

## An analysis grid to identify strategic industries

The aerospace case

Analysis by Alain Dubuc, Adjunct Professor, HEC Montréal



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### PREFACE

There will be life after the COVID-19 crisis.

And there will be a need for a rapid economic recovery, such as providing jobs as quickly as possible for the thousands of people laid off because their companies ceased operations, in whole or in part, during the quarantine period. And the demographic reality will gradually bring back full employment in Québec.

The government will have to make long-term choices.

The objective of this study, written in a period of economic prosperity and full employment (in 2020!), is to establish a number of criteria in order to define strategic sectors for the future of Québec.

Aeronautics, or aerospace, is one of the pillars of the Québec economy. Already in 2006, the Québec government developed the first strategy for this industry and the Aéro Montréal cluster was created, bringing together all the companies in the sector. There are more than 200 of them today. The sector thus provides a model for understanding what makes it a strategic sector at the Québec and Canadian levels, from which characteristics emerge that can guide government decision-making in crafting an economic development strategy.

#### Raymond Bachand, president

April 23, 2020

Alain Dubuc is an adjunct professor at HEC Montréal and a strategic advisor at the Institut du Québec. He has also worked as a consultant for Bombardier Inc, an aerospace company that is the subject of part of this study.

This text was written before the international crisis related to COVID-19.



For decades, the economic policies of governments have been designed to create jobs and reduce the unemployment rate. But this can no longer be an objective or a measure of success because we are witnessing a paradigm shift where, because of demographic factors, Québec and Canada are experiencing a natural reduction in their unemployment rate and are faced with labour shortages that jeopardize economic growth. This theme has been addressed many times by the Institut du Québec (IDQ).

Governments must therefore define new objectives and new criteria for economic success in order to free themselves from this dogma of job creation. To fill this gap, and to introduce more rationality into political decisions, this study aims to identify other economic policy objectives to guide decisionmakers in their strategies and choices.

This study proposes wealth creation and rising living standards as an economic policy objective, an issue on which there is broad consensus in Québec. It then identifies the main determinants of wealth creation. This makes it possible to define criteria that can be applied to determine the extent to which businesses or industries contribute to it. This approach thus provides a general analytical tool for identifying wealth-creating sectors which, as such, can be qualified as strategic and which deserve to be favoured in the choices made by decision-makers.

This exercise led to the identification of thirteen criteria. The first three are general in nature and constitute necessary but not sufficient conditions: **the size of the industry, its development potential, and its resilience**. Seven criteria relate to the specific contribution to wealth creation: **exports, innovation, investment, productivity, labour quality, education and structural effects**. Finally, three more contextual criteria relate to conditions to be respected in public policy choices: **state support, inclusion and sustainability**.

This approach, which is intended to be general and universal, is applied in detail initially to the aerospace industry, a major industry in Québec. If, *a priori*, the weight of this industry makes it instinctively recognized for its strategic nature, the analysis will make it possible to identify more precisely the factors that make it strategic and which are often ignored and misunderstood in the public debate.

It is not because of its jobs that the aerospace industry is strategic, but rather because of its major investments in R&D and its degree of innovation, which place it, by far, among the leading industries, both in Canada and in Québec. Then for its contribution to foreign trade: aerospace is the main exporting industry, with 14.8% of all exports from Québec, more than double the second largest exporting industry, and, moreover, in a high value-added field rather than in natural resources. Other strategic factors include the highly diversified nature of this industry, present in virtually all segments – aircraft, parts, engines, helicopters, materials, satellites, electronic systems – as well as the structuring effects of its head office activities, its investments, and its ability to attract foreign investment thanks to its know-how and specialized workforce. It is all these factors that make the Montreal region the third largest aerospace hub in the world, after Seattle and Toulouse.

All these elements make it a unique industry in Canada and Québec, which not only can be defined as strategic, but must be considered a national champion, because its success is an essential ingredient in the current and future development of the Québec and Canadian economy, like any industry designated as strategic. The study then looks, albeit in less detail, at the case of another major industry, namely Aluminum, to validate the approach and ensure that it is adaptable to various contexts. It shows that the primary Aluminum sector and the Aluminum industry meet most of the criteria that define an industry as strategic, particularly in terms of exports, investment, innovation, productivity levels and regional development. The approach, because it is not based on job creation, also allows for a different way to look at the issue of preferential electricity tariffs and shows why they are a judicious choice.

The findings on the contribution of the aerospace industry and its strategic nature show why it should be encouraged and supported. A second study, complementary to this one, will further explore this issue, analyse current support policies, and take into account the international context to identify support policies that are likely to be reasonable, acceptable and effective.

## **E** INTRODUCTION

For decades, job creation has been the main objective of economic policies and the main measure of their success. However, the Canadian and Québec labour markets are now close to full employment, characterized by historically low unemployment rates, labour scarcity and even shortages in some regions and several industries.<sup>1</sup> This trend is based on a lasting demographic phenomenon, the reduction of the working-age population.

The traditional objectives of job creation have lost their relevance because the unemployment rate has a natural downward trend and government efforts to add jobs can have perverse effects, such as increasing shortages or slowing down productivity growth.

It is therefore essential that economic policies be based on other objectives that are more appropriate to the economic context. This report is part of a trend toward giving priority to wealth creation rather than job creation as the objective of economic policies, and thus to interventions that support the sectors and companies most likely to contribute to increased productivity, economic growth, strengthening the competitive capacity of Québec and Canada, and thus improving the standard of living.

The objective of this report is to propose an approach to better identify the sectors of the economy and industries with the greatest potential to contribute to this wealth creation effort. These are industries that we describe as strategic and, as such, deserve special attention from public decision-makers.

The report therefore proposes a series of criteria for assessing the strategic nature of an industry. Taken as a whole, these are determinants of productivity. This general analysis grid is designed to apply to all sectors of activity.

In addition to the fact that such an approach can advantageously replace employment as a measure of economic success, it involves a more formal and less subjective method than those often used in public policy.

To illustrate the approach, the report applies it methodically to the aerospace industry. This choice is not haphazard, in the sense that it is a major industry in Canada, and particularly in Québec, in both qualitative and quantitative terms. It makes a major contribution, particularly in terms of exports and research and development.

In general, no one in political or economic circles disputes the importance of the aerospace industry to the economies of Québec and Canada. However, the traditional tools used to measure this contribution, whether it be the number of jobs – still the preferred yardstick for political decision-makers – or the concept of economic spinoffs, do not allow us to fully grasp the extent of its contribution. The report will highlight the elements that constitute attributes of a strategic nature.

This exercise, based on comparative data and a descriptive analysis of the aerospace industry, is intended to demonstrate that the industry clearly stands out in most of the criteria that can be used to define the strategic nature of an economic sector. These include: its contribution to R&D; synergies with the world of education and knowledge; the type and quality of jobs; contribution to international trade and increased productivity; the revitalization of the manufacturing industry; head office activities; and international influence.

<sup>1</sup> This text was written before the crisis caused by COVID-19.

The report will then apply the same analytical grid, albeit in a more summary fashion, to another major industry – Aluminum – to validate the approach and illustrate how a general method must be adapted to the specific characteristics of various economic sectors.

A second report, complementary to the first, will analyse aerospace in greater detail and cover the public policy implications of recognizing its strategic nature. It will take stock of the challenges facing this industry in a changing international context. It will also review current public policies directed at aerospace and compare them with those directed at other sectors of the economy and with existing policies in other countries that host an aerospace industry.

The report will support the view that this industry, which deserves to be called a national champion, must be encouraged, supported and nurtured by governments and the community because of its economic footprint and its contribution to growth and strengthening of the economy. But since this support must not come at any price, the report will also make recommendations on the types of tools, whether financial, fiscal, regulatory, economic or political, that would be most appropriate, effective and acceptable.

## THE ATTRIBUTES OF A STRATEGIC INDUSTRY

Before presenting the analytical grid for identifying the elements that make an industry strategic, it is important to illustrate the gaps that often exist in the mechanisms for political decisions or economic policy development.

The approach we are proposing will fill the gap left by the loss of relevance of the employment criterion. Secondly, it will introduce an element of rationality into decision-making processes that are often guided by subjectivity and political considerations.

The following pages explain why this change of approach is necessary. They describe the undesirable effects of employment-obsessed policies and the unwise choices that can result from subjectively driven decision-making processes.

#### From creating jobs to creating workers

We are witnessing, in Québec and Canada, a paradigm shift that can be described as radical. The decades of high unemployment in the 1970s and 1980s fully justified the desire of political decisionmakers to put job creation at the top of their priorities. But since the financial crisis a decade ago, Québec has seen strong job creation and a dramatic reduction in the unemployment rate, which by 2019 had reached its lowest level since 1976, the year in which the data still used for the Labour Force Survey began. The same trend is occurring in Ontario, albeit less dramatically where the unemployment rate has also reached an all-time low.

#### Graphic 1

Unemployment: a record low



Source: Statistics Canada (14-10-0287-01)

## 4

This result is due in part to cyclical factors, a long period of sustained growth, but mainly to demographic factors, which are long-lasting: a low birth rate, which has had a twofold impact, an aging population and a levelling off, in Canada, of the working-age population, and even its decline in Québec.



#### Graphic 2

Annual variation in the population by worker age (15-64 years old) in Québec

Source: Statistics Canada (14-10-0327-01)

For this reason, job creation can no longer be regarded as a relevant economic policy objective. First, because the effects of economic growth and labour market requirements to replace retirements are such that the economy no longer needs massive state intervention to create jobs. Second, since we are close to full employment, the maturation of the labour market means that many provinces, industries and companies are now facing shortages and hiring difficulties. This must lead to a realignment of priorities.

The Institut du Québec, in its Employment Report 2018, came up with the following recommendations:<sup>2</sup>

The first step toward adapting public policies is to recognize that Québec's socio-economic potential is limited by its aging population. Public authorities are slow to recognize the extent of the problem and the challenges posed by regional and sectoral labour shortages.

Over the next decade, labour needs will be one of the main impediments to our economic growth, particularly in the regions.

We can go further. Not only is the criterion of job creation no longer appropriate, it can lead to perverse effects. In many cases, all other things being equal, a company's hiring plans, or government initiatives announcing new jobs, will not result in net job creation because they will hinge on the displacement of workers already active elsewhere. Or, as in the case of very large number of infrastructure projects, job creation announcements will instead create bottlenecks and cost pressures due to a lack of available human resources. The prioritization of employment, which is still very much present in many government economic programs, may also encourage companies to hire rather than invest in productivity enhancing investments.

<sup>2</sup> Mia Homsy, Simon Savard, Sonny Scarfone, *Bilan 2018 de l'emploi au Québec : L'émergence d'un clivage entre la métropole et les régions*, Institut du Québec, January 2019.

This objective is also likely to be at odds with economic reality. In a dynamic and expanding industry, cost pressures, international competition, increased productivity and technological advances may mean that growth will not be accompanied by job creation or may even lead to downsizing. This will be all the more the case with the advent of automation and advances in the use of artificial intelligence.

A change in attitude will only be possible if governments agree to revise their traditional credo and invest in new levers for growth. Their difficulty in giving up placing job creation at the heart of their discourse may be explained, in part, by the fact that this objective is easy to formulate and quantify, as well as by the fact that the population is still scarred by the unemployment of past decades. In fact, the process of adaptation to this new paradigm is slow and laborious, even if the problem that decision-makers are beginning to discover has been predictable for a long time. The essay, Éloge de la richesse (In Praise of Wealth), explicitly addressed it ... in 2006:<sup>3</sup>

But it must lead us to look at things in a different way. Changing demographics should lead us to look at things differently because the unemployment rate will drop on its own (...) Very soon there will be fewer and fewer people to fill jobs and the problem that Québec will face is not a problem of job shortages, it is a problem of labour shortages. The fight against unemployment, in its traditional forms, will therefore be like breaking down an open door.

The challenge is radically different and the way to help those excluded from the labour market will also be very different. It will not be a question of finding jobs for workers, but rather of finding workers who can fill the jobs. The future-looking strategy will not be to create jobs, because they are there, but rather to "create" workers through immigration, education and training.

And yet, in 2019, references to job creation remained omnipresent in political discourse, particularly at the federal level. We saw this, for example, in the debate over the future of SNC-Lavalin, when the federal government justified its support in the name of maintaining its 9,000 jobs, rather than because of the strategic role of Canada's largest engineering company. The references are still very present in Ontario, with the Ford government and its repeated call for "jobs". They had a strong presence in Québec, after the Couillard government's commitment to create 250,000 jobs. With the Legault government, however, we are seeing the emergence of a new discourse, that of well-paying jobs, jobs worth more than \$30 an hour, a discourse that introduces notions of dynamism and productivity.

#### From flagships to champions

Public debates on the economy in recent years have shown that political calculations, emotional considerations and identity reflexes may have influenced certain economic decisions. This is not to deny the fact that political and social factors can play a role in economic decisions. The democratic process is based on arbitration and consensus and must take into account social acceptability and citizens' expectations. However, in many cases, it has been found that the criteria on which the choices were based included subjective elements, such as corporate ownership, which took precedence over considerations of development and growth. This was the case, for example, in two events that were the subject of extensive political debate in 2016, namely the sale of the RONA hardware chain to the American company Lowe's, and the sale of Rôtisseries St-Hubert to Canada's Cara (now Recipe Unlimited Corporation).

