Challenge to the Boeing-Airbus Duopoly in Civil Aircraft: Issues for Competitiveness

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Summary

The importance of a successful aerospace industry to the United States economy has been repeatedly acknowledged by President Obama and members of his Cabinet, many Members of Congress, and by all concerned with the competitive fortunes of the U.S. aircraft manufacturing industry. The U.S. aerospace industry is highly competitive and global in scope. U.S. firms manufacture a wide range of products for civil and defense purposes and, in 2010, the value of aerospace industry shipments was estimated at $171 billion, of which civil aircraft and aircraft parts accounted for over half of all U.S. aerospace shipments. In 2010, the U.S. aerospace industry exported nearly $78 billion in products, of which $67 billion (or 86% of total exports) were civil aircraft, engines, equipment, and parts. The U.S. trade surplus (net exports) in aerospace products in 2010 was $43.6 billion – higher than for any other manufacturing industry. Aerospace employment totaled 477,000 workers, of which 228,400 were engaged in the manufacture of aircraft, 76,400 in the manufacture of engines and engine parts, and 97,600 in the manufacture of other parts and equipment. According to the International Trade Administration, "more jobs in the United States were supported by exports of U.S. aerospace products than of any other manufacturing or service industry."

Boeing is the only U.S. manufacturer of large civil aircraft. Civil aircraft engines are manufactured by General Electric (GE), in partnership with Safran (of France), and by Pratt & Whitney. Numerous firms manufacture sections and parts of the airframe, as well as original equipment for both domestic and foreign airframe manufacturers. The civil and military aerospace sectors are complementary in that many firms manufacture products for both. Although the products tend to be dissimilar, workforce skills are transferable, so a decline in military aerospace budgets or private sector spending on civil aircraft have significant economic and competitive effects for the United States.

A major issue for policymakers is whether the United States can sustain its preeminent position in aerospace, given the intentions of numerous foreign manufacturers to enter the small commercial jet aircraft segment by 2016. That segment accounts for nearly half of all commercial aircraft revenues and for more than 60% of commercial aircraft deliveries. It is also the gateway to building larger commercial aircraft. Boeing and Airbus are the sole rivals across all segments of large commercial aircraft manufacturing, but during the next decade both will confront a potentially serious challenge in one of the most important segments of their business, small commercial jets (which are also referred to as narrow-body or single-aisle aircraft). The CEOs of Boeing and Airbus have both agreed that their duopoly over small commercial jets is nearly at an end.

Boeing and Airbus will face competition from government-owned and subsidized firms in Russia and China, as well as companies in Canada, Brazil, and Japan. Several factors will determine the outcome of the coming competition in small commercial jets, including the openness of markets to foreign commercial aircraft and aircraft engines and parts; whether state-owned aircraft manufacturers continue to receive substantial government subsidies; whether the challengers to Boeing and Airbus achieve their goal of building innovative, efficient aircraft that establish excellent safety and service records; whether airlines will buy aircraft from companies that have no track record; and the effect of collaborative partnerships with other aircraft manufacturers and suppliers as a strategy for success. Boeing and Airbus are engaged in a struggle to be the world's preeminent manufacturer of civil aircraft and both have a depth of resources unmatched elsewhere. The competitive stakes for both companies will be very high during the next decade.

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The importance of a successful aerospace industry to the United States economy has been repeatedly acknowledged by President Obama and members of his Cabinet, many Members of Congress, and by all concerned with the competitive fortunes of the U.S. aircraft manufacturing industry. The U.S. aerospace industry is highly competitive and global in scope. Numerous U.S. firms manufacture a wide range of products for civil and defense purposes. In 2010, the value of aerospace industry shipments was estimated at $171 billion, of which civil aircraft and aircraft parts accounted for approximately half ($85 billion) of all U.S. aerospace shipments.[1]

In 2010, the U.S. aerospace industry exported nearly $78 billion in products, of which $67 billion (or 86% of total exports) were civil aircraft, engines, equipment, and parts.[2] The only U.S. manufacturer of large civil aircraft is Boeing. Civil aircraft engines are manufactured by General Electric (GE) in partnership with Safran (of France) and by Pratt & Whitney. Numerous firms manufacture sections and parts of the airframe, as well as original equipment for both domestic and foreign airframe manufacturers. The U.S. trade surplus (net exports) in aerospace products in 2010 was $43.6 billion – higher than for any other manufacturing industry.[3] In 2010, the aerospace sector employed 477,000 workers, of which 228,400 were engaged in the manufacture of aircraft, 76,400 in the manufacture of engines and engine parts, and 97,600 in the manufacture of other parts and equipment. According to the International Trade Administration (ITA), "more jobs in the United States were supported by exports of U.S. aerospace products than of any other manufacturing or service industry."[4] A major issue for policymakers is whether the United States can sustain its preeminent position in aerospace, given the intentions of numerous foreign manufacturers to enter the small commercial jet aircraft segment by 2016.[5] That segment accounts for nearly half of commercial aircraft revenues and for more than 60% of commercial aircraft deliveries.

[1] Civil aircraft include all large civil aircraft, fixed wing general aviation aircraft, and helicopters. Large civil aircraft include all aircraft in commercial use (i.e., those operated by airlines and charter operators). U.S. Department of Commerce, International Trade Administration (ITA), *Flight Plan 2011*, March 2011. p. 3.

[2] Department of Commerce, ITA, "2010 U.S. Exports of Aerospace Vehicles and Equipment," http://trade.gov/wcm/groups/internet/@trade/@mas/@man/@aai/documents/web_content/aero_stat_expqtr.pdf

[3] ITA, *Flight Plan 2011*, pp. 3, 5.

[4] Ibid, p. 3. Based on the latest available data (2008).

[5] "Small commercial jet aircraft" is a misnomer, in that it describes airplanes that can seat from 90-220 passengers. Other terms are equally inapt: "narrow-body" and "single-aisle" are frequently used to describe both small- and medium-sized aircraft, including in this report. Medium, large, and very large aircraft are usually twin-aisle airplanes that seat more than 200 passengers. One medium-sized exception is the now out-of-production Boeing 757, a narrow-body, single-aisle aircraft that seats between 186 and 279 passengers. On the other hand, regional jets are also narrow-body, single-aisle airplanes.

Some industry participants and analysts have recently suggested that the two dominant manufacturers of large civil aircraft, Boeing and Airbus, now face a new and significant group of competitors that are ready to challenge the incumbents for a potentially significant share of the market for small commercial jets. Currently that market is almost wholly owned by the Boeing 737 and Airbus A320 families of jets. In Boeing's *2010 Annual Report*, W. James McNerny, Jr., chairman, president, and CEO of Boeing, writes:

> At Boeing Commercial Airplanes, we must prepare now for increasing global competition. Aircraft manufacturers in several countries are poised to challenge us for a share of the market where we have been competing solely against EADS/Airbus. These emerging competitors see the same massive economic opportunity in commercial airplanes and related services that we do over the next 20 to 30 years.[6]

On June 20, 2011, the opening day of the 2011 Paris Air Show, the president of Boeing Commercial Airplanes, Jim Albaugh, announced "the days of the duopoly with Airbus are over."[7] Albaugh was referring to long-standing dominance that Boeing and Airbus have held over the commercial jet aircraft business and, in particular, to the 90-220 seat aircraft segment that has seemingly come into play with the entry of competitors from Brazil, Canada, China, Russia, and Japan.

Large Commercial Aircraft Types: Definitions

Commercial aircraft are defined in terms of market segments, but definitions are fluid and various segments overlap each other. In its 2010 forecast, Boeing defines aircraft as single-aisle passenger airplanes, twin-aisle passenger airplanes, and freighter airplanes (this report is primarily concerned with commercial passenger aircraft and will not discuss freighter aircraft in detail). Boeing further subdivides single-aisle and twin-aisle passenger planes into sub-categories. Single aisle aircraft comprise: regional jets (RJs) and narrow-body aircraft (in two classes: 90-175 seat airplanes and >175 seat airplanes). Twin-aisle airplanes (frequently referred to as "wide-bodies" and "large" passenger aircraft) are categorized by Boeing as small (180-340 seats), medium (260-450 seats), and large (>400 seats). Large twin-aisle passenger airplanes (e.g. the Boeing 747 and Airbus A380) are also referred to as very large aircraft (VLA). The most recent models of the Boeing 737 and Airbus A320 aircraft (the 737-900ER and the A321) can seat up to 215 and 220 passengers, respectively. Because the 737-900ER and the A321 do not differ significantly from other models in those aircraft families (except for capacity), this report will treat all members of the 737 and A320 families as single-aisle, narrow-body airplanes. For example, the width and height of the 737 fuselage remained the same from its first flight in 1967 through the most recent model, the 737-900ER, which was first delivered in 2007.

[6] The Boeing Company. *2010 Annual Report*. p. 5.

[7] *Financial Times*, "Boeing and Airbus call time on duopoly," June 21, 2011. In economic theory, a duopoly involves two sellers of either identical or "different but rival goods – goods the demand for which does not depend only on their own price but to a non-negligible extent also on the price of the other good." H. Neisser, "Oligopoly as a Non-Zero-Sum Game," *The Review of Economic Studies*, Vol. 25, No. 1, Oct. 1957. p. 7. Even with an effective prohibition against collusive practices, the entry of additional firms into a market characterized by duopolistic competition could be difficult under conditions where a duopoly has achieved an equilibrium position with respect to maximizing their output and revenues. One implication for new entrants is that they generally will have to provide a superior product at a price that is less than the price charged by the incumbents. However, the incumbents could be expected to respond to increased competition by reducing prices in order to maintain output. This will be true as long as marginal revenues exceed marginal costs. See H. Gregg Lewis, "Some Observations on Duopoly Theory," *The American Economic Review*, Vol. 38, No. 2 (May 1948).

Tom Enders, the chief executive officer of Airbus, agreed in part, saying "the duopoly is over in the 100 to 150 seat aircraft segment because that is where the new entrants ... want to be – so that doesn't mean the duopoly is over in the entire range of products."[8] Enders also mentioned that he doubted that there was room for six competitors and that "we think sooner or later there will be some consolidation."[9] If the small commercial jet segment is about to enter a new competitive phase, there is no evidence that the dominance of Airbus and Boeing over large (or wide-body) aircraft or very large (or super-jumbo) aircraft will face a similar challenge anytime soon.

The small commercial jet segment represents a significant share of U.S. aerospace manufacturing sector output (see text box above for a discussion of aircraft types). In 2010, Boeing delivered 462 aircraft, of which 376 (81%) were Boeing 737s. Boeing also reported that it booked 486 net 737 orders in 2010, and had a firm order book of 2,186 737s as of December 31, 2010. Boeing's rival, Airbus, delivered 510 aircraft, of which 401 (79%) were A320s.[10] Airbus booked 416 net orders for the A320 Family and had an order backlog of 2,418 A320 airplanes.[11]

Boeing and Airbus will likely face intense and determined competitors that see an opportunity to manufacture large civil aircraft in the 90–220 seat range. However, with the exception of Embraer's 190 and 195 E-Jets, none of the new competitors have yet to build any of the planes that they claim will be superior to Boeing and Airbus products.[12] Both Boeing and Airbus recognize the possibility that one or more aircraft manufacturers may succeed in building planes that will compete with the Boeing 737 and the Airbus A320 families. Boeing's Jim McNerny has to do little more than look at Airbus – a company formed in 1970 by three European governments to ensure that a previously fragmented European aerospace industry would survive – to recognize that additional competitors have the potential to fundamentally change the global aircraft manufacturing industry. But history has not been kind to a market crowded with suppliers of commercial jet aircraft.

Boeing and Airbus are the dominant producers of narrow-body commercial transport aircraft 90-220 seats). Two other aircraft manufacturers, Bombardier and Embraer, are the dominant producers of regional jets (RJs, which are defined as having fewer than 90 seats) and also manufacture narrow-body aircraft.[13] The entry of new competitors into both the RJ and narrow-

[8] Ibid.

