Journal of Open Innovation:
Technology, Market, and Complexity

Article

An Analysis of the Competitive Actions of Boeing and Airbus in the Aerospace Industry Based on the Competitive Dynamics Model

Ayoung Woo, Bokyung Park, Hyekyung Sung, Hyunjin Yong, Jiyeon Chae and Seungho Choi

Special Issue
Open Innovation and Business Model in the Global Economic Crisis Which is Triggered by the Pandemic of COVID-19

Edited by
Prof. Dr. JinHyo Joseph Yun, Prof. Dr. Lei Ma and Prof. Dr. Sungyong Choi

MDPI

https://doi.org/10.3390/joitmc7030192

Journal of Open Innovation: Technology, Market, and Complexity

MDPI

Article

An Analysis of the Competitive Actions of Boeing and Airbus in the Aerospace Industry Based on the Competitive Dynamics Model

Ayoung Woo, Bokyung Park, Hyekyung Sung, Hyunjin Yong, Jiyeon Chae and Seungho Choi *

Department of Management and Strategy, Ewha School of Business, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul 121791, Korea; wooayoungofficial@gmail.com (A.W.); bobakskydp07@ewhain.net (B.P.); julzsung0906@gmail.com (H.S.); dragoning@ewhain.net (H.Y.); cowldus0529@naver.com (J.C.)

* Correspondence: choise@ewha.ac.kr; Tel.: +82-232-774-138

Abstract: Focusing on competitive dynamics, this study examines the strategic issues Boeing has faced in seeking to maintain its leading position in the airline industry. Boeing's status as a first mover in the aerospace industry has made it a world-leading company; however, the external environment and various pressures have allowed Airbus to emerge as a strong competitor. By conducting a descriptive case analysis, this paper identifies the competitive issues between these two giants, analyzing continuous action and reaction processes throughout the whole history of the airline industry. Finally, by examining Boeing's main strengths, business diversification options, and risk-taking culture, this paper suggests ways Boeing can retake its place as the industry leader.

Keywords: competitive dynamics; action and reaction; first mover advantage; open innovation; aerospace industry; Boeing; Airbus

Citation: Woo, A.; Park, B.; Sung, H.; Yong, H.; Chae, J.; Choi, S. An Analysis of the Competitive Actions of Boeing and Airbus in the Aerospace Industry Based on the Competitive Dynamics Model. *J. Open Innov. Technol. Mark. Complex.* **2021**, *7*, 192. https://doi.org/10.3390/joitmc7030192

Received: 19 July 2021
Accepted: 11 August 2021
Published: 31 August 2021

1. Introduction

Acknowledging the competitive actions of rivals is critical to firms' survival. The central goal of this research is to elucidate the competitive dynamics between Boeing and Airbus in the aerospace industry and to demonstrate how they improve performance and strengthen their competitive strategies in response to one another's moves. The competitive dynamics literature examines such struggling for position and its implications for organizational outcomes. A series of moves and countermoves among firms can create new patterns that sabotage rivals' profits and even threaten their survival [1].

Boeing is the world's largest aerospace company and the leading manufacturer of commercial jetliners, defense, space and security systems, and service provider of after-market support [2]. As America's largest manufacturing exporter, Boeing supports airlines and U.S. and allied government customers in more than 150 countries [3]. Its products and services include commercial and military aircraft, weapons, defense systems, and advanced communication systems [2].

The COVID-19 pandemic forced Boeing to cut 12,000 jobs, a grave crisis both within the company and the U.S. aviation industry. Boeing also announced that it suffered a first quarter pre-tax loss of USD 1.5 billion after the pandemic began [4]. Since the pandemic limited most movement around the globe, the International Air Transport Association forecasts that global travel demand will not recover to pre-pandemic levels until 2024 [5]. Obviously, the recovery of international long-haul travel is expected to take longer than that of shorter, domestic routes.

This paper employs a competitive dynamics model to examine the interactions and improvements of each firm and, more specifically, how Boeing managed to gain advantages to maximize its performance. This approach allows us to understand the history of competitive moves in the aerospace industry and gain insight regarding the competitive

dynamics between Boeing and Airbus. We mainly focus on the specific action and response characteristics—that is, the competitive moves and countermoves—of these two companies.

Open innovation was one of Boeing's main strategies to regain its competitive advantage in the market after Airbus launched A380 [6] (pp. 129–139). Boeing initiated open innovation in its engineering and manufacturing divisions as well as its R&D department [7] (pp. 62–78). However, the initiative turned out to be a failure in controlling the assembly of the 787. This indicates that firms should outsource only non-core parts and not rely too heavily on suppliers [8]. A thorough early analysis of the challenges and potential difficulties open innovation faced might have enabled Boeing to avoid some losses [7] (pp. 62–78). Thus, maintaining a balance between management control and open innovation is critical for firms' survival.

Finally, these results suggest that the competitive dynamics between Boeing and Airbus eventually served as a positive stimulus for both companies. To maintain its leading position in the aerospace industry, Boeing invested substantially in R&D, which eventually fueled the company's technological progress and innovation. However, the results also reveal that the fierce competition between the two firms generated side effects. Indeed, Boeing's risk-taking culture—often regarded as one of its strengths—introduced the possibility of general disaster, a possibility this paper elaborates on.

To achieve our research goals, we first review literature related to the concept of competitive dynamics and then analyze Boeing's behavior in relation to Airbus as the main research example in our model. By analyzing Boeing's entire process, this paper provides deeper insights into the study of competitive dynamics.

2. Literature Review

2.1. The Concept of Competitive Dynamics

Existing competitive dynamics research has claimed that "competition" is a most crucial facet of competitive dynamics; the majority of studies have therefore focused on the competitive interactions between given firms and their rivals [9]. Thus, the literature describes specific behaviors in the process of competition as well as the responses of competitors. Firms become increasingly competitive during certain stages, including when launching new products, seeking to increase market share, or attempting to secure customers or address other external environmental factors [10]. The key issue explored by competitive dynamics research is how particular competitive behaviors affect firms' positions in their industries. As past research has demonstrated, the external environments in which firms compete differ across industries and time periods. Additionally, firms' actions and reactions are quite interdependent, and their strategic actions affect their performance. While exploring the ways in which specific industry dynamics (i.e., between Boeing and Airbus) have shaped the competitive actions of these two companies, this study extends its findings by analyzing the ways in which the competition between these two companies affected Boeing's strategic actions and how the company developed its competitive advantage.

Firms inevitably consider the moves and choices of their rivals when developing and implementing their strategic actions. Firms' recognition of the ways their competitors react to their moves impacts all interactions between competitors within the same industry. Prior research has examined action characteristics (e.g., scope and magnitude of strategic moves), the response characteristics of rival firms (e.g., timing, imitation), and the specific characteristics of competing firms (e.g., past performance, resource similarity) (Grimm & Smith, 1997) [1] (pp. 779–804). Additionally, research regarding competitive dynamics has flourished recently for many reasons. First, it offers a fine-grained approach to understanding what specific firms do when they compete with specific rivals. It also serves as a means of examining the measurable actions firms take and therefore yields cumulative findings. Moreover, it defines the interactions among competitors and takes advantage of several frameworks that enrich our understanding of the forces driving competition. Finally, this

model serves as a basis for the establishment of relations with other areas of strategy and organization (Chen & Miller, 2012) [9].

Notably, examinations of competitive dynamics have revealed that power shifts from industry leaders to challengers are highly likely. Challengers continuously take more aggressive actions than market leaders, and these attacks may cause leaders to ultimately lose their leadership positions. The actions of competitors exert considerable influence on the competitive dynamics between firms. Thus, to sustain their performance and position, industry leaders must evolve and develop in response to the specific requirements of their competitive contexts. Among the several concepts included in the competitive dynamics model, the first-mover advantage refers to the benefits gained from pioneering efforts such as the introduction of new products, entry into new markets, or the implementation of new processes (Lieberman & Montgomery, 1988) [1] (pp. 779–804). However, first movers also expose themselves to potential risks because late comers can easily imitate and learn from the mistakes made by pioneers. Thus, to maintain their positions, first movers must seek to create inimitable technologies and strategies. In this paper, we discuss the possible strengths of Boeing as a first mover in the aerospace industry, which include diversification and a risk-taking culture. We also discuss concerns and limitations regarding the company's strengths in the field.

