


# Why Querétaro? The Development of an Aeronautical Manufacturing Cluster in Central Mexico



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*In recent years, an aeronautical manufacturing cluster has emerged in Querétaro state, Mexico. In 2013, the aeronautical industry in Querétaro state represented 10% of the state's gross product and employed more than 5,000 people, and further private investments of over US\$160 million related to the aeronautical industry were expected (Secretaría de Desarrollo Sustentable, 2014). This article investigates the causes for the development of such a cluster, drawing upon Brenner and Mühlig's (2013) study of 159 industrial clusters, and identifies both the key factors in the development of the cluster and what makes Querétaro attractive to foreign direct investment. The findings indicate areas for further research for potential cluster development in other regions of Mexico. The article concludes with the challenge facing the aeronautical cluster in Querétaro if it is to create a sustainable competitive advantage and compete on a global scale. © 2016 Wiley Periodicals, Inc.*

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In recent years, an aeronautical manufacturing cluster has emerged in Querétaro state, Mexico, far from the border with the United States where, traditionally, most heavy manufacturing took place (see Figure 1), and in an industry demanding high-quality standards in which Mexican firms had hitherto scarcely participated. According to Mexico's Ministry for Sustainable Development, in 2013 the aeronautical industry in Querétaro state represented 10% of the state's gross product and employed more than 5,000 people, and further private investments of over US\$160 million related to the aeronautical industry were expected in the state (Secretaría de Desarrollo Sustentable, 2014). This article investigates the causes for the development of such a cluster and, in so doing, will identify the key factors in the development of the cluster and what makes Querétaro attractive to foreign direct investment. These factors may indicate areas for further research for potential cluster development in other regions of Mexico.

We start with a brief overview of the aerospace industry and a description of the main features and the unique geographic location of Querétaro. There follows a review of the literature on industrial clusters and an application to Querétaro of the main findings of the literature on cluster development, which will help to answer the principal research question of this study: why Querétaro? In examining the aeronautical cluster in Querétaro, we draw upon Brenner and Mühlig's (2013) study of 159 industrial clusters, which, in a very detailed manner, identifies the causes of the creation, success, and development of industrial clusters.

**FIGURE 1** Map of Mexico, Showing State of Querétaro (Wikimedia Commons, 2013)



## The Aerospace Industry

In this section, we define the aerospace industry as it applies to Mexico as “the grouping of firms and institutions that deal with the research, development, and manufacture of passenger aircraft and their components.” In some of the literature, the aerospace industry includes the defense industry, but given the composition of Querétaro's aeronautical cluster, manufacturing for defense is limited at present, so we focus here on the civilian passenger aircraft sector.

There is high global demand for passenger aircraft. Emerging markets in Asia, the Middle East, Eastern Europe, and Latin America are driving the need for new aircraft, due to the increased demand for both business and personal travel. According to the International Air Travel Association (2015), international passenger traffic rose 7.4% year-over-year in March 2015; capacity increased 5.4% and the passenger load factor increased 1.2 percentage points to 78.9%. All global regions recorded year-over-year increases in demand except for Africa (International Air Transport Association, 2015). Also, in the coming years, aging aircraft fleets will have to be replaced by new, lower-fuel-consumption planes, especially in the developed economy markets, which tend to have the largest and oldest fleets. By the end of 2015, the high demand for aircraft had created a backlog of more than 12,000 orders for the main two aircraft builders, Boeing and Airbus. The sale and production of smaller business jets is also expected to continue to improve due to rising business confidence and the introduction of new, more fuel-efficient models. In recent years, the volume of passenger air traffic has been increasing by more than 5% annually and continues to do so (International Air Transport Association, 2015). Airbus expects strong growth in the industry over the next 20 years, predicting global demand for over 32,000 new passenger aircraft (Airbus SAS, 2015), and Boeing expects the Latin America region to experience the highest annual growth rate in the world over the same period, with a robust 6.9% growth (Industry Surveys: Aerospace & Defense, 2014).

Although Boeing and Airbus dominate the market for long-haul and medium-haul passenger aircraft, Bombardier Inc. (Canada), Embraer SA (Brazil), and Gulfstream Aerospace Corporation (United States) are strong competitors in the regional aircraft segment. Regional jets (RJs) are those with up to 90 passenger seats; however, Embraer and Bombardier now produce aircraft that seat more than 100 passengers. The Bombardier C-series, with 150 passengers and a range of up to 3,000 miles, is

already competing with Boeing and Airbus at the low end of the medium-haul market (Sanders & Michaels, 2010) and was expected to have over 300 orders by early 2016. New competition in this sector is expected to arrive, with Russian, Japanese, and Chinese manufacturers trying to compete for the market. In October 2014, Mitsubishi launched its first commercial aircraft (Industry Surveys: Aerospace & Defense, 2014).