[9] Ibid.

[10] Net orders include total orders minus cancellations.

[11] Boeing, *Annual Report 2010*; Airbus, *2010 Commercial Review*.

[12] Embraer, which delivered 58 E-190s and 17 E-195s in 2010, is competing against Airbus' smallest jet, the A318, which has not experienced strong sales.

[13] With some "regional jets" seating more than 120 passengers, the term "regional jet" has becoming increasingly meaningless. Larger Bombardier and Embraer RJs are classified by Boeing in the same single-aisle category as the Boeing 737 and the Airbus A320 (90 – 175 seats). Thus Boeing definition of RJs accounts for jet airplanes that carry fewer than 90 passengers. According to a 2001 study by the U.S. General Accounting Office (GAO)(since renamed the U.S. Government Accountability Office): "There is no uniformly accepted definition of a regional jet either in the industry or in federal laws and regulations. For example, the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, P.L. 106-181, variously defines a regional jet as having a maximum seating capacity of "not less than 30 nor more than 75" (sec. 210) or "less than 71" (sec. 231). Within the industry, "regional jet" is sometimes used to (continued...)

body markets could result in a much higher level of competition for both the dominant RJ manufacturers (Bombardier and Embraer) and the dominant narrow-body manufacturers (Airbus and Boeing).

All of the new entrants are almost certain to face a number of hurdles that will determine whether they succeed, go back to the drawing board, or exit large commercial aircraft manufacturing. Chinese, Russian, and Japanese manufacturers have not previously built *commercially competitive* large civil aircraft, and Canada's Bombardier and Brazil's Embraer have primarily manufactured regional jets, albeit with considerable success. The complexities that aircraft integrators, such as Boeing and Airbus, have faced with various aircraft development programs (including recent programs such as the Airbus A380 and A350 and the Boeing 787) would be sufficient to sink all but the strongest aerospace companies. However, because some of the new entrants into the large civil aircraft sector are state-owned and -controlled companies (i.e., Russia's United Aircraft Corporation and China's Commercial Aircraft Corporation of China) that are funded by the government, commercial considerations may be less important during the development phase of the Russian and Chinese commercial aerospace projects.

Growing Demand for Narrow-body Aircraft: A Market Signal to New Entrants?

One of the major market drivers for new narrow-body and RJ aircraft is projected high demand for efficient narrow-body aircraft in markets that are expected to grow rapidly during the next 20 years, especially in Asia and Latin America. The other major driver is the anticipated retirement of many of the airplanes in the current narrow-body fleet. Expected high demand for aircraft has attracted additional manufacturers, especially those that have the technical capacity to build such planes or those who possess a rapidly growing market for these, such as China and potentially India.

Some of the new entrants have programs to build RJs that seat 70-90 passengers, but they could reasonably be expected to build larger aircraft in the not too distant future. Others are developing narrow-body aircraft that their manufacturers expect will compete head-to-head with the Boeing 737 and Airbus A320 families of narrow-body jets. The manufacturers of the new aircraft claim their planes will deliver substantially greater fuel efficiency than current versions of the 737 or A320 families, although it remains to be seen if the new planes will actually do so.[14]

(...continued)

describe larger aircraft, such as the Fokker F-100 (107 seats) and Boeing 717 (106 seats), and older-technology aircraft, such as the Fokker F-28 (69 seats) and BAe 146-100 (70-82 seats)." GAO, *Aviation Competition: Regional Jet Service Yet to Reach Many Small Communities*, GAO-01-344, February 2001.

[14] Unless otherwise indicated, this report focuses on single-aisle, narrow-body planes that are similar to all variants of the Boeing 737 and Airbus A320 aircraft. The 737 and A320 are mainline aircraft that are flown on what are considered to be short-to-medium-haul routes by large airlines, such as American or United, or by low cost carriers (LCCs), such as Southwest Airways and JetBlue Airways. Smaller regional jets (RJs), primarily produced by (continued...)

Table 1. In Production, Launched, and Out-of-Production Regional Jets and Single-aisle Narrow-Body Aircraft

Regional Jets (34-89 seats)	Narrow-body, Single Aisle Jets (90-220 seats)
Antonov An-148[a]	Boeing 707, 717, 727, 757[b]
AVIC ARJ-700	Boeing 737-100 through 500
Avro RJ70, 85	**Boeing 737-600/700/800/900ER**
BAe 146-100	**Airbus A318, A319, A320, A321**
Bombardier CRJ	Boeing-MDC DC-9, MD-80, -90
Dornier 328JET	**AVIC ARJ-900**
Embraer 170, 175	BAe 146-300, Avro RJ100
Embraer ERJ-135/140/145	**Bombardier CRJ-1000**
Fokker 70, F28	**Bombardier CS100, CS300**
Mitsubishi MRJ	**COMAC C919**
Sukhoi Superjet 100	**Embraer 190, 195**
Yakovlev Yak-40	Fokker 100
	Ilyushin IL-62
	Tupelov TU-154
	Tupelov TU-204, TU-214
	Yakovlev Yak-42

Source: Boeing, *Current Market Outlook 2011-2030*.

Notes: This table does not follow the Boeing classification scheme, which divides non-RJ, single-aisle planes into two categories ("90-175 seats" and "More than 175 seats"). This table combines all single-aisle, narrow-body jets into one column because the trend has been for narrow-body jets, including the Boeing 737 and Airbus A320 families, to grow larger.

a. Bolded text indicates an airplane that is in production or launched (i.e., in development). Unbolded text indicates airplanes that are no longer in production.

b. The Boeing 757 is a large single-aisle narrow-body jet that seats from 200 passengers (in a two-class configuration to 289 passengers in a single-class configuration.) The 757 has not been produced since 2004.

Several of the entrants to the narrow-body and RJ markets are well established aircraft manufacturers or are producers of major sections of airframes for others. The established firms include Bombardier (Canada), Embraer (Brazil), and Mitsubishi Heavy Industries (MHI)(Japan). Others, such as United Aircraft Corporation (UAC)(Russia) and Commercial Aircraft Corporation

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Bombardier of Canada, and Embraer of Brazil, typically carry 35 to 90 passengers and are usually operated by regional and feeder airlines.

of China (COMAC)(China), are new firms that reflect a reorganization of existing state-owned aerospace (defense and commercial) manufacturing resources by Russia and China. Their intent is to create industries that are viable international competitors. Both UAC and COMAC will produce RJs and narrow-body aircraft in cooperative partnerships with Western suppliers (see **Table 1**).

With the entry of additional competitors, the major producers of narrow-body airplanes (Boeing/Airbus) and RJs (Bombardier/Embraer) will potentially face disruptive competition. All of the newcomers will have to build market share quickly if their airplanes are to achieve viability. Bombardier and COMAC have signed a partnership agreement and are developing complementary, but non-overlapping, narrow-body airplanes that will seat 100-149 passengers (Bombardier) and 156-190 passengers (COMAC).[15] This partnership may pose the most serious challenge to the Boeing/Airbus narrow-body franchise if COMAC and Bombardier are able to gain a significant share of the fast-growing Chinese market – a market that both Boeing and Airbus intend to contest. Embraer, which had considered and rejected stretching its 190/195 E-jet (98-122 seats), may also decide to build a larger narrow-body airplane, especially if China, Russia, and Japan move into Embraer's core RJ market.[16] Embraer is considering the development of a new larger airplane, but has not yet announced whether it will proceed, a decision that may ultimately depend on Boeing's plans and schedule for developing a replacement aircraft for the 737.[17]

Boeing and Airbus are, at present, the premier manufacturers of large civil aircraft of all sizes, but the importance of narrow-body aircraft to both companies cannot be overstated. According to Boeing's forecast for 2011-2030, narrow-body jets are expected to account for about 60% of all sales and about 47% of all revenues during the period. Although the two companies have, in recent years, sold roughly equivalent numbers of narrow-body planes, the projected demand for 23,330 narrow-body airplanes through 2030 suggests that the market may be theirs to lose if they do not keep ahead of the competition or if they are not capable of producing enough airplanes to meet their customers' demands.[18]

Airbus has announced that it will upgrade the A320 family by 2015, offering two new models of high efficiency engines. Airbus has announced that it does not intend to develop a replacement for the A320 until the mid-2020s. On July 20, 2011, Boeing followed Airbus' lead and announced that it would re-engine the 737 rather than replace it with a new small aircraft by 2020. Neither company appears to take competition (with each other or with newcomers) for granted, but both companies appear to believe the risks that the newcomers are willing to assume will be greater

[15] Bombardier, "COMAC and Bombardier Sign Strategic Agreement on Commercial Aircraft," Press Release, March 24, 2011; *Bloomberg News*, "Bombardier, China's Comac to Cooperate on Plane Development," March 24, 2011.

[16] *Air Transport Intelligence News*, "Proposed stretch dubbed E-195X by Embraer," January 26, 2010; *Air Transport Intelligence News*, "Embraer kills 195X over range concerns," May 13, 2010.

[17] Telephone conversation with Mauro Kern, Embraer's Executive Vice-President for New Programs, Airline Market, February 14, 2011; *ATW Online*, "Embraer eager for Boeing to make 737 re-engine/replacement decision," May 18, 2011.

[18] Boeing, *Current Market Outlook 2011-2030.*

than those that should taken by market leaders with strong reputations for building commercial aircraft. Boeing and Airbus, with complete access to the latest aerospace technologies, may believe that they can learn from the experience of the newcomers without compromising safety, their overall competitiveness, or their ability to deliver a plane within a time-frame necessary to remain competitive.

Aircraft Development: A High Stakes Venture

The decision to develop (or "launch") a new airplane exposes commercial aircraft builders, jet engine manufacturers, and a host of other suppliers to very high levels of risk. Throughout the twentieth century, most firms made losing bets on aircraft and exited the commercial market entirely.

Various types of risk are associated with aircraft development, including a manufacturer's ability to access capital markets to bring a plane to market; to deliver a plane that meets the performance requirements that were promised to launch customers; to deliver the plane in a timely manner; to attract sufficient customer demand to recover launch costs and earn a profit; and to anticipate the response of competitors.

Investment Risk

Large capital investments are required to bring a new plane to market. For publicly traded, shareholder-owned (as opposed to state-owned) corporations that manufacture commercial aircraft, the inability to raise launch capital would be sufficient to doom most projects. For commercial aircraft manufacturers, the overall risks associated with the launch of a new airplane is high enough that the term "betting the company" is frequently used to describe it. According to the U.S. International Trade Commission (USITC), "the development costs incurred by Boeing in 1966 for its 747 program are estimated to have been $1.2 billion – more than triple Boeing's total capitalization at that time."[19] In other words, Boeing's level of risk was sufficiently high that failure could have brought the company down. Airlines and aircraft leasing corporations also bear similar risks: the purchase of a new airplane requires an airline to either borrow to finance the new airplanes or, as many airlines do, lease the new aircraft from one of the many companies that offer planes for lease. However, in the event that a particular aircraft does not generate enough sales to justify its place in the market, a launch customer (whether it be an airline or an aircraft leasing company) does not want to be the largest or only operator/owner of an airplane that is deemed a commercial failure.

[19] United States International Trade Commission, *The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry*, Investigation No. 332-384, Publication 3143, November 1998. Footnote 15, p. 2-1.

Fleet Complexity

For airlines, who are the main customers of large civil aircraft manufacturers, fleet complexity provides flexibility but increases costs because of the need to support additional and different parts inventories and multiple training programs for aircraft crews and maintenance personnel. Fleet complexity emerges by design or by merger. It has been common for airlines to map out (or expand) a network and then acquire aircraft that best fit the needs of that network, or to outsource parts of the network to regional carriers that use RJs to feed the major airlines at their hubs. This was the strategy favored by legacy carriers (most of the airlines that predate airline deregulation in 1978). Bankruptcies and numerous airline mergers have also contributed significantly to fleet complexity, as large numbers of very different aircraft types were integrated into the merged enterprise. Fleet complexity is frequently necessary to support a varying mix of short- and medium-haul domestic and long-haul international operations.

