

The Embraer E-Jets have made it possible for airlines to downsize from the smallest jetliners without sacrificing efficiency of cost per seat. Large RJs allow airlines to match supply more closely with demand and save aircraft trip costs. New generation large RJs should offer further cost savings.

The economics of downsizing to large RJs

The past five or six years have seen the delivery of about 430 Embraer E-Jets and orders for a further 450, the launch of three large regional jet (RJ) programmes, and the possible launch of others. Of the four markets for large RJs, the largest comprises those airlines that need to improve the overall economics of poorer-performing routes and periods of weak demand by downsizing from 110- to 150-seat jetliners, thereby reducing capacity, realising savings in aircraft trip costs, and improving passenger yields.

Downsizing objectives

Downsizing has certainly occurred to a large degree following the delivery of large RJs, but what are the economic benefits and are they realised in practice?

The four Embraer E-Jets have a standard capacity of 70-122 seats, depending on type and configuration, but actual seat numbers do not exceed 118.

The Bombardier CRJ-700 has a standard capacity of 70-79 seats, and actual seat numbers of 66-70. The larger CRJ-900 has a standard capacity of 86-90 seats, and the recently-launched CRJ-1000 has 100-104 seats as standard.

The seat capacities of the E-Jets and the larger CRJ model compare to 110-155 seats for the A318, A319, A320, 737-600, 737-700, and MD-87 operated by airlines in the US and Europe.

Prior to the arrival of the CRJ-900, CRJ-1000 and E-Jets, there was a large gap in seat capacities between RJs and jetliner types of 45-50 seats. This was between the CRJ-700 and smallest available jetliner, the 737-500/-600.

There were, of course, earlier types available to fill this gap: the BAE 146, later becoming the Avro RJ; and the Fokker 70 and 100. The Fokker 70/100

have not been available for more than a decade, however, and the BAE 146/Avro RJ were deemed too expensive to operate in many of the roles that large RJs are now expected to fill. Production of the Avro RJ ceased in 2002.

The airline market has also changed since these two main types went out of production. One change has been the softening of pilot union scope clauses, particularly among US carriers, which have generally permitted greater numbers of larger RJs. More stringent pilot union scope clauses previously limited the market potential of the Fokker 70/100 and Avro RJ, and other similar-sized types.

More flexible scope clauses, and their expected further relaxation over the next few years, has recently increased the potential market for large RJs. Airline costs have also been streamlined, especially since 2001. This generally makes the operation of smaller types more feasible.

Downsizing is intended to match passenger demand levels and aircraft size more closely. This is expected to improve passenger load factors and passenger yields, and incur lower aircraft trip costs.

While smaller aircraft generally have higher costs per available seat-mile (ASM) than larger types, new generation large RJs have new technologies that are intended to result in lower fuel burn and direct maintenance costs that will allow them to provide overall lower unit costs per ASM than jetliners.

Scope clause issue

In addition to fuel and maintenance costs, the third important cash operating cost element is flightcrew. The salaries of flightcrews operating large RJs relative to jetliners depends on whether the large RJs

are operated by regional affiliates at regional airline salary scales, or as part of the mainline fleet at higher salary scales.

One major carrier operating both jetliners and large RJs is USAirways. The difference between its captains' hourly pay rates for the A320 and E-190 is \$30-33, depending on the number of years of service. Differences in first officers' hourly pay rates are smaller at \$13-33. The difference between salaries paid to E-190 pilots at USAirways and to E-175 and -190 pilots at its regional affiliate Republic Airways is \$5-15 per hour for captains and \$10-18 for first officers. This clearly illustrates the difference between salaries according to aircraft size, as well as lower salaries for regionals for the same aircraft type.

The large RJs are designed to provide large enough fuel and maintenance savings to make their replacement of jetliners compelling, even if they have to be operated with pilots on mainline salary scales.

These points raise several issues. The first is which aircraft types are available for airlines that want to downsize.

Another issue is which markets have the potential for downsizing. This can be answered in part by examining where downsizing has already occurred. There is also the issue of pilot union scope clauses, and how they are expected to develop.

The third main issue is the relative economics and trip costs of the types under consideration, and the potential increase in passenger yields that might follow a reduction in seat capacity.