Jet engines represent a major part of the cost of passenger aircraft. The jet engine industry is considered to be an oligopoly formed by GE's jet-engine division, Rolls-Royce's jet engine division, and United Technologies' Pratt & Whitney division. Jet engines also form part of Querétaro's aerospace cluster, along with firms that provide ancillary services such as engine overhaul and repair, and growth in the jet engines market is also linked to the expected growth in the large regional markets. If predictions for industry growth are realized, the aerospace sector in Querétaro appears to be well positioned to capitalize on it.

The following section discusses the location and industrial environment of Querétaro, in order to provide some insight on why it was chosen as a manufacturing site for the aeronautical industry.

## Querétaro: City and State

Querétaro is one of 32 states in the United States of Mexico. It is located in central Mexico, about 200 kilometers (130 miles) northwest of Mexico City. The state of Querétaro covers an area of 11,683 square kilometers—slightly smaller than the US state of Connecticut—and it is one of Mexico's smaller states, ranking 27th in size. Though small in size, Querétaro has recently enjoyed an average gross domestic product (GDP) growth of 5.5% per year, the highest among Mexico's states (Gallant, 2014). With a population of about 1.8 million, it has the country's second-largest state population and a population annual growth rate of 2.6% compared to a national average of 1.4%. This is mostly due to immigration from other states, which accounts for 23.11% of the state's total population (INEGI, 2014).

The state of Querétaro ranks as one of the safest in Mexico. The homicide rate for 2014 was 13.5 homicides per 100,000 inhabitants, much lower than the country's average of 19.7 homicides per 100,000 inhabitants. (Incidencia Delictiva 2014 Del Fuero Común, 2014). Querétaro ranks high on personal security, and its quality of life is well regarded; this partially explains the increased migration into the state in recent years.

The city of Santiago de Querétaro is the state's capital, with 60% of the state's population; it is commonly referred to as just "Querétaro." This combination of a large city in a small state, both with the same name, creates the mistaken impression that they are one and the same, especially since the distances between towns and villages are short and moving around the state is easy. Two of the major highways in Mexico, Route 45 and Route 57, connect the country's northwest and northeast through Querétaro. The same goes for railway lines; the train service, used mainly for cargo service, has its main two lines running north-south, both intersecting Querétaro. With Mexico's proximity to the US market, this location offers the advantage of relatively low transportation costs and short transportation times. Also, US firms find Mexican international policies easier to comply with than those of other low-cost countries in Asia (Arroyo-López & Bitran, 2009). Querétaro's location at the intersection of major highways and railways is a significant added value when transportation is needed for large intermediate goods, such as an aircraft fuselage or aircraft engines.

The state has one international airport located 22 kilometers (14 miles) from the capital and co-located with the Querétaro Aerospace Park, home to both the largest companies in the Querétaro aerospace cluster and the aerospace university, Universidad Nacional Aeronáutica en Querétaro (UNAQ), founded in 2005 to support the burgeoning aeronautical industry. UNAQ is Mexico's first and only aerospace university (Gallant, 2014), and it would not exist without Bombardier Aerospace's engineering and production facility. Establishing the school was the main incentive that the national and state governments used to lure Bombardier Aerospace to Mexico (Gallant, 2014), and it has since proven beneficial to all parties involved.

In 2006, there were only two aerospace companies in the region, employing about 700 people. By 2015, Querétaro boasted 33 aerospace companies, employing more than 5,000 people, and an estimated US\$1.5 billion in investment; Bombardier alone accounted for a third of that figure (Gallant, 2014). Bombardier arrived in Mexico from Canada in 1992 through the acquisition of a train manufacturing plant, Constructora Nacional de Carros de Ferrocarril, while Bombardier Aerospace started its operations in Querétaro in 2005, with a US\$200 million investment. Querétaro is different from the many towns and cities that provided large pools of unskilled and semiskilled labor for the "maquiladora" assembly plants that sprang up along the Mexico-US border in that Querétaro offers low-cost *skilled* labor. A manufacturing

engineer in Querétaro might make less than US\$60 a day, compared to the US\$35 an hour for an aerospace engineer in Quebec (Gallant, 2014), a significant cost saving for a foreign manufacturer. Today, UNAQ-trained graduates may end up working for Bombardier, for one of its local suppliers, or for one of the many other multinational firms that have been attracted to Querétaro in recent years, such as Safran (France), Airbus Helicopters (France/Germany), Hitachi (Japan), and Ericsson (Sweden). Furthermore, the barriers between local and international staff are more permeable in high-tech manufacturing than in low-tech manufacturing or assembly. It is easier for a multinational corporation (MNC) to relate to workers in a high-tech environment that has highly trained and knowledgeable employees. Creating this supporting relationship has led to the talent pool needed for the cluster development.

