (and skills). Recently, the COVID-19 pandemic has also highlighted the capacity of universities to play a fundamental role in providing knowledge-based solutions as well as scientific and technological innovation in their respective ecosystems. For example, many Higher Education Institutions (HEIs) have mobilised scientific and medical resources to address the health emergency, contributing to research but also to the production of medical equipment (respirators, masks, hand sanitisers). Universities can continue this work and support their regions leading innovative research, offering digital and entrepreneurial skills in their ecosystems. Yet, HEIs should not become regional development agencies and it is important for them to generate activities that are internationally relevant, also to represent a gateway for the communities that hosts them. The ideal situation would be represented by place responsive HEIs in which there is a sustainable equilibrium between curiosity driven research and co-specialisation, which is managed by an entrepreneurial

leadership and organisation capacity capable to facilitate the implementation of research (Atta-Owusu, Fitjar and Rodríguez-Pose, 2021[5]).

Conceptual framework used for this review: the Geography of Higher Education, a place-responsive approach to innovation and entrepreneurship

This review on Memorial University's role within the regional innovation ecosystem is the part of a series of regional reports on the theme of the Geography of Higher Education being conducted by the OECD. The reports are part of a policy dialogue that aims to assess the role of universities in their local ecosystems, and how these can be drivers of growth for their regions, thus the relevance of the role of HEIs play in supporting regional economies. The main assumption is that collaboration and co-specialisation need a mix of conditions, in which physical proximity plays an important role.

The focus on collaboration and co-specialisation of HEIs within their communities may represent a driver for reform in higher education policy, to overcome the "space-blindness" that characterises this policy area and stimulate policy complementarities with other policy sectors, for instance, by generating synergies with entrepreneurship, innovation, regional development, and employment policies, with positive effects on policy outcomes and public investment.

The review will also draw upon the HEInnovate guiding framework as it offers a comprehensive understanding of HEIs' entrepreneurial and innovative agenda and how HEIs are implementing this agenda (Box 1). The present study draws inspiration from this guiding framework to understand how HEIs promote entrepreneurship education and co-produce knowledge to support regional innovation. Two key concepts to understand the impact that universities have in their surrounding ecosystems. The GoHE framework builds on HEInnovate, by adding the concept of a "place-responsive" HEI and how each institution adapts their entrepreneurial and innovation activities to their surrounding communities, also considering the policy agenda of the given national or sub-national concept.

Box 1. About the HEInnovate guiding framework

The European Commission (EC) and the OECD developed the higher education innovation framework and programme HEInnovate in 2011.

HEInnovate is a guiding framework for higher education institutions (HEIs) wishing to develop their entrepreneurial and innovative potential. The framework, developed by the European Commission in collaboration with the OECD includes a self-assessment tool, which helps higher education institutions assess their entrepreneurial and innovative agenda. The interactive tool facilitates discussion within an institution on how to drive forward the entrepreneurial and innovative agenda. Through the continued use of the tool, HEIs can monitor their progress against actions taken, gain inspiration from material available on the HEInnovate webpage and be part of a community of practice. HEInnovate covers eight broad areas, under which are the statements for self-assessment:

- Leadership and Governance
- Organisational Capacity, People and Incentives
- Entrepreneurial Teaching and Learning
- Preparing and Supporting Entrepreneurs
- Digital Transformation and Capabilities
- Knowledge Exchange and Collaboration

- The Internationalised Institution
- Measuring Impact

Source: EC/OECD (2022[3]), HEInnovate, https://heinnovate.eu/en., accessed 24 October 2022.

Understanding entrepreneurship education and the entrepreneurial mind-set

The entrepreneurial mindset, and, entrepreneurial skills can be taught and learned (Saraiva, 2015[6]). For many countries and education institutions, teaching entrepreneurship has become a priority, and courses have been created for primary and secondary students, to life-long learning courses. Entrepreneurship education provides students with a set of cognitive skills such as financial literacy, business plan development, accounting, and a set of non-cognitive skills. The set of non-cognitive skills and attitudes includes, perseverance, tolerance to risk, and leadership, creativity (Bacigalupo, 2016[7]).

This combination of transversal cognitive and non-cognitive skills is a value-added for students, even if for those who do not wish to start a business. This skills-set helps them in the job market, and more specifically, it helps them navigate uncertain and changing labour markets.

In many countries across the globe, entrepreneurship teaching, and support initiatives have flourished. It is especially at the level of tertiary education that the bulk of these initiatives is concentrating. In Slovenia for instance, GEA College (the Faculty of Entrepreneurship) teaches students entrepreneurship courses, and some of these have created their own venture, but some have taken-over their family owned-business, providing a fresh and innovative perspective to existing business (OECD/EU, 2021[8]). In addition, many universities have established infrastructure to support aspiring entrepreneurs, such as centres for entrepreneurship incubators, accelerators, co-working spaces, technology transfer offices. Such institutions are designed “safe-spaces” for students to apply their entrepreneurial skills and access a large network of potential funders and meet other student-entrepreneurs. Some institutions are closer to the market than others, such as accelerators and technology transfer offices whereby the entrepreneurial ventures are ready to be matured and tested in the market.

From knowledge transfer to collaboration and co-creation

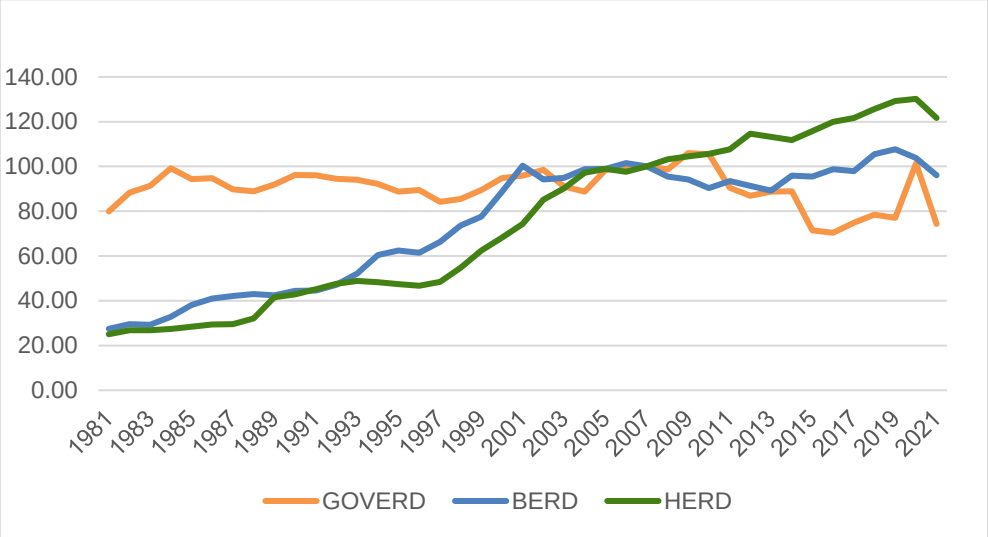
The role and the activities of universities has changed over the past decades, with the consolidation of knowledge as a production factor and the constitution of knowledge-based economies. Universities are becoming more entrepreneurial, and are fulfilling their “third mission”, as explained by scholars such as Etzkowitz (2001[21], 2003[21]). This mission encompasses all activities that constitute an exploitation and application of knowledge for socioeconomic development. In practice, this implies connecting teaching and research activities to the needs of the ecosystem, making them more innovative (through project-based learning, problem-solving, use of massive open online courses), as well as engaging the university with their local communities. Thus, knowledge transfer and collaboration between universities and external stakeholders becomes an essential task in the most entrepreneurial universities. Etzkowitz and Leydesdorff (2000[21]) further analyse the knowledge exchange between actors, as an exchange between government, industry and university (the “triple helix”) and subsequently the “quadruple helix” (university, government, industry, civil society interlinkages) (Carayannis and Campbell, 2009[9]) have emerged to analyse knowledge exchange between these actors. The concept of the “civic university” as an institution embedded and active in its territory has also emerged in the discussion.

Against, this background, HEI in many countries have doubled their efforts to support innovation, through entrepreneurship support but also by supporting cutting-edge research and technology development and engagement in societal issues. Over recent decades, in OECD countries the share of Higher Education

expenditure on research & development has risen steadily, overpassing government expenditure in research and development. This has been particularly the case in Canada, as Figure 1.1 shows.

Figure 1.1. Gross domestic expenditure on R&D by performing sector in Canada (1981-2021)

Expressed in constant USP PPP, index 2007=1000



Note: GOVERD or Government intramural expenditure comprises all expenditure executed by the Government sector, in a given territory. Business expenditure on R&D (BERD) comprises business expenditure and HERD Higher Education expenditure in research and development (HERD) comprises all expenditures done by the higher education sector.
Source: OECD calculations based on OECD, Main Science and Technology Indicators Database, November 2022

The place responsive HEI

Because of the importance of proximity vis-à-vis innovation and entrepreneurship, knowledge exchange, collaboration and co-production have a strong spatial dimension.[1] Entrepreneurial HEIs are able to respond to the innovation needs (including social innovation) of their own communities and networks. In other words, HEIs are able to generate innovation and entrepreneurship activities that reflect the needs and opportunities in their communities and networks without replicating collaboration models in a spatially blind way.[2] The place-responsiveness of an HEI can help institutions tap into the needs of its surrounding ecosystem and contribute to regional obstacles (Atta-Owusu, Fitjar and Rodríguez-Pose, 2021[5]). Place-responsive HEIs are particularly important in non-metropolitan regions or less developed ones, in which HEIs generate linkages with local stakeholders and can offer support to coordinate narratives and policy interventions (OECD, 2023[10]). Place responsiveness is driven by three factors:

- The ability of the university to specialise and develop over time research, education, and innovation according to the specific capacities, gaps and opportunities of the regional economy and society where the university is based.
- The ability of the university to offer multi-level responses to the regional needs and opportunities.
- The possibility for the university to be assessed based on metrics that measure the university's impact in the region.

[1] In this context, concepts such as collaboration, co-specialisation, co-creation describe the activities and engagement of HEIs with their networks/communities/territories.

[2] A place-responsive strategy refers to a strategy that responds to the needs of a local community in a given territory.

However, place responsive HEIs are also able to engage in internationally relevant research activities by identifying a sustainable balance and integration between teaching, research and collaboration activities. In other words, co-specialization seems to be desirable to enhance place-responsiveness but needs to be qualified:

- full co-specialisation is not desirable, and the process is a matter of finding a balance between developing regional specific assets and maintaining generic programmes;
- co-specialisation should not mean co-obsolescence at a subsequent period. This means that the development of specific assets to respond to regional gaps and opportunities need to be dynamic. There is a need for the region and the university to engage in strategic interactions to transform the regional system continuously and move together towards new areas where the region can build new competitive advantages and manage the transition of its economy. This is the philosophy of smart specialization – a strategy of regional transformation in which the local university plays a central role.

Methodology used in this review

The role of Memorial University in the province of Newfoundland and Labrador offers the opportunity to understand the role of a higher education institution in promoting regional innovation in a low populated province, with a high proportion of population living in rural areas[3]. Thus, it offers the potential to better understand a place-responsive approach to higher education reflecting on the tension between local needs and international relevance, in terms of research. The novelty of this review is that it provides a perspective into the university's work in the ocean economy, which refers to the sum of economic activities of ocean-based industries (fisheries, marine transportation, manufacturing and construction, maritime tourism) as well as assets goods and services provides by marine ecosystems (OECD, 2016[11]).

The review represents the collaborative effort between the OECD Centre for Entrepreneurship, SMEs, Cities, and Regions, and Memorial University. The methodology used in this review is in line with the one used for other GoHE review and includes the steps described below:

- The OECD team, in collaboration with an expert, prepared a background report containing information on the province of Newfoundland's regional and innovation context, as well as an overview of Memorial University, and its activities to support economic development of the province and ocean-related innovation.
- To evaluate the university's contribution to the province's regional development, a delegation composed of OECD staff and international experts travelled to St. John's in June 2022 to conduct a study mission. The team met with +100 representatives within the various parts of the university, federal and municipal public officials, industry representatives, and local associations.
- This review was then prepared by the OECD, with input from experts, drawing on the information gathered during the study mission, and all information available online. A draft report was submitted to counterparts in Memorial University in December 2022 for written comments. The Secretariat took into the feedback, and a second draft was presented in March 2023 and discussed in an interactive meeting with Memorial's Innovation Advisory Committee. Following the meeting, the OECD Secretariat finalised the report, considering feedback and contributions that have been made.