Large RJs

Four large RJ families are available: the E-Jet; the Superjet100 (SSJ100); the Mitsubishi Regional Jet (MRJ); and the Bombardier C Series. The two C Series

LARGE REGIONAL JET & RIGHT-SIZED NARROWBODY SPECIFICATIONS

Aircraft type	CRJ-700	CRJ-705	E-170	E-175	MRJ70	SSJ100-75	
Seats	70-79	75	70-80	78-88	70-80	78-83	
MTOW-lbs	72,750/ 77,000	80,500/ 84,500	79,344/ 85,098	82,673/ 89,000	81,200/ 84,700/ 88,600	85,585/ 93,210	
Range-nm	1,434/ 1,732/ 2,002	1,719/ 1,963 1,999	2,100	2,000	800/ 1,270/ 1,800	1,570/ 2,460	
Long-range cruise speed-Mach	0.78	0.78	0.75	0.75	0.78	0.78	
Aircraft type	CRJ-900	CRJ-1000	E-190	E-195	MRJ90	SSJ100-95	C110
Seats	86-90	100-104	98-114	108-122	86-96	98-103	110
MTOW-lbs	80,500/ 84,500	90,000/ 91,800	105,359/ 114,199	107,564/ 115,280	87,300/ 91,400/ 94,400	93,740/ 101,150	118,800/ 127,800
Range-nm	1,350/ 1,593/ 1,828	1,491/ 1,691	2,400	2,200	870/ 1,400/ 1,770	1,590/ 2,390	1,800/ 2,700
Long-range cruise speed-Mach	0.80	0.78	0.75	0.75	0.78	0.78	0.78

models have standard seat capacities of 110 and 130 seats, so Bombardier classes them as right-sized narrowbodies, rather than large RJs. Taking into account actual probable airline seat configurations, the C110 will be close to, or slightly smaller than, the 737-500/-600 and E-195. The C130 is likely to be close in capacity but a few seats smaller than the 737-300/-700 and A319.

A summary of the large RJs and C Series models illustrates their seat capacities and key specification data (see table, this page).

The large RJs are intended to fill the gap between the CRJ-700 and the smallest jetliners. The CRJ-700's and -705's details are shown for the sake of comparison. The CRJ-700/-705 and CRJ-900 are theoretically direct competitors to the E-170 and E-175. These have the same or similar seat capacities in most operators' configurations. Most airlines configure the CRJ-700 with 70 seats, while the E-170 has 70 in most cases, but a few operate the aircraft with 76. The CRJ-900 has a standard seat capacity of 86-90 seats. Actual airline seat numbers are as low as 76 in the case of many US regional feeders which use the aircraft, because of scope clause limitations. Other airlines have the CRJ-900 configured with 84-88 seats. The E-175's standard seat capacity is 78-88, but actual seat

numbers are 72-82. Republic Airlines and Compass Airlines, which operate regional services for USAirways, Midwest Airlines and Northwest Airlines, have their aircraft configured with 76 seats because of scope clause limitations.

While the seat capacities of the CRJ-700 and E-170 are close, and the CRJ-900's are also similar, a larger proportion of CRJ-700s and -900s are used for regional feeder services than the E-170/-175 fleets.

The CRJ-700 is used almost purely as a regional feeder. The E-170 fleet, however, is split between operating as a regional feeder, and as an aircraft used by major carriers on routes where they have downsized from jetliners, or on city-pairs that have been opened with the aircraft. This includes aircraft operated by Finnair, LOT Polish, Kenya Airways, Paramount Airways of India, TAME and Virgin Blue.

While most of the 172 CRJ-900s in operation are used for regional feeder services, 35 are used in mainline operations. Operators include Air One, Atlasjet, Myair and Pluna.

The E-175 is utilised in a similar way. While most of the 93 aircraft in operation are used as regional feeders, some airlines use the aircraft for right-sizing on their smaller routes. This includes Air Canada, LOT Polish and Paramount Airways. There are also 41 E-175s on firm order,

including 12 for LOT Polish.

The larger E-190 and E-195 have standard seat capacities of 98-114 and 108-122, depending on internal configuration. Actual seat numbers for the E-190 are 93-106. There is a legal requirement in many jurisdictions for one flight attendant to every 50 seats, so a configuration of more than 100 seats necessitates a third crew member, which may be uneconomic for 105-120-seat aircraft.

