A Detailed Analysis of Newfoundland and Labrador's Productivity Performance, 1997-2018

Executive Summary

Driven by the mining and oil and gas extraction sector, Newfoundland and Labrador's economy experienced impressive growth from 1997 to 2007, with real business sector output advancing at a compound annual rate of 7.7 per cent, more than double the Canadian average (3.4 per cent per year). The situation changed dramatically after 2007 when oil and gas output plummeted. Real business sector GDP in the province declined during the 2007-2018 period at a rate of 1.1 per cent per year while that in Canada rose at 1.5 per cent per year. The productivity performance mirrored that of real output. Business sector labour productivity in the province grew at 6.0 per cent per year during the 1997-2007 period and then fell 1.2 per cent per year during the 2007-2018 period.

The main goal of this report is to describe and explain the trends in productivity in Newfoundland and Labrador. In doing so, the report also describes trends in the variables used in the calculation of productivity, including output, labour input, and capital input. The numbers for Newfoundland and Labrador are compared to those in Canada as a whole, as well as to specific provinces.

The main take-away from the report is the importance of the oil and gas sector to the economy of Newfoundland and Labrador. That sector has been responsible for most of Newfoundland and Labrador's economic growth, and now accounts for the largest share of the province's business sector value added among 2-digit NAICS subsectors, even though it employs only 3.8 per cent of the province's business sector workers in 2018. Due to the size of the mining and oil and gas extraction sector, overall productivity continues to represent a major challenge for the province. However, looking at the business sector excluding mining and oil and gas, productivity growth does fare better. Identifying the main sources and drivers of productivity growth is a necessary first step towards shaping policies that promote growth output and productivity in the province.

Trends in Output

Among two-digit NAICS subsectors of the business sector, the mining and oil and gas extraction sector played an essential role, either positive or negative, in the province's business sector output. Indeed, this sector accounted for 77.7 per cent (6.1 percentage points of 7.8 percentage points) of the business sector real GDP average annual growth from 1998 to 2007 and -1.8 percentage points of -1.0 percentage points of the growth during the 2008-2018 sub-period. In

2015, this sector also had the largest share of nominal output (25.8 per cent) among all two-digit NAICS subsectors of the business sector. Some key trends from the report follow:

- In terms of business sector real GDP, the province has yet to re-attain its peak of $25,680 million (in chained 2012 dollars) from 2007, when oil and gas output peaked at $16,188 million. In 2018, real business sector GDP in Newfoundland and Labrador's GDP was $22,714 million, up from $12,285 million in 1997, but still 11.6 per cent below the 2007 peak.
- Compared to other provinces, Newfoundland and Labrador ranked first in terms of business sector real GDP growth (3.0 per cent per year) during the 1997-2018 period. This performance is driven by the 1997-2007 period. During that period, real GDP in the province grew at 7.7 per cent per year, more than double that of the national average (3.4 per cent per year) and was higher than in all other provinces. During the 2007-2018 period, the province's real GDP growth ranked lowest among Canadian provinces (-1.1 per cent per year).
- On a sectoral basis, compound annual growth in Newfoundland and Labrador and Canada was slower after 2007 in most subsectors of the business sector. In particular, growth of the mining and oil and gas extraction sector in Newfoundland and Labrador slowed down from 24.7 per cent per year during the 1997-2007 period to -3.4 per cent per year during the 2007-2018 period. One notable exception was the construction sector, which saw its growth rate increase from -0.7 per cent per year in the first sub-period to 7.0 per cent per year. Excluding the mining and oil and gas extraction sector, the province's business sector real GDP grew at 1.8 per cent per year during the 2007-2018 period, in contrast to a decline of 1.1 per cent per year growth of the province's real GDP in the whole business sector.
- In terms of nominal GDP as well, mining and oil and gas extraction in Newfoundland and Labrador had the highest growth among all two-digit NAICS subsectors of the business sector during the 1997-2015 period (14.8 per cent per year). As in the case of real GDP, the mining and oil and gas extraction sector explains much of the trend in nominal GDP. During the 1998-2007 period, the mining and oil and gas extraction sector alone contributed 75.7 per cent of the business sector nominal GDP average annual growth (10.8 percentage points of 14.2 percentage points) in the province. During that period, the growth of mining and oil and gas extraction's nominal GDP was extremely strong (40.2 per cent per year) in Newfoundland and Labrador. During the 2007-2015 period, however, the nominal GDP of the mining and oil and gas extraction sector declined 10.5 per cent per year).
- Because of various development projects in Newfoundland and Labrador such as the Muskrat Falls and the Hebron oil field, nominal GDP of the construction sector during the 2007-2015 period grew 4.6 times faster than in the 1997-2007 period (4.4 per cent per year versus 20.3 per cent per year). This growth only partially offset the decline in the mining and oil and gas extraction sector. Without mining and oil and gas extraction, the

