Bombardier's CRJ – Rumors of its Demise are Greatly Exaggerated

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I. Executive Summary

Our analysis of the Bombardier CRJ program results in several conclusions:

- ***We conclude that the Bombardier CRJ program, considering the various equipment advances and technology improvements, remains an effective and credible regional jet option.*** The CRJ will certainly be effective through 2019, and if US scope clause size limits do not ease, will be effective through 2024. Rumors of its premature demise are therefore overstated.

- ***The CRJ is the best-selling regional jet in history, and continues to have market success.*** While the CRJ has been in service since 1991, newer models and continuous improvement enable the aircraft to retain industry-leading economics, particularly for aircraft that meet US scope clauses.

- ***The CRJ remains an effective competitor in the US market because of scope clause restrictions on aircraft capacity and weight, and internationally because the CRJ-1000, too large for US markets, has competitive trip costs for short-haul routes.*** While the Embraer E-175 has gained market share in recent years, the CRJ remains a popular regional aircraft, particularly in the US market.

- ***Since the US represents about 70% of the global regional jet market, it exerts tremendous influence on regional jet OEMs, with US scope clause restrictions impacting aircraft programs and designs.*** Embraer deferred its E175-E2 due to its perception that scope clause changes will not be coming by 2019. No regional jet OEM can create a successful program if it cannot sell the aircraft in volume, which requires selling in the US market. The CRJ-700 and CRJ-900 meet US scope clauses.

- ***Scope clause restrictions on the number of aircraft a major US airline regional partner can fly constrains regional jets sales in the US.*** Absent scope clauses, we believe regional airlines would serve many more communities with higher frequencies and require additional regional aircraft. While the restrictions on aircraft size may help the CRJ against its competitors, the overall restrictions on the number of regional aircraft harms the entire market.

- ***The US scope restrictions on aircraft size will be a factor in the economic life of the CRJ program.*** If the E175-E2 is allowed, its newer technology will place significant market pressure on the CRJ. If new aircraft are not allowed, the CRJ remains competitive with the existing E-175 model. We produced alternative scenarios around four critical issues facing regional jet operators in the US, and it is scope clause restrictions that act as the "joker in the pack".

- ***Bombardier can, at relatively low cost, continue to improve the CRJ's performance to ensure it remains competitive***. A further improvement of 4.5% in fuel burn is planned by 2020 through additional aerodynamic and other improvements.

- ***US regional airlines, in particular, face an ever-tightening business environment.*** Therefore, they are likely to favor lowest risk and lowest cost aircraft options. Both the CRJ and E-175 are proven, low risk, aircraft.

- ***Based on current guidance from the pilot unions and industry experts, the US scope clause does not appear to see any easing, neither in number of aircraft nor aircraft size.*** The latter clause will result in US regional airlines being unable to deploy the next generation of regional aircraft despite their availability in the rest of the world.

- ***US regional airline margins may not justify the investment in the next generation aircraft.*** While regional jet operators outside the US are not directly subject to this rule, its impact is readily seen as an indirect influence.

II. The CRJ Program

A. History

The term "regional jet" became popular in the early 1990s after the introduction of the Canadair Regional Jet. But the concept of a short- to medium-range passenger aircraft had existed for some time. Indeed, there is an argument that Russia's Aeroflot conceived of the idea first when it deployed small jet powered airliners (Yak 40) in the 1960s.

These first Western-built regional jet aircraft focused on the 50-seat market. When US airline deregulation occurred (in 1978), the market expanded considerably to include smaller aircraft for traffic feed. These early small aircraft, typically seating 19, fed major hubs where their passengers connected to larger aircraft[1]. The early post-deregulation period for regional airlines utilized turboprop feeder aircraft. But the market changed dramatically after the introduction of the CRJ in 1992.

Airlines operating these small aircraft were constantly watching the cost of fuel. Smaller aircraft offer exceptionally tight operating margins. In 1986 Bombardier, a Canadian company with no aerospace experience, bought struggling Canadair. In 1987, studies began on stretching the Canadair Challenger business jet into a small commercial airliner. By 1989 the concept was formally approved and the project launched.

The CRJ was substantially reinforced and "ruggedized" when compared to the Challenger business jet on which it was based. Business jets typically operate with low utilization, but the CRJ would be in a high cycle, high utilization commuter airline operations. The aircraft, with more robust landing gear and reinforcement of critical parts, was rapidly developed and first flew on May 10, 1991.

The first Canadair Regional Jet, the CRJ-100 model, was delivered to Lufthansa City Line in late 1992. During the early 1990s, oil prices were trading below $20 per barrel. This allowed for effective use of a small jet, as fuel costs were not a primary concern.

The primary benefit from a regional jet, versus a turboprop, was the ability to expand the catchment basin of a hub. A typical regional connecting flight on a turboprop would provide about a 250-nautical mile range from a hub, given that passengers started to shun propeller aircraft. Even the fast turboprops of the time, SAAB 2000 and Dornier 328 proved insufficiently attractive despite having flight times only marginally longer than jets up to 400 miles. With a regional jet flying at true jet speeds, the catchment basin expanded to about 700 miles, enabling more effective connecting hubs. This technology change spurred a revolution in regional airlines, with a dramatic change in hub and spoke networks, particularly in the United States. Regional jets quickly replaced turboprops for many routes, and were a success.

[1] The Deregulation Act allowed an increase from 30 seats to 55, payload rose from 7,500 pounds to 18,000 pounds.

Comair, a Delta connection carrier based in Cincinnati, operated a large fleet of CRJs and even built a special terminal at the airport geared around CRJ operations, as many of the flights feeding Delta's Cincinnati hub were CRJ operations.

A second major use for regional jets was for hub bypass and direct service between smaller markets outside the US. With both extended range and jet speeds, the CRJ opened new non-stop markets between cities too small for larger jet non-stop service. This use became quite popular in Europe, as airlines expanded their reach into cities that were infeasible to reach by turboprop and lacked the traffic to warrant larger jet operations.

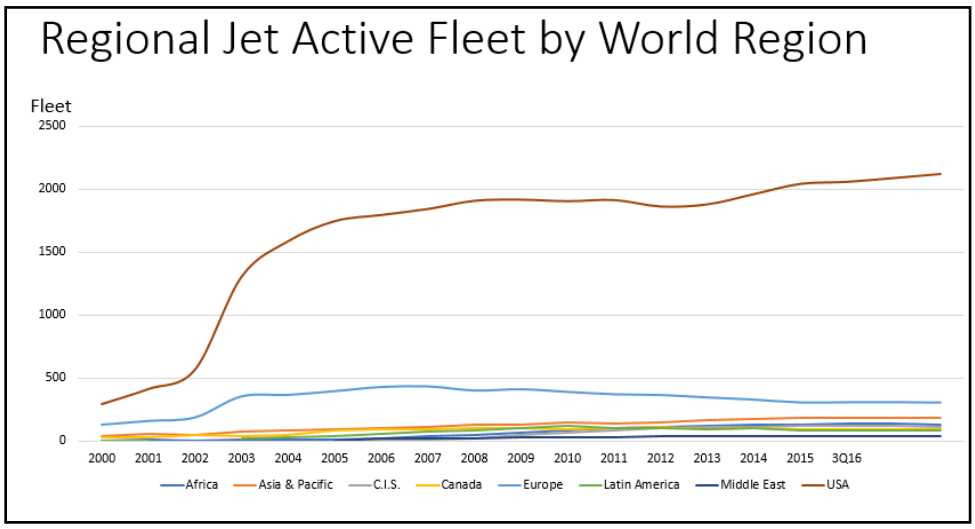
In Brazil, Embraer noting the success of the Canadair regional Jet and, using its EMB-120 turboprop as a base[2], developed its own regional jet, the ERJ-145. The ERJ-145 entered service on April 6, 1997. Airlines flocked to these new jets, retiring turboprops that were prematurely seen as outdated. The ability to fly at jet speeds on small routes cheaply made regional jet offerings highly attractive to US network airlines, because they could feed networks at hubs from many small communities. Besides, these small jets meant larger jet aircraft could be focused on larger markets and therefore ensured better overall economics. Gone were the turboprops and the 50-seater regional jet market expanded rapidly.

By 2000, the market had grown strongly and the US dominated regional jet use. The following chart illustrates the extent of this market dominance. Whereas in 2000, the US-based regional jet fleet accounted for 32% of the global fleet, it rose to over 50% by 2003 and has remained at that level ever since.

[2] Embraer initially thought it could utilize the E120 as a baseline, but after aerodynamic issues, substantially changed its regional jet design – i.e. going from straight to swept wing, along with other major modifications. Thus, commonality was restricted to nose and fuselage diameter – the regional jet was a new design with major changes. First flight of the ERJ was August 11, 1995 and it entered service on April 6, 1997.

(footnote continued)

Figure 1 World Active Regional Jet Fleet[3]



The chart includes the CRJs (100, 200, 440, 700, 705 & 900) and E-Jets (E-135, 145, 170 & 175). The United States is the dominant player in the regional jet market because it has had the most airports and sources of air travel. Many of the US airports serve small communities scattered across the nation. The early adoption of the regional jet by US airlines grew into a dominant and influential role. This meant that regional jet OEMs had to satisfy US equipment demands.

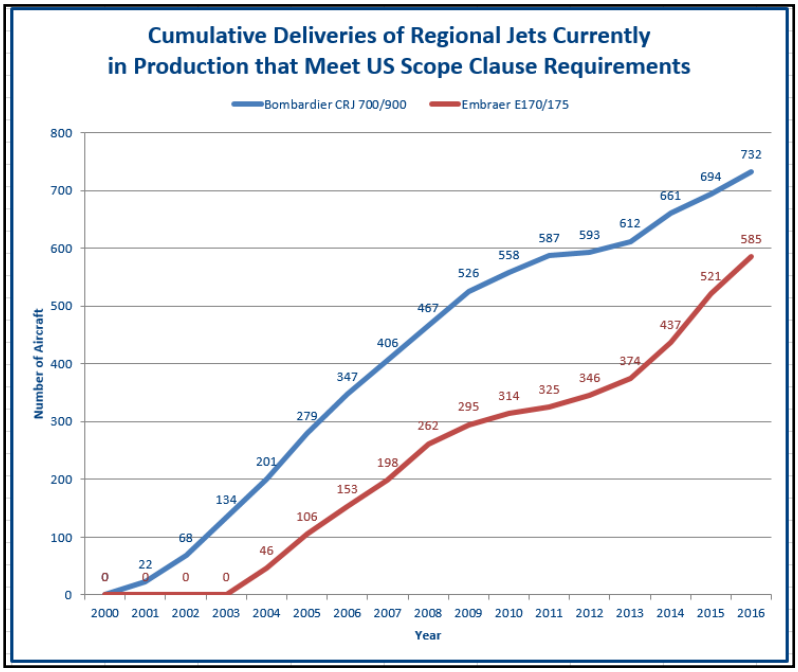
B. Current Models

The following chart shows aircraft deliveries for the competing models that meet current US scope clause limits since direct competition began in 2004. The aircraft are almost dead even in terms of cumulative sales. Bombardier had an early lead, but Embraer has closed the gap in recent years.

[3] Source: Jet Information Services - where we do not provide a specific source, our data comes from this source.

(footnote continued)

Figure 2 Market performance comparison, CRJ and E-Jet[4]



The following table lists the key numbers comparing the various CRJ models as well as its primary competitors. The table lists all aircraft used in a regional role both within and beyond the United States. As will become apparent in this report, this distinction is important.

Within the United States, regional aircraft are subject to a set of rules limiting the seat capacity and takeoff weight. Outside the United States these limits do not exist, and airlines can purchase aircraft on a purely economic basis. Consequently, we see outside the United States that it is common for regional airline flights to utilize larger aircraft.

[4] Source: OEM data

Figure 3 Comparing Current Model Regional Jet Aircraft[5]

Comparison of CRJ and E-JET Aircraft						
	CRJ700	CRJ900	CRJ1000	E-175	E-190	E-195
Seats (2 Class)	66	76	97	76	94	106
Length	106 ft. 1 in	118 ft. 11 in	128 ft. 5 in	103 ft. 11 in	118 ft. 11 in	126 ft. 10 in
Height	24 ft. 10 in	24 ft. 7 in	24 ft. 6 in	32 ft. 4 in	32 ft. 4 in	32 ft. 4 in
Wingspan	76 ft. 3 in	81 ft. 7 in	85 ft. 11 in	94 ft. 2 in	94 ft. 3 in	94 ft. 3 in
Cabin Width	100.5 in	100.5 in	100.5 in	108 in	108 in	108 in
Cabin Height	74.4 in	74.4 in	74.4 in	79 in	79 in	79 in
MTOW (lbs)	75,000	84,500	91,800	85,520	110,900	111,970
OEW (lbs)	44,245	48,160	51,120	48,080	61,910	63,870
Max Payload (lbs)	18,055	22,590	23,380	22,220	28,840	30,090
Range (nm)	1,378	1,553	1,622	2,150	2,400	2,000
Max. Cruise (M)	0.825	0.82	0.82	0.82	0.82	0.82

C. Product Improvement Plans

An aircraft cannot remain static over the life of a program. New technologies, improvements to engines, avionics, interiors, and other components continue to evolve. Bombardier has provided continuous improvement to its CRJ models, and continues to improve the airplane nearly 25 years after the delivery of the first CRJ-100 in 1992.

i. Economic Improvements

Bombardier has been working on keeping the CRJ updated on an ongoing basis. The current goal, established earlier this decade, is to reach "double digit" improvements by 2020[6]. The current CRJ900NG has a 5.5% lower fuel burn than the initial CRJ900. Bombardier is considering carbon brakes along with improvements to the wing and other aerodynamic improvements to further improve efficiency. Today the CRJ900NG is offered with conical engine nozzles that provide 0.5% better fuel burn. These nozzles also reduce noise footprint[7].

ii. Interior

At the 2016 Regional Airlines Association convention Bombardier announced that it was updating the CRJ cabins. The changes involved widening the passenger entry, new mood lighting and a new lavatory design. The bins in the cabin were also upsized in the main cabin and premium seating areas. In the premium cabin, taking advantage of two-by-one seating, Bombardier increased the right-hand bins by 50% allowing for wheels-first stowage of standard size roller bags.

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[5] Sources: OEM data

[6] http://aviationweek.com/farnborough-2014/bombardier-aims-double-digit-crj900-improvements

[7] Among US-based airlines, Delta Air Lines has selected this, while American Airlines has not.

The original CRJ700 and CRJ900 "classic" bins were able to accommodate bags up to 22"X15"X9". For the CRJ "NextGen" (NG), bin doors were upsized to accommodate bags up to 22"X15.5"X10.5". Bombardier optimized the length of these bins to maximize the number of these bags that could be carried in overhead bins, adding nine additional bags to a maximum of 58 bags in a single class configuration on the CRJ900. Bombardier claims this is the largest number of carry-on bags that can be accommodated in a regional jet of this size category.

In 2016 Bombardier introduced a Cabin Upgrade for the CRJ700, CRJ900 and CRJ1000 which featured new bins with the ability to accommodate even larger bags. Bombardier optimized bin hardware and structure to accommodate bags up to 23"X16"X10.5".

Additionally, they added larger business class bins that accommodate bags wheels first, which increases the number of bags carried in the business class section by 50%. On the left, we see the original CRJ900 overhead storage and on the right, the most recent improved storage option. There has clearly been an improvement in storage space[8].

In the lavatory[9], Bombardier added 57% more space including three inches' additional head clearance.

[8] Images from Bombardier

[9] Ibid

The focus on these refinements are a direct result of the competing Embraer E-175's larger cabin. Embraer managed to successfully market its aircraft as more comfortable. A key advantage for Embraer was the large bins allowing for passenger bag storage. In addition, the cabin is taller, allowing most people to walk upright. The cabin windows are relatively large, providing passengers with a bright interior.

iii. The re-engine question

The concept of doing a re-engine is not new. Recent moves by Airbus, Boeing and Embraer and the success of their programs, demonstrates that a re-engine program can be a viable solution for some aircraft. The idea of Bombardier needing to re-engine the CRJ has some traction[10]. But the official word from Bombardier is that they do not have plans for this. Bombardier is pleased with the CRJ as it is.

Why is there a question? The case against doing a re-engine program on the CRJ is based on several factors.

First, the ever-present scope clause. Because the current scope clause acts as a fence around the CRJ900, Bombardier is under no critical pressure to do anything. Two new competitors, the E175-E2 and MRJ have both moved back their introductions to beyond the next scope clause negotiations in the United States market. These aircraft will not be available until 2020 at the earliest, giving the CRJ four more years with the existing competition, the E-175. The CRJ program is a cash cow and it delivers exactly what its biggest customers want; low costs and meets scope clause. Second the case for a re-engine program can be laid out as follows. The CRJ900 entered service in 2003 and the E-175 entered service in 2004. In 2014 Embraer modified the E-175's wing to lower fuel burn by 6.4%, adding bigger wingtips and extending wing size by nearly nine feet. In

[10] http://www.theglobeandmail.com/report-on-business/bombardier-looks-at-upgrading-commercial-planes/article33766016/

2014 Bombardier also made aerodynamic improvements, but these came with improvements at 5.5% improved fuel burn. The E-175 has seen greater success from these improvements, and has become the market leader over the last few years. The following table illustrates how Embraer plans to improve its E-175 to the new E2 version. But the E2 version falls outside current scope and is therefore not a CRJ900 threat - for now.

