

# Basics of Aircraft Market Analysis



Forming a Policy to Identify Ideal Assets for Long-term Economic Returns

By: Shannon Ackert  
sackert@aircraftmonitor.com

## Abstract

Confidence in aircraft transactions by investors depends critically on the objective assessments of those factors that influence its residual value over time. There are numerous market and performance factors that determine how well an aircraft retains its value as well as how successful its prospect for remarketing is. Aspects such as the number of an aircraft in service, its firm backlog, geographical distributions, a broad & expanding customer base, position of the aircraft on the product life cycle, specification, etc., should be considered during the aircraft selection process.

In addition to aircraft market and performance attributes, the outside influence of macroeconomic forces, such as demand in passenger air traffic and airline profitability, should also be considered. Indeed, the economic result from buying, selling, leasing and/or financing aircraft will be greatly influenced by the timing of an investment and/or divestment in relation to the aviation cycle.

This research examines those factors that influence an aircraft's value retention capability, and highlights how to gauge the aviation cycle as a means to benchmark the investment entry/exit point. A sample case study is included, which guides the reader through the analysis and assessment of the Airbus A330-300, one of the most popular medium-long-haul widebody aircraft.

# Basics of Aircraft Market Analysis



## TABLE OF CONTENTS

1. INTRODUCTION .....	2
2. AIRCRAFT VALUES.....	2
3. AIRCRAFT VALUE RETENTION FACTORS.....	5
3.1 Aircraft Market-Driven Factors.....	5
3.2 Aircraft Performance-Driven Factors.....	11
4. BENCHMARKING AIRCRAFT VALUE RETENTION.....	14
5. AIRCRAFT VALUE CYCLES.....	15
6. BENCHMARKING WHEN TO INVEST IN THE AVIATION CYCLE.....	17
APPENDIX A: CASE STUDY – A330-300 MARKET ANALYSIS & COMMENTARY.....	19
APPENDIX B: AIRCRAFT MARKET VALUE INDICATORS.....	26

# Basics of Aircraft Market Analysis



## 1. INTRODUCTION

While both airlines and aircraft investors value an aircraft as an economic entity, the value in use to each differs considerably. An airline will analyze an aircraft's profit-generating potential where the value of the asset is justified based on the expected present value of the operating profits that the aircraft is expected to generate over its life. Analysis of the aircraft's Direct Operating Cost (DOC) per available seat mile, maintenance costs, dispatch reliability, and mission flexibility are also weighed in the decision framework. Fleet commonality will also play a significant factor given the substantial cost savings in training and spares inventories that can be achieved by operating a common fleet of aircraft.

In contrast, aircraft investors derive their investment decision based on the expected present value of the lease income and the capital gains from the sale of the aircraft. The key risk factors in aircraft leasing are credit risk and asset risk. Asset risk can be mitigated if aircraft investors purchase assets that are readily financeable and saleable reflecting:

- Aircraft that can be transferred from one operator to another in an active, liquid and global market,
- The value of the aircraft does not decline substantially given a key component of the overall return is the residual value of the underlying aircraft.

Forming a policy to mitigate asset risk is crucial to aircraft investors given they stand to lose a substantial portion of their potential profits if the value of their investments diminishes. The ability to select assets having the greatest remarketing potential and exhibiting better than average value retention behavior is the critical first step towards building an aircraft investment portfolio. This requires a comprehensive understanding of those qualities that enhance an aircraft's relative asset strengths. Another important criterion for maximizing return on invested capital is the ability to discern the optimal time to invest and/or divest in aircraft assets. Benchmarking when to perform these activities requires consideration of the economic indicators that serve as entry and/or exit points in the aviation cycle.

## 2. AIRCRAFT VALUES

An aircraft's value means different things to different people. An accountant will think of it in terms of book value, or the value recorded in the ledger. An aircraft trader will consider it as the fair market value. The standard aircraft value terms used by the vast majority of aircraft appraisers are defined by the International Society of Transport Aircraft Trading (ISTAT). The following is a representative sample of key definitions that conform to the standards set forth by ISTAT.