business sector grew at a rate of 7.0 per cent per year during the 2007-2015 period, compared with the business sector average of -0.7 per cent per year.

- During the 2008-2015 period, the mining and oil and gas extraction sector was the only subsector that had negative contribution (-2.8 percentage points) among two-digit NAICS subsectors in the province. On the other hand, the construction sector contributed the most to the business sector nominal GDP growth in the province (1.8 percentage points of 0.8 percentage points), but this sector's contribution only partially offset the negative contribution from mining and oil and gas extraction.

Trends in Labour Input

Despite the significant role of mining and oil and gas extraction on Newfoundland and Labrador's economy, this sector's employment shares in the province were relatively low. Specifically, the mining and oil and gas extraction in the province only accounted for 4.8 per cent of the business sector total hours worked in 2018. Other important observations regarding labour inputs from the report follow:

- During the 1997-2018 period, the number of jobs in Newfoundland and Labrador's business sector grew at a compound annual rate of 1.0 per cent. The growth in the province was particularly fast during the 2009-2013 period (5.4 per cent per year), three times the national average of 1.68 per cent per year. However, in the 2013-2018 period, the number of jobs in Newfoundland and Labrador's business sector declined every year at an annual rate of -2.2 per cent when the growth in Canada was 1.1 per cent. This decline was due to the lower level of mining activity at Vale's nickel processing site and the closure of Wabush Mines
- While 2002 was an exceptional year in terms of real business sector GDP growth (22.4 per cent), because of the beginning of the oil production at the Terra Nova offshore oil platform, the number of jobs in the province barely increased in 2002 (0.5 per cent). The same development occurred in 2007, 2010 and 2011. The low correlation between business sector output and business sector employment in Newfoundland and Labrador was due to the dominance of mining and oil and gas extraction in the province's output combined with its disproportionately low employment shares. For example, in 2007, the mining and oil and gas extraction accounted for 59.2 per cent of the province's business sector nominal GDP but it was only responsible for 3.2 per cent of the business sector employment in the province.
- As for output, the construction sector played an important role in recent trends in labour inputs. In 2018, the employment share of the goods-producing sector in the province rose significantly to 30.6 per cent from 25.4 per cent in 2007. This increase is mainly explained by the increase in the employment shares in the construction sector by a factor of two from 8.5 per cent to 17.7 per cent. This jump in the construction employment in

the province in 2018 was attributable to various public sector infrastructure and commercial projects such as the Muskrat Falls project.