Competitive dynamics research will continue to play an important role in expanding our understanding of firms' behavior in ever-changing competitive environments. This research area has evolved from microeconomic models of competition to more complex theoretical frameworks that accurately depict the characteristics of today's industries. Based on our reading of related literature, we believe that competitive dynamics studies will make crucial contributions to scholarly understanding of both open innovation and Boeing's behavior and performance, especially if future studies consider the variables and characteristics discussed in this study.

2.2. Concept of Open Innovation

Open innovation is an innovation-focused business management model that seeks to stimulate collaboration between firms and outside employees and companies [11]. In other words, open innovation means that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well (Chesbrough, 2003) [12] (p. 43). This innovation model can be represented in a variety of ways: alliances between companies, research sharing with universities, cooperation with suppliers/competitors, and crowdsourcing.

To understand open innovation, it is helpful to compare it to closed innovation. Traditionally, new business development and marketing processes have taken place within firms' internal boundaries. However, several factors have spurred the destruction of the knowledge monopolies implemented by centralized R&D organizations as knowledge diffusion has occurred in the real market [12] (pp. 43–56). First, lucrative patents have been distributed outside the R&D departments of large companies. Previous research has shown that the number of patents held by individuals and small firms rose from about 5 percent in 1970 to more than 20 percent in 1992 (Chesbrough, 2003) [12] (p. 45). Increased distribution of patents across countries also led to greater knowledge diffusion. Second, between 1981 and 1999, much of the industrial R&D moved to companies with fewer than twenty-five thousand employees [12] (pp. 43–56). Even though large companies have still played an important role as the source of R&D, their share of industrial R&D spending fell from 70 percent to about 41 percent during this time period [12] (pp. 43–56). Third, most firms came to recognize that highly educated employees could be found outside the company and even dispersed across external markets as mobility between affiliated corporations and industries became more common. Lastly, the increased availability of venture capital has promoted the possibility that valuable ideas and technologies can be developed outside companies, especially in start-ups [12] (pp. 43–56). In this regard, corporations have started to move beyond the closed innovation paradigm and to embrace

an open innovation model that enables them to acquire and utilize high-quality knowledge more efficiently and effectively.

As this innovation model shift became increasingly widespread in the market, Boeing spontaneously tried to acquire innovative ideas outside company walls by crowdsourcing aircraft model design and outsourcing engineering. In this paper, we discuss how Boeing has utilized the open innovation model to develop technologies and sustain its leading role in the aerospace industry. We also discuss how Boeing's open innovation model has influenced the development of new products and why this innovation became a failure in the case of the B787.

3. Method

This study analyzes the competitive dynamics of the aerospace industry by focusing mainly on the actions and responses of Boeing and Airbus. By examining the real aerospace industry, we shed light on the competitive behaviors of Boeing and Airbus. We have limited the focus of our research to Boeing and Airbus because these two companies account for most of the market share in the aerospace industry. The Boeing and Airbus duopoly in the industry has generated a series of competitive moves. Thus, the competitive interactions between Boeing and Airbus can be interpreted from the competitive dynamics perspective.

We conduct a qualitative case study because this is the typical approach used to for elaborate analyses of specific situations. Case analyses can effectively explain how and why phenomena occur [13] (pp. 532–550). Qualitative case studies offer deeper insights into particular situations than deductive studies. In this specific study, we used the descriptive case study method. Descriptive case studies highlight important areas and enhance the overall understanding of case procedure [14] (pp. 544–559). In short, we deemed qualitative case study the most appropriate research method because it provides a means of conducting a comprehensive examination. Most of the data used in this analysis came from secondary sources such as journals and news articles, which can be accessed on the Internet. Using this data, we have analyzed a sequence of competitive actions taken by Boeing and Airbus. Our analysis reveals that Boeing is struggling to maintain its leading position in the aerospace industry.

4. Background Information

Boeing and Airbus are one another's main competitors in the aerospace industry. A recent sequence of accidents with Boeing's products has enabled Airbus to overtake Boeing in certain areas of the market. Moreover, the COVID-19 pandemic has deteriorated each firm's management, increasing competition between the two companies.

4.1. History of Airbus

Headquartered in Toulouse, France, Airbus is the leading European aerospace company, and it is the main competitor of Boeing, which is headquartered in the U.S.A. Airbus was first established on May 29, 1969, based on the A300 program, which was launched as part of a milestone agreement signed by French Transport Minister Jean Chamant and German Economics Minister Karl Schiller at the 1969 Paris Airshow, to build a commercial aircraft that was smaller, lighter, and more economical than its three-engine American rivals [15].

While Boeing initially held the leading position in the commercial aircraft market, the gaps in commercial aircraft deliveries and market share between Airbus and Boeing decreased as time went on [16]. The recent Boeing Max crisis enabled Airbus to take over the leading position in commercial aircraft.

4.2. History of Boeing

Boeing is the world's largest aerospace company and the leading manufacturer of commercial jetliners, military aircraft, helicopters, space vehicles, and missiles [17]. The

company encompasses three main businesses—commercial airplanes, defense aircraft, and space and security systems.

Boeing was founded by William E. Boeing, then an American timber merchant, in 1916. Shortly after William and his partner Conrad Westervelt, a U.S. Navy officer, manufactured a single-engine, two-seat seaplane, called B&W, he decided to found an aero product company [17]. Thus, in its early days, Boeing mainly focused on making military-related products such as pursuit planes, observation craft, torpedo planes, and patrol bombers for the U.S. military [17]. In the late 1920s, Boeing expanded its business into airmail services and subsequently into manufacturing and airline operations.

While Boing successfully continued its military aircraft business, it decided to place greater emphasis on its commercial aircraft division. The aerospace industry quickly developed after World War II, and Boeing's commercial airliners lagged behind both its military business and its competitors. As Appendix A shows, Boeing decided to manufacture a comfortable and safe new jet airliner, the Boeing 707, in 1952. This decision was quite interesting and far different from the approaches taken by its major competitors at that time. Douglas, then the leading firm in the commercial sector, and most of the other manufacturers focused on the less-expensive propeller-driven planes [18]. However, the risk Boeing took with the 707 in the commercial market soon paid off as its shorter flight times and smoother rides began attracting customers' attention. The 707 enabled Boeing to triumph over prior competitors and eventually become the industry leader in the commercial market. Furthermore, this risk-taking culture soon became a part of Boeing's organizational DNA as it pushed to build more and more innovative and revolutionary aircraft.

4.3. Diversification of Boeing: Comparison with Airbus

The recent Boeing Max crisis and the outbreak of COVID-19 have once again highlighted the importance of diversification in the aerospace industry. Firms such as Boeing and Airbus must rebalance their portfolios and not give all their attention to individual divisions such as commercial airplanes. As Figure 1 shows, Airbus has three divisions: commercial aircrafts, defense and space, and helicopters [19]. Boeing, meanwhile, has four divisions: commercial aircrafts; defense, space, and security; global service; and capital corporation. Apart from capital corporation, which (as Figure 2 shows) accounts for less than 1% of total company revenue, Boeing's revenue is well diversified across three divisions [20]—unlike Airbus, whose revenue comes primarily from commercial aircraft; this is definitely a strength for Boeing because it enables the company to hedge potential financial risks.