A. Base Value (BV) - represents the opinion of the value of single aircraft in a single arms-length transaction between a willing and informed buyer and seller with no hidden liabilities in a balanced market. A balanced market is one where supply and demand are reasonably equal, and where neither is affected by short-term events. Short-term events generally include events that temporarily alter values such as, for example, extraordinary manufacturer price discounts, fuel costs, war or recessions.

# Basics of Aircraft Market Analysis

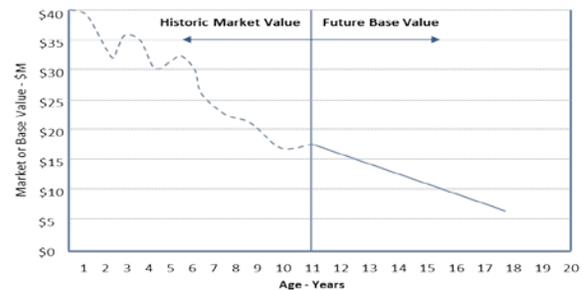


Base value then is a hypothetical value, as the real market is never completely balanced or unaffected by short-term events, and it is generally used to analyze historical values or to project future values. Importantly, base value assumes an aircraft's maintenance status is at half-life, or benefitting from an above-average maintenance status if it is new or fairly new.

B. Current Market Value (CMV) - represents the appraiser's opinion of the most likely trading price that may be generated for an asset under market conditions that are perceived to exist at the time in question. Market values are often value opinions based on each appraiser's careful analysis of information about recent transactions. Current market values also considers the perceived demand for the type, its availability on the market, and further takes account of the expressed views of informed industry sources. Similar to base value, current market value assumes an aircraft's maintenance status is at half-life, or benefitting from an above-average maintenance status if it is new or fairly new.

FIGURE 1- CURRENT MARKET AND BASE VALUE MARKET CORRELATIONS

- If  $CMV = BV$  than market conditions are in equilibrium.
- If  $CMV > BV$  than market conditions are tending to support higher prices.
- If  $CMV < BV$  than market conditions are tending to support lower prices.



The current market value of an aircraft will tend to be consistent with its base value in a stable market environment. In situations where a reasonable equilibrium between supply and demand does not exist a divergence between base and market value indicates the existence of some form of imbalance in the market. For example, if the current market value is in excess of base value, this would indicate that prevailing market conditions are tending to support higher trading prices for the aircraft. Figure 1 above illustrates the relationship between current and base values based on fluctuations in market conditions.

## Aircraft Value Perspective

Opinions of base and current market values can often vary widely among aircraft appraisers, and that variation is as much due to differences in methodology as it is to optimism or pessimism. However, there are three underlying philosophies that are generally consistent among all aircraft appraisers:

1. There is an orderly relationship in the values of a given aircraft type from year to year of build, all else equal;
2. There is an orderly relationship between value of competitive aircraft of the same year of build, all else equal,
3. Values of a given aircraft type must be considered in the context of the values of all competing aircraft.



# Basics of Aircraft Market Analysis



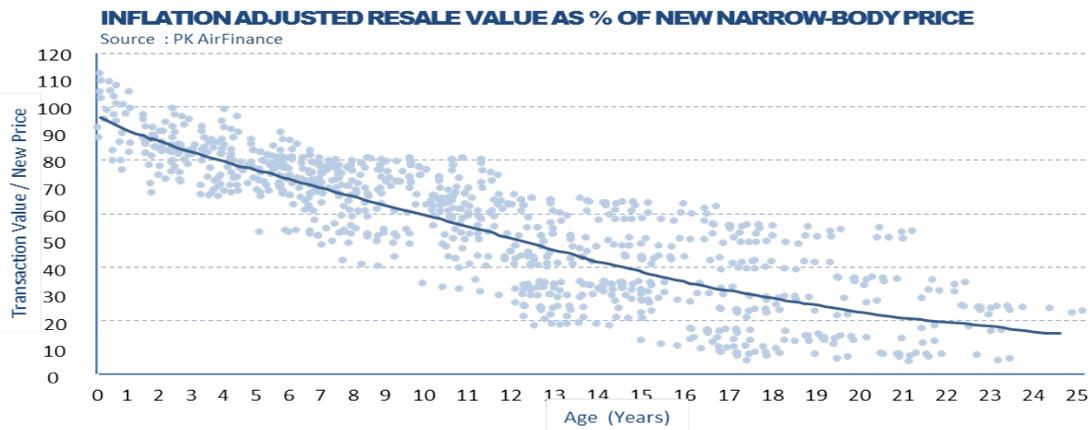
C. Future Base Value - is the appraiser's forecast of future aircraft value(s) from an initial starting point that is generally its base value - a curve is generated using normalized data points derived from a base value, and an extension of that curve produces the future base value curve for an aircraft type. Future values are normally projected in current dollars and, as such, entail inflation assumptions. Appraisers often forecast future values assuming an inflation rate ranging from 2% to 3%.