- In terms of weekly hours worked, the average worker in Newfoundland and Labrador consistently worked longer than the average Canadian in a week over the 1997-2018 period. In 2018, a worker in the province worked on average 2.1 hours more than the average Canadian worker in the business sector, working on average 35.45 hours per week instead of the national average of 33.41 hours per week. The difference between hours worked also demonstrated an increasing trend throughout the 1997-2018 period, up from 1.5 hours in 1997 to 2.0 hours in 2018.
- On a sectoral basis, from 1997 to 2018, hours worked in agriculture, forestry, fishing and hunting industries, utilities and manufacturing decreased while hours worked in mining and oil and gas exploration and construction increased. In particular, while the growth in mining and oil and gas extraction was not as strong as before (3.9 per cent in the 1997-2007 sub-period versus 1.9 per cent in the 2007-2018 sub-period), the growth of construction sector in Newfoundland and Labrador increased from -0.07 per cent in the 1997-2007 sub-period to 6.99 per cent in the 2007-2018 sub-period. Such growth in the province was driven by both the public and the private sector, including construction of the Trans Labrador Highway, the Hebron project and the Muskrat Falls project.
- In terms of labour compensation, Newfoundland and Labrador ranked second last in 2015 for business sector labour compensation as a share of business sector nominal GDP. At 50.9 per cent, that indicator was only higher than Saskatchewan's (41.9 per cent), another province where capital-intensive resources industries are very important. The below-average share of Newfoundland and Labrador in 2015 (59.5 per cent in Canada versus 50.9 per cent in the province) was due to the dominance of the capital intensive mining and oil and gas extraction sector in the province's nominal GDP.
- While Canada's labour compensation in the business sector as a share of nominal GDP exhibited a stable trend between 59.7 per cent in 1997 and 59.5 per cent in 2015, the labour compensation share of Newfoundland and Labrador's business sector has been much more volatile, falling from 58 per cent in 1997 to a trough 25.3 per cent in 2008 at the peak of the oil boom before rebounding to 50.9 per cent by 2015.
- It is notable that the large decrease in labour compensation share of nominal GDP from 1997 to 2007 was not due to a below-average growth of labour compensation in itself. Rather, the decline in the province's labour compensation share was due to the very rapid growth in capital compensation, driven (once again) by the capital-intensive mining and oil and gas extraction sector
- In terms of real hourly labour compensation, the business sector in the province experienced an increase from $19.85 (2012 dollars) per hour in 1997 to $22.88 per hour in 2007, and then to $31.55 per hour in 2018. This faster growth in the second sub-period in the province's real labour compensation was due to the rise in output from the labour-

intensive construction sector and the decline in the capital-intensive mining and oil and gas extraction sector in the province.

Trends in Capital Input

The mining and oil and gas extraction sector's role in Newfoundland and Labrador's business sector was also important in capital input. For example, in 1997, this sector alone accounted for more than half (55.7 per cent) of the province's business sector nominal gross capital investment. In 2007, more than 60 per cent (63.6 per cent) of the province's nominal net capital stock came from this sector. During the 2007-2017 sub-period, because of the development of the Muskrat Falls project, utilities gained higher importance than mining and oil and gas extraction with respect to capital input. For example, real gross investment and capital services of utilities in the province grew the fastest during the 2007-2017 sub-period among two-digit NAICS subsectors of the business sector (35.7 per cent per year and 12.5 per cent per year respectively).

- During the 1997-2017 period, real fixed non-residential investment in Newfoundland and Labrador's total economy grew at an annual compound rate of 5.5 per cent per year, from $2,990 million chained 2012 dollars in 1997 to $8,741 million in 2017, after peaking at $11,383 million in 2016. In Canada, real total economy investment grew at a lower rate, at 2.6 per cent per year.
- During the 1997-2007 period, the growth in real investment in the province's total economy was lower than Canada (1.6 per cent per year versus 5.2 per cent per year). This is mostly due to the decline in the province's real investment in engineering construction at a rate of 4.4 per cent per year, contrary to a rise of 5.9 per cent per year at the national level. This corresponds to the completion of construction of offshore oil rigs in the province by 1997. Moreover, the much higher growth of investment in mineral exploration and evaluation than the national average (18.6 per cent per year versus 6.5 per cent per year) reflects that the focus of the mining and oil and gas extraction sector shifted from developing oil field before 1997 to exploring for new oil fields, with the construction of new off-shore oil platforms having started again during the 2007-2017 period.
- During the 2007-2017 period, investment in Newfoundland and Labrador rose significantly (9.6 per cent per year). Such growth was due to the investment growth in engineering construction (16.5 per cent per year) and in non-residential building investment (11.9 per cent per year). As the focus shifted back to the construction of offshore oil rigs, real investment in mineral exploration and evaluation dropped during the 2007-2017 period at an annual compound rate of 6.5 per cent per year.
- Given the predominance of the mining and oil and gas extraction sector in Newfoundland and Labrador and the capital-intensive nature of this sector, it is not surprising that