Figure 4 Planned improvements from E-175 to E175-E2[11]

Comparison of E-175 and E-175-E2		
	E-175	E175-E2
Seats (2 Class)	78	81
Length	103.9 ft.	106.3 ft
Wingspan	92.2 ft.	101.7 ft.
MTOW (lbs)	85,520	98,767
Max Payload (lbs)	22,220	23,369
Range (nm)	2,150	2,060

In the following table, we compare the Embraer improvements against the current CRJ900. The green boxes show where Embraer has the advantage. Range is useful but not critical in the key US market. In the US, about 70% of all domestic air travel is under 1,000 miles. Embraer plans an increased payload on the E175-E2 and that means potential revenue for operators. Since the E2 has an anticipated EIS of 2020, the CRJ900 continues to work satisfactorily.

The next table shows how the Bombardier CRJ900 compares against the Embraer E-175 and future E175-E2. The CRJ900 has a 1% lower MTOW but has a higher payload and a range that is adequate for the US market, which is where most its sales occur. We can see that range in this category is useful but not critical as Embraer has reduced the range for the E2 compared to the current E-175, while giving it a 3% higher payload.

The bottom line is that there is a small difference in these critical metrics between the larger Embraer (seen as the more modern aircraft) and the CRJ, perceived as older technology. Re-engining the CRJ might provide additional range, but this is not a key market driver.

The following table makes use of red and green to illustrate the advantages or disadvantages of the Embraer models with the Bombardier CRJ-900. Red indicates what we believe to be a disadvantage for Embraer, and the green indicates what we believe to be an advantage for Embraer.

There are eight items in the table, and our view is that the CRJ-900 does very well against the newer Embraer models. Certainly, in our view, the CRJ-900NG today is a highly effective low cost, low risk solution for regional airlines in the US.

[11] Source: Embraer

Figure 5 E-175 & E175-E2 advantages over CRJ900NG[12]

Comparing the E-175 and E-175-E2 to the CRJ900			
	CRJ900NG	E-175	E175-E2
MTOW	84,500	1%	14%
Max Payload (lbs.)	22,590	-2%	3%
Range (nm)	1,553	28%	25%
Seats (2 Class)	78	0%	3.8%
Cabin Width (in)	100.5	7.5%	7.5%
Cabin Height (in)	79.0	6.2%	6.2%
Cost/AC Mile	$7.94	0.5%	1.3%
Cost/Seat Mile	$0.0882	4.2%	2.5%

Since Embraer has moved market performance goals, can Bombardier afford to ignore this? We think Bombardier has some time before it needs to react. Bombardier's reaction is likely to be continued refinement of the CRJ. For example, increased use of lighter materials can further reduce the weight of the CRJ900.

Embraer has started to focus on its new E175-E2, and this provides Bombardier with an opportunity. The E175-E2 does not meet the current US scope clause limits (MTOW is the hurdle). To keep selling aircraft in the key US market, Embraer has said it will keep producing its existing E-175. The CRJ900 can compete with the E-175, as it has lower capital costs and has competitive operating economics. The E-175 has better cabin comfort because of the larger fuselage. But on shorter regional flights this may not be an advantage that airlines feel is worth paying for.

Another item worth pondering is how production costs of the E-175 will change when Embraer is building its new E2 range, starting 2018. Embraer indicated that it can produce the current E-175, the E190-E2 and the E195-E2 on one production line. But this may prove more complex or costlier than expected.

The GE CF34 used by the CRJ was developed in the 1980's, and dates to the GE TF34 developed in the 1960s. The E-175 uses a different variant of the GE CF34. GE has said it will continue to support the CF34. Part of this reasoning is no doubt its own assessment of US scope clause. GE sees demand for its CF34 for both Bombardier and Embraer going on through 2020 and beyond.

In the following table, we list some potential new engine options for the CRJ. Because the CRJ has rear-mounted engines, engine weight and impact on center of gravity is significant. Bombardier has to be careful with engine weight. The CF34 is the engine on the current CRJ.

[12] Source: OEMs

(footnote continued)

Looking at the various offerings, the SNECMA Silvercrest appears to be the closest in weight terms to the CF34. The Silvercrest is going to power the Dassault 5X. This engine has generated numerous delays to the 5X program. It is potentially a program risk for anyone adopting it. As should be clear by now, the regional airline market (especially in the US) is a low margin business with the low tolerance for risk.

Figure 6 Potential CRJ re-engine choices[13]

Potential CRJ Re-Engine Candidates					
CRJ900	CF34-8C	BR710-48	Passport	PW814	Silvercrest
Diameter (In)	52	48	52	50	42.5
Length (In)	128	134	132.5	105.8	74
Thrust (LBS)	13,790	14,750	17,745	15,144	11,450
Weight (LBS)	2,450	4,640	4,554	3,136	2,290

Replacing the CF34 would be difficult. Moreover, a challenge facing Bombardier is convincing engine OEMs that investing in the CRJ program is worthwhile. How long will Bombardier keep the CRJ program in production? Our view is that Bombardier is better off staying with the CF34 and ensuring it keeps the CRJ program operating at lowest cost for its airline customers. If US scope clauses ease, then our view might change.

While there is an argument to re-engine, it is not compelling. Should present US scope clause restrictions remain as they are, Bombardier is better off keeping the present CRJ power plant. It is better for the company to continue harvesting its investment in the program and consider a clean sheet replacement, when and if scope clause limits are eased. This will allow Bombardier to refine future design thinking as new engine technologies and new materials emerge. At this time, we do not believe that a re-engining of the CRJ would be a prudent investment, nor do we expect Bombardier to undertake such a program.

[13] Source: OEMs and FAA certification documents

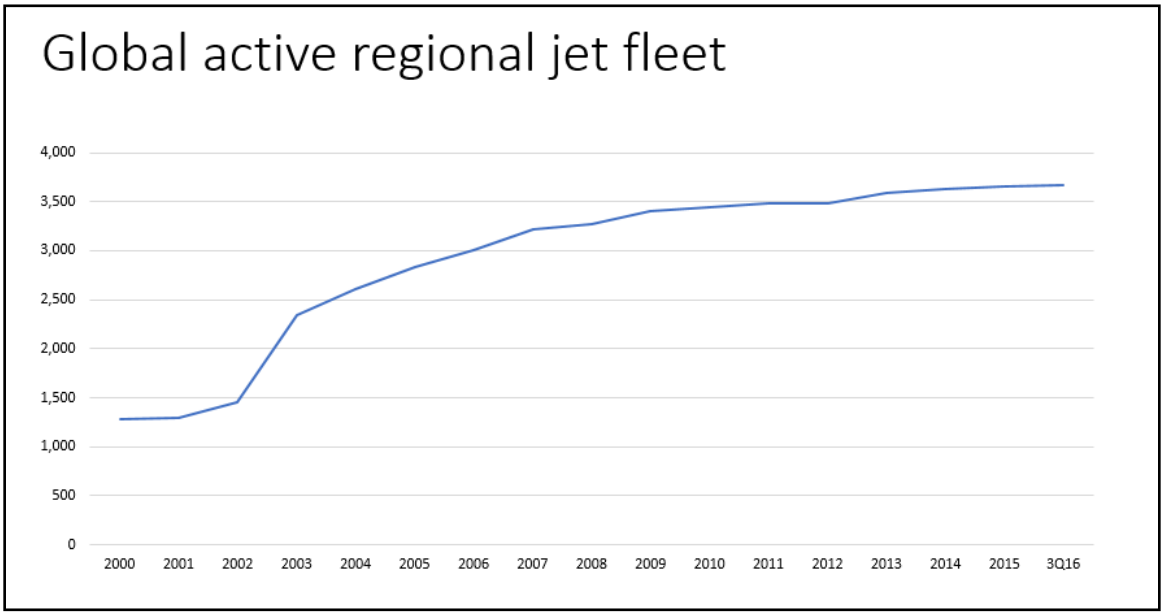
II. The Regional Jet Market

A. Market Size and Potential

The world market for regional jets is mainly in the United States. But looking at the market from the various OEMs provides a sense of how the market is changing. The following chart shows how the industry has consolidated but also the first emergence of a new OEM in China is just now moving into production and deliveries. We define a regional jet as an aircraft used by any airline that is categorized as a "regional" in the Jet Information Services, Inc. database[14]. Consequently, the aircraft in our analysis range from 50 to 100 seats[15].

The regional jet market has grown in recent years, with 3,672regional jets in operation at the end of the third quarter, 2016. The chart below illustrates the growth in the regional jet market since 2000.

Figure 7 Global regional jet fleet



The market grew by 5.3% over the last five years. With respect to market share, the following chart illustrates the percentage of the active global fleet by major manufacturer, including Bombardier, Embraer, Sukhoi, COMAC and other.

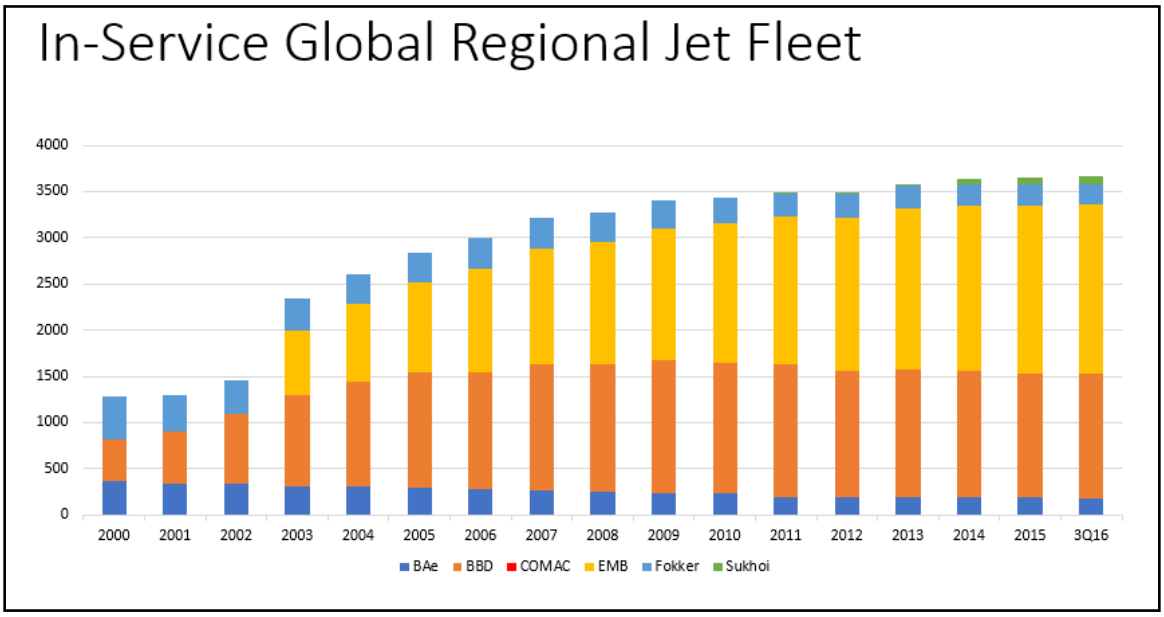
The "Other" category applies to former OEMs that have left the industry. As we can see, these firms were rapidly eclipsed by Bombardier and Embraer. The in-service fleet at the end of the

[14] All fleet related data in this report, unless otherwise specified, is sourced from Jet Information Services, Inc.

[15] This includes BAe Systems (and AVRO), all Bombardier CRJs, all Embraer ERJ and E-170/75s, Fokker and Sukhoi Superjet.

3Q16 for the "Other" category was 456 aircraft, a 70% decline from the start of the period illustrated.

Figure 8 In-Service Regional Jet Fleet



The chart demonstrates that even with newcomers Sukhoi and COMAC, the industry is dominated by Bombardier and Embraer. The COMAC ARJ-21 is a 78-seater and does not appear to offer any meaningful competition, even with a protected Chinese home market. The Sukhoi SuperJet is a credible aircraft but is hampered with slow production rates and geo-political constraints.

We examine the regional jet market requires from two viewpoint points: seating capacity and markets.

i. Replacement of 50 seat jets

The regional jet is thought to have started out focusing on the 50-seat segment. But it is subtler than that. Aircraft OEMs like Sud Aviation, Yakolev, Fokker and British Aerospace offered aircraft with 70 to 100 seats. These aircraft were marketed to and used by mainline airlines. The Fokker 100 and 70 were regional jets and used by both mainline and regional airlines. The following table illustrates that from 2000 through the 3Q16, there has been a change in seating. As OEMs like BAe left the market, the participating OEMs continued to evolve, with Bombardier and Embraer gaining dominance. The chart in Figure 6 above illustrates how this played out.

Figure 9 Regional Jets by Seating

Regional jets by seats					
Average Seating	2000	2005	2010	2015	3Q16
BAe	90	88	91	92	91
Bombardier	50	60	64	65	65
COMAC	N/A	N/A	N/A	78	78
Embraer	50	53	68	68	68
Fokker	73	77	78	82	82
Sukhoi	N/A	N/A	N/A	98	98
Industry Average	75	69	72	72	72

Bombardier, followed shortly by Embraer, offered 50-seat jet aircraft for use by regional airlines beginning in 1992. The idea was not only novel, but in the hands of lower cost regional airlines, became very popular. As the fleets of Bombardier and Embraer aircraft grew, those of the older OEMs focusing on mainline airlines saw their business decline. This is what is driving the changes in average seating. The subtlety is that as the older fleets are retired, Bombardier and Embraer have seen a need to grow their seating count.

The following table illustrates how quickly Bombardier and Embraer dominated the regional jet industry. Embraer entered the market in 2003, and was delivering turboprops before then.

Figure 10 Bombardier and Embraer Regional Jet Market Share

Regional jet market share leaders				
Market Share	2005	2010	2015	3Q16
Bombardier	38%	38%	36%	36%
Embraer	29%	40%	46%	47%
Total	68%	77%	82%	83%

Bombardier and Embraer focused, initially on 50-seater regional jets. These were state of the art and had better economics than the older aircraft in the segment. For example, the new 50-seaters had twin engines and were consequently more efficient than the four engined BAe 146 and successor AVRO, which were operated by mainline airlines. These new regional jets were also much lighter than the Fokker twins which were aimed at mainline airline use.

But as fuel prices rose, regional airlines saw their revenues crimped by the network airlines. In the US regionals saw their business models changed by their network partners, who were less profitable than their regional partners. Soon it became clear the 50-seater was losing its economic viability. The subsequent decline in fuel prices has given many of these aircraft a second life. Even

so, a highly influential US regional SkyWest is retiring its 50-seat fleet[16]. As demand for the 50-seater regional jets declines, demand for the larger models is growing.

ii. Demand for 70-100 seat jets

As the larger, but older aircraft started leave to the market, Bombardier and Embraer were encouraged to grow their aircraft[17]. Since the US market is so influential, regional airlines in the US were pushed for lower costs, which encouraged these two OEMs to move up to 70 seats and then 100 seats. In the early days, the regionals were selling their capacity to the network airlines at highly profitable rates.

However, as indicated above, network airlines changed their business model to a new procedure called "Capacity Purchase Agreements"[18]. Under these agreements, a regional airline operates some, or all, of their aircraft under the network flight code. The network airline schedules those aircraft, sells the seats on those flights and retains the related revenues. The network airline pays the regional airline a fixed amount, defined in the agreement, which is based on a determination of the regional's operating cost for those flights and other factors for those services, and regional airlines need not worry about marketing or revenue collection.

This link provides a view on the agreement between Horizon Air and its network parent, Alaska Airlines. In 2007, when this agreement was established, Alaska paid "Horizon for specified flying based on predetermined rates plus a negotiated margin, regardless of the number of passengers on board or the revenue collected. The arrangement also includes a bonus that will be paid to Horizon if it meets certain operational performance measures. Alaska has assumed the revenue risk for the incentive markets and therefore will record all of the related passenger revenue".

This change created a new era for US-based regionals. These regionals became dependent on the contract with the network partner. The bigger partner took the risk, but also controlled the revenues. Smaller 50-seat aircraft started to become too much risk for regionals. Moreover, large airlines like JetBlue entered formally lucrative markets like Boston-Baltimore. This change made regionals even more dependent on their agreements with major airlines. Or the regional had to readjust its business, but that also came with risks. For example, Republic Airways ordered Bombardier's CSeries with a view to deploy these aircraft as mainline service under its Frontier and Midwest brands. That deal soured and Republic had to walk away from its plans, and is currently in Chapter 11.

The upshot of these changes was that the US market saw 584 50-seat regional jets leave the market and 346 70-seat regional jets enter the market. The net effect was the regionals saw a 3%

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[16] http://aviationweek.com/awincommercial/settlement-removes-crj200s-skywest-service

[17] To provide viable seat-mile costs that didn't exceed yield levels at the time.