D. Adjusted Market Value - indicates that the market or base value of the aircraft has been adjusted from half-life condition to account for the actual maintenance status. The maintenance you perform on an aircraft has an impact on its value. Therefore, it is important to quantify in monetary terms the maintenance status of aircraft involved in transactions, since a strong relationship exists between the cost of conducting maintenance and value enhancement.

Value Trends - An aircraft, like most physical assets, exhibits a depreciation profile whereby its current market value depreciates to a residual value over time. This trend, along with growing obsolescence resulting from new technologies and improvements in fuel burn, contributes to the depreciation process and limits an aircraft's economic useful life. Older aircraft in need of major cash expenditures for pending major maintenance events are not likely to remain in service, instead they will be relegated to part-out or permanent retirement. The rationale for this is that; a.) Operators and owners no longer have the cash outlays to expend on maintenance and, b.) Any significant expenditure for maintenance is not expected to augment the market value of the aircraft.

Figure 2 below illustrates the resale value for narrow-body commercial jets in inflation adjusted USD expressed as a percentage of the new price - the trend-line illustrates the depreciation pattern ignoring cyclical movements in prices whereas each dot represents an aircraft's resale (traded) value. The graph clearly demonstrates that aircraft values are unpredictable and that there is a wide disparity in traded values as an aircraft ages.

FIGURE 2- NARROW-BODY AIRCRAFT INFLATION ADJUSTED RESALE VALUES



# Basics of Aircraft Market Analysis

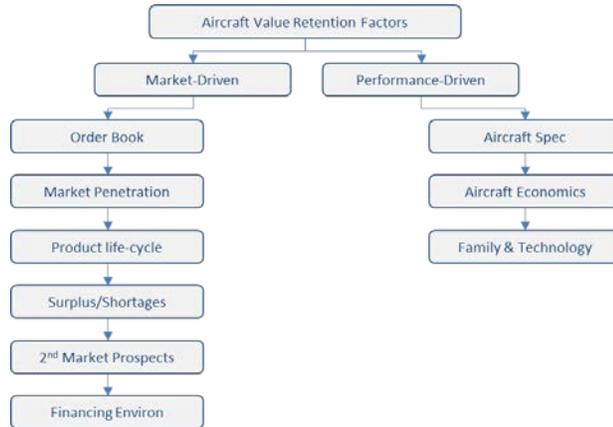


## 3. AIRCRAFT VALUE RETENTION FACTORS

Aircraft investors look to optimize their return on invested capital by establishing a diversified portfolio of liquid aircraft, and then spreading the risk amongst multiple operators and geographic regions.

Forming a policy to identify those popular aircraft that are capable of retaining their value over time should be a core investor strategy. This is especially true of leasing companies, which tend to view an aircraft more as an investment rather than a tool to generate traffic.

**FIGURE 3- AIRCRAFT VALUE RETENTION FACTORS**



The factors that enable an asset to retain its value over time are inevitably subjective in nature nonetheless they do provide indications of potential advantages and disadvantages. Setting aside the outside influence of economic conditions, there are numerous intrinsic factors that influence aircraft value retention. These factors can be categorized under market-driven and performance-driven factors – see Figure 3 above.

