



TrueNoord

Regional Aircraft Leasing



TrueNoord Insight

Regional Jet Market Report

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Executive Summary

Scope

- Although there are dedicated 50 seat and below regional jets, this report covers those with a capacity above that threshold and up to a maximum of 124 seats.
- Types covered include: CRJ700; CRJ900; CRJ1000; E170; E175; E190 and E195. New generation E190/195-E2 and A220 are excluded and are the subject of a previous report “TrueNorth Crossover Jets Market Report” (May 2021).

Key Facts

- The total fleet of all subject regional jets comprises over 2,500 aircraft. This compares to nearly 17,000 A320 and 737 family narrowbodies and some 4,500 A330, A350, 777 and 787 widebodies.
- The majority (79%) of all CRJ and smaller E170/E175 regional jets are operated in North America and 58% of all classes of regional jet.
- Larger 100+ seat regional jets are more common outside North America.
- All subject regional jets, except the E175, are now out of production.
- While the longest range of a regional jet is over 2,000nm or in excess of four hours, the vast majority of regional jets perform short sectors of 1-2 hours.
- All the subject regional jets are powered by General Electric CF34 engines. The CRJ and E170/175 are equipped with CF34-8s while the E190/195 have a larger CF34-10 powerplant.
- Regional jets offer lower trip costs than larger narrowbodies, but higher per seat costs.
- Regional jets have higher operating costs per trip compared to turboprops, but that difference erodes substantially on sectors over two hours as turboprops are slower.
- The largest number of regional jets were manufactured between 2005 and 2009 with an average of 175 units each year. A second production peak with an average of 150 per year occurred between 2014 and 2016, thus a large portion of the fleet has an average age of around 15 years or 7 years.
- The youngest regional jet fleet is the E175 with peak production levels reached in 2016.
- According to CH-Aviation, TrueNorth is ranked 4/25 lessors based on the proportion of active aircraft in their fleet in April 2022.
- 31% of all E-jets and 26% of all CRJs are owned by lessors. There is considerable variation among the aircraft types and this rises to 50% for the E190/195.
- There are eight lessors with over 10 regional jets that exclusively serve the regional aircraft segment and a similar number of mainstream large lessors are exposed to regional jets.
- The COVID-19 pandemic has caused far fewer airline bankruptcies than initially feared, partly due to extensive state backed emergency funding.
- Outside North America, regional jet and turboprop carriers received far less state support than their mainline counterparts, but some benefited indirectly.
- Many regional carriers began recovering ahead of their mainline counterparts as their lower capacity aircraft were ideal to supply the pandemic-induced lower levels of demand.
- While the number of stored aircraft should not be viewed as a proxy for available supply, the pandemic-induced proportion of regional jets stored remains at around 16%. This compares favourably with 20% for A320 and 737 family narrowbodies and 30% of A330, A350, 787 and 777 widebodies.
- The secondary market for used regional jets has been reasonably active with 260 E-jets and 160 CRJs changing operators since 2015.



Regional Jet Swot & Key Takeaways

Strengths

- Regional jets address a sizeable market for capacity of between 50-120 seats that has been vacated by Boeing and Airbus who focus on larger aircraft
- Some of the regional jets can operate from restricted airports with short runways or obstacle clearance impediments
- Provides mainline carriers with ideal complementary capacity to feed hubs
- Enables major airlines to rightsize capacity during weaker demand periods
- Can be used to maintain or develop frequency and consequently improve yield
- Tend to operate in higher yield markets with monopolistic characteristics

Opportunities

- Can be ideal new route development tool at lower risk
- Unexploited routes in developing world with poor alternative transport infrastructure
- Ageing fleet provides opportunity to further diversify operator base at relatively low cost

Weaknesses

- Regional jets have higher operating costs per seat than narrowbodies and turboprops
- Relatively high fuel-burn per seat leads to above average emissions
- All subject regional jets apart from the E175 are out of production so the fleet is ageing
- With the demise of the Mitsubishi MRJ no new regional jet is on the horizon apart from the E175-E2 in a timeframe to be confirmed
- Excess concentration in North America for smaller 70+ seat category
- Despite increased global demand for cargo aircraft, demand for the capacity that regional jets could provide remains unproven due mainly to relatively high operating costs

Threats

- Sustained higher fuel prices could reduce attractiveness of regional jets
- Ageing fleet will lead to greater obsolescence risk although much of this fleet remains relatively young
- Alternative propulsion systems could impact economic life of regional jets more than other aircraft classes



Values and Lease Rates

- According to appraisers, current market values and lease rates of all regional jets have fallen significantly since the start of the pandemic. However, this is not limited to regional jets. It applies similarly to narrowbodies, and even more so for widebody aircraft.
- A number of jets that were repossessed or returned following scheduled lease returns have been placed at low lease rates since 2020, but available inventory of airworthy aircraft has reduced substantially since late 2021. Therefore lease rates have stabilised and in some cases are showing signs of recovery.
- Appraisers partially rely on transaction datapoints to determine current market and future values, but very few regional jet sales have occurred at any value. This means that insufficient empirical evidence exists to support the current market values suggested by the appraisal community.
- Some regional jet values are starting to recover faster than others. The initial recovery candidates appear to be the E175 and E195.

Viewpoint

Regional jet recovery has been slightly faster than for other classes of jet powered aircraft as they provide the ideal capacity for a reduced passenger environment, but as passenger demand continues to recover, narrowbody values are likely to converge with or possibly overtake the early partial rebound in regional jet values. This is driven by high levels of summer 2022 leisure travel bookings and a developing acute shortage of pilots and cabin crews that arose from staff leaving the industry during the pandemic. As a consequence, airlines can satisfy seasonal 2022 requirements more easily with larger gauge aircraft. This may constrain regional jet recovery in the short-term.

However, there is a risk that the widely publicised pent-up demand for leisure travel in 2022 may prove to be short-lived. The longer term economic and supply chain legacy of the pandemic and the current political instability that is exacerbating the negative global outlook may create downward pressure on travel demand after this year's summer season. This would then affect all classes of aircraft, but regional jets could be less affected due to the lower capacity they offer.



1 Introduction & Scope

Today's regional jet types comprise a combination of Embraer E-jets and the formerly Bombardier owned CRJ series. The Embraer E-jet is a family of medium range jets, carrying from 66 to 124 passengers, while the now out of production Mitsubishi Heavy Industries owned CRJ family ranges from 50 to 104 passengers. In addition, there is a category of so-called crossover jets comprising the Airbus A220 family (the A220-300 in particular) and the larger E195-E2, which are increasingly classed as small narrowbodies. These crossover jets and their implications are outside the scope of this report, but are addressed in TrueNorth Insight's "Crossover Jets Market Report" (May 2021).

The current generation of CRJ was initially launched as the CRJ700 in 1997 and while it was a stretched derivative of the previous 50 seat CRJ100/200, it also incorporated a slightly wider fuselage, a lower floor and a new larger wing. In 2007, it was superseded by a stretched Next Gen variant, the CRJ900 with improved fuel burn and a further lowering of the floor. This is now the dominant CRJ variant. In addition, 2010 saw the introduction of the CRJ1000 with up to 104 seats.

The E-jet family came later than the CRJ700, and was first launched in the late 1990s with entry to service as the 70 seat E170 in 2004. The 76-88 seat E175 and larger 100-114 seat E190 followed quickly thereafter, with both entering service in 2005. The largest E195 with up to 124 seats followed into commercial service in 2007.

Both the CRJ and E-jet aircraft are principally used by mainline and regional airlines around the world, but a restricted number of executive E-jet aircraft have been manufactured as "Lineage" versions for VIP applications. In the case of the CRJ, the application as executive jets arose in the opposite direction as the CRJ100/200 was born as a derivative of the Challenger business jet.

After the relative success of both Bombardier and Embraer in the 37-50 seat segment, both OEMs had observed that Boeing and Airbus were gradually leaving the 100-150 seat segment and believed there remained a strong market below 120 and up to 150 seats. Both adopted a different larger aircraft strategy to supply that market. Bombardier preferred to upgrade and stretch its existing platform, while Embraer had to adopt a clean sheet approach as the smaller E145 aircraft generation aircraft only offered three across seating, while Bombardier already had four across. However, the Embraer approach proved more successful in the long-run as it now provides the dominant platform in the regional jet space.

Scope

This report provides an overview of the 70-125 seat regional jet market primarily covering the above referenced in-service current generation aircraft.

The report will examine aircraft characteristics, applications, market penetration, and operating economics as well as addressing the current dynamics in values of these aircraft, which continue to see some variety of values from the appraisal community. The impact of the COVID-19 induced pandemic on the market for the aircraft types will be included. Furthermore, in the economic analysis, the effect of reduced passenger demand will be assessed.

In addition, the report includes a comparative section on emissions for the applicable aircraft.

The CRJ900 and the E175 are the closest competitors in terms of capacity and both offer a similar payload. Across the range, the E175 and the CRJ900 are now also the most popular variants from both manufacturers, although the majority of both fleets operate for large US regionals.

However, the E175 has become the aircraft of choice for US regionals because:

- As referenced above, the aircraft offers a wider cabin for first class/larger overhead stowage bins for carry-on bags;
- The E1+ variant with winglets offers a 5% fuel burn benefit over the previous E175; and
- The cargo hold capacity of E175 is also slightly greater than that of the CRJ900. The CRJ900 offers a cargo compartment volumetric load of 16.8m³ compared to 17.3m³ in the E175.

Given that US regionals order aircraft in bulk, this has had the effect of making the E175 the most popular variant of the E1 family, consequently overtaking the E190 in terms of numbers manufactured.

2.1.2 Configuration

Figure 3 below shows a selection of available seating lay-outs for each member of the E-jet and CRJ families in their lowest and highest density configurations. (The 50 seat CRJ550 variant of the CRJ700 is not shown.) At the upper end the CRJ1000 can have an extra row with 104 seats (not shown). Both the -550/700 and 1000 have become types with a very small operator base in the USA and Europe respectively. Neither are targets for TrueNorth and so are only treated cursorily.

Figure 3: E-jet and CRJ Seating Layout

E-Jet

E170 Dual Class 6 x J-Class & 60 x Y-Class



E175 Dual Class 12 x J-Class & 64 x Y-Class



E170 Single Class 78 x Y-Class



E175 Single Class 88 x Y-Class



E190 Dual Class 8 x J-Class & 88 x Y-Class



E195 Dual Class 12 x J-Class & 88 x Y-Class



E190 Single Class 114 x Y-Class



E195 Single Class 124 x Y-Class



CRJ

CRJ700 Dual Class 6 x J-Class & 60 x Y-Class



CRJ900 Dual Class 12 x J-Class & 64 x Y-Class



CRJ700 Single Class 78 x Y-Class



CRJ900 Class 90 x Y-Class



CRJ1000 Single Class 100 x Y-Class





2.2 Principal Specifications & Weights

The principal weights and specifications of all four current generation E-jets and those of the three CRJs are shown in Figure 4 below.

Figure 4: E-jet Key Specifications

Variant	E170	E175	E190	E195
Length	29.9m	31.68m	36.24m	38.67m
Wingspan	26.0m	28.65m	28.72m	28.72m
MTOW (max)	37,360kg	40,370kg	51,960kg	52,290kg
Max. Payload	9,100kg	10,094kg	13,000kg	13,917kg
Engines (2x)	CF34-8E5	CF34-8E5	CF34-10E	CF34-10E
Range	2,150nm	2,200nm	2,450nm	2,300nm
Take off Distance*	1,151m	1,266m	1,267m	1,432m
Landing Distance	1,241m	1,261m	1,244m	1,275m
Max Pax Capacity	78	88	114	124

*Min Certified Takeoff Distance (TOW for 500nm Range) Source: Embraer APM & TC

Figure 4: CRJ Key Specifications

Variant	CRJ700/(550)	CRJ900	CRJ1000
Length	32.3m	36.2m	39.1m
Wingspan	23.2m	24.9m	26.2m
MTOW	34,019kg (29,545kg)	38,329kg	41,640kg
Max. Payload	8,190kg	10,247kg	11,966kg
Engines (2x)	CF34-8C5	CF34-8C5	CF34-8C5
Range	1,378nm (2,200nm)	1,553nm	1,622nm
Take off Distance*	1,516m	1,760m	1,876m
Landing Distance	1,536m	1,632m	1,750m
Max Pax Capacity	78 (50)	90	104

*Min Certified Takeoff Distance Source: CRJ APM & TC

In addition to seating capacity, another measure can be seen in terms of the payload capability of each of the aircraft. If you assume an average passenger including standard luggage weighs 100kg, the CRJ900 with 90 passengers can carry an additional 1,247kg, whereas the E175 88 can carry a further 1,294kg. In the case of the larger aircraft the CRJ1000 with 104 passengers can carry another 1,566kg and the E190 with 114 can accommodate an extra 1,600kg.

2.3 Engines

All CRJ models are powered by the CF34-8C5, whereas the E170 and E175 have the same engine with a slightly different CF34-8E5 nomenclature along with marginally different weights and dimensions. While there are several divergences between the engines on the CRJ and the E-jet so that they cannot be interchanged, the main difference is that on the CRJ the engines are mounted on the rear of the fuselage as opposed to under the wings for the E170 and E175. Accordingly, the -8C5 mountings are located to the side instead of on the top for the -8E5. The engine dry weights differ at 1,261kg for the -8C5 and 1,428kg for the -8E5. The length and diameter of both models also differ slightly. The maximum thrust rating of both models is 14,500lb (6,577kg).

The larger E190 and E195 are powered by a bigger CF34-10E variant with a maximum thrust rating of 20,360lb (9,235kg). Compared to the -8E5, it is a newer design based upon a shrunk version of the successful CFM56 platform. For the maximum increased thrust (40%) that the engine is able to produce over its smaller sibling, its dry weight at 1,678kg is only 17.5% heavier than the -8E5.

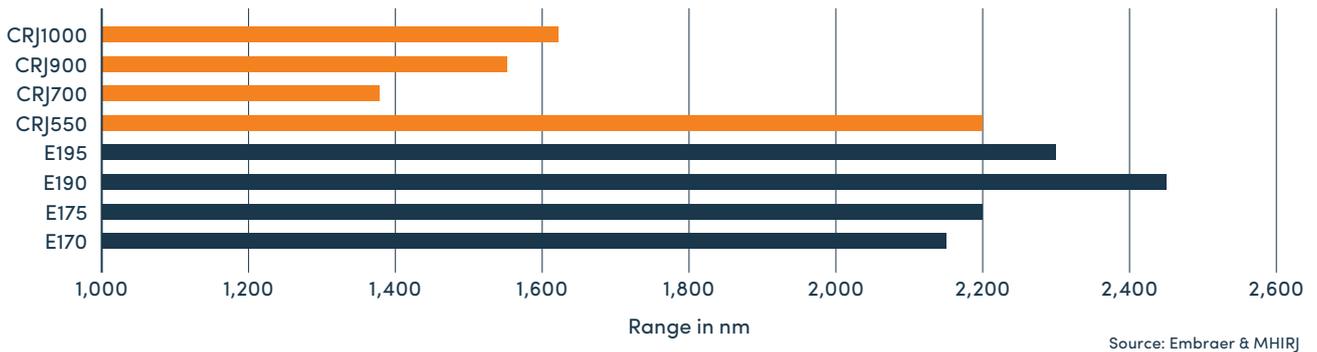
The maintenance costs for the above referenced power plants are outlined in section 2.6 on page 12.