[18] Essentially a fixed fee as opposed to a pro-rate, or revenue sharing arrangement

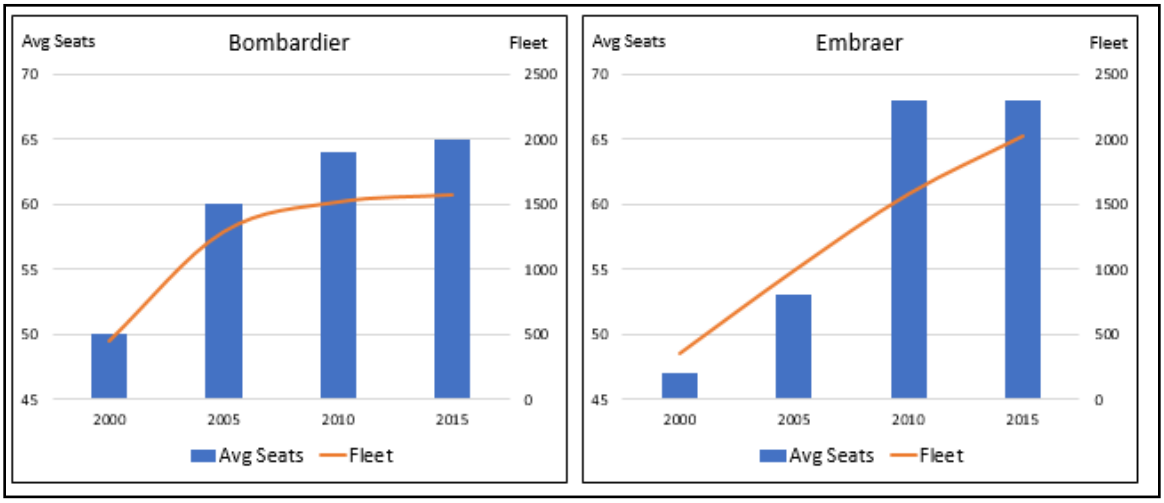
(footnote continued)

reduction in seat capacity. On a per seat basis, a switch from the CRJ200 to a CRJ700 meant a 4%[19] better fuel burn on a per seat basis (500 NM segment). Switching from a CRJ200 to a CRJ900 meant a 12.5% improvement in fuel burn[20]. More importantly, the larger aircraft have better overall economics because they have higher aircraft mile costs but lower seat-mile costs. The upshot of the change is that with the network partner absorbing almost all the risk, the regional must focus on generating each seat at lowest cost. What was formerly a high margin business is now a low margin business.

To make matters worse, network airlines are now trying to move to a pro-rate model so they carry less of the risk. The big airline buys the aircraft and has the regionals bid to fly them. Compounding the risk, the capacity agreements go up by the consumer price inflation. But costs such as labor are rising faster than the consumer price inflation as the current pilot shortage starts to have an impact.

As the next chart illustrates, both Bombardier and Embraer have been pushing up aircraft seat capacity. Whereas Bombardier has stretched the CRJ from 50 to 100 seats, Embraer decided to develop an entirely new aircraft (E-170, E-175, E-190, E-195) to handle seat capacity above 50 seats.

Figure 11 Bombardier and Embraer fleet and average seat count



The Bombardier chart average seat count differs from the Embraer chart because Embraer has been less dependent on the scope clause restricted US market. For example, as of 3Q16, Bombardier had 70% of its CRJ fleet active in the US compared to 52% for Embraer. The following table illustrates how each of these OEMs have seen their market share shift.

[19] Jeppesen data http://www.team.aero/files/aviation_data/owners_n_operators_guide_crj.pdf

[20] Ibid

Figure 12 Bombardier and Embraer market share changes

Evolving market share	2005	2010	2015
Bombardier			
USA	57%	55%	51%
World (incl USA)	57%	49%	44%
Embraer			
USA	43%	45%	49%
World (incl USA)	43%	51%	56%

Whereas Bombardier has been focused on the scope clause restricted market, it has held on to half the market in the US while losing ground outside the US. Embraer has managed to acquire share in the US and performed strongly outside the US. With a product selection that came in four options compared to Bombardier's two, airlines had more choices from Embraer until the introduction of the larger CSeries at Bombardier.

Figure 13 Comparing Bombardier and Embraer models

CRJ and E-Jet model comparison by seats	2000		2005		2010		2015	
Aircraft Model	Avg Seats	Active Fleet	Avg Seats	Active Fleet	Avg Seats	Active Fleet	Avg Seats	Active Fleet
CRJ-100	50	230	50	219	50	181	50	119
CRJ-200	50	222	50	696	50	687	50	629
CRJ-440			44	96	44	96	44	96
CRJ-700			70	241	70	300	70	313
CRJ-705					70	15	70	15
CRJ-900			90	39	90	238	90	360
CRJ-1000					86	3	86	43
Sub Total		452		1291		1520		1575
ERJ-135	37	108	37	132	37	116	37	111
ERJ-140	44	74	44	74	44	74	44	74
ERJ-145	50	530	50	670	50	681	50	685
E-170	70	46	70	92	70	183	70	189
E-175			78	14	78	135	78	331
Sub Total		758		982		1189		1390

The chart displays the larger models have become increasingly popular. Embraer has declined to create an E2 version of its E-170.

The following table illustrates a point. The table lists parked regional jets as of 3Q16. There were 171 Bombardier aircraft parked compared to 167 from Embraer. The average age of the parked Bombardier fleet was 15.4 years compared to 12.7 for Embraer.

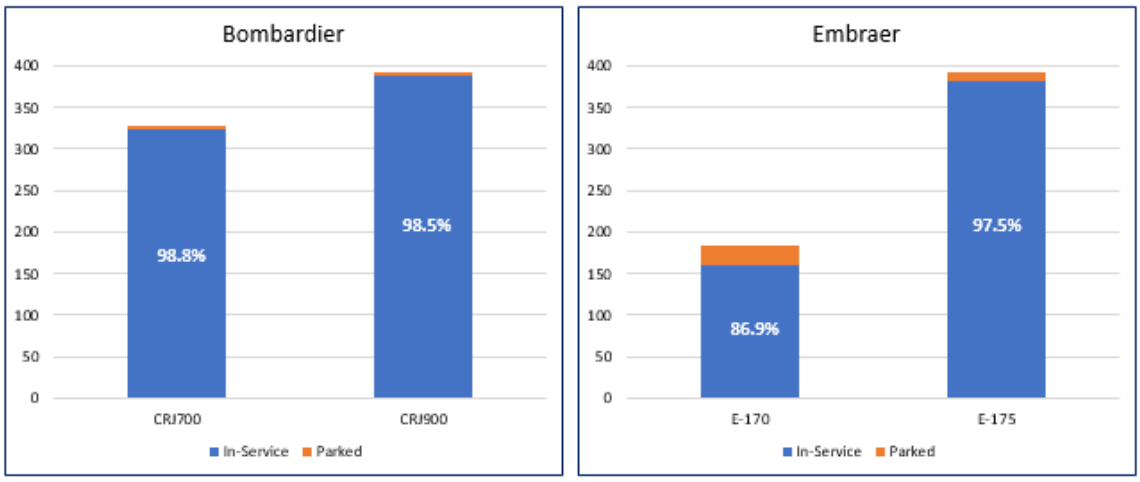
Breaking this down further, 163 of the 171 (95%) parked Bombardier aircraft were 50-seat and below models. For the parked Embraer fleet, 133 of 167 (80%) were under 50-seat and below models. Therefore, Embraer had 20% of its parked fleet in the large regional jet category compared with under 5% for Bombardier. Moreover, the average age of the parked Embraer larger regional jets was younger than those of Bombardier.

Figure 14 Bombardier and Embraer parked fleet comparison

Bombardier and Embraer 3Q16 parked fleet		
	Fleet	Avg Age
Bombardier	**171**	**15.4**
CRJ100	25	19.4
CRJ200	92	16
CRJ440	46	13
CRJ700	2	15
CRJ900	6	8
Embraer	**167**	**12.7**
E-170	24	10.7
E-175	10	9
ERJ135	29	15.8
ERJ140	25	14
ERJ145	66	15.4

Embraer did outsell Bombardier, but it also has seen its aircraft parked sooner. The next chart illustrates the point of our report title. Embraer may have recently outsold Bombardier but the sales volume and market share do not highlight the core strength of the CRJ. Airlines continue to see the CRJ as a workhorse. There are relatively more parked Embraer E-17X models than CRJ-NGs. Of these parked regional jets, 52% are based in the US where it appears several 50-seat regional jets have been retired from service.

Figure 15 Comparing Bombardier CRJ and Embraer E-17X in-service vs parked



To provide some perspective there were 889 single aisle jets parked at 3Q16. Of these 21% were in Russia, 18% in the US and 6% in Indonesia. The Russian based aircraft were typically aged Soviet-era aircraft. Overall, the most common retired single aisle aircraft was the Boeing 757-200. There were 15,360 single aisle aircraft available in 3Q16, and of these 5.9% were parked.

iii. Regional Analysis

GDP has been shown to be the key driver for commercial aviation demand, it should be readily obvious that investing in aviation infrastructure is a good basis for economic development. The US FAA provided an excellent report on this[21] in 2014. Indeed, it is estimated that the aviation industry supports 3.5% of the global GDP[22].

Since commercial aviation is a source of economic progress, it should be supported by via infrastructure development. The regional jet industry is a critical part of the commercial aviation industry. It is the segment that serves the small communities, connecting them to the global economy.

a. United States

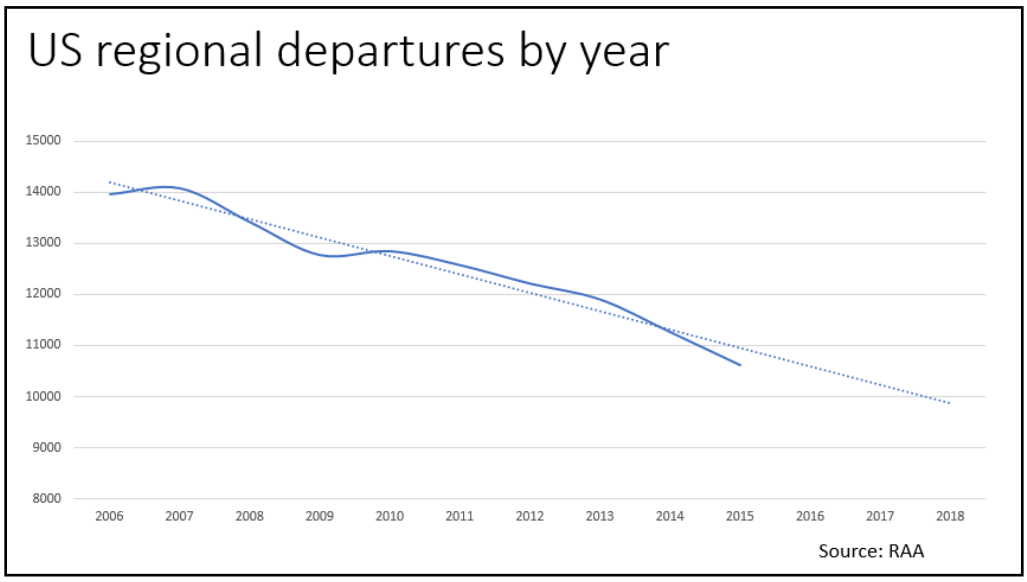
Since the regional jet market is US-biased, much of what we have said so far applies to this part of the report. The operational pressures on US-based regionals are the most severe given their role as feeders for the network airlines. As we have described, these network airlines have consolidated into three companies and therefore have unprecedented negotiating power. With several regional airlines in the position of having to bid for service, network airlines have managed to push down bidding rates. These bids have razor thin margins because the network airlines also own their own regional companies. All the "in-house" regional must do is match the lowest external bid and the business stays within the company.

In the next figure, we can see that US regionals are doing less business. This is due to network airlines changing their own business by offering fewer flights and in many cases, cutting flights to small communities altogether. Whereas regionals have seen enplanements decline 4% between 2000 and 2015, the network airlines have enplanements grow 11%.

In addition, regional airlines face the worst part of the pilot shortage. Their best pilots are either migrating to the larger network airlines or moved overseas. With exceptionally tight margins the regionals are hard pressed to increase labor costs, especially for pilots[23]. This is driving the US pilot shortage. The US Regional Airline Association claims[24] its members have between 17,000 and 18,000 pilots and the US network airlines require over the next four years is going to be 18,000 to 20,000.

[21] https://www.faa.gov/air_traffic/publications/media/2014-economic-impact-report.pdf
[22] http://aviationbenefits.org/economic-growth/value-to-the-economy/
[23] http://www.alpa.org/news-and-events/news-room/2016-03-09-airline-pilots-in-strong-supply-right-career-opportunity
[24] http://www.ainonline.com/aviation-news/air-transport/2016-12-22/starting-salaries-rise-regional-airlines

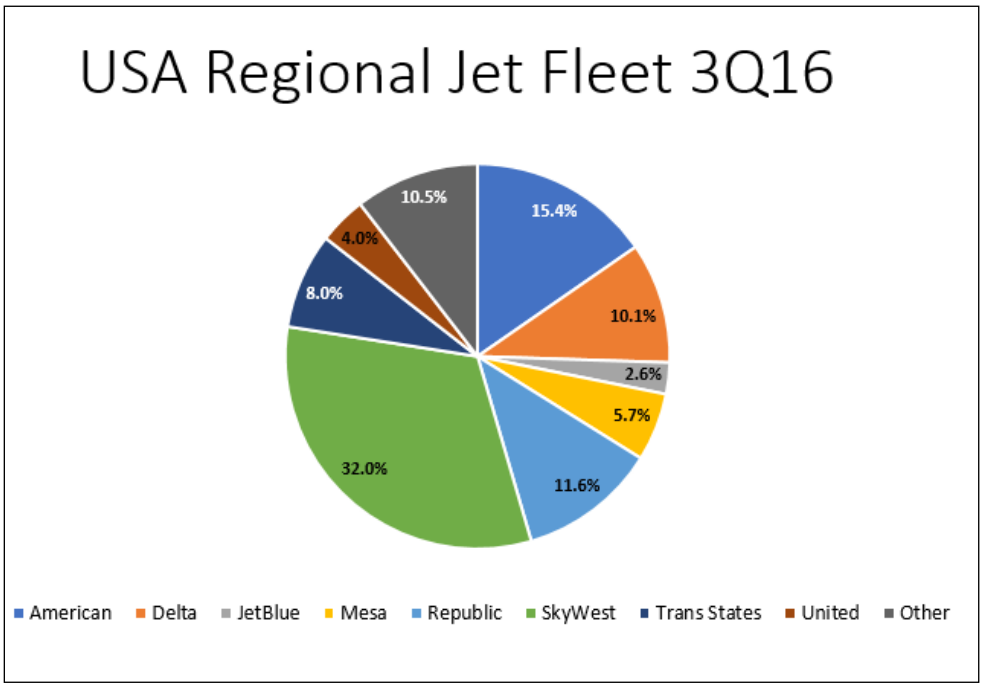
Figure 16 US regional airlines' declining deprtures



The next chart focuses on the United States, the world's largest regional jet market. It is appropriate to start with this market because it is by far the most influential on the industry. The success of the regional jet market in the US also demonstrates what other physically large nations might expect from providing their economies with infrastructure and delivering small communities with air service.

The US experience is a useful guide in some ways. But because of the scope clause, it is also a "closed system" where aircraft improvements are unable to be exploited. This means the US is limited as a source of how an economy could develop by building up regional air service.

Figure 17 US regional jet fleet 3Q16



Although the US regional fleet has fallen under the same consolidation wave as the network airlines, the market still has several operators. These operators typically sell their seat capacity to the network airlines using Capacity Purchase Agreements, as describe earlier.

Among these regionals, SkyWest had a fleet of 716 aircraft in 3Q16. This makes SkyWest the world's largest *regional* airline[25], with double the fleet of its nearest competitor. By comparison the world's largest airline, American Airlines, had just over 1,000 aircraft. The smallest independent US regional, Mesa, had 128 aircraft. According the US-based Regional Airline Association, US-based regional airlines generated an average of 10,613 daily departures in 2015.

[25] The FAA considers SkyWest a major airline because of its revenue (over $1B) and fleet size – even though it operates nothing larger than a regional aircraft.

Figure 18 In service US regional airline fleet

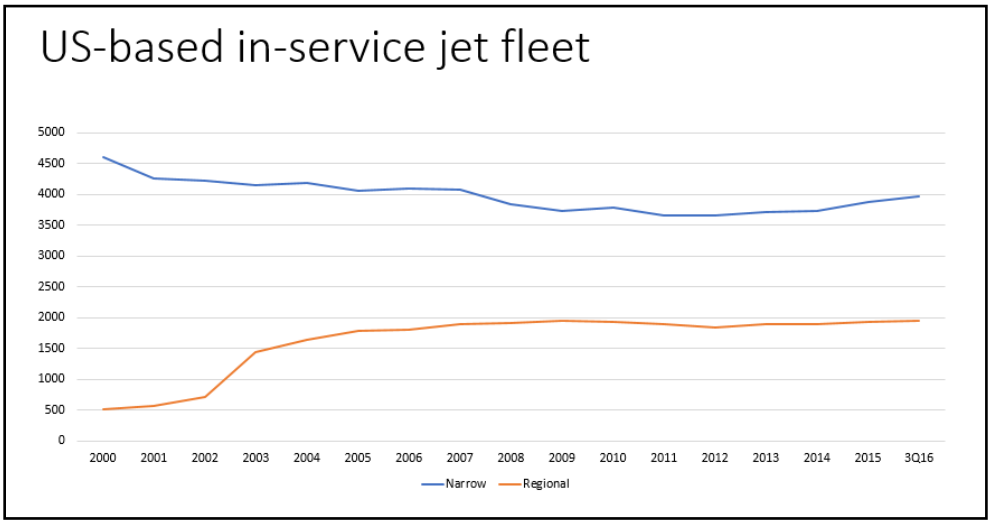
US regional fleet by age and OEM		
	Aircraft	Avg Age
BAe Systems	6	27.2
Bombardier	926	13.4
Embraer	884	12.2
Total	1,816	13.1

The US-based regional jet fleet is primarily Bombardier and Embraer sourced. Both OEM fleets are about the same age and of similar size.

The US-based in-service regional fleet consists of 1,816 aircraft and compares to a total narrow-body fleet of 3,960 (excluding regional jets) in 3Q16. The following chart demonstrates how the single aisle and regional jet fleets have evolved since 2000. Regional numbers have stayed largely stable while the single aisle fleet has grown.