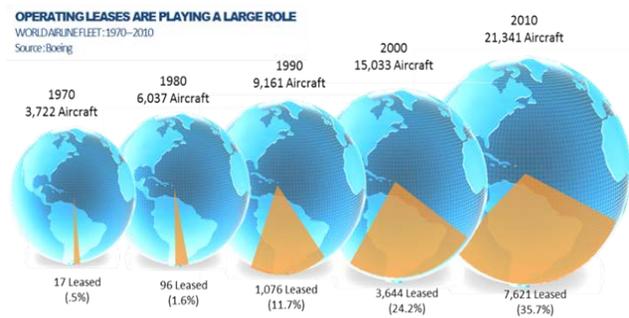
### 3.1 Aircraft Market-Driven Factors

Market-driven factors that consistently rank high among investors consist of an aircraft’s order-book, market penetration, production life cycle, surplus/shortages, secondary market prospects and financing environment. The following sections discuss each of the market-driven factors in greater detail.

### Aircraft Operating Lessor Perspective

Among aircraft investors, operating lessors currently account for ownership of over 35% of the global commercial fleet. Given the aircraft’s residual value is the second major component of a lessor’s return, most leasing companies will ensure their equity investment is placed among a portfolio of high quality aircraft types with wide user bases to reduce risk.

Broadly speaking, aircraft that are currently popular with lessors tend to have low value volatility, and also provide an excellent indicator as to which are aircraft are considered tier one level.



# Basics of Aircraft Market Analysis



A. Order-Book - An aircraft's order book reflects the number of firm orders outstanding, and is broken down by number of deliveries (in service & storage) and number on firm backlog. The order book serves to highlight the market share an aircraft has achieved, and represents one of the largest influences on value retention. This explains why investor focus on popular aircraft with large order books to reduce their investment risks; these aircraft tend to be more liquid with implied wide user bases, have lower risk profiles, are easier to purchase and finance, and can be easily remarketed.

Today, best-selling narrowbody choices with large order-books come from the 737NG and A320 family aircraft, while best-selling widebody choices come from the 777 and A330 family aircraft. Figure 4 highlights the 737NG order-book and illustrates the popularity of the 737-800 compared to other 737NG models.

FIGURE 4- 737 NG ORDER BOOK AS OF DEC-2011

Source: Ascend	Firm Orders	Deliveries	Firm Backlog
Boeing 737-600	68	68	0
Boeing 737-700	1,425	1,084	341
Boeing 737-800	3,910	2,385	1,525
Boeing 737-900	474	158	316
<b>Totals</b>	<b>5,877</b>	<b>3,695</b>	<b>2,182</b>

When evaluating an aircraft's order-book it is instructive to analyze its firm backlog since it serves as a barometer to future guidance. A high and robust backlog generally implies many years of production output. However, one should also discern the quality of the order backlog because a backlog deemed excessive represents a risk to aircraft market values and lease rates.

Additionally, it is good practice to ascertain what percentage of an aircraft's backlog is coming from operating lessors. Given that lessor orders are generally regarded as speculative, it can represent a risk to aircraft market values and lease rates should they not be placed.

Another effective policy when evaluating an aircraft's order book is to determine: a.) How the fleet is being deployed and, b.) what type of carriers (i.e. network, regional, and LCC) are operating them. Greater market deployment and broad carrier usage serves to enhance aircraft values.

## Aircraft Backlog Perspective

Each individual airline's backlog is nothing more than an estimate of its requirement for new aircraft to support growth as well as replacement. This estimate would most certainly account for perceived levels of future traffic growth over a defined time horizon.

Thus, by examining an airline's backlog one can make inferences as to the level of traffic growth and/or replacements that would be required to justify such a capacity requirement. If analysis indicates an extremely high level of traffic growth than backlogs are over-ordered and production rates are therefore unsustainable. Such a scenario can lead to deferrals/cancellations and depress residual values of recently-delivered and ordered aircraft.



