

Bombardier has pioneered the regional jet market and won orders at an alarming pace. Embraer's late entry means it has not been able to catch up, but it has still caught an appreciable market share. Regional jets have not killed the turboprop market completely. Europe still provides a large home for used turboprops where regional jets cannot compete.

ERJ hot on the heels of CRJ

Embraer's recent success at the Paris Airshow might lead observers to believe that it is dominating the 50-seat jet market. Although Bombardier failed to announce any new regional jet orders at the show this article will examine just how well both Bombardier and Embraer are performing, and whether Fairchild Aerospace is likely to be a serious third force.

The aircraft

No-one can dispute the fact that the Canadair RJ (CRJ) has revolutionised the regional airline industry. Since it was launched in 1989 some 551 aircraft have been sold, together with 96 of the stretched 70-seat 700 Series.

The CRJ entered service several years earlier than the Embraer ERJ-145 and a fair comparison of sales performance must take account of this.

With the 328Jet, a simple re-engined development of the 328 turboprop, Fairchild had hoped to jump on the regional jet bandwagon. Unfortunately technical problems during its development have caused setbacks. JAA certification has been delayed to the end of June. FAA certification will follow soon after.

The 428Jet is not just a stretch of the 328Jet. In addition to extending the fuselage to accommodate 12 more seats, the 428's wing has been enlarged to maintain airfield performance and to increase maximum cruise speed from Mach 0.66 to Mach 0.70.

When the 428Jet was launched deliveries were scheduled to commence in December 2000/January 2001, but they will not now commence before the spring of 2003.

Seat capacity

The CRJ offers a very basic configuration, with 50-seats, one toilet and a single galley. The same can be said for the two Fairchild jets which, when configured in their standard 32- and 44-seat layouts, offer one toilet and a galley.

The Embraer regional jets have space available for additional galley and stowage areas without losing any seats. To equalise the facilities on each aircraft a carry-on stowage unit would have to be added to the 328/428Jet (losing a single seat in each case) and the CRJ (losing a double seat), reducing seating capacity accordingly. For the purposes of the economic analysis that follows, the manufacturers' standard seating layouts have been assumed. This could arguably give the 328/428Jets and CRJ an unfair advantage.

Passenger comfort

Bombardier makes great claims about the level of comfort on its aircraft. This is based largely on its four-abreast cross-section versus the three-abreast of the ERJ-135/145 and the 328/428Jet.

Each aircraft is offered with a standard layout at 31-in seat pitch and on this criteria they are equal. Passenger comfort thus becomes a measure of cabin dimensions, baggage capacity and internal noise.

One of the 328Jet's advantages is its superior and spacious cross-section. The 328Jet's non-circular cabin is 3 inches wider at elbow height, but 10 inches wider at floor level. The result is that seats are on average 1 inch wider than those on the Embraer RJ and CRJ. The 328/428Jet also has greater leg

room.

The two Embraer regional jets both feature wardrobes and carry-on stowages in addition to overhead bins. The result is more than twice the carry-on baggage capacity per seat of the 328Jet/428Jet and 50% more than the CRJ.

None of the aircraft has an internal noise advantage, the noise levels likely to be between 76 and 80dBA for all aircraft.

Performance

There are significant differences between the airfield performance capabilities of the five aircraft.

The ERJ-145 suffers in terms of take-off performance capability, requiring 10% more runway than the CRJ at maximum take-off weight in standard atmosphere and sea-level conditions.

The CRJ uses higher thrust engines to achieve this advantage, but improved landing performance cannot be achieved so easily.

The 328Jet's big strength is claimed to be its combination of turboprop airfield performance and jet speed.

In summary, the 328/428Jets require up to 4,500ft airfields, the CRJ and ERJ-135 need up to 5,500ft runways and the ERJ-145 up to 6,500ft.

This is based on published data for the 328/428Jet, although it is known that one of the technical problems that has slowed down the certification process is a significant degradation in predicted airfield performance.

The CRJ is marginally faster than the ERJ-135/145, which, in turn, are faster than the 328/428Jets. The difference is not enough significantly to increase utilisation for the faster types.



Despite this, Fairchild has decided to design the 428Jet for a maximum operating speed of Mach 0.70, compared with the Mach 0.66 of the 328Jet.

On a typical 300nm sector, block time differences between the five aircraft are less than three minutes. Similarly, fuel consumption between the different aircraft varies by less than 10%.