The E-190 is the most successful model of the E-Jets, with total firm orders of 457, equal to half of all E-Jets. A large number of firm orders are outstanding for the E-190, from Aeromexico Connect, jetBlue Airways, KLM Cityhopper, Lufthansa, TACA and USAirways.

Few E-190s are used as regional feeders, and virtually all aircraft operate mainline services. Major carriers using the aircraft include Air Canada, Finnair, COPA Airlines, jetBlue, and USAirways.

The E-195 is less popular than the E-190, and has standard seat configurations of 100-118. Of the four airlines operating it, only Flybe and Royal Jordanian have sizeable fleets, although there are several other carriers with large numbers on order. Like the E-190, the E-195 is used for mainline operations.

The E-Jets have a standard four-abreast cabin configuration. The E-170/-



175 are powered by the General Electric (GE) CF34-8E, which has a bypass ratio of 5.0:1. The E-190/-195 are powered by the CF34-10E, which has a higher bypass ratio of 5.4:1. These bypass ratios affect the aircraft's fuel burn efficiency. The large RJ programmes that have been launched in the past two years use engines with higher bypass ratios than the CF34-8E and -10E. This clearly gives the new generation aircraft an advantage in fuel burn performance over the E-Jets.

Superjet 100

The Superjet International SSJ100 was the first of the three new large RJ programmes to be launched. The SSJ100 is based on a five-abreast cabin, and is offered in two basic models: the SSJ100-75 and SSJ100-95, with standard capacities of 78-83 and 98-103 seats respectively (see table, page 32). This puts the SSJ100-75 in direct competition with the E-175, and the SSJ100-95 in direct competition with the E-190.

The SSJ100 has so far won 98 firm orders, with the majority coming from Russian airlines, although two Western European operators have ordered 30 aircraft. All orders so far are for the larger -95 model.

There are two MTOW and range variants for each of the -75 and -95 models. The higher weight and longer range variants have range capabilities of 2,500nm (see table, page 32), so they are suitable for trans-European operations.

A key feature of the SSJ100 is that it is powered by the new Powerjet SaM146 engine rated at 13,500lbs thrust for the -75 and 17,500lbs thrust for the -95. This is a conventional two-shaft design and has a fan diameter of 48.2 inches. The

engine has a bypass ratio of 4.4:1, lower than the bypass ratio of the CF34-8E. Despite this, Superjet International claims that the aircraft will have 10% lower fuel burn than its closest competitors. The aircraft will also have wide margins for CAEP IV and CAEP VI NOx emissions standards.

The engine will also have 20% fewer stages than the CFM56, and 30% fewer HPC stages than the CF34, for example. These features should help it deliver savings in engine maintenance costs.

The aircraft will also use carbon fibre and composite materials to combat corrosion. The maintenance programme will have an A check interval of 750FH and C check interval of 24 months. There will be C check multiples as high as 96 months, and a structural inspection at 12 years and multiples thereof.

The SSJ100-75 will have a 2009 list price of \$26.4 million, and the -75LR a list price of \$27.0 million. The larger -95 and -95LR models will have list prices of \$29.9 million and \$30.5 million.

Mitsubishi Regional Jet

The Mitsubishi Regional Jet (MRJ) comes in two basic models: the MRJ70 nominally sized at 70-80 seats; and the MRJ90 with 86-96 seats as standard (see table, page 32). The aircraft has the same basic configuration as the E-Jets, with a four-abreast cabin. The MRJ-70 has the same standard seat capacity as the E-170, while the MRJ-90 has 86-96 seats, which puts it between the E-175 and E-190.

The MRJ's main feature is its Pratt & Whitney (PW) geared turbofan engine, the PW1000G. This engine will be rated at 15,000lbs and 17,000lbs thrust for the two aircraft variants.

Air Canada is one example of an airline that has used large RJs to replace A319s and A320s, and operate at higher frequencies.

The first main feature of the geared fan is that it provides the engine with a high bypass ratio of 8.0:1. This will give the MRJ a significant fuel burn performance advantage over its competitors. Mitsubishi says that it expects the MRJ70 and MRJ90 to have 20% lower fuel burn than the similar-sized current generation aircraft.