Querétaro has a tradition of industrial manufacturing. The metallurgical industry has been present there for more than three decades. The industry started with the automobile manufacturing industries that were established in the north of Mexico, close to the US border, in the 1950s and 1960s, for which Querétaro served as a second-tier supplier location. The metallurgical industry helped the creation of the automobile components industry and electronics industry in Querétaro (Morissette et al., 2013). As Arroyo-Lopez and Bitran (2009) point out:

Globalization permits [production in] almost in any place in the world, but in order to attain cost savings and increased productivity, organizations involved in global sourcing need to identify competent suppliers, synchronize the production of multiple specialized manufacturers and efficiently move products among multiple manufacturing locations and from production to consumption points. (p. 39)

In summary, Querétaro has many advantages when it comes to attracting new industries. It is fortunate to be in a strategic location in Mexico where it has easy access to major axes of communication, by road, rail, and air. It has been relatively spared from the violence and insecurity associated with the Mexican government's war on drugs, and this has been a factor in attracting labor from other parts of the country. It has a manufacturing tradition, first in metallurgy and, more recently, in the automotive industry, whose core functions and technologies are transferable to other industries. The presence of a technical university has provided a pool of skilled but relatively low-cost labor, which in turn has attracted foreign direct investment (FDI) and given rise to an aeronautical

cluster. In the next section, we provide an overview of the literature on industrial clusters: why and how they arise, the types of industrial clusters that exist, how they are configured, and the advantages of industrial clusters.

## Industrial Clusters and Location

Michael Porter (1990) is given credit for popularizing the term *industrial cluster* in his book, *The Competitive Advantage of Nations* (1990), where he stated, as one of the four determinants of a national advantage, that a country must have related and supporting industries to achieve, or at least to increase the chance to gain, a competitive advantage in an industry over other countries. However, those related industries are not evenly distributed through the economy; they tend to be located in specific regions, and they are connected through links of buyer/supplier relationships or links through common customers, technologies, or channels, forming relationships among them. Porter called them industrial clusters, and they form a central feature of advanced industrial economies.

We can define an industrial cluster as a geographic concentration of companies and institutions in a particular area of industrial activity. A cluster includes an array of linked related industries, including first- and second-tier suppliers, complementary products, and customers. It may also include government institutions, trade associations, and universities. Participants are linked to one another, and they benefit from the existence of the cluster, such that the flow of goods and services within the cluster is greater than the flow of goods and services connecting them to the rest of the national economy (Porter, 1998). An industry cluster differs from an industry sector in that it includes the whole value chain of a broadly defined industry, from the suppliers of parts and components through to the finished product, and it includes supporting services, shared labor pools, specialized infrastructure, and technology spillovers. Though first described by Porter (1990), the cluster literature has taken the concept a step further, explaining the relationship between industrial clusters and the economic performance of regions within nations, given the fact that industry clustering is a basic feature of regional economies and a strong influence on innovation, competitive-ness, and economic performance (Porter, 2003).

## Regional Clusters

The regional performance of clusters is better understood if we separate clusters into three kinds, each of which benefits a regional economy in different ways: (1) local industry cluster; (2) resource-dependent cluster; (3)



traded industries cluster. The *local industry cluster* refers to a grouping of industries that provide goods and services to local markets; *resource-dependent clusters* comprise those industries that are located where natural resources are found and rely on them as their main business feature—for example, in mineral extraction or fishing; *traded industries clusters* sell products and services across regions and often export to other countries. An example of a traded industry, in line with the cluster in Querétaro, is aircraft engines.

In the United States at the turn of the millennium, local industries provided 67% of employment, traded industries accounted for 32%, and resource-dependent industries accounted for 1% (Porter, 2003). However, traded industries are fundamental to prosperity as they have higher wage growth, higher productivity and higher patenting rates. Traded industry clusters appear to heavily influence the prosperity of regions. Clusters normally designated as high-tech, including aerospace engines and aerospace vehicles, account for about 9% of employment in the United States and in 2000 the average high-tech cluster wage, at US\$63,972 per year, was 48% higher than in other clusters (Porter, 2003). Since the Querétaro aeronautical cluster manufactures products that are sold both domestically and internationally, it fits the definition of a traded industries cluster. In this case, we are examining an industry that sells primarily outside its region and is not dependent on natural resources.

### Cluster Configurations

Clusters may have different configurations, based on their dependence on a predominant actor. Clusters may be dominated by several small and medium-sized firms, formed around a leading MNC, formed by many branch firms, or anchored by a government industrial district (Ingstrup, 2013). The configuration of the cluster may explain the dynamics of how the cluster works. In the case of Querétaro, the cluster was initially formed around an MNC, Bombardier, with significant influence from the local government, but as it has prospered, the cluster has shifted more and more to a multibranch configuration. Bombardier's aerospace confidence in Querétaro has proved contagious as the region has attracted suppliers and other support services, paving the way for the development and expansion of the cluster.