2.4 Range

While the CRJ family is a capable aircraft for the majority of typical regional flights, its range is more limited than the Embraers, as shown in Figure 5 below. A mission capability exceeding 1,500nm, or around 3 hours, enables the aircraft to perform the vast majority of sectors that any airline may wish to fly. There will always be some sectors in some locations where the longer range may add value such as various long North American routes. The 50 seat CRJ550 is more than adequately capable of the limited number of long sectors required for US operations as is the E175. (Note that the maximum range shown for the E175 is that of the more recent “+” variant that has improved fuel burn and therefore range capability.)

Figure 5: E-jet & CRJ Range Comparison



2.5 Performance

The ability to operate from restricted airports with short runways and/or obstacles is often a key attribute of regional aircraft. Typically, this favours turboprops over regional jets, but where turboprops are not optimal, strong airfield performance of regional jets find many applications notably at airports such as London City or Florence.

In this context the CRJ family was never designed with short field performance in mind. Its former owner, Bombardier’s position was that this was more the role of its Dash 8 turboprop product line. By contrast, Embraer, which never updated or replaced the E120 turboprop, designed the E-jet to maximise its capability for short runway operations so that performance differences between the two types are quite evident as shown in Figure 6 below. Figure 6 shows the minimum certified takeoff distance and the field length required when the aircraft operates at MTOW. The differences in terms of climb performance where obstacle clearance is relevant are similar.

Currently, the E190 shows a similar take-off performance compared to the E175, which seems illogical given the lower weight of the latter. Embraer stress that since there has been little demand to operate the E175 at short field airports, the same efforts to improve certification for the type have not been applied to the E175 compared to the E170 and E190 which both have significant short-field performance demand.

Figure 6: E-jet & CRJ Runway Performance – Takeoff Distance





2.6 Economic Comparison

The elements of operating costs, excluding the aircraft capital portion, are often referred to as cash operating costs (COC). The elements that are driven by the aircraft itself are briefly reviewed below. While crew costs are a major COC component these are assumed to be the same for all the aircraft under review, and therefore do not materially impact the relative outcomes of each of the types reviewed (see note a). In practice, these may differ significantly between high and low labour cost regions, and between regional and mainline operators which will benefit those operated in regional entities that generally have lower crew salaries and costs. While navigation and landing charges are included in the COCs, these are not separately reviewed as these are largely driven by varying criteria including aircraft weight in many parts of the world.

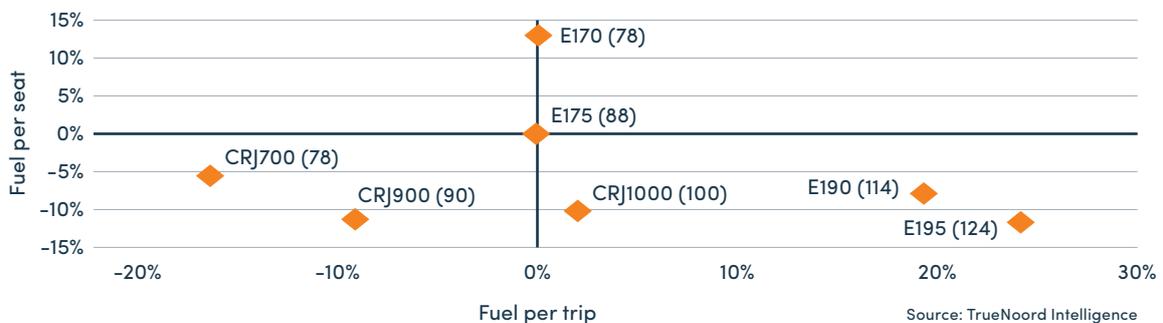
2.6.1 Fuel Burn

As mature aircraft types, the fuel burns of the CRJ and E-jet families are a relatively well-known quantity. For the types where both manufacturers have equivalent capacity aircraft (CRJ900 & E175), the former will consume around 2,200kg of fuel on a 500nm trip or 24.5kg (see note b) per seat. This compares to around 2,400kg for the E175 which equates to 27.25kg per seat. The slightly greater fuel consumption of the E175 is not surprising since it is a heavier aircraft that offers the benefits of its larger cabin and greater baggage capacity, as well as two less seats in the assumed configuration.

On a shorter 300nm sector the CRJ burns about 1,500kg compared to just below 1,600kg for the E175. This means that for the shorter sector, the gap in fuel efficiency between both aircraft narrows in both absolute and relative terms. On a longer sectors of 700nm the gaps widens to 350kg but in relative terms remains similar to the 500nm sector.

The smaller CRJ700 and E170 burn marginally less fuel on the same journeys, but more per seat given their lower seat counts. The larger E190 and E195 consume 2,850kg and 2,970kg respectively, while the CRJ1000 burns 2,440kg. The relative fuel burn of each type compared to the E175 is shown in Figure 7.

Figure 7: Block Fuel Burn Relative to E175 (Single-Class(number of seats))



2.6.2 Maintenance/FH/FC

As the CRJ and E-jet families are both mature aircraft programmes, there is a wealth of data available from the manufacturers (including the engine OEM), as well as direct experience from the TrueNorth fleet. Therefore, a combination of OEM data, which has been cross checked with TrueNorth's own internal experience, has been applied. As a consequence, the scheduled tasks and hard time intervals are reasonably accurate, but the associated costs are estimates, which have been slightly escalated to be conservative unless an actual published figure is used, as is the case with engine LLPs. (Note that the engine LLP costs are 2021 figures, which would need to be escalated annually. Since scheduled engine shop visits should not occur for some years, the actual prices are likely to be significantly greater.) The principal scheduled maintenance tasks, intervals and estimated costs are as outlined in Figure 8 as follows:

(a) Note that the COC comparisons may show a slight difference in crew costs for different aircraft notably the E190 and E195, which reflects an additional cabin crew member on both types.

(b) Jet A-1 fuel is typically measured in kg or lbs. There are 3.02kg/US gallon so that 24.5kg represents 8.11USG or 6.75 imperial gallons/30.38 litres.

Figure 8: Maintenance Comparison CRJ & E-jet

CRJ700/900/1000	E-170/175/190/195
Airframe Base Maintenance	
<p>Base maintenance is divided into a series of Flight Hour (FH) limited checks and calendar time limited checks. In general, operators try to limit the number of heavy base maintenance visits to minimise both down-time and the opening of panels. Ideally, the FH and calendar interval of base checks is determined so that both would coincide. Assuming an annual average utilisation of 2,500–3,000 FH, this usually ensures optimal alignment. In the event that utilisation is lower, calendar checks would be needed earlier so that the full potential of FH life cannot be used. Conversely, if utilisation is higher then some calendar time may not be used in order to achieve check alignment.</p>	
<p>The airframe maintenance heavy base check interval (C-check equivalent) is currently 8,000FH for all three variants. This has been escalated from 6,000FH since the previous CRJ report in 2019 at which time this was planned but not yet implemented.</p> <p>In addition there are calendar time checks at 6, 9 and 12 years. Assuming a utilisation of around 2,500+ hours per year, the 6 year check would align with the second C-check.</p> <p>TrueNoord estimates the average cost of a base check to be approximately US\$27 per FH. This is a useful guide but may vary according to findings. This estimate is based on the CRJ900, but is similar for both other models.</p> <p>At the second base check, the 6 year CPCP tasks would also normally be performed. This is expected to add about US\$1,100 per month to the base check cost.</p> <p>Each subsequent calendar check includes additional tasks so that each subsequent check is expected to cost double the previous check so that the 12 year tasks are expected to reach costs of US\$2,200 per month</p> <p>In addition there is a 40,000FC structural inspection.</p>	<p>The airframe maintenance heavy check (C-check equivalent) remains at 7,500FH for all models.</p> <p>In addition there are calendar time checks at 6, 9 and 12 years. Assuming a utilisation of 2,500 hours per year the 6 year check would precisely align with the second C-check.</p> <p>The base check cost is estimated to cost in the region of US\$40 per FH for the E170/175 and US\$44 per FH for the E190/195. This may vary according to findings.</p> <p>All of the calendar time based checks and costs apply equally to all E-jet models. The calendar based checks at the second base check are expected to add an additional US\$1,200 per month. The subsequent 9 and 12 year checks cost in the region of US\$1,200 and US\$1,700 per month respectively.</p> <p>In addition there are 20,000FC and 40,000FC structural checks.</p>
Landing Gear	
<p>Overhaul limits are 20,000FC or 12 years, whichever occurs first. The expected overhaul cost is in the region of US\$28 per FC.</p>	<p>Overhaul limits are 30,000FC or 12 years whichever occurs first for the E170/175 and 25,000FC for the ER190/195. The expected overhaul cost is in the region of US\$14 per FC for the E170/175 and US\$18 per FC for the E190/195.</p>
Engine Performance Restoration (EPR)	
<p>As a mature engine platform, all models of CF34 engines are on-condition, but typically require their first EPR at around 15,000FC and at roughly 12,500FC intervals thereafter in a relatively benign environment, earlier in a hostile climate. This applies equally to all CRJ and E-jet models.</p>	
<p>While engines are maintained on-condition, the LLPs have a life of 25,000FC at which time a shop visit for their replacement is needed. An EPR would also be performed at this point.</p> <p>This first run EPR event cost is in the region of US\$133 per FC (at 2021\$). Each subsequent shop visit (SV) would be expected to considerably exceed the cost of the first SV at about US\$210 per FC.</p>	<p>While engines across all E-jet models are maintained on-condition, the LLPs have a life of 25,000FC at which time a shop visit for their replacement is needed. An EPR would also be performed at this point.</p> <p>The first run EPR for the E170/175 has an event cost in the region of US\$133 per FC (at 2021\$) and US\$220 per FC for the larger -10E on the E190/195. The subsequent SV costs for the E170/175 increase to US\$210 but remain similar for the E190/195 due to the application of discounts under GE's Set Maintenance Offer (SMO) kit contributing to the EPR reduction.</p>



Engine Life Limited Parts (LLPs)

All CF34 variants have LLP lives of 25,000FC except 2 of 23 on the -8 with a slightly lower 24,100FC limiter, (which effectively becomes the limiter creating some wasted stub life on the rest). Each engine also has a static LLP which has a longer life of 41,000FC for the -8C/E and 44,600FC for the -10E. These are also the most expensive individual LLPs.

For the CRJs and E-170/175 the -8 engines have high LLP replacement costs exceeding US\$127 per FC million excluding static LLPs. In the case of the larger -10E LLP costs are a bit lower at some US\$110 per FC, and can be reduced further to around US\$70 per FC with the application of the SMO kit discount.

APU

The APU interval on the CRJ has been escalated from 8,000 to 10,000 APU hours (AH) since 2019. The expected overhaul cost is in the region of US\$25 per APU hour.

The APU is the same across all E-jet models and is expected to require a performance restoration at about 9,500 APU hours (AH). The expected overhaul cost is in the region of US\$32 per APU hour.

Source: TrueNoord Intelligence

Comments on Maintenance

The above maintenance costs and intervals are based on fixed intervals except for engines and APU, which are maintained on-condition. The actual maintenance costs will vary considerably according to how the aircraft are operated and the environments in which they fly.

With regard to engines in particular, there is considerable disparity between benign and inhospitable climates. Hot and high operating conditions will cause more stress on engines and reduce the intervals between EPRs. Similarly, high humidity; sandy/dusty airports, or areas with high pollution levels also negatively impact engine performance. The cost estimates above assume a relatively benign European operating environment.

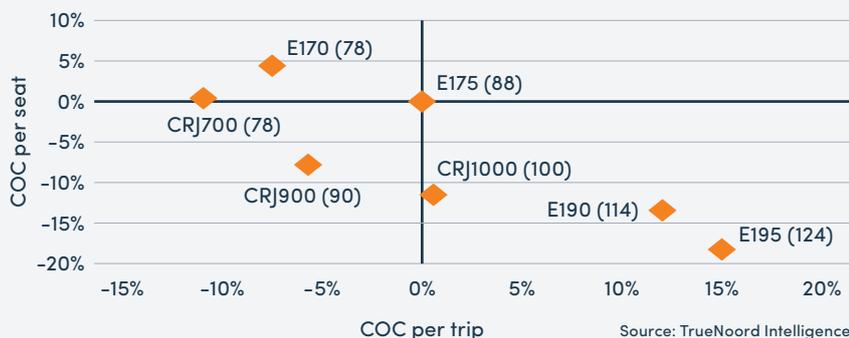
The estimated costs in Figure 8 above are based upon prices applicable for events in 2021.

2.7 Discussion of Economic Comparison Points

Figure 9 below compares the principal cash operating costs (COCs) per month (assuming around 200 trip sectors/mth) of the highlighted regional jets with each other. This suggests that in general, the COCs of the CRJs are slightly below those of the E-jets, which given their lower operating weights is unsurprising. However, in practice, the larger E-jet cabin means that it is increasingly preferred by operators in the 70-90 seat category. In the larger category, the E-jets have greater trip costs but lower seat costs. The costs assume a European environment with associated weight related charges in relation to navigation. For comparison consistency with previous reports, the fuel cost assumption remains as before despite recent cost increases. Given the scope of the comparison between the different regional jets only, any fuel price changes affects all types similarly.

The analysis of differences in the operating costs that do not relate to specific aircraft types (cockpit crew scheduling and costs, airport handling charges, line maintenance) have been cursory in this report.

Figure 9: Relative Cash Operating Costs in US\$/mth (500nm at US\$0.79/kg fuel)



Previous type reports included a comparison of Direct Operating Costs (DOCs), which included the monthly cost of each of the relevant aircraft. These showed a mix of new generation and current generation widely in-service types so that the greater capital cost of new types often cancelled out, or in some cases, made the DOCs of new aircraft greater than used examples.

The aircraft under review all adopt used aircraft value assumptions. Although the values and monthly lease costs of each type do vary, the differences have converged as a consequence of the pandemic to a level that means there are only minor changes in the position of each aircraft compared to the COC review. Consequently, the relative DOCs are not shown.

2.8 Emissions

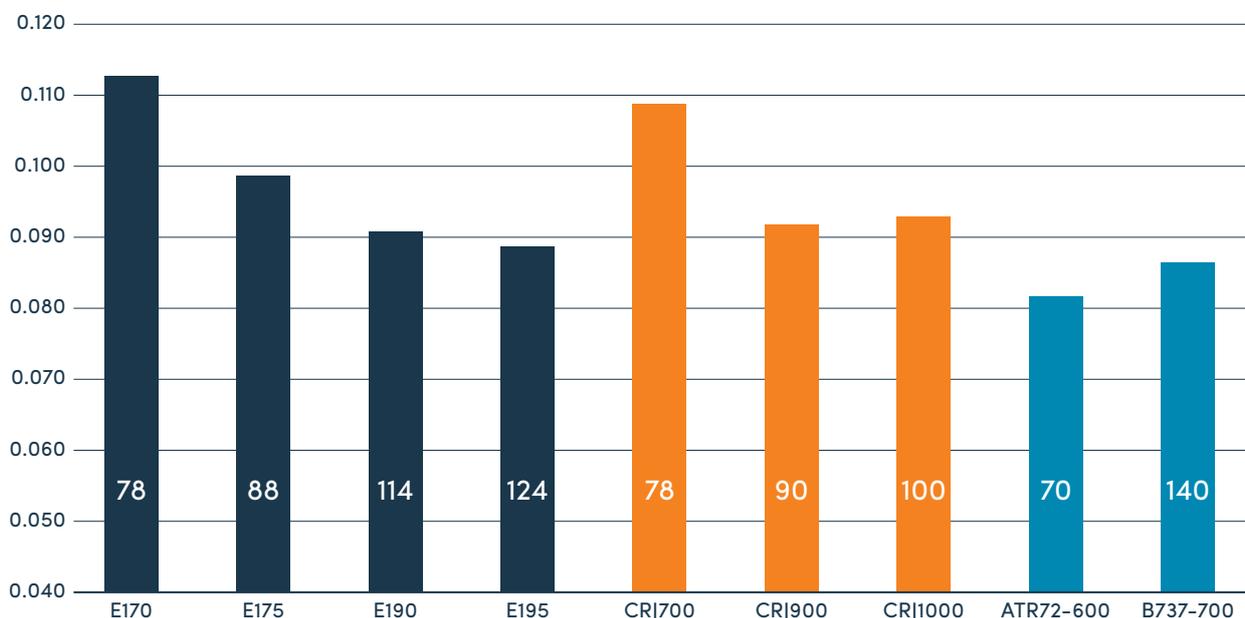
Prior to the onset of the current pandemic, aircraft emissions had already become a major industry concern and this is expected to return to the forefront in future. As the principal concern relates to CO2 emissions, Figure 10 below shows carbon emissions for the subject aircraft on a per seat per km basis over a 500nm sector. For each aircraft the number of seats from which the per seat calculation is derived is also shown. Carbon emissions are a function of fuel burn. For each kg of fuel consumed, a generally accepted multiplier of 3.16kg of CO2 per kg of fuel is applied (Source: ICAO).