In both cases, there was extremely intense political pressure for the government to intervene, notably through the Caisse de dépôt et placement du Québec, to prevent these "foreign" takeovers. These reactions are legitimate. The purchase of a national business by non-Québec interests involves certain risks and disadvantages: the relocation of head office activities; uncertainties related to the acquirer's projects – restructuring, job losses, economies of scale – or, in the case of RONA, the impact on Québec suppliers of a disruption in procurement policies by the new American owner. These fears proved to be well founded.

However, in such cases, before deploying energies and devoting public funds to an intervention, the contribution of these businesses to economic growth and the final effect of a change of ownership should also be considered. Without minimizing the quality of the businesses targeted by these transactions, it can be argued that a chain of family restaurants and even a large network of hardware stores provide substantial services, but do not play a strategic or structuring role for the Québec economy.

Without minimizing the importance of identity factors in collective choices, it is desirable, in order to arrive at optimal decisions, to weigh them with economic factors, and with a more structured and formal reflection.

A more strategic approach must also be reflected in the terms we use. Caution must be exercised when trying to prioritize our choices by referring to the fact that companies are jewels. We prefer the term champion, which not only has an element of passion, but also a connotation of development.

#### From creating jobs to creating wealth

To steer away from emotion and arbitrariness, and to fill the void left by the loss of relevance of job creation as a primary economic objective, we propose an approach based on another target, that of wealth creation and raising the standard of living through economic development.

Raising the standard of living does not consist in seeking growth as an end in itself, but for what it enables: an improvement in living conditions through additional resources for citizens – for consumption or savings – and for governments – for the attainment of collective objectives, including interventions that promote well-being and quality of life. It is therefore not a matter of advocating growth at all costs, but of aiming for a pace of wealth creation that takes into account other objectives that will ensure balance and harmony. First and foremost, that it benefits the greatest number of people and is accompanied by a better distribution of income, and that it is part of a sustainable approach that reduces the environmental footprint of human activity and contributes to achieving the objectives of the fight against global warming.

This economic policy objective, which has proven its worth in other societies, is based on a fairly broad consensus in Québec and across Canada, both among economic specialists and the general public.

The idea of wanting to improve the standard of living is not theoretical. It seeks to correct a known and measurable problem: Québec's per capita gross domestic product – the standard of living – is lower than that of most jurisdictions with which the province can compare itself. The following graph shows that Québec is among the bottom of a ranking of advanced economies, which includes members of the Organization for Economic Development and Cooperation (OECD) and Canadian provinces.



Source: CPP, Overview 2018

The graph also shows that this relatively low standard of living is a problem common to most Canadian provinces. Ontario, long Canada's wealthiest province, is actually in the middle of the pack, as is Canada as a whole, even if its results are boosted by the performance of the oil-producing provinces, which have a very high standard of living.

Factors that determine the standard of living are well documented in the literature. Among others, the Centre for Productivity and Prosperity (CPP) – Walter J. Somers Foundation of HEC Montréal has identified them well for Québec and Canada.<sup>4</sup> According to the CPP, the standard of living is based on three determinants: labour availability, work intensity and labour productivity. Since the ability to influence the first two is very limited because of social and demographic constraints, increasing productivity remains the only lever on which action is possible, especially since Québec's lag in the standard of living is essentially due to low productivity.

In fact, Québec has one of the lowest labour productivity levels in a comparison with the same group of provinces and OECD countries. This is also true, to a lesser extent, for Ontario and for Canada as a whole.



Graphic 4 Work productivity, 2017

GDP per hour worked in Canadian dollars from 2017 at purchasing power parity

Source : CPP, 2018 Overview

The CPP's research is helping to better identify the factors that explain this productivity gap and the interventions that could be used to close it. The three main sets of factors that contribute to this situation are the composition of work – labour quality and an adequate level of training – capital intensity and, most importantly, multifactor productivity, which is largely associated with resource use and innovation.

This leads the CPP to the following conclusion:

#### "Ultimately, we understand that Québec can take action in three closely related areas to sustainably improve its labour productivity: improving the quality of its labour force, stimulating private investment, and fostering innovation."

In this report, we cite the work of the CPP because it has become an authority on the subject of productivity through its publications, including its annual review, educational efforts and research to document and analyze the productivity issue. That said, there is a very broad consensus among economists and policy makers alike that lagging productivity is the major economic challenge and that investment, education and innovation are the key to progress in this area.

This was in fact the central thesis of Éloge de la richesse,<sup>5</sup> in addition to being central to the work of economists Marcel Boyer<sup>6</sup> and Pierre Fortin.<sup>7</sup> In 2012, these were the main conclusions of the Advisory Committee on the Economy and Public Finance, mandated by then Finance Minister Raymond Bachand and composed of Claude Montmarquette, Robert Gagné, Pierre Fortin and Luc Godbout.<sup>8</sup> This was also the premise of the Minister of Finance of the Marois government, Nicolas Marceau, in his budget 2013-2014.<sup>9</sup> Finally, this was the central concern of the Advisory Committee on the Economy and Innovation, chaired by Monique Leroux, in its September 2017 report<sup>10</sup> submitted to the Couillard government. In short, this analysis grid is part of a long tradition.

These findings for Québec apply, to varying degrees, to most Canadian provinces. a phenomenon masked at the national level by the performance of the oil-producing provinces. This lag in productivity is not just a Québec issue, it is a Canadian issue.

Efforts to increase productivity, and therefore the standard of living, will thus be based on three intervention drivers:

- Put in place fiscal policies, a favourable regulatory framework, and attractiveness measures to encourage growth in business investment, particularly in machinery and equipment.
- Enhance the quality of the workforce through education, particularly through initiatives aimed at combatting the school drop-out rate, developing labour training, increasing university graduation, and better matching the education system with economic development needs.
- Promote innovation, for example through the production of patents, increased business investment in R&D, and the adoption of measures to optimize the development of an innovation culture in SMEs, increase graduate and post-graduate graduation, and the emergence of researchers, and strengthen the links between research and development.

A strategy of governments to increase productivity and living standards will rely, in part, on the use of the levers they control, such as taxation, infrastructure, education in its broadest sense, and research policies.

But it will largely depend on the success on the ground of companies' actions, their investments, their efforts to innovate, to increase productivity, to develop markets, and to create value. In many cases, their success will also depend on the support of the state or its pro-development policies.

In many of these areas of intervention, governments often have to make choices about which businesses they can support, which industries they can decide to support or mentor, and consequently, to which they will devote resources. How do we choose these companies, these industries? Often, these decisions are made in an emergency, when a crisis occurs, or out of necessity, for example to reduce the consequences of a weakening sector.

The grid we propose is to identify those industries that already stand out in terms of the factors contributing to productivity growth, as described above, or that will best contribute to efforts to strengthen them. Industries that, for this reason, can be described as strategic and, as such, should be encouraged, supported if necessary, and deserve to be at the top of the list in the hierarchy of choices.

<sup>5</sup> Alain Dubuc, *Éloge de la richesse*, Voix parallèles, 2009.

<sup>6</sup> Marcel Boyer, La performance et le développement économique à long terme du Québec, les 12 travaux d'Hercule, CIRANO, 2019

<sup>7</sup> Pierre Fortin, Les 12 travaux du Québec, L'Actualité, February 1, 2017.

<sup>8</sup> *Le Québec face à ses défis, Fascicule 3, Une voie durable pour rester maîtres de nos choix*, Advisory Committee on the Economy and Public Finance, Government of Québec, 2012.

<sup>9</sup> Investir pour assurer notre avenir, la vision économique du gouvernement, Budget 2013-2014, Finances et Économie Québec.

<sup>10</sup> Agir ensemble, pour un Québec innovant, inclusif et prospère, Advisory Committee on the Economy and Innovation, 2017.

## THIRTEEN CRITERIA FOR DEFINING A STRATEGIC INDUSTRY

In order to determine the strategic nature of an industry, thirteen measurable criteria were selected, most of which are linked, directly or indirectly, to the determinants of productivity and wealth creation. These criteria are intended to be universal, but they will have to be adapted to the particularities of each industry to account for factors that are specific to them.

It is not a ranking list or a scorecard, but a method of analysis that serves a dual purpose. On the one hand, to better identify strategic sectors to guide decision-makers in their choices. On the other hand, to help better understand how an industry contributes to economic development.

We will not present these various criteria in order of importance, but according to what we believe to be a logical sequence.

#### Criteria of a general nature

As a first step, some criteria are general in nature and focus on an industry's potential for success rather than its specific contribution to wealth creation. They are based on the principle that industries, to be strategic, must be or be capable of being winners. In this sense, these first criteria are basic attributes that an industry must possess. These are necessary but not sufficient conditions.

**1 – Economic weight.** To play a strategic role, the activities of an industry must have measurable impacts on the economy. This is not to ignore the important role that can be played by promising emerging and niche industries. But strategic industries, on which a government must rely, must be able to make a measurable contribution to wealth creation.

**2 – Development potential.** Canada and Québec have experienced several cases of dominant industries – very important but losing momentum – for which significant resources have been deployed without success and without halting their decline. An assessment of an industry's growth potential is necessary for interventions to be successful. This will be even more the case for industries that are promising but have not reached maturity.

**3 – Resilience.** It is not enough for a sector to have strong global potential. The domestic industry and its component companies must be able to participate in this success and to do well. And we must not forget that our outward-looking economy is subject to international competition. We must therefore take into account various factors that reflect an industry's ability to bounce back and withstand shocks, such as its diversification, structure, attractiveness and critical mass. These factors will vary by industry.

#### Criteria related to raising the standard of living

The second set of criteria focuses on elements more directly related to the determinants of an industry's contribution to raising living standards. These are the "pluses" that will ensure that a strong and healthy sector will be an engine for growth and productivity, and that it can be an economic champion.

4 – Exports. The ability to export constitutes in itself a net contribution to economic growth, and thus to living standards, since the balance of payments surplus is one of the components of GDP. In small open economies such as those of Canada and Québec, success on foreign markets is one of the essential ingredients for growth. It is also an indirect measure of an industry's ability to compete in international markets. Beyond raw statistics, the type of exports and the destination of products are factors that will make it possible to measure the structuring nature of this presence on foreign markets. This is particularly the case for value added, i.e. the difference between the value of an industry's output and the value of the inputs it has used. In the case of foreign trade, it makes it possible to capture the degree of processing of exported products, an element that contributes to the creation of relevant wealth in the case of Québec and Canada, where a large proportion of exports come from natural resources or products resulting from limited processing of these resources.

**5** – **Innovation.** Innovation is one of the key determinants of productivity growth. Spending on research and development is one of the predictors of an economy's potential and competitiveness, particularly that of the private sector, which is more likely to lead to economic activity. Industries with high R&D investment are more likely to change their products and processes, to innovate, and thus become more productive. While R&D is an important component of innovation, it can be based on other factors and measured by other indicators, such as the number of patents, links between firms and universities, or the degree of adoption of new technologies.

**6** – **Investment.** The level of investment in an industry has a direct impact on productivity growth and, subsequently, on the standard of living. This will be even more true for the portion of investment devoted to machinery, equipment, software, computer systems and information and communications technology tools that transform processes and ways of doing things, as opposed, for example, to investment in non-residential construction. An industry whose companies make investments will thus make a positive economic contribution on two levels: by supporting growth through the economic activity generated by the investments, and by increasing the economy's capacity to perform in the future. Similarly, an industry's potential and ability to attract foreign direct investment, which beyond the injection of capital is often accompanied by the transfer of knowledge and technology, needs to be assessed. Such foreign direct investment (FDI) is a vital contribution to our under-invested economy.

**7 – Productivity.** By definition, the level of productivity of an industry, and of the companies in it, as well as the growth of this productivity, are direct measures of its capacity to contribute to the general level of productivity of an economy. However, as we shall see in the following pages, there are methodological pitfalls in measuring productivity by industry.

**8 – Workforce.** This is not about the quantitative aspects, such as the number of jobs and job creation in an industry, an element whose limits we have shown. Rather, it is a matter of analyzing qualitative aspects, such as the attributes of an industry's workforce – the composition of its personnel, its level of qualification and skills, its level of education, the quality of remuneration, the pool of expertise – or the type of activities, such as head office functions or research activities. This is an important criterion for measuring an industry's competitiveness and productivity. It is also a predictor of adaptation to change, since an educated and sophisticated workforce will more easily adopt new technologies and will be better able to support the company in its transformations. Finally, a skilled labour pool is a factor in attracting foreign investment.

**9 – Education.** The level of education in a society is one of the important factors for improving productivity. But an industry's contribution to the goal of improving education is more complex and is not limited to its demand for graduates. An industry that requires a well-educated workforce stimulates the education network and contributes to its adaptation. The contribution to this essential criterion may also be greater for industries whose activities encourage student graduation, those that participate in interactions with the education network, and those that are active in continuing education.

**10 – Structural effects.** The contribution of a strategic industry should not be simply to inflate certain economic statistics, such as exports. It must also have a structuring effect on the economy as a whole, on its potential and competitive capacity, in addition to generating maximum benefits. Its strategic nature will be all the greater if these benefits are sustainable, for the economy and society. We could have used the term economic spinoffs if it was not used in another context. This criterion encompasses disparate elements that involve elements of subjectivity, such as the presence of head offices, with their spinoffs, research activities, the degree of influence that Canada or Québec can have on the development of an industry, the ownership structure, and international influence. Tax contributions through salaries, taxes and dividends must also be taken into account, as well as the balance sheet in terms of technology transfers or intellectual property.

#### Criteria of a contextual nature

The last group of criteria is contextual in nature. They focus on the relationship of an industry to the economy as a whole and the society in which it operates. For an industry does not operate in a vacuum. The social, political and economic context, as well as the quality of interaction with its environment, can add elements to its contribution or become constraints that limit its potential for success. Finally, a strategic industry must possess attributes that are not directly related to its ability to create wealth, but which are essential to contribute to the common good, generate the necessary buy-in and acceptability, and thus make government intervention acceptable.