This demonstrates how tough the regional jet market has become. This may be the largest regional jet market, but it is increasingly the toughest. Since airlines are naturally risk-averse, it seems that airlines (and lessors) serving the US regional market need to be careful when considering fleet options. Does this market allow sufficient margin for a new entrant?

Figure 19 US in-service jet fleet

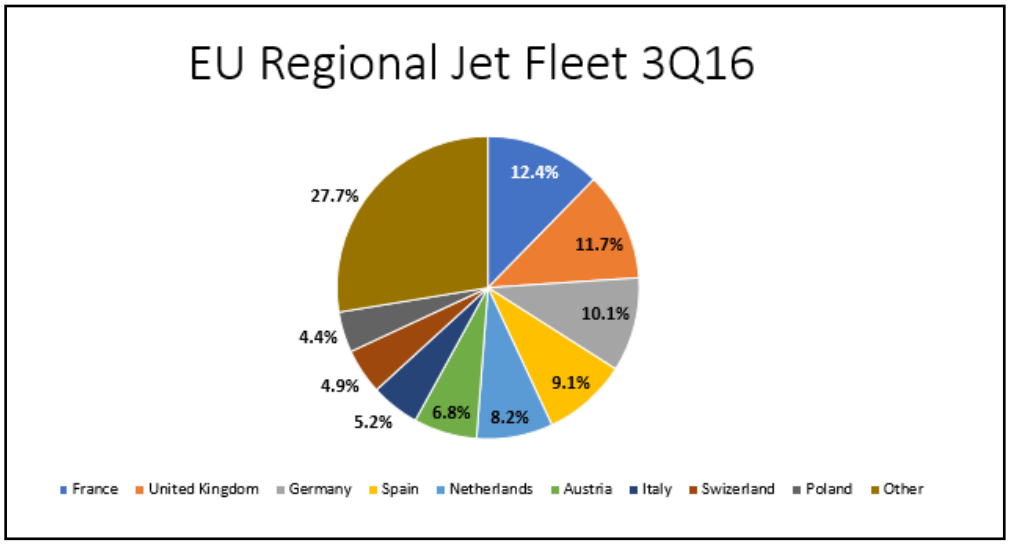


b. Europe

Europe has been an important market for regional jets for many years. It was the home base of Fokker, one of the industry's pioneers. Compared to the US, we note that regional jets are frequently operated by mainline or network airlines. There is no scope clause to create an artificial impediment to the industry. The EU market faces competition from high-speed rail, and might be more open to new technologies and next generation regional aircraft to open markets where rail is too cumbersome for convenient travel.

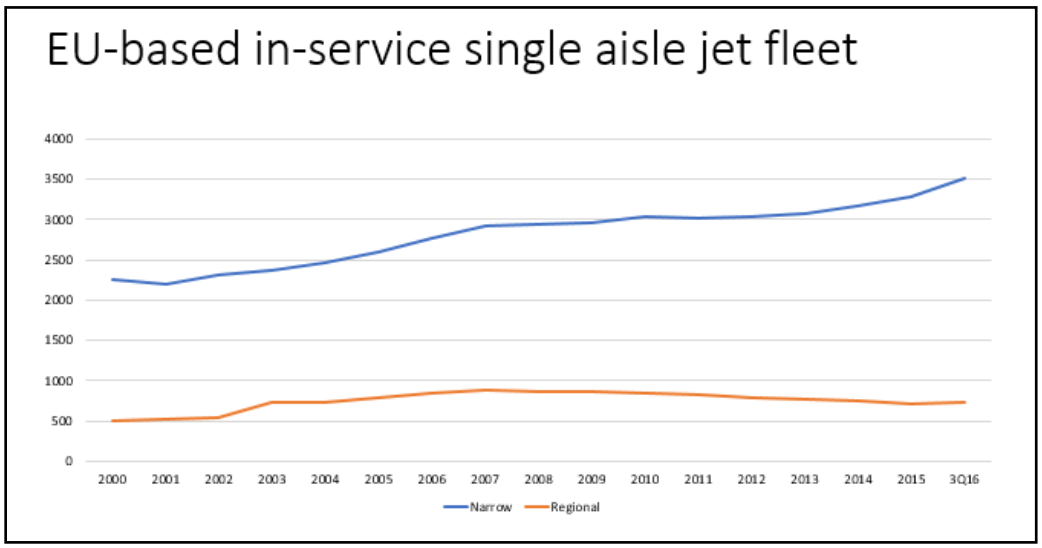
As the chart below illustrates, the market is well distributed across the region. The EU open skies process allows any EU-based airline to serve any EU markets, and therefore regional jets have become useful tools to develop new routes and markets. Because there are no scope limits, EU airlines have been able to deploy the largest regional jets and exploit the combination of range and capacity these largest regional jets offer.

Figure 20 Distribution of EU Regional In-Service Jet Fleet by Country



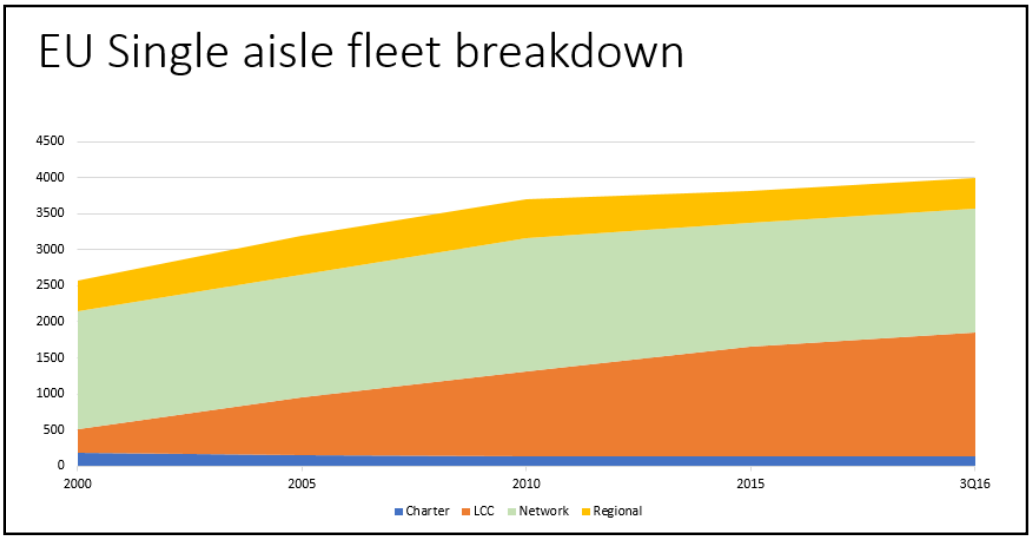
However, it is also useful to see the market for single aisle and regional jets as we saw for the US market. The following chart demonstrates that as was the case in the US, the EU has also seen faster growth in single aisle fleets. This has been driven by the EU's rapid growth in LCCs, which use larger aircraft.

Figure 21 EU In-Service Single-Aisle Jet Fleet



The EU-based single aisle fleet growth from 2000 through 3Q16 is shown on the following chart. The most virile growth segment has been the LCCs. The obvious brands that stand out are Ryanair and EasyJet. These two airlines have been growing rapidly. But there are up and coming brands such as Vueling and Wizz. Low cost airlines select bigger aircraft to get the lowest seat mile costs under or around 150 seats.

Figure 22 EU Single Aisle Fleet by Airline Type



The next chart shows how concentrated the EU regional jet fleet is, despite an apparent broad geographical base. The three big airline alliances accounted for two-thirds of the region's regional jet fleet. Clearly airline alliances see great value in using smaller jets to feed their regional hubs.

Figure 23 EU Single aisle fleet by airline alliance

Single aisle fleet by airline alliance					
	oneworld	Sky	Star	None	Total
Regional jet	63	110	150	201	524
Single aisle	351	269	649	3,325	3,378
Regional %	15%	29%	18.80%	5.70%	

Aggregating the regional fleet by alliance the numbers disperse somewhat. The ratio of regional jet to single aisles is lowest for oneworld among the three airline alliances.

Figure 24 In-service EU regional jet fleet under 120 seats

EU regional jet fleet age		
	Fleet	Avg Age
BAe Systems	60	20.6
Bombardier	141	10.7
Embraer	301	9.1
Fokker	20	21
Sukhoi	2	0.5
Total	**524**	**11.4**

Evaluating the regional fleets in the EU, Embraer has done very well. It has the highest market share and, excluding Sukhoi, its fleet is the youngest. Within the airline alliances, SkyTeam is an Embraer stronghold. 73 (77.7%) of the Embraers in SkyTeam use are at KLM and Air France. For Bombardier Star Alliance is a stronghold, where Lufthansa accounts for 36 (70.6%) of its Star Alliance fleet. Bombardier had delivered 48 CRJ1000 by 3Q16, and 29 of these operate in the EU. Embraer had delivered 641 E-190/5s by the same period and 177 27.6%) operate in the EU.

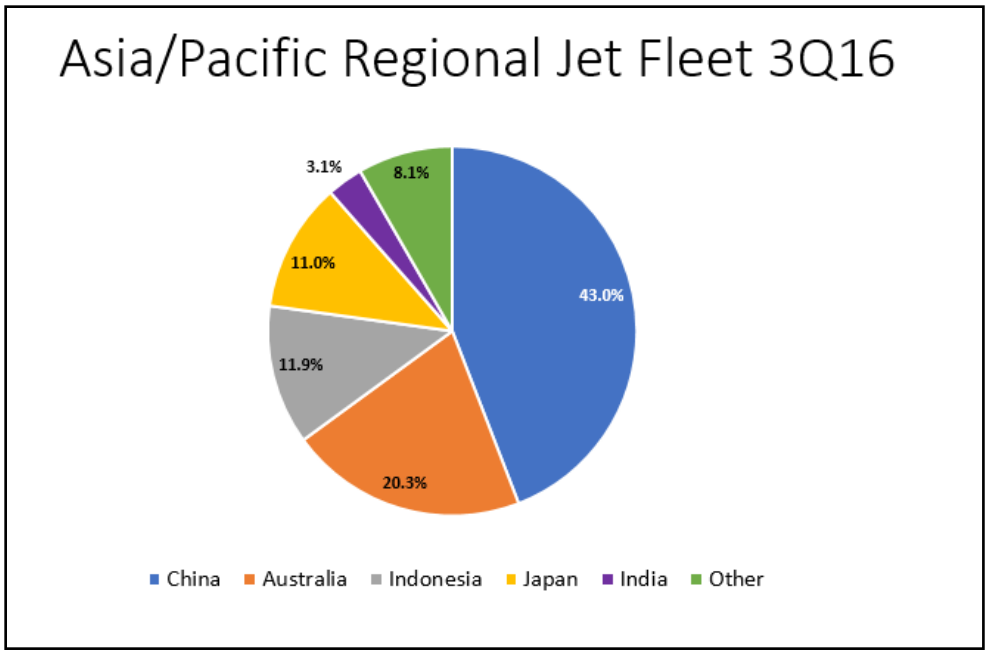
One last thought that might hamper regional jet business in Europe, and that is its extensive high-speed rail network. This network can be expected to grow because the EU regards rail as a lower source of pollution than aviation. This link allows the reader to download the 2016 EU Aviation Environmental Report. Europe has a highly-developed system of taxes that are designed to combat climate change[26].

[26] http://ec.europa.eu/clima/policies/ets_en

c. Asia/Pacific

Asia is the great hope of commercial aviation. Within the region are the key growth markets of India and China. These are the fastest growing commercial aviation markets. Both markets offer regional jet OEMs significant promise. The following chart illustrates the region's major markets. The listed countries account for 86% of region's regional jet fleet of 379 aircraft.

Figure 25 Asia/Pacific regional fleet



Demand for air travel in India in 2016 grew faster than in China for the first time[27]. This demand is spurred by low fares. India has a complicated system of fuel taxes. The tax system favors turboprops over jets. In addition, India has a dearth of airports capable of handling large jet aircraft. Light regional jets are likely to see demand growth as India simplifies its tax structure and expands its airport infrastructure. But with airfare price wars (sometimes started by the state-owned Air India) the market often does not provide viable revenues to seat-mile costs. In India, the yield environment is low and does not favor regional jets.

China, on the other hand, has a different set of challenges. It has a rapidly growing high-speed rail network connecting major centers[28]. However, as we have seen in other mature travel markets where high-speed trains are commonplace, such as Europe, regional aircraft remains in demand for now.

[27] http://www.iata.org/pressroom/pr/Pages/2016-03-08-01.aspx

[28] http://www.voanews.com/a/ap-china-plans-30000-km-high-speed-rail-network-by-2020/3655234.html

CAAC Rule 96

A recent legislative change in China also comes into play. This is the CAAC Rule 96 which was issued in August 2016. The CAAC is China's civil aviation administration. The organization concerns itself with all country's civil aviation matters. Rule 96 is complicated and addresses items such as safety and the fleet growth during the country's current five-year plan. Rule 96 also promotes regional airline growth.

Rule 96 (for a summary of the rule, see this source[29]) establishes a set of criteria for new airlines entering the Chinese domestic market. The Rule does not apply to non-Chinese airlines. New Chinese startup airlines must start off as either a regional or cargo airline with a sufficiently large fleet (at least 25 aircraft for a regional airline or 20 for a cargo airline) and have a certain minimum number of monthly flight hours before moving to mainline operations or switching from cargo to passenger service. This Rule's details will be described further soon. The Rule apparently is an attempt to restrict the market for new entrant airlines by mandating minimum requirements. As an indication of the Rule's impact, even startup airlines with current CAAC approval, are to be re-examined for compliance. Moreover, no details of regional aircraft size (i.e. seating) have been defined yet.

What are the primary impacts of this Rule? It appears that the Rule will ensure that startup airlines must focus on secondary markets[30]. In addition, the Rule making all startup have at least 25 aircraft for passenger service should create demand for fleet growth. While China has a locally made regional jet in the ARJ-21, this aircraft is not seen by industry analysts as economically efficient. Even with 400 orders, it is telling that the launch customer has been slow to put the aircraft into service[31]. The ARJ-21 took more than a decade to develop.

Other options such as the Mitsubishi MRJ are delayed until 2020. Then Mitsubishi also must overcome Japanese/China relations. The Sukhoi SuperJet is a credible solution, but is hampered by slow production levels. Obviously the more industrially efficient sources for volume production are Bombardier and Embraer. Embraer advised us that the typical time lag between an order and a delivery for the E-175 is between 10 to 12 months. Bombardier advised it takes about 12 months to deliver a new aircraft. This can be a bit shorter if it is an existing customer with an existing specification or a bit longer if it is all new.

Among regional jet OEMs, only Bombardier and Embraer can deliver at this rate. If indeed China's startup airlines need 25 (20 for cargo) aircraft each and they cannot get sufficient aircraft on the second-hand market, then these two OEMs stand to benefit. We believe the newer models of the parked regional jets (CRJ700, CRJ900, E-170 and E-175) are the most attractive for Chinese

[29] http://www.pgaaviation.com/Documents/2016%20Q3%20Report%20-%20PGA%20Aviation.pdf

[30] http://www.reuters.com/article/us-china-aviation-regional-analysis-idUSKBN14803E

[31] http://www.caac.gov.cn/en/GDTPXW/201609/t20160928_39933.html

airline startups. If China sees strong demand for regional jets, Bombardier and Embraer are bound to win new orders.

The focus on secondary cities by CAAC in its Rule 96 also suggests that perhaps China's high-speed rail will not be connecting all the secondary cities, at least not soon. If this assumption is accurate, this would be a further boost to demand for new regional jets.

One final thought on Rule 96, it may be that when the Rule is further clarified there may also be language that limits aircraft beyond a certain age from entering Chinese service. Such a re-clarification could be expected since China wants to boost ARJ-21 demand. This will only serve to also assist Bombardier and Embraer as well.

The following table lists the Asia/Pacific regional fleet size as of 3Q16. Excluding any growth, there is already a requirement to replace 126 aging BAe and Fokker aircraft with newer models. The Bombardier CRJ-1000 or CS100 and Embraer E-190 are appropriate sized replacements for aging BAe146 and Fokker 100 models.

Figure 26 Asia/Pacific regional jet fleet and age

Asia/Pacific regional fleet and age		
	Units	Avg Age
BAe Systems	29	24.1
Bombardier	100	10.6
COMAC	2	0.5
Embraer	190	6.9
Fokker	97	27.4
Sukhoi	5	2.8
Total	**423**	**14.7**

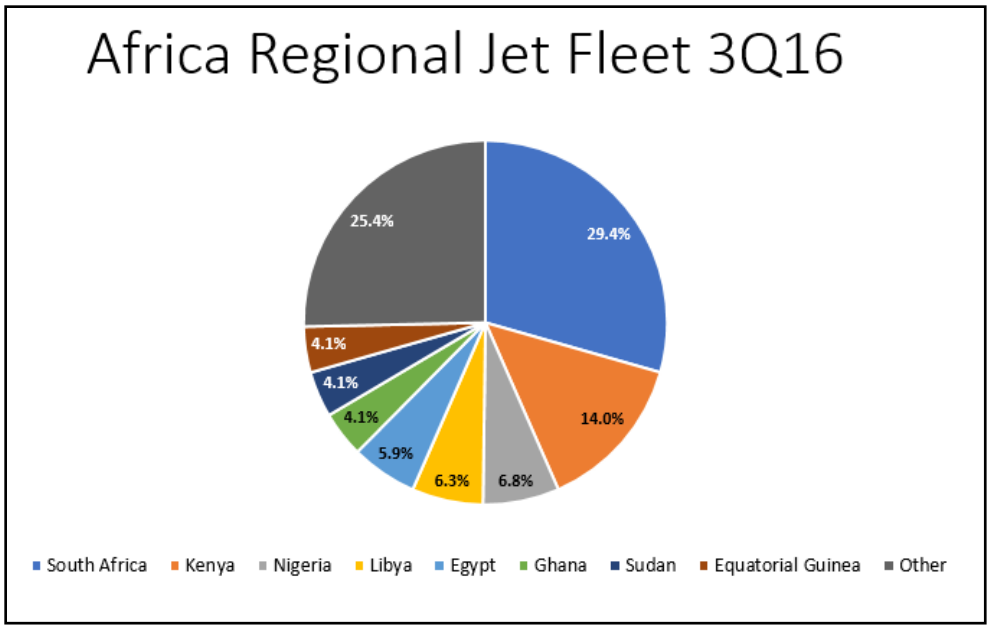
Based on the data sources about replacement and the potential boost from Rule 96, the Chinese market warrants attention from the OEMs. Add to this the potential growth that India represents and the Asia/Pacific market is of significant interest.