Unsurprisingly, the largest capacity aircraft (E195 & CRJ1000) have the lowest emissions per seat. In order to show how the regional jets compare to other classes of aircraft, the equivalent emissions for the larger 737-700 with 140 seats and the ATR72-600 with 70 seats are also shown in Figure 10. Given that the largest of the regional jets have 22-40 less seats than the 737, both are relatively strong performers. By contrast, the smaller ATR72-600 turboprop remains the lowest emission aircraft of any under consideration. The fuel burn, and therefore emissions for turboprops have always been substantially better than the equivalent regional jets over short to medium sectors. Indeed, the difference between the ATR72 and the CRJ700 would be even greater over a 300nm journey.

However, the 500nm sector shown in Figure 10 is relatively long for an ATR72 as the journey time is close to 30 minutes greater than for any of the jets generating a flight time of around 2 hours. For such journeys and longer sectors up to the maximum range of the ATR (approx. 700nm), the turboprop increasingly suffers from poor passenger perception especially if a competing jet alternative operates the same route. Thus for longer thin routes that are more common in markets such as North America, the jets are almost always preferred. Furthermore, as the sector length increases, the fuel burn and thus the emissions gap between the jets and turboprops rapidly erodes because of the greater flight time difference.

For short sectors of 200-300nm where the flight is much shorter the difference between the jets and turboprops on average 1 hour sectors reduces to a more acceptable 10 minutes.

Figure 10: Regional Jet CO2 Emissions in kg per Seat per km (500nm Sector)



Source: TrueNorth Intelligence & IBA



3 Market Review

While the following market review maintains the same structure as previous aircraft type reports, this version has been prepared in the context of the COVID-19 pandemic and the current geopolitical situation. This necessitates a different emphasis within certain sub-sections and also addresses the fact that it is not necessarily possible to draw similar conclusions from the empirical data shown. It also includes a new introductory section 3.1 to explain the role of regional jets within global air transport as these jets rarely operate independent networks that are not integrated with larger carriers.

3.1 Deployment of Regional Jets

In order to understand the position and demand for regional jets in the short-haul air transport ecosystem the role of this gauge of aircraft can be summarised as follows:

- Providing air service between cities where passenger demand is insufficient for larger aircraft. In the US such services are almost exclusively provided by regional jets, elsewhere these can be served by either jets or turboprops.
- Serving locations with airports that have short runways or obstacles where larger aircraft cannot operate, for example, London City. (Currently, the largest LCY capable jet is an A220-100, but the larger E195-E2 will be certified later this year.)
- Connecting markets where frequency is important, but where larger aircraft could only provide limited regular flights.
- Providing lower levels of off-peak capacity between cities such as middle-of-the-day services or low season connectivity. This is common practice in North America.
- Enabling airlines to offer flexible capacity levels on short to medium haul routes according to passenger demand by interchanging regional jets and narrowbodies. (A good example is KLM's service from Amsterdam to Dublin, which is provided by a range of aircraft from B737-800s to E190s.)
- Facilitating new route development. A lower capacity regional jet offers major airlines a lower risk way of proving a new route until it becomes more established and merits the deployment of larger capacity aircraft.

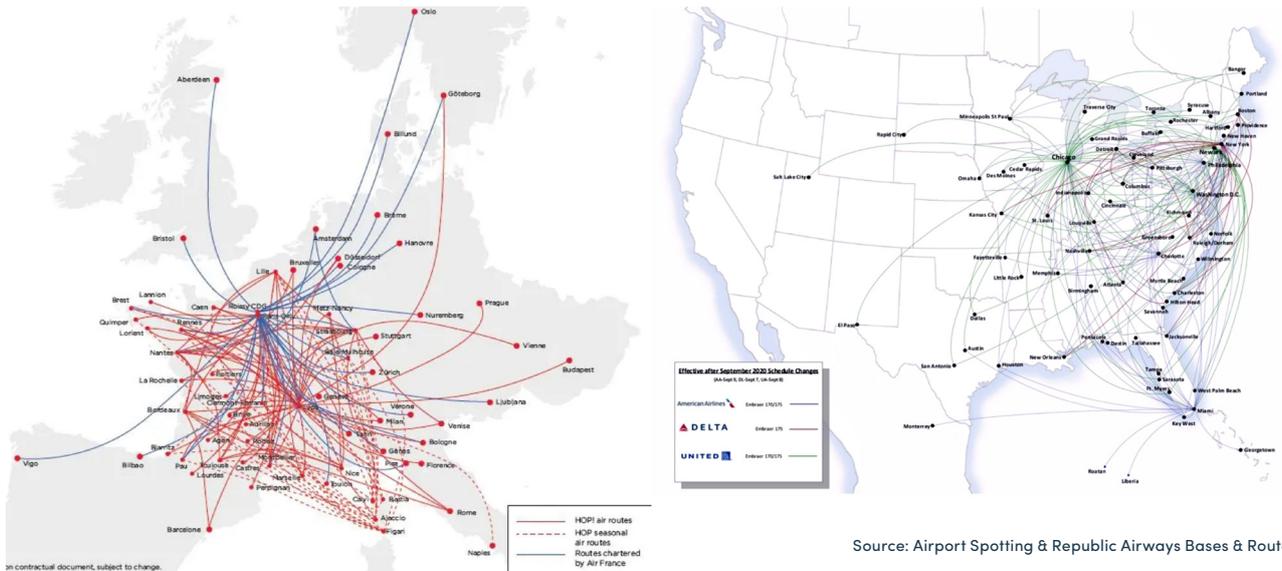
Increasingly, regional jet operations have over the last two decades become integrated into the networks of major airline networks. As such their role is greater than serving the specific point-to-point operations described above. European and North American major carriers in particular, have developed hub and spoke systems that materially rely on their short-haul services to feed long-haul services. (Middle East and Asian airlines hub and spoke business models rely more on long-haul to long-haul feed.) Regional Jets provide an increasingly important proportion of passenger feed to such carriers' long-haul networks.

There can also be defensive reasons for deploying regional jets in times of constrained demand. If an airline needs to protect its slots at congested airports, regional jets can enable them to use the slots while reducing capacity. This was a common tactic in the 2008 financial crisis in the US, which included their deployment on popular shuttle routes between Boston and New York.

The points above can be illustrated by the typical route network examples for two major European and North American regional operators shown in Figure 11. Air France HOP, and Republic Airways for several US majors. Both show the domination of connectivity from secondary cities. In the case of Air France, some of the network is between secondary cities, which also includes some feed to Lyons and to its main Paris hub. (Air France has announced it will increasingly focus this network on hub connectivity.) In the case of Republic, a greater proportion connects secondary cities to major hubs including Chicago, New York and Miami.



Figure 11: Regional Jet Networks of Air France HOP! & Republic Airways for US Majors



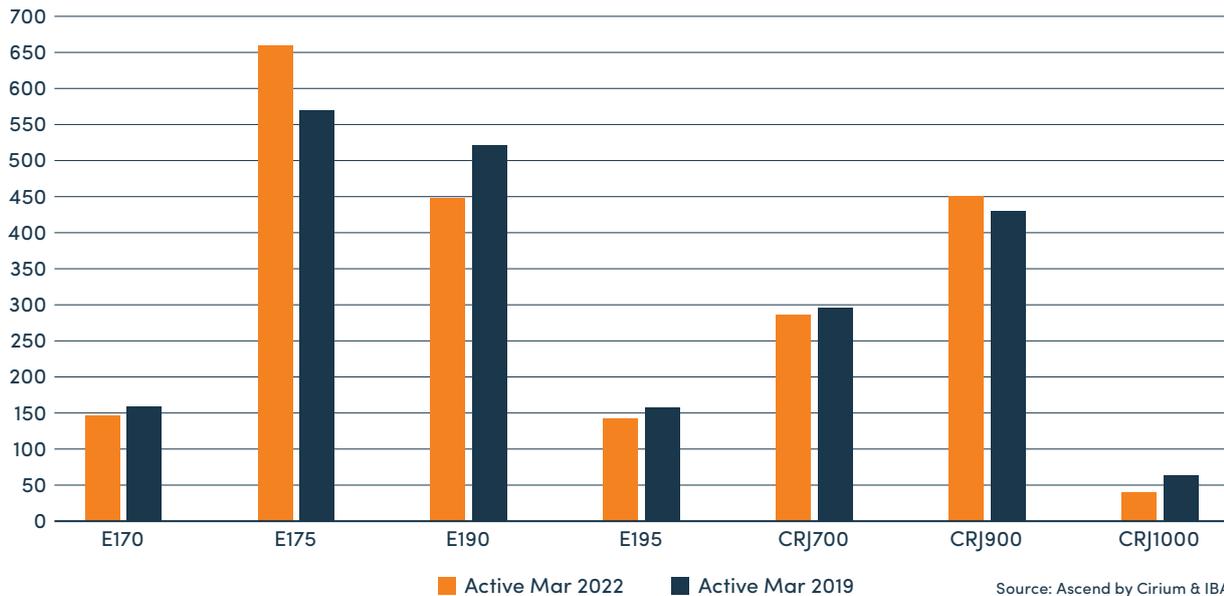
Source: Airport Spotting & Republic Airways Bases & Routes

3.2 Numbers in Service Update

The total number of active regional jets under examination now exceeds 2,000 aircraft of all models, of which the E175 at 660 is the most common variant followed by the E190 and CRJ900 at 450 of each. The actual number of each type of aircraft in service, shown in Figure 12, varies slightly according to the source data. The differences amount to between 10 and 50 aircraft of each type, which historically reflected the fact that no database is 100% accurate. However, in the current climate which remains impacted by the effects of COVID-19, the differences are greater than before and relate primarily to how many aircraft of the total fleet of each aircraft type are classified as stored or parked.

None of the data sources used by TrueNoord including: Ascend by Cirium; IBA or CH-Aviation, are completely consistent in their assessment of grounded aircraft numbers as their respective definitions of stored or parked units are not identical. Furthermore, a number of aircraft are classed as stored when they are only temporarily out of service due to COVID-19. This effect has rapidly reduced since the summer of 2021, but some do continue to be temporarily stored. This category is expected to erode to smaller numbers by summer 2022. Accordingly, TrueNoord Insight has adjusted the stored aircraft category to remove those that are obviously temporarily stored, and added these to active units to more accurately reflect aircraft that are parked for the reasons that have historically prevailed. However, this adjustment will not have been completely accurate either, and some will have remained classified as stored but only temporarily. It is therefore not correct to infer that stored aircraft is a proxy for available aircraft.

Figure 12 on the next page shows the adjusted active fleets of each of the subject regional jets compared to the situation in early 2019.

Figure 12: Active Regional Jets in Mar 2022 and Mar 2019


Although passenger traffic remains depressed due to COVID-19, compared to any previous economic downturn most of the subject aircraft have now returned to service compared to early 2019. Airlines, primarily in the US have continued to take deliveries of E175s, the only current generation type that remains in production. The active fleets of most other types remain only marginally down on 2019 with the exception of the E190 and the CRJ900. The reasons why there are comparatively more inactive E190s are discussed in section 5.2. Remarkably, there are more active CRJ900s today than in 2019 despite the termination of production.

From a leasing perspective, the number of E175s, E190s and CRJ900s in service represents a significant critical mass of aircraft sufficient to render both variants attractive leasing candidates. This is more restricted for the other types, which as a consequence might be considered less attractive. However, as will be addressed in section 7, the capacity and current values of the E195 also render the type an attractive leasing proposition.

3.3 Delivery Profile

The delivery profile of regional jets is an important consideration for lessors as it enables the age of their aircraft to be compared with the total population of aircraft manufactured. To date, more recent vintages have been considered to be more attractive to the used market, so a relatively young fleet should facilitate easier future placement opportunities.

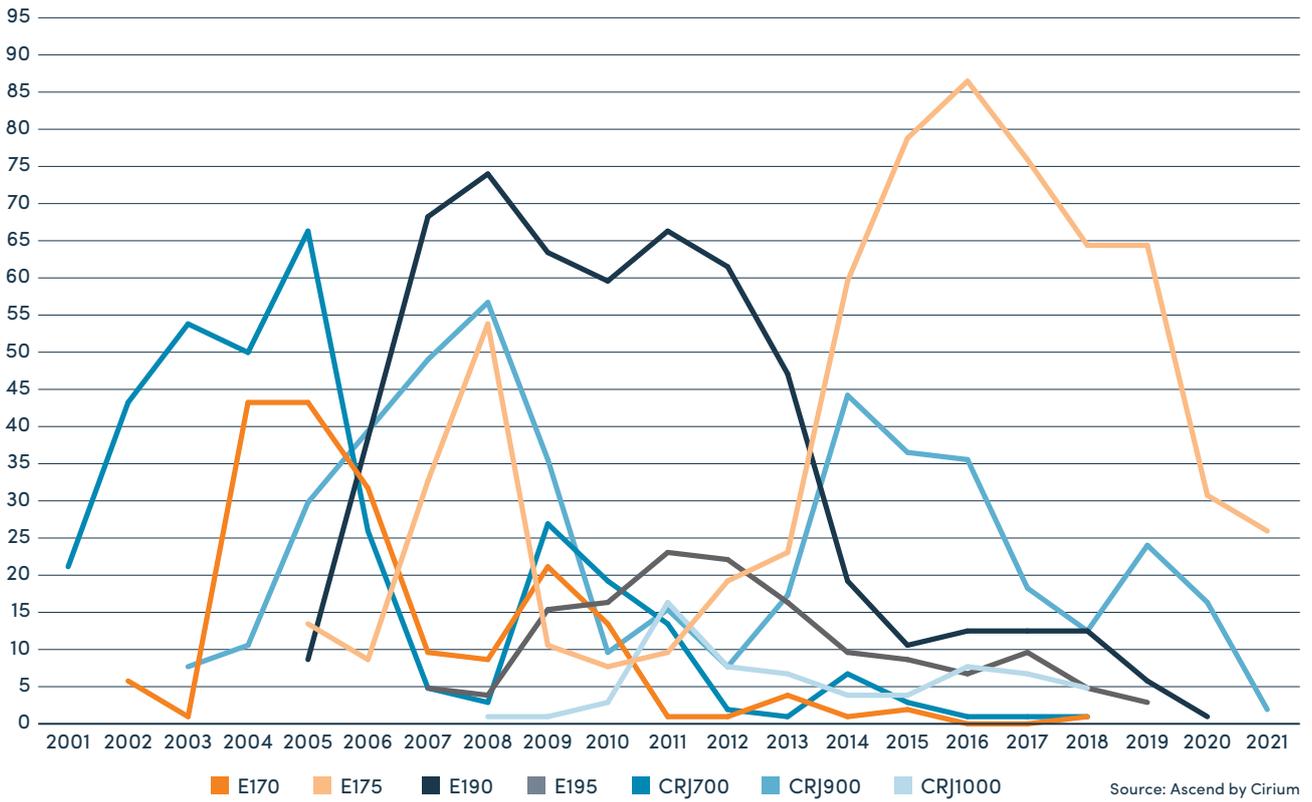
However, this is not universally true, particularly in times of depressed demand. In periods such as the pandemic, lease rates for available aircraft have tended to fall to levels where the premium for more recent vintages has eroded. The older mid-life 10–15 year old vintages also have cost advantages. Their longer depreciation time and lower associated book values can make them more attractive to a price conscious secondary market, provided that their maintenance condition, particularly in relation to engines, enables them to be operated without major overhauls for a period of at least two years.