Product support

All three manufacturers support a large number of in-service aircraft. Surveys have consistently rated Bombardier product support as the best in the industry. Both Embraer and Fairchild have tended to lag behind, but judging by the recent sales success of Embraer at least, this is improving.

Canadair has the benefit of seven years of in-service experience and most of the systems on the 328Jet are taken from the 328 turboprop. The ERJ-145 is the least proven aircraft in some respects, but is rapidly gaining service experience and most operators seem satisfied with the aircraft.

Of the three engine families powering the aircraft only the CF34-3 that powers the CRJ can be considered a tried and trusted powerplant. Neither of the other two turboprops are truly proven and in this respect both can be expected to suffer from poor initial reliability as a result.

Economics

Having compared the technical features of the regional jets it is now necessary to examine the most important evaluation criteria, that of economics.

For this comparison we have also included the more common turboprop types that are still in production plus the discontinued Saab 340, Saab 2000 and Fokker 50.

Sticker prices for new aircraft are as

STICKER PRICES FOR AIRCRAFT

Canadair RJ	\$19.1m
Embraer ERJ-135	\$12.0m
Embraer ERJ-145	\$16.0m
Fairchild 328Jet	\$11.6m
Fairchild 428Jet	\$13.1m
ATR 42-500	\$13.1m
Dash 8-200	\$10.3m
Dash 8-300	\$12.9m
Fairchild 328	\$10.1m
Saab 340B+	\$10.27m
Saab 2000	\$15.51m

follows:

These prices for the ERJ-135/-145 take no account of the effect of Proex subsidies in Embraer's sales. Taking this into account reduces the price of the aircraft by about 15%. Although the World Trade Organisation has ruled that Embraer can no longer continue with Proex, Embraer may be able to continue using it over a number years during a phase-out period.

Having analysed data from various sources for all of these aircraft and attempted to reconcile the differences, the maintenance cost per flight hour (FH) varies between \$280/FH for the 328Jet up to \$350/FH for the CRJ. Such a relatively small variation is not unrealistic, since generally these aircraft

Despite Embraer's late entry into the market, it has sewn up the 35-seat jet market in the US. This could give it access to Bombardier's customers if they wanted to upgrade to larger aircraft.

are all of a similar technological standard, size and complexity.

For an equivalent range capability the maximum take-off weight of the CRJ is some 5,500lbs heavier than the ERJ-145. The CRJ in particular will therefore suffer higher weight-related user charges in the European environment. The reverse is the case with the 30-seat jets, where the shortened ERJ-135 is some 8,000lbs heavier than the 328Jet.

The economics of the aircraft have been analysed in the north American and European environments, reflecting the cost structures of airlines in the two regions.

North American economics

The economics of the 30/35-seat aircraft and 45/50-seat aircraft are displayed in two charts (see page 54).

The first chart (see page 54)

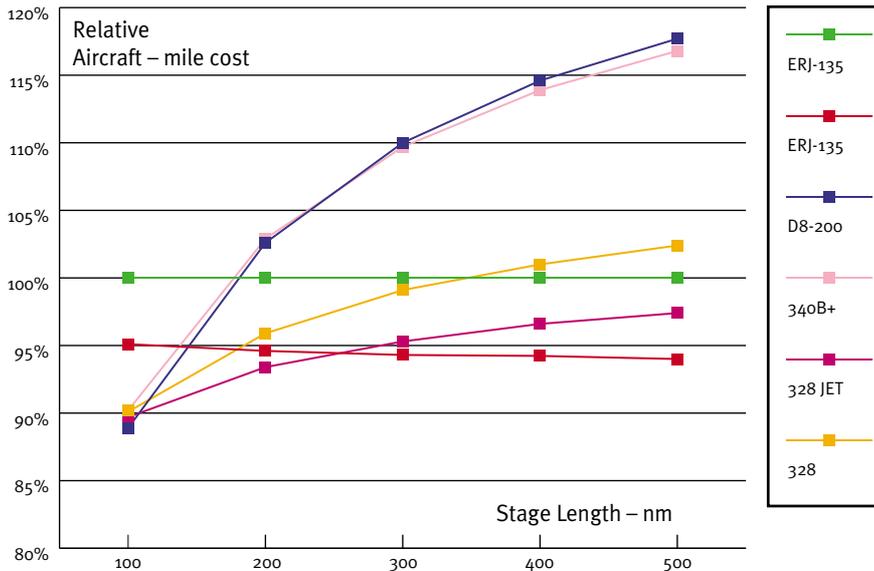
compares the aircraft-mile costs of the 30/35-seat aircraft in a north American environment, taking the ERJ-135 as the baseline.