[3] As per OECD's definition of rural versus urban areas, where urban areas must contain at least a city of 50 000 inhabitants or more (EC/OECD, 2019[61])

2 Innovation and entrepreneurship in Newfoundland and Labrador

Memorial University represents an important case study of stimulating international ocean-related innovation and entrepreneurship in a small, resource-based economy through engagement and collaboration with private-sector actors and government institutions. To understand Memorial University's contribution performance, it is important to provide information about the socio-economic context in which it operates. The next section discusses some key economic and societal data about the province of Newfoundland and Labrador.

The province is a resource-based, low-population density economy that possesses an abundance of natural resources—above-soil (e.g. hydroelectric and wind power), subsoil (e.g. iron ore, nickel), in coastal waters (e.g. fisheries), as well as subsea (e.g. petroleum) (McKnight, 2022[12]) (Mold, 2003[13]). Government spending is relatively high compared to other Canadian provinces, especially for innovation-facilitating public goods like healthcare, education, and infrastructure. The province's people are famously resourceful, close-knit and make up the workforce of several globally competitive companies and industries (Greenwood, 2015[14]). The province of Newfoundland and Labrador is home to Memorial University, which has consistently contributed to the province through its education and training of the workforce, as well as research in a wide range of fields such as marine engineering, oceanography, and geological studies. For its part, the university has developed a number of world-class programmes and facilities, including the, C-CORE, the Marine Institute (MI) campus, the Canadian Centre for Fisheries Innovation as well as the Ocean's Science Centre.

However, the resilience of the Newfoundland and Labrador economy is exposed to structural challenges: declining population, low density and dependency on capital-intensive extractive industries may hinder economic growth prospects, and limit innovation capacity and diffusion. This situation may require Memorial to engage in additional efforts to promote innovation and entrepreneurship in the province.

The province innovates in a mostly rural setting

The province of Newfoundland and Labrador, located on Canada's northeast Atlantic coast is a large sparsely populated province of Canada (view map in Figure 3.2). It is one of the country's least populated provinces. At the start of 2022, the population was estimated to be slightly less than 522,500 people. The province reached a low of 509,000 in 2007, following a notable and sustained decline in population through much of the 1990s and 2000s, largely due to the closure of the cod fishery that resulted in one of the largest layoffs in Canadian labor history. Since then, the province has experienced modest and periodic growth, including population growth in all four quarters of 2021.

Population density in the province is very low, even by Canadian standards. Some 42% of Newfoundlanders and Labradorians lived in rural areas as of 2011 and nearly 90% of the over 500 communities in the province have a population of less than 1,000 inhabitants per square kilometer. This creates a wide range of challenges not merely for innovation, but also for the provision of healthcare and

education, transportation, and physical and social infrastructure, among other goods and services vital to innovation

Declining birth rates and net out-migration of young people contribute to the province having one of the country's most rapidly ageing populations. The province currently has the second lowest birth rate in Canada. The number of births in Newfoundland and Labrador have been on a steady downward trajectory since the 1960s. More specifically, the annual number of births has plummeted, from roughly 12,000 in 1974 to less than 4,000 in 2021. An important contributor to this declining birth rate is the sharp decrease in the number of females aged 15 to 49 in the province. From 1997-2019, the female demographic has decreased by about 30%. In addition, out-migration of people under 35 years of age has been especially pronounced, a demographic cohort widely seen as vital to innovation due to their generally greater tolerance of risk and diversity.

As such, the province currently features a median age six years older than the Canadian average, which affects province's finances as well as the provision of healthcare. For nearly three decades from the 1970s and into the 1990s, the province boasted three potential labor force participants for every potential retiree. Now, for every labor force entrant, there are 1.5 potential retirees, reversing that trend and raising the specter of a 'demographic burden'.

The province can rely on a highly skilled workforce and St. John's thriving agglomeration

In a general negative demographic trend, the greater St. John's area or Census Metropolitan Area (CMA) represents an important exception, in part due to intra-provincial urbanization, that is, people leaving many of the province's small rural communities to settle in larger regional centers. For example, the total population of St. John's CMA grew from 165,000 in 1986 to about 213,000 by 2020. Nearly 40% of the province's population now live in this urban area, compared to only 30% in 1992. Population growth in the capital city can be explained by in-migration from rural areas as well as from outside the province, drawn to the various dynamic sectors, public-sector jobs and multinational corporations that base themselves in the city (see below).

Moreover, the demographics of St. John's also capture this conglomeration of talent and resources, with nearly one-third (32.7%) of the population between the ages of 18-44 and a mere 12.2% aged 65 years or older. This contrasts sharply with the province's broader demographic make-up, wherein the largest population cohort in Newfoundland and Labrador is 50 years or older.

The provincial capital has pulled in rural residents as well as the *"been aways"* from other parts of the country or from outside Canada who bring their spending power and skills to the province and often work on mega-project development or in the offshore petroleum industry (see Box 2.1). As a result, the unemployment rate in St. John's CMA is some ten-percentage points lower than elsewhere in the province. Likewise, given that the city serves as the base for the petroleum industry, tech sector and government, this metropolitan area has also witnessed a sustained construction and real estate boom.

By contrast, the population outside of St. John's CMA since the mid-1980s has shrunk by one-fourth from about 410,000 in the mid-1980s to about 310,000 today. Larger towns like Conception Bay South and Paradise with populations of about 26,200 and 21,400 respectively also witnessed single-digit population growth in the period of 2016-21, while similarly sized Mount Pearl, Corner Brook, and Grand Falls-Windsor all experienced small declines in population over the same period.

St. John's is also home to the largest campus of Memorial University as well as its Marine Institute campus and other innovative Memorial-connected entities like C-CORE and the Genesis Centre among others. Memorial University has been central to the province's labor market. The nearly 20,000 students currently enrolled across its six campuses represent an important community and a potential labor force that is

educated and vibrant. Likewise, some 68,000 Memorial alumni live in the province, accounting for about 13% of the total population, though a portion of these no longer participate in the labor force.

Box 2.1. The "been-away" workers a potential source of entrepreneurial workforce

The province is also home to a sizable number of skilled workers who often work outside the province but whose skills, capital and entrepreneurial acumen may be harnessed for the province's innovation efforts, the "been-away" employed in the technological sector or working in extractive industries (oil, gas, and mining).

This impressive reserve of skilled workers responds to the lure of high-wage employment in other provinces (such as Alberta), resulting in significant amounts of cross-country commuting in sectors like oil and gas extraction, mining, utilities, and construction. From 2007 to 2014, which was a period of particularly high oil prices and robust growth in Alberta's oil sands, some CAD900 million per year or about 6% of total provincial earned income was generated outside the province. Because of this mobile labor force, remittances contribute an unusually high percentage of household income in the province and to the provincial economy more broadly.

This mobile labor force may be a positive source of innovation. For one, as skilled workers and potential entrepreneurs, the 'been aways' have the experience, learning and modest amounts of capital to strengthen innovation in the province. Likewise, these workers are often from rural communities, and thus their high wages—often earned abroad—contribute to spending in local communities, which one scholar calls a 'de facto rural economic development strategy'. However, too often their economic impact within the province takes the form of consumption, such as home building, spending, and basing their families in Newfoundland and Labrador, while awaiting their next assignment outside the province.

Source: (Spencer, 2010[15])

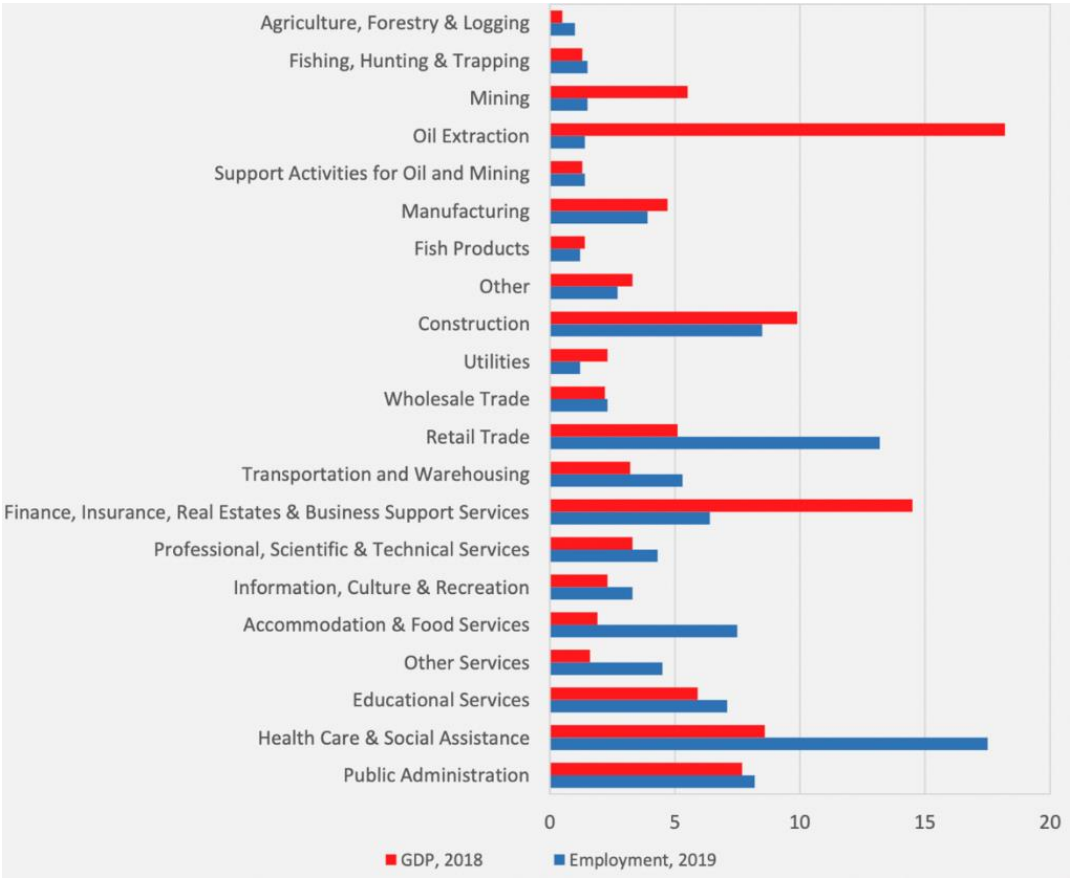
Resource-based industries represent the lion's share of companies in the province

The province has undergone significant structural economic change since the turn of the twenty-first century, in large part due to the commercial exploitation and expansion of the offshore petroleum industry. Notable primary-sector activities such as fishing, agriculture, forestry, and logging that defined long stretches of the province's history now contribute significantly less to the province's economy, whether measured in employment or GDP[4].

More recently, a mining renaissance in the province, especially in Labrador and to a lesser extent in central Newfoundland, has taken place. Both industries have generated high- and middle-paying jobs as well as significant rents for the province, which in turn can be used for innovation-enabling spending. However, these sectors also deepen the province's dependence on commodity rents and prices, the latter of which is virtually entirely out of the province's control. In addition, while these contribute significantly to provincial government revenues but tend to employ directly relatively small numbers of people, only accounting for 3.5% of total provincial employment (see Figure 2.1).

[4] Other sectors that contribute marginally to provincial revenues tend to directly employ significant numbers of people such as healthcare, public administration, and retail.

Figure 2.1. GDP and Employment by industry, as a percentage of total (2019)



Source: Statistics Canada (14-10-0023-01); Department of Finance cited in Province of Newfoundland and Labrador, 2021[5]

The petroleum industry in Newfoundland and Labrador has emerged as an engine of economic growth and revenue for the province since offshore oil was first commercially exploited in the late 1990s. As a result, the fate of the Newfoundland and Labrador economy tends to shift with global commodity prices, especially oil. Newfoundland and Labrador's oil production is relatively small. The province contributes about 5% to Canada's overall oil production and less than 0.3% of global oil output.

The mining sector has undergone a revival in recent years. This sector is a generator of high and medium-paid jobs and revenue in Labrador in particular. Mining has been considerably less prominent in the island of Newfoundland, though several notable discoveries of gold deposits have heightened mining interest on the island. Since 2000, the mining industry has nearly doubled its share to account for 8% of the province's GDP. Since 1990, private mining companies have invested some CAD 9 billion in the province. Iron ore still commands the lion's share of this sector, contributing 70% of shipment value in 2019. Nickel, copper, and cobalt together contribute much of the remaining share. Altogether, the value of production in 2019 was CAD 0.7 billion.

Mining investments peaked with the construction of the Long Harbour hydromet plant, mine expansion at Voisey's Bay, and investments by Tata Steel and Tacora Resources.