### Advantages of Clusters

Ironically, clusters promote both competition and cooperation. The competition helps the cluster to innovate and create new competitive advantages. Competition within the cluster stimulates the creation of new busi-

nesses. On the other hand, the proximity of companies and institutions creates better coordination and trust among the cluster participants. A cluster promotes productivity among its members. In various ways, it creates a talent pool of specialized and experienced employees from companies within the cluster, and it attracts outside talent toward the cluster. Companies in the cluster benefit from active, collective efficiencies, such as improved access to knowledge and from job-specific training at local higher education institutions (Bell, Tracey, & Heide, 2009). A growing cluster is regarded as a sign of opportunity, and success stories related to the cluster attract talent. As immigration restrictions are currently limiting the number of innovative, highly skilled individuals entering the United States or remaining in the United States after earning advanced degrees (Porter & Rivkin, 2012), the availability of talent outside the United States is growing, and this supports the creation or relocation of enterprises outside the United States that can offer employment to skilled labor.

A cluster creates a specialized supplier base, and the informal relations between people working in the cluster both develop trust and facilitate information flows. For example, it is easier to catch up on information if you run into a coworker while attending a parents' meeting at your child's school. Romanelli and Khessina (2005, p. 347) state: "When individuals interact in multiple settings—for example, at work, at industry association meetings, at meetings of local civil groups, and over the proverbial backyard fence—their opportunities for discovering and socially negotiating a shared understanding of themselves and their distinctiveness from others increase substantially." Similarly, innovation-related operations are located more efficiently in a cluster because firms in clusters can benefit from technology spillovers and tend to be more innovative than firms that operate independently. High-tech firms in California's Silicon Valley exemplify this notion. Bell (2005, p. 293) notes: "Managers must recognize the importance of network ties, especially their managerial network ties, on the performance of their firms."

### How Are Clusters Created?

Brenner and Mühlig (2013) examined 159 local industry clusters and identified three conditions that have to be met for a cluster to emerge and prosper. First, the emergence of a cluster is only possible if the relevant factors and features (prerequisites) are present in the region. These prerequisites do not determine where the cluster emerges, but they do influence the likelihood of its emergence. Second, an actor or actors have to be present and

make use of the potential for cluster emergence. Some action has to take place, either by a founding firm or some triggering event, such as a technological innovation, that mobilizes the actors in the region. Third, given the presence of the prerequisites and a triggering event, a self-augmenting process of growth occurs.

Clusters can create clusters. The existence of supplier industries, related industries, or even related clusters provide the start-up basis for new cluster development (Porter, 1998). Also, the intersection between clusters creates new clustering possibilities. Clusters may also emerge from MNCs' location decisions. Through reduced barriers to FDI, globalization has facilitated moving some or even all of an MNC's operations to pursue location advantages such as low wages, taxes, and utility costs. Cluster rationality suggests that it is better to move groups of linked activities to the same place than to spread them across numerous locations, due to the advantages that clusters offer. This occurred with the Japanese auto industry in the 1980s; as the major Japanese manufacturers established production and assembly plants in North America and Western Europe, their main Japanese suppliers relocated with them, exposing local companies to the best rivals from around the world. Sophisticated leaders understand that a company can benefit from building local clusters and upgrading the business environment (Porter & Rivkin, 2012). In the following section, we examine the three preconditions for cluster existence in the context of Querétaro, and we discuss how the establishment of the aeronautical cluster has resulted in the region becoming a powerhouse of the Mexican economy.

## The Aeronautical Industry Cluster in Querétaro

Internalization theory (Buckley & Casson, 1976, 1985) and Dunning's (1979) eclectic paradigm of FDI help to explain why MNCs might choose to invest in Mexico in general, and in Querétaro in particular. However, they do not provide a full explanation for why an industry cluster has emerged there. Romanelli and Khessina state: "Why industry clusters locate in particular regions is an important but unevenly answered question in organization theory" (2005, p. 344). Perceptions rather than resources or expectations can trigger investment decisions, and regional economies grow and change as a consequence of the resources that they attract and retain based on their industrial identity. Wage levels, skills availability, utility rates, taxes, subsidies, shipping costs and reliability, local productivity, and supervision costs are

among the factors affecting location decisions (Porter & Rivkin, 2012). In 1982, when the Honda Motor Company decided to establish a manufacturing base in the United States in order to evade import quotas and tariffs, it chose not to relocate to Detroit or other traditionally industrial areas where its US competitors were located. Instead, it chose Maryville in rural Ohio, where in 1979 Honda had already established a successful motorcycle plant. By 2014, Honda had invested over US\$4 billion in the Maryville area; 16 other Japanese firms had also established operations there, with over 6,000 employees and a gross investment of almost US\$5 billion. In the case of Querétaro, however, there was already a strong manufacturing tradition present that formed the basis for a new, related cluster.