The major weakness of fleet complexity is the impact of changing business conditions on airlines. Rapidly fluctuating fuel costs or a sharp drop in the number of passengers (due, for instance, to a recession or economic downturn) have potentially greater negative effects on airlines that purchased aircraft to fit a network than on airlines that built a network on the basis of a specific type of aircraft. After airline deregulation, many airlines sought to compete for the same high density routes. This competition frequently created overcapacity, and resulted in low passenger yields and low fares on high density routes – a business model that practically guaranteed poor financial results. Deregulation also resulted in the abandonment by airlines of many routes that generated too few passengers to be profitable – leaving some communities with limited service and few direct flights other than to the nearest hub or with no service at all. Many of the flights to "thin" markets use smaller turboprops or RJs flown by regional carriers under contract to legacy carriers.

In contrast, numerous low-cost carriers constructed networks based on a fleet of only one or two types of aircraft, including Southwest (737); AirTran (717, 737),[20] JetBlue (Airbus A320, Embraer 190), and Ryan Air (737) of Ireland, among many others. This strategy has proved effective for growth and has allowed airlines like Southwest to move into territories that were once controlled by large legacy carriers.

Fleet complexity has direct and indirect effects on aircraft manufacturers. Aircraft manufacturers have found it easier to compete against one another for an airline's business if the airline owns various models of airplanes made by multiple aircraft manufacturers. Aircraft manufacturers typically work closely with launch customers to create an airplane that meets customer

[20] The parent company of AirTran, AirTran Holdings, Inc., was acquired by Southwest on May 2, 2011 for $1.4 billion. AirTran's fleet comprises 88 Boeing 717s and 52 Boeing 737s. Southwest and AirTran will continue to operate as separate carriers until the Federal Aviation Administration (FAA) grants the airline a Single Operating Certificate, which it is expected to do in February 2012. In addition to the Airtran fleet and network of 69 cities, the asset that Southwest may have prized most was the 31 gates at Hartsfield-Jackson Atlanta International Airport that Airtran controls. With its purchase of AirTran, Southwest has established a presence at the busiest passenger airport in the world.

requirements. This has frequently led to bidding wars among major aircraft makers, which sometimes offer airplanes to launch customers at unrealistically low prices, which then requires the manufacturer to sell many more planes to reach a breakeven point.[21]

Conversely, an airline that builds its network around one manufacturer/one type of aircraft creates a network effect that results in "lock-in." A low-cost carrier with a network based on one aircraft model has little incentive to purchase a comparable airplane from another manufacturer, even if the upfront price of the alternative airliner is attractive. In the case of Southwest Airlines, this strategy works well for Boeing, but effectively locks-out other competitors as long as they do not produce a competing product that is so recognizably superior to the Boeing 737 that Southwest has little choice but to switch. On the other hand, the current generation of 737s appears to be moving toward the end of its product life cycle in terms of the technological improvements and efficiency gains that can be made to it.

For a number of months, Boeing engaged in a lively debate with its customers and itself about building a newer, more technologically advanced plane to replace the 737 by the end of the current decade. Southwest, Boeing's largest customer, has said that the replacement for the 737 is needed sooner rather than later. Against this customer pressure to replace the 737, the immediate success of the A320neo (new engine option) increased pressure on Boeing to put new, more efficient engines onto the 737, thus prolonging the life of one of the best known planes flying today. However, American Airlines, an all-Boeing customer, announced on July 20, 2011 a massive order for 430 narrow-body jets. In splitting its order between the A320 and 737, American announced that given its need to acquire the planes rapidly, no one company could deliver the all of the planes quickly enough.

For those manufacturers that do not currently control a significant share of the 90-200 seat aircraft market, whether Canadian, Brazilian, Chinese, Russian, or Japanese, the larger challenge will be to produce and sell a commercial product that is superior to the planes currently on offer by Airbus and Boeing.[22] The prospect that Airbus and Boeing may deliver more efficient planes in a timeframe that approximates the challengers' schedules further complicates their ability to claim existing market share from Boeing and Airbus.

The difficulties, however, are more complex than building a more efficient airplane. Jet aircraft require a significant support network that is capable of supplying parts and assistance on a 24/7 basis with next-day delivery anywhere those planes fly. A plane that cannot fly because a part is not available cannot earn revenue, and airlines cannot afford to have a $50–$250 million piece of equipment sitting on the tarmac waiting on a part for very long. Bombardier and Embraer have both demonstrated that they can support the airlines that operate their aircraft. Russian aircraft manufacturers have traditionally had a poor reputation for service and parts supply. Russian and Chinese aircraft companies have announced that support services will be accomplished via joint

[21] This is especially true when delivery delays and serious cost overruns occur.

[22] Embraer's 190/195 E-Jet, with 108-122 seats, has sold well, but that plane (a stretched version of the 170/175 E-Jet) cannot be stretched further without degrading its efficiency. Embraer will have to develop a new plane rather than a larger variant if it wants to compete in the 125-200 seat segment of the narrow-body market.

ventures with European or North American partners. A proposed link between Bombardier and COMAC may help the Chinese manufacturer sell planes in some foreign markets.

Reputational Risk, Uncertainty, and Inefficiency

Reputational risk could be a significant problem for some manufacturers. This type of risk stems from many sources, but primarily affects the willingness of airlines and airline leasing companies to make large financial commitments to aircraft manufacturers that have not previously achieved success in competitive markets or who are new to the aircraft market segment they are entering. It seems highly unlikely that a major U.S. or European airline would commit to purchase a large number of expensive aircraft built by companies that have a limited track record and a poor reputation for after-sales support and quick parts delivery. Even if the airplanes are certificated in Europe or the United States, passenger airlines that purchase Russian-built airplanes could alienate their customers. From a competitive perspective, it will probably take years of solid service (including maintenance and parts support), possibly in the fleet of a reputable European air cargo operator, to convince passenger airlines and their customers that the airplane can deliver a level of service equivalent to that of Boeing and Airbus aircraft.

One reason for concern is that the major aircraft manufacturers in the Soviet Union (Ilyushin, Sukhoi, Antonov, and Yakovlev) were protected from competition and market forces for decades prior to the collapse of the Soviet Union. With the breakup of the Soviet Union, none of the Russian companies could produce a commercial airplane that was competitive against products by Boeing or Airbus. By 2005, the entire Russian aircraft manufacturing industry was producing an average of 10 commercial aircraft a year.[23] A widely held view is that the major problem with Russian commercial aircraft was poor after-sales support and poor maintenance by the airlines that operated the airplanes.[24] The collapse of the Russian aircraft industry led to its reorganization by the Russian government in 2006. The new umbrella company, United Aircraft Corporation (UAC), is more than 92% owned by the Russian Federation and the Russian Development Bank (*Vnesheconombank*).[25] With government support, Sukhoi has launched the SuperJet 100, a regional jet, and Irkut is developing the MS-21, a narrow-body (150-210 seat) airplane that will compete directly with Airbus A320 and Boeing 737 aircraft.

The outlook for the Russian civil air transport sector, however, is problematic. In a 2008 study, the U.S. Commerce Department, citing the Russian Transport Ministry, reported that "by 2005, of the 2,528 total civil aircraft currently in service, more than one-half had passed their legal operational limits and needed replacing...[and]...industry experts forecast that Russian airlines would need at least 620...aircraft in the next 20 years."[26] Boeing's 2010 forecast for the

[23] Department of Commerce, International Trade Administration, *Russia: Consolidation of the Aerospace Industry*, 2008. p. 1.

[24] Department of Commerce, International Trade Administration, *Russia: Consolidation of the Aerospace Industry*, 2008. p. 1; Vasigh, Bijan, Ken Fleming, and Liam Mackay. *Foundations of Airline Finance*. Burlington, VT: Ashgate Publishing, 2010. pp. 13-14.

[25] United Aircraft Corporation (UAC) website: http://www.uacrussia.ru/en/investors/shares/.

[26] Department of Commerce, International Trade Administration, *Russia: Consolidation of the Aerospace Industry*, (continued...)

Commonwealth of Independent States (C.I.S.), a group comprising Russia and eight former Soviet republics, projects that the region will acquire 960 new commercial airplanes between 2010 and 2029, with a market value of $90 billion (in 2009 dollars). The new aircraft will have an average value of $90 million each (in 2009 dollars). The number of commercial airplanes in the C.I.S. in 2009 was 1,150 and is projected to rise to 1,300 in 2029 – an annual rate of 0.6%. Most of the new deliveries will replace older equipment.[27] With limited future demand for new commercial airplanes in Russia and the rest of the C.I.S., Russian manufacturers will have to compete against both new and used Boeing and Airbus airplanes in non-C.I.S. markets where high demand is anticipated or where demand for replacement aircraft is high.

In contrast to Russia and the other C.I.S. countries, the outlook for China is highly positive. Boeing projects that Chinese demand for new aircraft between 2009 and 2029 will be 4,330 new airplanes, with a market value of $480 billion (in 2009 dollars), with an average airplane value of $110 million (in 2009 dollars). Of new deliveries, 71% are projected to be narrow-body airplanes and only 6% are expected to be regional jets.

To overcome the reputation issue, both Russian-owned UAC and Chinese-owned COMAC have sought well established international joint venture partners that will be involved in the design, manufacture, marketing, and maintenance of commercial aircraft manufactured by those state-owned companies. Their expectation is that such partnerships will increase credibility and reduce the risk to airlines that purchase or lease such planes – especially if the partnerships help those companies establish a reputation for product safety, performance, quality, comfort, and price competitiveness. Such partnerships may benefit the various partners in the short-run, but as the new aircraft firms gain confidence and market share, both Russian and Chinese companies are likely to seek higher levels of national (or indigenous) competency and competitiveness across the range of advanced technologies (e.g., engines, wing, and avionics and other systems) and after-sale support.

COMAC, the state-owned Chinese commercial aircraft company, has set out a number of basic principles for the development of a narrow-body aircraft that includes bringing into "full play the political superiority of the socialist system," competitiveness with Western products, commercial independence, and "independent intellectual property rights." These raise the possibility of a captive domestic market in which Chinese airlines will buy COMAC airplanes – even if they prove to be inferior to competing products (see text box below).[28] The Chinese commercial aircraft industry is currently at a stage of developing domestic capabilities that require complex cooperative partnerships with foreign (chiefly European and American) suppliers. But COMAC's principles suggest an agenda that envisions a national policy of economic independence for its aircraft industry and possibly its aircraft market – a more autarkic vision that appears to differ

(...continued)

2008. pp. 1, 3.

[27] Boeing, *Commercial Market Outlook 2010*.

[28] Commercial Aircraft Corporation of China (COMAC) website: http://english.comac.cc/products/ca/pi/index.shtml

from those of companies that are pursuing market opportunities within a free trade context in China and elsewhere.

COMAC: Basic Principles of Developing the C919

- **Chinese Characteristics**. We should set our footing on the practical situations in China, leverage on the whole nation's strengths and wisd[o]m, and bring into full play the political superiority of the socialist system which is capable of concentrating all of its resources in achieving great things.
- **Cutting-edge Technology**. We must consider user needs in the beginning during design and make sure the trunk liners that we are going to develop and manufacture will be competitive with other products in the same class.
- **Strategic cooperation**. We will commit to national and international cooperation based on the "airframer-suppliers" model to share risks and benefits, and build a system of both national and international suppliers for trunk liner, and eventually establish relatively complete service and industrial chains in the commercial airplane business.
- **Innovative System and Mechanism**. We should establish the notion and use of systematic engineering to promote innovations in systems and mechanisms, as well as in management.
- **Independent Intellectual Property Rights**. In order to meet the demand of the domestic aviation market, we should comply with the safety, economy, comfort and environmental regulations of the aviation authorities and acqui[r]e ownership of our independent intellectual property rights.