Beyond extractive industries, St. John's budding technology sector employs Memorial University graduates in faculties like Engineering or collaborates with in business-promoting entities like the Genesis incubator and the Memorial Centre of Entrepreneurship (see below). For example, Verafin, a tech company focused on fraud detection, was created by two students undertaking a master's in computer engineering. Originally

the founders of Verafin were working on mining-related issues in Memorial's Department of Engineering. Verafin was purchased for USD 2.75bn, the biggest Canadian software buyout since 2007. The province's tech sector employed over 6,400 people in 2017, contributing nearly CAD 1.4 billion in economic activity. The province is also endowed abundant renewable resources, in particular hydro, wind, biomass, solar and wave resources, and 80% of the electricity production stems from renewable resources (wind and small-scale hydro-projects) but also has untapped renewable resources that could create new employment opportunities and help the province lower its carbon emissions.

Dependency on extractive industries conditions the employment outlook

The COVID-19 pandemic and the movement restrictions that followed greatly reduced demand for petroleum. During the sharpest fall in prices, Canada's oil and gas sector lost 24,000 jobs in the second quarter of 2020 alone. In 2020, Newfoundland and Labrador had the highest unemployment rate among Canada's ten provinces. At 13.7% in 2020, its unemployment rate was considerably higher than the national average of 9.5%, although employment picked up in the aftermath of the pandemic, and the unemployment rate in December 2022 was of 9,5% (Government of Newfoundland and Labrador, 2022[16]).

This High unemployment preceded the onset of the COVID-19 pandemic by several years and shows how population movements in and out of the province have tended to follow economic trends: net-outmigration during economic downturns, the ending of major project construction or the collapse in oil prices (for example, early 1990s to late 1990s; post-2016) and net in-migration during economic upswings and boom periods (2008-15).

Conversely, strong commodity prices and major project activity increased labor demand and spurred net in-migration. This resulted in the population growing for nine consecutive years from the late 2000s to mid-2010s. Commodity prices have surged in the wake of Russia's invasion of Ukraine in February 2022 and continue to be high at the time of writing. Furthermore, the province, with its endowment of iron ore, nickel, cobalt, copper, and certain rare earth minerals, have drawn interest from companies sourcing minerals for the unfolding 'green transition', including those going into wind turbines, solar panels, and electric vehicles. The strength of these two extractive industries has been both an opportunity and constraint for innovation in the province, greatly influencing the nature, size and focus of the businesses in the province.

Dependency on oil extraction raises the question of innovation spillovers and entrepreneurship

The prominence of big Canadian firms and multinationals in the province's economy raise questions about innovation 'spill-overs' into the local economy. It also raises questions about the long-term viability of this type of carbon-emitting development path. The capital-intensive and enclave-like oil and gas (O&G) sector tends not to naturally generate 'linkages' with the local economy. Furthermore, as several scholars have found, multinational companies (MNCs) are not naturally open to transferring or 'co-creating' knowledge in the area where they are operating (Peter Warrian and Ray Gosine, 2021[17]). In the same vein, the presence of companies that can pay high salaries could represent a deterrent for highly skilled individuals to start their own business. A similar phenomenon is observed in other countries such as Austria, which has a strong manufacturing base but with a small SME tissue which has hindered innovation, and technology diffusion (OECD/European Union, 2019[18]).

Apart from private-sector success stories like Genoa Design, Sulis Subsea, Kraken Robotics Virtual Marine and Cougar Helicopters, home-grown firms have generally struggled to break into the intensely competitive global oil supply chains of the offshore petroleum industry. Overall, MNCs and Memorial University have collaborated significantly over the past decade, often working together to solve very specific technical

issues, but again the levels of interest vary greatly with the fate of the resource economy. Foreign-based MNCs have been a major source of funding for research at Memorial (see Figure 3.1).

Yet, the technology sector represents a source of hope for business innovation. Overwhelmingly based in St. John's, this sector features prominently in government plans to support business innovation. According to government estimates, the tech sector earned revenues of CAD 1.6bn in 2019, making it larger than fisheries, forestry, or tourism in terms of revenues generated. It is also an area where Memorial University has played a key role (see below). One study from 2019 ranks St. John's 17th overall in Canada on technology talent, tenth in technology concentration, and 13th on education attainment (Coldwell Banker Richard Ellis (CBRE), 2019[19])

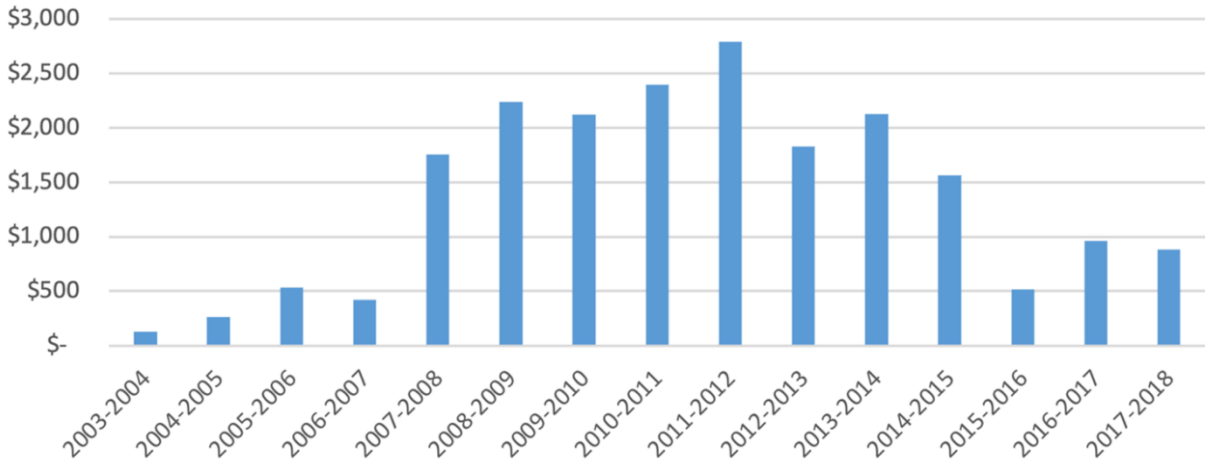
Dependency on commodities has led to an unprecedented fiscal crisis during the pandemic

From the late 2000s on, the province's finances slipped into a pattern familiar to other resource-rich jurisdictions: higher commodity prices meant higher royalty payments, which in turn unleashed government spending and capital investments in major projects. Although oil production in the province began in 1997, it had only marginal impacts on the province's finances given the very low volumes produced and very low world prices at the time. It was not until 2007-2008, following a surge in the province's oil production as well as oil prices hitting historic highs (see Figure 1.4) that royalties truly transformed the province's finances. In the year 2008 alone, oil royalties more than quadrupled, from CAD 400 million to CAD 1800 million and came to represent 24.6% of the province's total revenues. Riding this wave, by 2011-12, the province recorded seven consecutive years of cash surpluses amounting to a whopping CAD 5.1 billion.

Comparing 2004-05 to 2020-21, the provincial government had nearly doubled its spending, from CAD 4970 million to CAD 8970 million. With this surge in revenues especially during the 2009-13 period, the province oversaw the launching of several mega-projects, including the Long Harbour nickel processing facility, the Hebron offshore oilfield, and later the Muskrat Falls hydroelectric project. Largely because of these mega-projects, total capital investment in the province increased substantially from 2007-16. After peaking at CAD 1380 million in 2016, capital investment is still large for a province with a population of just over half a million people.

While oil price gyrations were beyond the government's control, the province has spent oil and gas royalties as an annual revenue source and did not create a 'heritage fund' as many resource-exporting jurisdictions do. Much of this spending has been of the 'catch-up' nature, including increasing public-sector salaries; generously subsidizing post-secondary education (see below); and modernizing or expanding the province's infrastructure, schools, and health care system. For example, in part due to this spending, almost one in every three employed persons in the province are employed in the public sector, which is significantly larger than the national average of 25.6%. The provincial government also spends liberally on maintaining a vast apparatus of infrastructure and social services of various kinds. This is in part explained by the relatively high portion of the population (42%) living in rural areas as well as its ageing population. For example, Newfoundland and Labrador spends the most of any Canadian province on health per resident. At CAD 6,443 per person in 2019, this average figure is considerably higher than even the next highest-spending provinces of, Nova Scotia, and New Brunswick at CAD 5,619 and CAD 5,596 respectively.

Figure 2.2. Provincial government royalties from the offshore (CAD million)



Source: Nahid, Masoudi, 'Oil and Gas Development in Newfoundland,' NHH and Memorial Joint Workshop on Offshore Oil and Gas Development, May 2017.

The government also invested in a network of infrastructure, from schools, health care sites, ferries, airstrips, highways, bridges, forest access roads, as well as electricity and transmission lines and distribution lines for which there is no straightforward alternative or financing solution. This vast and far-reaching infrastructure should theoretically serve as an important physical base for economic activity and innovation to occur. However, much of the infrastructure and services are underutilized. High-speed broadband network is expanding, but only three-quarters of the population have access to it in 2019, although the federal and provincial government have announced important investments to support connectivity in remote and rural areas of the province (Government of Newfoundland and Labrador, 2023[20]).

Box 2.2. Broadband network in the province

Innovation requires interconnectivity, technology can facilitate new modes of delivering healthcare, education, and wide range of government services. Access to broadband network has become indispensable for business growth and could become a long-term solution to stabilize the province finances. Yet, in 2019, only three-quarters of households in the provinces had access to high-speed broadband services, with the numbers even lower in Labrador. Only half of households in rural areas have access to high-speed services, and no high-speed services existed on First Nation reserves or to Inuit communities in the province.

As a result, the provincial and federal government announced that they will invest to support access to high-speed broadband services in rural and remote areas of the province. The Government of Canada will invest CAD 116 million in funding to underserved areas, inclusive of First Nation communities in the province, through the Universal Broadband Fund, a dedicated fund that aims to support access to high-speed internet for all Canadians by 2030 The provincial government will also invest CAD 20 million, bringing up to CAD 136 million the investment to support high-internet connectivity in all of Newfoundland and Labrador.

Source: (Goverment of Canada, 2022[20]) (Government of Newfoundland and Labrador, 2022[21]) (McKnight, 2022[12])

The collection of corporate taxes took a hit with the falling rates of oil production (see Figure 2.2). While personal income tax and sales tax have risen sharply since 2009-10, reaching CAD 1600 million in 2019-20 and CAD 1220 million in 2020 respectively, while corporate tax rates in the province have plunged, accounting for a mere CAD 220 million in 2019-20. Falling rates of oil production help explain this decline. Making fiscal matters even more challenging for the government, the province has not qualified for equalization payments since 2007-08, given its much-enhanced ability to raise revenue within the province.

All this spending, when combined with the pandemic-induced collapse in oil revenues in early 2020, added to the province's debt and triggered a downgrade of economic outlooks for the province. For 2022-23, offshore royalties are expected to contribute CAD 866 million to government revenues, down from the CAD 11300 million handed over in 2021 and a fall drop their peak of nearly CAD 2800 million in 2011-12 (Figure 2.2). This shock may force the province to break from the government's fiscal approach of dependency to the whirlwinds of commodity prices (Hanniman, 2020[22]) and provide m. ore reasons for to transition towards a more diverse economic model.

3 Memorial, an entrepreneurial university at the service of its province

Territorial engagement is in Memorial University's DNA

Since its foundation, Memorial University has acknowledged a "special obligation to the people of the province", tying the university's teaching, research, and public engagement activities to the needs of the province (Memorial University, 2021[23])[5]. As the only university in the province, Memorial University represents the centre of the Higher Education system that also encompasses a community college (the College of North Atlantic, CNA), which offers professional training to learners of all ages. The university has always been considered as a vehicle for modernising the sparsely populated province and its resource-based economy. The province's first premier said Memorial could 'foster individual and community independence and self-reliance'. Throughout the 1950s, Memorial University's successive University successive presidents advocated that the university play a key role in promoting the province's social, economic, and cultural development. Throughout the years, Memorial University has strengthened its core activities of research, education, and public engagement.