The conventional turboprops offer lower aircraft-mile costs out to a range of around 175nm. The higher speed 328 turboprop can maintain this advantage out to 350nm but is itself more expensive than the 328Jet on all sector lengths.

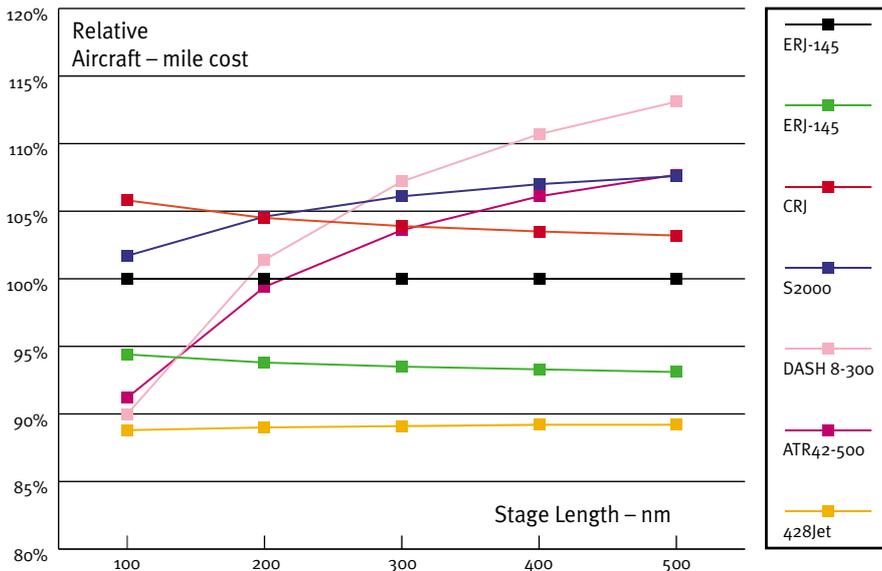
A comparison of the two jets highlights the attractiveness of the ERJ-135 over the 328Jet. On a typical 300nm sector the 328Jet has 5% lower aircraft-mile costs, but the ERJ-135 has five more seats, and so offers a 9% seat-mile cost advantage. With the effect of Proex financing included, the ERJ-135 is even more attractive, having a 1% aircraft-mile cost advantage over the 328Jet and 14% lower seat-mile costs. To those operators that do not need the extra capacity, the 328Jet could be attractive but at a similar price most operators will probably go for the larger aircraft: the ERJ-135.

It is a similar picture for the 50-seaters. The second chart (see page 54) has the ERJ-145 as the baseline. The conventional turboprops offer an advantage out to 175nm but in this case the Saab 2000 fails to show any advantage. The ERJ-145 offers aircraft-mile costs between 3% and 6% better

30/35-seat aircraft – North American Economics



45/50-seat aircraft – North American Economics



than the CRJ. If the Proex effect on financing charges is taken into account then this advantage is increased to 9–11%.

The 428Jet fits neatly between the two, which is a considerable achievement considering it has six less seats. This is due largely to the low sticker price for the aircraft that has been used in these calculations. At \$13.1 million compared to the \$19.1 million assumed for the CRJ, the 428Jet's cost per seat is about 20% lower.

The overall conclusion is that providing the high utilisation theoretically available with the regional jets can be obtained in practice then these aircraft are more economically efficient than the turboprops on all but the

shortest sectors. Future sales of new 30–50-seat turboprops into the USA are now very unlikely.

European economics

Repeating the analysis for the European market with its lower utilisation, congested airspace, high personnel costs and weight-related user charges, the overall picture is somewhat different.

The economics for the two groups of aircraft are summarised in the charts (see page 56). Relative to the ERJ-135, the first chart (see page 56) compares the aircraft-mile costs of the 30/35-seaters.

The conventional turboprops cannot be beaten on any sector distance likely to

be flown by a turboprop. The higher speed 328 turboprop is 8–9% cheaper to operate than the 328Jet on all sector lengths.