Note: Text is verbatim from the Commercial Aircraft Corporation of China website.

Source: Commercial Aircraft Corporation of China (COMAC) website: http://english.comac.cc/products/ca/pi/index.shtml

In markets where the state owns or controls both the aircraft manufacturing industry and airlines (China, in particular), governments can apply pressure to ensure that airlines purchase domestically produced aircraft. In combination with industrial policies that could potentially hinder market access by foreign aircraft manufacturers, a protected market for aircraft sales could easily guarantee sufficient local demand to allow a domestic producer to achieve scale economies. Of course, the Chinese market is sufficiently large that it should be capable of supporting domestic production and imports. The question is whether China will protect the market for its own narrow-body and regional jet aircraft while continuing to purchase aircraft that it cannot yet produce (i.e. wide-body medium and large aircraft). Whether Airbus or Boeing could challenge such an approach without fear of retaliation (loss of sales of large airliners to large state-owned airlines) remains to be seen.

The Changing Economics of Small Commercial Jets

The Boeing 737 and Airbus A320 families of airplanes (see **Figure 1** for an illustration of the various models in the Airbus A320 family) overwhelmingly define the narrow-body, single-aisle market.[29] Sales of 737s and A320s provide the bulk of orders and earnings for both Boeing Commercial Airplanes (BCA), based in Renton, WA, and Airbus SAS, based in Toulouse, France.[30] These companies have been the sole competitors for the large commercial aircraft market since Boeing and McDonnell Douglas merged in 1997.[31] Boeing is the sole U.S. producer of large commercial aircraft. Unlike many other manufacturers of aircraft, Boeing and Airbus are the only companies that produce a complete range of mainline commercial aircraft (small narrow-body to very large aircraft). The Boeing Company and EADS, Airbus' parent company, are also major international defense aerospace contractors. The Brazilian aerospace company, Embraer, produces the 190 and 195 E-Jets, which competes with smaller narrow-body planes by Airbus (the A318) and Boeing (the 737-600 series).[32]

Large civil aircraft are typically used for 25 years or more before being sold to cargo fleets, non-scheduled carriers, or to foreign airlines that lack the resources to buy newer equipment. Some narrow-body passenger aircraft, including the DC-9, have flown in U.S. airline fleets for up to 40 years. The first Boeing 737s (the 100 and 200 series) were delivered in December 1967 – or 43 years ago.[33] Because of the longevity of commercial aircraft, manufacturer's must consider the entire life-cycle of the plane and the likelihood that there will continue to be a market for the jet for more than enough years to cover the development costs of the plane.

[29] Large civil aircraft (LCA) typically refers to aircraft with more than 90 seats. Regional jets (RJs) refer to jets with up to 90 seats, although Embraer and Bombardier both produce aircraft that seat more than 100 passengers.

[30] Boeing Commercial Airplanes, the division that manufactures commercial aircraft, is a subsidiary of The Boeing Company, of Chicago. Airbus SAS is a subsidiary of the European Aeronautic Defence and Space Company EADS, NV (EADS), headquartered in Paris, France.

[31] McDonnell Douglas, which merged with Boeing in 1997, produced a family of narrow-body, single aisle aircraft, beginning with the DC-9 (built between 1965 and 1982; capacity: 90-135) , the MD-80 (1980-1999; capacity: 130 and 155 passenger versions), the MD-90 (1995-2000; 153 to 172 seats), and the MD-95/Boeing 717 (1999-2006; 106-117 seats). After the merger, Boeing quickly phased out the MD commercial line, with exception of the MD95, a regional jet that was renamed the 717. Of 2,443 DC-9/MD-80/MD-90/717s placed in service, 1,066 remain in service as passenger or cargo aircraft. Parenthetically, early versions of the Boeing 707, once one of the largest passenger aircraft capable of international travel, carried only 149 passengers. Boeing; Airlinerlist.com (December 2010). Lockheed, another major commercial aircraft manufacturer, exited the commercial aircraft market after its wide-body L-1011 failed to win enough orders.

[32] JetBlue and US Airways operate the Embraer 190 E-Jet. Although the Boeing 737-600 is part of the 737 NextGen series, the last order and delivery for that model was in 2005 and 2006, respectively.

[33] Some 737-200s remain in service, although high fuel prices and maintenance costs are causing airlines to retire the plane. No U.S. airline has flown the plane in the continental United States since 2006, when Delta retired the last of the 40-year old jets. Another jet, the 737-300, is the most popular of the 737 Classic series (737-300/400/500 models) with 1,113 deliveries between 1984 and 1999. Recent discoveries of metal fatigue on some of the 737-300s suggest that the life-span of these planes may be shorter than the manufacturer or airlines anticipated. Southwest has stated its intention to retire its 171 737-300s as it receives 737-800s from Boeing.

Airlines use aircraft intensively for many years and incur various operating costs that play a critical role in measuring aircraft performance. Costs include salaries, wages, and benefits; fuel and oil; maintenance materials and repairs; landing fees and other rentals; depreciation and amortization; aircraft rentals; and other expenses. According to Southwest Airlines' most recent annual report, "except for changes in the price of fuel, changes in operating expenses for airlines are largely driven by changes in capacity, or [available seat miles] ASMs."[34]

Figure 1. The Airbus A320 Family of Jet Aircraft

A318, A319, A320, and A321

Source: Airbus.

The demand for commercial aircraft changed in significant ways during the last decade in response to a number of exogenous events, including 9/11 and the shock experienced by the aerospace industry as a whole; the deep recession of 2008-2009; and fuel costs that have generally been rising since 2004. Since 2008, the volatility of fuel prices have caused significant problems for the airline industry (see **Figure 2**). During a five-month period in 2008, airlines were buffeted by crude oil spot prices that peaked at $147/barrel (bbl.) before falling below $35/bbl. Again in April 2011, the refiner acquisition cost of a barrel of crude oil rose to approximately $112, or nearly $28 higher per barrel than the year before.[35] The 2008 and 2011 spikes in fuel costs, associated with oil prices greater than $100 per barrel, is part of what spurred

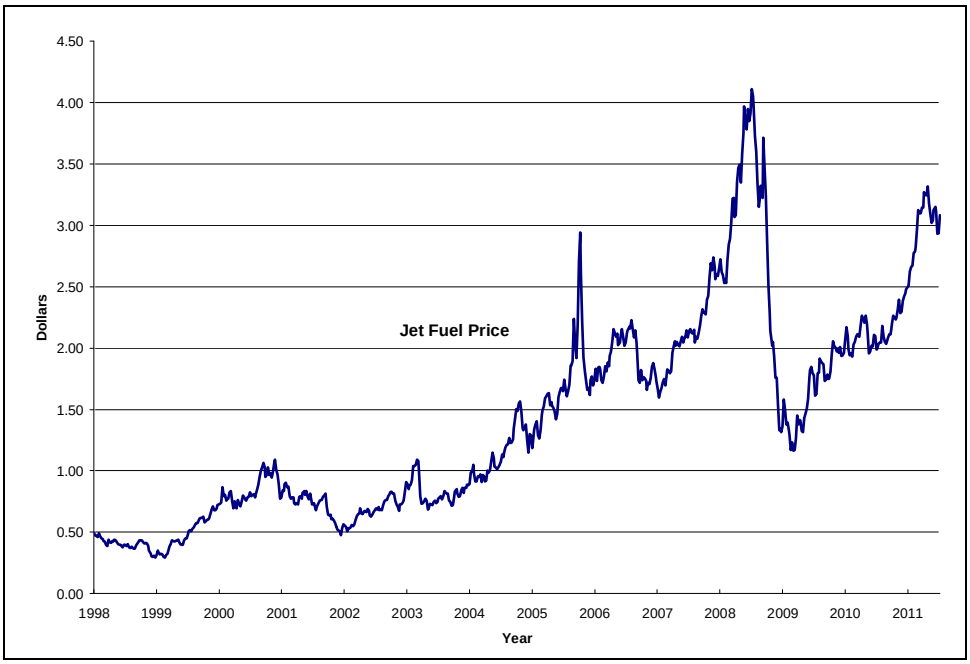
[34] Southwest Airlines. *Annual Report, Form 10-K*, February 8, 2011, p. 42. Available seat miles (ASMs) are the number of seats available multiplied by the number of miles flown.

[35] Department of Energy, U.S. Energy Information Administration, *This Week in Petroleum*, "The outlook for transportation fuel markets this summer," April 13, 2011.

airlines to increase load factors by reducing the number of available seats miles (i.e., retiring or parking aircraft); [36] reduce excess network capacity by reducing the number of scheduled flights and discontinuing service to some cities; eliminate formerly profitable 50-seat regional jets from many routes; increase ticket prices and impose "ancillary fees" for baggage and numerous other services; [37] and retire many older aircraft and demand more fuel-efficient replacements.

Figure 2. Price of Jet Fuel (January 1998 – July 8, 2011)

Weekly U.S. Gulf Coast Kerosene-Type Jet Fuel Spot Price FOB (Dollars per Gallon)



Source: Energy Information Administration.

Airlines have constrained capacity by grounding many older planes and reducing the number of flights from 11.6 million per year in 2005 to 10.1 million per year in 2010. For the period between 1978, the year airlines were deregulated, and 2002, system-wide (domestic and international) load factors for all U.S. airlines averaged 64.5%. Between 2003 and 2010, load

[36] Load factors, which measure the number of seats sold in terms of total seats available, is calculated by dividing revenue passenger miles by available seat miles.

[37] Ancillary fees have been a significant source of revenue for airlines. Air fares are subject to a 7.5% excise tax that funds the Airport and Airway Trust Fund. Ancillary fees that airlines charge for a range of optional services, such as checked and carry-on bags; meals; blankets; early boarding; and seat selection are not subject to the 7.5% excise tax. According to GAO, DOT-reported airline ancillary revenues amounted to $7.8 billion in 2009 – an amount the GAO reports is understated, as well as unreported by airlines to the FAA.GAO also noted that, with the exception of checked baggage fees, many of the charges are not provided to the passenger at the time of ticketing, making it difficult for customers to make price comparisons. U.S. GAO, *Commercial Aviation: Consumers Could Benefit from Better Information about Airline-Imposed Fees and Refundability of Government-Imposed Taxes and Fees*, GAO-10-785, July 2010.

factors rose dramatically from 73.5% to 82.1% – the highest levels ever achieved. Together with the consolidation that has occurred within the airline industry and the numerous fees that airlines are using to boost revenues, the outlook for the industry has improved.

Although maintenance, repair, and overhaul (MRO) spending generally amounts to less than 10% of total annual operating expenses, long lasting assets, such as airframes and engines, require ongoing maintenance and repairs, as well as overhauls as planes age. Over the course of an aircraft's lifespan, engines account for 46% of maintenance, repair, and overhaul (MRO) spending, while airframes account for the rest. Total global MRO spending was $42.6 billion in 2010.[38]

Many older airliners are being retired, including the Boeing 737-300/400/500 series (also called the "737 Classic" series) that seats 122-159 passengers depending on the specific model and seating configuration), the MD-80/90 series, the DC-9, and older model Airbus A320s.[39] At the same time, the economics of regional jets have also changed. With high fuel prices, once profitable 50-seat RJs have become money-losers and airlines have shifted to larger aircraft.[40]

Figure 3 provides a chart that shows the average stage length (left axis of chart) of narrow-body mainline jets and wide-body jets and operating cost per ASM (CASM)(right axis of chart).[41] In **Figure 3**, the single-aisle narrow-body planes with the shortest average stage length usually have higher operating costs per available seat mile (CASM). The age of the plane also plays a role. The DC-9s, some of the oldest planes, have the highest cost per available seat mile, followed by the "737 Classic" series.[42]

[38] *Aviation Daily*, "Intelligence," April 12, 2011, p. 1. The article's source is TeamSAI, an aviation consulting firm that publishes an annual MRO forecast.