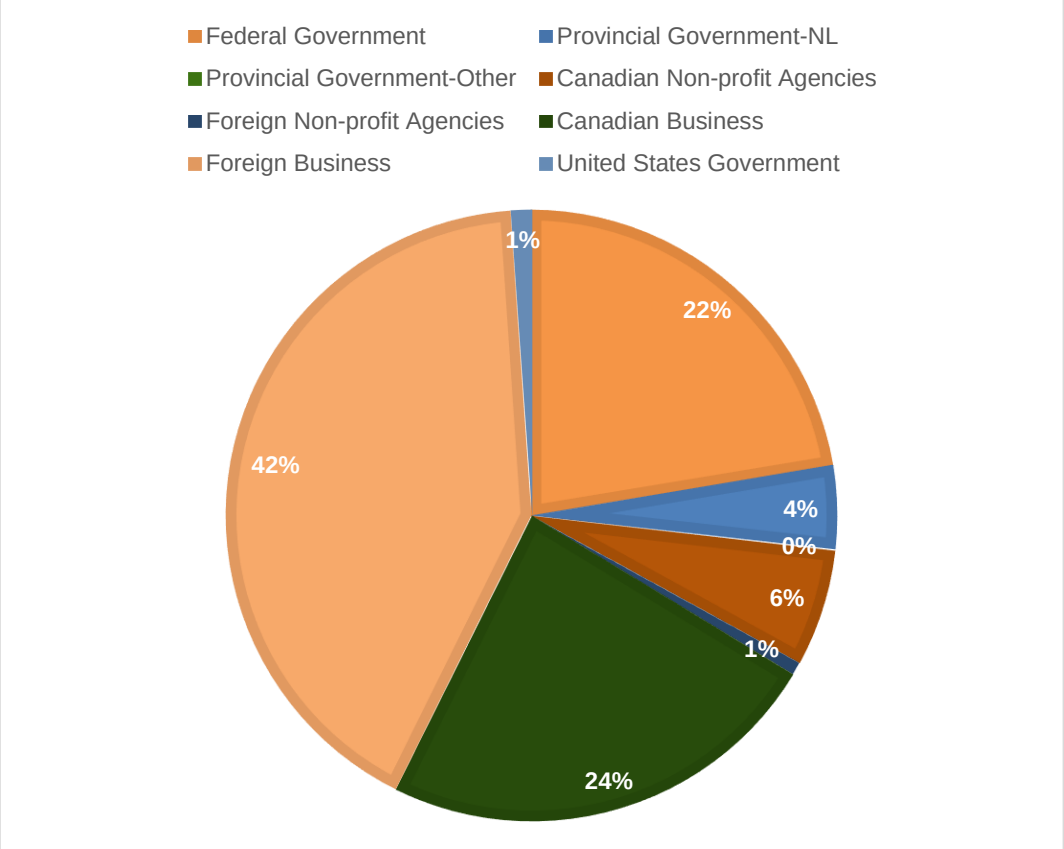
In 1961, Memorial established the Institute of Social and Economic Research (ISER) "to address specifically the social and economic problems of the province". In 1964, the institute that became the Fisheries and Marine Institute was established. The Marine Institute (MI) has since become one of Canada's leading Ocean Institutes, conducting training, applied research and industrial support for ocean industries (Usher, 2019[24]). In 1975, a non-for-profit university-owned entity, C-CORE (originally Centre for Cold Oceans Research) was founded to provide solutions to a wide range of challenging industrial issues in offshore industries. It has since grown into a globally competitive provider of research and solutions in offshore industries, leading in fields such as remote sensing using satellites or hardware and systems adapted to harsh environments (Warrian, 2016[25]).

The Marine Institute and C-CORE, created connections to industries like petroleum, mining as well as fisheries, aquaculture, marine transportation, and shipping. In fact, Memorial University has been both a driver and beneficiary of the province's economic transformation, most notably through research relating to the petroleum industry and through funding from that industry. Most of the university's funding for research activities comes from industry, which places the university among the top five universities in Canada in industry funding (see Figure 3.1). Memorial uses the industry's funding stream to boost research

[5] Memorial University was founded as a college in 1925 and acquired the status of university in 1949, the same year the province of Newfoundland and Labrador, a former British dominion, joined as Canada's tenth province (Memorial University, 2021[15]).

and learning in many fields, such as biology, aquaculture, fishery, marine transport, and sustainable agriculture[6].

Figure 3.1. External sources of research funding, 2020-21



Source: (Memorial University, 2021[23])

As of April 2022, the university's student body consists of 19,270 students, with almost 20% of foreign students from 118 countries (67% of Newfoundlanders, 14% from the rest of Canada) (Memorial University, April 2022[26]). It has a ratio of 16:1 faculty-student ratio, which is one of the best in Canada. About 20% of Memorial's research funding comes from industry, which places it among the top five universities in Canada in industry funding. Worldwide it is ranked top 751-800 in QS World University Ranking 2022[7], and within the different university ranking organizations, Memorial is highly ranked (among the top of global university ranked) for the study of Food Science and Technology, and Oceanography; Telecommunications Engineering; and Remote Sensing; and Petroleum Engineering (Memorial University, 2021[23]). Overall, these rankings reflect the close ties the university has with the Oil & Gas industry and its important work on marine and ocean science. Memorial has progressively expanded its campus in the province. As of 2022, Memorial has three campuses (St. John's campus, Signal Hill Campus and the

[6] Memorial also receives large support from the federal government for research activities and from the provincial government for teaching and research. For example, the province invests 1.4% of its gross domestic product (GDP) in post-secondary education, compared to the Canadian average of about 1%.

[7] It is a ranking published by Quacquerilli Symonds of 13000 universities across the globe, which ranks the universities according to six indicators such as academic reputation, number of citations that university faculty haven and the faculty to student ratio.

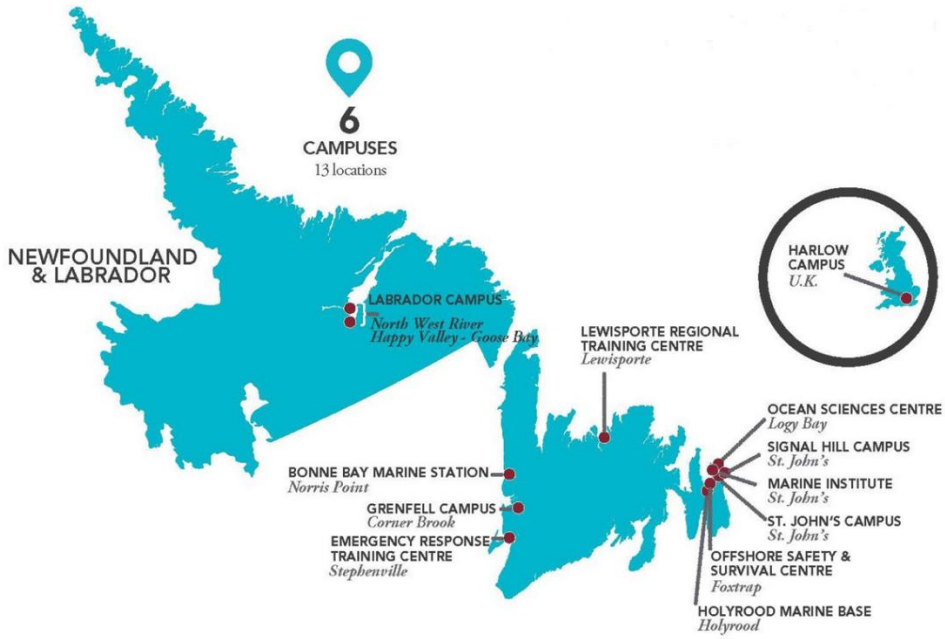
Marine Institute) in St. John's (the capital of the province), Grenfell Campus in Corner Brook and the Labrador Campus in Happy Valley-Goose Bay, Labrador (see Figure 3.2).

Table 3.1. Memorial University: fast facts

Total number of students	Number of foreign students	faculty-student ratio	Campus	Ranking by disciplines
19,270 students	20%	16:1	3 campuses in St. John's Grenfell Campus Corner Broke and one campus in Happy Valley-Goose Bay, Labrador	Only university in Canada to make it to the post-secondary institutions for the study of marine and ocean engineering (38th among global universities ranked) Memorial is highly ranked for and Oceanography; Telecommunications Engineering; and Remote Sensing; and for Petroleum Engineering

Note: Data for 2022 or the latest available year
Source: (Memorial University, 2021[23])

Figure 3.2. The six campuses of Memorial University



Source: (Memorial University, 2022[27]), accessed October 2022

A solid public engagement strategy enables Memorial University to connect with SMEs, local municipalities

Besides generating most of the talent and research feeding into regional industries, such as oil and marine technologies, the university plays a pivotal role in engaging with public authorities and other stakeholders. Memorial has developed a public engagement strategy to support collaborative relationships between Memorial and a broad range of stakeholders, including NGOs, community organizations, governments, industry, and others. In 2011, Memorial University undertook a major consultation with hundreds of public and private stakeholders to develop a framework for the university's collaborations with its many public partners. These contributions informed the Public Engagement Framework, which was endorsed by Memorial's Senate and Board of Regents in 2013 the first and only senate-approved university public engagement strategy in Canada.

To implement of the Public Engagement Framework, Memorial created an Office of Public Engagement led by an Associate Vice President for Public Engagement and Strategic External Relations. The office is responsible for all public engagement and external relations activities, and supports other public engagement units within the University, including the Leslie Harris Centre of Regional Policy and Development Harris Centre.

The "Harris Centre" has two primary goals: to assist in the responsible development of the economy and society of Newfoundland and Labrador; and to stimulate informed discussion of important provincial issues". The Harris Centre works with local communities throughout the province creating spaces and events for different stakeholders to convene. It works closely with several Community Business Development Corporation (CBDCs), which are government agencies supporting the creation of SMEs to understand the needs of local stakeholders. Specifically, the Harris Centre and the university work with regional organizations to connect research and students to communities. For instance, the representatives of Memorial's Grenfell Campus work closely with the "Workforce innovation centre" based in the college system in Corner Brook with representatives at the Grenfell campus as well. Additionally, another organization the Harris Centre has collaborated with is Shorefast a Canadian non-for profit located in Fogo Island in the north of the province, which has a very long-standing relationship with the university's Centre for Social Enterprise.

Moreover, in the words of stakeholders interviewed working at the Harris Centre, "we try and support communities by bringing the knowledge from the university to the region." To this end, the Harris centre also funds innovative research in public policy and regional development with a direct impact on the province. Such funding for research project is opened to Memorial faculty and students, but allows for project partners from other universities, and external stakeholders. The Harris Centre has created four funds, including the "Thriving Regions", that provides up to CAD 15 000 for research that impacts sustainability in specific regions of the province.

Memorial University is supporting young entrepreneurs in the region

Memorial is unique in its interconnected approach to entrepreneurship. It offers tailored courses for business and social students and advanced courses for graduate students and researchers through the "lab-to-market ocean" programme. It also supports faculty and students to move their ideas from inception to the public domain, through different groups such as the Research Innovation Office, the Genesis Centre, or the Centre for Entrepreneurship (see Table 3.2). More than this, Memorial's approach has demonstrated its flexibility when working with industry and with external stakeholders at large and their entrepreneurship strategy contributes to stimulating the nascent technology sector, to some extent the ocean industry and supporting an entrepreneurial culture in the province. Fundamentally, the mechanisms put in place by

Memorial University can serve as an example to other universities who are attempting to assist an innovation ecosystem.

Table 3.2. Moving ideas to the public domain: MUN's entrepreneurial pipeline

	Foundational entrepreneurial skills courses	Pedagogic incubators, events, competitions for students	Incubators, accelerators, technology transfer offices
Signal Hill & St. John's Campus	Undergraduate entrepreneurship course (for all students in all campus) MBA with courses on Leadership and new venture creation Lab2Market Oceans, Translational R&D MBA in Social Enterprise	Memorial Centre for Entrepreneurship Genesis Centre (Evolution Programme)	Genesis Centre Research Innovation Office (services to all campus)
Grenfell Campus	Entrepreneurship courses in the Bachelor for Business Administration	Memorial Centre for Entrepreneurship Navigate Entrepreneurship Centre	Navigate Business Incubator Research Innovation Office
Labrador Campus	NA	Memorial Centre for Entrepreneurship Genesis Centre (Evolution Programme)	Memorial Centre for Entrepreneurship Research Innovation Office Genesis Center (Evolution Programme)

Source: Author's elaboration

Memorial is multiplying its courses and programmes on entrepreneurship

Entrepreneurship culture is embedded in Memorial. According to a study by Professor Carlos Bazan, Engineering chair in Entrepreneurship, 2018-2020 saw an increase in students' entrepreneurship intention at the university. Over the years, the university created a pipeline for entrepreneurship with a variety of programs for undergraduate, graduate and PhDs students.