Brenner and Mühlig (2013) ranked the various factors that determined the emergence, triggering events, and self-augmenting processes in the development of the local industry clusters that they studied. In this section, we apply Brenner and Mühlig's study as a framework to the specific case of Querétaro's aeronautical cluster in order to examine what caused its establishment and success. Based on what we know about Querétaro and the aeronautical cluster, with the weighted relevance of each factor, Brenner and Mühlig's approach can give a good indication of the most relevant factors. As mentioned before, three conditions must be met: the existence of prerequisites, the presence of an actor or a triggering event, and a self-augmenting process.

### Prerequisites

These are related to Porter's (1990) factor conditions; the existence of favorable factors of production in a region make the emergence of a local cluster more likely. The factors are ranked here by their relevance according to Brenner and Mühlig's findings, and the number of times that each particular factor was mentioned as important among the 159 cases is noted within parentheses:

*Qualified Labor* (105): Qualified labor possesses knowledge and skills obtained through education and practice. This is clear in Querétaro's case, with both the creation of UNAQ and the knowledge obtained through the metal and automobile manufacturing industries. Given that those clusters are related, skills could readily be converted and used in the aeronautical industry.

*Networks* (78): Usually, networks are assumed to develop during the emergence of an industrial cluster, but sometimes existing networks function as a supporting prerequisite. There was already a network of

companies working together before Bombardier initiated operations in Querétaro. These companies later became Bombardier's suppliers, providing the needed network for the development of the aeronautical cluster.

*Universities and Public Research* (70): In this case, the university was identified as one of the main prerequisites demanded by Bombardier, and it became the main incentive for investment provided by the local government.

*Tradition* (66): Tradition was not present as a prerequisite for the cluster development in Querétaro. There was some tradition in textile manufacturing that began in the 1830s and the later development of segregated industries after the development of a train station in 1882 (Rivera Aguilar, 2014). However, the textile tradition is unrelated to the aeronautical cluster.

*Industrial Structure* (61): The existence of a supporting industry in a region may provide technologies or skills due to similar activities present. In Querétaro's case, it was the metallurgical and automobile industries.

*Local and National Policies* (56 and 47): Specifically, the local industrial policy, though not totally existent before the cluster creation, developed along with it and provided support to the aerospace industry and confidence to investors.

*Culture* (52): The local culture influences attitudes toward self-employment, cooperation, or innovation. The local culture in Querétaro has always favored attracting a hardworking community from other regions of Mexico that wants to develop a prosperous zone away from Mexico City.

*Geographic Location and Transportation Infrastructure* (51 and 52): This includes the presence of natural resources, access to transport infrastructure, and geographical location in relation to other regions. In Querétaro's case, its geographic location gives it a unique strategic position within the country that facilitates easy transportation of goods both within Mexico and to the North American market.

*Local Demand* (49): Not present in the Querétaro aeronautical cluster.

*Suppliers* (43): The preexistence of supplier firms in the region helped make it more attractive to Bombardier and to those that followed.

*Quality of Life* (31): Attracting talented and highly skilled people to the region is fundamental for cluster development, and that has been feasible due to the

high quality of life in the Querétaro region. People have migrated to Querétaro due to insecurity in other parts of Mexico. Querétaro has the reputation as one of the best and safest places to live in Mexico.

*Local Capital Market* (30): Not a strong factor. The availability of financial resources in the region that can boost start-ups and innovative activities is no different in Querétaro than in any other developed or urban region in Mexico.

*Wages* (23): Comparatively low wages are put forward as a cause for the emergence of a cluster, and the case holds for Querétaro's aerospace cluster. As stated before, there is a significant wage difference for skilled labor in Querétaro that helps explain why the cluster has taken off. Though the relative weight of wages as a factor may seem low, Brenner and Mühlig (2013) found that the wage factor is significant only in developing countries. "No differences were found between developed and developing countries, except the importance of wages that only holds for developing countries" (pp. 493–494).

*Urbanization* (21): Cities are the breeding ground for ideas and technological developments. Querétaro is a vibrant, small city in a small region. The population is at the same time large enough for new ideas to arise and small enough for people to get to know one another and spread ideas.

*Technology Parks* (21): While the aeronautical park helped in the development of the aeronautical cluster in Querétaro, it was not a prerequisite but a result of the cluster.

## Triggering Events

A cluster may emerge in places that have less favorable conditions but where a triggering event occurs. Five triggering events are considered in the Brenner and Mühlig (2013) study and are linked here to the Querétaro cluster ranked in order of importance:

*Founding of Leading Firms* (62): One successful firm can be the starting point for the emergence of a cluster that spurs the emergence of numerous smaller ones. This is very much the case in the development of Querétaro's aeronautical cluster. It was Bombardier's arrival (with government assistance) that triggered the establishment of the aeronautical cluster.

*Specific Policy Measures* (53): Policymakers actively create or support the emergence of local clusters. There were no specific policy measures created for the Querétaro

cluster, although the support of the local and national governments could be viewed as relevant in this case.

*Historical Events* (52): Historical events, such as wars, may cause the emergence of clusters, but that was not the case here.