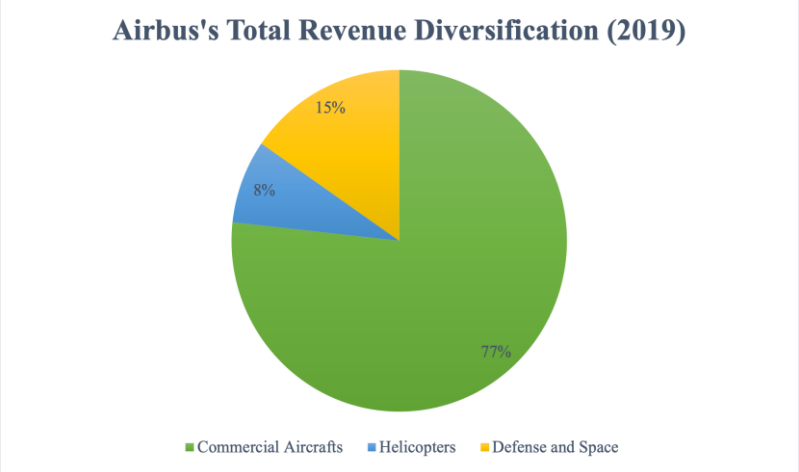

Figure 1. Airbus's total revenue diversification. Source: Forbes (2019).

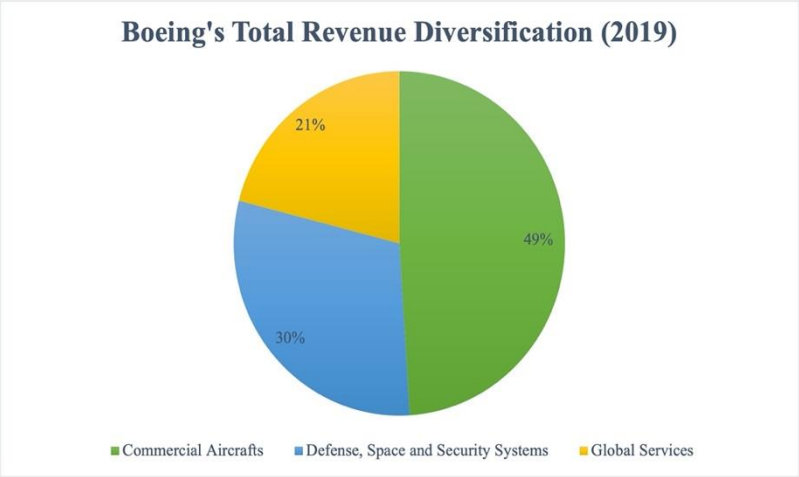

Figure 2. Boeing's total revenue diversification. Source: Airbus (2019).

4.3.1. Boeing Defense, Space, and Security (BDS)

Boeing's defense, space, and security (BDS) division accounts for the second largest share of the Boeing group's total revenue. The BDS sector researches, develops, produces, and modifies military aircraft, satellite systems, weapon and strategic defense systems, and intelligence systems. Supported by its top customer, the U.S. government, which contributed 90% of BDS' revenue in the third quarter of 2020, Boeing ranks second in this industrial sector. Over the past five years, the U.S. government has consistently increased spending on national security, spending the most, 887 billion dollars, in 2020 [21]. Although the U.S.A. underwent a presidential transition in 2020, national security spending is expected to remain at a similar level due to the fortified alliances between the U.S.A. and several countries.

The defense sector features several crucial players and is characterized by severe competition. Thus, to acquire more contracts than their competitors and enhance their competitive advantages in the market, many companies pursue acquisitions aggressively. For instance, in March 2019, Boeing acquired a company named ForeFlight. This company began partnering with Boeing in 2017, using its pioneering aeronautical application to offer aviators information and charts relevant to aeronautics [22].

Moreover, Boeing's defense, space and security (BDS) division cooperates with the National Aeronautics and Space Administration (NASA). To prepare for the upcoming space age, it helped design and construct the international space station. It also runs satellite and space shuttle businesses. The U.S. government's investment in space development will increase due to the onset of intense competition over space. Actions by the U.S.A. to deter its archrival China, which has recently achieved significant space exploration outcomes, are inevitable. Therefore, BDS, which currently accounts for 30% of the firm's total revenue, plays a vital role in Boeing's overall performance [20].

4.3.2. Boeing Global Service (BGS)

Boeing Global Service (BGS) was established as a company business domain in 2016. With Boeing's integrated resources, innovation, and investment, BGS has succeeded in optimizing aircraft operations and providing superior customer services. BGS includes supply chain and logistics management, engineering, maintenance and modifications, upgrades and conversions, spare parts, and data analytics and digital services [20]. Since BGS does a great deal to support and develop aviation industry infrastructure in general, BGS acts as an essential business domain that can ultimately be regarded as one of Boeing's strengths.

Boeing Global Service (BGS) has excellent crisis management capabilities. In particular, following the recent 737 Boeing Max crisis, BGS has tried its best to restore its damaged

image. In 2020, Boeing contracted with several major airlines to provide service solutions including maintenance, cost reduction, and human resource management. For instance, Xiamen airlines, ANA, and JAL decided to accept Boeing's maintenance program, which offers data analysis tools and engineering technology. Moreover, Xiamen Airlines decided to use Boeing's digital solution, which optimizes flight efficiency with customized chart and navigation data [23]. Lastly, Boeing also decided to offer pilot training sessions to reduce pilots' confusion caused as they transition from the 737 Max to other 737 models [24]. By implementing such measures via BGS, Boeing has endeavored to rebuild its image and regain its business competitiveness.

Boeing has also engaged in efforts to diversify its global service sector and build R&D capabilities across the aviation service sector. In this effort, Boeing Global Service (BGS) also provides supplementary features to its customers while in flight. In particular, with a fully customized portal design and all the typical content channels, BGS is trying to enter the wireless inflight entertainment market while also providing valuable insights for airlines [25]. In addition, Boeing established Immfly, an inflight entertainment company, in February 2020 to enhance its onboard digital capabilities. With Immfly, Boeing aims to enhance its digital capabilities so that it can offer its customers optimal onboard experiences [26]. Furthermore, in response to the current COVID-19 outbreak, the company is poised to offer passengers a new health information service.

5. Aerospace Industry

5.1. Overall Industry

As Table 1 shows [27–29], by 2019, Boeing and Airbus were producing high returns, and experts predicted that the global aerospace industry would continue to grow over the next few years. In its Commercial Market Outlook 2019–2038, Boeing predicted that the global economy would grow 2.7 percent annually and that air traffic demand would grow 4.6 percent annually over the next 20 years (CMO 2019). Meanwhile, Airbus predicted that air traffic would grow at an annual rate of 4.3 percent over the next 20 years and that the related service market would reach USD 4.9 trillion over the same period [30].

Table 1. Top 2 aerospace companies by revenue 2020 (million USD) [27–29].

Company Name	Sales (Revenue) 2020	Sales (Revenue) 2019	Operating Profit 2020	Operating Profit 2019
Airbus	40.865	78.900	−510	1.500
Boeing	58.160	76.600	−12.767	−1.980

However, as Table 1 shows, the aviation industry, including Airbus and Boeing, faced a major crisis in 2020, as the global aerospace industry underwent two significant changes. The first change was the global aviation market downturn caused by COVID-19. Airbus said that "according to IATA (International Air Transport Association), worldwide domestic flights have dropped by 70% and the loss of passenger revenue is reaching USD 314 billion. Europe's largest airports have managed 90% fewer flights and the recession combined with a perceived COVID-19 infection risk when travelling, is damaging passenger confidence." Airbus further noted that, to date, approximately 57,000 people have been furloughed and 33,500 made redundant across airlines, airports, and aerospace businesses [31].

The second change occurred in the competitive relationship between Boeing and Airbus. A year after the Boeing 737 Max incident, Airbus replaced Boeing as the industry leader for the second time this century. Airbus's sales surged from USD 75.1 billion to USD 78.9 billion in 2018, while Boeing's sales plunged from USD 101 billion to USD 76 billion. Boeing's loss of nearly USD 2 billion compared to its operating profit of around USD 12 billion in 2018 helped push the overall profit growth rate of global aviation industry companies into the negative.