The entrepreneurship Training Program (ETP) the first-in-Canada training program for international graduate students interested in starting a business. This programme supports an international visa support scheme put in place by the province[8]. The program covers core entrepreneurship themes and skills such as problem solving, design learning, lean start-up, sales, marketing, and financial planning. As a result, Memorial's Entrepreneurship Training Program has graduated over 200 students and has received multiple national awards for innovation in student services and career education. In addition to this training program, the university's a Bachelor of Commerce program in the Faculty of Business Administration at the St. John's campus includes a mandatory, for Faculty students, course on the Entrepreneurial Mindset. This course, the more advanced Starting a New Business course and a Tax and Regulatory Issues for Small Business course are open to any student across the campus. The Master of Business Administration (MBA) of the Faculty of Business Administration includes a course on leadership and interpersonal skills for Manager, which covers skills such as problem solving, decision-making and team building, all aptitudes that refer to the entrepreneurial mind-set. Both the MBA and undergraduate programs offer an elective consulting course, whereby students work with local small businesses. While many courses are not unique to this university, they reflect Memorial's will to train a generation of young entrepreneurs.

[8] The province has put in place important support schemes through the "Dutch Visa," "a residence visa permit for people from outside the European Union (EU), who are looking to start an innovative business. The start-up visa is valid for a maximum of one year, within which, individuals are expected to produce or introduce an innovative new product or service under the guidance of an experienced facilitator."

The Grenfell Campus has also developed curricular activities designed to stimulate students' entrepreneurial mind-set. The Bachelor of Business Administration includes introductory courses on entrepreneurship, courses on enterprise development and elective courses on social entrepreneurship. This is a separate programme from the ones provided at other campuses.

Memorial has opened several facilities to support aspiring student entrepreneurs

The Memorial Centre for Entrepreneurship (MCE) is open to students, faculty, and staff, who are interested in entrepreneurship and start-up ideation. It offers a wide variety of programmes, events, courses, hackathons depending on the interest and the business venture idea of the participants. "Pre-entrepreneurs", students or faculty that have not developed yet their own venture ideas are invited to take courses on entrepreneurship, attends events workshops, or access to mentors to identify a business idea. There is also the possibility for undergraduate and graduate students to undertake "entrepreneurial internship" (EI) or an "Entrepreneurial Work Term" (EWT) a semester to create a start-up during which students are remunerated CAD 4,500 and receive mentorship on a weekly basis as well as help for application to funding or other entrepreneurial support programs. These students get to attend the Genesis centre "Evolution" pre-incubation programme, which is an 8-week programme, designed for early-stage technology start-ups. Thus, MCE is a funnel for start-up ideation, where students are provided with a safe space to test their ideas.

In addition to the MCE, Memorial has opened a Centre for Social Enterprise (CSE), dedicated to social ventures which aims to enhance the quality of the human experience via social enterprise and social innovation. It is a multi-disciplinary and multi-campus partnership that seeks to include all students. Since 2019, the university offers a one-year MBA in social enterprise, the first in Canada that teaches students social and sustainable entrepreneurship. Students can already be working for a start-up company when they enrol in the course or opt to develop their own over the duration of the course. Although it is small (15 students a year) it provides work experience in social enterprise through work placement in the community (the program helps subsidize the position for the student). For MBA students that want to develop their venture, they can apply to the Social Ventures Incubator and can receive funding of CAD 2,500-7,500.

Scaling-up faculty and students ventures: MUN's incubators are spurring the culture of entrepreneurship in the region

The Research and Innovation Office (RIO) supports all Memorial faculty, students, and staff to commercialise research projects (licensing or start-up or spin-off) or develop new partnerships with industry. They help aspiring entrepreneurs to identify resources and facilitate connections with industry and assist them with protection of intellectual property, licensing, and new start-up creation. This office has developed several programmes to help the students bring their ideas to the market or learn how to commercialise their research. For instance, the Insight Business Consulting programme gives MBA students the opportunity to work in a start-up, while receiving a fellowship and, of connect talent with the booming technology industry. The Translation R&D Programme helps students identify the commercial potential of their research or connects students and faculty to federal programmes funding research such as Springboard Atlantic, or Lab2Market Oceans (see section below) (Memorial University of Newfoundland and Labrador, 2021[28]).

The Genesis Centre is Memorial's incubator for technology-based ventures with high-growth potential and is open, not just to students, but to start-ups and entrepreneurs. It has a three-year incubation programme celled Enterprise, which has initiated twenty-five years ago, that help entrepreneurs scale-up their business and get their product to market. To enter the start-up needs to have a minimum viable product and less than CAD 1 million in revenues. This programme provides office spaces (located on Signal Hill Campus), access to training programmes and workshops and gives start-ups access to mentors and advisors (industry representatives or other entrepreneurs) (Genesis, 2021[29]). It has an eight-week pre-incubator

programme for entrepreneurs that do not have minimal viable product but have identified a problem to solve and have less than CAD 1 million in revenues. It helps entrepreneurs identify their market, pitch, and connect to industry advisors (Genesis, 2021[29]). Genesis also offers other programmes such as a peer-to-peer group for women in working technology companies (or founders of a technology start-up), to support women in that field. Genesis gives access to a federal programme "Start-up Visa" which allows immigrants living in the province develop their business in exchange for permanent residency.

Genesis has become Newfoundland and Labrador's innovation hub, and the heart of a nascent technology sector. Since its launch in 1997, Genesis has incubated over 70 start-up companies, who have raised $624 million in capital, generated CAD220 million in revenue, and created 2500 jobs (Genesis, 2021[30]). With the help of Genesis and Navigate, several of the province's budding tech champions including Genoa Design (providing advanced services for shipbuilding and offshore industries) Verafin (a financial crimes' software company (see Box 3.1) and Mysa (a thermostat company), among others emerged from Memorial's campuses, faculties, and schools.

Box 3.1. Verafin a Memorial start-up turned into an industry pioneer

Verafin, a financial crime management solutions company, specialises in fraud and anti-money laundering, was founded by three former Memorial students while they were completing their graduate studies on computer-science engineering. The company was founded in 2003 after the terrorist attacks of 9/11, when there was a push to protect the financial system and enhance surveillance on international transactions and money-laundering schemes. The founders created an anti-financial crime software for banks and credit unions. As of 2021, by the American company Nasdaq bought the company to enhance the quality of its financial security software.

The company keeps a strong connection to Memorial University, with 60% of Verafin employees being Memorial graduates are mainly business graduates and software developers. In fact, Verafin helps design computer engineering programmes at Memorial and CNA. As such, the company accomplishes a vital role in retaining and employing young graduates. It collaborates with the Genesis Centre, to provide mentoring and funding to start-ups.

Initially a pioneer in the tech sector, Verafin has been pivotal to the growth of the sector, with many more companies emerging and increased venture capital.

Source: (Verafin Solutions ULC, 2019[31])

Grenfell campus created the Navigate Entrepreneurship Centre in 2004 to support the local entrepreneurial community. Navigate includes the entrepreneurship centre, as well as a makerspace, and a business incubator to support student, staff faculty and alumni of Grenfell campus and CNA's Corner Brook Campus, as well as local business owners, entrepreneurs, and artists. The entrepreneurship centre helps entrepreneurs turn their idea into a business-model and plan and offers advisory networking, and financial resources. The makerspace located at Grenfell Campus is a free space equipped with advanced IT equipment such as 3D printing, robotics, laser cutters and is designed to help students turn their ideas into prototypes. The business incubator, located at the CNA Corner Brook Campus, offers to support the commercialisation of ventures. This centre has contributed to spurring the culture of entrepreneurship in the region, it supports all aspiring entrepreneurs from the "little coffee house to the new tech start-up" (Navigate Small Business, 2020[32]). Since November 2018, four start-ups have graduated from the business incubator and, 400 SMEs, start-ups and entrepreneurs have been supported since 2012 (Navigate Small Business, 2020[33]).

MUN's entrepreneurial activities are spurring a generation of young entrepreneurs especially in the ocean sector, but needs to connect to more traditional sectors to provide enabling innovations

The numbers show growth in student-led entrepreneurship, and the Genesis Centre and the Navigate Entrepreneurship Centre have become innovation hubs assisting local start-ups and SMEs. Yet there are still opportunities to connect entrepreneurship to rural communities and the ocean economy. Stimulating entrepreneurship in rural communities is key to revamp low-density territories and traditional industries such as agriculture, forestry, or fishery. Innovative solutions from young entrepreneurs could provide enabling technology for these traditional, but still key, sectors. In that sense, the challenge is to identify a problem or a business opportunity in the province. The CSE constitutes an attempt by Memorial to connect local stakeholders with students who are interested in social entrepreneurship. Furthermore, during interviews, Memorial professors reported that more could be done to stimulate the connecting between ocean-related research with entrepreneurship. For instance, the Labrador Campus specialised in sub-arctic studies, does not have any courses on entrepreneurship at that moment (although researchers and students can apply to campus-wide programme such as lab-to-market, Genesis, or the MCE).

Many stakeholders pointed out to the need to connect venture capital to early-stage start-ups, increase seed funding. The venture capital sector, initially underdeveloped, is growing rapidly as the provincial government has made a CAD10-million-investment in a private venture capital fund (Venture Newfoundland and Labrador LP). This funding has been backed by private investment, with one third from outside the province (Government of Newfoundland and Labrador, October 2021[34]).

4 Memorial's place-responsive activities to support the ocean economy

While the previous chapter explains Memorial University special obligation to the province, its public engagement and entrepreneurial strategy, through which the university has developed important research ties with the public sector, SMEs and entrepreneurs, this chapter focuses more on the activities that connect Memorial to the ocean-based industry, a core overarching sector which drives the province's economy. This chapter also explores how Memorial's different initiatives and partnerships position the university as a leader in ocean science.

Box 4.1. Understanding the ocean economy

Ocean economy refers to the "sum of economic activities of ocean-based industries as well as assets, goods, and services of marine ecosystems" as the defined by the OECD. Ocean-based industries include, already established industries such as marine transportation (shipping, ship building, marine equipment), fisheries, maritime and coastal tourism, offshore oil and gas exploration and production as well as emerging industries offshore wind, tidal wave energy, offshore extraction in deep-sea, ocean monitoring and marine biotechnology. Marine ecosystems refer to natural ecosystems which assets are used for ocean-based industries (oceans, lagoons, coral reefs, deep sea, sea floor).

Source: (OECD, 2016[11])

Memorial is emerging as a leader in ocean science and has built strong ties with ocean-based industries

Memorial University has emerged as a leader in the research and training of its graduates in a wide range of fields relating to ocean innovation, including marine engineering and oceanography (Usher, 2019[24]). A recent estimate has over 40% of Memorial's research being ocean-related (Memorial University, 2021[23]). Memorial is home to 18 active Canadian Research Chairs, and five of those are undertaking research on ocean-related of cutting-edge fields, including ocean mapping, marine geology, biological oceanographic processes, coastal environmental engineering, and boreal biogeochemistry [9]. Memorial University hosts the National Research Council on its campus. Since 2010, Memorial University has invested in technology, social sciences, and humanities, notably through the COAST initiative. Given this wealth of knowledge,

[9] The Canada Research Chairs Program (CRCP) was created by the government of Canada in 2000 and allocated on yearly basis national and international researchers to postsecondary institutions to conduct research and teach.

experience and infrastructure, Memorial University is in prime position to contribute to the continued growth of the ocean economy.

Innovation in ocean-related industries can be extremely capital-intensive. In this area, too, Memorial University has succeeded as the university boasts significant infrastructure across the province that can be tapped for ocean-related innovation. For example, the Ocean Sciences Centre is a cold ocean research facility in Logy Bay specialised in research on the North Atlantic fishery, aquaculture, oceanography, ecology, and physiology. The Bonne Bay Marine Station is research, teaching and conference centre in Norris Point on the west coast of the island of Newfoundland. Even centres such as the Alexander Murray Earth Sciences Building and Johnson GEO Centre, geological centres of research dedicated to the mining industry, conduct research on the fields of oceans space. A new Core Science Building which includes a dedicated reserved space for industry and R&D collaboration has also been established with an investment of CAD 325 million.

Memorial has also created dedicated programmes and institute to foster connections with external stakeholders across the province, to drive cutting-edge research in ocean science, train workers in the industry. For instance, the Cold Oceans and Arctic Science, Technology and Society (COASTS) initiative is a strategic initiative designed to position the university as a leader in ocean science. Under this initiative, many teaching, research, public engagement, and collaboration activities are led to support ocean science. This initiative mobilises, different institutions across Memorial University, including the Faculty of Social Sciences and Humanities. Projects include research on historical affects and the North Atlantic offshore oil industry on the people of Newfoundland and Labrador in areas of energy extraction or research on integration of immigrants in the province. The initiative is supported by Memorial's cutting-edge facilities and equipment to support research and public partnerships in the field of ocean science. The COASTS initiative is funded by Memorial university, with a third of contribution coming from industry partners. For the next five years it is expected that the industry partners contribute up to CAD 130 million to the initiative. In addition, Memorial has two dedicated institutes to ocean science: the Marine Institute campus and C-CORE, which are important players that directly connect with industry and have been crucial to the province's economy.