As shown in Figure 13, the smaller E170 and CRJ700 delivery profile peaked in the early production years and then trended downwards rapidly thereafter. Some of the capacity demand for its size category was then replaced by the slightly larger E175 and CRJ900, which had its first peak in 2008. Both the CRJ900 and E175 had a more recent recovery from 2013 and reached a new peak in 2014 and 2016 respectively. This satisfied demand from the US market for scope clause compliant aircraft to replace many of the incumbent 50 seaters.

The larger E190 and E195 had a steadier demand and delivery profile with some 75–95 annual deliveries between 2007 and 2012. This dipped to 30 units in 2014, and has slowly trended down from there. Both are now out of production and have been superseded by the E2 generation. By contrast the CRJ1000 has had a short production run and never achieved significant market acceptance with a one-off peak of just 17 aircraft in 2011.

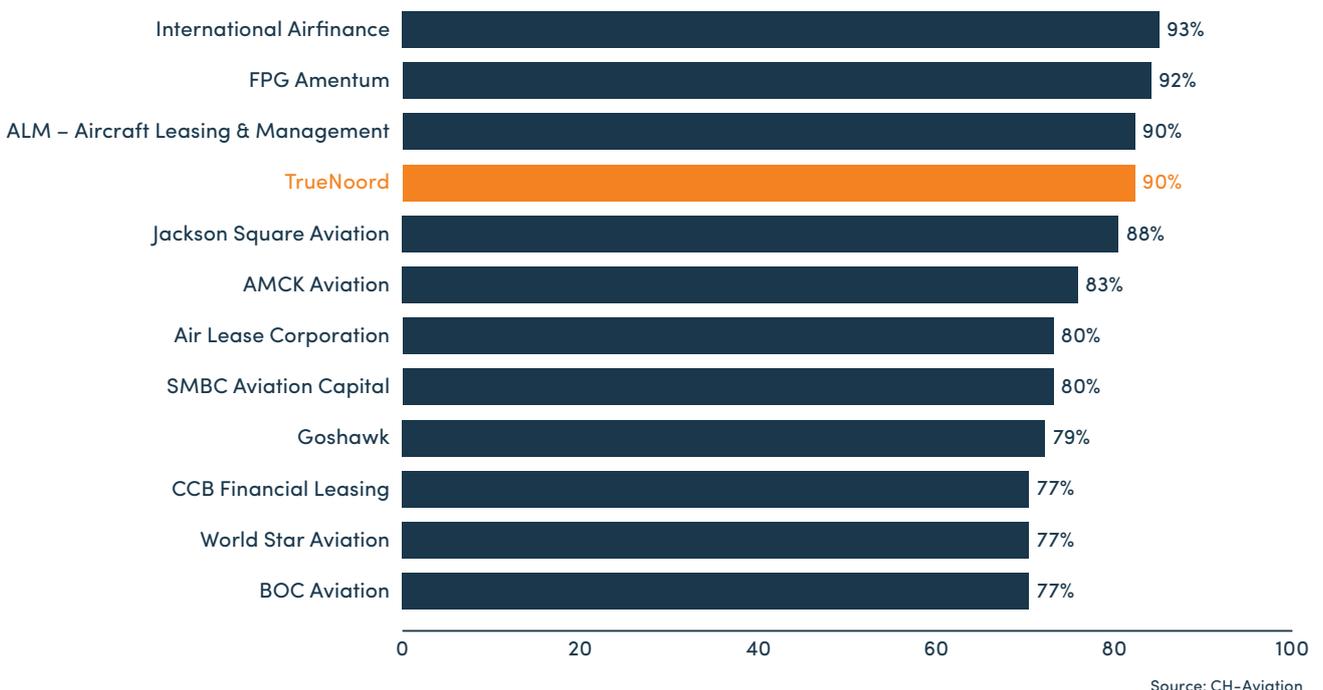


Figure 13: Regional Jet delivery profile



TrueNoord’s view of the mid-life vintage regional jet aircraft is that their remarketing prospects will largely depend on their condition, particularly in relation to engine LLP and overhaul status. If such engines have enough green time remaining, then the redeployment prospects remain good. By way of evidence as at April 2022, TrueNoord has either placed all of its scheduled and unscheduled early lease returns or secured commitments to do so. This places TrueNoord near the top of lessor league tables for active aircraft as published on a monthly basis by CH-Aviation (Figure 14).

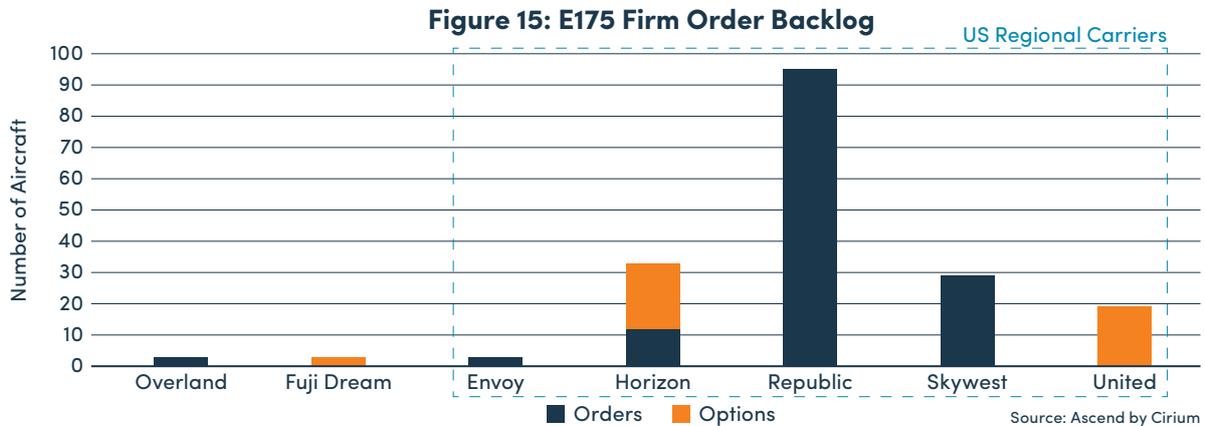
Figure 14: Top 12 Lessors with the Most Active Aircraft, April 2022





3.4 Firm Order Backlog

Production of all the subject aircraft except the E175 has ceased so that the order backlog applies to this type only. The official E175-E1 generation orderbook backlog stands at 142 aircraft with an additional 43 aircraft on option. This relatively robust order book primarily reflects ongoing demand from US regional carriers and is shown in Figure 15.



Production of new CRJs has ceased with the last CRJ900s delivered to PSA in 2020 and the last CRJ700s in 2018 and CRJ1000s to Air Nostrum also in 2018. MHRI has no plans to recommence production and will only support the existing fleet.

At Embraer, the larger E190 and E195 models have been replaced by their E2 equivalents. Production of both models is increasing, albeit slowly, reflecting the impact of slow orders against the COVID-19 backdrop and the greater success, so far, of the competing A220 product line in recent sales campaigns. So far, 48 aircraft of both types are in service since initial deliveries began in 2018, and 175 units are on firm order.

The continued relatively strong interest in the existing E175 product reflects:

- The monopoly position that the aircraft now occupies since the cessation of CRJ production; and
- The continued constraints imposed by North American scope clause agreements. These limit both the capacity of regional jets that can be deployed to 76 seats and the maximum takeoff weight of the aircraft permitted. Embraer had hoped to introduce the E175-E2 to this market, but its geared turbofan engine renders the aircraft too heavy to meet scope clause requirements.

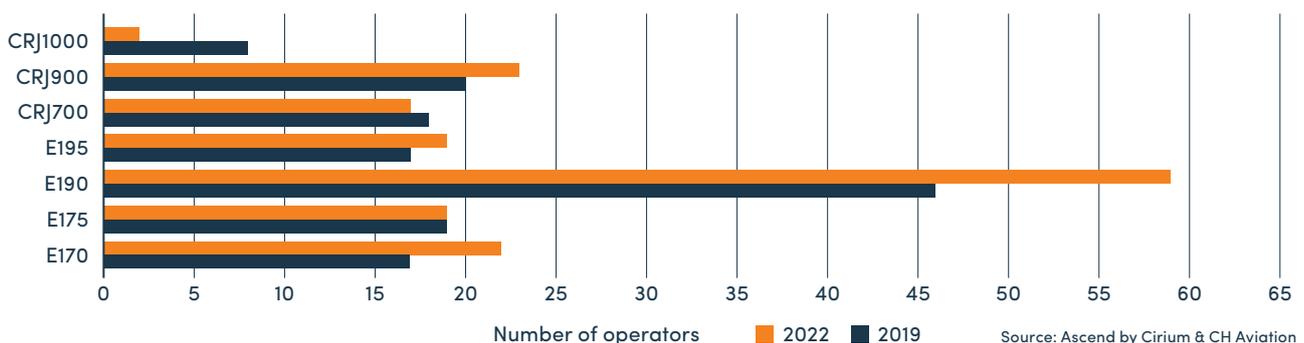
However, growth in the US regional market may be limited by the availability of suitably qualified (ATPL rated) flight crew. As the regional market serves as an entry level for a large proportion of flight crews, this is affecting the regionals through increased levels of churn.

3.5 Number of Regional Jet Operators

The absolute number of operators of any particular aircraft type is a vital determinant of its suitability as a leasing product because it is a prime driver of liquidity by showing the number of operators that could absorb additional incremental aircraft to their existing fleets.

As shown in Figure 16, the number of regional jet operators has either remained stable or grown since the previous E-jet and CRJ reports in 2019, with the E190 leading at 59. The exception is the CRJ1000 which is now only in service with Air Nostrum. Air France's regional operator HOP! has sold its fleet and is removing the type from service and Garuda is also returning its fleet.

Figure 16: Number of Regional Jet Operators in Mar 2019 and Mar 2022



New regional jet operators are listed in Figure 17 below. Given the number of airlines seeking to dispose of substantial numbers of E190s which predate the pandemic, including Air Canada; COPA and JetBlue, this has been the most active market. This has seen a substantial number of transitions and Australia has witnessed the largest absorption of aircraft at Alliance in particular.

Figure 17: New Regional Jet Operators in the period 2019 to March 2022

E170	Air Botswana and Jasmin Air in Africa; and two US private jet operators
E175	Mauritanian Airlines and Air Burkina, Africa; and Marathon Airlines, Greece
E190	Alliance Air, Australia; Amas, Bolivia; Bamboo, Vietnam; Cobham, Australia; Eastern Airways, UK; German Airways, Germany; Hunnu, Mongolia; Myanmar International, Myanmar; Pionair, Australia and seven private jet operators
E195	Breeze, USA; SAS Link; Denmark; Ukraine International, Ukraine
CRJ700	Shree Airlines, Nepal; and two private jet operators
CRJ900	Cemair, South Africa; Syphax, Tunis and two private jet operators

Source: Ascend by Cirium & CH Aviation

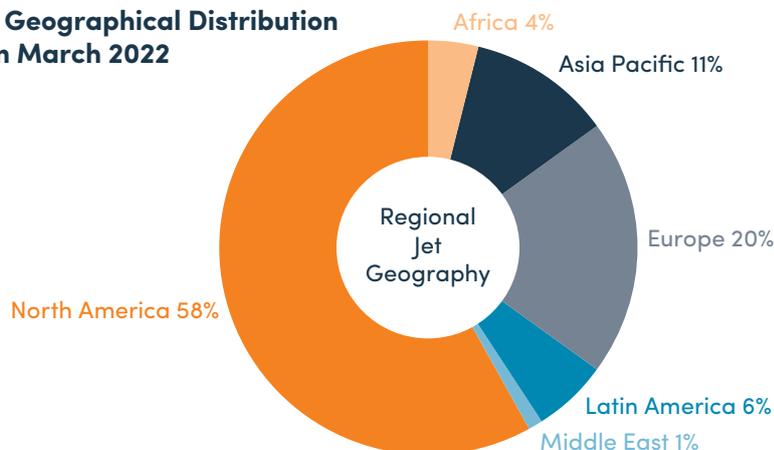
3.6 Geographical Dispersion

From a lessor perspective, a wide geographical distribution is desirable since this not only underscores the versatility of regional jets, but also assists market liquidity and placement opportunities in the secondary market. Furthermore, a wide geographic dispersion ensures access to local crew training facilities, maintenance facilities, spare part stocks and trained staff. Often, if a type falls out of favour in one region this can affect several operators in the same area, so that the ability to place used fleets in other regions is important.

Ever since regional jets were first produced, their main market has been North America and this remains the case in 2022 with 58% of the global fleet located in that region (Figure 18). In North America, where distances are long and smaller cities are often poorly connected to larger centres by alternative transport modes, there is a much larger number of smaller local airports compared to Europe or Asia. These enable the fastest connectivity to the main east and west coast urban centres, as well as more central hubs. This creates a level of demand for smaller capacity aircraft that either does not exist elsewhere, or is only slowly developing in emerging economies.

By contrast, regional airport infrastructure is far more constrained in Europe due to both national fragmentation, more developed rail networks, and the increasing focus on environmental concerns.

Figure 18: Global Geographical Distribution of Regional Jets in March 2022



Source: Ascend by Cirium & IBA

However, there are substantial differences in geographical concentration according to different aircraft types. As can be seen in Figure 19, the prevalence of CRJ700/900s and E175s is even more centred on North America than the overall average shown in Figure 18. Although the relatively small E170 fleet remains more evenly distributed around the world as incremental disposals occur, these aircraft are increasingly also being redeployed in North America.