*Promoting Activities* (22): A group of individuals develop a vision for the region and promote the emergence of a cluster. This was not specifically clear in Querétaro's case, though some promoting activities by the local governments helped to develop the cluster after its initial formation.

*Crucial Innovations* (15): A specific innovation causes successive developments that lead to the emergence of a cluster. It was not the case here.

*Chance* (14): Some cluster developments are due to chance, but it was not clear that chance helped triggering this cluster surge.

## Self-Augmenting Processes

Once a cluster is formed, self-augmenting processes need to occur for it to be successful. Ranking them in order of importance found in Brenner and Mühlig (2013), we elaborate here on the impact of each process on the Querétaro aeronautical cluster:

*Accumulation of Human Capital* (116): Local firms contribute to the education of the local labor force and attract qualified people to the region. That is indeed the case here through the talent existing in the related industries, the creation of the specialized university, and the development of the cluster's own talent.

*Cooperation among Firms* (87): Related and overlapping buyer–supplier relations and knowledge spillovers. There is no strong evidence, except from the natural cooperation fostered by the cluster itself, to affirm that this is happening in Querétaro.

*Choice of Co-Location* (83): The conscious decision to establish a firm or firm site in a region where many competitors are already located is evident in Querétaro's cluster. Competitors, especially competing suppliers for the cluster's main manufacturers, are settling in Querétaro.

*Intra-Industry and Inter-Industry Spillovers* (81 and 46): The exchange of knowledge between actors in the cluster generates both intended and unintended spillovers to firms within the industry or to related industries. In Querétaro, the intra-industry spillover is likely due to the small population size and the presence of the

aeronautical park, where aeronautical companies are located within close proximity to one another.

*Interaction between Firms and Public Education and Research* (66): There is interaction between aerospace firms and the higher education institution, UNAQ, but since most of the research is being done in the companies' home countries, little research is being conducted on-site. "Innovation is seldom radical in aeroplane manufacture but rather incremental, hence R&D is less pronounced an element" (Cooke & Ehret, 2009, pp. 562–563).

*Spin-offs* (60): Local clusters generate new clusters, and successful firms generate spin-offs that may contribute to an augmented or different cluster. This is not the case so far in the Querétaro cluster but, as the cluster develops, spin-offs are likely to occur in the future.

*Interaction between Firms and Local Policymakers* (49): Policymakers influence not only the emergence of clusters, but also their continuity. Policymakers seek to develop the cluster's prosperity. They advertise it and openly use it for their own political benefit. In Querétaro's case, policymakers include the city government and the local state government, which have organized trade fairs, events, and trade missions and offered tax breaks and other incentives to companies.

*Interaction between Firms and Local Public Opinion* (44): Specific attitudes are developed within a region, and they could not be more positive in Querétaro's case. Because of the region's economic success and its ability to attract FDI from major MNCs, local people are proud of their city and state. Rated on a government survey (Índice de Calidad de Vida [Quality of Life Index], 2015), Querétaro was ranked the seventh most livable city among 52 in the country, based on its quality of life index.

*Interaction between Firms and Venture Capital Firms* (35): There is no noticeable difference in the interaction between firms and venture capital firms in this region.

*Buyer–Supplier Relations* (30): The presence of similar firms attracts suppliers to the area, which makes it more appealing to more firms to join the cluster. This has happened in Querétaro.

Following Brenner and Mühlig (2013), a summary table of the relevant factors and mechanisms causing the emergence of local industrial clusters as they apply to the aerospace cluster in Querétaro may be found in Table 1. As shown, many of the prerequisite factors existed, while others developed during the creation of the aerospace cluster in a somewhat serendipitous fashion.



**TABLE 1** Factors Promoting the Establishment of the Aerospace Cluster in Querétaro

Factor	Explanation	Note
<b>1. Prerequisites</b>		
Qualified Labor	Local labor possesses knowledge and skills obtained through education and practice	Previous related industry knowledge in metallurgy and automotive industries
Networks	Existing networks (social) may bring support for the creation of a cluster	Networks were already in place
Universities and Public Research	Perform a function as a source of entrepreneurs and cooperation partners	Local government's creation of UNAQ to attract Bombardier
Industrial Structure	Presence of other supportive industries in a region or similar activities	Metallurgical and automotive industries
Culture	Fosters attitudes toward self-employment, cooperation, or innovation	Internal immigrant hardworking community
Geographic Location and Transportation Infrastructure	Presence of natural resources, access to a natural transport infrastructure, geographical specificities in relation to other regions	Strategically positioned on Mexico's main transportation axes
Suppliers	Presence of supplier firms in a region	Suppliers from the metallurgical industry
Quality of Life	Attracts highly skilled people to the region	Querétaro has the reputation as one of the best places to live in Mexico
Wages	Comparatively low wages are put forward as a cause for the emergence of the cluster	Significant wage difference for skilled and trained labor compared to Canada
Urbanization	Cities are the breeding ground for new ideas and thus new technological developments	Vibrant small city in a small region
<b>2. Triggering Event</b>		
Founding of Leading Firms	One successful firm acts as the starting point for the emergence	Bombardier's arrival acted as a trigger to develop the aeronautical cluster