The PW1000G will also have fewer stages and airfoils than types like the CF34-8E, thereby contributing to lower engine maintenance costs. PW is targeting 40% lower maintenance costs than current generation engines of similar thrust ratings.

Like the SSJ100, the MRJ will use carbon fibre and composite materials to minimise corrosion.

The MRJ70's list price will be \$43 million, and the MRJ90's \$49 million.

C Series

The Bombardier C Series is the most recent new aircraft. Launched in July 2008 with a firm order for 30 aircraft from Lufthansa, the C Series is classed as a right-sized narrowbody. The first aircraft will enter service in 2013.

There are two basic models: the 110-seat C110 and 130-seat C130 (see table, page 32). The C110 is closest to the E-190 and E-195. The C130 is larger than all large RJs. The C Series has a five-abreast economy cabin as standard, which has been selected as the optimal cross-section for aircraft in the 100-150-seat range. Bombardier has conceived the C Series to provide mainline services. The aircraft has overhead bins which are as large or larger than those on the 737NG and A320 families. The C Series also has trans-continental range capability, and enough toilets and galleys for operations of up to six hours. The C Series is therefore pitched to compete directly with jetliners in the same size category, rather than as a large RJ.

Like the MRJ, the most notable feature about the C Series is that it is powered by the PW1000G, although these will be larger variants. The engine powering the C110 will be rated at 23,500lbs, and is expected to have 20% lower fuel burn than the E-190 and E-195. The engine will also have the same advantage of a smaller number of airfoils that the engine powering the MRJ has over current generation engines.



The C Series will also use carbon fibre and other lightweight materials to save weight and provide resistance to corrosion. The aircraft's maintenance programme will have extended intervals of 750FH for the A check and 7,500FH for the C check. Bombardier is aiming for a 25-30% lower maintenance cost than the E-190/-195.

Downsizing

There are four markets that large RJs can fill: downsizing; satisfying natural growth on routes that have operated 50- and 70-seat jets and need larger aircraft; direct replacement of aircraft in the same size category, including types like the Fokker 100, BAE 146 and Avro RJ; and opening all-new routes.

Embraer's analysis shows that, of the 430 E-Jets delivered to date, the majority, about 53%, have been used in right-sizing or downsizing from jetliners like the 737, A319 and A320. The percentage of aircraft used in downsizing varies with global region, but the highest level is in the Middle East and Africa, where 78% of the aircraft have been used for this purpose. Airlines using the E-Jets for downsizing include Saudia, Royal Jordanian, Egyptair, Kenya Airways and Virgin Nigeria. Downsizing has already taken place on 106 city-pairs in the Middle East and Africa region, meaning that these routes are now flown with the E-Jets or CRJ-700/-900 where the 737, A320 or MD-80 family aircraft had previously been used or still operate.

Latin America has also seen a high percentage of these aircraft being used for downsizing on thin city-pairs. About 60% of the aircraft delivered are utilised this way. Aeromexico, Copa Airlines,

Satena, TACA and TAME have used the E-Jets for right-sizing.

The downsizing in these parts of the world is inevitable, since traffic volumes are relatively light. Large RJs have allowed airlines to optimise frequencies, capacity levels, load factors and aircraft trip costs.

North America

The percentage of E-Jets in Europe and North America used for downsizing is lower at 40-50%, but still accounts for the majority of the aircraft. Examples of airlines downsizing in North America are Air Canada, Northwest and jetBlue.

Air Canada, for example, has 15 E-175s and 45 E-190s where it had previously operated the A319 and A320 on routes at lower frequencies. An example is Toronto-Halifax, where it now uses the E-190 at times of lower demand, and the A319 and A320 at times of higher demand, and has been able to increase frequencies by two additional daily services.

USAirways, which has 22 E-190s and another 25 on order, has used the aircraft in a similar way to Air Canada, by increasing frequencies on its Charlotte-Toronto route where it had previously operated the 737-300.

Embraer says that there are 373 markets or city-pairs in North America where right-sizing has already taken place. Airlines that have right-sized are Air Canada, American, Delta, jetBlue, Northwest, United and USAirways.