5.2. Open Innovation

In response to the success of the Boeing B747, which features excellent durability and sufficient flight capabilities, Airbus launched the A380 jumbo jet. The A380 effectively reproduces all the advantages of the B747, reducing costs with fewer take-off slots. The launch of the A380 intensified competition in the jumbo jet market and forced Boeing to implement strategic measures to regain its competitive advantage.

To this end, Boeing sought to bolster open innovation by collaborating with several different partners. Companies usually employ several different methods to implement open innovation, a business model that enhances innovation through collaboration with organizations and people outside of firms [11]. To be specific, Boeing adopted crowdsourcing to design the Boeing 787. While manufacturing was outsourced to thousands of Boeing's suppliers, it was mainly completed using the build-to-point method [32].

Initially, Boeing engaged in open innovation to enhance innovation and its R&D department. However, as time passed, Boeing's open innovation turned out to be a failure. Although this failure had several causes, the most crucial contributing factor was that Boeing outsourced way too much to its suppliers. Instead of simply outsourcing supplemental parts, Boeing outsourced its core functions, such as engineering, and this resulted in a seriously detrimental outcome. Boeing thus became overly reliant on its suppliers. Additionally, Boeing was blamed for not guaranteeing core technologies and specialties and for focusing solely on cost reduction and profit maximization [33].

Boeing's failure to control the assembly of its new 787 sends a serious message about the pitfalls of open innovation. Especially in this era of global resources and up-to-date technologies, Boeing must identify optimal solutions to conduct innovation outside its own corporate walls. Management of details when collaborating with other firms is critical to firm survival.

Thus, Boeing should use outsourcing or so-called open innovation only for its non-core areas of business. Sharing ideas and solutions in the engineering and manufacturing sectors may lead Boeing to another failure because these sectors represent the core areas of Boeing's business.

Experts also believe that the cultural, linguistic, and physical distances associated with different supply chains pose additional risks, insisting that practical and continuous communication with partners and field intervention are essential to properly implement open innovation. Thus, maintaining a balance between management control and open innovation seems crucial for Boeing's future.

6. Boeing's Strengths

6.1. Risk-Taking Culture

Boeing's reputation as a risk-taker shows that the company's risk-taking culture has permeated the entire Boeing group. One particular department that epitomizes Boeing's risk-taking culture is Boeing Phantom Works. Boeing Phantom Works is a unit of Boeing where a high level of R&D has proceeded. Bob Krieger, who oversaw Boeing Phantom Works in 2004, noted that "Risk-taking is at the heart of what we do best, breaking new ground and advancing to new frontiers" [34]. Kreiger's words demonstrate that Boeing considered merely staying inside the box and playing things safe as behaviors that hinder innovation. Thus, in its efforts to achieve outstanding progress, it was natural for Boeing to accept a high level of risk.

Some may think that Boeing has only taken financial and physical risks. However, in some cases, researchers working in Boeing have also risked their reputations while overturning existing knowledge popularly supported by others. To be specific, no one had previously imagined using a spatula-shaped fuselage for the X-43. Indeed, the appearance of this fuselage was entirely unique compared to existing hypersonic configurations. Thus, devising and experimenting with this unique design was an adventure for Boeing. However, the risk paid off since the new design was subsequently widely employed in Boeing hypersonic concepts due to its good performance in horizontal flight [34].

6.2. R&D Investment and Training Personnel

As a manufacturing company, Boeing has remained committed to research and development investment to build its new models and to improve the completeness of existing aircraft. As Figure 3 shows, Boeing has invested over USD 3 billion annually on R&D (except in 2020) [35], far exceeding the expenditures of its major competitor, Airbus, which invested around USD 2.5 billion during the same period [36].

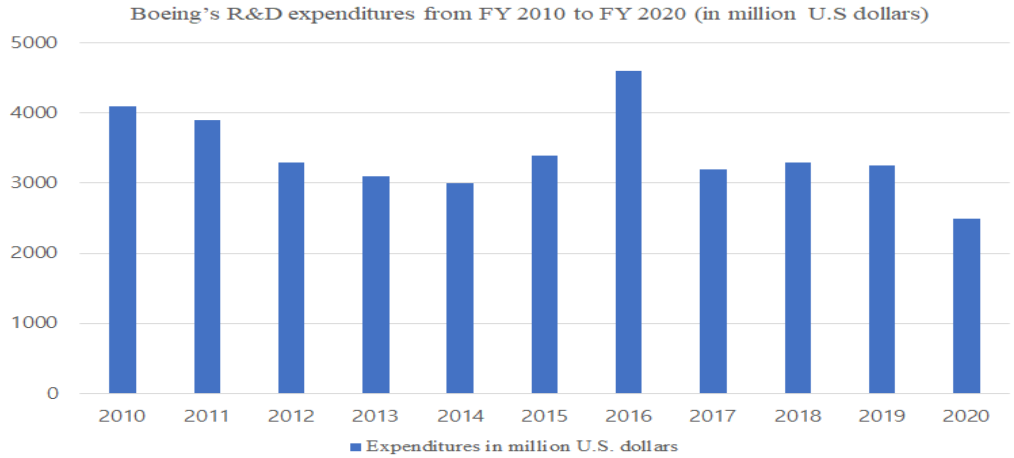

Figure 3. Boeing's R&D expenditures from FY 2010 to FY 2020. Source. Statista (2021).

Due to serious financial losses in 2019 derived from the Boeing 737 MAX crisis, Boeing's operating investment in R&D declined to a negative USD 2.4 billion in 2020. However, Boeing remained committed to investing, especially in its defense-related business, and it additionally has set aside USD 12 billion worth of development funds [37].

Aiming to provide even more reliable and satisfactory aviation products and services to customers, Boeing focused on not only material-oriented investments but also human-related resources. Even though the COVID-19 caused a serious downturn in the industry and there now appears to be an oversupply of qualified personnel, Boeing has demonstrated a strong belief that this situation will soon turn around as commercial traffic demand returns to its 2019 level.

Based on this positive forecast of market recovery and further commercial market growth, Boeing emphasizes the need to prepare personnel training programs and operates "Training and Professional Services" [38]. This program is dedicated to educating professionals including pilots, technicians, cabin crew, and operations and administration management for both government and commercial aircraft businesses. To be specific, it includes flight training, maintenance training, pilot services, pilot development programs, and simulator services. The "Training and Professional Services" program demonstrates how seriously Boeing takes training human resources in its efforts to develop its overall businesses in the aerospace industry.

7. Competitive Dynamics between Boeing and Airbus

7.1. Competition between Boeing and Airbus in the Aerospace Industry

The first single-leaf aircraft, the mother of today's passenger aircraft, was developed in the 1930s, and in World War II, these airliners were used to transport manpower and equipment, drawing attention as a major industrial development item. At the time, the U.S.A. played a leading role in the development of passenger aircraft and European countries including Britain, France, and Germany had to acknowledge a simple truth: without a joint aircraft development and production program, Europe would be left in America's wake [39]. To respond to the U.S.A., the French, German, and British governments decided to enhance their cooperation in the aerospace industry. Promising to take proper measures to engage in aviation collaboration, these three governments signed an agreement in July

1967, forming a consortium that led to the establishment of the company we know as Airbus to counter the emerging American influence on the aerospace industry [40].

Prior to the Airbus A300, the first plane model built from European collaboration was called the Concorde. During the 1960s, several European countries proved their abilities to build successful aircraft. For instance, Britain successfully produced the Hawker Siddeley Trident while France produced the Sud Aviation Caravelle. The construction of the Concorde resulted from teamwork between these two nations [40]. However, the Concorde was not enough to counter American dominance in the aerospace industry.

Many European countries feared dominance of the aerospace industry by American exporters. To compete with the Americans, however, they needed to develop a wide-body jet of their own. Thus, on May 29, 1969, the Europeans decided to devise and produce an appropriate model, the Airbus A300B, to take over the aerospace industry [40]. With this new model, Airbus sought to expand its global market share. Airbus acknowledged the importance of the American market and tried its best to break down Americans' negative perceptions of European aircraft dependability. Therefore, in September 1973, Airbus took the A300 on a six-week tour of North America to demonstrate its dependability to American skeptics. The competition between Airbus and Boeing in the aerospace market started from this point and grew increasingly fierce as time passed [41].