**11 – Government support policies.** In order to measure an industry's strategic potential, account must be taken of its regulatory environment and its relations with governments, including the degree of public support it enjoys, particularly since in some cases this can be an indication of its weakness and vulnerability. The use of government assistance also opens the door to public debate and may raise issues of social acceptability. These are considerations that policy makers will necessarily have to consider when deciding whether to continue or strengthen their intervention in a sector.

**12- Inclusion.** Inclusion is not, in itself, a criterion for determining the strategic nature of an industry. Rather, it is a factor that decision-makers will have to take into account when implementing their economic policies. It is difficult for a government to rely on industries whose development is in flagrant contradiction with its social policies, including the imperative to ensure that the benefits of growth go to the greatest number of people. Similarly, it is difficult for a state to rely on industries that are display retrograde labour relations, even if they are considered strategic by other criteria. This is because it needs to defend its principles and values and base development policies on a certain social acceptability. Inclusion can also apply to regional distribution considerations. It is a factor that governments cannot neglect, either out of a concern to encourage regions excluded from development or – and this is a major challenge at the Canadian level – because of the geographic fragmentation of the economy and the political fragmentation of the country.

**13** - **Sustainability.** Most strategic industries do not have the primary objective of countering the effects of global warming. However, strategic industries can no longer be developed without taking this factor into account and focusing on those that are not part of a sustainable development approach. The future of our economies rests on our ability to sustain a form of growth that accompanies and supports efforts to reduce the carbon footprint. A strategic industry must be able to deal with the major trends that will shape our future. We also know that failure to respect environmental considerations can provoke very strong reactions and that social acceptability is a guarantee of long-term success.

#### Taking account of emerging industries

The grid we have just established allows us to better identify the strong economic sectors that already play a strategic role, or are ready to play it, and the champions on which we can base more rapid development. Such criteria make it possible to choose, from among the industries already established, those with the greatest potential. But it is clear that such a tool does not apply, as it stands, to emerging industries that may become the foundation of tomorrow's success.

Identifying emerging sectors with promising potential is a high-risk exercise. Governments have often bet on sectors that seemed to be promising successes and turned out to be failures. Conversely, the potential of an industry has often not been identified until late in the game. Thirty years ago, for example, the aerospace industry may have appeared to be a struggling industry with an uncertain future. At the same time, few people foresaw the explosion of information and communications technologies.

In order to identify these emerging sectors more quickly, if at all possible, and knowing the degree of uncertainty that surrounds it, two elements may need to be added.

The first is the identification of sectors with great development potential, based on an analysis of economic trends and transformations. This exercise, in which all countries are engaged, will tell us, for example, that certain sectors of activity have enormous potential, such as artificial intelligence. Or that major trends will change the way things are done and make the success or failure of an economy depend on its ability to adapt to them, such as new manufacturing processes arising from Industry 4.0 or the requirements of sustainable development. It may also point to socio-economic movements that will force adaptation and create new needs that must be addressed, for example, in sustainable transportation. The problem is that this reflection is taking place around the world. In doing so, at the risk of choosing the wrong sectors or not identifying those that will be promising, there is the added risk of many betting on the same horses.

The second element, once a high-potential industry or activity has been identified, is to ask whether, in a small economy like Canada's or Québec's, it can play a significant role in a context of global competition. Is it possible to stand out and make one's mark, even in a modest way? This exercise involves identifying our competitive advantages – whether in terms of technologies, research centres, talent pools, high-performance companies – evaluating whether we are already behind or ahead of the curve, and targeting niches or areas where we can excel.

It goes without saying that the ultimate goal of this exercise, which consists of identifying and supporting sectors of the future, is to move them from potential to realization, that is, to a real contribution to wealth creation. Once we know with greater certainty whether it is really a sector of the future and whether our companies can make their mark, we will have to ask ourselves whether their activities will support foreign trade, contribute to R&D, increase productivity, and so on. In that sense, when the right choices are made, the objective of economic policies will be to transform these emerging industries into strategic industries, and the grid we have proposed will then be applied quickly.

## THE CHARACTERISTICS OF THE AEROSPACE INDUSTRY

In this section, we will apply this analysis grid to the aerospace industry. The conclusion that it is a strategic industry is predictable, given its known attributes. This is, moreover, the conclusion reached by the Government of Québec:<sup>11</sup>

#### "The aerospace sector occupies a strategic place in the Québec economy by constituting one of the main engines of growth and wealth creation for all of Québec."

The value of the exercise, therefore, lies not so much in its overall conclusion that aerospace is a strategic industry, but rather in its ability to show why it is so.

An industry such as aerospace is spontaneously perceived as important because of its size, the number of jobs it generates, and the reputation of its players. However, the factors that give it a strategic character are little known and poorly understood in the public debate.

The two areas in which aerospace makes a remarkable contribution, foreign trade and research and development, are not elements that strike the popular imagination or whose economic importance the public realizes. As a result, it becomes difficult for decision-makers to explain and gain acceptance of the reasons why the state would be justified in putting such an industry at the top of its priorities.

#### 1- Economic weight

Let us start with the obvious: to be called strategic, and to have a significant influence, an industry must have a certain weight and a measurable impact on the economy. Size alone cannot be the only criterion, especially since an industry can be large in size but underperforming or in decline.

#### The Canadian footprint

This advantage of size plays very clearly in the case of aeronautics, one of Canada's major industries. It has two major sectors. First, the aerospace manufacturing industry, which is the design and production of airplanes, helicopters, parts and components. According to a report by Innovation, Science and Economic Development Canada (ISED), carried out in collaboration with the Aerospace Industries Association of Canada (AIAC),<sup>12</sup> these manufacturing activities account for 69% of the industry's total contribution to GDP. The other sector, with 31%, is maintenance, repair and overhaul services, MRO Services. The bulk of the industry's sales, 86%, is concentrated in commercial aerospace. Defence-related activities account for 12% and space systems for 2%.

According to Statistics Canada, the "aerospace products and parts manufacturing" industry, according to the North American Industry Classification System (NAICS), accounted for 53,800 jobs in 2018, contributing \$7.4 billion to GDP. The ISED study proposes an alternative definition of the industry's contours, notably by adding space manufacturing, avionics manufacturing and flight simulators. According to this definition, in 2018, the industry accounted for 56,707 jobs.<sup>12</sup>

Also to be included are the 32,756 jobs identified in MRO services, for a total of 89,463 direct jobs. The study adds to these jobs those of suppliers to industry, 40,088 in manufacturing and 30,645 in MRO services, bringing the total to 160,196 jobs for all activities.

<sup>11</sup> Québec aerospace strategy: Redefining the horizon 2016-2026, Québec government, 2016.

<sup>12</sup> State of the Canadian Aerospace Industry 2019, Innovation, Science and Economic Development Canada, 2019.

As the table shows, the industry has sales of \$31.6 billion, exports of \$16.7 billion, and a contribution to GDP of \$13.1 billion. Taking into account the activities of suppliers, the total contribution to GDP is \$20.3 billion.

Chart 1 Weight of the aerospace industry in 2018

	Manufacturing	MRO Services	Suppliers	Total
Jobs ('000)	56,707	32,756	70,733	160,196
GDP (billions \$)	9,077	4,012	7,230	20,319
Sales (billions \$)	23,559	8,016		31,575
Exports (billions \$)	16,704			16,704

Source: ISED, State of the Canadian Aerospace Industry 2019

By and large, aerospace is an important industry in terms of employment, contribution to GDP, sales – which account for 3% of manufacturing shipments – and exports – for which it ranks fourth in Canada. Its weight is comparable to that of the furniture, paper or computer and electronic equipment industries, but far exceeds sectors such as steel, Aluminum or pharmaceuticals. Its size is similar to that of the automotive manufacturing industry, to which, as we know, Canada has always attached great importance.

#### The weight of Québec

This descriptive analysis of the industry would not be complete without addressing the issue of its regional distribution within Canada. Although it has a real presence in several Canadian regions, Québec is the region with the greatest concentration of aerospace industry activity.

The Québec data are not based on the same bases as the ISED data for Canada, in part because the definition of the aerospace industry is not exactly the same. As Aéro Montréal's latest activity report,<sup>13</sup> as well as a document presenting the industry by Montréal International,<sup>14</sup> indicate, Québec accounts for more than half of the Canadian industry as a whole: 49% of jobs and 53% of sales. However, for 2018, Investissement Québec estimates that 70% of research will be carried out in Québec.<sup>15</sup> Data from the Institut de la statistique du Québec show that 68% of the industry's international exports come from Québec.<sup>16</sup>

# Chart 2<br/>Aerospace in QuébecNumber of jobs42,100Number of companies205Proportion of Canadian jobs49%Proportion of Canadian sales53%Proportion of Canadian exports68%Proportion de of Canadian R&D70%

Source : Investissement Québec, website, "Touch down in the heart of the action"

The website of the Québec Ministry of Economy and Innovation states: "In this field, Québec ranks 6<sup>th</sup> in the world for its workforce, behind the United States, France, the United Kingdom, Germany and Spain."

<sup>13</sup> Innovation, Transformation and Growth, 2018 Activity Report, Aéro Montréal, 2019.

<sup>14</sup> Greater Montreal: A global aerospace hub, Montréal International, 2019.

<sup>15</sup> Investissement Québec.

<sup>16</sup> International merchandise exports, Institut de la statistique du Québec, April 2019, Vol. 19, nº 4.

This concentration means that the relative weight of this industry is higher in Québec than elsewhere in Canada. At the Canadian level, according to the ISED definition, one out of every 223 jobs is in aerospace. This proportion is one in 103 in Québec. According to Montréal International, it rises to one in 52 in the Montréal region. That is considerable. As a result, the Québec metropolis can be proud to be the third largest aerospace city in the world, behind Seattle, the stronghold of Boeing, and Toulouse, the stronghold of Airbus.

However, Québec's weight must not make us forget the importance of aerospace in other Canadian regions. Its activities are geographically distributed at a high enough level that it can be described as a national industry, in the Canadian sense of the term.

The regional distribution will depend very much on the definition of the industry we chose. For the manufacturing portion, which is the most visible and the most structuring because of its industrial character, research activities and exports, Québec largely dominates, with 51% of jobs, according to the definitions in the ISED report, followed by Ontario at 30%, while the West accounts for 14% and the Atlantic region for 5%.

However, if we take the industry as a whole, adding MRO services, the regional distribution of the approximately 90,000 jobs changes significantly: 39.4% are located in Québec, 26.0% in Ontario, 26.3% in the Western provinces, and 8.2% in the Atlantic provinces. These data suggest a relatively balanced regional distribution, reflecting the concentration of MRO services in the West, which accounts for 41% of jobs in this sector.



Source: ISED/AIAC, State of the Canadian Aerospace Industry 2019

This regional distribution has a corollary. Since a large part of the industry is concentrated in Québec, it occupies a major place in the Québec economy, proportionally enough to be perceived as dominant. As a result, Quebecers naturally show more interest and express a greater sense of support for this industry, and the Québec government puts it at the heart of its priorities. A bit like we see in Ontario for the auto industry.

However, Québec's weight has an impact. It affects the attitude of citizens in other provinces, who tend to consider aerospace as a Québec industry, which in turn affects Canadian public policy. This must be seen as a constraint that has a negative impact on the industry's potential. We will talk about this again.

#### 2- Growth potential

Size is a necessary but not a sufficient condition. The economy often has to deal with large but shrinking sectors whose future is at risk, which one may be tempted to support, not because of their potential, but for fear of the negative effects of their weakening. An industry's capacity for growth and development is therefore an essential ingredient in determining its strategic character.

Since the development of the Canadian aerospace industry relies heavily on its exports, and since the industry operates in a completely globalized environment, it is the sector's potential on a global scale that must first be looked at. Its prospects can be assessed by briefly reviewing the findings of authoritative private and public organizations.

In by far the largest segment of the aerospace industry, commercial aviation, it is the growth in the volume of air travel, both passenger and cargo, that will determine the need for new aircraft or support services.

According to the International Air Transport Association (IATA),<sup>17</sup> with a basic industry measure, revenue passenger kilometres (RPK), passenger transportation growth has been steady for several years: 5.7% in 2013, 6.0% in 2014, 7.4% in 2015 and 2016, 8.1% in 2017, 7.4% in 2018, and 4.2% estimated for 2019, and 4.1% projected for 2020. The number of passengers is also rising sharply, from 3.145 billion in 2013 to 4.540 billion in 2019.

This growing importance of air transport is due to several major trends in daily life and economic activity:

- The expansion of international tourism and the growing popularity of more distant destinations;
- · Rising household incomes in many parts of the world;
- The proliferation of low-cost airlines;
- Job mobility in advanced economies, leading to an increase in domestic air travel, for example, in North America and Europe, for work, study and family reunification;
- The globalization of the economy and the development of international business travel;
- The movement of people, with political and economic immigration, which in many cases involves air transport and is subsequently sustained by travel between host countries and countries of origin.

There are also geopolitical factors. According to IATA data for 2018,<sup>18</sup> emerging economies show the strongest growth in demand, particularly in the world's two most populous countries, China, with 18.9% growth between 2017 and 2018, and India, with 12.1%, followed by Russia, at 9.1%.