Europe

Several airlines in Europe have downsized from jetliners to E-Jets. One

jetBlue is one of the few carriers in the US to not be restricted by pilot union scope clauses. The airline uses its E-190s on routes that have lower traffic volumes than where it operates its A320s. The E-190 is an interesting fleet choice, given the availability of the A319.

example is Finnair. Prior to the arrival of the E-Jets, Finnair operated its Finnish domestic and trans-European network with a fleet of A319s, A320 and A321s, which it configured with 123, 159 and 196 seats respectively. The airline has a strategy of using its network and hub at Helsinki to interline traffic between its European and Asia Pacific networks. "We selected the E-170 and E-190, configured with 76 and 100 seats, mainly to optimise capacity on most of our European routes during periods of lower demand. These aircraft replaced A319s and A320s on most routes," explains Maunu Visuri, assistant vice president of fleet management at Finnair. "We use the E-170/-190 on Helsinki-Manchester, -Paris and -Brussels routes. The E-170 and -190, together with the A319, A320 and A321, give us fairly even gaps in seat numbers between five aircraft types from 76 to 196 seats. The E-Jets are mainly used in the middle of the day, while the larger A319 and A320 are used at either end of the day when demand is higher.

"The economic benefits for us have been an increase in load factor from using a smaller aircraft and lower aircraft trip cost," continues Visuri. "The E-Jets' available seat-mile (ASM) costs are higher than the A320's and similar to the A319's. The E-Jets benefit from being a lighter design and slightly better engine technology, which offsets their similar smaller seat numbers."

LOT Polish operates 10 E-170s and six E-175s. The carrier has partially used the aircraft to downsize from the 737-500. It uses the E-Jets on routes from its Warsaw hub to Dublin, Zurich, Nice, Lyons, and Barcelona. The main benefits have been reduced trip costs, 15% higher frequencies, and higher passenger load factors and yields.

Downsizing has already taken place on 153 city-pairs in Europe with Adria Airways, Air France, Air One, Alitalia, Finnair, Iberia, LOT Polish and Lufthansa now operating either E-Jets or the CRJ-700/-900 instead of, or in addition to, the A320, 737 and MD-80 jetliner families.

Pilot scope clauses

The market for RJs with more than 50 seats has been restricted by pilot union scope clauses. These are used by the pilot unions of major airlines to prevent larger

E-JET & JETLINER COMPARATIVE OPERATING COSTS

Aircraft type	E-170	E-175	E-190	E-195
Engine	CF34-8E	CF34-8E	CF34-10E	CF34-10E
Seats	76	82	100	116
Sector length-nm	600	600	600	600
Trip ASMs	45,600	49,200	60,000	69,600
FH/year	2,800	2,800	2,800	2,800
FC/year	1,800	1,800	1,800	1,800
Fuel burn-USG	770	810	940	990
List price-\$m	31.5	33.5	37.5	39.5
Monthly lease rate-\$	198,000	211,000	236,000	249,000
Total trip costs-\$	4,640	4,820	5,380	5,700
Cost per seat-\$	61	59	54	49
Aircraft type	737-600	737-700	A319	A320
Engine	CFM56-7B20	CFM56-7B24	CFM56-5B6	CFM56-5B4
Seats	115	126	126	155
Sector length-nm	600	600	600	600
Trip ASMs	69,000	75,600	75,600	93,000
FH/year	2,800	2,800	2,800	2,800
FC/year	1,800	1,800	1,800	1,800
Fuel burn-USG	1,130	1,165	1,163	1,251
List price-\$m	54	62	70	77
Monthly lease rate-\$	340,000	391,000	441,000	485,000
Total trip costs-\$	6,860	7,370	7,700	8,220
Cost per seat-\$	60	58	61	53

RJs being used in large numbers by their regional affiliates, and to prevent a continual stream of thinner routes being passed from majors to regional affiliates. This is because pilot salary scales in major carriers are higher than in regional airlines. A transfer of routes to regional affiliates would mean more pilots being paid at lower salary scales.

Scope clauses are most prevalent among US airlines, but are also used among some European major carriers. Most US airline scope clauses have some limit on the number of aircraft larger than 50 seats that regional affiliates can operate. Scope clauses do gradually evolve, however, and slowly relax to allow greater numbers of larger jets.

Alaska Air and jetBlue are two US majors not constrained by scope clauses.

American Airlines has no limits for operating jets up to 50 seats, but was limited to 50 jets of up to 70-seats, which explains its fleet of 25 CRJ-700s. Its scope clause was modified in 2008 to allow up to 50 aircraft of up to 70 seats, and is due to be discussed in 2009.