**TABLE 1** Factors Promoting the Establishment of the Aerospace Cluster in Querétaro (*Continued*)

Factor	Explanation	Note
<b>3. Self-Augmenting Processes</b>		
Accumulation of Human Capital	Education of the local labor force and qualified people attracted to the region	Existing related industries plus aeronautical industry growth fostered the cluster
Choice of Co-location	Conscious decision to establish a firm in a region where already many competitors are located	The effect is taking place; businesses are setting up presence due to the cluster
Intra-industry and Inter-industry Spillovers	Intended and unintended exchange of knowledge between the actors	Aeronautical park and aeronautical companies are located in proximity to each other
Interaction between Firms and Public Education/Research	Regional firms and the local public education and research influence one another	Interaction is occurring—but limited research is being performed
Interaction between Firms and Local Policymakers	Local policymakers influence the emergence of local clusters mainly by taking specific actions	Local policymakers openly address and seek cluster prosperity
Interaction between Firms and Local Public Opinion	Specific attitude develop within a region	Very positive and proud local public opinion
Buyer–Supplier Relations	Presence of many similar firms in an area also attracts suppliers to this area	Suppliers are attracted to the cluster

## Discussion

Location decisions for MNCs are based not just on resource allocation decisions in order to obtain a competitive advantage. Strategic considerations such as access to technical knowledge and management expertise now play a much larger role, and MNCs are now selecting locations where they can deploy their core competences (Dunning, 1998). For Bombardier, the location advantages of Querétaro were evident (see Table 1), offering a pool of skilled, relatively low-cost labor, an advantageous geographical location with excellent communication links to the rest of the country, a supportive local government that was willing to invest in a technical university, the presence of

related metallurgical and automotive industries with their supply-chain network, and a location with the reputation for a high quality of life that would attract skilled workers and managers from other regions of Mexico. Furthermore, the knowledge and skills of a related cluster were already in place. Clusters do overlap, which means that some skills, markets, suppliers, knowledge, or talent may cross over between clusters. Specifically, Querétaro has a tradition of metal manufacturing that later evolved into a supplier base to the automobile industry; the aerospace engine cluster is linked with the auto manufacturing cluster (Porter, 2003) and that link has supported the surge of the aeronautical cluster in Querétaro.

For an enterprise like Bombardier, moving its operations from Québec to Mexico seemed feasible given that most of the prerequisite conditions could be met. Bombardier's decision to establish its aeronautical operation in Querétaro was founded on several factors: rising competition from Brazil's Embraer; the trade advantages of the North American Free Trade Agreement (NAFTA); trade agreements between Mexico and the European Union and Japan; a generous offer from Querétaro's government, including a land use concession; the presence of aeronautical suppliers already operating in the region, such as Honeywell and Delphi; but, most importantly, the preexistence of metallurgical and automotive industries and the capabilities that those industries generated. The Bombardier plant currently manufactures the aft fuselage for Bombardier's Learjets Global 7000 and Global 8000. European firms that have been attracted to the aeronautical cluster include Safran Mexico, owned by SNECMA, France (aircraft engines, nose landing gear); Industria de Turbo Propulsores, Spain (aircraft engine maintenance and repair); Aernnova Aerospace, Spain (metallic components and aircraft structural assembly); Elimco-Prettl Aerospace, a Spanish-German joint venture (electrical wiring harnesses for aircraft); and Navair, Spain (electrical cables for aircraft).

By late 2014, over 70 businesses were operating in the Querétaro Aerospace Park, creating a 15% annual growth rate in the aerospace sector versus 10% nationwide. By then, investment in Querétaro had totaled US\$1.5 billion, and this was expected to double over the next five years, creating a demand for more trained and specialized workers and for new industrial parks (More Aerospace Firms for Querétaro, 2014). The Commercial & Contracts director of Elimco-Prettl encapsulated the attraction of the Querétaro cluster thus:

Being in Querétaro gives you enormous advantages: you're well connected to other states like Guanajuato

and have access to airports in Mexico City and Querétaro. Also, Prettl imports a lot of materials via Veracruz and Laredo, so these two factors—geographical location and existing infrastructure—were central to the signing of the agreement. However, an even more important factor was the boom Querétaro's aerospace sector has experienced. Over the last three or four years, the state government has been promoting the sector by organizing fairs, events and trade missions and offering tax, trade, and strategic incentives to companies like ours. It's a set of conditions that, together, paint a bright development outlook. (Elimco-Prettl Aerospace, wired for success, 2014)

## Conclusions and Recommendations

Bombardier Aerospace's experience in Querétaro has illustrated many of the prerequisites, the triggering event, and the self-augmenting processes that are required in order for an industrial cluster to develop. But the creation of Querétaro's aerospace cluster was not by chance. The existence of related industries in the right location at the right time, with the right skills at a competitive cost, allowed the aeronautical cluster to be established and to grow. The local government made the right decisions and offered the right incentives, but Querétaro also provided the infrastructure and security for those already skilled, or willing to become skilled, to relocate there.