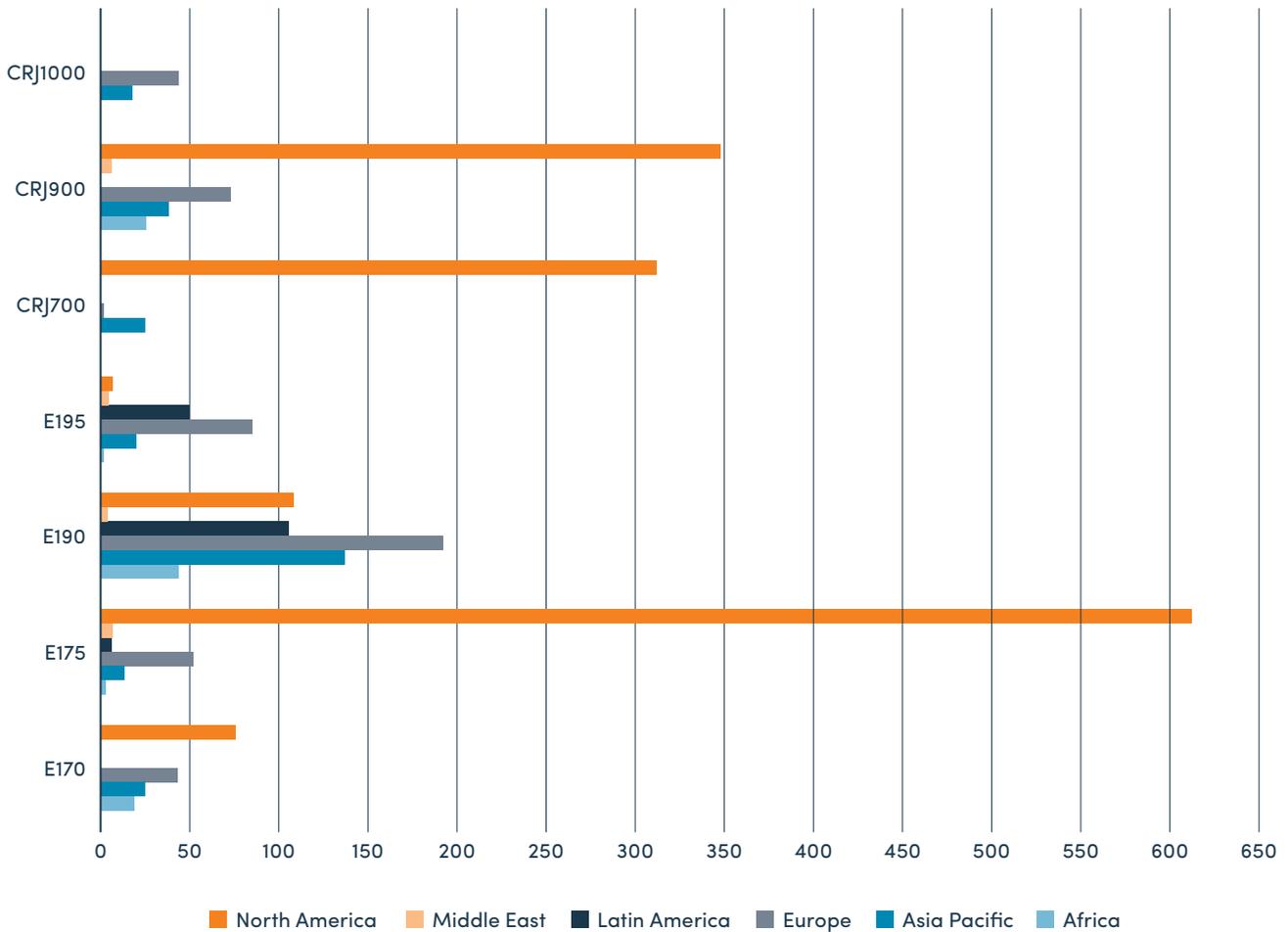


The primary driver for the prevalence of the smaller jets is not so much a demand for the capacity they offer, but the regulatory constraints of scope clauses which prohibit larger regional jet operations by the capacity providers to US major airlines. Despite years of hope that scope clauses might be relaxed, there has been almost no progress towards this end over the last decade and no changes are expected in the foreseeable future.

For the larger regional jets, the global population is much more evenly distributed. For the E190 and E195 Europe leads the way with Latin America, Asia and North America lagging behind. Since 2019 the European fleet of E190s has continued to grow to 190 units compared to 160 in 2019, and the smaller E195 fleet has grown from 60 to 85 examples. This growth was mainly fuelled by used aircraft previously in both North and Latin America (e.g. Air Canada and Copa). The E195 fleet in Europe has also increased with some capacity absorbed from Latin America. Africa has also seen E190 growth and Asia Pacific has seen expansion in Australia, Vietnam and Myanmar partially counterbalanced by reduction in China. There has also been modest development in Africa.

However, geographical dispersion remains handicapped by the costs associated with a change in regulatory jurisdiction and seating arrangements. Cabin rearrangements are still expensive on E-jets and are generally avoided by lessors. As aircraft age and their values depreciate, the costs of such modifications will become an even greater proportion of any transition.

Figure 19: Geographical Dispersion of Regional Jet Fleet by Number of Aircraft in Feb 2022



Source: Ascend by Cirium & IBA

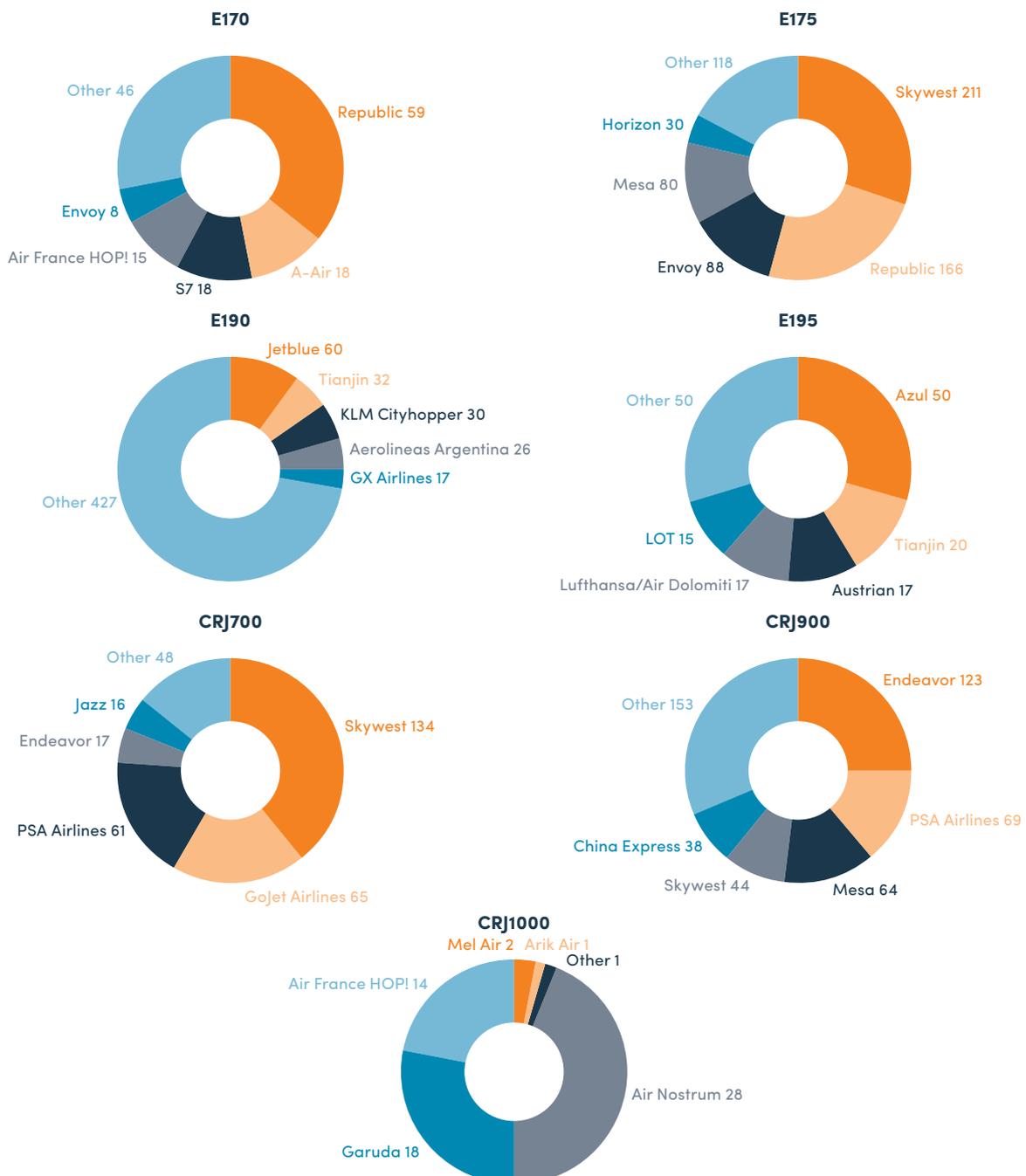
3.7 Concentration

If a large portion of any fleet is concentrated in the hands of a small number of operators, this does not assist market liquidity.

The E190 sub-fleet is the least concentrated of any regional jet, with 165 or 28% (see Figure 20) of the fleet in operation with its five largest operators. JetBlue remains the largest operator, although this will reduce over time as the airline continues to induct new A220s into its fleet as part of its order for 130 aircraft of the type and dispose of its E190s. By contrast, the small CRJ1000 fleet is the most concentrated regional jet with the entire fleet concentrated with its largest operators. Of these Garuda has grounded its aircraft and is to return its fleet, and Air France HOP is removing the type from its fleet following their sale to Jetcraft.

All other regional aircraft types are also relatively concentrated due to the dominance of US regional carriers in the space. The exception to some extent is the E170, but the expectation is that many of these aircraft will also be absorbed by US carriers as second or subsequent operators.

Figure 20: Largest Operators of Regional Jets





3.8 Operator Quality

There are too many airline operators to comment meaningfully on the credit quality of individual operators of regional aircraft. However, some trends provide indicators of future risk levels:

- North American carriers that fly the majority of regional jets all operate on behalf of major airlines under capacity purchase agreements. In many cases the major partner airlines own the aircraft, which are dry leased to the capacity providers who in turn wet-lease them back to the majors. This means the counterparty risk lies primarily with the fortunes of the major airlines.
- In Europe, the second largest regional jet market, the aircraft remain primarily operated as network feeders by the subsidiaries of flag carriers. Their fortunes therefore primarily rely on the associated flag carriers. However, note that although these subsidiaries are wholly owned, the parent owners do not always guarantee their subsidiary's obligations so that, strictly speaking, the counterparty risk can be that of the regional aircraft entity.
- With few exceptions such as Azul, JetBlue and Breeze, regional jets are not operated by LCC airlines.
- As the fleet of any aircraft type ages, aircraft tend to transition away from tier 1 carriers, to smaller second and third tier airlines, and sometimes in higher risk jurisdictions. Significant numbers of aircraft have transitioned to such carriers in parts of Asia, Africa and Latin America. However, this is not always the case. Plenty of used aircraft have transitioned to tier 1 carriers including British Airways Cityflyer and Alliance in Australia, who operate for Qantas. Similarly, smaller European flag carriers including TAP and Austrian have, and are looking to expand with, used regional jets.
- As fleets of any aircraft type age, some used aircraft are often placed with lower utilisation special mission specialist carriers (e.g. Fly-in fly-out operators like Cobham) or ACMI carriers such as German Airways. This represents a different kind of counterparty risk that relies on the quality and duration of their contracts to supply capacity. The COVID-19 pandemic has proved that the nature of such contracts is not always as robust as previously anticipated.
- Often used aircraft find applications when converted to cargo. In the regional jet space this potential is more limited because apart from the recently launched E190/195 passenger to freight conversion programme, there are no such conversions for other regional jets. (In the case of the CRJ, there is a passenger to freight conversion for the smaller CRJ100/200 only.) Furthermore, the demand for capacity that can be satisfied by regional jets remains unproven.

4 Regional Jets Owned by Lessors

4.1 Proportion of Leased Regional Jets

The number of aircraft as a proportion of the total fleet is a strong indicator of the maturity of any type among the leasing community. Normally, a strong level of lessor penetration suggests that an aircraft is perceived as a strong asset class with good liquidity characteristics and high value retention. For example, it is widely known that close to 50% of the ubiquitous fleet of A320 and 737-800 aircraft are owned by lessors.

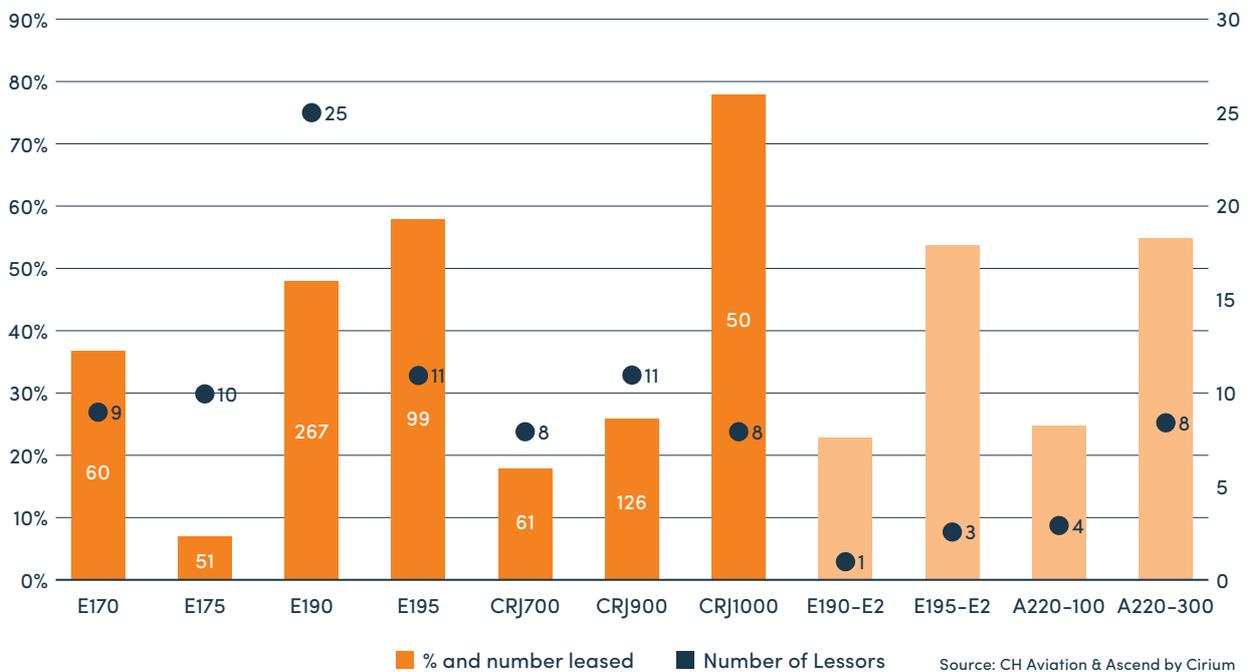
However, this approach can yield outliers that do not conform. Despite the very limited fleet of 64 CRJ1000s, 78% are owned by lessors, as shown in Figure 21. This is likely to reflect the fact that when the programme garnered little interest after its launch, Bombardier supported the placement of aircraft with a combination of residual value guarantees, attractive pricing and Export Development Canada (EDC) financing. These transactions were later sold to third party lessors.

Conversely, it might have been expected that the relatively large fleet of E175s would have garnered greater attention from the leasing community. The 7% owned by lessors looks like an outlier at the other extreme. This is mainly caused by the concentration of the type with sizeable North American feeder airlines that have greater access to other domestically available sources of finance than their counterparts in other parts of the world.

Lessor penetration of the E-jet fleet is at 31% and 26% for the CRJ fleet. Both are lower than for the above referenced narrowbodies and also lower than the proportion of larger new generation Airbus and Embraer crossover jets shown. This would suggest that the regional jet market is less mature (see above effect of US concentration). This could mean that the aircraft are viewed less favourably by the leasing community than narrowbody types, or that there is still growth potential and the competitive landscape is less crowded. It could also reflect the distinct scale and market dynamics of the regional sector that needs a different skill set to manage compared to larger aircraft. Certainly there are far fewer lessors active in the regional aircraft sector.