Forecasts by the International Civil Aviation Organization (ICAO)<sup>19</sup> indicate that these observed trends will continue in the coming decades, with an annual growth in passenger traffic of 4.6% over the period 2012-2032. As a result, revenue passenger kilometres (RPKs) will increase from 5.5 billion in 2012 to 13 billion in 2032. A study by the international consulting firm Deloitte<sup>20</sup> estimates that, with an annual growth rate of 4.6%, the volume of passengers will double between 2018 and 2038. According to an analysis by another international consulting firm, McKinsey & Company:<sup>21</sup> "The commercial aerospace industry is poised for continued growth. Air transport passenger demand is expected to grow at around 4 percent a year in the next ten years."

<sup>17</sup> Industry Statistics fact sheet, IATA, 2019.

<sup>18</sup> Air travel by regions, IATA.

<sup>19</sup> State of Global Air Transport and ICAO Forecasts for Effective Planning, ICAO, 2017.

<sup>20 2019</sup> Global aerospace and defense industry outlook, Deloitte.

<sup>21</sup> Refining the flight path: Seven priorities for commercial aerospace leaders through 2020, McKinsey & Company, 2019.

The cycle for freight transport responds to another dynamic and depends essentially on the volume of world trade. After years of growth similar to that of passenger transport, freight transport, which generates revenues equivalent to 15% of those of passenger transport, came to a halt in 2019. This is mainly due to uncertainties in international trade, according to IATA.<sup>22</sup> "The outlook for world trade has weakened sharply as a result of trade disputes, damaging cargo."

In addition to demand fundamentals, other considerations include economic cycles and the cost of fuel, which is a key determinant. Rising fuel prices are helping aerospace because the search for greater fuel efficiency is putting pressure on fleet renewal and the construction of new aircraft.

Now let's look at how these trends translate into demand for aircraft. According to the Deloitte study: *"The commercial aircraft order backlog is at its peak of more than 14,000, with about 38,000 aircraft expected to be produced globally over the next 20 years."* Boeing, for its part,<sup>23</sup> estimates that 38,360 new aircraft will be built between 2018 and 2038.

While commercial aviation depends on global trade and passenger numbers, the potential of two other significant segments of aerospace is based on other determinants.

First, the defence sector. This concerns Canada even though the country does not produce military aircraft, since 12% of the sales of the country's aerospace industry are defence related. The prospects for growth are strong. The Deloitte study suggests a resurgence in global military spending due to increased global geopolitical risks. Think of the climate created by the Trump administration and the commitments of NATO member countries. Canada is no exception, with the replacement of its F-18s. Let us not forget, moreover, that several countries that may be associated with geopolitical risks are also major customers of American and European suppliers.

Next, the business aviation segment, which is very important for Canada because of the presence of Bombardier, one of the two major world players, is responding to other types of incentives and constraints. Business jets, whether to enable companies to be more efficient in moving their executives around or to satisfy the personal needs of wealthy clients, are luxury goods. As such, this sector is known to be more sensitive to economic cycles, as buyers may postpone their purchase intentions or resort to less expensive alternatives, such as used aircraft, during difficult times.

However, consulting firm Air<sup>24</sup> believes that the dark days following the 2008 financial crisis are over and that production will enter a recovery period between 2018 and 2024. According to McKinsey, "In the business aviation segment, the declining inventory of used aircraft and increased utilization rates are both reassuring signs." Honeywell Business Aviation, in its annual industry-leading forecast,<sup>25</sup> comes to the same conclusions: "*The business jet industry is expected to experience strong growth in the short to medium term, supported by several new airplane models coming to market and an improved used aircraft environment.*"

This brief overview of the industry's outlook shows that worldwide growth potential is positive for many years to come: demand for air transport will support aircraft construction, the political context favours the defence industry, and the business jet segment can also count on a favourable environment.

However, these positive prospects do not come without a cost. This is what the McKinsey study says: *"Recently, however, we see indications of disruption."* These include the pressure of this well-filled order book on production capacity and the risk of bottlenecks, competition from new entrants, notably China and Russia, which could threaten the current Boeing-Airbus duopoly, cost pressures from increased competition, and the rising cost of technological developments.

<sup>22</sup> Economic Performance of the Airline Industry, IATA, 2019.

<sup>23</sup> Commercial Market Outlook, 2019-2038, Boeing, 2019.

<sup>24</sup> World Business Aviation Market: 2018-2030, Air.

<sup>25</sup> Global Business Aviation Outlook, Honeywell, 2019.

#### **3– Resilience**

The global potential is there. The next question is whether the Canadian industry is in a position to take advantage of this favourable market. And this is where considerations related to the unique characteristics of Canadian aerospace, such as its structure, the nature of its operations and the dynamics of the ecosystem, come into play. All of these elements give the Canadian aerospace industry a certain resilience: a capacity to withstand shocks and the effects of the economic environment, to adapt to new contexts and to remain competitive.

Aeronautics is an old industry that will soon mark its centenary. Deeply rooted in Canada's economic history, it was born between the two wars and flourished in the wake of the Second World War, with names such as Canadian Vickers, de Havilland, Canadair, Pratt & Whitney, and Héroux-Devtek. Unlike other traditional industries, it has managed to overcome crises that threatened its survival and been able to renew itself.

We identify five characteristics that give reason to believe in its resilience and potential in the years to come: its critical mass; the degree of diversification of its activities; the strength and complexity of the ecosystem; the cluster dynamics; and the architecture of the industry.

However, three factors must also be taken into account that may cloud this picture: the impact of international competition; labour shortages; and its ability to adapt to technological change and Industry 4.0.

#### **Critical mass**

Canada can be considered an important player. Its aerospace industry ranks 5<sup>th</sup> in the world. That being said, Canada is far behind the countries that were ahead of it in the 2018 world rankings:<sup>26</sup> The United States, in first place, accounted for 41.9% of total exports, France, in second place, for 15.6%, Germany, in third place, for 12.5%, and the United Kingdom, in fourth place, for 5.7%. Canada, in fifth place, is far behind with 3.2% of the world's export volume.

While Canada is not a giant in aerospace, its weight in this industry is nevertheless greater than its weight in the world economy. However, size is not always sufficient for an industry to be a major market force. We saw this, for example, with the difficulties encountered by Bombardier, when its CSeries entered a segment occupied by the two giants, Boeing and Airbus.

This weight nevertheless gives Canada the critical mass needed to attract talent and capital. Canada has the know-how, the skilled labour pool, and the industry structure to attract and retain foreign companies.

#### **Diversification of activities**

Canada, active in all aspects of civil aerospace, is unique in that it is the only country in the "top five" in all segments of the industry: 1st world producer of civil flight simulators; 2<sup>nd</sup> for business aircraft; 2<sup>nd</sup> for regional aircraft; 4<sup>th</sup> for large jet production; 5<sup>th</sup> for helicopters; 3<sup>rd</sup> for civil engines. The Canadian industry manufactures complete aircraft and components (wings, cockpits, fuselages, landing gear). It produces and develops inputs (machining, composite materials). It designs computer systems, avionics and robotics, as well as evaluation and control tools. It is in maintenance, repair, inspection and verification. It is present (albeit to a lesser extent) in the military segment, as well as in the space industry.

Such a degree of diversification gives depth to the sector and reduces its vulnerability to cyclical shocks and global industry transformations.

#### The strength and complexity of the ecosystem

The Canadian aerospace industry is also characterized by a complex structure that adds depth to the industry, not only because of the diversity of its activities, but also because of the multiplicity of its players and the degree to which they interact and complement each other, making it a true ecosystem. This is well described, in the case of Québec, in Aéro Montréal's documents.

To grasp the importance of these factors, a few pages must be devoted to describing the industry participants and their activities, to better understand the structure of the industry and appreciate the quality of the interaction among its stakeholders.

There are some 250 aerospace companies across Canada, according to ISED and the Conference Board of Canada.<sup>27</sup> Approximately 200 of these companies are established in Québec. This is not counting the 500 or so companies that have ties to the industry as suppliers. There is a mix of large Canadian companies, foreign multinational sand SMEs, but also very small companies, with suppliers whose involvement in aerospace activities varies.

The industry is structured on three levels. The first is the Original Equipment Manufacturers (OEM), essentially large companies that manufacture finished products (see box). In Québec, four companies were recognized as prime contractors, all of them world-class: Bombardier (aircraft), Pratt & Whitney Canada (engines for small aircraft), CAE (flight simulators), and Bell Textron (helicopters). A fifth player, Airbus, now produces the CSeries.

These prime contractors play a major role, given their size, international reach and influence on the industry. According to Aéro Montréal, in 2015, they alone generated about 70% of the industry's sales in Québec and 62% of jobs.

The second level is that of equipment manufacturers, integrators and world-class MROs (maintenance, repair and overhaul), some of which can carry significant weight. Québec has about a dozen of them (see box).

The third level includes subcontractors and dedicated suppliers.

Because of the numerous players and their diversity, we are dealing with an industry that is by no means rigid or monolithic. Two elements – cluster dynamics and industry architecture – ensure that this diversity does not produce a patchwork.

#### THE OEMS

**Bombardier.** Initially involved in recreational products and rail transportation, Bombardier became the heir to Canada's traditional aerospace industry with the acquisition of Canadair in 1986 and de Havilland in 1992, becoming the largest company in the industry. It then disengaged from commercial aviation beginning in 2017, first with the transfer of control of the CSeries to Airbus, then in 2018 with the sale of the Q Series (Dash-8) to Longview Aviation and the CRJ program to Mitsubishi, and finally in 2020 with the complete withdrawal of the A220. Bombardier has thus focused its activities on business aircraft, of which it is one of the world leaders with three programs, Learjet, Challenger and Global, including the new Global 7500. As the company has also withdrawn from the rail sector, when these transactions are concluded, it will employ 18,000 people, including 14,000 in Canada and 10,000 in Québec. It will still be the largest company in the aerospace industry, both in Canada and in Québec.

**Pratt & Whitney Canada.** A subsidiary of the American group United Technologies, one of the world's four major producers of civil and military engines, Pratt & Whitney has been present in Canada for more than 90 years. Within the group, Pratt & Whitney has a mandate to design, develop and produce engines for helicopters, smaller aircraft and turbines. It is a company that invests significantly in R&D. It has 10,000 employees around the world, including about 6,000 in Canada, mainly in Québec, but also elsewhere in Canada. It employs about 1,400 engineers at its research centres in Mississauga and Longueuil, where its head office is located.

**CAE.** An international leader in modelling, simulation and training for civil aviation and defence, as well as the healthcare industry, CAE produces full-flight simulators - 1,000 simulators sold to more than 130 airlines around the world. The company also offers training services, including NATO training, integrated business solutions, in-service support and crew placement. It trains approximately 100,000 crew members per year. Founded in 1947, the company has more than 8,000 employees, including 3,000 in Montreal, where its head office is located.

**Bell Helicopter.** A U.S. company owned by Textron Inc., Bell Helicopter is a leading manufacturer of military and civilian helicopters. Established in Mirabel since 1986, it produces most of the company's range of commercial helicopters in Québec. It is responsible for the design, production, flight testing and post-flight support of these aircraft, and has delivered 5,000 worldwide since its establishment in Québec, where it has 920 employees.

**Airbus.** A European giant, Airbus, the second largest aircraft manufacturer in the world, was already present in Canada. But by taking a majority interest in the CSeries Limited Partnership (now Airbus Canada), it integrated into its operations the production and sale of these aircraft, now the A220-100 and A220-300, which will be manufactured mainly in Mirabel, but also in the United States. Airbus thus becomes a fifth prime contractor in Québec. With Bombardier's withdrawal, Airbus holds a 75% interest in the A220 program, with the remaining 25% held by Investissement Québec. The company's President and Chief Executive Officer stated that he plans to invest between 500 million and 1 billion euros in Mirabel in 2020.

#### **EQUIPMENT MANUFACTURERS**

Québec's aeronautics industry also relies on a network of top-notch equipment manufacturers, integrators and maintenance companies. Montréal International identifies some thirty of them. For example, for aerostructures: Stelia, Avior, Sonaca, Mecacichrome, Arsonic. For landing gear: Héroux-Devtek, Liebherr, Safran, Mecaer. For avionics and software: Esterline, Cs Communications, Thales. For propulsion: Safran Helicopter Engines, GE Aviation. For defence: L3 Communications MAS, Lockheed Martin. For engineering and subcontracting: AKKA, Tech Mahindra, Expleo, AAA. For space: MDA. For simulation: TRU. For interiors: MSB, F/List, Hutchison, Facc.

#### **ELSEWHERE IN CANADA**

Ontario is the second largest hub of Canada's aerospace industry. According to the Ontario Aerospace Council, its industry has sales of \$6 billion and employs 21,000 people, 48,000 including indirect jobs, or about 30% of activities and research. A large number of Québec-based companies also have operations in Ontario, including Bombardier, again the main one with the assembly of Global business aircraft. This is also the case for Héroux-Devtek, with its subsidiary Magtron, or CAE. Ontario also has prime contractors such as Magellan, which specializes in complex systems, and is home to most of the world's largest players, including Airbus L3, Honeywell, General Electric and Lockheed. Ontario is the leader in turboprop aircraft, the Q400, produced until recently by Bombardier, whose production and maintenance is now handled by Viking, a Longview subsidiary. It is also a leader in business jets.<sup>28</sup>

Finally, we must not forget Manitoba, especially the city of Winnipeg, the third largest centre with 4,400 jobs and the presence of 31 companies in the field, including Boeing, StandardAero, Magellan Aerospace, GE Aviation, Rockwell Collins, Cormer Aerospace and Cadorath Aerospace. Boeing's composite plant in Winnipeg is one of the largest in Canada, with more than 1,400 employees.