7.2. Boeing and Airbus—Action and Reaction in M&A

Boeing expanded its business through mergers and acquisitions (M&A). On August 8, 1997, Boeing and McDonnell Douglas, the first and third largest producers of civilian jets, merged to form a single company. Following this M&A, only Boeing and Airbus remained to compete in the large commercial aircraft market, which was estimated to be worth USD 1.1 trillion over the next two decades. Boeing's merger with McDonnell Douglas boosted its market share to 70 percent [42] (p. 805).

In response, Airbus decided to change its management structure from a consortium to a corporation. Airbus' management committee said the move aimed to strengthen the company's competitiveness by facilitating rapid decision-making and independent financing, which were among the benefits of such independent management, to counter the Boeing and McDonnell Douglas attacks [43].

In October 2016, Airbus acquired a majority stake in the C series of small passenger aircraft developed by the Canadian aircraft company Bombardier. In response, Boeing sought to acquire Brazilian aircraft manufacturer Embraer. Embraer mainly manufactured 70- and 100-seat aircraft.

To that point, Boeing and Airbus had focused on the large passenger market, ignoring the market for less than 100 passengers because the development costs for smaller aircraft were similar to those for large passenger planes, but the margins were too low. However, Airbus had begun implementing a small passenger plane strategy by securing a majority stake in the C series of small passenger jets developed by Bombardier. Boeing's attempt to acquire Embraer seemed to acknowledge Airbus's small-sized passenger plane strategy, an approach that Boeing had been reluctant to implement [44]. However, it was not able to reach a final agreement until April 24, 2020, and on April 25, it decided to terminate the deal with Embraer to form a joint venture [45].

7.3. Boeing and Airbus—Action and Reaction in Launching Aircraft

7.3.1. Boeing—B747

The Boeing 747 is the company's representative model; it revolutionized the airplane industry with its innovative production method, and tremendous passenger and flight capacities. In fact, the 747—called "The Queen of the Skies" and featuring a rare combination of beauty and strength—changed the face of world travel, facilitating airline growth, opening up new tourist markets, and making flying accessible to the masses [46] (pp. 17–18). The Boeing 747 was operated not only as a passenger plane, but also as a presidential plane in the U.S.A. and Korea, due to its excellent durability. There were several specs of the

Boeing 747 series; the very first variant was the Boeing 747-100. Following the great success of the Boeing 747-100, Boeing introduced the subsequent generations of the 747—Boeing 747-200, 747-300, and 747-400—which integrated updated technologies and flight capacities. Boeing introduced the Boeing 747-8 as the last version of the 747 series, and its production ended in 2009.

7.3.2. Airbus—A380

As Table 2 shows, the A380 was developed to compete with the Boeing 747. In fact, since the 1980s, with the pre-A380 series such as the A300, the A310, the A320, the A330, and the A340, Airbus had been working hard to develop aircraft that could compete with Boeing. In the early 2000s, after succeeding in establishing the A330 and A340 family as alternatives to the Boeing 767 and 777, Airbus set its sights on a bigger target, the Boeing 747-400 [47], and they soon started to develop a jumbo jet—the A3XX—which they eventually named the A380. The Airbus A380 was so overwhelming that it was dubbed "a luxury hotel in the sky". With the A380, Airbus sought to assume a luxurious and prestigious position in jumbo jet market, offering premium features such as walk-up bars, private lounges, and bathrooms with showers [47]—options that Boeing did not offer. The A380 can carry up to 800 passengers at once and maintain high in-flight stability. Designed to reduce the number of flights and create cost savings while maintaining capacities or to offer increased capacities with fewer take-off slots, the A380 brings operators a wide range of commercial advantages [48]. The A380 was well operated in large cities with high demand for long-distance customers, and due to its huge size, it was operated only at major hub airports.

Table 2. Boeing and Airbus aircraft model comparison; B747-100 vs. A380.

	BOEING B747-100	**AIRBUS A380**
First Date of Flight	9 February 1969	27 April 2005
Accommodation	374–490 passengers	400–550 passengers
Overall Length	70.54 m	72.7 m

Source: Boeing webpage, Airbus webpage. It is written based on the first model of each series.

7.3.3. Boeing—B787 Dreamliner (Based on 7E7 Project)

The Boeing 787 Dreamliner emphasized superior efficiency compared to the A380. Unlike Airbus's A380, which operates with four engines, the 787 Dreamliner is a twin-engine aircraft that enjoys relatively low fixed costs, increased operational efficiency, and relatively light volume because it uses different materials than previous aircraft models. The airplane's unparalleled fuel efficiency and range flexibility enable carriers to profitably open new routes as well as optimize fleet and network performance [49]. Boeing introduced the 787 Dreamliner to be operated mostly in medium-sized cities, using 20 percent less fuel than today's similarly sized commercial jets [50] (pp. 36–37). The 787 Dreamliner is the fastest-selling wide-body jet in history and has opened up 180 new markets for carriers [51].

7.3.4. Airbus—A350, A350 XWB and A330neo

As Table 3 shows, the A350 is an aircraft developed to compete with Boeing's 787 Dreamliner. Installing a new engine in its most successful wide-body airliner, the A330, Airbus started developing the A350 series in 2004, a year after Boeing announced the 7E7 project, to respond to Boeing; however, it failed to counter the 787 Dreamliner, which remained overwhelmingly superior in terms of efficiency. In fact, when the Airbus showed their first model of A350 in the 2005 Paris Air Show, Henry Hubscham, the president of GE Capital Aviation Services and Steve Udvar-Hazy, the CEO of International Lease Finance Corp., expressed their disappointment with A350, pointing out that Airbus's strategy was "a Band-aid reaction to the B787." Airbus finally decided to redesign the A350 and

introduced the A350 XWB, the upgraded version of A350 series. While it did actually offer an A350-800, the first model of A350 XWB, but Airbus confirmed the cancellation of the A350-800 [52] in 2014 right after revealing the A330neo—the latest generation of Airbus' market-leading A330 product line, comprising two versions: the A330-800 and A330-900 [53]. In fact, Fabrice Brégier, former CEO of Airbus, said that the A330neo is a more efficient solution than the A350-800.

Table 3. Boeing and Airbus aircraft model comparison; B787-8 Dreamliner vs. A330-800(Neo).

	BOEING B787-8 Dreamliner	**AIRBUS A330-800 (Neo)**
First Date of Flight	15 December 2009	14 July 2014
Accommodation	210–250 passengers	220–260 passengers
Overall Length	56.69 m	58.82 m

Source. Boeing webpage, Airbus webpage. This table was originally written based on the first model of each series. The first model of the A330 series was the A330-200, which was first released in the 1980s, but we inserted the first model of the A330neo series, the A330-800, to focus on the model released in response to the B787.

The Boeing 787 -8, -9, -10 and the Airbus A330 -800 and -900 (both classed as neo) effectively leapfrogged each other, with Airbus trying to outdo Boeing's offerings at each turn, and vice versa [54]. Since the details are slightly different for each aircraft, it is necessary to compare each model regardless of the series, to generate an accurate model comparison. However, because this paper focuses on describing the action and reaction process between the two companies, we organized the process as shown above.

7.4. Strategic Difference between Boeing and Airbus

7.4.1. Core Model—Jumbo Jet vs. Supersonic Aircraft

Britain and France, who sought to develop aircraft in response to airline developments in the U.S.A., created the Concorde aircraft, which was introduced commercially in 1969. It has been called "the world's fastest supersonic plane" and high expectations accompanied its release. However, despite its high speed, it consumed vast quantities of fuel and generated noise during flights. Moreover, its high cost made it unaffordable for much of the public; as a result, it was not actively utilized commercially. Following the explosion of a Concorde aircraft in 2000, the line was discontinued in 2003.