On a 300nm sector the relative position of the ERJ-135 versus the 328Jet is unchanged, with the 328Jet offering 4% lower aircraft-mile costs (3% higher with Proex), but the ERJ-135 offering 10% lower seat-mile costs (16% lower with Proex).

The 50-seaters are shown in the second chart (see page 56) relative to the ERJ-145. What is demonstrated here is the even greater appeal of the ERJ-145 to European operators. The CRJ's higher weight-related landing charges make a larger impact on the overall cost equation and the CRJ's higher capital cost is even more of a burden when utilisation is limited. The ERJ-145's advantage in aircraft-mile cost over the CRJ has now been increased to 9–10%. If the Proex effect is considered then the advantage is 15–16%.

The economic comparison shown earlier highlights the problem that the remaining turboprop manufacturers are having while trying to sell new production aircraft versus the 50-seat regional jets. On a typical turboprop sector of 200nm the direct operating costs of the ERJ-145 are only 15% higher than the new production Dash 8-300, assuming the same utilisation for both aircraft.

With this small difference the airlines can justify the acquisition of jet aircraft on the basis of the increased load factors they can achieve with jet equipment. This demonstrates why sales of new 50-seat turboprops have slowed dramatically.

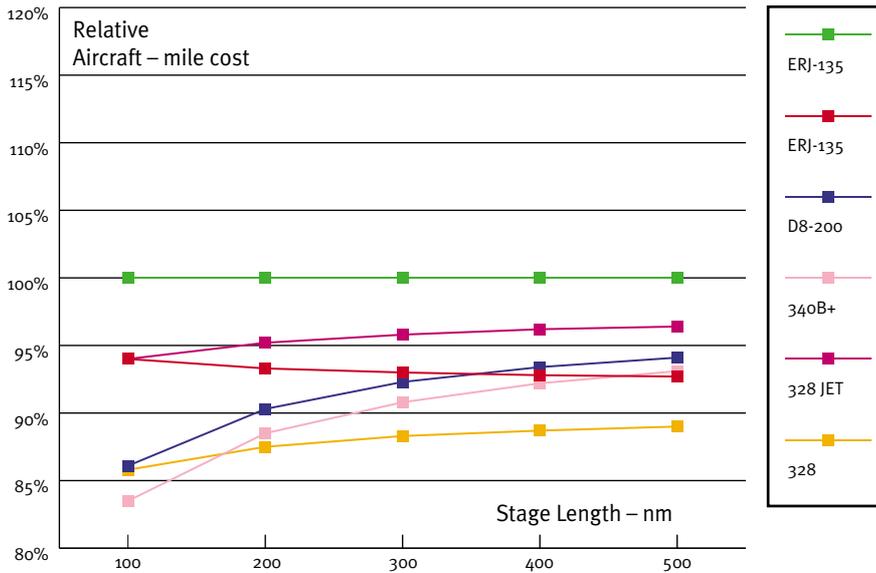
Where the acquisition of new 50-seaters can be justified, the turboprop is not much more efficient than the jet, which offers far more passenger appeal.

This is only half the story since the turboprops that are already in the market are well written down and their economics cannot be matched by either new production jets or turboprops. If rather than an all-new Dash 8 we consider a used Fokker 50, the increased cost of the ERJ-145 is more than doubled to over 40%.

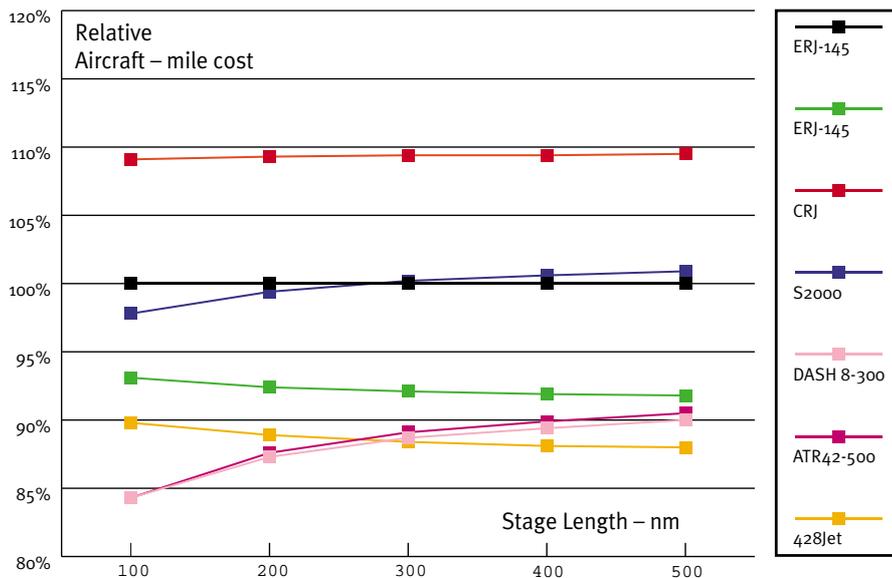
Obviously, there are a huge number of turboprop aircraft in service that could be replaced by the regional jets. In reality many turboprops are flown on routes that simply could not support the costs of the new regional jets. Examples include local service routes that are already operating with subsidies, or low-yield domestic sectors that are competing with other modes of transportation.