The third large national market of size in the region is Australia. There were 92 regional jets in the market as of 3Q16, of which 14 were aging BAe models and 56 were Fokkers. The average age of the BAe jets was 22 years and the Fokkers averaged 23 years. Rounding out the region with these three major markets, provides OEMs with a demand for over 150 aircraft. Growth in the Indian and Chinese markets could easily double that number.

d. Africa

The pie chart below illustrates the relative size of the principal regional jet markets in Africa. The eight nations listed account for three quarters of the fleet, and the top three nations account for half the fleet. Embraer projected the African market would see 240 regional jet new deliveries from 2016 to 2036[32].

Figure 27 Africa regional jet fleet



While the African market is small compared to other markets, it is a source of attention for the same reasons as India and China. The region offers growth potential. A white paper by Norton Rose Fulbright in December 2015[33] noted that: "Despite representing 15% of the world's population, the 230 airlines present in African airspace operate just 5.5% of the world's commercial passenger and freighter aircraft."

As the table above illustrates, the region's aircraft are ageing. Regional jets do more daily turns than larger aircraft, this means higher wear and tear given higher cycle to hour ratios. There are 62 aircraft in this market that need replacing in short order. The only credible alternatives to Bombardier and Embraer in this market are COMAC's ARJ-21 and Sukhoi SuperJet. Both have production rates too slow for African airline requirements. Two ARJs were sold to a Congolese operation, but that deal appears to be China state funded. Similarly, we expect any SuperJet sales to be soft money deals used as foreign aid. Whereas China and India might not be interested in the parked Bombardier and Embraer aircraft alluded to in figure 26, African airlines might. Even if African airlines took all 42 they would still another 20 to replace the aged fleet in service.

[32] http://www.ainonline.com/aviation-news/air-transport/2016-04-29/embraer-sees-african-regional-jet-fleet-doubling-20-years

[33] http://www.nortonrosefulbright.com/knowledge/publications/134084/africa-is-it-a-major-untapped-market-for-the-airline-industry

Figure 28 Africa regional fleet under 120 seats

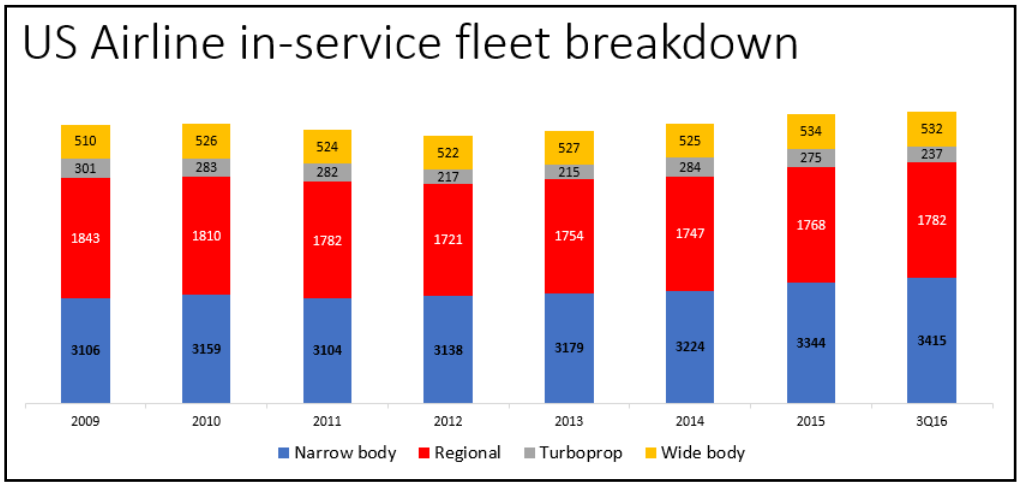
African regional fleet and age		
	Units	Avg Age
BAe Systems	27	22.3
Bombardier	50	14.6
Embraer	93	12.5
Fokker	18	30.1
Total	**188**	**17.2**

Scope Clause and the US Market

The US scope clause issue has been discussed in detail earlier in this report. This section discusses the US implications for airlines as well as the OEMs in more detail. We also offer a view at what scope easing might need to look like in 2020 to allow the newer and more advanced regional jets to be deployed in the US.

The following chart serves to underscore that the concerns among US network pilots was valid. To ensure regional jets did not encroach on their "turf", network pilot unions demanded something called "Scope Clause[34]". We have a summary of the scope clauses in the Appendix.

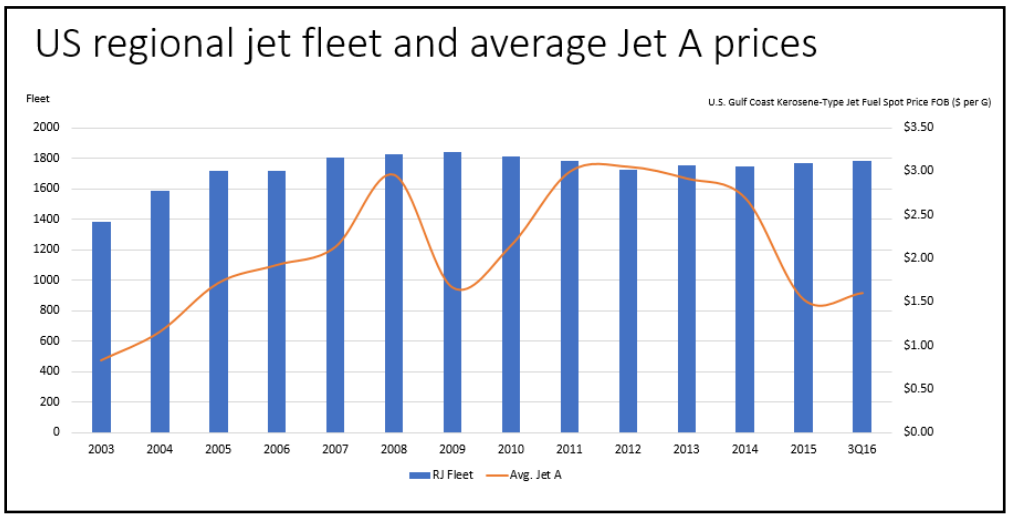
Figure 29 US Airline In-Service Fleet



The original scope clause was an agreement between network airlines and the pilot unions that such aircraft would be limited to 50 seats. Regional jet crews were paid less than network airline crews. The network airline crews feared the lower cost pilots would take work away from them. Figure 28 illustrates that this was a rational fear.

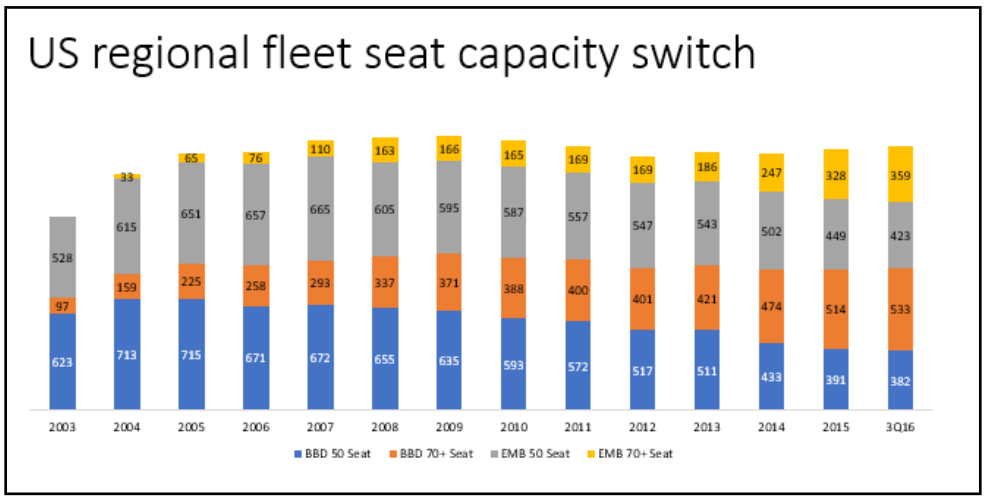
[34] The current scope clause essentially limits regional aircraft to 76 seats and MTOW below 86,000 pounds

Figure 30 US regional fleet growth and Jet A prices



As fuel prices rose, airlines grew the regional jet fleet to about 1,800 aircraft. The attraction was because these aircraft evolved from 50 seats, to 70 seats and then 86 seats. Scope was renegotiated after 9/11 to allow up to 70 seats. In 2006 Bombardier delivered its final CRJ-200 and Embraer delivered its final ERJ-145 in 2011. Figure 31 illustrates how the seat capacity switch occurred.

Figure 31 US regional fleet seat capacity switch



The popularity of the regional jets was also driven by their increased capabilities. It was not just capacity that made them attractive. The table below illustrates how both Bombardier and Embraer continued to offer more from their aircraft. Embraer developed an entirely new range of aircraft with its E-Jets. Bombardier simply kept stretching and improving their CRJ. There is an even larger version available, the CRJ-1000, which seats 100 but falls outside US scope clause and is therefore not listed. Similarly, there are larger Embraer models that are not listed in this US oriented section as they also exceed US scope limits.

Figure 32 US Scope- Clause Compliant Regional Jets

US scope compliant fleet						
Model	CRJ200	CRJ700	CRJ900	ERJ145LR	E-170LR	E-175LR
Seating capacity	50	66	76	50	78	86
Range (NM)	1,644	1,378	1,553	1,550	2,100	2,150
Payload (LBS)	13,500	18,055	22,590	12,755	20,100	22,220

With each refinement from Bombardier and Embraer that the airlines selected, it was clear to pilot unions that their dominance of network fleet activity was threatened. As 50-seater jets became inefficient with rising fuel prices while fares hardly rose, the solution was larger regional jets. As the table illustrates, as aircraft capacity grew, so did range. These small jets became a growing threat to mainline pilots.

Looking ahead to 2020 when it is expected that US pilot unions will once again review scope limits, what might need to occur with these limits to allow larger aircraft to be utilized in the US? We used a growth in seat capacity to 90 (+18%) and MTOW of 100,000 pounds (+16%) to see how the current and future aircraft fit this potential new limit.

Figure 33 Potential 2020 scope easing

Potential 2020 scope easing									
	2020 Scope	E-175LR	E175-E2	CRJ700	CRJ900	CRJ1000	MRJ70	MRJ90	SSJ100
Seats (2 Cl)	90	76	80	70	90	90	76	81	87
Over/Under	18%	16%	11%	22%	0%	0%	16%	10%	3%
MTOW (Lbs.)	100,000	85,520	9,867	75,000	84,500	91,800	81,240	87,303	101,150
Over/Under	16%	14%	90%	25%	16%	8%	19%	13%	-1%

All aircraft barring the SSJ can fit into these limits. While all the information we have been able to gather indicate scope will not move before 2020, the hard positions might soften by 2020. The difficulty, we assume, is that pilots at network airlines will be wary of regional jets going over the 100-seat capacity. But the looming US pilot shortage may impact their thinking.

i. The pilot shortage

The scope clause has led to consequences that may not have been foreseen. The commercial pilot profession has become Increasingly unattractive, as this once high paying profession has seen substantial wage reductions after US carrier bankruptcies. A US-based commercial pilot's career typically starts at the regional airlines. As the network airlines need new pilots, they reach down to the regionals to find them. But because fewer people are entering the profession, regional airlines can't find enough pilots.

The issue of a plot shortage goes back a long way though. In 1985 it was noted that there was a high turnover among commuter airline pilots[35]. Major airlines poached commuter pilots – and in 1985 commuter airlines (as regionals were called then) had to replace 50% of their pilots. Training the new pilots is a significant cost burden for the small regional airlines. In 1985 this training cost is estimated to have provided the majors with a subsidy estimated at between $200m and $300m[36]. We are not aware of a more recent figure, but it is certainly much higher.

The problem for regional airlines is that they are not a career destination for pilots, but merely a stepping-stone to be hired by larger airlines, with significantly higher pay. Thus, regional airlines are in a constant hiring and training mode. Delta Air Lines, which sold its regional affiliates some years ago, purchased Pinnacle (renaming it Endeavor) to, in part, secure a source of new pilots for mainline operations.

US regional airlines, which continue losing pilots to the network airlines, are the hardest hit[37]. In 2016, Republic Airways saw monthly flight cancellations hit 9%. The problem started to manifest itself in 2010[38]. While the airline industry struggles to find pilots, the pilots remaining have seen

[35] Commuter Airlines of the United States by R.E.G. Davis & I.E. Quastler, p. 159

[36] Ibid

[37] http://www.travelweekly.com/Travel-News/Airline-News/Pilot-shortage-a-growing-problem-in-regional-air-service

[38] http://swelblog.squarespace.com/articles/mainline-pilot-scope-will-regional-carriers-be-permitted-to.html

their salary negotiating power rise. Scope clause limits and the pilot shortage are intertwined issues the US airline industry must work out to ensure it can sustain an adequate pilot pool.

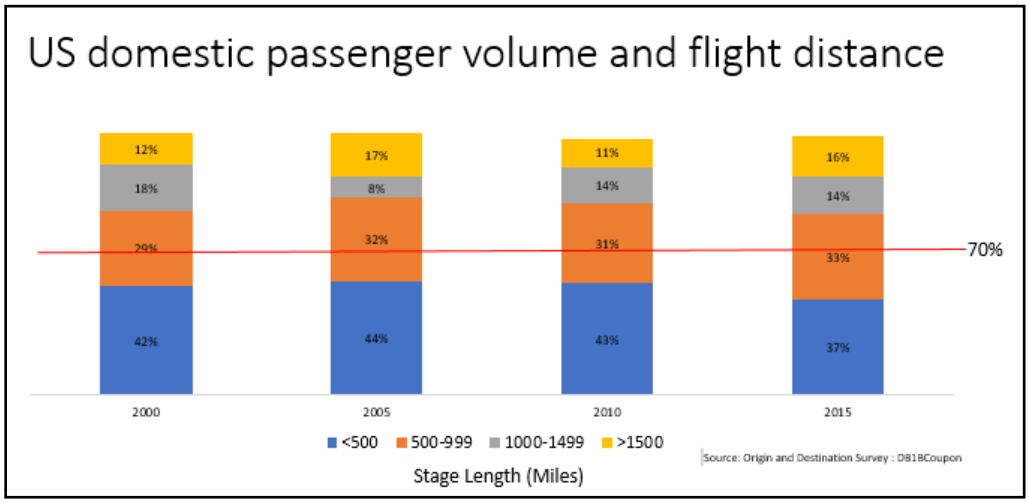
United Airlines blamed the pilot shortage when in closed its Cleveland hub, and the pilot shortage was effectively what put Republic Airways into bankruptcy. It is rare when a company emerges from bankruptcy with higher pilot costs than when it entered, but this happened at Republic and reflects the impact of the shortage and current market dynamics.

The following chart demonstrates that not only the original regional jets, but the subsequent updated versions could handle much of the US traffic. Looking at the years 2000, 2005, 2010 and 2015, we note that, on average, 41% of US domestic traffic flew under 500 miles, and then another 31% flew under 1,000 miles.

On average, 72% of US domestic air traffic flew under 1,000 miles, a range well within the capabilities of all regional jets. It is no wonder that US airlines decided to deploy them in volume. It is also no surprise that mainline pilots saw these aircraft as a threat and enforced scope limits.

In the following chart, we show how US domestic air travel has been changing since 2000. The data shows the range of flight length in nautical miles and the percentage of traffic on those segments. Our data source is the US Department of Transport DB1B coupon database. This source is defined as follows: "Origin and Destination Survey (DB1B) is a 10% sample of airline tickets from reporting carriers. Data includes origin, destination and other itinerary details of passengers transported."

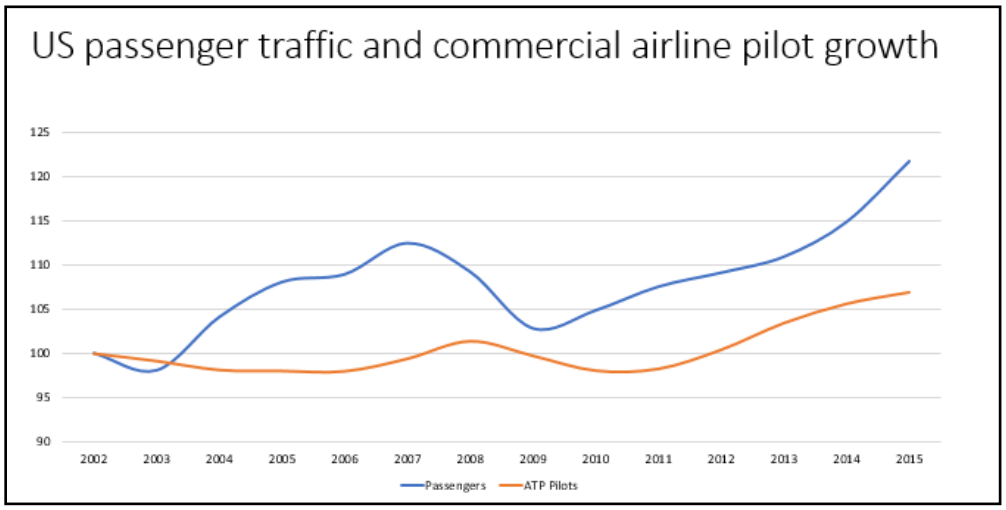
Figure 34 US Passenger Volume by Flight Distance



Over time, the number of passengers on flights under 500 miles has started to fall. The number of passengers on flights under 1,000 miles has risen. This is due, in part, to airlines cutting flights to smaller communities. Small-town America has lost airline service, as regional costs have increased. Regional jets with 50 seats have started to become less economically effective in these markets.