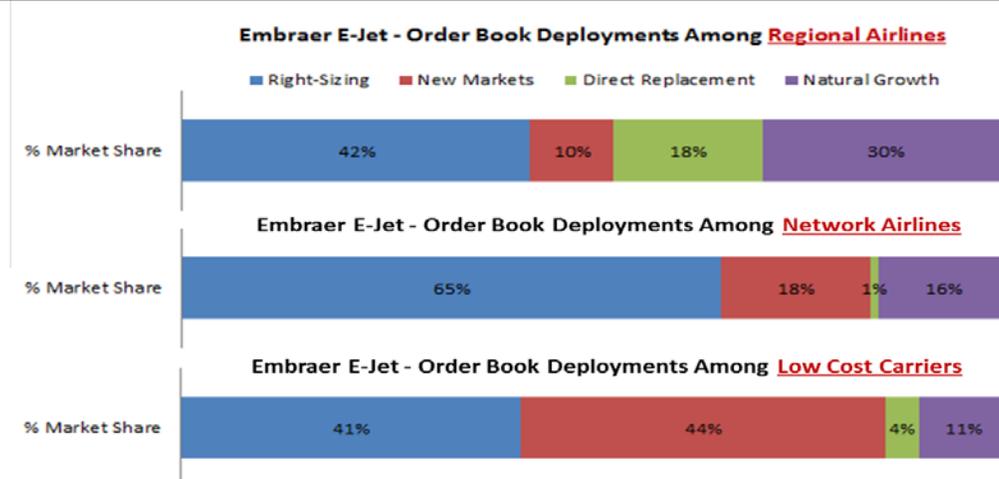
# Basics of Aircraft Market Analysis



There are generally four areas in which aircraft are deployed, consisting of; 1) New Markets, 2) Replacement / Retirements, 3) Natural Growth, and 4) Right Sizing. Figure 5 below illustrates the market deployment for the Embraer E-Jets.

- i. **New Markets** - Greater liberalization of aviation markets is often a driver for aviation growth and the development of new markets through the opening of new air routes between growing numbers of origins and destinations. The impact of liberalization is particularly dramatic in the case of low-cost airlines, which are stimulating air travel by lowering fares and opening new markets.
- ii. **Replacement / Retirements** - Replacements are a key part of any forecast, as the time at which aircraft leave passenger service to retire or be converted for other uses has an impact on both the level of demand of new aircraft deliveries. High fuel costs and the need to meet new environmental regulations are compelling airlines to accelerate replacement of older airplanes.
- iii. **Natural Growth** - Worldwide economic activity is the most powerful driver of natural growth in commercial air transport and the resulting demand for airplanes. World GDP is expected to grow at over 3% per year, with emerging economies such as China and India leading the way with growth exceeding 6% and 8% respectively.
- iv. **Right-Sizing** - Using right-sized equipment allows airlines to maximize operational efficiency and profitability by optimizing capacity to demand. For example, the Embraer E190 provides operators with an optimally designed aircraft to targeting routes/frequencies where regional jets are too small and standard 737/A320 family aircraft are too large.

**FIGURE 5- ORDER BOOK DEPLOYMENT**



Source: Embraer

# Basics of Aircraft Market Analysis



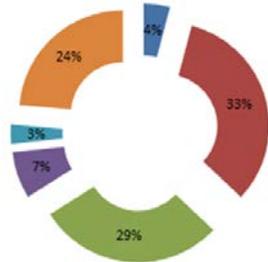
B. Market Penetration - Perhaps the greatest factor influencing value retention is the market penetration an aircraft type has achieved. Market penetration is made up of an aircraft's customer and geographical base.

Limited geographical and global fleet spread will limit secondary market prospects so aircraft investors almost always focus on popular, liquid aircraft that are well dispersed among customers and regions. Figure 6

**FIGURE 6 – MARKET PENETRATION EXAMPLE**

Firm Orders	Deliveries	Firm Backlog	Customers	Lessors
3,910	2,385	1,525	150+	40+

**737-800 Geographic Base**



Region	Fleet
Africa	153
Asia Pacific	1,236
Europe	1,088
Latin America	275
Middle East	113
North America	886

Source: Ascend

6 highlights the market penetration of the 737-800 aircraft; currently one of the best-selling, liquid aircraft in production with over 150 customers and 3,910 firm orders globally dispersed among all regions.