#### **Cluster dynamics**

In Québec's case, there is a functional cluster, a true hub, where these big players, suppliers and SMEs form a coherent and interdependent whole. Its effectiveness can be measured first by the degree of participation of members in the Aéro Montréal cluster, by the fact that this cluster also includes partners from the world of education and public organizations such as Montréal International, and that it initiates interventions on behalf of the industry – international representation, management of support programs, educational initiatives, research projects, and support for small businesses.

Ontario also has participatory mechanisms, particularly between industry and the education community. Despite its geographic dispersion, the Canadian network shows a high degree of cohesion and a real capacity for mobilization, as shown by the pan-Canadian consultation process carried out by AIAC with its Vision 2025 exercise.

The Canadian industry has undergone a profound transformation since 2018 with Bombardier's withdrawal from commercial aviation. However, the impact of these changes will be relatively limited, at least in the short and medium term, which attests to the strength and resilience of this cluster.

On the one hand, because the activities that Bombardier has divested have been transferred to companies that will continue operations in Canada and Québec (Longview for the Q Series, Mitsubishi for the CRJ, Airbus for the CSeries), the level of activity and jobs remains unchanged, and is even expected to grow. The industry as a whole remains intact, even though the distribution of activities within it is no longer the same. This fairly smooth transition may even strengthen the industry, since it has allowed it to diversify with the arrival of two major international players, both of which have announced an increase in their activities in Québec: Airbus with the increase in production of the A220, and Mitsubishi Heavy Industries (MHI) with a \$135 million investment in a research centre. Some 1,000 jobs have thus been created at Airbus since 2018 and 250 are to come at MHI in Boisbriand.

On the other hand, because the business aircraft sector (little known to the general public) has always been, by far, Bombardier's main aerospace segment. It generates substantial business in a global market where the company plays a dominant role.

However, in the longer term, this could affect the evolution of the industry. Bombardier, as a dominant company, will not be able to exercise the same leadership because it will only be present in a niche market, that of business aircraft. It will no longer be able to rely on the prestige conferred by its size and international weight strengthened by its presence in the rail sector, nor will it be able to engage alone, as it has done in the past, in major development projects which have had knock-on effects on the industry as a whole. In addition, part of its operations have been sold to foreign companies which, even if they continue to operate in Canada and Québec, will probably begin their development projects in their home countries.

#### Industry architecture

The strength of the cluster is also linked to the architecture of the industry, which is more complex than it appears. The classic presentation of the cluster – the OEMs, then the integrator group, then an army of suppliers and subcontractors – suggests a pyramid structure. This perception is correct to a certain extent, since the big players do indeed have a great deal of influence on the industry and contribute to its vitality. As we have seen, prime contractors account for 70% of activities in Québec.

This pyramid structure has advantages and disadvantages. The Canadian and Québec aerospace industry would not be what it is without the presence of these prime contractors, who have enabled the development and success of a large number of suppliers. For example, without Bombardier, Montreal would not be a world aerospace hub and Canada would not be one of the world's major players. However, this entails a number of risks, such as a weakening of a prime contractor, which would have a cascading effect on the industry. Conversely, what could be called an umbrella effect where prime contractors, with their vertical network, shield their suppliers from competition to a certain extent.

However, in addition to this traditional vertical structure, a more horizontal structure is developing, with local companies developing in whole or in part in other markets, or foreign companies that have chosen Canada as part of their global operations.

This complexity can be illustrated by significant data presented in the ISED report, showing that only 38% of the industry's exports are finished products, while 62% are exports linked to the global supply chain, and therefore destined for markets other than major Canadian OEMs. This shows that many companies can thrive outside the traditional pyramid structure. The best example is Héroux-Devtek, which supplies landing gear for civil and military aircraft to prime contractors outside our borders, including Boeing. This is an indication that several producers are perfectly capable of standing on their own two feet and facing global competition.

#### 4-A highly export-oriented industry

At the first level, the ability to export enables Canadian and Québec companies to expand their markets and increase their activities. At the macroeconomic level, industries that export contribute to economic growth by improving the balance of payments. For a small open economy like ours, exports are an important source of growth. This contribution will be all the more structuring with the greater the degree of transformation and the level of value added. This macroeconomic contribution has a positive impact on all citizens of the country, wherever they live.

At a second, more structuring level, an industry's ability to export can be seen as an indicator of its productivity or competitive abilities. This is not necessarily the case for industries producing commodities or low-processed products governed by world prices, or for natural resources dependent on the vagaries of geology. For example, Québec's ability to export electricity does not so much reflect the productivity of this industry as the existence of hydroelectric resources that could be developed at relatively low cost.

In the case of a high value-added manufacturing industry, however, the ability to export will largely depend on the productivity and competitiveness of companies, their products, their costs and their approach to foreign markets.

The aerospace industry, which ships about 70% of its production abroad, with exports of \$16.4 billion in 2018, up 7% from the previous year, ranks fourth among exporting industries, behind oil and gas extraction, motor vehicles and petroleum refining.

Industry	Exports 2018 (in M \$)		
Oil and gas	96,542		
Automobiles	53,773		
Refining	20,430		
AEROSPACE	16,391		
Gold and silver	15,896		
Sawmills	11,084		
Pharmaceuticals	11,003		
Cast non-ferrous metals	10,939		
Aluminium	10,712		
Non-metallic minerals	9,979		
Pulp and paper	9,376		
Rubber	8,600		
Engines and turbines	8,008		
Slaughter	7,796		
Coal	7,528		
Wheat	7,398		
Steel industry	6,884		
Paper	6,419		
Measuring instruments	6,382		
Vegetable oils	6,292		
SUB-TOTAL	331,191		
Other	252,971		
ALL INDUSTRIES	584,151		

Chart 3 Canadian Exports: Top 20

Source: Exports, 25 main products, 2018, Statistics Canada, online trade data

In terms of quality, aerospace exports are distinguished by their value added, i.e. the difference between the value of output and the value of inputs, which indicates a high degree of processing, as they are finished products requiring complex interventions, specialized work and research input.

This helps to reduce the dependence of the Canadian economy on the resource sector. Indeed, natural resources and primary processing of natural resources dominate Canada's exports. Of the top ten export products, which account for 43% of the total, six industries are closely related to natural resources: oil and gas, gold and silver, wood, non-ferrous metals, aluminium and non-metallic minerals.

In this top 10, therefore, there are only four industries with the highest value added: automotive, aerospace, refining and pharmaceuticals. The first has a high level of exports thanks to its crossborder activities with the American industry on which it depends. The refining industry carries out activities in Canada similar to those in other countries. In short, only the aerospace and pharmaceutical industries export high value-added products, whose export success is strongly linked to innovation and competitiveness.

In Québec's case, aerospace literally dominates the export rankings. The "aircraft sales" category ranks first, but we must add the other two segments of the industry that also appear in the top 5, namely engines and parts. Together, these three aerospace segments account for \$13.6 billion, or 14.8% of the province's total exports. Aerospace exports twice as much as the second largest export industry, aluminium at \$6.6 billion, and outpaces electricity exports by 11½ times. As in Canada as a whole, the aerospace industry stands quite alone in Québec in a ranking dominated by natural resources and products that are not very highly processed.

Industry	Exports 2018 (in M \$)		
AIRCRAFT	7,679		
Aluminium	6,633		
AIRCRAFT ENGINES	<b>3,753</b> 2,983 <b>2,227</b>		
Iron ore and concentrate			
AIRCRAFT PARTS			
Paper	2,016		
Trucks	1,769		
Pharmaceuticals	1,714		
Non-ferrous metal	1,618		
Newsprint	1,490		
Pork	1,465		
Wood pulp	1,464		
Copper	1,430		
Commercial machinery	1,353		
Lumber	1,340		
Electricity	1,173		
Heavy fuel oil	1,164		
Other metals	1,127		
Semi-conductors	1,023		
Gold and silver	1,009		
TOTAL 20 MAIN PRODUCTS	44,472		
TOTAL	92,237		

Québec exports: Top 20

Chart 4

Source: Institut de la statistique du Québec

Another feature of this industry's exports is that it contributes to the diversification of export markets. Canada is seeking to reduce its dependence on its main partner, the United States, an issue that has become more pressing with the numerous trade disputes under Donald Trump's presidency.

ISED, citing the Global Trade Atlas, reports that Canadian aerospace sold its products to 193 countries in 2018, almost everywhere in the world. However, what matters is not the number of countries where we export, but the relative weight of export markets. The following table shows that aerospace exports to the U.S., at \$10.9 billion in 2019, account for 62.6% of the total (Switzerland and Latvia's presence among the main export destinations is due to CSeries sales). This proportion, relatively constant over time, is much lower than that of other exporting industries, for which the United States accounts for 75% of shipments. Aerospace is therefore less dependent on the US market and more present elsewhere in the world.

	Destination	Value (in M \$ CA)
	United States	10,931
	Germany	759
)	France	548
	Latvia	399
	United Kingdom	359
	Egypt	329
	Singapore	333
	The Netherlands	280
	Switzerland	257
	Turkey	248
	SUB-TOTAL (10 main countries in 2019)	14,499
	Other	2,995
	TOTAL (all countries in 2019)	17,445

Source: Statistics Canada, online trade data



10 main countries (2018)

#### 5– A domination in research

Aerospace's most significant contribution is definitely its investment in research and development. Business R&D is one of the foundations, but not the only component, of the innovation process. It is associated with the culture of change, with efforts to modify production methods and to develop new products or new processes.

In this regard, Canada and Québec are deficient. Total domestic business expenditure on research and development (BERD) is stagnating: from \$18.2 billion in 2014, it levelled off at \$18.3 billion in 2019.29

This level is not only stagnant, it is insufficient, as the following graph shows. Compared to other industrialized countries, Canada is clearly at the bottom of the pack in terms of BERD as a proportion of GDP. This is also the case for all provinces except Québec, which, while not excelling, is close to the average.



of GDP in %; 2016 and 2017 data

The aerospace industry plays a critical role by being, by far, the largest contributor to private sector R&D in Canada. It is not experiencing the stagnation observed for all companies. Quite the contrary. A study by the CPP<sup>30</sup> highlighted the fact that this industry was literally the only one in Québec to post substantial growth in research spending.

The aerospace industry invested \$1.786 billion in R&D in 2017, according to ISED data. However, the level of spending dropped to \$1.4 billion in 2018, a decrease that is partly due to the completion of research programs at Bombardier and Pratt & Whitney. This accounted for almost one-quarter of all R&D in Canadian manufacturing. Research intensity, as measured by the ratio of research spending to industry GDP, was 16%, five times higher than the manufacturing average of 3%.

Statistics Canada's research data, based on an alternative methodology,<sup>31</sup> show that in 2018, aerospace R&D was \$863 million by this measure, representing 14.8% of manufacturing research, while industry GDP was 3.7% of manufacturing GDP. Thus, its proportion of research was 4 times higher than its proportion of GDP.

Source: Conference Board of Canada

<sup>29</sup> Business enterprise in-house research and development expenditures, by industry group based on the North American Industry Classification System (NAICS), country of control and expenditure types, Statistics Canada (27-10-0333-01).

<sup>30</sup> Jonathan Deslauriers, Robert Gagné andt Jonathan Paré, Manufacturier 4.0 : Dynamiser l'activité manufacturière au Québec, Centre for Productivity and Prosperity (CPP) - Walter J. Somers Foundation, HEC Montréal, 2019.

<sup>31</sup> Business enterprise in-house research and development expenditures, by industry group based on the North American Industry Classification System (NAICS), country of control and expenditure types, Statistics Canada (27-10-0333-01).

These data explain why Québec dominates the other Canadian provinces in terms of the weight of BERD in relation to GDP and manages to approach the average for industrialized countries. This is because the aerospace industry conducts 70% of its research in Québec. These data also highlight the fact that Canada's position in terms of BERD, which is already very low, would be even lower without the contribution of this industry.

Research Infosource,<sup>32</sup> a Canadian firm specializing in consulting and analysis, publishes an annual ranking of companies that invest in research and development. Its latest report, covering 2018, places three aerospace companies in the top 20. Bombardier ranked first with R&D investments of \$1.471 billion (it is reasonable to assume that this level will be reduced with the completion of its two most recent development programs). This is more than double the investment of the second ranked company, Magna International (\$762 million). Two other aerospace companies were in the top 20: Pratt & Whitney, in fifth place with \$552 million, and CAE, in 20<sup>th</sup> place with \$183 million. Three other companies in the sector were in the top 100: Lockheed Martin Canada (54<sup>th</sup>), L3 Wescam (59<sup>th</sup>) and Héroux-Devtek (99<sup>th</sup>).

Rank	Name	R&D (in M \$)	Industry
1	Bombardier	1,472	Aerospace
2	Magna International	762	Automobile
3	Suncor Energy	635	Energy
4	Constellation Software	585	IT
5	Pratt & Whitney Canada	552	Aerospace
6	BCE	537	Telecom
7	Bausch Health Co	535	Pharma
8	IBM Canada	512	IT
9	Shopify	454	IT
10	OpenText Corp	419	IT
11	Rogers	415	Telecom
12	Ericsson	368	Telecom
13	AMD Canada	319	Electronics
14	Telus	307	Telecom
15	CGI	288	IT
16	BlackBerry	284	IT
17	Canadian Natural Resources	265	Energy
18	BNP	222	Others
19	Huawei	187	Telecom
20	CAE	183	Aerospace

Source: Research Infosource

This very high level of research also allows industry to forge links with academia beyond teaching and education issues. Data from the Defence, Aerospace and Marine Industries Survey, cited by ISED, show that this level of collaboration is high, with 75% of companies having links with academia and 71% with governments. Another survey by Statistics Canada<sup>33</sup> sets this level of collaboration at 72.6% between 2015 and 2017, the highest rate of any industry.