The case for scope clauses being a rational reaction by mainline pilots to protect their job security is straightforward. It is useful to see what the trend for commercial pilots in the US looks like. The following chart tracks passenger traffic and the number of commercial airline pilots in the US with FAA licenses from 2003.

Figure 35 US passenger traffic and commercial airline pilots



The chart shows that passenger traffic has been volatile over the period, even though the long-term trend is steady growth. Equally volatile has been the number of commercial airline pilot licenses. But whereas passenger traffic recovered from the financial crisis of 2009, the number of commercial pilots has grown more slowly. In 2002 there were 3,758 passengers per commercial airline pilot, and by 2015 the ratio had risen to 4,279 or by 14%. The issue of the commercial airline pilot shortage has been well documented[39]. The latest source in this saga is SkyWest Airlines, whose CEO stated at a US House of Representatives Transportation and Infrastructure Committee hearing that the airline could significant cuts in service[40].

Exacerbating the problem, the FAA increased the minimum number of hours required to obtain an Air Transport Pilot rating from 250 to 1,500 hours overnight in 2013[41]. This had a chilling impact on the supply of new pilots for regional airlines, as most pilots came into the airline with "on the job" training. With the 500% increase in requirements, there are few pilots that qualify, as they need to build their hours before being able to qualify for the right seat of a regional jet.

This placed an economic burden on students seeking to become airline pilots. They need to pay about $150,000 in additional training costs to obtain a job with a $35,000 starting salary. This is clearly not economically feasible, or find a job through which they could build flight time, such as

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[39] http://aviationweek.com/commercial-aviation/coming-us-pilot-shortage-real

[40] http://atwonline.com/government-affairs/skywest-ceo-warns-pilot-shortage-could-lead-big-service-cuts

[41] https://www.faa.gov/news/press_releases/news_story.cfm?newsId=14838

(footnote continued)

flight instruction. But those jobs tend to be low paying as well and result in a severe financial burden on candidates. Some airlines have begun ab-initio training programs, which they fund, to train candidates who promise to work for the airline for a period of years after graduation.

There is an argument, based on the pilot shortage that scope clauses need to be relaxed to move the traffic with larger aircraft. Such logic is unlikely to prevail among the current pilot union leadership. In late 2016, Reuters had a story[42] on this matter. They quote Mesa Air Group Inc Chief Executive Jonathan Ornstein, who said he will not purchase new aircraft that do not comply with existing scope clauses as he does not believe the current limits will be changed soon.

An airline union representative shared this view with us on relaxing scope clause: "There is zero appetite to allow the Scope limits to relax any further on the part of mainline pilots. Why? Because there is no realistic and credible pressure to do so, either internally or externally. The regionals cannot staff their operations with rock-bottom wages and new pilots aren't flocking into the industry in large enough numbers. Given that the financial risk of overcoming the barriers to entry into the pilot industry is entirely borne by the individual pilot, that the gain for assuming that risk and recouping the investment can take many years to achieve, and that the career path can disappear in an instant it should be little wonder that the youth of today are looking elsewhere."

Airline consolidation and the vagaries of commercial airlines do not make the career of a commercial airline pilot attractive in the US. Indeed, US commercial pilots are finding a much better market for their skills abroad[43]. In summary, there is nothing we know of that will cause US-based commercial pilots at the network airlines to give up their position on the current scope clause. These pilot unions have negotiating power and will not give this up easily.

Historically, scope clauses evolved as new aircraft were introduced into the market. The 19 seat turboprops of the 1970s gave way to 30 seat turboprops in the 1980, then 50 seat jets in the 1990s, and scope limits have increased to the 76 seats today. We may be on the verge of the 90-seat regional jet, which will be a topic for the scope clause negotiations in the next contracts scheduled for 2019. The Embraer E175-E2 and Mitsubishi MRJ-90 are two new aircraft that depend on an increase in scope clause limitations. If they are successful, the market in the US will become more competitive. If not, the US market will not enjoy the latest technology aircraft available in that sector.

In the US, the scope clause and the FAA 1,500-hour rule have created a pilot shortage. This means the mainline airline pilots have power in negotiations with the airlines. The plan is that mainline pilots continue to take over more flights, using smaller aircraft, from regionals. United Airlines is doing this with 737s, and Delta Air Lines ordered the Bombardier CS100 for the same purpose.

Given the economic improvement these new aircraft provide, airlines have a strong incentive to include them in their next contracts. The pilots will seek to exclude them. History tells us that

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[42] http://www.reuters.com/article/us-delta-air-union-embraer-idUSKBN13K2BS

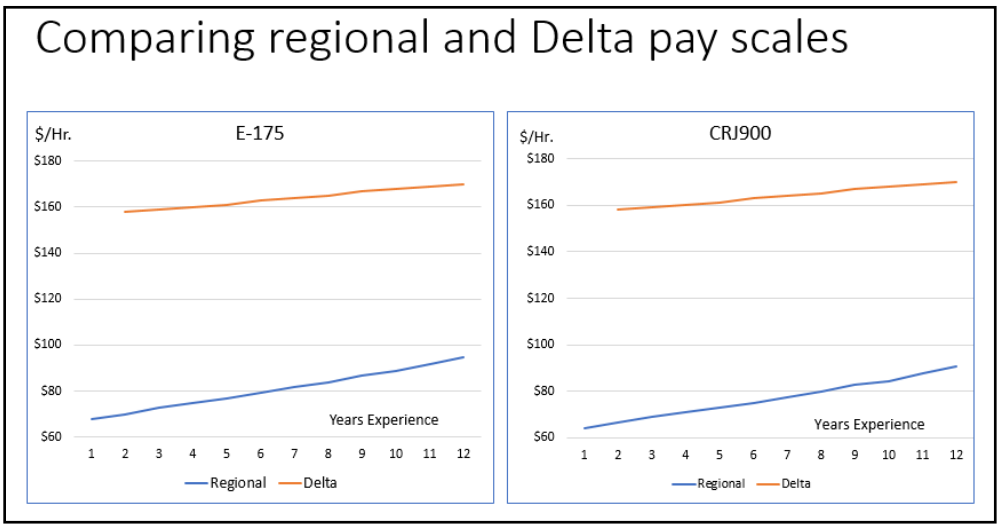
[43] http://aviationweek.com/commercial-aviation/asia-pacific-offers-much-opportunity-expatriate-pilots

regional market growth might prevail, and as mainline narrow-body aircraft increase in size, so should regionals, given airline focus on seat-mile costs. With recent five-year contracts concluded in 2014, the next opportunity will come in the 2019 renegotiations. At present the pilots have made their views clear.

The regional airline business, certainly within the United States, is the most cost intensively managed part of the airline business. US-based regionals sell their capacity to the large network airlines, which market the capacity to their customers. This means these regionals have a revenue stream defined by the network airlines. They have control over costs but not revenue. There is one key cost input that regionals must manage and that is labor. Their network partners are typically the buyer of fuel.

Consequently, regional airlines try to manage labor rates. But as the chart below illustrates the market is highly competitive. Delta Air Lines has bought regionals to secure a future pilot feed source. The table illustrates the pilot rates for Delta, were its crews to fly these aircraft. Delta does not fly these aircraft, but its pilot contract has them specified in case the airlines wants to do it. The disparity in salaries is a factor of 2:1. Regional airlines therefore must seek the lowest costs as labor rates for the two aircraft types are essentially equal.

Figure 36 Comparing Regional and Delta Air Lines Pay Scales[44]



[44] http://www.airlinepilotcentral.com/articles/job-search-articles/airline-pilot-salaries-which-airlines-have-the-highest-pay.html

III. Competition

The regional jet market is competitive. The following table contains regional jet deliveries from 2000-2016 by model. Embraer and Bombardier are the two dominant players in the regional market, and are being challenged by COMAC, Sukhoi, and Mitsubishi, who have new models entering service or under development.

The CRJ faces competition in the 70- to 100-seat segment from several competitors, including Embraer, Sukhoi, Mitsubishi, and COMAC. The following three tables illustrate the current and future competitive environments for the CRJ, including anticipated dates for entry into service for new models. Existing competitors to the CRJ include the E-Jets from Embraer, the COMAC ARJ-21-700, and the Sukhoi Superjet 100.

Figure 37 Bombardier CRJ Current Competitors[45]

Bombardier CRJ and its Competitors										
	EXISTING MODELS									
Aircraft OEM	Bombardier	Bombardier	Bombardier	COMAC	Embraer	Embraer	Embraer	Embraer	Sukhoi	Sukhoi
Model	CRJ700	CRJ900	CRJ1000	ARJ-21-700ER	E170LR	E175LR	E190LR	E195LR	SSJ100/95	SSJ100/95
1 Class Seating Normal	78	90	104	90	78	86	106	118	98	98
2-3 Class Seating	66	76	97	78	70	78	94	106	87	87
Length (ft.)	106.08	118.92	128.42	109.75	98.08	103.92	118.92	126.83	98.25	98.25
Wingspan (ft.)	76.25	81.58	85.92	89.5	85.33	85.33	94.25	94.25	91.16	91.16
Height (ft.)	24.83	24.58	24.5	27.66	32.33	32.33	34.58	34.58	33.75	33.75
Cabin Width (in.)	100.5	100.5	100.5	124	108	108	108	108	127.4	127.4
Cabin Height (in.)	74.4	74.4	74.4	80	79	79	79	79	83	83
MTOW (lbs.)	75,000	84,500	91,800	95,900	82,000	85,520	110,900	111,970	101,150	101,150
Normal Cruise Speed (Mach)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Maximum Cruise Speed (Mach)	0.825	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.81	0.81
Range (full pax in nm)	1,378	1,553	1,622	2,000	2,100	2,150	2,400	2,000	1,646	1,646
Number of Engines	2	2	2	2	2	2	2	2	2	2
Engine Manufacturer	General Electric	General Electric	General Electric	General Electric	General Electric	General Electric	General Electric	General Electric	PowerJet	PowerJet
Model	CF34-8C5B1	CF34-8C5	CF34-8C5A1	CF34-10A	CF-34-8E	CF-34-8E	CF-34-10E	CF-34-10E	SAM146-1S17	SAM146-1S17
Thrust (lbs)	13,790	14,510	14,510	17,057	14,200	14,200	18,500	18,500	17,270	17,270
Meets Existing US Scope	Yes	Yes	No	No	Yes	Yes	No	No	No	No
Expected Entry Into Service	In Service	In Service	In Service	In Service	In Service	In Service	In Service	In Service	In Service	In Service

Future competition will include the EJets-E2 from Embraer, an additional model of the ARJ-21, and the Mitsubishi Regional Jet.

[45] Source: Bombardier, Embraer, Sukhoi, COMAC websites and marketing brochures.

Figure 38 Bombardier CRJ future competitors[46]

Bombardier CRJ and its Competitors						
	FUTURE MODELS					
Aircraft OEM	COMAC	Embraer	Embraer	Embraer	Mitsubishi	Mitsubishi
Model	ARJ-21-900ER	E175-E2	E190-E2	E195-E2	RJ70LR	RJ90LR
1 Class Seating Normal	105	88	106	132	80	92
2-3 Class Seating	98	80	97	120	69	81
Length (ft.)	119.25	106.25	118.67	136.17	109.67	117.42
Wingspan (ft.)	89.5	101.58	110.5	115.17	95.83	95.83
Height (ft.)	27.66	32.7	36.1	35.8	34.17	34.17
Cabin Width (in.)	124	108	108	108	108.08	108.08
Cabin Height (in.)	80	79	79	79	80	80
MTOW (lbs.)	104,019	98,767	123,900	133,821	88,626	94,358
Normal Cruise Speed (Mach)	0.78	0.78	0.78	0.78	0.76	0.76
Maximum Cruise Speed (Mach)	0.82	0.82	0.82	0.82	0.78	0.78
Range (full pax in nm)	1,800	2,060	2,800	2,450	2,020	2,040
Number of Engines	2	2	2	2	2	2
Engine Manufacturer	General Electric	Pratt & Whitney	Pratt & Whitney	Pratt & Whitney	Pratt & Whitney	Pratt & Whitney
Model	CF34-10A	PW1715G	PW1919G	PW1923G	PW1215G	PW1217G
Thrust (lbs)	18,500	15,000	19,000	23,000	15,600	17,600
Meets Existing US Scope	No	No	No	No	Yes	No
Expected Entry Into Service	2019	2020	2017	2018	2022	2020

A. COMAC ARJ-21

The COMAC ARJ-21, an abbreviation for Advanced Regional Jet for the 21st Century, is a key element of China's 10th Five Year Plan. The project began in 2002, and required 13 years to deliver its first aircraft to Hainan Airlines in 2015, eight years behind its initial schedule. The aircraft entered service last summer, with 85 segments operated by 2 aircraft, but was dropped from the fall and winter schedule. The ARJ-21 program is viewed upon as a failure[47], but a learning experience for the Chinese aircraft industry, and an effort they will build on as they develop future models.

The aircraft was plagued with delays and certification difficulties throughout its development. COMAC had to "go back to the drawing board" when its wing failed to reach the predicted load

[46] Source: COMAC brochure, Embraer website, Mitsubishi website.

[47] http://aviationweek.com/commercial-aviation/comac-arj21-enters-service-14-years-after-project-launch

(footnote continued)

during static testing and needed to be redesigned. Additional issues occurred with wiring and avionics, per industry sources[48]. COMAC has not publicly revealed details of the causes for other program delays. The fact that the two aircraft that have been delivered are not currently in service is somewhat disconcerting.

Nonetheless, the ARJ-21 will be a major competitor in the Chinese market, as COMAC has already accumulated 302 orders. With only two aircraft delivered to Hainan Airlines to date, the backlog of 300 aircraft, which includes only 16 aircraft for airlines outside of China and 5 for US leasing company GECAS, will likely be fulfilled given the Chinese government's requirement for approval of any aircraft purchase, including alternatives should delays continue. This aircraft will, like the CRJ, fulfill Rule 96 for new entrant airlines in China and could potentially be mandated for those upstarts by the Chinese government.

With the delays and certification issues, some[49] view the ARJ-21 as a learning program as it develops its mainline C919 competitor to the Airbus A320 and Boeing 737. That aircraft, which is also behind schedule, represents more advanced technology and has a stronger potential for market success.

In 2017, we do not believe that the ARJ-21 represents strong competition for the CRJ outside of China (despite small orders from Myanmar, Laos, the Congo and Indonesia) but could potentially be a spoiler within the Chinese market if the government mandates its selection. Chinese airlines will likely need to justify why they choose a foreign aircraft over the ARJ-21, which could impede sales of western-built aircraft. In the near-term, however, production difficulties alone should provide a continuing opportunity for western aircraft while COMAC continues to struggle with aircraft reliability and its production ramp-up.

B. Embraer E-Jets

In the mid-1990s, when Bombardier decided to stretch the CRJ, Embraer, which would have had difficulty doing the same with its ERJ-145, decided to develop an entirely new family of regional aircraft. That four-aircraft family, the E-Jets was born, and serves both regional and mainline customers with aircraft that meet and, in some cases, exceed US scope clause requirements. The E170/175 and E190/195 represent two different sub-families, the former being smaller and within the US scope clause, while the latter are used by mainline airlines in the US, notably JetBlue, and by regionals and majors internationally.

[48] http://www.aero-news.net/index.cfm?do=main.ajTextPost&id=5401f24e-5613-4800-a089-21a0530f9e85

[49] http://www.reuters.com/article/us-china-aircraft-arj21-exclusive-idUSKCN0SF2XN20151021

The fuselage diameter of the E- Jets is larger than the CRJ fuselage, providing additional room and comfort for passengers in a similar 2x2 configuration in economy class. The E-Jets cabin is 7.5 inches wider than the CRJ, with 5.6 inches of additional headroom, enabling wider seats, a wider aisle, and larger overhead bins. This provides a level of cabin comfort equal to or better than A320 or 737 mainline jets in economy class, enabling seamless service levels.

The E-Jets are currently the second most successful family of regional aircraft, with more than 1,300 delivered since the first aircraft entered service in 2004. The E170 and E-175 models meet US scope clause requirements, and E-Jets are in the commuter fleets of each of the US legacy carriers, American, Delta and United. The larger E190 and E195 models are too large for operation by regionals in the US, but the E190 is in service with JetBlue, American, and Air Canada in mainline operations.

C. Embraer E2 Jets

With the availability of new engine technology, Embraer decided in 2011, only seven years after initial entry into service, to re-engine the E-Jets with the Pratt & Whitney Geared Turbofan (GTF) engine that offers a double-digit improvement in fuel efficiency and substantial environmental benefits in terms of emissions and noise reduction. Three E2 models were developed, the E175-E2, with one additional row of seats, the E190-E2, which remains the same size as the existing E190, and the E195-E2, which includes three additional rows of seats, bringing single class capacity to 132 seats.