On the other hand, Boeing was highly motivated to develop a jumbo jet. In fact, the U.S.A. was deeply interested in developing supersonic aircraft. In the 1960s, following the moon landing, President Kennedy urged the airline industry to develop a supersonic airliner superior to Concorde, which resulted in efforts to develop the "Boeing 2707" [55]. However, Boeing canceled the development due to the environmental problems and the huge financial cost. Instead, they decided to focus on developing jumbo jets, forecasting the popularization of commercial air travel in the future. The era of the Big Jet arrived on January 22, 1970, when the first commercial flight of the Boeing 747 left New York, bound for London, operated by launch customer Pan Am [56] (pp. 17–18). The 747 changed the face of world travel; it facilitated airline growth, opened up new tourist markets, and made flying accessible to the masses. The 747 fleet may be coming to the end of its reign as "The Queen of the Skies", but what a proud and productive reign it has been, a rare combination of beauty and strength [56] (pp. 17–18). The appearance of the 747 received rave reviews in the aerospace market, and it became one of Boeing's most iconic models.

7.4.2. Forecasts regarding the Aerospace Industry—Direct Point-to-Point Model vs. Hub-and-Spoke Model

Boeing and Airbus also employed different aircraft operation strategies. The significant impact of the Boeing 747 prompted Airbus to launch the A380, a jumbo jet designed to counter the B747. The B747 and A380 became their respective companies' core models and major competitors in the jumbo jet market. The advent of the jumbo was key to the emergence of the modern airport strategy adopted in most major cities around the

world—the hub-and-spoke model [56] (pp. 28–29). This hub-and-spoke template succeeded the traditional model of flying point-to-point, which many travelers—especially those on business—prefer, given the extra hassle and potential for delays and lost luggage that changing planes entails [56] (pp. 28–29).

As the competition between Boeing and Airbus around the jumbo jet continued, and with the prospect that the number of passengers would continuously increase in the future, the hub-and-spoke model became the core strategy for the future of the airline industry. In fact, Airbus looked at the forecasts of exponential passenger growth and growing airport slot congestion to project a future characterized by the rise of international traffic through major hubs—a scenario the A380 would fit perfectly [46] (pp. 17–18). Based on these expectations, Airbus invested about USD 30 billion in the A380, betting that the hub-and-spoke model, in which passengers have layovers at top-tier airports to catch connecting flights, would continue [51]. Airbus believed that as airlines attempted to optimize their flight schedules in the coming decades, more people would have to fly through centralized hubs, such as London, Tokyo, and Chicago, and the A380 would cheaply move huge throngs of people in and out of such hubs [50] (pp. 36–37).

Meanwhile, rather than betting on the marketability of the jumbo jet, Boeing employed a completely different approach that focused on efficient airline operations with high-speed airplanes. Even though their flagship aircraft was the jumbo jet, the B747, Boeing thought that the relatively small, long-range planes could offer routine flights to far-flung international cities without stops in large hubs [50] (pp. 36–37). In other words, in contrast to Airbus, Boeing predicted that the direct point-to-point model would expand in the future airline industry. Based on this forecast, Boeing initiated the new "7E7 project" with the goal of leading the mid-size plane market with high efficiency, aiming for low operating costs and increased scheduling flexibility and to provide a desperately needed boost to the ailing airline industry; Boeing's engineers and designers thus wagered that the 7E7 would be the right plane for the struggling, highly competitive air travel business [50] (pp. 36–37). The aircraft that this project ultimately created was later named the "787 Dreamliner".

In sum, the two companies started with different macroscopic strategies. If Boeing 7E7 represented a gamble that passengers would want more nonstop long-haul flights between a wide range of cities, the A380 was a bet that air congestion at centralized hubs would become even worse, putting more pressure on airlines to find ways to increase passenger capacities [50] (pp. 36–37).

However, the market went as Boeing predicted, and interest in the jumbo jet started to decline. The jumbo jet had the advantage of being able to carry a large number of passengers, but it was inefficient to operate because of the time it took for all those passengers to board and deplane. Moreover, when jumbo jets operate on domestic flights, there are cases in which the seats are not completely filled, resulting in inefficiencies for airline companies. In particular, with the emergence of an efficiency-oriented aircraft, the Boeing 787 Dreamliner, sales of the massive jet were undercut by other more fuel-efficient offerings [51]. According to Scott Kirby, the CEO of United Airlines, the "bittersweet milestone—the jumbo jet with its unmistakable silhouette once represented the state-of-the-art in air travel. But in modern aviation, there are more fuel-efficient, cost-effective and reliable wide-body aircraft that provide an updated in-flight experience on long-haul flights" [56] (pp. 28–29). In fact, in 2017 Airbus offered its customers a moderately updated version of the plane, the A380 Plus, with room for 80 more people and new winglets for better fuel economy, but there have been no takers [47].

These changes in the airline industry demonstrate that competition between Boeing and Airbus ultimately led to a focus on improving operational efficiency. The future success of both companies will rely on the creation of aircraft that provide the best services to customers, while incorporating different technologies to improve the airlines' flight efficiency. The historical success of Boeing's 7E7 project, which led it to implement a novel strategy in the market, suggests that Boeing's risk-taking attitude will give it a good chance of overcoming the current crisis and taking back its leading position in the market.

8. Discussion

Boeing relied on open innovation while building its 787 model. However, many critics now regard this effort as a failure for several reasons. Fundamentally, Boeing collaborated with too many players in developing its new model. As a result, Boeing lost control and had to rely on outside partners. Moreover, because it placed too much focus on cost reduction and profit maximization during its open innovation, Boeing could not maintain its core technologies and specialties.

Therefore, to succeed in future open innovation, we recommend that Boeing consider the following measures.

First, Boeing should focus on company strengths such as engineering. In the case of open innovation during the 7E7 project, inordinate outsourcing undermined Boeing's reputation. In short, it is crucial for Boeing to manage its industry-leading technologies independently based on strategic and practical decision-making.

Second, Boeing should maintain close relationships with cooperating firms. This is important not only to communicate but also to form a tight network and centrally control partners. In the case of aircraft manufacturing where the movement of components is essential, maintaining physical control is critical so that the company can respond rapidly should something unexpected occur.

By using its past failure as a steppingstone and making some corrections in its approach to open innovation, Boeing could simultaneously become an example of successful open innovation and take a significant step forward as a leader in the aerospace industry.

9. Conclusions

As demonstrated above, Boeing has made a number of strategic decisions to acquire and maintain its position as the world's leading aircraft company and survive in the fast-paced aerospace industry. Sometimes, it has made risky market-leading decisions and sometimes it has made decisions in response to changes in the strategies of its competitors or industry predictions. In the case of the B707, Boeing made a gamble by developing a totally new non-propeller-driven jetliner, a revolutionary step in the commercial market.

In particular, Boeing's competition strategy was mainly based on an "action and reaction" dynamic with Airbus, its biggest rival. The B747's excellent durability and sufficient flight capacity facilitated its successful commercialization, and Airbus actively responded to this model by manufacturing the A380, which provided all the benefits of the B747 and allowed for additional cost-savings by occupying fewer take-off slots. After that, Boeing reacted by introducing the B787 Dreamliner, which had superior fuel efficiency and was therefore more cost-effective than the A380. While the process of open innovation that Boeing used to develop the B787 Dreamliner proved problematic, it nevertheless enabled Boeing to successfully launch a new model and maintain its position as a market leader. Airbus subsequently released the A350 and A330neo as competitive countermeasures to the B787 Dreamliner. These actions and reactions demonstrate that Boeing has grown by analyzing and improving on its competitor's representative products by designing more efficient and profitable ones.

In addition to product-based competition, the establishment of competitive strategies based on different predictions about the future of industry has also been a major component of the competitive dynamic between Boeing and Airbus. Their utilization of different operating models (direct point-to-point and hub-and-spoke) led to differences in the companies' overall operational strategies, generating significantly different results.