[39] The 737 is a mid-1960s-vintage plane; in 1993, it underwent a major upgrade (new cockpit; redesigned wings, and an improved engine that is 5% more fuel efficient and offers 15% lower maintenance costs). The A320 family (the A318/ 319/320/321) is relatively newer: the A320 entered service in 1987, the A321 in 1994, the A319 in 1996, and the A318 in 2003.

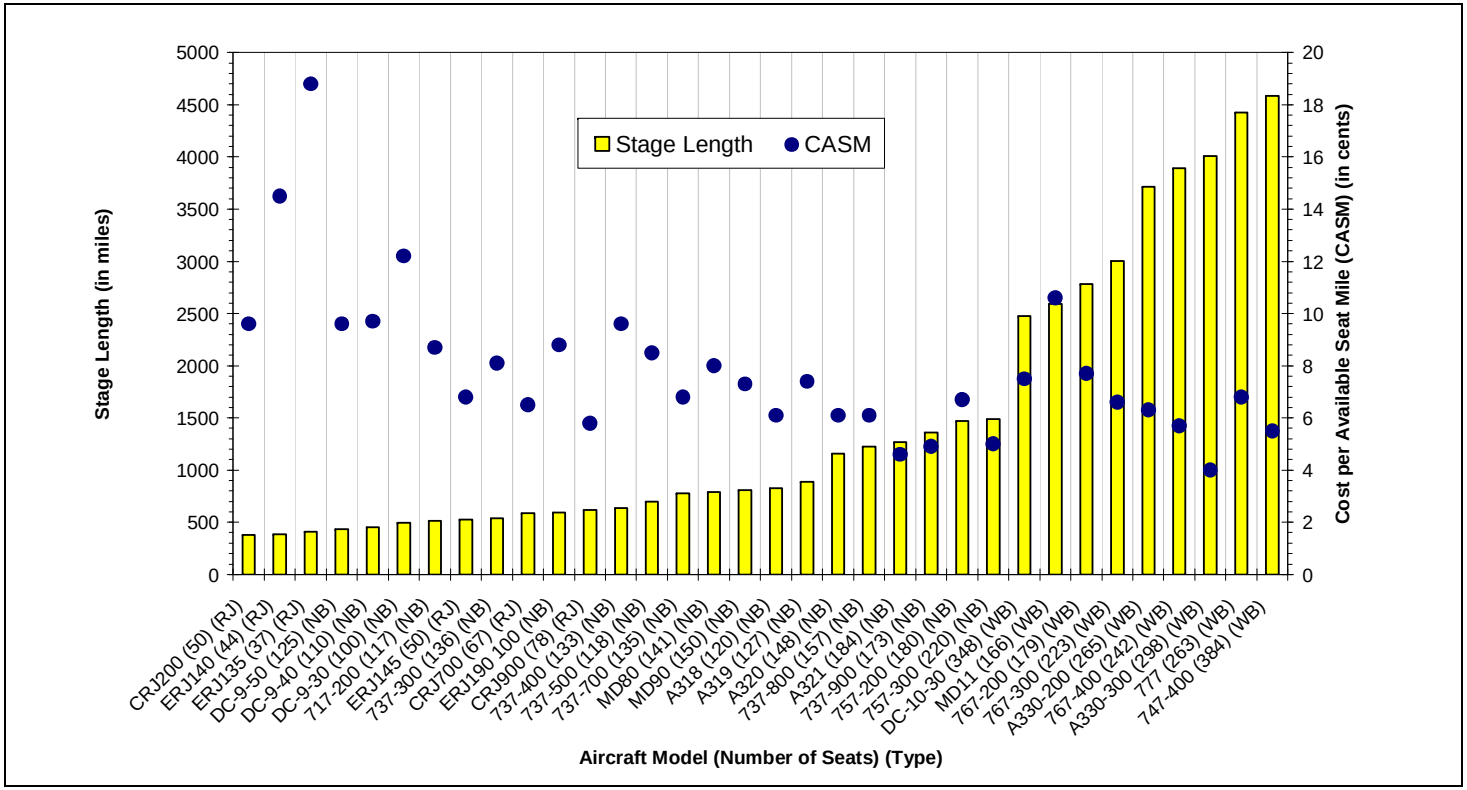
[40] U.S. Department of Transportation, Federal Aviation Administration. *FAA Aerospace Forecast, Fiscal Years 2011-2031*. p. 24

[41] The Massachusetts Institute of Technology (MIT) Airline Data Project defines *stage length* as "The average distance flown, measure in statute miles, per aircraft departure. The measure is calculated by dividing total aircraft miles flown by the number of total aircraft departures performed" using data collected from airlines by the FAA. *Cost per available seat mile* is a "measure of unit cost in the airline industry. CASM is calculated by taking all of an airline's operating expenses and dividing it by the total number of available seat miles produced." http://web.mit.edu/airlinedata/www/Res_Glossary.html

[42] The A300, a wide-body with a relatively short stage length, had the highest CASM among all the wide-bodies surveyed.

Figure 3. A Comparison of Average Stage Length (in miles) Versus Cost per Available Seat Mile (CASM) (in cents) of Various Aircraft

October 2009 – September 2010



Source: This graph was prepared by CRS and is based on data published in *Aviation Week Intelligence Network* as presented in various spreadsheets published by *Aviation Daily* in February and March 2011. Data are based on Federal Aviation Administration Form 41 data analyzed by Oliver Wyman, a management consulting firm.

Notes: This figure is arranged according to average (avg.) stage length (yellow bar) of a sample of passenger aircraft, arrayed from shortest avg. stage to longest avg. stage length. The blue dots indicate the average cost (in cents) per available seat miles (CASM) flown by aircraft in the sample. The longer the yellow bar, the greater the stage length. Conversely, a high blue dot indicates high a high average CASM, while a low blue dot indicates a lower average CASM.

In addition to the aircraft model, the average number of available seats is shown, as is the type of plane – regional jet (RJ), narrow-body jet (NB), and wide-body jet (WB), The various aircraft models are or were manufactured by the following companies or predecessor companies: CRJ: Bombardier; DC, MD, 7xx: Boeing; ERJ: Embraer; A3xx: Airbus.

Aircraft Investments and Forecasting

The Federal Aviation Administration (FAA) and major aircraft companies produce an annual 20-year forecast for the aviation industry and markets. These forecasts consider numerous factors that weigh on the market for commercial aircraft, including carrier schedules, passenger load factors, average aircraft size, the average length of flights (or stages, which involve one take-off and one landing), airspace and airport capacities, fuel costs, and different rates of growth of various regions of the world economy, among many other variables. The various segments of the industry interact in a complex manner and there are many unknowns that can quickly undercut the accuracy of any forecast. Nevertheless, forecasts guide planners as they make very large investment decisions about the production and purchase of aircraft, infrastructure development, air traffic control modernization, and regulation. The forecasts provide guidance both to the private sector and to policymakers.

The range of narrow-body models produced by both Boeing and Airbus are designed to complement almost any fleet and, in some cases, comprise the entire fleet (e.g., Southwest: 737s; Virgin America: A319s and A320s; Ryanair: 737s). During the 2000-2010 period, more than 11,000 narrow-body units were delivered or on backlog. Because demand for narrow-body airplanes was so strong, production at Boeing and Airbus did not slump during the 2008-2009 recession.[43] From 2000 through 2010, Boeing 737 orders averaged 395 per year. In 2010, Boeing 737 deliveries numbered a record 376 planes. According to Boeing, "The 737 program currently produces 31.5 airplanes per month and expects to go to 35 per month in early 2012, 38 per month in second quarter 2013 and then to 42 per month in the first half of 2014."[44] With Boeing 737 backorders of 2,101 airplanes as of May 31, 2011, it would take Boeing nearly 5.6 years (until the end of 2016) to deliver the current backlog of orders at current rates. At the end of May 2011, Airbus had backorders of 2,420 of the A320 family of aircraft and had also announced that it would gradually increase production of the A320 to 42 per month.[45] The most recent order from American Airlines and an anticipated order from Delta Air Lines may raise production levels at both companies by as much as 20 additional planes a month.

In most forecasts, increased demand for new planes is expected to be boosted by the continued growth of low cost carriers (LCCs), by the rapid growth of emerging markets, and by continued market liberalization (access and deregulation). Through 2029, new airplane demand is expected to double, with 56% of deliveries supporting the expansion of air service in growing markets, and

[43] Boeing experienced a lengthy 52-day strike in September and October 2008, when 27,000 workers walked out at facilities in Washington State, Oregon, and Kansas. Aircraft production was halted during the strike. *New York Times*, "Boeing and Union Reach Tentative Deal," October 27, 2008.

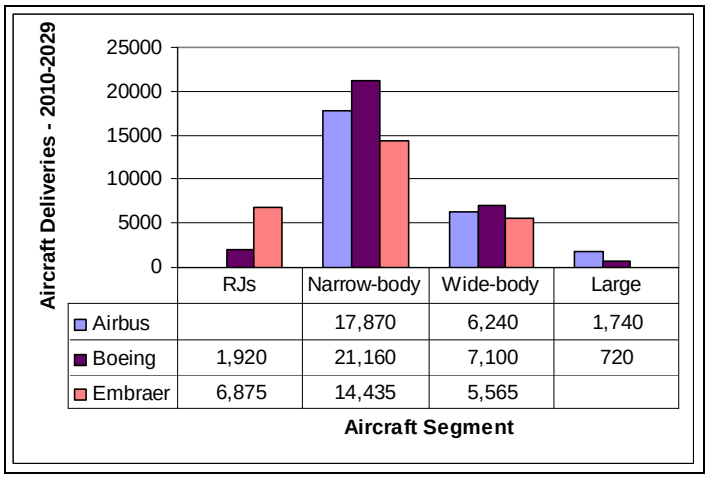
[44] Boeing, "Refurbished Boeing 737 Paint Hangar Opens to Meet Rate Increase," Press Release, July 13, 2011.

[45] Data are from the Boeing and Airbus websites. See also *Aviation Daily*, "Boeing Sets 737NG Production Rate At 42/Month," June 16, 2011.

44% of new airplanes replacing older, less efficient airplanes. Boeing projects that replacement of existing aircraft will result in 85% of the fleet having been delivered after 2010.[46]

Figure 4. Forecast of New Plane Deliveries

2010-2029



Source: Boeing Commercial Airplanes, *Commercial Market Outlook, 2010-2029*; Airbus, *Global Market Forecast, 2010-2029*; Embraer, *Market Outlook, 2010-2029*.

Notes: The Airbus forecast does not include regional jets. The Embraer forecast combines all twin aisle and large aircraft. Bombardier's forecast includes only the market outlook for turboprop and jet aircraft in the 20-149 seat range.

Boeing, Airbus, and Embraer forecasts vary significantly. Airbus projects a rosier outlook for very large jets (A380s and 747s) than does Boeing: 1,740 deliveries versus 720. At a 2011 list price of US$375.3 million per A380 and about US$201 million per Boeing 747-8/9, the additional sales by Airbus and Boeing for very large aircraft could amount to about $300 billion (at current's prices) if each aircraft maker each sold half of the additional 1,020 large jets forecast by Airbus[47]; Boeing projects that large aircraft sales will amount to $220 million. Airbus, Boeing, Embraer, and Bombardier all project strong demand in the single-aisle, narrow-body category (see **Figure 4**). According to Boeing 2010–2030 forecast, the number of narrow-body aircraft will more than double, rising from 12,100 to 27,750, or from 62% of the total airplane fleet in 2010 to 70% in 2029 (see **Figure 5**). Boeing estimates that the market value of narrow-body aircraft sales will amount to $1.95 trillion, or 48% of the $4.0 trillion market for commercial aircraft in 2030.[48]

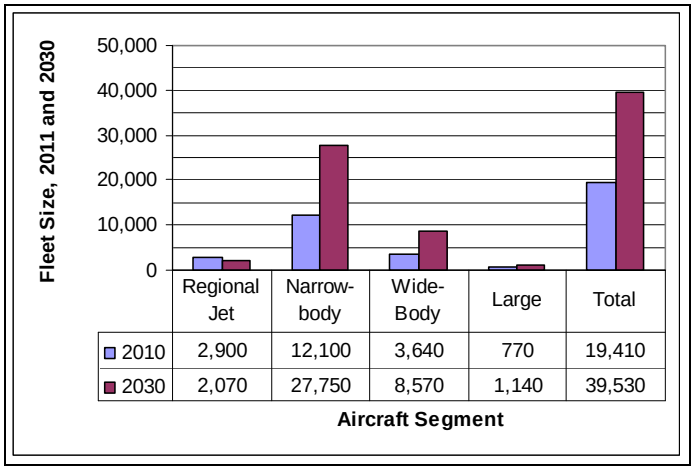
[46] Boeing Commercial Planes, *Current Market Outlook, 2010-2029*.