C-CORE (Centre for Cold Oceans Research) an independent research centre that provides ice-related research services to industry

C-CORE (originally Centre for Cold Oceans Research) was founded in 1975 to provide technology and research-based solutions to challenges in offshore industries, notably oil and gas but also aerospace and defence sectors. It has grown to become a competitive provider of research solutions for offshore industries. It is based at the St. John's campus but has opened offices in Ottawa and Halifax. The centre has an independent board of directors which includes industry representatives, university members, and is self-funded through project-based contracts. Yet it still has important ties with Memorial, as it accesses Memorial's access testing and engineering facilities and has staff appointed from the faculties of Science and Engineering (Warrian, 2016[25]).

C-CORE has expertise in ice engineering, geotechnical engineering and its research also focuses on maritime surveillance through remote sensing to monitor ice and icebergs. It works closely with oil and gas companies to secure offshore sites and carries further in satellite technology, satellite monitoring of wetlands and space debris.

C-CORE's funding model enables the centre to thrive without depending too much on public resources. It is not influenced by changes in faculty and their specific research interests and does not depend on government transfers to thrive. In fact, C-CORE owns all intellectual property (IP) resulting from their research; it manages IP on their own and not through the university's Technology Transfer Office. Only payroll and benefit plans are done by the university. It makes its own proposals to industry. Its budget is based on about 17-20% foreign industry (location of the project) and 25% Canadian business, while 9-

13% comes from the Canadian Excellence Centre, and 25% from the Canadian government. Moreover, the industry is required to spend 0.5% of revenues on local Research & Development and this benefits greatly C-CORE.

The Marine Institute: a portal for the ocean economy

The Marine Institute (MI) is a campus of Memorial University that provides education, training, technology and applied research in the oceans industries It has three Schools, the Schools of Fisheries, the School of Maritime studies, and the School of Ocean Technology which includes specialized research and training centres. Its vision is to help the province become a world leader in applied oceans education and research (Fisheries and Marine Institute of Memorial University of Newfoundland, 2022[35]). (Warrian, 2016[25])

MI delivers a significant curriculum, with a focus on applied academics and has a more direct connection to "learning by doing", training students with technical skills, and connecting them to the labour market through internships. It offers not only undergraduate and graduate degrees and doctoral programmes, but it also offers technical certificates (one-year programmes on marine safety and mechanics) and diplomas of technology (one-to-three year and certificates on marine engineering or technology) providing training to students and professionals, serving the needs of the industry. MI has centres around the province that develop courses and technology that meets the needs of the local industry (fisheries and marine transportation, ferry services, boat building, seafood harvesting).

Another factor enabling the Marine Institute to connect with the industry, is the applied nature of its ocean-related research. It conducts research in the areas of fisheries, maritime operations, ocean safety, and ocean technology, and others. In line with its Vision 2020, the Marine Institute has developed a specialisation in ocean technology (Usher A., 2019[36]).

To maintain its applied research and education activities, the Marine Institute has invested in cutting-edge infrastructure spread across its different centres, located in several communities in the province (St. John's, Foxtrap, Lewisporte, Stephenville, and Holyrood). This infrastructure is diverse and responds to different research priorities including fishing gear design and testing, fish development and hydrodynamic testing of marine structures (non-fishing gear) such as turbines and structures used in exploration. Given this, the fishing industry is one of MI's largest client groups. In the period of 2011-2018, MI has invested a cumulative CAD24 million in its big infrastructure projects which include storage facilities, simulators, and the construction of The Launch (formerly the Holyrood Marine Base).

The Launch handles at-sea training relating to ocean science, ocean technology, fish harvesting technology, fishing handling methods, aquaculture, and the marine ecosystem more broadly. Home to a new 36,000 sq. ft. multi-purpose building with a large, high bay workshops with access to a breakwater and marginal wharf, The Launch partners with the municipality's ocean-industrial park and incubator. It provides access to vessels, technology, technical expertise, and collaborative partnerships (Town of Holyrood, n.d.[37]).

The Ocean Supercluster: an opportunity for Memorial to connect with public and private stakeholders across Canada

Memorial University is central to the province's involvement in the "Ocean Supercluster', part of the Global Innovative Clusters Program Supercluster" that the Canadian federal government launched in 2017. The Ocean Supercluster is one of five pan-Canadian clusters and is based in Atlantic Canada. The Ocean Supercluster touches on a range of ocean-related industries, including marine renewable energy, fisheries, aquaculture, oil and gas, defence, shipbuilding, transportation and ocean technology, through a sustainability lens. Given its inclusive cross-sectoral nature, Ocean Supercluster membership includes private sector companies (SMEs and larger firms), academic and research partnerships, not-for-profits and

government and is supported by modern research infrastructure, some of which is housed at Memorial University. Formally supported by the federal government through the department of Innovation, Science, and Economic Development (ISED), the OSC is an industry-led not-for-profit anchored in but not exclusive to Atlantic Canada. The aim of the Ocean Supercluster is to bring together companies of various sizes to grow the ocean economy 'sustainably, inclusively, and digitally' (Canada's Ocean Supercluster, 2022[38]). This cross-sector effort to develop and commercialize globally relevant ocean solutions fits with the province's efforts to train and prepare workers for technology sector jobs given the inevitable technology-centric focus of this initiative.

The Ocean Supercluster aims to develop and commercialize ocean solutions, positioning Canada to become a global leader in ocean innovation. The Canadian government envisions fostering innovation and entrepreneurial capacity through funding and leveraging cluster-building activities that will benefit the collaborative projects. In particular, the Ocean Supercluster pursues five main objectives (Doloreux and Shearmur, 2018[39]):

- 'Strengthen links between ocean-based value chains and providers of enabling technologies'
- 'Develop, deploy, and export innovative technology platforms applicable to multiple ocean industries'
- 'Fill capability gaps in the innovation ecosystem through the attraction, recruitment, training, and retention of diverse, highly qualified personnel'
- 'Extend the global reach, attraction, network and market opportunities for Ocean Supercluster partners'
- 'Address global challenges related to sustainability, reducing carbon foot-print and improving energy efficiency'

While 'clusters' have long been a driving force in the global economy and a core concept in the innovation literature, the key players within clusters are not exclusively companies, include academic institutions and not-for-profit organizations that each contribute to boosting growth and innovation in a particular area. The notion of 'supercluster' builds on this, but spans various sectors, making it 'a cluster of clusters' Shearmur (Doloreux and Shearmur, 2018[39]). So, while clusters tend to focus more on specific industrial sectors and their sub-contractors, 'superclusters' aim to look at the entire value-chain and to facilitate the cross-fertilization of knowledge and ideas between previously unconnected or distantly connected sectors.

Although Canada's five official 'superclusters' are sectorally focused, partners from other regions and/or transversal sectors are welcome to participate. Indeed, at present, the ocean-focused cluster has members from nine of Canada's ten provinces (more than 45% of members are from outside Atlantic Canada), as well as from one of Canada's three territories and twenty partners from outside Canada. Under the first iteration of this initiative, the federal government matched every dollar the private sector puts forth (Government of Canada, 2022[40]). In the case of the OSC based out of, but not exclusive to Atlantic Canada, six categories of ocean technologies have applications across the aquaculture and fisheries, renewable energy and oil and gas; sensors and imaging; satellite technologies; computerization and big data; autonomous systems; subsea engineering and technologies; and advanced materials.

As of early-2023, the Ocean Supercluster has some 530+ members enrolled, with CAD 400+ million pledged in project commitments, half of which comes from industry partners. The lion's share (86%) of these projects is led by small- and medium-sized firms, 96% (Canada's Ocean Supercluster, 2022[38]). Furthermore, some 70 projects have been approved, another 47 projected announced, which includes over 110 new 'made-in-Canada' ocean products, processes, and services. OSC estimates that over 4,500 jobs may be created from these projects.

Expectations for the Ocean Supercluster are high, particularly in Newfoundland and Labrador. According to Canadian government estimates, the expected impact over ten years is more than 3,000 new jobs and more than CAD 14 billon added to the country's GDP (Canada's Ocean Supercluster, 2022[38]). The

Government of Canada reinvested in the Global Innovation Clusters program for Budget 2022, with CAD 750 to March 2028. In the second phase, clusters are expected to continue growing their ecosystems, promote investment in innovation and commercialization, expand their national and global presence, collaborate to deepen their impact (including through projects aligned with cross-cutting national priorities such as fighting climate change & addressing supply chain disruptions), act as a catalyst for skills and talent development, and support the growth and scale-up of Canadian SMEs. The allocation of funds between the 5 clusters will be determined through a competitive process (Government of Canada, 2022[40])

In phase II, Ocean Supercluster has released its Ambition 2035 document with the goals of growing Canada's ocean economy to $220 billion (5x growth). The renewed mandate of the OSC will focus its co-investment in four key areas, designed to help drive the ambition for ocean in Canada forward including: 1) Scaled Ocean Energy – Supporting the greening of Canada's economy through the development of Canada's renewable ocean energy industries; 2) Sustainable Seafood – Increasing the provision of sustainable, secure food for ocean-based sources; 3) Future Ocean Transportation – Transforming vessel powering, autonomy and control; and 4) Ocean Climate Solutions – Accelerating the delivery of innovations that mitigate climate change.

The university, through the Marine Institute, C-CORE, Genesis, Memorial's Engineering Department as well as the Harris Centre among other entities, act as a meeting ground for these promising cross-sectoral exchanges to occur. Furthermore, Memorial boasts valuable personnel to stimulate the Ocean Supercluster. Now, Memorial University, through its different entities is engaged in several OSC projects (see Table 4.1). For example, in November 2020, Canada's Ocean Supercluster announced funding for three projects based in Newfoundland and Labrador, collectively worth about $6 million.

Memorial hosts the "Lab2Market Oceans", part of the OSC Ocean Start-up Project, in collaboration with Atlantic Canada Opportunities Agency ACOA and Mitacs (see Box 4.2). This programme is dedicated to PhDs, postdoctoral fellows, graduate students, and research teams not only in Memorial but also across the whole of Canada to encourage researchers to find career opportunities beyond academia and in the field of entrepreneurship. This seven-week programme trains students to bring their research in the field of ocean science to the market, by teaching them how to identify market opportunities and manage intellectual property (start-up or spin-off creation, licensing, research contracts with industry). It also teaches students with practical business skills such as stakeholder engagement, regulation, customer discovery and accounting. This programme was launched in 2020, and with the participation of 38 teams amongst which twenty-four are now commercialising research or pursing an entrepreneurial venture (Oceans Start-up Project, 2022[41]). Regular challenges and other activities are held under this initiative, for instance the Ocean Start-up Challenge has awarded more than CAD 1.4 million to fund entrepreneurs developing ocean industry solutions, to build an ocean data marketplace for organizations to access, store, and profit from data-sharing across a wide range of ocean-related industry.

Table 4.1. A select list of Ocean Supercluster projects based in Newfoundland and Labrador with Memorial University Involvement

Name	Project in Brief
GeoScan Project	Received CAD 2 million in funding from Canada's Ocean Supercluster, along with CAD 32 million from other industry partners. This project works to provide innovative solutions to de-risk offshore wind, oil and gas, and other offshore installations with underwater robotic systems. The project involves the Marine Institute.
Digital Offshore Canada Project	Project led by Petroleum Research Newfoundland and Labrador (PRNL) in collaboration with Memorial University and other stakeholders to accelerate the digitalisation of Canada's ocean industries granting user access to analytical tools and 3D assets. The CAD Ocean Supercluster will provide CAD 9 million in funding along with CAD 9 million from other partners
Marine Search and Rescue (SAR) Helicopter Mission Simulation Project	The Marine Search and Rescue (SAR) Helicopter Mission Simulation Project (led by Bluedrop Training and Simulation, partnering with Cougar Helicopters and the Marine Institute of Memorial University) helps better prepare SAR technicians for marine rescues in extreme weather and sea conditions. Graduate students from Memorial University also contribute to this project.
SmartICE (Sea-ice Monitoring and Real-Time Information for Coastal Environments)	With about CAD 1.1 million provided by the Ocean Supercluster based in Nain, Labrador to enable Inuit to participate more fully in the ocean economy. This is a multi-disciplinary project involving scholars from Memorial university, government, and industry to adapt technologies for testing ice temperature. This project helps Inuit participants across Inuit Nunangat develop technical skills to be operators of this technology.
Precision Fish Harvesting	The project for the construction of a vessel with acoustic technology that can localize fish to be fed back to the vessel. The Marine Institute is a partner in the project, testing of net design is being carried in the flume tank. Received CAD 1.6 million in funding from Canada's Ocean Supercluster
Marine Search & Research Simulation	A crew search and rescue helicopter mission simulation for marine environments for training Canada's rescue team. Memorial university participates in this project and helps with data analytics

Source: (McKnight, 2022[12]) ; (Innovation Science and Economic Development Canada, 2021[42])

Box 4.2. Mitacs a non-for-profit organisation fuelling Canada's knowledge-based economy by connecting talent to industry, government, and non-governmental organisations (NGOs)

Mitacs is a national non-for-profit organisation operating in Canada since 1999 with the purpose of stimulating innovation by driving collaboration throughout the ecosystem and facilitated access to skills and talent. It connects students (from undergraduates to post-doctorates) of Canadian post-secondary institutions (colleges, polytechnic, and research universities) to external organisations, to create solutions to real-world challenges. It has developed several research and innovation programmes and has expanded its original focus on applied research in the field of mathematic, to STEM and social innovation. Mitacs collaborates not only business but also hospitals, municipalities, and non-for-profit organisations. It benefits from the support and funding the federal government through the Innovation, Science and Economic Development Canada (ISED), which invested CAD708 million in 2021 to support Mitcas activities. Mitacs has offices in regional centres (Montreal, Ottawa, and Toronto) as well as representation across the country.