Continental's scope clause only prevents the operation of jets larger than

59 seats. It is currently under discussion.

Delta's scope clause was modified in 2008 to allow its regionals to operate up to 200 aircraft with up to 50 seats, and only up to 30 with up to 76 seats.

Northwest's scope clause was modified in 2008 to allow it to operate an unlimited number of aircraft with up to 50 seats, and up to 90 aircraft with 76 seats.

United's clause is one of the more relaxed, and allows its regionals to operate an unlimited number of aircraft with up to 70 seats.

USAirways also has one of the most relaxed scope clauses. This was recently modified and permits an unlimited number of aircraft with up to 78 seats, and up to 93 aircraft with up to 86 seats.

Europe's majors have fewer limits than the US majors, so there is less of a capacity gap between them and their regional affiliates: Alitalia has no limits on the number of aircraft of up to 100 seats operated by its regional affiliates; Iberia has no limits up to 90 seats; and KLM, Air France and Austrian have no limits up to 110 and 120 seats. SAS and British Airways have no scope clauses, and

Lufthansa has an agreement for CRJ-900s and Avro RJs operated by Lufthansa Cityline.

Aircraft economics

For downsizing from smaller jetliners to large RJs to be economic, a more than proportionate reduction in aircraft trip costs is required so that unit seat-mile costs are similar between the two categories of aircraft.

The trip and unit CASM costs can be examined on a route length that is representative of most of the markets these aircraft will operate in. These are routes of 400-700nm, and a 600nm sector length is used here as being representative of an average route length.

The analysis assumes that the large RJs are operated by major airlines, but at lower pilot salary scales than the small jetliners they are being compared to.

The jetliners included are the A319, A320, 737-600 and 737-700. The large RJs included are the four E-Jets. Some of the economic characteristics of the SSJ100-75 and -95, MRJ70, MRJ90, C110 and C130 can be examined, but it is not possible at this stage to make reliable assessments on their mature maintenance costs.

The number of seats used for these aircraft is based on typical numbers for airlines in Canada, Europe, the Middle East, Africa, Latin America and the Asia Pacific (see table, this page). This avoids any distortions caused by scope clauses, and illustrates typical seat numbers of all the types when used by major airlines.

The number of ASMs each aircraft generates on the 600nm is illustrated. This varies from 45,600 for the smallest E-170 to 93,000 for the A320 (see table, this page).

The important cost categories to analyse are fuel, direct maintenance, flightcrew, flight attendants, and aircraft financing. These account for the highest proportion of all aircraft operating costs.

Aircraft utilisation is also important. The analysis examines how aircraft trip and unit seat-mile costs compare on the same trip and route network. The level of utilisation is therefore not expected to differ significantly between types. A 600nm trip will have a block time of 111-115 minutes. Turnaround times between flights depend on airline service and airport and airspace congestion factors. Most airlines that have downsized to large RJs are full-service carriers, so turnaround times will be at least 50 minutes. Operating parameters differ from North America to Western Europe, where most large RJs are operated. The analysis assumes that the aircraft complete five flight cycles (FC) per day, with annual utilisations of 1,800FC and 2,700-2,800 flight hours (FH).

The Bombardier C Series is one of three new generation large RJ programmes. The C Series is classed as a right-sized jetliner, and will compete closely with the 737-600, 737-700 and A319. One of the new technology features the C Series is offering is Pratt & Whitney's PW1000G geared turbofan engine.

Fuel cost is the product of fuel burn and unit fuel cost. Fuel costs based on an oil price of \$65 per barrel are \$2 per US Gallon (USG), although they have been as high as \$4 per USG. Fuel burns for the CRJ-900, E-170, E-175, E-190 and E-195 are 770-990USG for a 600nm sector.

Fuel burns for the MRJ70/90 and SSJ100-75/-95 are based on estimates in relation to their nearest-sized competitor. The MRJ70 is expected to have 20% lower burn than the E-170/-175. The MRJ70 would therefore have a fuel burn of 600-650USG on the 600nm sector, and the MRJ90 a fuel burn of 750USG.