[47] Prices are from the Airbus and Boeing websites.

[48] Boeing, *Current Market Outlook 2011*. Presentation by Randy Tinseth, Vice President, Marketing, Boeing Commercial Airplanes, Paris, France, June 2011.

Figure 5. Boeing Forecast – World Fleets by Aircraft Size

2011 and 2030



Source: Boeing, *Commercial Market Outlook, 2011-2030*.

Has the Boeing/Airbus Rivalry Left the Narrow-body Market Open to New Competitors?

The single-aisle, narrow-body aircraft segment of the market is directly affected by larger and smaller aircraft programs, which influence investment decisions and competition among aircraft manufacturers. Manufacturers carefully consider their use of capital, labor, and engineering and manufacturing resources, and prioritize their projects accordingly. The ongoing or potential programs of competitors also receive scrutiny. A manufacturer that is developing a new plane will probably not take on additional projects that cannot be handled with available resources unless it believes it must do so to gain a competitive edge or to protect its market.

In the case of the Boeing/Airbus rivalry, there has been a willingness by both companies to pursue strategic goals that have involved attempts to outflank or pre-empt market segments. This has frequently led both companies to take on multiple projects to maintain parity or gain a competitive edge, with the two companies frequently producing similar families of planes. This strategy is not new: Douglas Aircraft, Lockheed, and Boeing earlier fought similar battles in the commercial sphere. One of the consequences of the three-way competition was oversupply of "me too" aircraft, especially large aircraft, and, with the arrival of Airbus, the exit of Lockheed from commercial production and Douglas Aircraft's merger with McDonnell, which effectively eliminated Boeing's U.S. commercial rivals, but left it with a single, stronger European challenger that had strong political and financial support from the governments of France, Germany, the UK, and Spain.[49]

[49] This report does not discuss aircraft subsidies (alleged or otherwise) that might have been provided to either Airbus (continued...)

An intense competition between Boeing and Airbus in large wide-body aircraft (A380/747-8 and 787/A350) absorbed significant resources during most of the last decade.[50] But competition in the very large, large, and medium aircraft market segments has been a normal pattern for companies that manufacture advanced commercial aircraft. The drivers of these programs are rising fuel prices, strong demand for more efficient, quieter, and less polluting aircraft, and growing demand for air travel.

Whether the Boeing/Airbus competition in the wide-body market has had any overall effect on their narrow-body aircraft programs is arguable. Some airlines have pressed Boeing to develop a replacement for the 737 that incorporates the technologies that are used on the Boeing 787 (composite materials, newer flight deck technologies, new wing designs, and improved engines, among other features).[51] However, Boeing's experience with production delays, supplier delays, cost overruns, and technical problems in the 787 program has resulted in estimated cost overruns of at least $12 billion more than Boeing's initial target development cost of $5 billion.[52] Whether these technologies can be adapted to smaller planes at a cost that airlines could absorb is a significant part of debate over the futures of both the 737 and A320 programs.

Can Boeing and Airbus Stay Ahead of New Competitors?

The most recent additions to the 737 and A320 families are relatively fuel efficient, operate over longer distances, and carry more passengers than earlier models. Boeing and Airbus will each probably spend more than $10 billion to develop replacement planes, but both appear to be somewhat hesitant to rush into full-scale replacement programs while their current jets remain popular. Airbus, in particular, has raised a concern that the technologies needed for a significantly improved narrow-body aircraft may not be available until the mid-2020s; instead, it has

(...continued)

or Boeing. Airbus was organized in 1970 through the actions of the French, German, and British governments; Spain joined in 1971. The company essentially pooled the assets of several aviation companies, all of which were individually too small to compete against Boeing, Lockheed, or McDonnell Douglas.

[50] It has been argued that the Airbus decision to build the very large A380 was designed to kill the smaller 747, a successful plane that has played a significant role in both the long-haul passenger and cargo sectors since 1970. Boeing's response, however, to enlarge and update the 747 with a plane that is larger than the 747-400 but still smaller than the A380 may have been the appropriate response to Airbus. Some observers believe that the Airbus A380 is a niche product that is too large to operate on any but the longest routes. Proponents of the A380 claim that it is the perfect vehicle for long-haul flights between major hubs. They point to strategies being pursued by Emirates Airline and Singapore Airlines, which use the planes to move passengers through large hubs in Dubai and Singapore that serve as gateways to other destinations using smaller aircraft. Emirates currently has a fleet of 15 Airbus A380s and 53 Boeing 777s for long-haul flights.

[51] *The Seattle Times*, "Southwest wants new fuel-saving 737 version," September 13, 2005. Southwest's acquisition of Airtran Airways, with its mixed fleet of Boeing 717s and 737s, could cause Southwest to rethink its long-time one-fleet strategy. Southwest's vice-president operations coordination center, has said that Boeing's timing on the 737 replacement by 2020 is too late for Southwest, which is looking for a plane that can deliver 25% better efficiency: "We've squeezed the turnip, there's nothing left in the [737]NG. It now goes back to the airframe and the engine. We'll look at re-engining, but we're waiting for someone to tell us what [Boeing is] going to do." *Flight International*, "2020 too late for Southwest 737 replacement," May 12, 2011.

[52] *The Seattle Times*, "Dreamliner's woes pile up," December 18, 2010.

announced that it will re-engine the A319, A320, and A321 by the end of 2015, at an estimated cost of $3 billion.

Boeing had been reluctant to pursue the new engine approach because it would cost several billion dollars without providing Boeing with a new replacement airplane that would deliver the greater efficiencies that customers want.[53] In defending a replacement for the 737 over re-engining the current generation 737, James McNerny, Boeing's CEO, said in February 2011, "Putting our backlog at risk twice, once with re-engining, not to mention the cost, and then with the new airplane, only makes sense if it's required in the 2025 timeframe. We are preserving the option if we're wrong - but I don't think so."[54] However, after sales momentum shifted heavily in favor of the re-engined Airbus A320neo during the first half of 2011 (with an order backlog of 1,029 aircraft, including 667 orders announced during the Paris Air Show in June), Boeing came under pressure to provide customers with a re-engined 737 (dubbed the "737RE").

American Airlines (AA), with an all-Boeing fleet, reportedly entered into negotiations with Airbus in March 2011 for the replacement of its fleet of 271 aging MD-80s and 124 Boeing 757s.[55] On July 20, 2011, at a press conference held jointly with Boeing and Airbus, AA announced that it was splitting its order between Airbus and Boeing after Boeing agreed to deliver a re-engined 737, using the CFM International (GE/Safran) LEAP-X engine – one of the two available options for the Airbus 320neo.[56] The 460-aircraft order, the largest ever, is valued at $40 billion. AA will buy or lease 130 A320s, 130 A320neos, 100 737NGs, and 100 737REs, with deliveries of current generation models beginning in 2013. Airbus will begin deliveries of A320neos in 2017 with final deliveries expected in 2022. A decision on Boeing's schedule for delivering its re-engined 737 has not yet been determined.[57]

One major benefit that AA gained was "approximately $13 billion of committed financing provided by the manufacturers through lease transactions that will help maximize balance sheet flexibility and reduce risk. The financing fully covers the first 230 deliveries."[58] Although AA's purchase of A320s could be viewed as a defeat for Boeing, Gerald Arpey, the president and CEO of American, said that such a large number of aircraft could not reasonably have been delivered by a single manufacturer in the timeframe required by American. Splitting the order between

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[53] *Aviation Week*. "Single-Aisle Aircraft: Financing Gains Influence," March 21, 2011.

[54] *Aviation Daily*, "Boeing Leans Further Toward 737 Replacement," February 11, 2011.

[55] *ATWOnline (Air Traffic World)*, "Facing pressure from fast-selling A320neo, Boeing's hand forced on 737 re-engining," July 20, 2011.

[56] *SeattlePi.com*, "American Airlines buys Airbus, stings Boeing: Boeing proposes re-engining 737 to get share of 460-jet order," July 20, 2011. According to AMR, the parent of American Airlines, American "will have 365 options and purchase rights for additional [Airbus] aircraft. American has the flexibility to convert its delivery positions into variants within the A320 Family, including the A319 and A321."

[57] One issue posed by the Boeing 737 is its ground clearance. Hanging a larger CFM LEAP-X engine will require that the plane's landing gear be lengthened or that the plane use an engine with a smaller diameter fan blade, which could potentially limit some of the expected efficiency gains. AMR Corporation, AA's parent, stated in its July 20, 2011 Form 8-K Security and Exchange Commission (SEC) filing that it "intends to order 100" Boeing 737REs. American also announced that it is Boeing's launch partner for the re-engined plane.

[58] AMR Corporation. Form 8-K filing, July 20, 2011.

Airbus and Boeing provided AA with some earlier delivery slots that will presumably be created by expanding A320 and 737 production capacity. The negotiations with American Airlines also forced Boeing to make a decision in favor of re-engining rather than building a new replacement plane by the end of the decade – a win for Washington state (with its Boeing 737 production lines), and Kansas (where Spirit AeroSystems builds the 737 fuselage).[59] Delta Air Lines, which is also expected to place a large order for narrow-body jets, reportedly also put pressure on Boeing to re-engine its 737 in response to the A320neo.[60] Delta, formerly an all-Boeing airline, began flying Airbus A320s and A330s as a result of its merger with Northwest Airlines in 2008. Like American, Delta could also split its order between Boeing and Airbus. The result for Boeing and Airbus is overflowing order books that may carry 737 and A320 production into the 2020s.

Although the new entrants into narrow-body production believe their products will have distinct advantages over the re-engined Boeing/Airbus products, high demand for the A320neo at the Paris Air Show by numerous international air carriers, the American Airlines order, and the expected large order by Delta Air Lines in the near future, suggest that many air carriers may be taking a wait-and-see approach toward the new competitors.

Is There a Really a Market Opening for New Competitors?

The most significant effect of the two-way Boeing/Airbus competition may be that it has created a perception that the current narrow-body offerings by Boeing and Airbus are outdated. In contrast to this perception, the 737-700/800/900 series and the Airbus A320/A321 models are significantly larger capacity planes that can fly greater distances than earlier models (see **Figure 6**, which shows the transcontinental reach of the 737NG family). The additional range, greater number of seats, and history of continuous incremental improvements, as well as major upgrades to engines, wings, cockpits, and interiors have allowed Boeing and Airbus to continue to reduce the cost per available seat mile (see **Figure 3**) on its 737s and A320s. The 737-800, for instance can carry 162 to 189 passengers, while the 737-900ER can carry 180 to 215 passengers. The Airbus A320 can carry 150 to 180 passengers, while the larger A321 can carry 185 to 220 passengers.

There is also perception that the market for 100-149-seat jet aircraft has been all but abandoned by Boeing and Airbus, thus leaving an opening for new entrants. As to the supposed 100-149-seat "gap," there are several issues that cast the entire "gap" debate into question: Is there a need for such a new jet aircraft in emerging markets? If so, Bombardier, Embraer, Boeing, and Airbus all appear to be the companies best positioned to exploit the 100-149 seat gap. The Chinese appear to be more interested in using its C919 as an entry point to build larger, wide-body civil aircraft.