engineering construction had the predominant share of investment in the province's economy. In 1997, more than a half (54.2 per cent) of investment went to engineering construction which reflects investment in the offshore oil rigs before the first flow of oil in the province. In 2007, as oil price and oil production in the province reached the peak, engineering construction dropped from 54.2 per cent in 1997 to 34.0 per cent while the share of mineral exploration and evaluation increased by 442.3 per cent from 2.1 per cent in 1997 to 11.3 per cent in 2007. In 2017, investment in engineering construction in the province as a share of investment in the province's total economy rose to 66.2 per cent because of the development of the Hebron oil field.

- In terms of capital stock, during the 1997-2017 period. Real capital stock growth in Newfoundland and Labrador outpaced Canada's by a considerable margin (4.1 per cent per year versus 2.7 per cent per year). During the 2007-2017 period, real capital stock growth in Newfoundland and Labrador was more than two times faster than in Canada (6.5 per cent versus 2.5 per cent per year). In the province, net real capital stock growth of (non-residential) building and engineering construction was the highest (7.50 per cent per year and 7.47 per cent per year respectively). This huge growth can be explained by the new Hebron oil field and the Muskrat Falls project in the province.
- Both in Newfoundland and Labrador and Canada the net capital asset of engineering construction always had the largest shares of nominal net capital stock from 1997 to 2017. In 2017, engineering construction represented almost 70 per cent of nominal net capital stock in Newfoundland and Labrador's business sector (69.4 per cent) while it took just more than a half (53.1 per cent) in Canada's business sector. This predominance of engineering assets in Newfoundland and Labrador's business sector capital stock is explained by the fact that a large part of the province's capital stock is in the mining and oil and gas extraction sector and the utilities sector, sectors very intensive in engineering capital. In fact, the share declined in 2011 to 60.0 per cent from 66.9 per cent in 1997, but then gradually climbed to 69.4 per cent in 2017. Canada's capital stock, on the other hand, had a more "balanced" capital stock

Productivity

During the 1997-2007 sub-period, Newfoundland and Labrador was the province that had the highest growth rates in labour productivity, capital productivity, and multi-factor productivity. However, during the 2007-2018 sub-period, the province ranked last in the growth rates of all three productivity measures. The decomposition of labour productivity growth by sector shows that the mining and oil and gas extraction sector contributed the most to the decline.

The report first looks at labour productivity, defined here as real GDP (in chained 2012 dollars) per hour worked. Similar to the discussion on output and inputs, the report stresses the

importance of the oil and gas sector in the determination of the aggregate productivity trend. In fact, Newfoundland and Labrador's labour productivity growth at the aggregate or business sector level is not indicative of the performance at the industry level. In the 1997-2007 sub-period, labour productivity in the mining and oil and gas industry advanced at a 20.0 per cent average annual rate, resulting in the 6.0 per cent annual rise for business sector productivity. In contrast, output per hour in industries excluding the mining and oil and gas averaged only -0.4 per cent per year. The situation was reversed after 2007. Labour productivity in mining and oil and gas fell at a 5.2 per cent per year from 2007 to 2018, resulting in a 1.2 per cent annual decline in business sector productivity. In contrast, output per hour in industries excluding the mining and oil and gas advanced at 1.8 per cent per cent per year. Other interesting trends regarding labour productivity include the following.