#### Chart 6

R&D expenditures – Top 20 (2018)

<sup>32</sup> Canada's Top 100 Corporate R&D Spenders 2018, Research Infosource Inc.

<sup>33</sup> Co-operation on innovation activities, by type and location of co-operation partners by industry and enterprise size, Statistics Canada (27-10-0178-01).

This is also reflected in the fact that public sector and academic organizations are involved in this research effort, such as the National Research Council Canada (NRC), the Canadian government's research vehicle which has a major aerospace component, or the Canadian Space Agency. In addition, there are numerous aerospace-related research chairs, laboratories and institutes at the École de technologie supérieure (ÉTS), McGill University, Concordia University, Polytechnique Montréal and Université Laval.

Another factor, much more difficult to measure, also weighs in the balance. The aerospace innovation process takes place within a value chain in which a fair proportion of the production is not carried out by prime contractors and OEMs, but by a network of smaller companies that are also involved in the innovation process to improve products and processes and solve problems faced by their large customers. These are not necessarily large budgets. Often they will not be counted as research expenditures and will not be included in industry statistics.

This constant process of effort and creativity is not measured, but it plays an important role. It also serves as a reminder that innovation is not just about research; it is essentially about the transition from ideas to economic activity. SMEs, competing for costs, but also for providing solutions, can play an important but less recognized role. Although this phenomenon cannot be documented and supported by evidence, it plays a role in aerospace and contributes to its culture of innovation.

Innovation can also be expressed through the use of advanced technologies or stimulated by the adoption of these technologies. A Statistics Canada survey sponsored by the Canadian Ministry of Innovation, Science and Economic Development (ISED) sheds light on this issue.<sup>34</sup>

The survey shows that companies in the aerospace industry have the highest use of advanced technologies in manufacturing, after the semiconductor industry, with a rate of 72.5% compared to 52.8% for the manufacturing sector as a whole. Aerospace also stands out for its use of advanced processing or manufacturing technologies, at 56.2% versus 35.4%, and for design and control technologies, at 40.8% versus 24.6%. It also stands out for its use of artificial intelligence, which is used by 11% of companies in the sector, placing it in second place behind the manufacture of computer and communications equipment.

#### 6– A channel for investment

Investment growth is at the heart of any strategy to increase productivity and, subsequently, wealth creation. A strategic industry must be able to contribute to this objective or have the potential to do so. Investments that play a crucial role in improving productivity are those that are used to acquire machinery and equipment, especially from businesses, as opposed to investments in non-residential construction. It is through machinery, tools and equipment, including information and communications technology, that a company will be able to improve its products, services and processes, modernize its operations, and increase its efficiency. In general, it will thus be able to increase its productivity and allow for greater production per worker.

We do not have disaggregated data to measure the precise contribution of aeronautics to this major objective. Statistics Canada data cover all transportation equipment manufacturing, which makes it impossible to distinguish the contribution of aerospace from that of the automobile or train manufacturing industries. However, these same data can be used as an indication, with provisos, for Québec, where the share of the automobile industry is almost nil. Investment in transportation equipment reached \$464 million in 2018, a significant and relatively stable proportion of 12% of the total \$3.8 billion invested in the manufacturing industry as a whole.

Furthermore, Montréal International, citing the Ministère des Relations internationales, estimates that investments will reach \$2.8 billion for the 2016-2021 period.

There is also another indirect measure which, *a posteriori*, shows a constant flow of investments in aerospace, namely the regular arrival of new foreign players. This illustrates, on the one hand, the presence of a flow of investment spending made in Québec or Canada, and on the other hand, the interest that the Québec, Ontario and Canadian markets can generate.

A compilation by the Québec Ministry of Economy and Innovation,<sup>35</sup> which specifies the date of establishment of large companies in the sector, is revealing in this respect: Esterline CMC Electronics (Marconi Canada) – 1903; Bombardier (Canadian Vickers) – 1923; Pratt & Whitney Canada – 1928; Héroux-Devtek – 1942; CAE – 1947; Rolls-Royce – 1947; MDA (Spar Aerospace) – 1968; General Electric – 1981; Bell Textron – 1986; L3 Technologies – 1986; Safran Landing Systems – 1991; Sonaca Montreal – 1992; Thales – 1996; Safran Helicopter Engines – 2001; Arconic – 2004; Stelia – 2011; AJW – 2012; Lockheed Martin, Aircraft Engine Maintenance – 2013; Airbus – 2018; Mitsubishi Heavy Industries – 2019.

Montréal International also offers a compilation of recent investments:<sup>36</sup> Stelia, \$75 million in 2012 for a fuselage plant; Pratt & Whitney, \$275 million in 2013 for three state-of-the-art production lines; GE Aviation, \$61.4 million the same year for a robotics research centre; Bell Helicopter, in 2016 for the transfer of production of the Bell 505; AP&C, \$31 million in 2015 for a new plant; F/List, \$20 million in 2017 for an interiors plant; Thales, \$25 million in 2017 for an Al laboratory; and CAE, \$1 billion in 2018 for an investment in training. Added to this are the announced investments by Airbus in Mirabel and Mitsubishi Heavy Industries in Boisbriand.

These compilations attest to the market's attractiveness and its ability to pull in new foreign companies on a sustained basis over time, and thus work on one of the key growth levers, that of foreign direct investment (FDI).

<sup>35</sup> Ministry of Economy and Innovation, Presentation on the aerospace industry.

<sup>36</sup> Greater Montreal: A global aerospace hub, Montréal International, 2019.

#### 7- Productivity

If the ultimate objective is to increase productivity in order to raise the level of wealth, it goes without saying that an economic policy will first seek to focus on the maintenance and development of sectors with high productivity. By definition, a highly productive sector has a strategic attribute.

However, the conventional tools available to us to measure productivity do not always allow us to properly assess it. This is particularly true of the most common measure, labour productivity, which is essentially a measure of the value of output per hour worked.

With this imperfect measure, the industries with the highest productivity rates are the most capitalintensive. Labour productivity<sup>37</sup> for all industries was \$56.30 in 2018. But it was \$700.60 for oil and gas extraction, which reflects neither the individual contribution of the worker nor the efficiency of work organization, but rather the huge level of investment in relation to the number of workers needed. According to this method of calculation, productivity is also high in electricity generation and distribution, at \$187.10, which essentially reflects the contribution of dams and transmission lines.

By comparison, the results for the aerospace products and parts manufacturing industry at \$70.40 are not remarkable, although they are above the manufacturing industry average of \$64.80. The fact that aerospace and other high-tech industries, such as pharmaceuticals or electronics, have rather modest hourly productivity levels illustrates the limitations of the measure rather than the productivity problems of these industries. It is also noted that labour productivity increased only very slightly over the period 2000-2018. In 2012 dollars, labour productivity remained stable, and was therefore stagnant over this period.

These results, in the case of aerospace, can also be explained in part by less well-known characteristics of this industry, many of whose activities are inherently labour intensive. Despite robotization and technological advances allowing for automation, a significant part of the activities - machining in SMEs, the manufacture of parts and components for short production runs, assembly and finishing activities - require a significant human contribution.

The very nature of the industry, where equipment design is done in tandem with production planning, means that once a product is developed and production begins, it becomes very difficult to change manufacturing processes. The construction of older aircraft is based on older processes. You cannot, for example, robotize the manufacture of an aircraft that was designed decades ago.

So we can conclude that in order to assess the productivity of this industry, we have to use indirect measures to see how competitive it is, which we have done, particularly in the section on foreign trade.

Nonetheless, international studies indicate that the aerospace industry is lagging behind in the adoption of Industry 4.0-associated practices.<sup>38</sup> This delay is partly due to the nature of the industry, which is not based on mass production.<sup>39</sup> A major aircraft manufacturer produces about 1,000 aircraft per year, while, for example, automotive production is measured in millions of vehicles, which may have impeded the adoption of certain practices, such as robotics and its contribution to repetitive task sequences.

In addition, there is evidence to suggest insufficient productivity. This was seen, for example, with Bombardier's rationalization efforts or Airbus's initiatives when it took over production of the CSeries. Its first step was to try to reduce the cost structure and to require suppliers to make efforts to reduce their costs by a percentage in the double digits.

<sup>37</sup> Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts, Statistics Canada (36-10-0480-01).

<sup>38</sup> Beyond the hype, Separating ambition from reality in 4.0, KPMG, 2017; Industry 4.0 in the aerospace and defense industry, Deloitte, 2019.

<sup>39</sup> KPMG looks beyond the hype, FINN, Farnborough International News Channel, 2019.

#### 8- Workforce: strategic talents

We have explained at length why employment can no longer remain a key objective of economic policies and an adequate measure of their success. We will therefore focus on the qualitative elements of the labour pool rather than its quantitative aspects. In this respect, four elements are of particular interest to us.

Firstly, aerospace is a cyclical industry, largely influenced by and dependent on the growth rate of the world economy. The "boom and bust" nature of the industry can be seen in the evolution of employment levels. According to ISED data, the gap is 10.8% between the low point in 2017, with 53,588 manufacturing jobs, and the peak in 2014, with 60,074 jobs. Note that the level of employment in the MRO sector is more stable.



Source: ISED, State of the Canadian Aerospace Industry 2019

This change in employment has consequences. It can affect the availability of labour, either by pushing those who have lost their jobs to move to another field of activity, or by sending a negative message to those who would like to undertake training that would enable them to land a job in the field. Bad news can thus have a negative effect on the participation rate in aerospace training and education programs and make recruitment more difficult in times of expansion.

It should also be noted that employment for the industry as a whole increased by 4.53% in 2018. In Québec, Aéro Montréal estimates this growth at 5%. Nevertheless, this higher level of employment in 2018 remains lower than in 2014. And the outlook for the future is mixed. The Conference Board of Canada, in its analysis of the sector,<sup>40</sup> forecasts that, following the sharp increase in employment in 2018, employment will grow by about 1% per year until 2022.

Secondly, industrial wages are relatively high. In 2018, average weekly earnings were \$1,434.75, 43.3% higher than average earnings for all industries. This clearly positions the aerospace industry in the category of industries that pay wages of \$35 and more, to use the formula of Québec Premier François Legault. But it should also be noted that average salaries in the aerospace industry are not exceptional. The extractive sector (oil, mines, gas pipelines) offers higher salaries, around \$2,000, but with much more demanding working conditions. Several manufacturing sectors also offer comparable wages, including pulp and paper, chemicals and iron and steel, while the automotive sector offers slightly less (\$1,355.43).

Thirdly, this relatively high level of remuneration reflects the level of qualification and training required of industry personnel. Research intensity helps to explain the high weight of jobs in science, technology, engineering and mathematics (STEM). The proportion of STEM jobs in aerospace manufacturing was 26% in 2017, which, according to ISED, is three times the average for all manufacturing industries. But these university-level jobs are complemented by the participation of highly trained technicians, specialists and other skilled workers, making the aerospace industry's labour pool particularly sophisticated.

This highly skilled labour pool is certainly an asset. We saw it in 2019 with Mitsubishi's investment to create an engineering centre in Boisbriand, linked to the development of its SpaceJet. This potential investment of \$135 million, which could create 250 jobs, is largely due to the availability of a specialized workforce.

Montréal International has made it one of the elements in its argument for attracting investment in Québec. The organization has identified 33,700 specialists in the Greater Montréal area - aerospace engineers, electronic engineers, software design engineers, computer engineers, mechanical engineering, industrial engineering and electronic engineering technologists, etc. - who have been trained in the Greater Montréal area.

This quality of the workforce also offers some protection against competition from low-wage countries where the industry is increasingly carrying out certain elements of its production.

Fourthly, this asset could become a handicap if the availability of this skilled labour is compromised. The needs in jobs is considerable. In addition to finding the labour needed to meet the needs generated by growth, existing jobs will have to be replaced.

Looking forward, the aerospace industry and educational institutions have mobilized through the Rise to the Future initiative to meet what they call the "critical need for skilled labour." The industry, in the case of Québec, estimates that it will have to fill some 37,000 jobs in ten years, or by 2028. Across Canada, AIAC has made this one of the key issues in its Vision 2025 exercise.

The magnitude of these needs became apparent in 2018 when Bombardier announced a major reduction in its workforce, which would affect 2,500 aerospace positions in Québec after the completion of the Global 7500 and CSeries programs. A quick response from the industry showed that it could provide opportunities for this workforce and absorb departures.

This will certainly be one of the major challenges for the industry in the coming decade. Failure to recruit the technicians, specialists and university graduates it will need could affect its ability to sustain growth and attract foreign investment.

#### 9– A lever for education

The link between the level of education and productivity stems first and foremost from the need for graduates and skilled workers in an economy that requires an increasing level of qualifications. Educational attainment also allows for a greater degree of flexibility and adaptation of the workforce to change.

At the first level, aerospace, because of the specialization of its workforce, places a significant demand on the education system. But the relationship goes beyond the simple supplier-customer relationship. The needs of the industry have led it, through its cluster, Aéro Montréal, to develop organic links with the world of education. Not only does the industry's growth rely on educational resources, but conversely, its dynamism exerts a leverage effect on the education system itself. This interaction ensures that the industry contributes to the development of the world of education, the improvement of its adaptability, and its modernization.