Whether new, smaller (100-150 seat) narrow-body aircraft can profitably provide the increased fuel efficiency necessary to serve short-haul markets in many of the countries where air travel is

[59] *SeattlePi.com*, "American Airlines buys Airbus, stings Boeing: Boeing proposes re-engining 737 to get share of 460-jet order" July 20, 2011; *The Wichita Eagle*, "Spirit to gain from Boeing's 737 choice," July 21, 2011.

[60] *ATWOnline*, "Facing pressure from fast-selling A320neo, Boeing's hand forced on 737 re-engining," July 20, 2011.

expected to grow fastest may depend on jet fuel prices. Additionally, a new generation of larger, quieter (70-90 seat) *turboprop* airplanes, such as the Bombardier Q Series and the ATR 72,[61] can operate more efficiently on short-haul flights than the most efficient small jets – especially where passenger volumes are thin. The larger, more efficient turboprops are equally capable of replacing some smaller jets on short-haul U.S. and European routes.

The 100-150-seat jet aircraft currently being sold or marketed are capable of flying greater distances (2,000 – 6,400 miles) with increased passenger capacity (up to 150 seats). But the larger 737-800/900s and A320/A321 are capable of carrying more than 150 passengers at a lower cost per available seat mile than jets in the 100-150-seat range. Demand for the smaller Boeing and Airbus narrow-body jets has declined as airlines have shifted toward the more efficient Boeing 737-800 and 737-900ER models and Airbus A320s and A321s.

Embraer, traditionally a manufacturer of small regional jet aircraft, move into the lower end of the small narrow-body space in 2005/2006, with the E-190 and E-195. These airplanes seat 94-114 and 108-122 passengers, respectively. Embraer's E-Jet series has sold well and is flown by low-cost carriers, some legacy carriers, and a number of foreign airlines. Bombardier plans to deliver its CSeries jet in 2013, with two variants that will have 100-125 seats and 125-145 seats. Significantly, the Chinese and Russian narrow-body jets will not compete in the 100-150 seat market. Instead, they will compete directly against the largest narrow-body jets in the 737 and A320 series. The Chinese COMAC C919 will have 156-190 seats[62] and the Russian UAC/Irkut MS-21 will have 150-212 seats.[63]

The entry of Chinese, Russian, Canadian, and Brazilian competitors into the narrow-body segment has already forced both Airbus and Boeing to respond to increased competition. The Airbus A320 re-engining program is expected to provide an interim solution that allows it to sell a more fuel-efficient airplane beginning in late 2015 – just before COMAC and UAC/Irkut deliver their first narrow-body jets.[64] However, it appears that the Airbus decision was more directly aimed at Boeing. Its decision to re-engine the A320 was pragmatic because the A320 series (with the exception of the A318) was designed to be re-engined, whereas the 737 can only be re-engined by lengthening the landing gear or by using a smaller CFM LEAP-X engine. Because re-engining the A320 can be accomplished in five years, Airbus took the lead and airlines, desperate for greater fuel efficiency, responded quickly.

While Airbus and Boeing landed billions of dollars in new orders at the Paris Air Show, the Chinese, Russian, Canadian, and Brazilian aircraft manufacturers apparently gained little. Bombardier announced a 30-order deal for the CSeries, but apparently could not conclude a deal

[61] The ATR 72 is manufactured by Avions de Transport Régional (ATR), a joint venture between Alenia (Italy) and EADS.

[62] COMAC website: http://english.comac.cc/products/ca/pi/index.shtml; *MarketWatch*, "Safran, GE win contract for engines to upcoming Chinese jet," December 21, 2009; *Flightgolbal*, "Comac plans six C919 models targeting Airbus and Boeing," November 16, 2010.

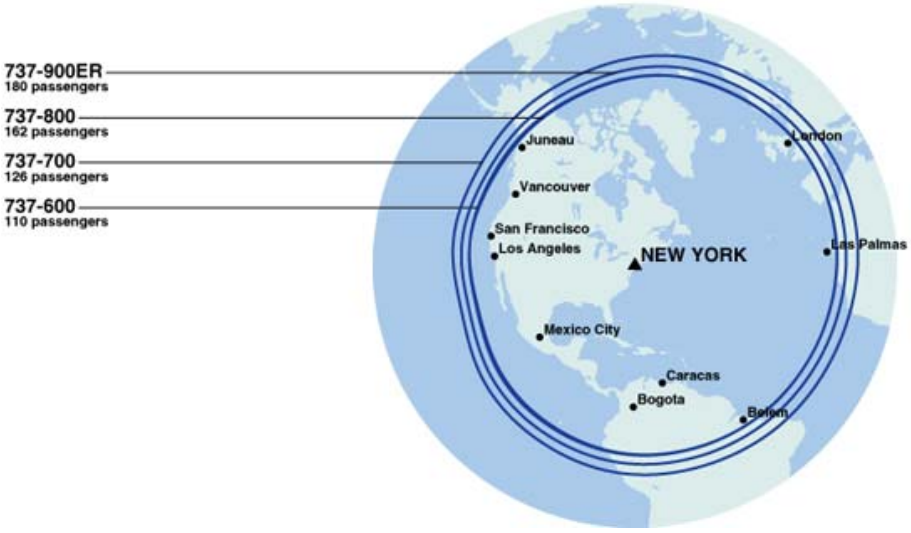
[63] Irkut website: http://www.irkut.com/en/services/projects/

[64] *Wall Street Journal*, "Airbus Ends Air Show With Huge Order," June 23, 2011.

with Qatar. Six customers have placed a total of 113 firm orders for the CSeries planes. The Russian-built Sukhoi Superjet gained one order for 12 planes, and China's COMAC reportedly signed an agreement with Ryanair to be a development partner, although it is unclear whether Ryanair will eventually buy the C919. Embraer's chief executive officer, Frederico Curado, said, "Going up against Boeing and Airbus in head-to-head competition is really tough, not only because of their size, but because of their existing product line and industrial capacity. They can have a very quick response and literally flood the market."[65]

While anticipated demand for narrow-body aircraft is high, there is also the larger question of whether the market can accommodate four-to-six firms competing to sell narrow-body aircraft. The decision by Airbus and Boeing to re-engine their A320/737 families appears to have prevented any erosion of sales and has created a cushion against the challengers. With the combined experience that both Boeing and Airbus have in building mainline narrow-body, wide-body, and very large jet aircraft, neither appears ready to take risks that the newcomers have apparently embraced; that is, manufacturing a more efficient aircraft than the 737 or A320. Boeing and Airbus appear to have protected and extended their franchises from an untested group of competitors.

Figure 6. Boeing 737 Range Capabilities from New York with Full Passenger Payloads.



Source: Boeing Commercial Airplanes. http://www.boeing.com/commercial/737family/pf/pf_rc_newyork.html

[65] Ibid.

Will China's Market for Aircraft Remain Open to Competition?

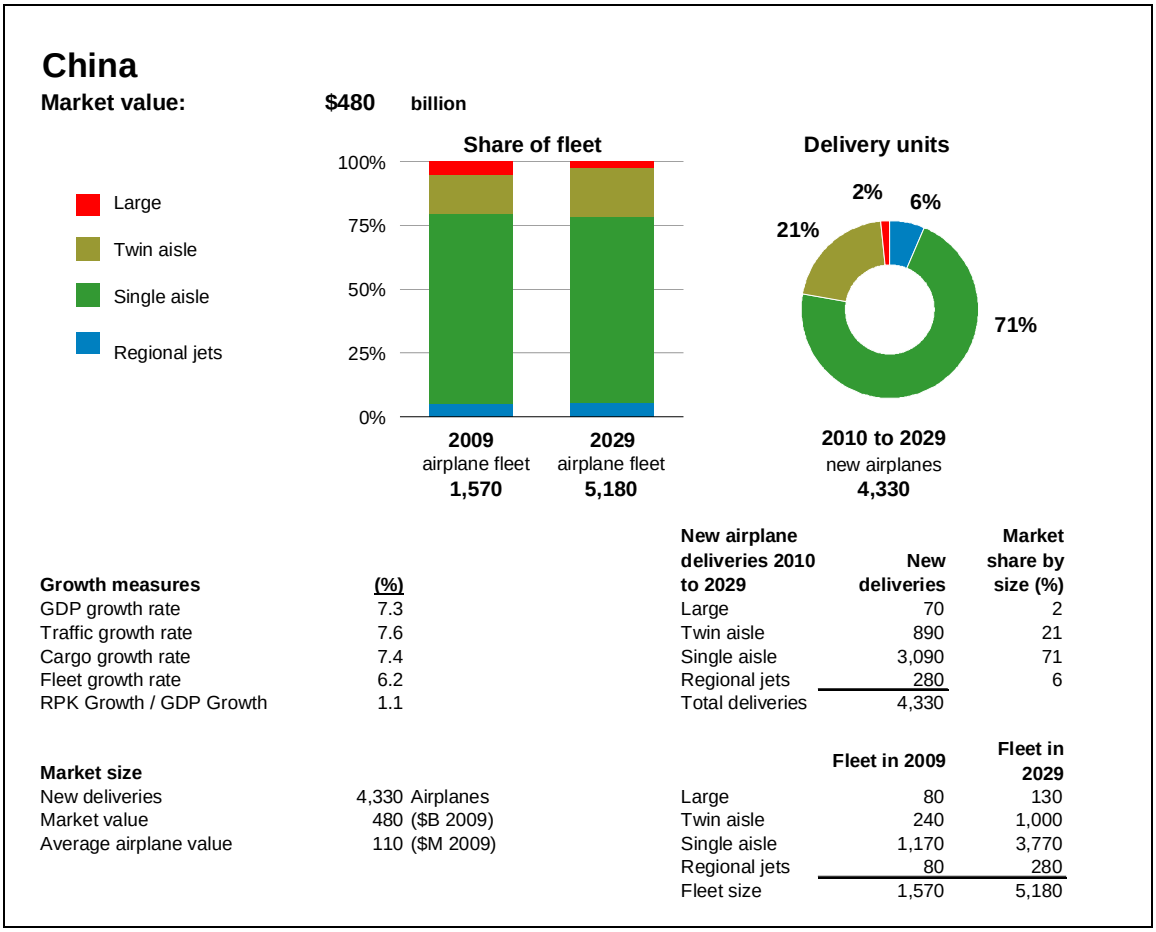
The Chinese market is projected to be one of the major drivers for all civil aircraft manufacturers through 2029. Boeing's *Commercial Market Outlook 2010-2029* forecasts that demand for new planes could total 4,330 units worth $480 billion (in 2009 dollars). Single-aisle, narrow-body jets are projected to account for 71% of new deliveries (or 3,090 planes). In contrast, regional jet deliveries are projected to total 280, or 6% of new deliveries – a relatively small number. The Chinese fleet of civil aircraft is expected to increase from 1,570 planes in 2009 to 5,180 planes in 2029, with single-aisle mainline jets increasing from 1,170 to 3,770 between 2009 and 2029 (See **Figure 7** for more detail).

The Asia Pacific region is forecast to account for a third of all new plane deliveries during the next 20 years. Although this figure is below total deliveries to slower-growing North America and Europe (which together will account for 13,390 deliveries, or 47% of new plane deliveries), the fleet growth rate for the Asia Pacific region is projected at 5.6% (including China at 6.2%), compared to North America at 1.6% and Europe at 2.3%.[66] So rapidly growing markets are likely to be a major focus for aircraft manufacturers and suppliers, even as slower growth in mature markets continues to produce a significant number of aircraft replacement sales. One major issue for Western aircraft manufacturers and suppliers in the future is their access to the Chinese aircraft market. To date, Western aircraft manufacturers and suppliers have expressed concerns about the protection of their intellectual property and their ability to sell commercial jets in sectors with competing domestic products.