- Labour productivity increased at a rate of 2.2 per cent per year in Newfoundland and Labrador's business sector during the 1997-2018 period, above the 1.3 per cent national average (**Error! Reference source not found.**). Compared to other provinces, Newfoundland and Labrador ranked the first in terms of compound annual average productivity growth in the 1997-2018 period. Moreover, throughout the 1997-2018 period, the business sector labour productivity levels in Newfoundland and Labrador were higher than the national average
- This overall trend reflected very divergent trends during the 1997-2007 and the 2007-2018 sub-periods. Productivity growth was strong in the first sub-period (6.0 per cent per year), the best among all ten provinces, but negative during the second sub-period (-1.18 per cent per year), the worst provincial performance.
- In 2002, the productivity growth was particularly impressive (24.1 per cent). This substantial increase was caused by the beginning of oil production in the Terra Nova oil field. There was also a marked productivity increase in 2007, due in large part to the return of Terra Nova to full capacity after a six-month halt in operations in 2006 as well as increased production from the White Rose oil field.
- Interestingly, the trend in the labour productivity level in Newfoundland and Labrador relative to the one in Canada is the same as the trend in the province's oil production, rising from 1997 to 2007, the peak year of oil production, and falling from 2007 to 2018. The similarity between the trends in business sector labour productivity in the province, the relative labour productivity level between the province and the national average, and the province's oil production reflects the considerable influence of the oil production on the province's business sector labour productivity during the 1997-2018 period.
- The report also discusses the decomposition of business sector labour productivity growth in Newfoundland and Labrador over the 1997-2017 period using a growth accounting approach. The sources of productivity growth were drastically different in the 1997-2007 and the 2007-2017 sub-periods. During the 1997-2007 sub-period, the province's business sector labour productivity growth was driven by the MFP growth due to the adoption of new technology for offshore oil drilling (5.1 percentage points of 5.9 percentage points).

> Labour productivity growth fuelled by MFP growth is usually regarded as sustainable growth because technological progress does not face decreasing returns. However, in Newfoundland and Labrador's case, the MFP growth was not sustainable because of the depletion of the province's oil fields operating at the time. Therefore, contributions from MFP to the business sector labour productivity growth turned negative during the 2007-2017 sub-period. Instead, over this sub-period, capital intensity made a significant contribution to the province's business sector productivity growth. Unfortunately, labour productivity growth from this source is usually temporary because capital accumulation will eventually face decreasing returns.

The report then analyzes contributions to labour productivity by sector, decomposing it in three components. The first is the within-sector effect, capturing changes in labour productivity happening within the sector. The second is the reallocation level effect, capturing changes in labour productivity when more input is used in sectors with higher productivity levels. The third is the reallocation growth effect, capturing changes in labour productivity when more input is used in sectors with faster-growing labour productivity.

According to CSLS calculations, Newfoundland and Labrador's mining and oil and gas extraction sector was responsible for 60.1 per cent (1.5 percentage points of 2.4 percentage points) of the province's business sector labour productivity average annual growth during the 1998-2018 period. Contribution from this sector alone is larger than the double of the sum of all sub-sectors of the service sector (1.5 percentage points versus 0.7 percentage points). It was followed by manufacturing (0.23 percentage points); agriculture, forestry, fishing and hunting (0.21 percentage points); and retail trade (0.20 percentage points).

During the 1998-2007 sub-period, the mining and oil and gas extraction was the largest contributor among sub-sectors of the business sector, and alone contributed 5.3 percentage points, 4.3 percentage points of which are from this sector's within-sector effect. Excluding the mining and oil and gas extraction sector, other sub-sectors of the business sector altogether contributed 1.0 percentage points. Therefore, the business sector labour productivity growth in Newfoundland and Labrador during the 1998-2007 sub-period was driven by the mining and oil and gas extraction sector.