Although most investors tend to focus primarily on liquid aircraft, there are a number of lessors whom will invest in specialist/niche aircraft, or those considered to have poor residual value prospects. They will generally do so by either buying these aircraft at low market values, by charging premium rents, or by a combination of the above. Examples of specialist aircraft today are the 777-200LR and A380.

C. Production Stages - Aircraft with sustained production runs have greater market share and geographical spread than those with shorter product life cycles. More importantly, aircraft that are still in production tend to retain their values and lease rates to an even greater degree than those that have ceased production.

What phase an aircraft is in its production cycle also influences its value retention. More often, early production units tend to be heavier, have lower gross weights and thrust, and incur higher direct operating costs when compared to mid-to-later build higher specification units. In contrast, aircraft manufactured at the tail end of its production cycle tend to experience higher declines in future values given these aircraft are competing against newer technology aircraft that often offer significant improvements in operating efficiency.

## Aircraft Production Rate Perspective

Both Airbus and Boeing continue to raise their production rates by more than previously expected. Boeing is increasing the production rate for its 737 to 42 aircraft a month from the first half of 2014, expecting to build on average two 737s each workday. Airbus is also currently increasing its A320 family output to 42 aircraft per month by 2013.

Although current production rates support a high and robust backlog, an increase of this level in narrowbody output will likely lead to increased retirements of older aircraft and detrimental to aircraft values and lease rates of newer production aircraft.

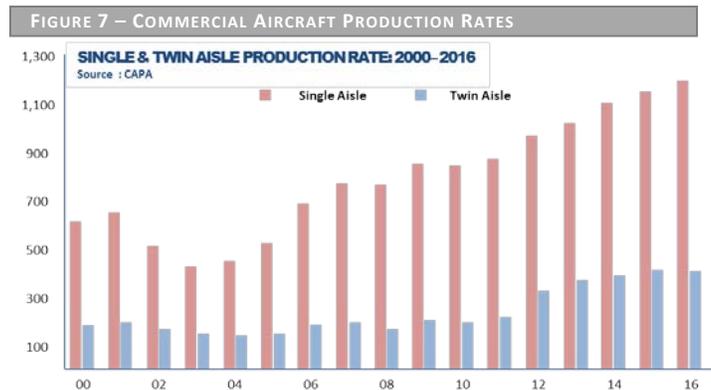


## Basics of Aircraft Market Analysis



An aircraft's production rate is a leading determinant of capacity growth, with consequent impact on market penetration. Airlines view higher production rates as a positive factor given it diminishes order cycle times and reduce volatility and costs. However, investors / lessors tend to have concerns over higher productions rates, which they view as creating an oversupply leading to volatility in lease rates, values, and liquidity of collateral.

As illustrated in Figure 7, the order backlog of 7,000 + commercial aircraft (as of the end of 2011) covers almost 5+ years of production out to 2016. Although many in the industry believe current production rates support this high backlog, others believe a further increase in production rates could be detrimental to aircraft values and lease rates, particularly if it coincides during a sustained economic downturn.



D. Surplus / Shortages - The number of stored aircraft is often used as an indicator of the airline industry's health; whereas shortages of aircraft imply strong market condition, surpluses imply weak. In valuation terms, shortages of aircraft naturally drive up values and surpluses push values down.

For a particular aircraft type, it's important to differentiate whether the aircraft are stored as a result of technical or economic obsolescence, in which case such aircraft would be unlikely to find its way back into service, or owing to the cyclic nature of the business, in which case such aircraft will be oversupplied.

In a downturn the oldest aircraft are often parked first and often suffer a higher percentage drop in value compared to younger aircraft. In many cases, values for these older aircraft never recover following a recession. A new / modern aircraft stored in a recession can wait for the markets to come back, and these aircraft provide a better indication of the availability of usable aircraft.

Moreover, the number of these aircraft that have been in and out of storage, and the number that remain in storage, is a barometer for how active the aircraft market has been. As the numbers of new / modern aircraft are returned to service, so does its value prospects begin to improve.