This can be measured by the increasing number of institutions and programs dedicated to aerospace, including: the École des métiers de l'aérospatiale de Montréal (ÉMAM) within the Commission scolaire de Montréal; the École nationale d'aéronautique (ÉNA) at Cégep Édouard-Montpetit; specialized programs at Polytechnique Montréal, ÉTS, McGill University, Concordia University, Université Laval, Université de Sherbrooke, and Université du Québec à Chicoutimi; and the joint master's program with an aerospace engineering project sponsored by the Comité sectoriel de main-d'oeuvre en aérospatiale au Québec (CAMAQ). Polytechnique Montréal offers a bachelor's degree program in aerospace engineering. In addition, there is the Montreal Aerospace Institutes (MAI), a grouping of Montreal's aerospace industry and universities to meet the sector's current and future needs for highly qualified engineering personnel. This has led, among other things, to a master's degree in aerospace engineering between 11 companies and six universities, as well as a bachelor's degree in aerospace engineering between two educational institutions, Polytechnique and ÉNA, and two companies, Bell Helicopter and Bombardier. We are seeing the same type of synergy in Ontario, with close ties between the Ontario Aerospace Council and the academic world.

This synergy can have a more profound effect, by reducing the impediments that prevent Canadians, and particularly Quebecers, from establishing education's rightful place in their family life, culture and values. To meet its needs, the industry must make efforts to convince young people to choose aerospace. This can have a positive influence on the choices young people make to pursue their training or education, and help counter two shortcomings from which Québec suffers, namely a high dropout rate and low university graduation rates.

#### 10-Structuring impacts

Economic statistics don't tell the whole story. The contribution of a strategic industry may be manifested in less tangible, more difficult to measure and sometimes subjective elements. These have in common the fact that they have structuring and lasting effects on the economy and society, beyond the usual contribution to traditional indicators, such as production or exports.

We have retained some qualitative elements that can have this structuring effect in the case of aerospace: the national character of the industry and the activities of head offices; the contribution to industrial diversification; the fiscal contribution; and the positive effects of success.

#### National character and head office activities

Although the aerospace industry is made up of many foreign companies, it can be defined as domestic, with large Canadian-owned companies such as Bombardier, CAE and Héroux-Devtek, and foreign companies with roots in Canada such as Bell Textron and Pratt & Whitney.

Because of their Canadian origin or roots, these companies are more likely to be sensitive to Québec and Canadian economic and social interests. This dynamic is reinforced by partnerships with governments and interactions with stakeholders. Canada is likely to be better served by a rooted industry, and this national character may give it some control over its strategic choices.

This national character contributes to the presence of noble activities, those of head offices and policy centres whose needs for consultants and professional services generate tangible economic benefits. There are also intangible benefits, because decisions made here are more likely to serve Canadian economic interests than if they were made in a distant metropolis, because of greater sensitivity to national interests and vulnerability to government pressure. This is also the case for research activities, which we have discussed at length.

In both of these areas, aerospace plays a positive role that is unique to a domestic industry, which distinguishes it from the industry with which it can best be compared, automotive manufacturing.

In this regard, Bombardier's shift to business jets may have an impact, especially in the long term. The decision-making centres of new entrants, such as Airbus and Mitsubishi, are not in Canada. Moreover, even if it remains the largest company in the sector, and the largest industrial company in Québec, Bombardier's weight will be reduced and, consequently, its influence may be lessened.

#### Contribution to industrial diversification

Aerospace contributes to the strengthening of the manufacturing industry and the diversification of the industrial structure. Canada, like Québec and Ontario, has been severely shaken by the erosion of its manufacturing base and the decline in the level of manufacturing jobs. This decline is due in part to automation and process transformation, but it is also due to offshoring, the weakening or even disappearance of sectors that were based on protectionism, and the effects of globalization on the development of value chains.

Between 2001 and 2018, while Canada created about 4.5 million jobs, 420,000 manufacturing jobs were lost. The 2018 level of 1.552 million jobs is only 78% of the 2001 level. Some sectors have been hard hit, such as the automotive sector, which lost 30% of its workforce between 2001 and 2011. This sector has recovered, but not enough to regain half of the lost ground. But the aeronautics sector has withstood these pressures.<sup>41</sup>

<sup>41</sup> Employment by industry, annual, Statistics Canada (14-10-0202-01).

#### The positive impacts of success

We don't always realize how unique the success of aerospace is. Canada's importance in this global industry far outweighs its economic heft, and this in an area where Canada has managed to make a name for itself in ways other than geological or natural advantages. In fact, there is no other sector in the industrial world in which Canada has been as successful as it has been in aerospace.

These accomplishments can certainly be a source of pride and even a source of healthy chauvinism for a country that, despite its presence in the G8, remains a small economy, relatively uninfluential and often dominated by its American neighbour. Moreover, beyond questions of image, it is important for a nation that wants to play a significant role on the international scene to be able to count on economic sectors that establish its credibility and influence.

These cultural and sociological considerations are relevant to the establishment of public policies in economics, because efforts to promote development, if they are to be successful, must also be able to count on a certain social cohesion and the perception of success by citizens, factors that can foster a sense of pride. In order to achieve economic progress and obtain buy-in to its development efforts, a country needs success, wins and champions.

#### 11 – The role of government

In order to thrive in an enabling environment, the aerospace industry will also have to deal with issues that can affect attitudes towards it and that can be associated with social acceptability. We identify three issues. They are relevant to all economic activities, but they are expressed with aerospace specificities.

The first is the role of the state and the degree of support an industry receives. There are few sectors of economic activity that are not supported by the state, in Québec, in Canada, and almost everywhere in the world. It is therefore relevant, in a public debate, to ask whether these forms of support are appropriate. The question is more acute in the case of aerospace because of the widespread perception that this industry lives on the public purse and receives substantial subsidies. This can lead to mistrust of government measures to support the industry.

It is true that, historically, especially after the last world war, the aerospace industry has flourished thanks to government support, particularly from the federal government, which even nationalized some of these companies. Today, the aerospace industry can still count on significant government support, particularly for its research spending, through refundable loan programs and research tax credits for all companies, but the industry benefits greatly from these because of its significant R&D spending. In our opinion, this assistance is not excessive. Contrary to perceptions, public funding for aerospace is modest when we consider the size of the industry and the support provided to other industries. It is also very modest when we compare the Canadian situation to that of other countries that host aerospace industries, particularly through spending on military aviation, which is very significant in all the countries with which Canada competes. We will address this issue in detail in the second report.

Having said that, we must recognize that the Canadian aerospace industry would not have reached the level of development it has without this government support. Looking to the future, we can hypothesize that it will not be able to continue to grow without continued government support. Should policies to support this industry be continued? The second report, which accompanies this one, will show that this must be the case.

#### 12-Inclusion

The second societal issue is that of inclusive growth. This is an issue to which the aerospace industry makes a positive contribution through the quality of the jobs it provides – high wages, traditions of healthy labour relations, and opportunities for advancement.

The issue of inclusion can, however, be expressed in another way in the case of aerospace, through the regional distribution of its activities and its concentration in Québec. In itself, this concentration is not an anomaly and should not be a source of problems. It is normal that the activities of industries are not distributed across Canada in perfect proportion.

But this perception in Canada outside Québec that the aerospace industry is strongly Québecbased has social and political consequences: there is a certain resistance to the federal government supporting this industry, which would be perceived as supporting Québec rather than a structuring Canadian industry. It could even be suggested that this regional divide is coupled with a linguistic divide in the sense that many of Québec's major aerospace companies can be described as Francophone.

While localism is an unfortunate natural social reflex, it takes on greater proportions in Canada, a vast country made up of very different regional economies. These differences are reinforced by a structure of division of powers between the centre and the provinces that deprives the country of national policies in key areas, such as energy. The result is that Canada is an economically fragmented country whose citizens lack a national vision of their economy.

This has a definite impact on the aerospace industry. Its future success will depend in part on its ability to show that it is truly Canadian. And on the ability of all those who can contribute to the economic debate – whether they come from labour, government, academia or business – to convince Canadians that the success of an industry, even if it is less present in their own region, benefits them as well through its contribution to growth, to the balance of payments, and to central government tax revenues.

#### 13- Sustainability

The third of these universal challenges is most certainly that of sustainable development. The aerospace industry itself is a modern industrial activity, based on state-of-the-art processes and with a relatively small environmental footprint. It cannot be called a polluting industry. However, it does contribute to one activity, air transport, which is responsible for about 2% of total greenhouse gas emissions (GHG).<sup>42</sup> Although air transport has increased its energy efficiency by 1.5% per year since 2009, and is aiming for a cap on emissions in 2020, it is under international pressure to reduce emissions further. This issue was high on the agenda at the ICAO Triennial Assembly in Montreal in October 2019, where members reaffirmed their support for a global CO<sub>2</sub> offset mechanism, CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation), implemented in 2016.

But the fact remains that there will be growing calls for a reduction in the use of air transport.

This debate may indirectly affect the Canadian aerospace industry. The industry can respond to this debate, at least in part, by promoting its technological efforts to bring to market products and aircraft that reduce hydrocarbon consumption. We also note that the industry, like the two levels of government, has as a priority the development of carbon-neutral aircraft. It should be pointed out, however, that the business aircraft segment, associated with luxury, will be more vulnerable to this environmental debate.

## CHARACTERISTICS OF THE ALUMINUM INDUSTRY

In this section, to better illustrate the proposed analytical grid and highlight the fact that specific issues will have to be taken into account for each industry whose potential and strategic nature must be assessed, we apply it in less detail to another major Québec industry, namely Aluminum.

Aluminum is a metal produced by processing alumina, extracted from a sedimentary rock not found in Canada, bauxite. The conversion of alumina into Aluminum is done through an electrolysis process that requires very large amounts of electrical energy.

#### 1 – Size

Canada is the fourth largest producer of primary Aluminum in the world, thanks to Québec, which is responsible for 90% of Canadian production. In 2018, world production totaling 60 million tonnes was dominated by China with 33 Mt, or more than half. It was followed far behind by Russia and India with 3.7 Mt each, and Canada with 2.9 Mt.<sup>43</sup> Canada would move up to fifth place if Middle Eastern producers were grouped together. Canada's primary Aluminum industry is based on three companies: two large multinationals, Alcoa of the United States and Rio Tinto of Australia, and a jointly owned company, Aluminerie Alouette. They operate nine Aluminum smelters, eight of which are located in Québec and one in British Columbia. In Québec, it is a major industry, accounting for 4% of manufacturing shipments.<sup>44</sup>

#### 2-Potential

The future of the industry is not at stake. Demand for this metal is growing because of its lightness, strength, remarkable recycling potential, and its contribution to efforts to reduce the carbon footprint, particularly in transportation. The potential risks are more related to global market imbalances. China, the dominant producer country, is suffering from overproduction problems due to its slowdown in domestic growth, which is leading this country, whose production is mainly for domestic needs, to turn to international markets. The downward pressure on world prices is all the more marked as the Chinese industry can rely on state support which leads to distortions of market mechanisms, including dumping and unfair competition. These price pressures create a degree of uncertainty about the future profitability of operations and investment potential. In addition, there are political factors, such as the tariffs briefly imposed by the Trump administration.

#### 3-Resilience

The structure of the Canadian primary Aluminum industry is relatively simple: three companies, imported ore, nine smelters, and essentially one market, the United States. The industry, by the size of its players, its share of the world market, its competence and its know-how, certainly has a critical mass. It is a world-class player, capable of competing despite the challenges posed by competition from countries with cheap energy or low wages, thanks in particular to the performance of several of its facilities and the relatively low cost of energy.<sup>45</sup>

<sup>43</sup> U.S. Geological Survey, 2019, United States Government; Aluminum Facts, Natural Resources Canada, 2019.

<sup>44</sup> *Portrait of the Canadian Primary Aluminum Industry,* Aluminum Association of Canada.

<sup>45</sup> Québec Aluminum strategy, consultation paper.

The structure becomes more complex when you look at the entire Aluminum industry. According to a mapping of the industry carried out by AluQuébec,<sup>46</sup> there are 53 equipment manufacturers providing specialized services upstream of Aluminum smelters. Downstream, there are 1,400 companies that transform Aluminum and 43 equipment manufacturers that support them. In addition to the 7,000 jobs in the primary industry, there are 17,000 jobs in processing and 4,000 in equipment manufacturers. All these players are grouped together in a dynamic cluster, AluQuébec, which works to strengthen ties between producers, processors and users and, above all, to increase the level of processing.

#### 4- Contribution to exports

Primary Aluminum plays a very important role in Québec's exports. The metal ranks in second place, with sales of \$6.6 billion in 2018, or 7% of all Québec exports. On a Canadian scale, Aluminum ranks ninth. That in itself is a substantial contribution. Moreover, the value of these exports very significantly exceeds that of electricity, at \$1.173 billion. This simple fact demonstrates that the use of electricity to transform alumina into Aluminum clearly generates added value, particularly because of the physical capital and technology involved. On the other hand, this foreign trade balance sheet also has two negative elements: on the one hand, the bulk of production, more than 80%, leaves Canada without transformation, and on the other hand, these exports are not very diversified, with 84% going to the United States, which reflects a high degree of integration in the North American value chain.

#### 5-Innovation

There are two streams of research and development within the industry. The first one comes from the investments in R&D of the three participants from the primary industry. Currently, for example, a joint project between Rio Tinto and Alcoa with Apple, called Elysis, aims to develop a carbon-free process. A total of \$558 million will be invested for this purpose in a research centre in Saguenay, whose first phase of \$188 million has begun. For its part, the cluster is devoting significant resources to R&D and support for innovation through, for example, Rio Tinto Alcan's Arvida Research and Development Centre, Alcoa Innovation, an NPO to support processing industries, and the Aluminum Research and Development Centre. In addition, there are university research centres and numerous initiatives to develop new uses for Aluminum. This means that Québec can count on an interesting potential if it succeeds in making a name for itself in areas where the use of this metal will increase because of climate issues.