[66] Boeing, *Commercial Market Outlook 2010-2029.*

Figure 7. China's Market for Civil Aircraft

2009-2029



Growth measures	(%)
GDP growth rate	7.3
Traffic growth rate	7.6
Cargo growth rate	7.4
Fleet growth rate	6.2
RPK Growth / GDP Growth	1.1

New airplane deliveries 2010 to 2029	New deliveries	Market share by size (%)
Large	70	2
Twin aisle	890	21
Single aisle	3,090	71
Regional jets	280	6
Total deliveries	4,330	

Market size		
New deliveries	4,330	Airplanes
Market value	480	($B 2009)
Average airplane value	110	($M 2009)

	Fleet in 2009	Fleet in 2029
Large	80	130
Twin aisle	240	1,000
Single aisle	1,170	3,770
Regional jets	80	280
Fleet size	1,570	5,180

Source: The Boeing Company, *Commercial Market Outlook 2010-2029*.

Some Western aircraft manufacturers and suppliers, however, take the view that participation in a Chinese-backed joint venture may boost sales, especially if they expect government-owned airlines to purchase what the central or provincial governments tell them to buy. However, this strategy has not always worked: Embraer, for instance, established a joint venture with Harbin, a subsidiary of state-owned China Aviation Industry Corporation (AVIC), to manufacture ERJ-145 regional jets in China. The ERJ-145 program produced an average of only 5 planes a year (a disappointingly small number). With the conclusion of the ERJ-145 program in April 2011, Embraer had hoped to manufacture and sell its larger Embraer 190 E-Jet in China. However, the company was blocked by AVIC, which viewed a Chinese-built Brazilian jet as a competitor to the AVIC-designed 90-seat ARJ21 regional jet. Whether the ARJ21 will be accepted by consumers is unknown.

Unlike Embraer's difficulty with regional jets, Bombardier and COMAC have signed an agreement to cooperate on future plane development, marketing, and customer support. The agreement includes sharing of parts between the CSeries and the C919. Additionally, Bombardier has outsourced production of the CSeries fuselage to a subsidiary of AVIC.[67] According to a recent press release announcing the agreement, "This long-term strategic cooperation agreement is based on both COMAC's and Bombardier's desire to build on the potential complementary nature of their products and respective expertise. This includes exploring collaboration in their marketing, customer relationship and customer support strategies to help each other increase overall market share in emerging and mature markets."[68] The resulting planes may share many commonalities, with a view to achieving interoperability among CSeries/C919 aircraft. The 100-200-seat span of the Bombardier/COMAC planes also offers the potential for a credible challenge to the Boeing/Airbus duopoly and may reduce Boeing and Airbus sales in the China market.[69]

New Single-Aisle, Narrow-body Market Entrants: A Brief Profile

Bombardier CSeries. The Bombardier CSeries jet is the only mainline plane currently in development that specifically targets the 100-149 seat market.[70] It will come in two versions that cover the alleged gap (or current lack of demand): the CS100 will seat between 100 and 125 passengers and the CS300 will seat between 125 and 145 passengers. Bombardier claims that the CS100 enter into service in 2013 and the CS300 will enter service in 2014. Bombardier's 2011-2030 forecast for the 100-149 seat commercial jet market calls for 7,000 deliveries over the next 20 years, with the retirement of 3,000 (57%) of the current 100-149-seat fleet. The total fleet of 100-149 seat jets is projected to grow from 5,200 units in 2010 to 9,200 by 2030.[71] Bombardier's competitors in the CS100 (100-125 seats) segment include the Airbus A318 and A319 and Embraer's 190 and 195 aircraft. At a future date, it may also include a stretched Russian-built Sukhoi Superjet 100.

COMAC C919. The COMAC C919 is frequently compared to the Airbus A320, possibly because Airbus has been assembling A320s and A319s in China since 2008, in partnership with AVIC. COMAC, which was spun off from AVIC in 2008, has signed agreements with a number of U.S. and European suppliers of airframe parts, engines, and various systems that will be critical to the success of the program. CFM International will assemble LEAP-X engines for the

[67] Bombardier, "Bombardier CSeries Aircraft Program Reaches Another Milestone," Press Release, March 25, 2010; *Aviation Daily*. "Aircraft Builders Hit Bumps In China," March 15, 2011.

[68] Bombardier, "COMAC and Bombardier Sign Strategic Agreement on Commercial Aircraft," Press Release, Shanghai. March 24, 2011.

[69] *Aviation Daily*, "Comac, Bombardier Aim For Long-Term Cooperation In Commercial Aircraft," March 28, 2011.

[70] As noted above, the Embraer 190 and 195 E-Jets, which seat 90-122 passengers, have been in service for at least five years.

[71] *Bombardier Commercial Aircraft Market Forecast 2011-2030*, May 18, 2011. p. 11.

C919 in China.[72] GE is also participating in a joint venture with AVIC to develop avionics for the C919.[73]

Whether the plane will achieve the efficiencies that COMAC has promised is an open question: reports that designers have had trouble with the plane's weight have apparently caused some of the major Chinese airlines to hold back on orders. The big three Chinese-owned airlines – China Southern, Air China, and China Eastern – apparently limited their exposure to 20 aircraft each. According to a recent study by the RAND Corporation, "the 'big three' each committed only to purchasing five C919s,"[74] with soft options for the other 45 planes. The apparent hesitation of central-government owned airlines to purchase aircraft built by a state-owned company is due, according to RAND, to an unwillingness to "take on more exposure to a program they regard as risky."[75] General Electric's leasing arm, General Electric Commercial Aviation Services (GECAS) has ordered 10 planes, as has the leasing subsidiary of the China Development Bank.[76]

UAC/Irkut MS-21. The three-version (150, 180, and 210 seats) MS-21 aircraft has been described as "Russia's great hope for the revival of its civil aircraft industry."[77] The MS-21, which the company expects to cost $6.3 billion to develop, is scheduled to enter service in 2016. The Russian government is funding 40% of the MS-21's development costs, with the remainder coming through loans, and from Irkut's parent company, the government-owned UAC. According to the MS-21 chief designer and project director, Andrei Matveyev, the aircraft will include 40% composite content (including a composite wing), weigh 15% less, and achieve 25% improved fuel efficiency over current comparable Boeing or Airbus aircraft.[78] Pratt & Whitney will supply engines, which will also power the A320neo (as one of two available engine options for that plane), the Bombardier CSeries, and the Mitsubishi Regional Jet. Irkut also has numerous U.S. partners supplying various systems for the MS-21. To date, 146 firm orders and 39 options have been placed for the MS-21, with 50 orders from Aeroflot, 50 orders from a Malaysian leasing company, and 46 orders from Russian leasing companies.

Embraer. The Embraer 190 E-Jet has 98-114 seats, while the larger Embraer 195 E-Jet has 108-122 seats. The first delivery of the E-190 was made in 2005 and the E-195 in 2006. Both planes are comparable to small mainline jets and, together with the Embraer 170/175 E-Jets, were designed specifically to fill what Embraer executives believed to be a gap in the 70-120 seat jet market.

The Embraer E-Jets represented a sharp departure from the RJs on which Embraer had built its reputation. Embraer used the E190 and E195 to beat Bombardier to market with a product that

[72] *Flightglobal*, "CFM to build LEAP-X engine in China after C919 deal," December 21, 2009.

[73] *Seattlepi.com*, "GE to develop avionics Chinese firm," January 19, 2011.

[74] RAND, Ready for Takeoff: China's Advancing Aerospace Industry, Santa Monica CA: RAND Corporation, 2011. p. 27.

[75] Ibid.

[76] *Aviation Week*, "Hainan, Gecas To Be Early C919 Customers," November 15, 2010.

[77] *Aviation Week and Space Technology*, "Russian Revival," October 18, 2010.

[78] *Air Transport World*, "Irkut calls for MS-21 tenders following design freeze," January 7, 2009.

upstaged regional jets of comparable size. By the end of 2010, 266 E-190s had been delivered to low-cost carriers, U.S. legacy airlines, and foreign airlines, with a firm order backlog of 157 planes. During the same period, 61 E-195s were delivered, with a firm backlog of 41 planes.[79] Embraer's chief competitor, Bombardier, delivered its first 100-seat CRJ-1000 regional jet (a stretched CRJ-900) in December 2010. As of January 2011, Bombardier had delivered 9 CRJ-1000s and had firm orders for another 40.[80] Whether the Bombardier CSeries will lead Embraer to develop a larger plane is uncertain at this point. Nevertheless, some have speculated that Embraer could develop a new plane in response to Bombardier's challenge to Embraer's E-Jet series.

Sukhoi Superjet 100. The first Sukhoi SJ100 was delivered to Armavia, an Armenian airline, on April 19, 2011, and was almost immediately placed in service. The Superjet 100 has a capacity of 86-103 passengers, depending on its seating configuration. After-sales support for the SJ100 will be provided by SuperJet International, a joint venture formed by Sukhoi and the Italian firm Alenia Aeronautica. Alenia owns 51% and Sukhoi 49% of the joint venture. Alenia also has a 25% stake in Sukhoi Civil Aircraft Co., the manufacturer of the SJ1000. The purpose of SJI is to provide the all important in-service support that airlines depend on. SJI provides pilot training, technical training for maintenance staffs, and operates spare parts warehouses for the SJ100 program. According to *Aviation Week and Space Technology*, "Commercial services also will test whether the program can deliver the promised in-service support, of which many customers are skeptical, given the poor reputation of Russia's aerospace industry in this regard."[81]

COMAC ARJ21. A new Chinese regional jet, the ARJ21 (a 90-seat RJ), which is being manufactured by COMAC in partnership with Bombardier, is based on the McDonnell-Douglas MD-90. All of the COMAC ARJ21's major subsystems were sourced to North American and European suppliers.[82] The project has experienced a number of delays and delivery slipped from 2010 to 2011. The ARJ21 was originally an AVIC project, but was transferred to COMAC when the latter assumed responsibility for commercial aircraft development. It is not clear whether regional jets will remain a focus for COMAC, because most forecasts do not anticipate much growth in the Chinese RJ market.

Large Regional Jet. One regional aircraft, the Japanese Mitsubishi Regional Jet (dubbed the "MRJ")(a 70-90 seat plane), appears to be primarily aimed at the Bombardier/Embraer RJ duopoly.

[79] Embraer, Investor Relations, Highlights, Orderbook. http://www.embraer.com.br

[80] Bombardier, Backgrounder. Program Status Report – Bombardier CRJ Series, January 31, 2011.

[81] *Aviation Week and Space Technology*, "Just How Super?," April 25, 2011. p. 41.

[82] RAND, *Ready for Takeoff: China's Advancing Aerospace Industry*, Santa Monica CA: RAND Corporation, 2011. p. 26.

Boeing and Airbus: Response to Competition

The decision by Airbus and Boeing to put new high efficiency engines on their planes will provide airlines with upgraded products that have a reputation for dependability. Although Bombardier, COMAC, and Irkut are building narrow-bodies that represent a more radical departure from the 737 and A320, their programs are inherently riskier and have not yet demonstrated that the promised benefits can be delivered. Many airlines may decide to stay with aircraft that they know. It is too soon to know whether the newcomers will succeed. Bombardier and Embraer have established themselves as successful aircraft manufacturers and the Chinese appear to be determined to build a civil aviation industry that competes directly with Boeing and Airbus. Whether the Russians will succeed in building civil aircraft capable of competing in international markets remains to be seen.

For now, the real competition is between Boeing and Airbus. Neither company appears likely to walk away from the segment of the commercial aviation industry that accounts for almost half of revenues. Although the Boeing/Airbus duopoly in small commercial jets is clearly under challenge, it is not obvious that the civil aircraft market is large enough to sustain as many as five additional competitors. Nevertheless, all of the challengers to the Boeing/Airbus duopoly believe that their ability to compete in the narrow-body segment will be critical to the creation of successful domestic aerospace industries. It is clear that the United States, the European Union, Russia, China, Japan, Brazil, and Canada all consider the aerospace to be commercially and militarily strategic.

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