The key to obtaining acceptably low costs with the regional jets is to increase utilisation enough to offset the higher capital costs. In the USA the ability to achieve this is made simpler by the size of

30/35-seat aircraft – European Economics



45/50-seat aircraft – European Economics



the country and the availability of runway and air traffic control resources. In Europe the exact opposite is the case and the inability to achieve this higher utilisation restricts the use of regional jet aircraft to high-yield, generally long distance, routes.

Market penetration

CRJ orders total 551 for the 100/200 series aircraft compared with 295 orders for ERJ-145s. Comparing total sales of both aircraft from the Continental Express order in September 1996 onwards and discounting repeat orders for the CRJ, the comparison is 215 sales for the CRJ against 292 sales for the

ERJ-145.

A total of 139 ERJ-135s have been sold to six airlines. In the same period Embraer has sold 107 ERJ-145s to 15 new airlines.

Fairchild has announced that it has increased its backlog of orders to \$8.35 billion. Few details were given other than the following: "The current order book, including firm orders and options, totals 160 728Jets, 28 Envoy 7s, 163 328Jets and 85 428Jets."

The total of 163 orders and options for the 328Jet is not supported by announced sales. The only announced orders are five aircraft for Midwest Express Holdings in the USA (operated as Skyway Airlines); nine aircraft for

German start-up carrier EuroCityLine; 10 for an undisclosed European carrier (known to be another German start-up Modernair); two aircraft for Tyrolean Jet Service and six aircraft for Proteus Airlines of France. The latter announced its defection to Embraer, placing an order for eight ERJ-145s and five ERJ-135s. The chief reason for this was given as the delay in launching the 428Jet.

North America

As with all regional aircraft types, the market for regional jets is predominantly in the US. Of the 50-seat regional jet sales to date, 66% have been to north America, 29% to Europe and 5% to the rest of the world.

This geographical distribution of sales highlights how successful Bombardier has been in north America, despite losing orders from Continental Express and American Eagle to Embraer.

The CRJ's backlog in the US remains strong, with barely half the aircraft on order actually delivered.

The overall total is 390 CRJs versus 156 ERJ-145s in north America.

Despite much publicised sales of the ERJ 145 to Continental Express and American Eagle, Embraer has failed to penetrate the north American market as widely as Bombardier.

With most of the US carriers having made their choice, there is little opportunity for Embraer to broaden its 50-seat market base. Repeat orders from existing operators are also problematic because of airline scope clauses.

Fortunately for Embraer it also has the ERJ-135 programme to keep its production lines busy. A total of 139 aircraft have been ordered. They are concentrated with American Eagle (including Business Express) and Continental Express. These three operators account for 120 aircraft or 86% of total sales.

One of the threats to Bombardier is that customers take ERJ-135s to meet any 30-seat requirements and then could acquire ERJ-145s rather than CRJs. Atlantic Coast Airlines, Comair and Skywest are all existing CRJ operators rumoured as possible customers for either the ERJ-135 or 328Jet/428Jet.

Europe

Bombardier must be disappointed at how fast Embraer has caught up with it in Europe. Since September 1996 Bombardier has gained only four European customers for the CRJ, which ordered a total of 20 aircraft. Over the same period Embraer has won orders from 14 new operators for a total of



99 aircraft.

The future

Until recently, airlines have been forced to place large orders for regional jets to secure delivery positions. Manufacturers have increased their production rates. Canadair will soon be producing eight aircraft a month and Embraer is considering an increase from 12 to 16 aircraft a month.