Mitacs developed internship programs to connect industry, non-for-profit organisations, municipalities, and hospitals to talent. At the time of writing, Mitacs has two internship programmes, the Business Strategy Internship, and the Accelerate, which are open to all students from undergraduate to post-doctorates. During these internships, students can apply their knowledge and research skills to help to solve practical problems faced by their employer. Students from diverse study disciplines (law, business medicine) participate in these programmes. Mitacs also has the Elevate Programme, an applied research fellowship for post-doctoral students at Canadian universities. The fellowship is completed in Mitacs' partner organisation to help these get the expertise to solve a pressing research and development (R&D) programme. It also has three dedicated programmes for international students (the Globalink internship programme, Globalink fellowship and Globalink awards) designed to attract international talent to help Canadian organisations solve R&D challenges.

Mitacs also has programmes to support entrepreneurs such as Mitacs Entrepreneurs International, linking start-uppers to incubators and accelerators in Canadian post-secondary institutions that are connected to international networks. The aim is also to help entrepreneurs seek market opportunities abroad and access foreign investment opportunities. Due to the COVID-19 pandemic, the programme has exhibited moderated growth for the 2021-22 period, with only twenty-eight MEI internship delivered during that year. Yet entrepreneurs that participated in the programme reported in an exit survey a 29% improvement of products and services, and a 42% attraction of investments. In addition, 84% of participants also highlighted that they received enquiries from investors and partners over the course of the programme.

Mitacs also offers students in Canada access to courses, workshops, and networking events. It offers courses in project and time management, career planning, R&D management skills, networking, and leadership skills. The number of students participating in this training has increased continuously since 2016, with a surge in attendance during the pandemic, as courses were offered online. In addition, Mitacs collaborates with the Innovation and Impact network of Canada (I-INC) to enhance knowledge transfer through different initiatives, such as the Lab2Market programme a sixteen-week programme for graduate, postdoctoral and faculty that provides training to support start-up creation and commercial development, IP development.

Source: Mitacs (2022), Mitacs Annual Report 2021-22 for Innovation, Science and Economic Development Canada, https://www.mitacs.ca/sites/default/files/uploads/page/2021-22_ised_annual_report.pdf Mitacs (2022), Mitacs Programs, https://www.mitacs.ca/en/programs.

Memorial's efforts to sustain the ocean economy has solidified its ties with the industry, including at the international level

As previously stated, the province of Newfoundland and Labrador's oil and gas policy requires companies to spend up to 0.5% of their annual oil production into education and training and R&D in Newfoundland and Labrador. This is managed by the Canada Newfoundland-Labrador Offshore Petroleum Board (CNLOPB) and has resulted in companies collaborating with Memorial, C-Core and MI. Though corporations, such as those within the local oil and gas industry, are oriented towards operation, the policy incentivizes them to collaborate with the university on topics such as icebergs and towing, which helps build local capacity. At the university level, such agreements helped C-Core and other departments to build their engagement with the oil and gas industry. These days the industry is reliant on the expertise that Memorial and its different units have developed.

Based on the ecosystem Memorial has created, participants interviewed highlighted the importance of Memorial University and the Marine institute in ocean innovation. Specifically, the Lab2Market Oceans engages graduate students and trains them in the commercialization of their research. Participants also highlighted the importance of technology like the Marine Institute's flume tank to conduct applied research by solving real world problems for the industry. The research focus varies and can include topics such as the behaviour of fishing gear on ocean floor to fuel efficiency. Ultimately, the close work with industry, students, and researchers at the Marine Institute have produced new firms. As one faculty indicated: "About 1 in 20 started a company – I started 4 companies with students", many of which continue their collaboration with MI and Memorial, as well as recruit students for research projects and work.

5 Opportunities to improve Memorial's contribution to regional innovation and entrepreneurship

After an in-depth analysis of Memorial University's activities in contribution to the province's economic development, this chapter explores how institutional settings could further support Memorial University's role within the province but also internationally. Memorial university could further enhance cooperation and incentives for staff and faculty in support of its "special obligation" to the people of the province. Better internal coordination, and connection with research groups in Canada and beyond could help the university enhance its position as a leader in the ocean-science sector. Furthermore, Memorial university should adopt a forward-looking perspective, and enhance its support to the green and digital transition, two trends will likely accelerate over the coming years, and will require massive transformation of businesses practices and models.

Enhancing incentives for cooperation within the university

As reported in the previous chapter, Memorial plays a central role in the provincial innovation and entrepreneurial ecosystem. The University has created several ties with the private sector through its different research campuses and research centres such as the Marine Institute, C-CORE, and the Ocean Science Centre. Memorial has also contributed to fostering a culture of entrepreneurship in its different campuses, through dedicated programmes of entrepreneurship, and through incubators such as Genesis and Navigate and connect the industry to research groups through the Research and Innovation Office Finally, Memorial plays the role of community anchor through the activities coordinated by the Harris Centre, which cuts across different disciplines and institutions within the University. However, the capacity of Memorial to operate holistically and generate positive externalities for its communities and networks can be improved by creating more synergies among different areas of research, entrepreneurship, and engagement.

For instance, C-Core and the Marine Institute and the Ocean Science centre all focus on ocean research. While opportunities for collaboration have arisen, university staff highlighted that engagement with industry was more carried on an ad hoc basis by different institutions or research groups. Even within the Marine Institute, different research groups engage with different interlocutors. To a certain extent, the relative autonomy of the Institutes has enabled these to engage with more freedom with different stakeholders, and to mould their activities to cater to local demands. However, this could generate duplications and fragment available resources, reducing investment capacity. Collaboration can also become a safeguard when funding for research decreases, and interdisciplinary research-driven innovation can generate important breakthroughs to address societal challenges. Equally, the siloing or duplication of activities may confuse external stakeholders and have negative implications on how the university is perceived externally.

Entrepreneurship support structure share the same traits. The Research, and Innovation Office (RIO), works with the Centre for Entrepreneurship, the Centre for Social Enterprise, Genesis and Navigate, but

each have their priorities, and their own governing bodies. For instance, the RIO is part of the Office of the Vice-President (Research) portfolio, who directly reports to the president, while the MCE is housed in the Faculty of Engineering and the Faculty of Business Administration and reports to the respective Deans. The Genesis Centre has its independent board of directors, which is composed of high-level staff from Memorial University such as the President and Vice Chancellor of Memorial University, but also members of industry, venture capital companies and start-ups. While this multiplication of structures does not affect the branding or the marketing of the university as a sole entity, according to stakeholders interviewed there is a lack of "colliding spaces", more physical and institutional spaces where staff, students and alumni from different faculties and disciplines can meet to discuss their entrepreneurial ideas and experiences, generating new spaces for innovation. Creating opportunities for these entrepreneurial groups to collaborate would make Memorial's mobilisation to support entrepreneurship more evident and perhaps more impactful.

Fostering career recognition and evaluation systems

Higher Education Institution needs to understand and reflect on how to put adequate incentives, to push forward their entrepreneurial and innovative agenda. Without proper recognition or acknowledgement of the efforts undertaken by staff and faculty, there are no possibilities of taking such activities forward, especially when incentives prioritise research and teaching activities over engagement for career advancement. Likewise, the understanding the changes that HEIs bring out when adopting an entrepreneurial and innovative agenda requires an evidence-based assessment. An evaluation of research impact, entrepreneurship and innovative activities will enable the university to take stock of such activities and asses their impact (OECD, 2022[43]).

In the case of Memorial, like many other universities around the globe, career recognition and evaluation systems represent areas in which there is the possibility to improve. Mirroring an international trend, also in Memorial stakeholders flag the lack of is that of career recognition. Equally incentives for faculty and staff related to entrepreneurship and innovation are missing. While it is common for universities to lack key performance indicators that allow to track their activities, some universities across the globe that, given the importance of knowledge exchange and collaboration in their institutional agenda, have started setting up incentives to measure this agenda, such as the *Tecnologico de Monterrey* in Mexico (see Box 5.1.). Because Memorial strategy is also focussed on the generation of economic and societal value, this would justify specific governance arrangements and regulation frameworks.

Box 5.1. Tecnologico de Monterrey has created distinct categories of professors to acknowledge engagement activities

The Tec of Monterrey has created distinct categories for its professors to acknowledge efforts undertaken by some professors to engage with industry.

At the time of writing, four main categories prevail:

- Teaching professor who teaches and undertakes some research
- Research professors who dedicate most of their time to research activities, and some to teaching
- Entrepreneurial professor who focuses on entrepreneurial activities and connects with the entrepreneurial ecosystem
- "Extension" professor (*profesor consultor y extensionista)* who must devote almost half of its time to connecting with the industry and carrying consulting activities

Professors are encouraged to take one of these carrier paths. Metrics differ for each category, and professors are evaluated and rewarded if they accomplish the objectives set in their job description. The extension professor is reported to be one of the most lucrative options.

Source: (Tecnologico de Monterrey, 2000[44]) ; (Tecnologico de Monterrey, 2016[45])

While Memorial cooperates actively on external stakeholders and engages in several entrepreneurial activities, it is still difficult to evaluate the impact of the university on its ecosystem. This is due to the lack of an evaluation framework. Although the RIO keeps track of essential key performance indicators (numbers of patents, spin-offs, start-ups, licensing agreements, number of project and collaborations with industry among others), the university lacks a more comprehensive evaluation framework While this is equally a challenge faced by many universities across the globe, a few country-level initiatives like in the United Kingdom enable universities to measure their impact in a comprehensive manner.

Box 5.2. Evaluation frameworks in other OECD countries

The United Kingdom Knowledge exchange framework

In 2017 the UK government asked Research England to produce a "Knowledge Exchange Framework" (KEF) to evaluate universities' contribution to the exploitation of knowledge and support HEIs' knowledge interactions with business, public and third- sector organisations, community bodies and the wider public. This framework would prepare the R&D system to meet the goals set out in the UK Industrial Strategy. In addition, the KEF was created to ensure that public funding in support for knowledge exchange was allocated effectively through the pre-existing Higher Education Innovation Fund (HEIF), and to obtain accessible and comparable information on knowledge exchange performance of different HEIs.

To consolidate this framework, Research England organised a consultation process. The proposed framework was well received by participants who validated the inclusion of qualitative metrics in the form of HEI narrative statements and made some suggestions regarding quantitative metrics. In addition, Research England selected twenty-one English HEIs, taking account of the type of institutions and their geographical location, and invited these to participate in a pilot exercise, consisting in a series of workshops in 2019, to test the new refined framework with revised metrics that emerged from the consultation process. The pilot exercise worked well as HEIs provided positive feedback on the KEF and suggested areas of improvement for the metrics used.

After the consultation and pilot exercise, the first knowledge exchange framework round took place in academic year 2019/2020. All HEIs eligible to the knowledge exchange funding participated in this exercise. For this and subsequent rounds, the KEF is evaluating HEIs based on quantitative metrics and qualitative metrics (narrative statements). These knowledge exchange metrics are grouped in seven different categories (research partnerships, working with business, working with the public and third sector, skills enterprise and entrepreneurship, local growth and regeneration, IP and commercialisation, public and community engagement). Data for the KEF is collected by the Higher Education Statistics Agency (HESA). HE providers that receive public funding in the United Kingdom are obliged to contribute to the HESA data collection exercise. To enable comparability between HEIs, the institutions were grouped in clusters by capability (research institutions versus more teaching-oriented institutions), by size and discipline (STEM, non-STEM, arts). The KEF assesses seven clusters of universities: five general clusters, the STEM cluster, and the "Arts specialist" cluster. The results of this first exercise were published in March 2021

A report was issued in February 2022 presenting the outcomes of the first iteration of the KEF which demonstrated the significant contribution that HEIs have made the economy and society, and has equally had a positive impact within HEIs, consolidating a culture of measurement and improving data collection. The second iteration of the Knowledge Exchange Framework took place in 2022, with a few improvements made to the methodology and the metrics.