Boeing's risk-taking culture has indeed served as a chief factor in Boeing's success. Its aggressive ventures have enabled it to sustain its leading position in the aviation industry for a long time. However, recent events suggest that Boeing must supplement its risk-taking approach with careful risk analysis and thorough inspection. Many critics have argued that the Boeing Max crisis was caused by a single factor. However, there is no doubt that Boeing's apathy toward safety is the main reason for the company's current predicament. In particular, rushing prevented the new aircraft model released by Boeing

from gaining predominance. Boeing decided to make several improvements on existing 737 models, rather than designing and manufacturing brand new aircraft. Moreover, to reduce expenses, it announced that further pilot training was not needed to steer the Boeing 737 Max [57]. Additionally, the aircraft's design contained a critical defect that raised the possibility of sudden stall during the flight, but Boeing never reported and, in fact, concealed this flaw [58].

When designing the Boeing 737 Max, the executives of Boeing focused solely on maximizing the company's profit and completely disregarded safety concerns. This led to the 737 Max crisis and a number of passenger casualties. If Boeing continues to overlook safety and only concentrate on risk-taking, its reputation will eventually be destroyed, and its risk-taking culture will become a deep-seated problem. Thus, Boeing must consider the seriousness of the current difficult situation it faces and reform its internal risk-taking culture.

Managers can refer to this research paper for several purposes. First of all, it provides general information about the overall aerospace industry and Boeing. In addition, it clearly shows how companies compete with each other from the perspective of competitive dynamics. In particular, this study analyzes the competitive interactions between Boeing and Airbus, thereby enhancing our general understanding of competitive dynamics.

This study's contributions include the following. First, this study identifies a series of competitive dynamics by examining specific case studies from the real market environment and enhances our overall comprehension of competitive dynamics. This study elaborates on competitive dynamics by analyzing the real-life competitive actions and reactions of Boeing and Airbus. By outlining a chain of competitive interactions between these two firms, we highlight the intense tension between them as well as the behavior changes they have undergone when jockeying for a dominant position. Second, in accordance with existing studies, this study successfully shows how competitive dynamics can eventually serve as positive stimuli for companies. In particular, to counter Airbus, Boeing invested substantially in R&D, which ultimately fueled the company's technological progress and innovation. Third, unlike other literature reviews, this study describes both the positive results and side effects of fierce competition between two firms. To be specific, Boeing's risk-taking culture was regarded as one of Boeing's strengths and helped Boeing sustain its leading position in the aerospace industry. However, its unwavering focus on risk-taking and willingness to overlook safety ultimately led to disaster. Indeed, counteractions fueled by the rashness of Boeing executives eventually endangered the firm's leading position and changed the game.

Future research should expand the time range of this study's analysis. For example, this study provides a descriptive case study rather than developing new theoretical constructs. Developing dynamic processes of competition by introducing new structures using case studies would be an interesting project for subsequent research. Furthermore, this study analyzed competitive dynamics based on the actions and reactions of Boeing and Airbus, thus focusing on unquantified competition and market trends between companies. We also encountered limitations in finding numerical data, as information regarding ongoing internal projects is often confidential. Future studies should seek to reinforce this study's findings by conducting more in-depth quantitative analyses of more comprehensive data.

Author Contributions: A.W., B.P., H.Y., conceptualization, original draft preparation, review and editing, data curation, visualization; H.S., J.C., conceptualization, original draft preparation, methodology, formal analysis, review and editing; S.C., project administration, supervision, corresponding author. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF- 2020S1A5A2A01046005).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data available in a publicly accessible repository.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Boeing Commercial Aircraft Models

The massive success of the 707 led Boeing to commit to the 727 Trijets, the 737 Twinjets, and the 747 Jumbo Jets in the 1960s. The 737 was introduced in 1967 to complement the 707 and the 727. To reduce production time and to enhance efficiency, the 737 was built with the same upper lobe fuselage as the 707 and the 727 [17]. Furthermore, the 737-200 could flexibly convert its interior design from a passenger plane into a cargo plane by adopting the 727's convertible cargo features. The 737 was lucrative because it had more seats than its rival, the DC-9 from the Douglas, and it also alleviated in-flight vibration and noise. In this regard, the 737 became the most ordered aircraft in the commercial business by 1987. Following the 737, the series of the 737 MAX came out: 737 MAX 7, 737 MAX 8, 737 MAX 9, and 737 MAX 10. The family of the 737 MAX is a more flexible and reliable single-aisle aircraft with efficient interior/exterior designs and lower engine thrust compared to the 737 [59].

In the late 1960s, the 747 Jumbo Jet was the largest civilian wide-body airplane in the world. This massive, more than 400-seat plane brought reductions in airfare and a surge in air-passenger traffic [17].

The 757, twin-engine, single-aisle aircraft was launched in 1980, and the very next year, Boeing introduced the 767 wide-body twin-engine aircraft. These two models had the same flight deck, so trained pilots for one aircraft could easily switch from one to the other, which reduced training costs and increased efficiency in business [17].

The 777, twin-engine and wide-body airliner was developed in 1994. Based on advances in computer-aided design and manufacturing software, the 777 was developed entirely on computers [17]. This change certainly reduced manufacturing costs since it allowed Boeing to skip the mock-up stage before building the actual planes.

The 787 Dreamliner, a speedy mid-range jet, was introduced in 2003; its new high-bypass turbofan engines and an innovative body design gave it great fuel efficiency [60]. The use of advanced composites such as carbon-fiber, aluminum, and titanium made the 787 lighter and simpler in design, which ultimately increased its fuel efficiency and reduced maintenance time and fees [60]. Due to its fuel efficiency, the 787 Dreamliner was contracted by a lot of airlines even before its official commercial launch. However, it experienced several production problems that forced Boeing to delay delivery—originally planned for 2008—until 2011.

References

1. Ketchen, D.J., Jr.; Snow, C.C.; Hoover, V.L. Research on Competitive Dynamics: Recent Accomplishments and Future Challenges. *J. Manag.* **2004**, *30*, 779–804. [CrossRef]
2. Boeing. Available online: https://www.boeing.com/ (accessed on 10 June 2021).
3. Boeing. Available online: https://www.boeing-me.com/en/about-boeing/general-information.page (accessed on 10 June 2021).
4. BBC. Available online: https://www.bbc.com/news/business-52468882 (accessed on 10 June 2021).
5. Airports Council International. Available online: https://aci.aero/news/2021/03/25/the-impact-of-covid-19-on-the-airport-business-and-the-path-to-recovery/ (accessed on 2 August 2021).
6. Allal-Chérif, O. The way towards open innovation: Airbus multi-functional teams. *Eur. Sci. J.* **2015**, *1*, 129–139.
7. Shenhar, A.J.; Holzmann, V.; Melamed, B.; Zhao, Y. The Challenge of Innovation in Highly Complex Projects: What Can We Learn from Boeing's Dreamliner Experience? *Proj. Manag. J.* **2016**, *47*, 62–78. [CrossRef]
8. Altfeld, H.H. *Commercial Aircraft Projects: Managing the Development of Highly Complex Products*; Ashgate: Farnham, UK, 2010.
9. Chen, M.-J.; Miller, D. Competitive Dynamics: Themes, Trends, and a Prospective Research Platform. *Acad. Manag. Ann.* **2012**, *6*, 135–210. [CrossRef]
10. Kwon, Y.; Kang, D.; Kim, S.; Choi, S. Coopetition in the SoC Industry: The Case of Qualcomm Incorporated. *J. Open Innov. Technol. Mark. Complex.* **2020**, *6*, 9. [CrossRef]
11. Ennomotive. Available online: https://www.ennomotive.com/open-innovation (accessed on 15 July 2021).