The result could be declining prices as the demand versus supply equation is tipped in favour of the airlines. The introduction of three 70-seat regional jets, the CRJ Series 700, Embraer ERJ-170 and Fairchild 728Jet, will apply further pressure on the market for the 50-seat regional jets.

Larger aircraft

A significant trend in the regional airline industry in both Europe and the USA is the ever-increasing size of the aircraft being flown. In the USA the average seating capacity in 1998 was 27 compared with 20 in 1988. In Europe the respective figures are 57 and 35.

The most popular aircraft in the US fleet remains the 30-seat turboprop, which accounts for more than a third of the total seats available. The presence of a large fleet of 30-seat turboprops however does not guarantee a large replacement market for the 30-seat jets. The US industry has never developed a market for 50-seat turboprops, having jumped straight from 30-seat turboprops to 50-seat regional jets. There are already three times as many 50-seat jets as there are 30-seat turboprops.

An interesting recent development in

the US market has been the prospect that the pilot scope clauses will be declared anti-competitive. If they are withdrawn what effect will this have on the aircraft market, and who will be the worst affected?

The most immediate casualties might be the 30-seat jets, and in particular the ERJ-135. These are seen as a method of getting round the scope clauses and not satisfying genuine demand.

Nearly 70% of the ERJ-135 order book is committed to AMR, which is one of the carriers worst affected by scope clause limitations. If the airline manages to re-negotiate the scope clause it will almost certainly convert the bulk of its ERJ-135 orders into ERJ-145s. At the stroke of a pen the majority of the market for this aircraft will have disappeared.

The demise of both 19- and 30-seaters in Europe has made the 50-seat aircraft the European entry level. Sales of new 70-seat turboprops continue with orders this year for the ATR72 and Dash 8-400 from Air Nostrum, Alitalia Express, Augsburg Airlines, Jersey European and SAS.

With a reasonable number of relatively young, well-maintained turboprop aircraft available it is no wonder that carriers, such as Finnair, KLM Cityhopper and Skyways have acquired used turboprops to augment their fleets. These have also proven to be a popular choice for start-up airlines. VLM, Denim Air and Air Nostrum are all recent examples of start-up operations that have prospered with fleets of used Fokker 50 aircraft while Air Europa Express has achieved the same with the BAe ATP. Skyways and Air Nostrum are also examples of airlines that have

The 328Jet offers lower aircraft-mile costs than the ERJ-135. Despite late market entry, Fairchild has made an impressive start in the 70-seat European market.

ordered 50-seat regional jets to complement their turboprop operations. These are to develop new business opportunities or to replace turboprops on extremely long routes in the case of Air Nostrum. They are not intended to be a wholesale replacement for their Fokker 50s and both airlines in fact continue to expand their turboprop operations.

Although mainline carriers have retired their fleets of turboprops, they have not been replaced by large fleets of regional jets. In the main the operations have passed on to other regional carriers either owned or affiliated to the main carrier. Turboprop operations continue under the Team Lufthansa franchise by Augsburg Airways and Contact Air.

Where regional jets have been acquired by the major carriers these have been the larger regional jets, such as the Avro BAe 146 family and the Fokker 70. Europe's air traffic control restrictions are unlikely to ease in the future, which will almost certainly see a move away from the 50-seat regional jets as the new generation of 70-seat regional jet aircraft become available. The recent launch of the Embraer ERJ-170 and the Fairchild 728Jet, both by European operators, highlights European interest in this class of aircraft.

Summary

There has been a view, fostered by Bombardier, that the Embraer relies on the Proex effect to compete with the CRJ. In reality the purpose-designed ERJ-145 can be seen to be a very competitive product. For European operators in particular, its combination of cabin facilities and low gross weight make it attractive in comparison with the CRJ. Recent sales success clearly demonstrates this, with European orders for the ERJ-145 being five times greater than those for the CRJ.

It is just possible that Embraer will get a second chance in the US with many CRJ operators if they get the 37-seat ERJ-135 into Bombardier's customers. The rumoured link-up between Fairchild and Bombardier would still make an ideal marriage. For Bombardier it would fill the bottom end of its product portfolio, while it would give the 328Jet the credibility of a major manufacturer. If scope clauses are scrapped then Bombardier will be under less pressure to have a 35-seat jet in its portfolio. **AC**