Evaluation of third mission, knowledge transfer activities in Italy

In Italy, evaluation of third mission activities started as part of a process of evaluating the quality of university research, a priority in the governments' higher education agenda. The ANVUR (National Agency for the Evaluation of Universities and Research), has been mandated by the government to evaluate teaching, research and technology transfer activities of universities and research institutes. At the time of writing Italy is carrying the third round of evaluation of research and third mission activities. After two previous evaluation the Agency has decided to adopt a qualitative approach, based on case studies. ANVUR asks the institutions to submit specific examples of third mission activities with impact. The definition of impact is open, but the case studies should refer to ten specific fields of actions:

Valorisation of intellectual or industrial property; Academic entrepreneurship; Technology transfer structures; Production and management of artistic and cultural assets; Clinical trials and health initiatives; Lifelong learning; Public Engagement; Production of social, educational and political public goods for inclusion; Innovative tools to support Open Science; Activities related to the Agenda ONU 2030 and the Sustainable Development Goals. For each of the field, a set of indicators is proposed for their potential use as evidence of impact. So, the model is based on self-determination with a definition grid.

Source: (Research England, 2022[46]); (Research England, 2022[47]); (OECD/European Union, 2019[48])

Standardising research contracts and setting-up an intellectual property policy

Unlike most European or US universities, Canada's Intellectual Property ownership policy at the federal or provincial level or at most universities is still incipient. Moreover, less than 50 percent of universities in Canada have a TTO, while only 41 percent provide any IP information, and only 18 percent have IP training workshops. Yet in 2018, the government of Canada launched a National Intellectual Property Strategy and in 2021, the government announced the creation of ElevateIP help of Business Accelerators and Incubators manage their intellectual property. ElevateIP will particularly help business accelerators and incubators located in Atlantic Canada including start-ups and business incubators in Newfoundland. To motivate faculty, researchers, staff and students to pursue commercialization and continue to cultivate an entrepreneurial culture, Memorial has adopted a creator-owned intellectual property (IP) model since 2019.

According to Hepburn and Wolfe (2015), not only does Canada have no national IP policy but it does not require its universities to set policies regarding mandatory disclosure or a requirement that researchers work with the university TTO. Moreover, Canadian university practice is a mixture of various IP regimes, and some universities follow more than one. The result is a non-uniform IP regime within Canada where firms negotiating licenses for IP that originated at more than one institution may have to deal with each institution's IP regime. Additionally, universities also have their own policies regarding IP ownership and are often included as part of faculty employment and collective agreements.

The ownership of IP that results from a collaborative research project with an industry or a public research lab is determined before the project starts as part of the research agreement, which in most cases favours the industry. Generally, in a collaborative project with an industry in which that industry also is the main funder, the IP is generally owned by the partner or determined through an exclusive license. Much of the research conducted on university campuses, however, is not covered by pre-existing research agreements and is funded by public research grants.

Like other universities around the world, technology commercialization and research partnerships at Memorial are not easy to implement. Most companies engage through federal government programmes that support technology innovation such as the Canada Industrial Research Assistance Program (IRAP) or Mitacs (see Box 4.2). The amount of funded research does not matter; companies will still need to go through the same level of bureaucracy with a grant of any size. While local communities, who may be interested in contracts, may not have the administrative capacity to navigate the university system. The online tool Yaffle, created at Memorial, helps connect companies and communities to the university and helps students find supervisors while the Harris centre helps connect regional players. Further consideration to hiring more staff to take care of the setting-up research and industry partnerships could be solutions.

The new strategy of innovation is a step in the right direction

Memorial university has an entire section on its website dedicated to innovation, which provides information on the public and private partnerships the university is involved in, entrepreneurial activities and activities related to social innovation, the liaison offices with the industry and the community (the Harris Centre and the Research Innovation Office). The website also gives information on the innovation strategy that Memorial University is undertaking for the period of 2023-2026, after conducting a series of consultations with internal and external stakeholders in 2021[10]. This strategy sets the priorities and the goals that the university aims to achieve over the coming years. It also provides a set of guiding principles, and a definition of innovation, which illustrate Memorial's commitment to achieving not only an economic impact but to contribute to social and sustainable goals. The innovation strategy presents several objectives that if implemented could enhance collaboration and provide interesting incentives for staff and professors to engage in entrepreneurship and innovation activities. For example, one explicit goal of this strategy is to create spaces to support innovation (physical infrastructure), and to foster interdisciplinary research-driven innovation. There's also a point about recognising entrepreneurial and innovation activities for promotion and tenure of staff, which will be important incentives to engage staff and faculty in those activities.

Finally, the innovation strategy gives a clear push towards communicating more on the research undertaken at MUN. This should provide an opportunity for the university to make more visible its activities abroad and position Memorial as a leader in ocean science within Canada and the world. The university could leverage their membership with the Ocean Supercluster to foster more partnerships with international stakeholders or build more bridges to collaborate in research projects with other universities. In that way, the university can position itself in the international scene and attract more students and researchers from abroad. This is particularly important given the declining youth population that should affect the university's enrolment rates (Usher, 2019[24]).

Responding to new demands

Enhancing Memorial's contribution to the green transition

Like many universities across the globe, Memorial is committed to advancing the United Nations Sustainable Development Agenda through teaching, research, public engagement, and knowledge transfer (Memorial University, 2022[49]). A university committee of faculty and staff was set-up to raise awareness about the Sustainable Development Goals as well a Sustainable and Climate Action Office. Furthermore, Faculty and departments are working in collaboration with the government and firms to develop sustainable and climate-neutral solutions. For example, the Harris Centre, has created a waste management applied research fund to push research in solid waste management (Memorial University of Newfoundland, 2020[50]). The programme is open to all faculty, students, and staff at Memorial, who can receive CAD 15 000 to undertake research in solid waste management to assist local policymakers with the waste treatment strategy. Memorial is also undertaking research on energy efficiency in the electricity sector and is contributing to a project to mitigate the risks of offshore wind, oil, and gas installations in glacial seabed. In the realm of teaching, the Faculty of Engineering and Applied Science has created a new master programme, Master of Applied Science in Energy Systems Engineering (MESE) which focuses on energy engineering with a focus on renewable energy systems (Memorial University, 2022[51]). Equally, the civil engineering department of the Faculty of Engineering was several research groups that investigate topics such as climate change, renewable energy, and offshore structure. The mechanical engineering

[10] Stakeholders consulted include a variety of different groups such as the provincial government, the entrepreneurial community, indigenous groups, alumni and the National Research Council as well as Atlantic Canada's development agency (Atlantic Canada Opportunities Agency)

department also house the thermal, fluids and Energy Research labs is dedicated to advancing sustainability through fundamental and applied research, in fields such as clean hydrogen production, thermal hydraulic dynamic, and energy storage.

Equally the university is taking steps to make its infrastructure more energy efficient and clean. To decrease its fossil-fuel consumption, the university has announced that the heating systems of the buildings will shift from oil-fuelled heating to clean energy electricity stemming from the province's hydroelectric gird. It is also working with a company specialised in energy efficiency, Honeywell, since 2017, to find energy-efficient solutions for the universities buildings (heating, ventilation, light systems). In 2020, the University has created the Sustainability and Climate Action Office directly under the supervision of the office of the Vice-President and will work with the University Sustainability Committee on setting-up strategies and plan to enhance the culture of sustainability within the university (Memorial University, 2022[51]).

Transitioning to a low-carbon economy has become a priority for the provincial government as well. The government launched in 2021 a Renewable Energy Plan to untap the province's renewable energy resources and create employment in emerging green sectors. While the province rich abundance in oil and gas and is heavily reliant on that industry for their economic growth, it also possesses renewable energy resources. According to Statistics Canada, 90% of the installed Electricity Capacity is produced with renewable energy resources (hydroelectricity and wind mainly). The plan aims to further enhance the exploitation and use of renewable energy resources (wind) in the province and to export the remainder to other parts of Atlantic Canada and to position the province as a Clean Energy Centre of Excellence. Another central idea of the plan is to phase-out fossil fuel consumption in transportation, heating, and industrial processes.

As the province transitions to clean energy, the oil and gas sector are also looking into finding clean solutions for their industry to respond to become more energy-efficient and reduce their carbon footprint. The green transition of the oil and gas will require enhanced collaboration between Memorial and the industry. Memorial will have to take further steps to offer research and training that will meet the industry's needs. Likely, companies will be turning to Memorial because these are lacking technical know-how on the effects of climate change or energy efficient solutions (Usher, 2019[24]). As the university develops strategic plans to mainstream a culture of sustainability across the institution, it should pay attention to new societal priorities. The university could also work with the provincial government to establish forward-looking innovation goals and create an entity to push forward these priorities at the university-level. Similar initiatives have been taken in other regions across the globe such as the Academy for Smart Specialisation, a joint initiative between the University of Karlstad and the region of Värmland, to undertake research in new areas such as the forest-based bioeconomy, and revamp an old industrial tissue composed of the declining pulp and paper industry (see Box 5.3).

Box 5.3. The Academy for Smart Specialisation a research and innovation agreement between the Region of Värmland Sweden and the Karlstad University to revitalise declining industries

The Academy for Smart Specialisation of the University of Karlstad was established as a partnership between the university, the regional government of Varmland in Sweden. Located at Karlstad, the capital of Varmland, the goal of this Academy is to provide research and skills that the region needs to implement its Smart Specialisation Strategy and drive innovation. The Smart Specialisation Strategy of region of Varmland aims at mobilising the region's competitive strengths, transforming the old industrial tissue of the steel and forestry industries which are facing headwinds of digital transformation. Employment in those industries has declined due to automation in manufacturing and production. As result the smart specialisation strategy, aims at modernising the economy and has identified six priority areas: forest-based bioeconomy, digitalisation of welfare service, advanced manufacturing, and complex systems.

The collaboration between the University of Karlstad and the region of Varmland was established in 2008, with an initial programme to link research and competences of the university with the industrial specialisation of the region. The region funded professorships to undertake research in areas liked to the needs of local industry. The Academy for Smart Specialisation initiated in 2016, with the purpose of scaling-up previous initiatives, and gave birth to a research platform, a meeting place for researchers, companies, financiers, and entrepreneurs. The region of Varmland and Karlstad University provide funds to the Academy, the Region has agreed to allocate EUR 4.53 million during the first five years of the Academy. One of successes of the Academy for Smart Specialisation was that it specialised in the areas of priorities of the smart specialisation strategy (adding another focus on gender). The management of the Academy has also been relatively successful, with the creation of a steering group and a working group as well as support functions to run the Academy.

Source : (OECD, 2020[52])

Upskilling and reskilling the workforce with digital skills

While the bootcamp industry is still emerging in North America, in Newfoundland the College of the North Atlantic provides a fifteen-month digital skills programme that is designed in conjunction with Verafin. Many graduates of that programme find a job in local companies, including in the technological sector Verafin. Memorial could also expand its offers of digital training programmes to contribute even further to the creation of an entrepreneurial ecosystem. These programmes allow workers to gain new marketable skillset in a very short period (Navarro and Cathles, 2019[53]). In relation to supporting the technology sector through venture creation, Memorial is however leading the way, through Genesis. Thanks to Nasdag donation of USD 1 million, the incubator is reinforcing its support to technology-driven start-ups.

Upskilling and reskilling students and the labour force is critical to ensure innovation drive-growth and to diversify a resource-based economy. In that sense, partnering with external stakeholders to understand and deliver the skills the industry needs are important. For instance, the Government of Canada is launching several initiatives to upskill industry workers by creating tailored short upskilling programmes in partnership with training institutions such as the Sectoral Workforce Solutions Program or the Upskilling for Industry Initiative (UII) (Government of Canada, 2022[54]). Furthermore, offering advanced digital skills training will be essential to position the university as a leader in ocean science and technology but also to respond to the needs of the emerging technology sector. This could also become of source of attractivity for international students in the hunt for advanced digital and entrepreneurial skills as the province faces a decrease youth population which poses enrolment challenges for the university in the years to come (Usher, 2019[24]).

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