The surge and development of the aeronautical cluster has provided a new path for the economic development of the region and the country. It supports Porter's development proposition that "the performance of regional economies is strongly influenced by the strength of local clusters and the vitality and plurality of innovation" (Porter, 2003, p. 549). It helps the country and the region to move further up the value chain, shifting the value from low-cost manufacturing toward a knowledge-based economy. The Querétaro aerospace cluster still relies on wage differentials compared to other countries, but this time, maybe for the first time in Mexico's manufacturing history, it may be different. This is an industry that needs different knowledge and skills, and creating those skills proves to be a big social differential since it promotes wealth and prosperity. An aeronautical cluster, as opposed to a low technology cluster, is based on human capital, and creating human capital will only create prosperity. Thomas Friedman recognized this in an article in the *New York Times*, "How Mexico Got Back in the Game," in which he stated:

Mexico has ... greatly increased the number of engineers and skilled laborers graduating from its schools. Put all that together with massive cheap natural gas finds, and rising wage and transportation costs in China, and it is no surprise that Mexico now is taking manufacturing market share back from Asia and attracting more global investment than ever in autos, aerospace and household goods. (Friedman, 2013)

Regional economic policies should be particularly attuned to traded clusters because these support higher wages and drive local employment. That is what Querétaro's cluster represents: a traded cluster that has brought prosperity to the region. Regional economic performance is strongly affected by the strength of clusters and the vitality and plurality of innovation (Porter, 2003). But there are risks in Querétaro's aeronautical cluster. Porter (2003) notes that it is dangerous to rely on just a few related industrial clusters because doing so may expose a region or a nation to the volatile economic cycle or to business shocks. If there is a downturn in the aerospace industry, the impact on the cluster and on Querétaro's economy may be severe. Prosperity in the aerospace sector depends on developing ever greater capabilities and competencies (Cooke & Ehret, 2009). Labor, universities, and public research institutions should be especially relevant in industries that place great importance on technological innovations (Brenner & Mühlig, 2013). Research and development of new technologies is the missing link in Querétaro's aerospace cluster and this may be the way to provide security and stability to the region in years to come.

We are living in globalized times, when a firm's assets have become mobile. Increasingly, intellectual capital has become the key to wealth creation. As explained in *The Economist*:

Measured in value-added terms, however, the importance of goods trade tumbled, from 71% of world exports in 1980 to just 57% in 2008, because of the increasing weight of services in the production of traded goods. Much of the value of an iPhone, for example, derives from the original design and engineering of the product rather than from its components and assembly. (The World Economies: Arrested Development, 2014, p. 9)

Added value is no longer about manufacturing. If Querétaro wants a bigger share of the value chain, then knowledge, and not just low-cost manufacturing labor,

has to be the driver in the cluster development in years to come. But even further, if Querétaro wants to compete globally and create a sustainable competitive advantage in the aeronautical cluster, it has to undergo further change and move toward aerospace research and development. Currently, most design and innovation, the bigger prize in the value chain, is being done in each company's home country.

Applying Brenner and Mühlig's (2013) framework, we have examined why Querétaro ended up as the place in Mexico for the emergence of an aeronautical cluster, and we have shown that the existence of prerequisite factors, the triggering event of Bombardier Aerospace's decision to establish a manufacturing plant there, and the subsequent self-augmenting processes all combined to create a dynamic industrial cluster. The experience of Querétaro provides further opportunities for research. For example, researchers should investigate the extent to which steps are currently being taken to further develop the cluster, moving it further toward a knowledge-intensive cluster rather than just a manufacturing cluster. Will the aerospace cluster in Querétaro provide support for the contention that high-technology firms tend to pursue cluster-based acquisitions (Yurov, Greenstein, Shanley, & Potter, 2013)?

The framework used here could also be applied to direct decisive action to develop new clusters in different industries in Querétaro, or to develop clusters in other locations. Are there other nascent clusters being drawn to the Querétaro area to take advantage of the industrial basis already developed there? Are there other areas of Mexico where the presence of an industry such as metallurgy or chemical manufacturing could form the basis for a new industrial cluster? It would also be interesting to examine whether the "maquiladora" assembly plants along the Mexico/US border could follow Querétaro's path and use their current skills to move up the value chain toward a new cluster. For example, those involved in textile manufacturing might move to a higher-value, overlapping cluster, such as the design of apparel or sporting goods. Making the transition from manufacturing high-tech products to inventing them is a huge crucial leap but Querétaro may be about to make it (Gallant, 2014).

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