Not only is the narrowbody leasing space very active and highly competitive, but also the role played by lessor forward order books is also much greater in that segment. Over the last decade, the demand for narrowbody aircraft has exceeded the ability of Boeing and Airbus to supply aircraft. So lessors have placed many speculative orders in the knowledge that they will be able to place them with airlines before they could procure aircraft directly from either OEM. This imbalance of demand and supply has, to date, not occurred in the smaller regional jet space. This makes it easier for regional carriers to access new aircraft directly from the manufacturers, which means that the business case for placing forward orders in the regional sector is less attractive.

Figure 21: Regional Jet Operating Lease Penetration Comparison by Aircraft Type (% and number leased)



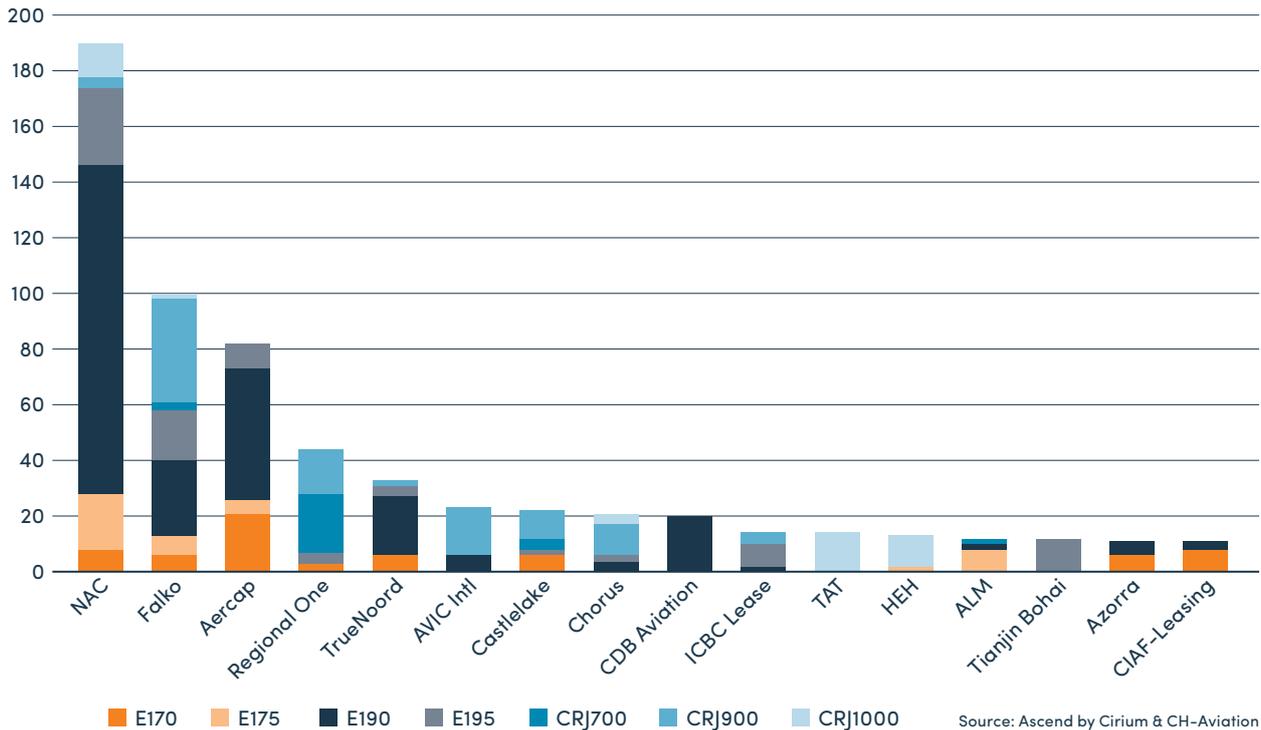
4.2 Regional Jet Lessors Who's Who

Figure 22 shows a fleet breakdown of the top 16 lessors in the regional space with a portfolio exceeding ten regional jets in March 2022. There are a further 19 lessors with less than ten regional jets. Of those with more than ten aircraft, exactly half are exclusively active in the regional aircraft segment. The largest non-regional specialists are Aeracop and Castlelake. Aeracop is relatively new to this regional jet segment through its recent acquisition of GECAS, although it previously already had a significant commitment to the crossover jet market. Castlelake has reduced the scale of its regional jet portfolio in recent years in favour of larger aircraft.

Amongst the purely regional aircraft lessors, NAC remains the largest with 190 aircraft in March 2022. However, the scale of the main regional players, which had been growing on a relatively stable basis prior to the COVID-19 pandemic, is starting to change significantly. NAC's extensively documented bankruptcy process will not only lead to a contraction of its portfolio, but its new management team is also committed to establishing a presence in the larger narrowbody market. Its regional portfolio contraction will continue to create opportunities for others to acquire discreet portfolios of NAC owned aircraft to accelerate their growth.

Furthermore, a previously predicted consolidation process amongst regional lessors has begun. The combination of Falko and Chorus (shown separately in Figure 23) will create a portfolio of regional jets in excess of 120 units. It will also create a lessor with the world's largest exposure to CRJs with over 70 aircraft. By comparison, both NAC and TrueNoord are more focused on their E-jet portfolios.

Figure 22: Regional Jet Lessor Who's Who in March 2022 (>10 aircraft)



Source: Ascend by Cirium & CH-Aviation

4.3 Regional Jet Leased Fleet Analysis

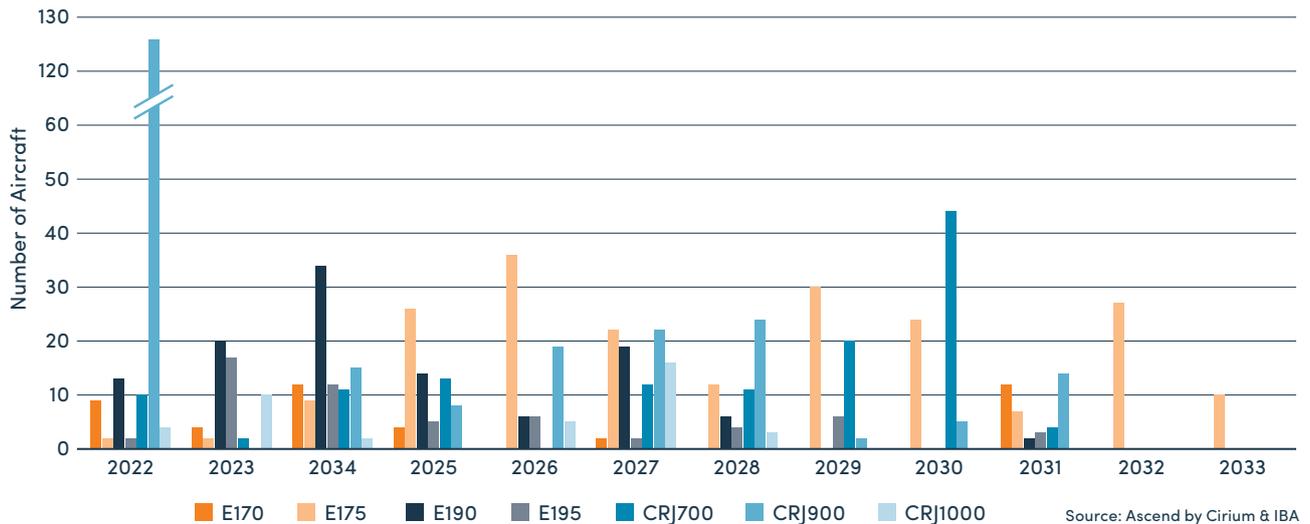
A significant driver of the ability to place an aircraft is the competitive position at that time. If there is a large number of any type that are scheduled to be returned in any year, it is likely to increase the competitive pressure on lease terms that can be achieved in the market at that time.

Based on the available lease return data, Figure 23 shows the known lease return dates from the second quarter of 2022 onwards, although some of these leases are likely to be extended. Given that there is incomplete data, the number of returns in each year shown should be viewed as a minimum.

Note: While there is no accurate profile of lease return data for all leased regional jets, Ascend by Cirium and InsightIQ by IBA provide partial data from those who have agreed to provide lease end data. Across both data sources lease return data for 850 regional jets is available. This includes data for some of the owned aircraft on finance lease structures.



Figure 23: Regional Jet Known Lease Returns (March 2022)



Overall the number of lease returns is relatively well dispersed over the coming decade, although there are some peak years for certain types.

CRJ Lease Returns

Although there appears to be 125 CRJ900 returns over the remainder of 2022, the vast majority of these are at Endeavor and some at Skywest. Many of these are leases with Delta Airlines (as owner) and will almost certainly be extended, so this outlier in the data should not be interpreted as showing an imminent flood of CRJ900 inventory becoming available. Furthermore, many of the CRJ900 leases scheduled to expire over the coming decade are still relatively young, so are likely to be required beyond these dates.

By contrast the incumbent CRJ700 fleet is older with a current average age already exceeding 15 years. This fleet is more likely to be retired and parted out later in the decade. The CRJ1000 is a niche aircraft with few remaining airline operators. The fleet at Garuda is to be retired, but some, notably Jetcraft which has purchased the Air France fleet, see a future for the type in special mission or corporate applications.

E-jet Lease Returns

As the majority of the E170/175 fleet is based in North America, its future as scope clause compliant aircraft remains relatively secure. A substantial portion of the smaller E170 fleet remains outside the US, but many are expected to migrate there over the coming years and some, such as the BA Cityflyer aircraft, already have. Other remaining European aircraft may follow suit as their current leases expire.

For the E175 fleet there are substantial numbers of lease returns shown in 2025–2027, but these are mainly owned by the US majors who lease them to their capacity purchase providers. As these fleets will still be relatively young, it is unlikely that these will be returned in practice, but some could be terminated and leased to alternative US operators to operate on their owners' behalf instead.

The E190 and E195 lease return profiles are a more meaningful indicator of fleet rollover plans. Amongst the E190 operators several carriers, such as Air Canada and Copa, have already completed their fleet disposal and many have been placed elsewhere. Some of these, notably those placed at Breeze, will be returned again over the coming years as A220s are delivered. However, JetBlue will rollover 60 remaining aircraft by January 2026. Around half of these will be returned to AerCap by late 2025 and the remainder, which are owned by the airline, are also due to be phased out over the next two to three years depending on the A220 delivery schedule. Aeromexico, which has emerged from Chapter 11, has not yet determined the future of its E190 fleet although its route network and large fleet would probably preclude a rapid disposal. This should enable a balanced remarketing programme.

The E195 lease return profile shows a peak of returns in 2023 and 2024 which reflects the continued gradual rollover of the Azul fleet to the E195–E2. Some of these have already been re-leased elsewhere notably at Portugalia, LOT and Breeze. Air Europa is also planning to return the remainder of its aircraft. However, the type remains in relatively strong demand particularly in Europe so that transition times should remain low.



5 Market Availability and Demand

5.1 Demand and Supply Drivers

As the current generation of regional jets aircraft continue to age, it is normal for top tier carriers to seek to roll over their fleets into newer generation equipment. This would usually have the effect of increasing the supply of used aircraft. However since, with few exceptions, the CRJ fleet is highly concentrated in North America where the regional operators tend to commit to aircraft for a longer period than elsewhere, there have been far fewer transitions than in the Embraer market.

In the Embraer market, the smaller capacity E170/175s are also highly concentrated in North America so that the same longevity with initial operators applies as with the CRJ. For the larger E190/195 fleets, these are more prevalent outside North America and even those in the area have, or are increasingly being, rolled over to other types. The secondary market for these is discussed in section 5.3.

Political or economic shocks can also have a substantial impact on the supply and demand for used aircraft. The COVID-19 pandemic impact had a dramatic short-term impact on the entire industry and upon the supply of aircraft. However, by late 2021 it became evident that excess supply of used inventory would be less severe than initially feared. It remains too early to determine whether the current crisis in Ukraine will have any material impact on the balance of supply and demand. Apart from aircraft in Russia and Ukraine, which includes few regional jets, there has so far been little discernable impact.

The pandemic caused far fewer bankruptcies in the regional jet segment than projected, despite some forced restructurings among European ACMI providers, such as Cityjet. More importantly, many mainline carriers deployed their regional jets in place of larger aircraft to maintain a reduced level of capacity during the crisis. For example, at the peak of the pandemic, European carriers including: KLM, TAP and to a lesser extent Air France and Lufthansa, were operating the majority of their regional partner fleets while larger narrowbodies were grounded. In the vast US market, domestic travel recovered far quicker than cross-border flights so regional operators benefited from a faster recovery than their mainline counterparts. This meant that regional jets were returned to service from temporary storage relatively quickly in North America.

Traditionally, a useful measure of used aircraft supply was the number of aircraft in storage in the short-term, and the number of projected returns in future. Stored aircraft are reviewed in 5.2 below and projected returns are discussed in 4.3. However, as evident in 5.2, a stored aircraft metric is currently not a good proxy for aircraft available since it is difficult to distinguish between aircraft that continue to be temporarily stored, those needing major maintenance inputs, and those available for sale or lease.

For most types, demand for used aircraft comes either from existing operators, which have made the conscious decision to remain with a particular type or from secondary carriers. In this respect section 5.3 reviews where many used aircraft have been placed in recent years.

The after-market for used aircraft is critical for current owners. In this respect, Embraer in particular have demonstrated reasonable success in developing new markets for used E-jets.

5.2 E-jet Availability – Aircraft in Storage

There is no complete inventory of aircraft available for sale or lease at any point in time. However, stored aircraft data is often used as a proxy. The weakness of this proxy is that it includes aircraft that are in transition between lessees or sellers and buyers as well as those that may be temporarily stored for a variety of reasons. In all cases the COVID-19 pandemic led to very large increases in stored aircraft particularly in relation to the E190/195 fleet as shown in Figure 24.

In addition, the COVID-19 pandemic means that a substantial proportion of stored aircraft have been parked for a long period. As such, many would now require significant return to service maintenance inputs, which in the case of some mid-life and older aircraft is uneconomic in relation to the value of such units.



According to Cirium, 159 E190s and 36 E195s remain in storage. However, many of these are still in pandemic induced temporary storage, or have not yet been inducted into service with their next operators. There is also a current shortage of MRO capacity for many aircraft types that may be precluding some aircraft from returning to service more quickly. For example, of the 30 former COPA E190 aircraft acquired by Alliance in Australia, 20 are still classified as stored, and only 10 of 20 Aerolineas Argentinas aircraft have so far returned to service. Some 20 aircraft across three Chinese airlines are also in temporary storage. Nevertheless, there remains greater market availability than would normally have been the case and this includes 20 owned by NAC.