During the 2008-2018 sub-period, the reallocation level effect was the only positive contributor (1.3 percentage points of -1.0 percentage point) to the business sector labour productivity growth among the three components. Contributions from the within-sector effect and the reallocation growth effect were negative (-1.6 percentage points and -0.8 percentage points respectively). The negativity of the business sector's within-sector effect was due largely to the negative contribution from the mining and oil and gas extraction sector (-2.0 percentage points) because of the reduction in the oil production.

The report then looks at capital productivity, defined as real GDP per unit of services. The pattern for this variable is similar to the one for labour productivity. During the 1997-2007 sub-period, capital productivity in the province grew at 4.8 per cent per year while that of all other provinces and Canada except Ontario (0.1 per cent per year) declined. However, during the 2007-2017 sub-period, Newfoundland and Labrador ranked the last in terms of capital productivity growth (-5.5 per cent per year). Between the 1997-2007 and the 2007-2017 sub-periods, Newfoundland and Labrador experienced the greatest capital productivity slowdown among provinces in Canada (10.2 percentage points). Other interesting trends follow.

- On a sectoral basis, 11 of 15 sub-sectors of the business sector in Newfoundland and Labrador had lower capital productivity than Canada in 2016. In terms of growth, the mining and oil and gas extraction sector had the largest capital productivity growth among subsectors of the business sector in Newfoundland and Labrador during the 1997-2017 period (4.9 per cent per year). This strong growth in the mining and oil and gas extraction capital productivity over the whole period reflects an even stronger growth during the 1997-2007 sub-period (20.8 per cent per year) and a large decline during the 2007-2017 sub-period (-8.9 per cent per year).
- The case of mining and oil and gas extraction is again interesting. The mining and oil and gas extraction capital productivity in the province grew from 11.6 per cent of the sector's capital productivity in Canada in 1997 to 99.1 per cent in 2007, and then fell to 49.4 per cent in 2016. The mining and oil and gas extraction capital productivity in 1997 was lower than the national average because a large amount of capital accumulated but the oil production only begun at the end of November 1997, leading to a low level of capital productivity in compared with Canada. As production increased, the mining and oil and gas extraction capital productivity level rose and became closer to the national average

The final productivity analysis in the report is about multifactor productivity (MFP). MFP captures the effect of several different factors, such as disembodied technological growth, capital utilization, returns to scale. MFP also incorporates errors due to mismeasurement of inputs and outputs. Interesting observations on MFP are as follows.

- Similar to labour productivity growth, MFP growth in Newfoundland and Labrador ranked first among provinces during the 1997-2007 and last during the 2007-2017 period. Specifically, during the 1997-2007 period, the province's MFP growth was almost five times as high as the province with the second highest growth (5.1 per cent per year in Newfoundland and Labrador versus 1.1 per cent per year in Manitoba). During the 2007-2017 period, Newfoundland and Labrador had the largest MFP decline (3.7 per cent per year) among provinces.
- Because the province's decline in MFP was large during the 2007-2017 period, the province's MFP growth during the 1997-2017 period only ranked 4th among all provinces.

- On a sectoral basis, given the dominance of the mining and oil and gas extraction sector in the province's economy in terms of real output and labour productivity, we see that the sector's MFP growth is indicative of the province's MFP growth in the goods sector and the business sector. During the 1997-2007 period, the province' mining and oil and gas extraction MFP grew at an impressive annual rate of 20.6 per cent (compared to the -4.5 per cent national average) while the province's business sector MFP growth rate was almost 15 times as high as that in Canada (5.1 per cent per year versus 0.3 per cent per year). The adoption of new technology with the offshore oil field was responsible for the impressive MFP growth in the province's mining and oil and gas extraction sector during the 1997-2007 period.
- During the 2007-2017 period, the MFP of the province's business sector declined at an annual rate of 3.7 per cent as the province's mining and oil and gas extraction MFP decline at 8.6 per cent per year. The decline in the province's mining and oil and gas extraction MFP was almost six times as large as that in Canada (8.6 per cent per year versus 1.5 per cent per year). One of the reasons was the depletion of oil reserves in the province.