The SSJ100 models are expected to have fuel burns about 10% less than their closest-sized competitors. The SSJ100-75 is expected to have a fuel burn of 700-760USG, and the -95 a burn of 800-900USG on a 600nm sector.

The C110 and C130 are expected to have burns of 900USG and 960USG. These compare favourably to the jetliners.

The larger jetliners have higher fuel burns. The smallest 737-600 will have a burn of 1,150USG, and the larger 737-700 and A319 a burn of 1,160-1,200USG. The largest A320 will have a burn of 1,250-1,300USG.

Maintenance is the next largest cost. The 737NG and A319/320 are now mature and maintenance costs are established. The E-Jets have a heavy check interval of six years, and a small number of the oldest aircraft are six years old. Most are only four years old or less. Engine maintenance reserves are not yet fully established either.

Flightcrew salaries and employment costs are the third largest item. These relate to aircraft size and are assumed to be for a mainline carrier, so there is no lower scale for the smaller RJs. Annual salaries for a crew of two vary from \$123,000 for the E-170/MRJ70 to \$192,000 for the A320. These annual salaries are escalated by 25% to account for the additional costs of per diems, subsistence, transport, training and employer's insurance. Pilots are assumed to complete 650FH per year, so about five crews will be required per aircraft.

Flightcrew costs per trip are \$450-690 depending on aircraft type.

The cost of flight attendants is related to aircraft size, since one attendant is required per 50 seats. All large RJs, except the E-195 and C110/130 are



assumed to need two flight attendants. The C110 and E-195 would use three, and the C130 and jetliners four. A flight attendant's annual salary is taken as \$28,500, and is escalated by 15% to cover additional employment costs. Flight attendants are assumed to complete 750FH per year, so more than four crews are required per aircraft.

Aircraft financing is the largest element of all costs, and is based on the manufacturer's list price and a purchase discount of 30%. A monthly lease rate is based on a lease rate factor of 0.9% of the discounted price. These result in lease rentals of \$198,000 for the smallest E-170, up to \$249,000 for the E-195.

Monthly lease rentals would be \$202,000 and \$240,000 for the MRJ70 and MRJ90, \$170,000 and \$190,000 for the SSJ100-75 and -95, and \$271,000 and \$309,000 for the C110 and C130. These lease rates alone illustrate how attractive these aircraft would be against current technology jetliners. Monthly lease rates are \$340,000 for the 737-600, \$391,000 for the 737-700, and \$440,000 and \$485,000 for the A319/320.

Analysis

The trip costs for the E-170/-175 are \$4,600 and \$4,800, and are higher at \$5,400 and \$5,700 for the E-190 and E-195 (see table, page 38). This compares with trip costs of \$6,900 for the 737-600, \$7,400 for the 737-700 and \$7,700 for the A319. The larger A320 has trip costs of \$8,200.

The E-195 and 737-600 are almost a straight comparison, illustrating the economic benefit of the E-Jet with a \$1,200 lower trip cost.

Given the difference in seat numbers,

the important issue is cost per seat. This is highest for the smallest types, but the E-170, for example, has the same costs per seat as the 737-600, and has costs only \$3 per seat more than the 737-700. Moreover, changing from a 737-600 to a E-195 reduces the cost per seat by \$11.

The 737-700 and A319 have costs per seat of \$58 and \$61, and downsizing to the E-190 and E-195 will save \$3-12 per seat. Downsizing to the smaller E-170 and E-175 will mean equal or similar costs per seat, so negating any need for higher passenger yields. Even downsizing from the A320 to the E-190 or E-195 results in either no change in cost per seat or a small saving (see table, page 38).

The new large RJs offer further savings and benefits to airlines that want to downsize. The MRJ70/90, SSJ100-75/-95 and C110 will have fuel costs per seat up to \$3 less than the E-Jets and the jetliners. The C130 will have fuel costs \$3-5 less per seat than the 737-600/-700 and A319.

The new large RJs also have competitive list prices, comparable to equal or similar-sized E-Jets. The large RJs will also have finance costs per seat that are up to \$6 less than the jetliners'.

Even though maintenance costs are not considered here, new generation large RJs will probably be able to deliver maintenance cost savings of at least \$2-4 per seat.

These all suggest that the new large RJs make attractive replacement options for the 737-600/-700 and A319, as well as the Fokker 70/100, BAE 146 and Avro RJ. **AC**

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