12. Chesbrough. *H.W. Open Innovation: The New Imperative for Creating and Profiting from Technology*; Harvard Business School Press: Cambridge, MA, USA, 2003; pp. 43–56.
13. Eisenhardt, K.M. Building theories from case study research. *Acad. Manag. Rev.* **1989**, *14*, 532–550. [CrossRef]
14. Baxter, P.; Jack, S. Qualitative case study methodology: Study design and implementation for novice researchers. *Qual. Rep.* **2008**, *13*, 544–559.
15. Airbus. Available online: https://www.airbus.com/company/history.html#1960s (accessed on 20 December 2020).
16. eFlightLevel.com. Available online: http://eflightlevel.blogspot.com/2012/02/airbus-reports-2011-aircraft-orders-and.html (accessed on 20 December 2020).
17. Amir, A.R.; Weiss, S.I. Boeing Company. Available online: https://www.britannica.com/topic/Boeing-Company (accessed on 13 May 2021).
18. Esty, B.C.; Ghemawat, P. *Airbus vs. Boeing in Superjumbos: A Case of Failed Preemption*; HBS Stratey Unit Working Paper No. 02-061; HBS: Boston, MA, USA, 2002; pp. 34–37. Available online: https://ssrn.com/abstract=302452 (accessed on 13 May 2021). [CrossRef]
19. Forbes. Available online: https://www.forbes.com/sites/greatspeculations/2020/01/02/how-much-of-boeings-revenues-comes-from-the-us-government/?sh=62a9a49a5144 (accessed on 1 March 2021).
20. Airbus. Available online: https://www.airbus.com/investors/financial-results-and-annual-reports.html (accessed on 9 May 2021).
21. Defense One. Available online: https://www.defenseone.com/ideas/2020/01/why-does-us-spend-so-much-defense/162657/ (accessed on 1 March 2021).
22. Mordor Intelligence. Available online: https://www.mordorintelligence.com/industry-reports/mergers-and-acquisitions-in-aerospace-and-defense-market (accessed on 9 May 2021).
23. News Impact. Available online: http://newsimpact.co.kr/View.aspx?No=1060875 (accessed on 2 March 2021).
24. Forbes. Available online: https://www.forbes.com/sites/johnstrickland/2020/11/28/boeing-737-max-the-steep-climb-to-rebuild-trust/?sh=3abedfc77ffb (accessed on 2 March 2021).
25. PAXEX.AERO. Available online: https://paxex.aero/boeing-digital-direct-wireless-ife-immfly/ (accessed on 2 March 2021).
26. PAXEX.AERO. Available online: https://paxex.aero/2020/02/immfly-boeing-horizonx/ (accessed on 2 March 2021).
27. Flight Global. Available online: https://www.flightglobal.com/flight-international/top-100-aerospace-companies-ranked-by-revenue/140025.article (accessed on 12 March 2021).
28. Statista. Available online: https://www.statista.com/statistics/264374/boeings-worldwide-revenue/ (accessed on 29 June 2021).
29. Airbus. Available online: https://www.airbus.com/newsroom/press-releases/en/2021/02/airbus-reports-full-year-2020-results.html (accessed on 29 June 2021).
30. Taejin, C. World Aircraft Industry Outlook and Forecast. *Curr. Ind. Technol. Trends Aerosp.* **2019**, *17*, 11.
31. IATA. Available online: https://www.iata.org/en/pressroom/pr/2020-04-14-01/ (accessed on 12 March 2021).
32. Harvard Business School Digital Initiative. Available online: https://digital.hbs.edu/platform-digit/submission/crowdsourcing-the-boeing-787/ (accessed on 15 July 2021).
33. Supply Chain Digital. Available online: https://supplychaindigital.com/supply-chain-2/boeing-787-dreamliner-tale-terrible-supply-chain-management (accessed on 15 July 2021).
34. Boeing Frontiers. Available online: https://www.boeing.com/news/frontiers/archive/2004/july/ts_sf8a.html (accessed on 12 March 2021).
35. Statista. Boeing's R&D Expenditures from FY 2001 to FY 2020 (in Million U.S. Dollars). Available online: https://www.statista.com/statistics/268991/expenditures-on-research-and-development-by-boeing/ (accessed on 14 May 2021).
36. Werner, B. Boeing Continues Investing in Defense R&D Even With 2019 Losses. Available online: https://news.usni.org/2020/01/29/boeing-to-continue-investing-in-rd-even-with-2019-losses (accessed on 14 May 2021).
37. Statista. Airbus Division's R&D Expenses from FY 2010 to FY 2020 (in Million Euros). Available online: https://www.statista.com/statistics/226726/rundd-expenditure-of-airbus/ (accessed on 14 May 2021).
38. Boeing. Pilot and Technician Outlook 2020–2039. Available online: https://www.boeing.com/commercial/market/pilot-technician-outlook/ (accessed on 14 May 2021).
39. Airbus. Available online: https://www.airbus.com/company/history/aircraft-history/1967-1969.html (accessed on 11 April 2021).
40. Business Insider. Available online: http://www.businessinsider.com/airbus-history-boeing-rivalry-2018-4 (accessed on 24 June 2021).
41. Modern Airliners. Available online: https://modernairliners.com/airbus-a300/ (accessed on 14 June 2021).
42. Kovacic, W.E. Transatlantic turbulence: The Boeing-McDonnell Douglas merger and international competition policy. *Antitrust Law J.* **2000**, *68*, 805.
43. The Korea Economic Daily. Available online: https://www.hankyung.com/international/article/1997010600331 (accessed on 27 June 2021).
44. Yonhap News Agency. Available online: https://www.yna.co.kr/view/AKR20171222063800009 (accessed on 27 June 2021).
45. Chosun Biz. Available online: https://biz.chosun.com/site/data/html_dir/2020/04/28/2020042802777.html (accessed on 27 June 2021).

46. Doran, M. Bon Voyage Big Jets: The Demise of the Big Jets is A Story in Two Parts—The Transformative Beauty of the Boeing 747 Opening up the Globe to People Who Had Never Flown Before and the Size of the Airbus A380 Built to Funnel High-Volume Traffic Through Mega-hubs. *Asian Aviat. Mag.* **2017**, *15*, 17–18.
47. Insider. Available online: https://www.businessinsider.com/airbus-a380-superjumbo-history-boeing-747-emirates-2017-11#during-the-1970s-airbus-a300b-was-the-new-kid-in-the-world-of-commercial-airliners-4 (accessed on 19 June 2021).
48. Airbus. Available online: https://www.airbus.com/aircraft/passenger-aircraft/a380/innovation.html (accessed on 20 April 2021).
49. Boeing. Available online: http://www.boeing.com/commercial/787/# (accessed on 20 April 2021).
50. Talbot, D. Boeing's flight for survival. *Technol. Rev.* **2003**, *106*, 36–37.
51. Investors Business Daily. Available online: https://www.investors.com/news/airbus-a380-canceled-emirates-order-boeing-747-787/ (accessed on 20 April 2021).
52. Simple Flying. Available online: https://simpleflying.com/what-happened-airbus-a350-800/ (accessed on 10 May 2021).
53. Airbus. Available online: https://www.airbus.com/newsroom/press-releases/en/2017/10/first-a330neo-successfully-completes-maiden-flight.html (accessed on 10 May 2021).
54. Simple Fling. Available online: https://simpleflying.com/airbus-a330neo-vs-boeing-787-9-which-is-best/ (accessed on 26 June 2021).
55. Hankyoreh. Available online: http://www.hani.co.kr/arti/science/future/883464.html (accessed on 20 April 2021).
56. Churchill, D. BATTLE OF THE GIANTS: Are Airbus and Boeing's super-sized aircraft heading for the scrap heap? 2018. Available online: https://www.businesstravelnewseurope.com/Air-Travel/Analysis-Battle-of-the-giants (accessed on 10 August 2021).
57. Industry Week. Available online: https://www.industryweek.com/leadership/article/22028283/boeing-must-fix-its-moral-compass-and-its-culture (accessed on 18 March 2021).
58. Audit Comply. Available online: https://www.auditcomply.com/2021/01/14/boeing-737-max-a-poor-culture-of-quality-exposed/ (accessed on 18 March 2021).
59. Boeing. 737 Commercial Transport. Available online: https://www.boeing.com/history/products/737-classic.page (accessed on 13 May 2021).
60. Boeing. 787 Commercial Transport. Available online: https://www.boeing.com/history/products/787.page (accessed on 13 May 2021).