Explaining the Productivity Performance

In order to develop policies to improve productivity performance, it is important to identify the drivers of productivity growth. The report identifies three key factors determining labour productivity growth, in line with the simple growth accounting model. The first is investment in human resources, capturing the quality of the labour input. The second is investment in capital goods, determining the size of the capital stock. The third is often referred to as the pace of technological progress (or innovation), but in fact encompasses all factors not captured by the previous two measures. It is very roughly proxied by the rate of multifactor productivity growth.

The report then identifies a number of specific issues related to these three drivers, such as schooling, training and skills, R&D spending, and investment in different types of capital goods. Some interesting trends are as follows.

- Newfoundland and Labrador ranks low in terms of the average years of schooling of the working age population, the labour force and the employed compared with other provinces in 2018. Looking at the highest level of educational attainment in Newfoundland and Labrador and Canada, we observe that the province had significantly lower shares of the population with university degree than Canada, although it had a higher share of the population with other post-secondary certificates or diplomas.
- The province also fared poorly in measures of adult literacy, numeracy, and problem-solving skills. Measures from the OECD's Program for the International Assessment of

Adult Competencies (PIAAC) indicate that Newfoundland and Labrador was below the national average in all three domains in 2012.

- This difference was also reflected in scores from the Program for International Student Assessment (PISA). Scores of Newfoundland and Labrador in all three domains were lower than the national averages in all years. In 2015,[1] out of the 10 provinces, the province ranked 7th in reading, 9th in mathematics and 7th in science.
- Newfoundland and Labrador is characterized by the second lowest proportion of individuals participating in job-related training. On a more positive note, when workers do participate in job-related training, Newfoundland and Labrador employers are among the most generous when it is time to financially support the training of their employees.
- A key component of a competent and skilled labour force is a well-trained and qualified skilled trades workforce. The number of apprenticeship registrations in Newfoundland and Labrador experienced an unusual progression during the 1997-2003 period, climbing from 3,531 registrations in 1997 to 10,641 in 2007. It went back down in later years, settling at 7,188 registrations in 2017. Over this period, apprenticeship completions increased at a higher rate in Newfoundland and Labrador (5.1 per cent per year) than in Canada as a whole (4.3 per cent). However, the completion rate was still low in 2017 in the province.
- In terms of inter-provincial migration, the amount of outgoing net interprovincial migration diminished since 1997 in the province because of the oil production. It reached a peak of 1,877 persons in 2008, before declining again, reaching -3,656 persons in 2017. From a Canadian point of view, inter-provincial migration increases output through the geographical composition effect. However, from the perspective of a policy planner in Newfoundland and Labrador looking at actual and future productivity, the fact that most of those who out-migrated from Newfoundland and Labrador are persons of age 15 to 29 and well-educated residents is an important problem.
- The analysis reveals that while it is implausible that Newfoundland and Labrador is experiencing generalized labour shortages, it is possible that labour shortages exist for certain types of skills specifically.
- In terms of investment intensity, fixed non-residential investment intensity in Newfoundland and Labrador's total economy grew at a faster pace than the national average (4.7 per cent annually during the 1997-2017 period, compared to 1.4 per cent). Growth in that indicator was especially strong for engineering construction during the 2007-2017 period. The strong growth in the province's engineering construction investment intensity during the 2007-2017 period and the province's high investment intensity of the asset in 2017 is not a surprise because engineering construction is the principal type of asset used in the mining and oil and gas extraction sector and utilities that had various development projects in the province.

[1] As of April 11th, 2019, the series of estimated PISA scores in Canada and the provinces end in 2015.