#### 6- Major investments

Because of its capital intensity, the primary Aluminum industry requires significant investment. In its Aluminum strategy, the Québec government estimated that the industry's investments totaled \$50 billion over the 2005-2014 period.<sup>47</sup> However, this process is not linear and is largely dependent on the global context, as shown by the postponement of projects worth \$300 million in the autumn of 2019 due, in particular, to world prices.

<sup>46</sup> Portrait of the Industry, AluQuébec, 2019.

<sup>47</sup> *The Future is Taking Shape*, The Québec Aluminum Development Strategy 2015-2025.

#### 7 – High productivity

Due to its capital-intensive nature, the primary aluminum industry also has a high productivity per hour worked, at \$100.60 per hour, which exceeds that of industries such as pharmaceuticals (\$97.20), automotive (\$80.70) and aerospace (\$70.40). It should be noted that this productivity increased by 24.4% between 2013 and 2018.<sup>48</sup> Data on downstream activities are more difficult to assess because of the dispersion of processing and usage activities across a variety of industrial sectors.

#### 8-Workforce

According to Statistics Canada,<sup>49</sup> the level of employment has declined significantly over a decade, from 16,653 to 9,713 between 2008 and 2018, (using a non-industry measure). This decline helps to explain the rise in labour productivity. Primary aluminum is an example of an industry whose success and development will no longer be accompanied by net job creation. It is also a high-wage industry, with an average weekly wage of \$1,482.03 in 2017.<sup>50</sup> The industry's payroll is equivalent to 4% of that of Québec's manufacturing sector.<sup>51</sup> However, as we have seen, employment is less in the primary aluminum industry than in the industry as a whole, for which official statistics are not readily available because they are broken down into various industrial sectors. Let us not forget that the aluminum industry is not immune to the issues of labour market maturity and labour availability that Québec is experiencing.

#### 9- Education

The Aluminum industry has an impact on the education system. Many educational institutions offer study programs leading to certificates and diplomas that meet the needs of the industry. These needs will be all the more pressing since, according to the Québec strategy: "Over the next few years, attracting the workforce, mainly to SMEs, will be the industry's main human resources issue. This problem lies in particular in the deficit of students in vocational and technical training."

#### 10- Inclusion: Regional Development

One of Aluminum's unique characteristics is the establishment of a cutting-edge industry, with its graduates, specialists and high salaries, in more remote regions, particularly in the Saguenay and the North Shore. This is obviously due to the location of Aluminum smelters close to hydroelectric resources. This location model has had a ripple effect on the development of the activities of equipment manufacturers, services and educational institutions. Added to this is the distribution of processing companies throughout Québec. This is a very important consideration in the context of efforts to ensure that all of Québec participates in development and has access to the benefits of growth.

<sup>48</sup> Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts. Statistics Canada (36-10-0480-01.

<sup>49</sup> Employment by industry, annual, Statistics Canada (14-10-0202-01).

<sup>50</sup> Average weekly earnings by industry, annual, Statistics Canada (14-10-0204-01).

<sup>51</sup> Portrait of the Canadian Aluminum Industry, Aluminum Association of Canada.

#### 11 - Sustainable development

Aluminum, thanks to its light weight and recycling possibilities, is a metal whose use contributes to the reduction of greenhouse gas emissions. In addition, the Canadian Aluminum industry has a competitive advantage in addressing the major issue of global warming because the electricity used for smelting is hydroelectric and does not emit greenhouse gases. Electricity used in China is generated from coal and in the Middle East from gas. Québec is thus the producer with the smallest carbon footprint in the world. In short, from a sustainable development perspective, Aluminum can make a positive contribution. And this is even more true of Aluminum produced in Québec.

The fact remains that electrolysis is not a neutral process because it relies on the use of carbon anodes whose degradation emits significant quantities of GHGs. For this reason, the production of primary Aluminum is the main GHG emitter in Québec. However, its emissions intensity has been reduced by two-thirds since 1990.<sup>52</sup> The ambitious Elysis project, still in the pre-commercial stage, will enable carbon-free production using ceramic anodes that emit oxygen instead. This is a useful contribution to the environment and potentially promising in terms of economic development.

The present advantages of Québec Aluminum, and even more so its future advantages from a carbon-neutral perspective, allow buyers to reduce their carbon footprint by choosing Québec-made metal. This is already symbolically the case with Apple, which purchased the first production from the Elysis system.

#### 12- The role of the state

The government intervenes in two ways to support the Aluminum industry. First, through its Aluminum development strategy, with relatively modest funding to promote the expansion of Aluminum and a greater degree of processing. Second, and most importantly, through agreements with primary metal producers to ensure globally competitive electricity rates since the cost of energy is the main determinant of the location of companies and their profitability.

Rio Tinto, which purchased Alcan, has facilities to meet most of its needs. It is nevertheless bound by a "continuity agreement" with the government, signed in 2006 by Alcan and renewed in 2018 by Rio Tinto. This agreement covers hydroelectricity production rights on Québec rivers and preferential rates for its additional needs, in exchange for a commitment to invest. Alcoa and Alouette have signed risk-sharing agreements that provide them with competitive rates, linked to metal prices and exchange rates, among other things, in exchange for investment commitments. Negotiations between generators and the government on electricity prices have often been acrimonious. And the agreements have been affected by the vagaries of global economic conditions that have led to the postponement or abandonment of investment projects. In addition, the price of electricity paid by Aluminum smelters has been at the heart of lively debates, which we will discuss in the following pages.

#### 13- Structuring impacts

These various factors lead to the conclusion that the primary Aluminum industry, with the industry surrounding it, is a strategic industry in terms of its weight, leadership and contribution to wealth creation, particularly through its investments and exports.

In addition to this, there are the elements we have described, such as its regional presence and its contribution to the development of a carbon-neutral economy. We must also take into account structuring factors, such as the presence of head office activities, particularly in the case of Rio Tinto, which also has a tradition of social roots inherited from Alcan, and the international leadership, know-how and influence that comes from being one of the world's major players.

However, progress remains to be made on the economic footprint of this industry. There is valueadded creation through electrolysis and primary Aluminum production, as well as through the first level of processing carried out by primary producers. However, the degree of secondary and tertiary processing of the metal remains an important issue. Over the years, this has given rise to lively debate, in which, however, the development of Québec know-how upstream, with equipment manufacturers, and the constraints that limit processing potential – the reality of the market, transportation costs, the nature of the value chain – have been underestimated. There has been a sustained effort in this regard by members of the ecosystem, starting with primary producers, and by the Québec government, for whom this issue is at the heart of the Québec Aluminum development strategy 2015-2025".<sup>53</sup> It aims to double the level of processing to increase the sector's exports from \$5 billion to \$10 billion. It is also the ultimate mission of the cluster, AluQuébec, through research and the promotion of Aluminum.

#### Aluminum, a little recognized positive contribution

In the public debate, the very positive contribution of Aluminum is not recognized because of the perception that this industry is supported by discounted electricity rates that are too costly for Hydro-Québec and Québec society.

The analytical grid we have proposed to identify strategic industries thus makes it possible to respond to these concerns. The negative perception associated with the rates granted to Aluminum smelters is largely due to the fact that the only criterion used to measure the merits of policies supporting Aluminum was job creation or maintenance. But if we break away from the dogma of job creation as a leading measure of economic success, we come to completely different conclusions.

Historically, negotiated rates have often been lower than the "L Rate" for large users, and sometimes lower than the revenues that Hydro-Québec would have earned from export sales. Support for primary Aluminum production has a collective cost through the loss of revenue suffered by Hydro-Québec and the lower dividends obtained by its sole shareholder, the Québec government.

As an example, we cite the summary calculations made when the agreement with Alcoa was signed in 2014, in a report by TVA Nouvelles, which is typical of the treatment usually reserved for this file:<sup>54</sup> "The agreement with Hydro-Québec provides for a rate of 3.3 cents per kWh. If the multinational company switched to the L Rate, or 4.7 cents per kWh, the electricity bill for Alcoa's three Québec smelters would have jumped by about 60%, from \$350 million to \$570 million." The report goes on to quote an independent energy analyst, Jean-François Blain: "And that's roughly equivalent to a subsidy in the order of \$65,000 per year per job."

<sup>53</sup> The Future is Taking Shape, the Québec Aluminum Development Strategy 2015-2025.

<sup>54</sup> Electricity rates: agreement reached at Alcoa, TVA Nouvelles, February 25, 2014.

Clearly, measured in this way, the cost of support appears prohibitive. It should be noted, however, that the baseline data are subject to caution because the rates charged under risk-sharing contracts are variable and depend, among other things, on the price of the metal. However, this measure, the cost of electricity rebates per supported job, which is often used in public debate, does not reflect the contribution of this industry and is not a relevant analytical tool.

This calculation is inappropriate because the Aluminum industry's contribution should not be reduced to job creation. This was already the case when these agreements were signed, and it is even more so in the current period of labour shortages.

If we want to evaluate the benefits generated by these rebates, and therefore the loss of revenue that Hydro-Québec may suffer with the performance contracts, we have to measure the industry's contribution based on its overall economic impact and its contribution to wealth creation, particularly through the effects on the economy of its substantial exports, its investments, its impact on regional development, its structuring effects of innovation, and so on. Preferential rate policy can then be seen in a completely different light.

Another factor must also be taken into account: the electricity market. The calculation of Hydro-Québec's revenue shortfall is based on the assumption that the Crown corporation would be in a position, if it were not required by government orders-in-council to grant preferential rates, to sell this electricity at a better price. But this is a theoretical debate because there is no evidence to suggest that such more lucrative opportunities exist.

First, it is highly unlikely that the Crown corporation could obtain these better prices from the primary Aluminum industry itself, because it would not be able to maintain its operations without competitive rates compared to those in other producing countries.

Second, there are no other buyers. The experience of the last decade shows that Québec has not been able to attract other industrial users for whom the price of energy is a locational factor on more advantageous terms for Hydro-Québec than contracts with Aluminum smelters.

And third, Hydro-Québec has had to deal with electricity surpluses for many years, and will continue to do so for many years to come. These surpluses are large enough that the Crown corporation is unable to sell its production and lose revenue. External markets are the main outlet for these surpluses, and these exports are a source of profit. However, the price obtained for these exports is, in many cases, similar to that of risk-sharing contracts.

And if the alternative outlets for Québec electricity are outside markets, the following question can be asked: Given that most of the primary metal produced is exported, and that electricity is a significant input in Aluminum production, can the activities of this industry be considered an indirect form of electricity export? If this is the case, one must ask whether it is economically preferable to export electricity directly, or to export it indirectly through the primary Aluminum industry, which places a significant value on inputs. To ask the question is to answer it.

These various considerations show that the activities of this industry have a number of structuring effects that may justify devoting hydroelectric resources to it at advantageous prices.

# CONCLUSION

This study examines the importance, in the development of economic policies, of breaking out of the mold, of freeing ourselves from the straitjacket of job creation as a public policy objective and as a measure of the success of economic development. This, given the demographic changes that have placed Québec and Canada in a situation of labour scarcity and declining unemployment rates.

We have proposed an approach other than job creation to measure economic success, which is based on wealth creation and a rising standard of living. It involves identifying the key determinants of wealth creation. This exercise has enabled us to propose thirteen criteria that make it possible to identify the industries and businesses that contribute to wealth creation and that can therefore be considered strategic and a priority in the choice of public policies.

Some of these criteria are of a general nature and constitute necessary but not sufficient conditions: the size of the industry, its development potential, its resilience. Others relate to the specific contribution to wealth creation: exports, innovation, investment, productivity, quality of the workforce, education, structural effects. Finally, three more contextual criteria are factors that must be taken into account in public policy choices: government support, inclusion and sustainability.

We then applied this approach to the aerospace industry, the largest manufacturing industry in Québec, and secondly, albeit in less detail, to the Aluminum industry, in particular to show that the approach could be adapted to different sectors.

We have just seen that, in the case of Aluminum, an analytical grid based on wealth creation rather than job creation convincingly defuses the negative perceptions caused by the electricity rebates granted to producers. These rebates, which represent a loss of revenue for the Crown corporation, may seem exorbitant when expressed as a subsidy per job. On the other hand, when we consider the industry's contribution to wealth creation – including its significant contribution to exports, its investments, its innovation, its impact on regional development, its world leadership – we see that these rate advantages allow Québec to maintain the activities of a structuring industry that plays a strategic role.

As for the aerospace industry, no one doubts its importance. But public opinion does not necessarily perceive how strategic it is. The study makes it possible to identify the factors that give it this character, beyond its size or jobs. We have also shown that it makes a significant contribution to the factors that ensure a rising standard of living. It is the main exporting industry in Québec, far ahead of all other exporting industries, and the fourth largest in Canada. It is overwhelmingly ahead of other industrial sectors in research and development in both Canada and Québec.

Because of its high degree of innovation, its contribution to the added value of this cutting-edge sector, its development of a specialized workforce, its leverage effect on education, and its place in world markets, aerospace is certainly the industry that has the most significant structuring effects on the Québec economy, and whose contribution to wealth creation is the most significant.

We believe that it has the attributes that make it a strategic industry that deserves to be recognized as a national champion. And as such, the pursuit of its development and success must be a priority of economic policy.

We will see, in a second study that accompanies this one, what are the implications for public policy.

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