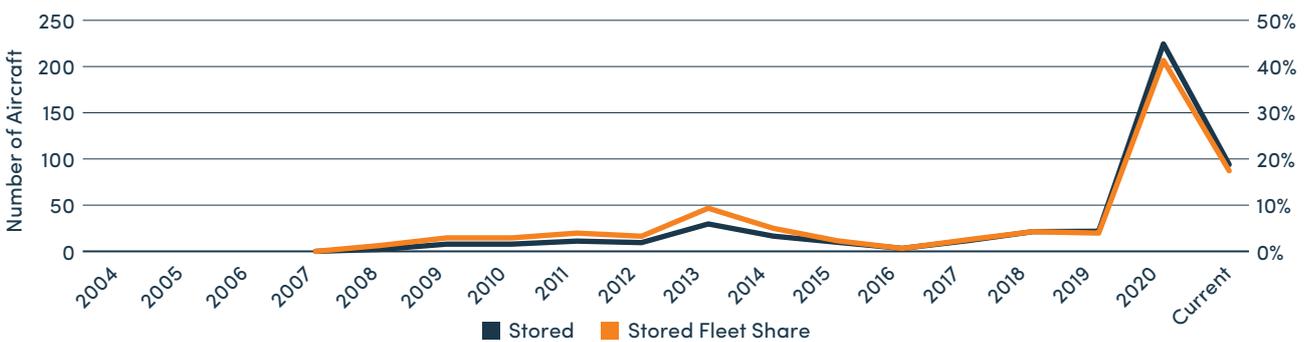
As at early Q2 2022 there are 8 x CRJ900s advertised for sale or lease, 9 x E170 (8 with Egypt Air), 4 x E175, 13 x E190 and 2 x E195.

The trends for future lease returns and likely disposals in the leased fleet analysis in 4.3 above combined with fleet transition data is more indicative of the future market..

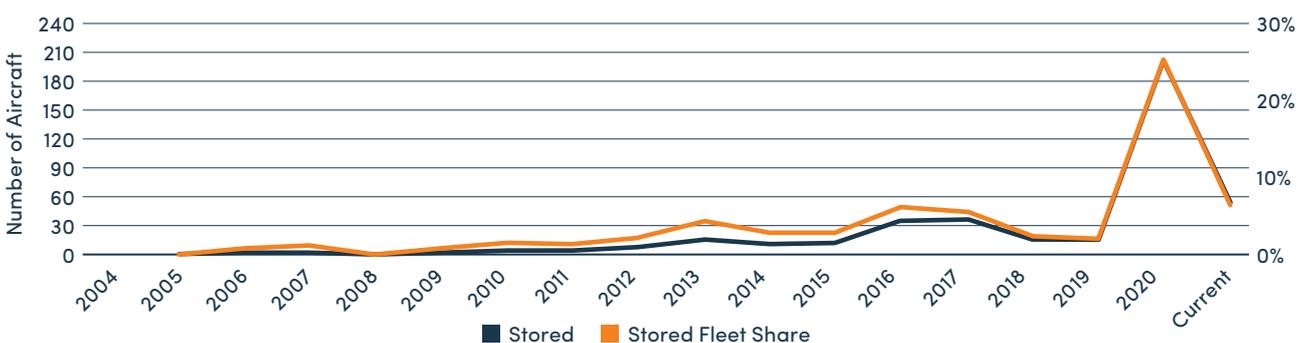
From a stored aircraft perspective, although numbers of parked aircraft remain high by historical standards in the short-term, the numbers of aircraft in storage is trending downwards. This suggests that aircraft are both being returned to service with existing operators and successfully placed with secondary operators. This can only assist long-term value retention.

Figure 24: Regional Jets in Storage Quarter 1 2022

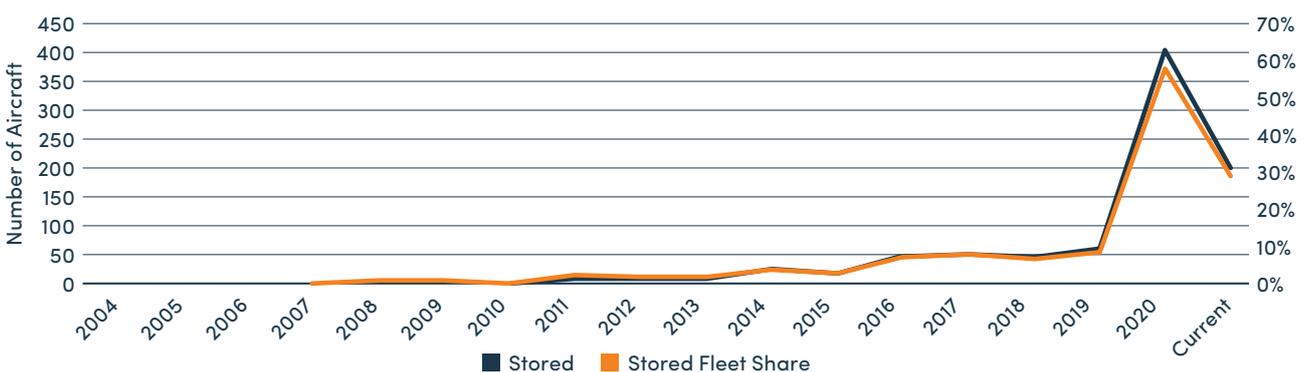
CRJ900/1000



E170/E175



E190/195



Source: Ascend by Cirium



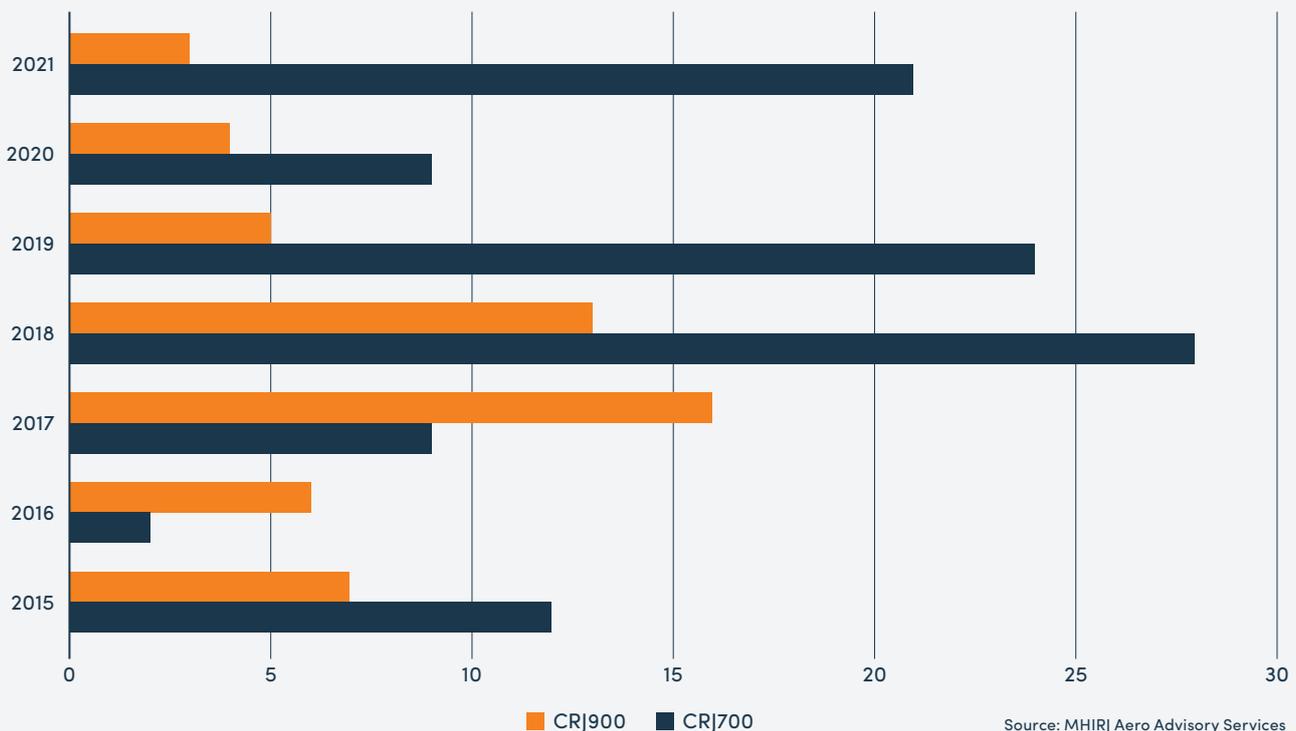
5.3 Placements of Used Aircraft from 2015 to Date

A useful indicator of liquidity for any aircraft type is the number of units that have transitioned from their initial operators to second or even third operators. If the traditional useful economic life of around 25 years is assumed, any aircraft would typically have a first operator that would keep it for an average of 7-10 years. (In North America, many airlines typically operate for much longer periods.) The aircraft would then typically transition to a second carrier for a shorter period (5-7 years) before moving to an end-of-life third user. Frequently, operators of late-life aircraft might either be cargo carriers that convert them from passenger to freight, or other lower utilisation special mission applications. If aircraft are proven to be successful in the secondary market then liquidity can be deemed strong.

Normally the above referenced late-life applications can only absorb a portion of any older aircraft fleet. In the regional jet market some such aircraft are also absorbed into the large fleets of US carriers that have the infrastructure to manage the greater maintenance inputs associated with older aircraft, or who acquire such aircraft for part-out to supply their existing fleets. This is particularly prevalent within the aging CRJ fleet. As previously mentioned, the majority of these have always operated in North America, but many have transitioned between US operators since 2015, often as a consequence of carrier consolidation or changes in the terms of capacity purchase agreements for the US majors. In addition, many aircraft that were previously outside North America have been absorbed by these carriers.

From a data perspective, the number of CRJ700 and CRJ900 aircraft that remain in operation and have transitioned between operators since 2015 is shown in Figure 25. The small CRJ1000 market is excluded as there have been no transitions except between related operators or occasional sub-leases or wet-leases to others. However, in 2022, the sale of the Air France HOP fleet to Jetcraft has been agreed.

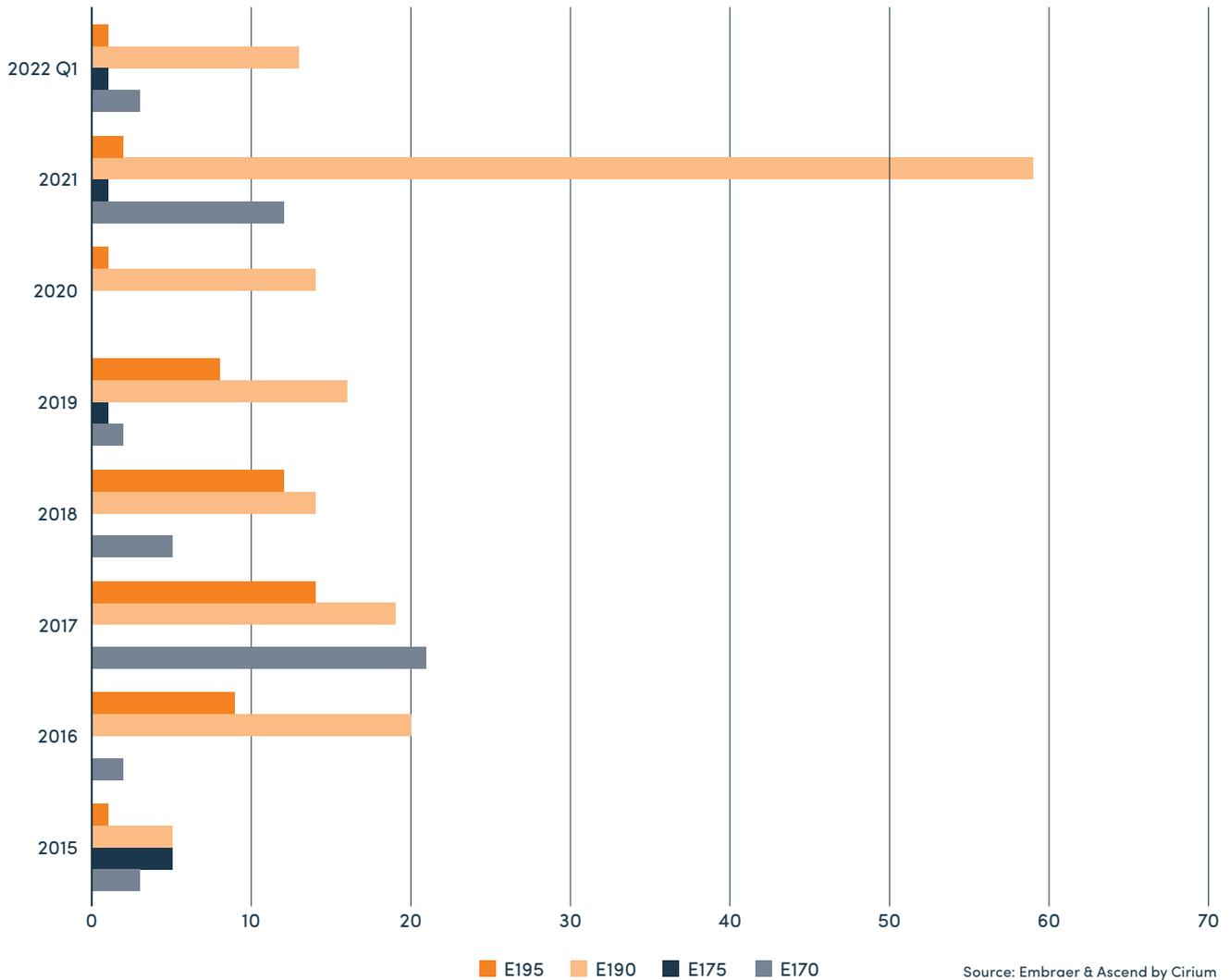
Figure 25: CRJ Fleet Transitions 2015-2021



In relation to the incumbent E-jet fleet, over 260 aircraft have transitioned between operators since 2015, which includes 18 in Q1 2022 (Figure 26). This represents 17% of the total fleet since 2015. In the case of the E190, it is 29% of the total fleet. In some cases the same aircraft have found new operators more than once. This means that used aircraft have found more and more applications with secondary operators in recent years. This would suggest that whatever short-term market conditions and values may exist, the E-jet secondary market has a proven track record. Given the numbers of aircraft due to be sold by their airline owners or returned to lessors, the ability to place these aircraft with their next operators is of paramount importance. In fact, some of the biggest operators of E-jets emerged from secondary market placements including: Aeromexico Connect (E190); Austrian Airlines (E195) and Envoy (E170).



Figure 26: E-jet Fleet Transitions 2015–2022 (Q1)



5.4 Risk Factors

While manufacturers, existing lessors and other owners have had some success in placing used aircraft with other carriers, significant risk factors remain. At a macro level and beyond any further pandemic related risks these include:

- Any economic deterioration globally or within certain key regions such as North or Latin America could have a substantial negative impact on the demand for used regional jets.
- If the strong economic growth of pre-COVID-19 years returns, the trend towards up-sizing capacity to narrow body jets could continue and slow the demand for regional jets.
- If continued higher fuel prices persist, the relatively high fuel burn per seat of regional jets compared to other classes of aircraft may diminish their attractiveness and hasten retirement.

At a micro level, despite restricted supply of new generation aircraft from the manufacturers, it only requires one or two major carriers with substantial fleets to decide to dispose of their aircraft to replace them with either E2, A220 or even narrowbody aircraft. This could dump significant fleets on the market in a short period, which would increase supply, and thereby lower values and lease rates. While many large fleets of E-jets have been placed with new operators, it is widely known that JetBlue will dispose of its fleet of 60 E190 family aircraft. Although a phased and gradual disposal is planned, there could still be a perceived over supply with associated negative market sentiment. Values and lease rates could then fall to encourage new entrants.



6 TrueNorth CMV and FMV Assessment

6.1 General Trends

Since the onset of the pandemic, all appraisers have reduced their Current Market Values (CMV) for all classes of aircraft, but there has been a marked divergence in both values and lease rates between various firms, and differences applicable to different vintages of aircraft.

With the exception of the E-175, all of the subject regional aircraft types are now out of production so that most CMVs are applicable to used aircraft that are now at least five years old (see section 3.3). For all aircraft classes including regional jets, it is used aircraft that are generally the most impacted during a market downturn. However, in the current pandemic long-haul widebodies have suffered more than regional or narrowbody aircraft.