- We also observe that Newfoundland and Labrador's investment intensity growth during the 1997-2017 period was higher than Canada's in machinery and equipment assets (2.1 per cent per year versus 1.1 per cent per year) as well as in intellectual property products assets (3.5 per cent per year versus 1.1 per cent per year), two types of assets that economists believe to be strongly correlated with productivity growth.
- The difference in investment intensity among sub-sectors in Newfoundland and Labrador was massive. In particular, in 2017, the utilities sector ($713.43 chained 2012 dollars per hour worked) had investment intensity level almost 16 times as high as that of the third highest sector (manufacturing, $44.81 chained 2012 dollars per hour worked) because of the Muskrat Falls project. In addition, the investment intensity level of the mining and oil and gas extraction sector ($220.86 chained 2012 dollars per hour worked) in 2017 was almost five times as high as that of the manufacturing sector. This large difference in investment intensity levels matches with the predominance of the mining and oil and gas extraction sector in the province's economy with respect to output.
- Because of the development of the Hebron oil field and the Muskrat Falls project, investment intensity in the province's mining and oil and gas extraction and utilities switched from decline during the 1997-2017 sub-period (-4.9 per cent per year and -1.4 per cent per year respectively) to growth during the 2007-2017 sub-period (5.6 per cent per year and 38.1 per cent per year respectively).
- In terms of capital stock intensity, the province had a higher capital intensity level in total investment, engineering construction and intellectual property products than the national average throughout the 1997-2017 period. This is explained by the domination in the province's output and capital stock of the capital-intensive mining and oil and gas extraction sector. Moreover, the capital intensity level of engineering construction and hence that of total investment took off in 2012 owing to increases in investment in various mining and oil and gas extraction projects.
- On a sectoral basis, all two-digit NAICS subsectors of the business sector in Newfoundland and Labrador except construction had higher capital stock intensity growth rates than Canada during the 2007-2017 sub-period. In fact, it is surprising to see that Newfoundland and Labrador's construction was the only sector that experienced a decline in capital stock intensity during the 1997-2017 period. Specifically, it decreased from $8.43 per hour worked in 1997 to $7.27 per hour worked in 2017 (both in chained 2012 dollars). This reduction in capital intensity level was due to a significant increase in hours worked, as capital stock grew at a slower rate (3.39 per cent per year versus 4.16 per cent per year) during the 1997-2017 period.
- In terms of innovation, in 2016, R&D intensity in Newfoundland and Labrador was at 1.1 per cent, well below the national average at 1.7 per cent. Compared to the other provinces, Newfoundland and Labrador ranked 7th in terms of R&D intensity. The province fared better in terms of R&D spending growth, although that variable does not

take into account the size of the regions. On a more positive note, Newfoundland and Labrador is catching up to the national average in recent years.

- Looking at innovation through the lens of who is performing it, we see that the business sector played a more important role in total R&D spending in Canada than in Newfoundland and Labrador. In the province, the higher education sector was always the most important between 1997 and 2016. In Canada, on the other hand, the business sector consistently had the highest share, followed by the higher education sector and the government sector.

The analysis of Newfoundland and Labrador's key economic variables shows that the mining and oil and gas extraction sector had a significant impact, either positive or negative, on the province's economy from 1997 to 2018. In particular, this sector was an excellent indicator of the province's overall business sector performance of most economic variables and productivity measures except employment because of this sector's considerable size in real output.

Although Newfoundland and Labrador had growth in R&D expenditure and investment and capital intensity higher than the national average, there are still some serious human capital questions that must be resolved. Indeed, the population in the province is not well-prepared for making full use of the gains from R&D, investment and capital intensity compared with the population in other provinces. Specifically, the province's youth and adult literacy is still significantly lower than the national average and other provinces. Together with the lower educational attainment in the province, the under-performance of these human capital indicators signifies skill shortages in the province. In addition, the province’s aging population, its shrinking working-age population and increasing youth out-migration, especially among the population of age 15 to 29, further worsened the human capital issue by offsetting the province's recent success in raising the apprenticeship training completion rate from 5.6 per cent in 1997 to 7.9 per cent in 2017. Therefore, the province is facing a number of human capital challenges that can hinder its productivity in the short run and the long run