The E190-E2 is scheduled for entry into service in 2017, the E195-E2 in 2018, and the E175-E2 has been pushed back to 2020, as scope clauses for the US will not change before then and the enlarged E175-E2 is slightly over the weight limit of the US scope clause. Those clauses will be renegotiated in 2019, and Embraer is optimistic that they will move up slightly to enable their new aircraft to comply. Should the scope clause not be amended, Embraer would need to create a lighter weight E175-E2 model for the US market.

The E2 jets promise significant economic improvements over their E-Jet predecessors, with 12-15% lower fuel burn, and a 75% reduction in the aircraft noise footprint. The technology update includes a new wing for each aircraft, with raked wing tips rather than winglets for optimized efficiency, like the Boeing 787. The E2 program entails substantial improvements to the E-Jet family, and should be successful given the economic benefits, commonality for existing E-Jet operators, and will be a strong competitor for the all-new Mitsubishi Regional Jet. The E2 program remains on-schedule and under budget.

D. Mitsubishi Regional Jet

The Mitsubishi Regional Jet program plans two models, the MRJ90 and the MRJ70, and a third potential variant, the MRJ100 is undergoing evaluation but has not yet been launched. This program has been plagued by development delays, and recently experienced a fifth delay, pushing the total program development to 12 years. The most recent delay slips the program an additional two years, moving back initial deliveries from 2018 to 2020 for launch customer All Nippon Airways. The program is now six and a half years behind its original schedule.

The MRJ90, which has prototype aircraft in flight test that it will be utilizing for some certification tasks, also utilizes the Pratt & Whitney (PW1200) GTF engine. With the aircraft design optimized for that engine, the MRJ should be an efficient aircraft, with equal or better performance vis-à-vis competing E2 Jets.

The first MRJ variant, the MRJ90, does not meet current US scope clause requirements, exceeding the limits of 76 seats and MTOW of 86,000 pounds. SkyWest and Trans States each have contracts with Mitsubishi with an "out" clause should scope clauses not be extended to include the MRJ90, and represent the largest portion of the MRJ order books.

The program is currently at the same timeframe for completion as it was in 2010, and we are cautiously optimistic that Mitsubishi will be able to maintain its current schedule and deliver the first aircraft in 2020.

E. Sukhoi Superjet 100

The Sukhoi Superjet is a 100-seat jet that is currently in service, is a joint venture between Sukhoi in Russia and several foreign partners. The aircraft entered service with Armavia in 2011, and 96 have been delivered through the end of 2016. Major customers include Aeroflot, Interjet (Mexico) and CityJet (Ireland). Marketing for the Superjet in the west is conducted through a Superjet International, a joint venture between Alenia, now a part of Leonardo in Italy and Sukhoi in Russia.

The aircraft is powered by the PowerJet SaM146 engines, developed by a joint venture between Snecma (Safran) in France and NPO Saturn in Russia. The engine was designed utilizing technology from the popular CFM-56 produced by CFM International, the Snecma/GE joint venture.

The Superjet is a modern design, including fly-by-wire controls, and is offered at a lower price than competing Embraer E-Jets and Bombardier CSeries aircraft. While direct operating costs are higher than western competitors, the low capital costs provide a strong economic case for the aircraft.

The aircraft is currently not FAA certified, as it remains outside US scope clause limitations and US airlines are unlikely to acquire a Russian-built aircraft. Nonetheless, Interjet, operating from Mexico, utilizes the Superjet on several routes to US cities. CityJet, an Irish regional, has also introduced the aircraft on routes in Europe, and the aircraft has gained an initial foothold with western airlines.

Nonetheless, we do not expect the Sukhoi Superjet 100 to become a major competitor in western markets, whether Embraer and Bombardier are currently the dominant players in the 70- to 100-seat market. We do expect the Superjet to be an effective competitor in Russia and the CIS, and that it will be able to win some campaigns in western countries due to its lower capital costs.

F. Competitive Summary

Embraer is the leading competitor to the CRJ, and its popular E-Jet program is likely to become even more popular with the E2 models that will be introduced over the next few years. The MRJ could also become a formidable competitor if the aircraft can be delivered without additional delays. The Sukhoi Superjet will be a niche competitor in the west, while the COMAC ARJ-21 will have limited success outside of the domestic Chinese market, where airlines will be mandated to acquire it by the government.

A key element for the CRJ is the scope clause negotiation in 2019. Should scope limitations remain at 76 seats and 86,020 pounds Maximum Take-Off Weight, the E175-E2 and MRJ90 will not

qualify. This would keep a market open for the CRJ without new technology competition. Should scope change, however, these more efficient aircraft will represent a strong challenge.

IV. Comparative Economics

The CRJ competes in the 70- to 100-seat market segment, with its CRJ700 and CRJ900 models competing in the scope-clause limited US market, and the CRJ1000 competing internationally. The major competitor in the scope-clause limited US market is the Embraer E-175. Other aircraft currently available or planned are outside of the current scope clause limitations, which will next be re-examined in 2019.

Market Bifurcation: Scope Restricted US and International Markets

The CRJ remains economically competitive in the US market, but will compete against emerging aircraft with new technology engines internationally, and likely fare less well. The CRJ700 and CRJ900 compete with the Embraer E-175 and forthcoming MRJ-70 (2022 at earliest) in the US market. The E175-E2, E-190, E-190E2, E195, E-195-E2, COMAC ARJ-21-700, Sukhoi Superjet 100, and Mitsubishi MRJ-90 compete with the CRJ1000 in the international market.

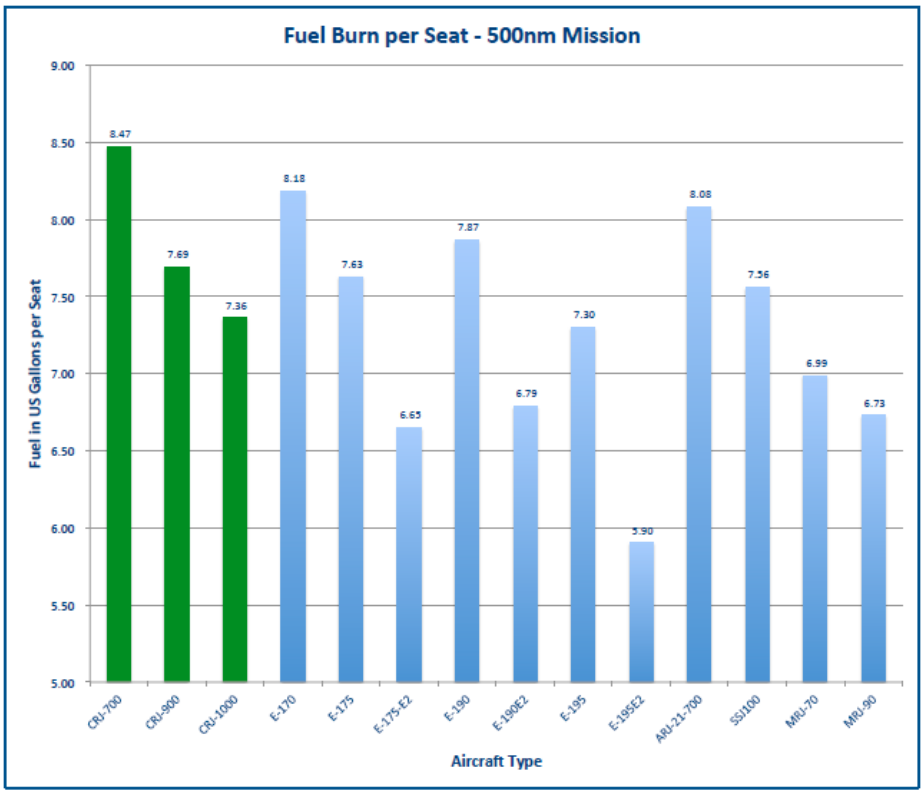
Because the CRJ has a smaller fuselage diameter and is lighter than most of its competitors, it remains competitive economically, with a trade-off between cabin size and comfort for operating economics. The CRJ is also priced lower than its new competitors, providing a capital cost advantage. In this section, we will review the key elements of operating costs for these competing aircraft, and illustrate how the CRJ stacks-up economically against its competitors.

Fuel Efficiency

The CRJ series utilizes General Electric CF34 engines, which are also used on the ARJ-21 and current E-Jets from Embraer. New technology engines, specifically the PW1900G geared turbofan, is utilized by Embraer for its E2 Jets and the PW1200G on Mitsubishi for its MRJ. These new technology engines offer a double-digit improvement in fuel economy, reduced emissions, and a noise profile 75% quieter than today's engines.

The CRJ, even with older technology engines, remains competitive in fuel efficiency. The following chart illustrates fuel burn per seat for a 500-nautical mile mission for competing regional aircraft.

Figure 39 500 Nautical mile missions



With a fuel price, currently at relatively low levels compared to the recent past, and unlikely to surge due to flexible oil production capacity in the United States and Canada, we expect a period of stability for fuel prices over the next 5-10 years. We have utilized an assumption of $2.00 per US gallon in our economic modeling, which appears to be sustainable for the oil industry for the foreseeable future.

The current low fuel price environment ameliorates the need for new technology aircraft, as existing models, at lower capital costs, can continue to operate profitably.

Overall Operating Economics

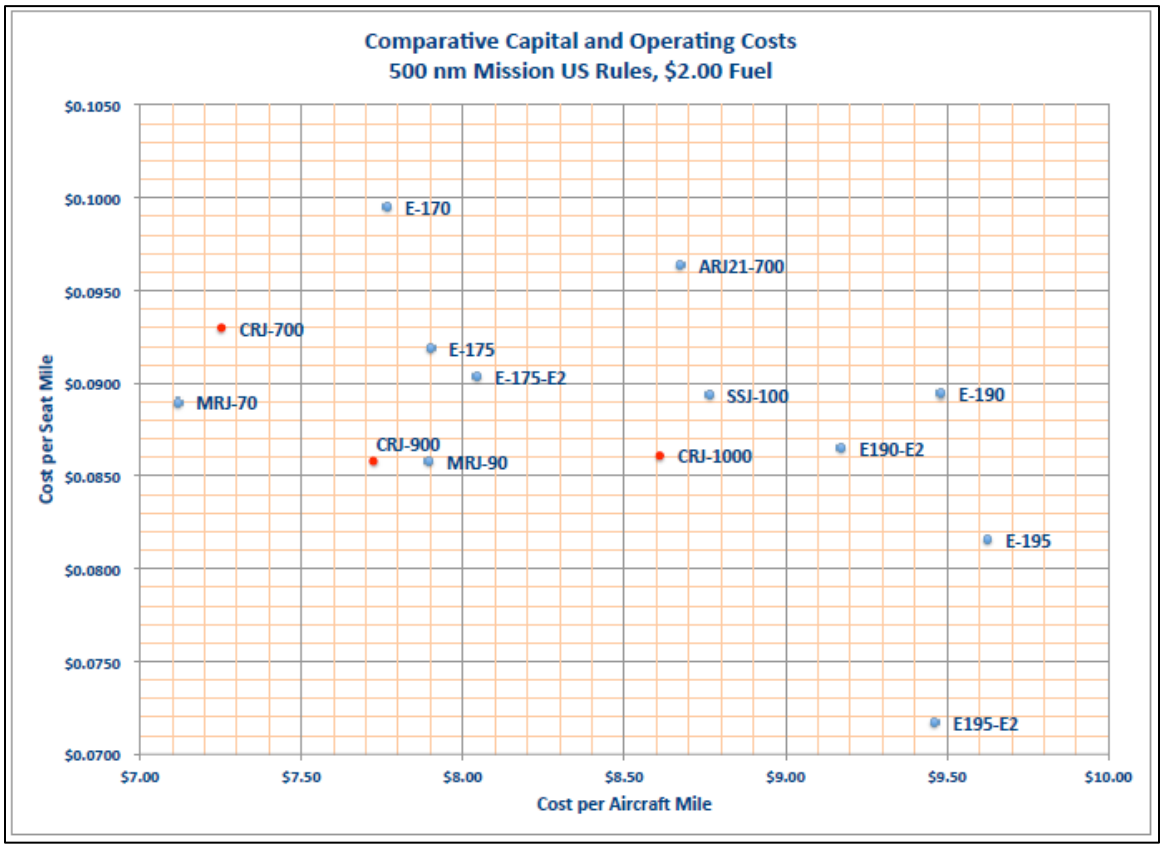
We have summarized the results of our economic model for a typical regional operation of 500 nautical miles, and segmented our comparison into aircraft that meet the current US scope clause and those which do not. Our estimate of total costs includes a monthly lease rate for each aircraft, based on market observations for existing aircraft and estimated lease rates for aircraft not yet in service. Our total cost comparison is shown in the table below:

Figure 40 Operating costs on 500 nautical mile mission

TOTAL COST COMPARISON - 500 Nautical Mile Mission	Fuel	Crew	Maintenance	Landing Fees	Capital	Trip Cost	Trip Cost/MI	Seats	Seat Mi Costs
CRJ700	$ 1,322.00	$ 693.00	$ 607.29	$ 337.50	$ 666.67	$ 3,686.46	$ 7.25	78	$ 0.0930
CRJ900	$ 1,384.00	$ 693.00	$ 637.65	$ 380.25	$ 766.67	$ 3,967.57	$ 7.72	90	$ 0.0858
CRJ1000	$ 1,472.00	$ 889.33	$ 747.09	$ 413.10	$ 783.33	$ 4,406.86	$ 8.61	100	$ 0.0861
E-170	$ 1,276.00	$ 690.00	$ 764.01	$ 369.00	$ 783.33	$ 3,882.34	$ 7.76	78	$ 0.0995
E-175	$ 1,312.00	$ 690.00	$ 764.01	$ 384.84	$ 800.00	$ 3,950.85	$ 7.90	86	$ 0.0919
E-175-E2	$ 1,184.00	$ 805.00	$ 705.25	$ 444.45	$ 883.33	$ 4,022.03	$ 8.04	89	$ 0.0904
E-190	$ 1,668.00	$ 881.67	$ 808.00	$ 499.05	$ 883.33	$ 4,740.05	$ 9.48	106	$ 0.0894
E-190-E2	$ 1,440.00	$ 881.67	$ 740.00	$ 557.55	$ 966.67	$ 4,585.88	$ 9.17	106	$ 0.0865
E-195	$ 1,722.00	$ 891.25	$ 812.00	$ 503.87	$ 883.33	$ 4,812.45	$ 9.62	118	$ 0.0816
E-195-E2	$ 1,558.00	$ 891.25	$ 780.00	$ 602.19	$ 900.00	$ 4,731.44	$ 9.46	132	$ 0.0717
ARJ-21-700	$ 1,614.00	$ 813.75	$ 828.00	$ 431.55	$ 650.00	$ 4,337.30	$ 8.67	90	$ 0.0964
SSJ100	$ 1,582.00	$ 805.00	$ 839.10	$ 455.18	$ 700.00	$ 4,381.28	$ 8.76	98	$ 0.0894
MRJ-70	$ 1,118.00	$ 690.00	$ 619.44	$ 398.82	$ 733.33	$ 3,559.59	$ 7.12	80	$ 0.0890
MRJ-90	$ 1,238.00	$ 805.00	$ 663.16	$ 424.61	$ 816.67	$ 3,947.44	$ 7.89	92	$ 0.0858

The following graph plots each aircraft by trip cost (aircraft mile) and seat-mile costs, measuring their relative efficiency.

Figure 41 Trip costs 500 nautical mile mission



Our cost estimates are based on data, or projections for aircraft not yet in service, from the OEMs under a set of similar assumptions developed by AirInsight. These estimates reflect the latest information we have obtained from OEMs. We have normalized assumptions under which the data were gathered to provide an "apples to apples" comparison whenever possible.

Fuel Burn

Our fuel burn assumptions are based on a normal flight profile for a specific flight segment, operating at normal (rather than long-range) cruising speeds, and including uniform assumptions for taxi times on the ground outbound and inbound. We utilized block fuel usage per mission at a fuel price of $2.00 US per gallon, which is the price one would expect in a stable fuel environment.

Crew Costs

Our assumptions for crew cost included a cockpit crew cost of $350.00 per block hours for aircraft that are within current US scope clauses, and $425.00 per block hour for aircraft that exceed US scope clause requirements, as they would need to be operated by higher cost pilots from major airlines. For flight attendants, we utilized the minimum number required under FAA rules, (1 for each 50 seats or fraction thereof), at a rate of $50.00 per block hour. Block hours were calculated utilizing standard taxi times plus the flight time for each mission, based on aircraft speeds.

Maintenance Costs

Maintenance cost estimates utilized in this analysis come from each OEM, based on our set of assumptions for each mission. We double-checked the reasonableness of this data for current models with airline operators to ensure that the estimates were realistic and reasonable.

Landing Fees

Landing fees vary considerably by airport, and we utilized a rate of $4.5 per 1000 pounds of maximum take-off weight. That rate appears to be a median for airports in the US, with some much lower and others more than double that rate. We utilized US rules in our analysis, and did not include typical international navigation fees in this analysis.

Capital Cost

We utilized estimates of lease rates for current aircraft from the aircraft appraisal community, and estimated monthly lease rates for new models based on their expected pricing.

Conclusion

The CRJ remains competitive, offering low aircraft mile costs with slightly higher seat-mile costs than competing aircraft. For aircraft currently meeting US scope clause requirements, the CRJ has lower costs than its key competitors. The proposed MRJ70, scheduled to enter service in 2022, would become a lower cost competitor meeting current scope clause limitations, but given five major program delays, is viewed by the industry with skepticism at this point. For the US market, the CRJ remains competitive.