TrueNorth uses appraised values provided by Ascend by Cirium, IBA, Avitas and mba. In the case of regional aircraft, IBA and mba generally have a more positive outlook while Ascend by Cirium is often the more conservative and this predates the pandemic. In the belief that long-term values have always had a tendency to return to normal depreciation profiles after shock events, some have been less reactive to the COVID-19 crisis than others, so in some cases the divergence of opinion has widened.

A Cautionary Tale

CMVs provided by appraisal firms are far from an exact science, particularly when external shock events occur. However, in such times the demand for CMV opinions usually grows because financiers and banks, in particular, tend to review and assess their risk profiles. In turn, this can impact the leasing community.

In order to provide CMVs, appraisers usually adjust their values to reflect market conditions and to do this rely on data points gathered from transactions in the market, and the views and opinions of market participants. In reality, few sellers are willing to accept lower sale prices in a market down-turn unless either they are forced to do so, in which case the all important premise of “willing buyer” and “willing seller” is compromised, or if a market down-turn proves to be prolonged over an extended number of years. This means there are very few real data points for appraisers to determine CMVs and this applies even more to regional aircraft where the fleet has a scale that represents a fraction of the larger aircraft market. Accordingly, regional jet CMVs often become subject to an element of estimation with a tendency to reduce values to reflect perceived greater risk. In turn, the publication of such revised CMVs can lead to the conclusion that CMVs have changed and thus create a self-fulfilling downward trajectory. This suggests that the downward pressure on values, including those of regional jets, may have been exaggerated since the onset of the pandemic, and indeed some appraisers have recently begun to show value recovery as the air travel market rebounds and the supply of airworthy inventory reduces.

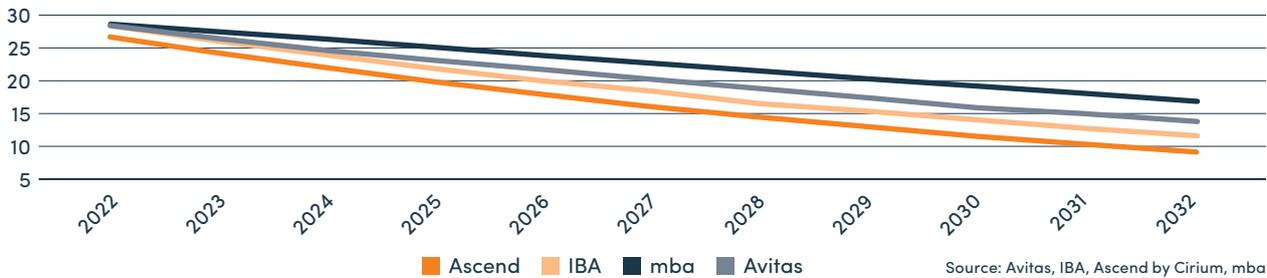
6.2 New Value Trends

As the E175 is the only subject regional jet that remains in production (Embraer E2 jets are not considered in this report – see “Crossover Jets Market Report, May 2021”), its new base values are shown in Figure 27. Given that any new regional jet delivered to an airline customer is either under stable market conditions or economically distressed conditions, it is highly unlikely to be traded during the current crisis. A review of CMVs for the type is unlikely to yield useful insights for asset risk analysis purposes unless the credit risk of the associated lessee is high. Since all outstanding orders for E175s are for large US regional carriers, the

counterparty risk would be considered to be low. Nevertheless, the projected average CMV for the type is nearer the lower end of the base value range shown.

The base values for new E175 aircraft are within a consistent range for new values, but diverge considerably over the ten year period shown. All the values assume a 2% rate of inflation. Given that inflation is currently far greater and forecast to remain high for at least the next two years or so, the future values are likely to be higher than shown. In addition, the new values do not fully account for OEM price escalation, which over the last decade has been around 2%, but exceeded 7% in 2021, and may be even greater in 2022.

Figure 27: E175 Base Values



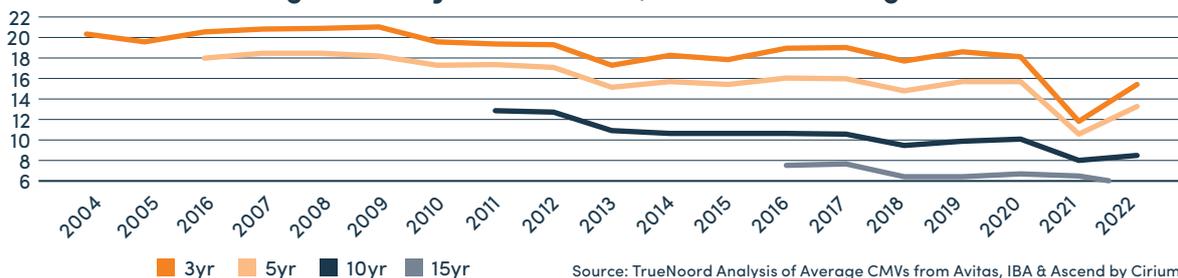
From a lease rental value perspective, the appraisal community believes that the current economic climate has negatively impacted monthly rent levels for new aircraft. According to Ascend by Cirium’s 2022 Q1 Asset Market Commentary, lease rates have declined from around US\$240,000/mth in 2019 to below US\$200,000 in 2022. At its suggested base value, this would imply a lease rate factor in the region of 0.7%. IBA suggests a similar market lease rental and mba believes that rental level to be closer to US\$230,000.

6.3 Used Regional Jet Value and Lease Trends

6.3.1 CRJ900

Figure 28 below shows the CMVs in each year of values for a selection of used vintage CRJ900s. Unsurprisingly, this shows the highest new aircraft values when historical demand was the greatest mirroring the peaks of the delivery profile shown around 2007/8. Since then values have fluctuated within a lower US\$2-3m range as demand reduced. The sharp CMV decline in 2020 reflects the impact of COVID-19. However, as noted in 5.3 there were only four recorded transitions in 2021, all to North American carriers. Nevertheless, appraisers suggest that newer vintages will have recovered at least half of the lost value this year.

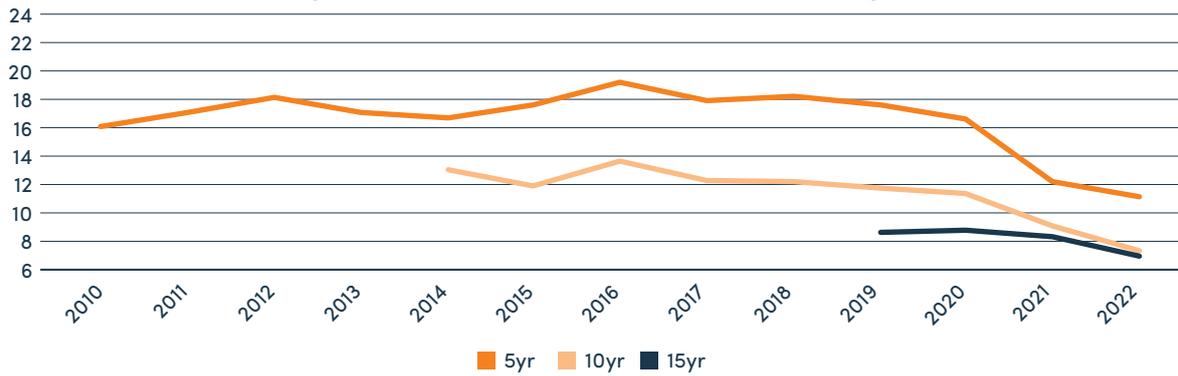
Figure 28: CRJ900 CMV in US\$million Constant Age



From a leasing perspective, all appraisers suggest that rentals have fallen significantly since the start of the pandemic. From rentals of US\$150-165,000 for three to five year old examples in 2019, these may now be as low as US\$100-115,000 in order to ensure that stored inventory is returned to service.

6.3.2 E170

Figure 29 shows the appraised values of used E170s. Since production of this model ceased some years ago, the newest constant age model is now already five years old. The appraisal community believes that all vintages have declined substantially with a relatively young 2017 vintage model at around US\$11million. This may reflect the fact that 31 of the total fleet of 164 units remain classified as stored. However, after no placement of used aircraft in 2020, 12 were returned to service with new operators in 2021 primarily at Envoy (under capacity purchase agreement to American Airlines) and a further three in early 2022.

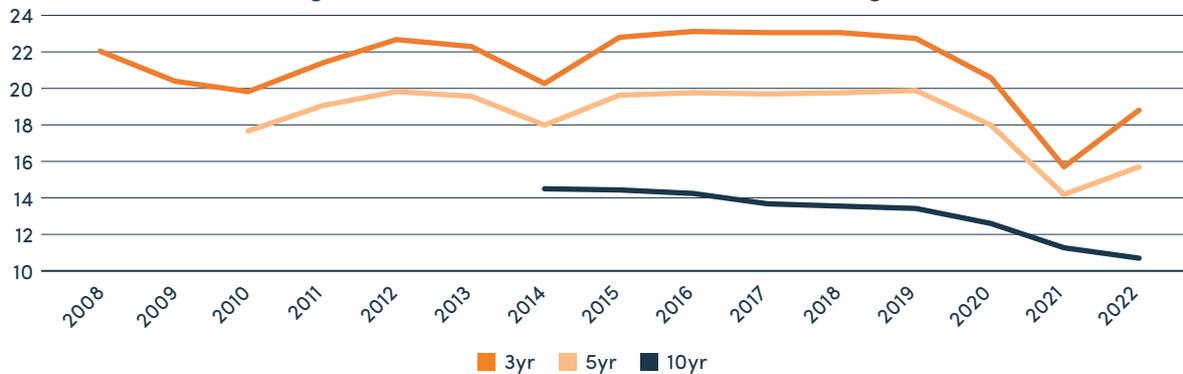
**Figure 29: E170 CMV in US\$million Constant Age**

Source: TrueNorth analysis of average CMVs from Avitas, IBA & Ascend by Cirium

In relation to leases, there are few data points, but appraisers suggest that rentals for older vintages have now declined from around US\$110,000 in early 2020 to as low as US\$75,000 per month in 2022.

6.3.3 E175

Along with all other regional jets, the used CMVs for E175s tumbled in the early part of the pandemic as shown in Figure 30. However, apart from the former Alitalia Cityliner fleet (10) and the Oman Air aircraft (4) which for reasons unconnected with the pandemic remain inactive, only some 20 of over 800 aircraft remain stored today. The E175 has become the favoured type for US regionals and has returned to active service faster than any other type. There have been few used market placements not through lack of demand, but more likely as a consequence of constrained supply. This means that appraisers have begun to re-adjust their CMVs upwards in 2022. Given the lack of used inventory, it is likely that the type will recover back towards its base values faster than other regional aircraft.

Figure 30: E175 CMV in US\$million Constant Age

Source: TrueNorth analysis of average CMVs from Avitas, IBA & Ascend by Cirium

From a leasing perspective, appraisers continue to suggest that rentals remain depressed, to the extent that these may be below US\$140,000, although whether any transactions have been completed at such levels is unknown. It may be that a small number of short-term lease extensions have been completed.

6.3.4 E-190

As the E-jet variant with the most extensive trading history, the appraisal community will have had more data points on the type than any other regional jet from which to generate CMVs. Accordingly, the CMVs are more likely to have reflected transaction values than other regional jets although the number of data points would still have been small compared to narrowbody aircraft. Nevertheless, it is significant that 59 E190s transitioned to new operators in 2021 and 13 in the first quarter of 2022, suggesting a reasonably active market

According to the averages of the appraisers (Figure 31), E190 values declined sharply after the onset of the pandemic in 2020 when a large portion of the incumbent fleet was grounded and there was little visibility on future likely demand. In some cases these had fallen to a level whereby the longer-term values were below the part-out values of those aircraft.

However, as airlines began to restore skeleton services later that year the E190, which unlike its smaller siblings was not concentrated in North America, found a role in providing services on routes that were previously served by narrowbody equipment. For example, several European carriers including KLM, TAP, Lufthansa and Finnair reactivated E-jets before A320 or B737 aircraft as their capacity was ideally suited to lower levels of passenger demand. This means that, although there are still quite a number of stored aircraft, many of which now require significant return to service maintenance, there are significant pockets of demand for the type, so appraisers have begun increasing their values since 2021. The alleged low pricing achieved by Alliance in Australia for much of the former COPA fleet in early 2021 is likely to mark the low point.

Figure 31: E190 CMV in US\$million Constant Age



Source: TrueNoord Analysis of Average CMVs from Avitas, IBA & Ascend by Cirium

With respect to leases, some new operators have taken advantage of excess supply to achieve significantly lower lease rates than would have been possible prior to the pandemic. Appraisers suggest a lease rate range of US\$130,000 to below US\$100,000. Carriers that extended or added aircraft are likely to have benefited from low lease rates in 2021.

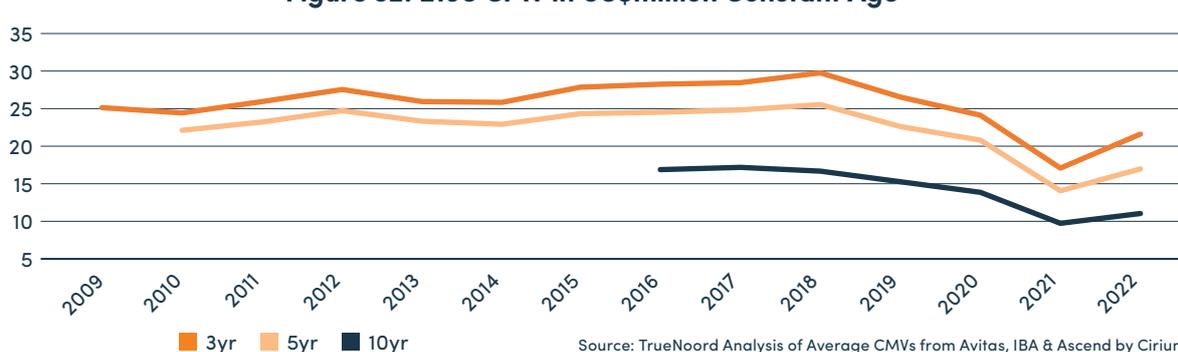
6.3.5 E195

The E195 has a substantially smaller incumbent fleet of 170 units compared to its smaller E190 sibling. Of these, 30 are still classified as stored, although this now includes five at Ukraine International and Belavia. It also includes seven grounded Air Europa aircraft that are known to require substantial return-to-service maintenance which may not be economically viable.

Despite the stored inventory and few placements in 2021, demand for this variant has increased substantially over the last year as it has become an economical way to acquire 120 seat capacity at attractive costs-per-seat (closer to those of larger narrowbody aircraft than any other regional jet). In the current post-pandemic recovery several airlines including Breeze, SAS, TAP, Austrian and LOT have deemed this to be a target aircraft type. Small numbers have already transitioned, but these carriers are all seeking to grow their fleets.

These market dynamics, including the small fleet size and limited carrier penetration, may explain why appraisers had already started to mark down the CMVs of the E-195 well before the pandemic in 2018 (Figure 32). This trend accelerated in 2020, but since 2021 over half of the COVID-19 induced decline has recovered.

Figure 32: E195 CMV in US\$million Constant Age



Source: TrueNoord Analysis of Average CMVs from Avitas, IBA & Ascend by Cirium

According to appraisers, lease rates tumbled for the type since the start of the pandemic, similar to the E-190. However, since the second half of 2021 these have been more stable and may have seen a small increase to around US\$100,000 as the level for the 10 year old models.



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