For aircraft beyond the current US scope clause, the CRJ remains competitive on an aircraft-mile basis, but newer models, including the forthcoming E2 models from Embraer that will enter service in 2018 and 2019, offer lower seat-mile costs. Airlines that are risk averse may choose an aircraft with low aircraft mile costs, while airlines that are more confident of their markets would likely choose an aircraft with lower seat-mile costs. The CRJ offers lower trip costs, but higher seat-mile costs, than its major competitors. We view its competitors from Embraer, and

Bombardier's own CS100, to be more effective competitors for operations above scope clause limitations.

V. Program Outlook and Conclusions

The market for regional jets will depend largely on several issues currently outside the control of regional airlines. These include fuel costs, a pilot shortage resulting in higher costs and operational interruptions, scope clauses in the US market, and trends in airline yields, which continue to fall long-term in real terms. We examined several potential scenarios involving these elements, which we will utilize in projecting the market demand for the CRJ.

Analysis of Alternative Scenarios for Regional Market Based on Forces Driving US Market							
Scenario	Fuel Cost	Pilot Shortage	Scope Clause	Yields	Outcome	Imact on CRJ	Likelihood
1	Stable	Stable	Stable	Stable	Positive	Positive	Likely
2	Stable	Acute	Stable	Stable	Neutral	Positive	Very Likely
3	Stable	Stable	Amended	Stable	Positive	Negative	Likely
4	Stable	Stable	Amended	Tighten	Neutral	Negative	Neutral
5	Stable	Stable	Stable	Tighten	Positive	Positive	Likely
6	Stable	Acute	Stable	Tighten	Negative	Positive	Neutral
7	Stable	Acute	Amended	Stable	Negative	Negative	Neutral
8	Stable	Acute	Amended	Tighten	Negative	Negative	Unlikely
9	Rise	Stable	Stable	Stable	Positive	Positive	Neutral
10	Rise	Acute	Stable	Stable	Negative	Positive	Neutral
11	Rise	Stable	Amended	Stable	Positive	Negative	Unlikely
12	Rise	Stable	Amended	Tighten	Positive	Negative	Unlikely
13	Rise	Stable	Stable	Tighten	Positive	Positive	Neutral
14	Rise	Acute	Stable	Tighten	Negative	Positive	Unlikely
15	Rise	Acute	Amended	Stable	Negative	Negative	Unlikely
16	Rise	Acute	Amended	Tighten	Negative	Negative	Very Unlikely

For each of the four factors, we defined two alternatives and assessed the probability of those events occurring for our analysis. For fuel costs, our alternatives were stable, with prices remaining at about today's levels, or a major rise to $100 per barrel levels seen during the recent peak, before new US fracking resources came on line. We view the probability of stability as higher than the probability of rising prices.

The pilot shortage dramatically impacts regional airlines that feed the major airlines and are constantly seeking new pilots. We viewed stability in the pilot shortage at today's levels as the most likely alternative, with the situation worsening a distinct possibility as stated by SkyWest's CEO to the US Congress cited above.

Scope clauses will remain at today's levels through 2019, but at that point a decision to keep or amend those clauses will be made. We view keeping today's limitations as slightly more likely than amending contracts to include the E175-E2 and MRJ-90 aircraft, currently outside scope limitations. An amendment would bring new technology competition to the CRJ in the US market and have a negative impact on the market for the aircraft.

Yields determine the profitability of airlines on regional routes, which typically have higher per seat costs than mainline routes. We view stable yields, which are in place today, as the most likely trend, with a lower probability that yields will tighten and negatively impact the regional market.

Assessing the probability of the scenarios shown above, we selected four scenarios for analysis and forecasting, scenarios 1, 2, 3 and 5.

Figure 42 Four Scenarios with High Likelihood

Most Likely Scenarios							
Scenario	Fuel Cost	Pilot Shortage	Scope Clause	Yields	Outcome	Imact on CRJ	Likelihood
1	Stable	Stable	Stable	Stable	Positive	Positive	Very Likely
2	Stable	Acute	Stable	Stable	Neutral	Positive	Likely
3	Stable	Stable	Amended	Stable	Positive	Negative	Likely
5	Stable	Stable	Stable	Tighten	Positive	Neutral	Likely

Scenario 1 projects stable fuel prices, no worsening of the pilot shortage, no changes to the scope clause, and stable yields. This scenario would be positive for the CRJ, as new technology competition would be squeezed out of the largest regional jet market, the US. This would provide additional life to the CRJ program through 2024.

Scenario 2 projects stable fuel prices, a more acute pilot shortage, no changes in scope, and stable yields. This scenario would result in less favorable conditions for the industry, but favor the CRJ-900, which can meet scope clauses in the US at their maximum capacity with low aircraft-mile costs.

Scenario 3 projects stable fuel costs, pilot availability and yields, but changes to the scope clause to permit larger aircraft, including the Embraer E175-E2 and MRJ after their planned entry into service in 2020. Each of these aircraft has new technology engines, and better economics than the CRJ, which would find itself at a major competitive disadvantage. To remain competitive, Bombardier would need to reduce margins to near break-even levels that would likely spell the demise of the CRJ program.

Scenario 4 projects stable fuel prices, pilot availability and scope, but yield pressure accrues from competition by low cost carriers. In this scenario, regional airlines become less profitable, and growth is curtailed. While this scenario is not negative for the CRJ, neither is it positive for market growth.

In summary, it appears that the CRJ program depends (in the US) heavily on the current scope clause to protect the aircraft form the next generation competition. None of these issues impact the operations outside the US – except that the US is likely to continue to hold about 70% market share for regional jets. Consequently, the US will continue to influence the market.

We are aware of one other regulatory possibility that could generate large orders, i.e. over 100 aircraft. That is Rule 96 in China, requiring new carriers to first serve regional markets for five years before expanding to mainline aircraft. Bombardier and Embraer could benefit from that rule, particularly since domestic production of the ARJ-21 is quite slow.

Internationally, without scope restrictions, the Embraer E175-E2 could become an effective competitor in China, even if it does not meet US scope clauses. We do not foresee the MRJ90

benefitting from Rule 96 due to geopolitical considerations between China and Japan, and the fifth program delay that resulted in pushing the MRJ EIS back to 2020 at the earliest.

A. Forecast of Projected Market

The market for regional jets is heavily dependent on North America, which is expected to continue to dominate the market. Scope clauses essentially dictate the acceptability of an aircraft for regional service, which is why there are no CRJ-1000 aircraft operating in the US.

Historically, scope clauses have changed with aircraft technology as the regional airline industry has grown. Data from RAA in the United States reflect the trend to introduce new regional aircraft into the market when they come available, as shown in the table below:

Key Regional Aircraft Statistics US Operations	1980	1990	2000	2010	2015
Average Seats per flight	16	24	37	56	61
Load Factor	47.2%	53.4%	57.0%	76.5%	80.6%
Avg. Stage Length (nm)	129	194	296	464	478
Pax Enplaned (millions)	14.69	41.49	82.49	163.5	156.6
No. of Carriers	247	153	91	61	64

As new aircraft were introduced over the years, the average size has increased with these new aircraft. In 1980, the industry was primarily 19-seat turboprops, which grew to 30- and 34-seat turboprops in 1990, and then grew through the 1990s as the 50-seat regional jets were introduced. By 2010, many 50 seat regional jets were augmented by larger 70-78 seat RJs, and by 2015, the average seat count had risen to 61. The industry continues to increase its average seat size as older aircraft are replaced with new aircraft.

Historically, scope limits changed as each new generation of aircraft arrived. But the current scope clause attitude among US mainline pilot unions indicates that such changes may be at an end. Why, when contracts are up for renewal in 2019, will pilots be adamantly against scope clause changes?

Several factors point to scope clauses remaining at current levels. First, pilot unions have more bargaining power, as airlines are profitable and pilots will demand larger salaries. While this might encourage airlines to schedule more regional operations with lower cost pilots, the shortage is impacting regionals harder than majors, with some airlines having been forced to cancel flights due to a lack of flight crews. The result is that regional pilots will also demand wage increases during the shortage, and likely receive them. It is likely that at least a portion of the substantial pay gap between regional and mainline pilots will be narrowed with the next contract negotiations.

The alternative view is that airlines will want the efficiency of the E175-E2 and MRJ90 when they enter service in 2020, and will provide incentives into the pilot contracts to permit the acquisition of more efficient and environmentally friendly aircraft for their regional affiliates. Scope clauses are a subject of labor negotiations, and like all other elements of a contract, will be negotiated. Pilots typically do not want to be the scapegoat if US carriers cannot acquire a newer and

environmentally better aircraft. With noise reductions of 75% for the E2 and MRJ models over existing aircraft, the new aircraft are compelling offerings for a regional carrier.

B. Forecast of Projected Demand for CRJ

Projecting demand for the CRJ will be influenced significantly by the direction taken in the next scope clause negotiations for the US market in 2019. Should scope clauses not change that will favor the CRJ. Should limits be raised to permit the E175-E2 and MRJ-90, new technology competition will negatively impact the CRJ and limit its production life.

Our forecast assuming scope clause does not change is for the CRJ to continue to have moderate success in the US market, where it competes primarily with the Embraer E-175. The current model of the E-Jet is the best seller in the market, followed by the CRJ900. We would expect that trend to continue, with the CRJ retaining a second-place position in the market.

Our projections for the CRJ are for continued modest sales into the US regional market, and continued success internationally with the CRJ-900 and -1000 with European carriers. The large unknown is China, which will require regional jets for its new regional airlines. If CAAC, which approves all airline purchases, enables Chinese new entrants, which per Rule 96, must operate as regional airlines for five years before they can operate larger equipment, the CRJ and E-Jets will be competitive in China. But the COMAC ARJ-21-700 aircraft could be mandated by the Chinese government, thereby limiting market access for Bombardier and Embraer.

With no change to scope clauses at the next negotiations, we expect the CRJ to continue to occupy a market niche in the US through 2025, and our delivery forecast is as follows:

Figure 43 First Scenario – no scope change

	Fuel Costs	Pilot Shortage	Scope Clause	Yields	Probable Outcome	Bombardier
Scenario 1	Rise	Stable	Stable	Tighten	Regionals struggle	CRJ safe
Scenario 2	Stable	Worsens	Stable	Stable	Regionals struggle	CRJ safe
Scenario 3	Stable	Stable	Eases	Stable	Regionals have to refleet	CRJ unsafe
Scenario 4	Stable	Stable	Stable	Tighten	Regionals struggle	CRJ safe
Scenario 5	Decline	Stable	Stable	Improve	Regionals do better	CRJ safe
Scenario 6	Stable	Worsens	Stable	Tighten	Regionals struggle	CRJ safe
Scenario 7	Rise	Worsens	Stable	Tighten	Regionals struggle	
Scenario 8	Rise	Worsens	Eases	Tighten	Regionals struggle and must refleet	CRJ unsafe

The following table lists our projections for the CRJ depending on scope remaining intact.

Figure 44 CRJ Projection with scope intact

CRJ Historic and Projected Deliveries Scenario: Continuation of Present Scope, Fuel, Yield and Pilot Shortage					
Year	CRJ-200	CRJ-700	CRJ-900	CRJ-1000	TOTAL
2000	99	0	0	0	99
2001	124	22	0	0	146
2002	136	46	0	0	182
2003	155	56	10	0	221
2004	108	52	15	0	175
2005	47	64	14	0	125
2006	4	26	42	0	72
2007	0	6	53	0	59
2008	0	4	57	0	61
2009	0	23	36	0	59
2010	0	19	13	3	35
2011	0	13	16	17	46
2012	0	1	5	8	14
2013	0	1	18	7	26
2014	0	1	48	4	53
2015	0	1	32	1	34
2016	0	1	37	8	46
2017	*0*	*0*	*30*	*4*	*34*
2018	*0*	*0*	*34*	*4*	*38*
2019	*0*	*0*	*26*	*4*	*30*
2020	*0*	*0*	*26*	*4*	*30*
2021	*0*	*0*	*36*	*4*	*40*
2022	*0*	*0*	*30*	*4*	*34*

Our forecast, assuming scope clause changes to allow new technology competition from Embraer and Mitsubishi into the marketplace provides a weaker picture for the CRJ, whose economics are not as compelling as those competitors offering new technology airframes and engines. Our scenario 3, which keeps fuel, yields and the pilot shortage stable, but changes scope, does not bode well for the program, which we estimate will cease production in late 2022. Until then, the CRJ would remain a niche player in the market until the decision is rendered in 2019, then rapidly fade in the wake of the superior economics and comfort levels of competing aircraft.

Figure 45 Second Scenario - scope does change

	Fuel Costs	Pilot Shortage	Scope Clause	Yields	Probable Outcome	Bombardier
Scenario 1	Rise	Stable	Stable	Tighten	Regionals struggle	CRJ safe
Scenario 2	Stable	Stable	Eases	Stable	Regionals have to refleet	CRJ unsafe
Scenario 3	Rise	Worsens	Stable	Tighten	Regionals struggle	CRJ safe

The following table lists our projections for the CRJ depending on scope easing.

Figure 46 Projection with scope eased

CRJ Historic and Projected Deliveries Scenario: Amended Scope, Stable Fuel, Yield and Pilot Shortage					
Year	CRJ-200	CRJ-700	CRJ-900	CRJ-1000	TOTAL
2000	99	0	0	0	99
2001	124	22	0	0	146
2002	136	46	0	0	182
2003	155	56	10	0	221
2004	108	52	15	0	175
2005	47	64	14	0	125
2006	4	26	42	0	72
2007	0	6	53	0	59
2008	0	4	57	0	61
2009	0	23	36	0	59
2010	0	19	13	3	35
2011	0	13	16	17	46
2012	0	1	5	8	14
2013	0	1	18	7	26
2014	0	1	48	4	53
2015	0	1	32	1	34
2016	0	1	37	8	46
2017	*0*	*0*	*28*	*6*	*34*
2018	*0*	*0*	*32*	*6*	*38*
2019	*0*	*0*	*24*	*6*	*30*
2020	*0*	*0*	*12*	*6*	*18*
2021	*0*	*0*	*6*	*6*	*12*
2022	*0*	*0*	*1*	*6*	*7*

Outlook for CRJ program

The CRJ program is nearing the end of its economic life, as competing new technology aircraft that combine both superior operating economics and better cabin comfort enter the market in 2020. Internationally, the larger version of these aircraft, like the E190-E2 scheduled to enter service in 2018, will take sales away from the CRJ-1000. The US market remains the key, and the scope clause decision will determine whether the CRJ has an additional four to five years of economic life through 2024, or whether a relaxation of scope clause enables competitive market entry for the E175-E2 and MRJ90 into the US market.

Should the latter case occur, we do not foresee new CRJ deliveries beyond 2022 without an engine change to close the economic gap vis-a-vis its competitors. The economics of such a program appear infeasible to us, and we would not expect significant further investment in the CRJ program beyond the current round of planned improvements.

Conclusion

The CRJ has been the mainstay at Bombardier for the last 25 years, and new aircraft will continue to be delivered over the next five years. But with new competition emerging, the CRJ appears to be relegated to niche-player status in both the US and international markets. Scope clauses could extend the market life by another five years in the US market, but the results of union and airline negotiations are often unpredictable. While today it appears about 75% to 25% that current scope restrictions remain in place, circumstances could change by the time the contracts are renewed in 2019 for the 2020-2025 period. A favorable outcome enables the CRJ to continue to participate, while an unfavorable outcome will decimate the outlook for the program as it reaches its 30th year in service in 2022.

VI. Appendix

Here is a summary of the current scope clauses with the three major legacy carriers in the United States. It is notable that the details are quite precise. These have been the subject of difficult negotiations, and while they have changed and grown somewhat over time, as aircraft have changed, any changes must be negotiated at the expiration of a contract, which typically run for multiple years.

Airline	Seats	Weight	Exceptions
American	76	86000	The existing 76 CRJ 900 and E175 aircraft operated on behalf of US Airways, Inc. as of January 7, 2013, are grandfathered as to the seat limitation, and they and their replacements may be operated with 79 and 80 seats, respectively.
Delta	76	86000	36 E175s at 89000 lbs. (grandfathered)
United	76	86000	Air Wisconsin exception expired 1 January 2014

Airline	Current Commuter Fleet	Current Single Aisle Fleet	Allowable Commmuter	Allowable Large RJ	Details
American	561	799	75% of Single Aisle	40% of Single Aisle	66–76 seats scale 2016 40% of NB fleet. Remainder 30–65 seats. In 2016: fleet could be 30-65 seats=279; 66-76 seats=320
Delta	482	653	Unlimited - see details	325 Total	Limit after reduction schedule of 50 seaters will be 450: ≤50 seats=125; 51–70 seats=102; 71–76 seats=223. 1:1.25 ratio on 76 seats (from 153 to 223) with B717/A319
United	521	543	740 - see details	325 Total	Limit after reduction schedule of 50 seaters will be 450 in 2016: ≤50 seats=125; 51–70 seats=102; 71–76 seats=223. 1:1.25 ratio on 76 seats (from 130 to 223) with CS100/E190/195

Airline	Hub to Hub	Spoke to Hub	Owned/Not Owned
American	Combined blockhours between 8 hubs not to exceed 1.25% of company total schedule blockhours	85% of Commuter flights into and out of 8 hubs	No distinction
Delta	6% of commuter flights can be flown between 13 hubs or any airport with 50 daily departures	90% of commuter flights into and out of airports	No distinction
United	5% of total United Express blockhours in between 10 hubs	90% of commuter flights into and out of 20 hubs + any within 30 sm of them or any airport with 50 daily departures	No distinction