# Basics of Aircraft Market Analysis

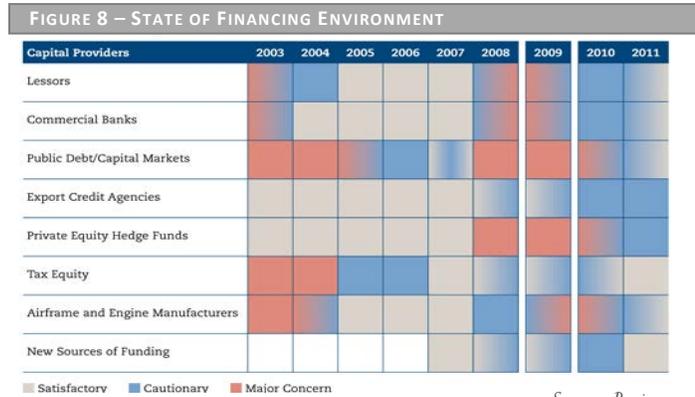


E. Aircraft Financing Environment - Capital/Lease market drivers, including the improving financial health of lessors, private equity inflows and re-opening credit markets are supportive to aircraft values, but prohibitively high funding spreads on non-export credit subsidized deals represent a drag.

Closure of credit markets in 2008-09 undoubtedly helped to depress aircraft values but the OEMs were very skillful in ensuring that virtually all deliveries were financed, mostly by export credit. Figure 8 highlights the current status of the traditional sources of capital for aircraft finance, which can be viewed as having reasonable near term liquidity and pricing with a degree of market uncertainty

On the lending front, loans collateralized with an aircraft will be evaluated based on the default risk of the obligor, the volatility in the value of the aircraft and the term and price structure of the deal.

Whereas the margin spreads on secured debt tends to be driven by the airline credit, the loan advance tends to be influenced by the volatility of the value of the aircraft used as collateral.



F. Secondary Market Prospects - There are several viable markets that exist for older aircraft, among them sale or lease to second and/or third tier operators, passenger-to-freighter conversion, and parting out for engine and other rotatable components.

Liquid aircraft that have a combination of low direct operating cost and capital cost will be in greater demand by second and third-tier airlines, in particular start-ups and low credit-rated carriers. However, despite the large availability of used aircraft in the secondary market, many airlines have begun to lease new aircraft from lessors eager to spread their customer base. These transactions have, in effect, made older aircraft harder to sell / lease, increasing their availability and reducing their values.

## Aircraft Finance Perspective

Aircraft deemed to have higher volatility in values will incur lower loan advances (have lower loan-to-value ratios) resulting in higher equity contribution. As a result, investors prefer to purchase high quality aircraft having low value volatility (good value retention), which helps reduce their risk and improves their chances of making a reasonable return.



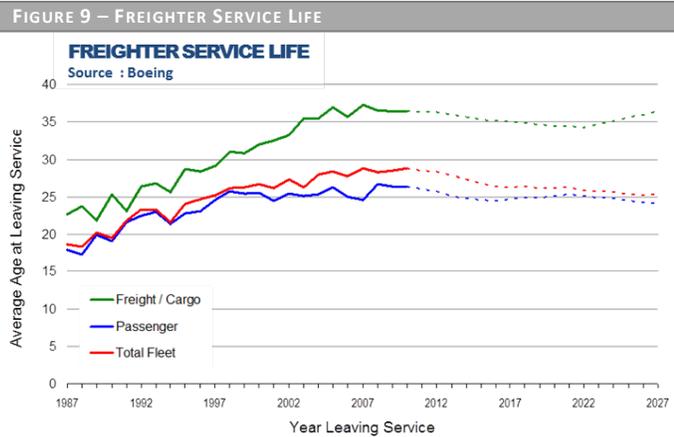
# Basics of Aircraft Market Analysis



Passenger-to-freighter conversion is a large secondary market prospect for older aircraft. Acceptable lease rates often dictate investments for passenger-to-freighter conversions, and this in turn will determine the current market values for prospective aircraft.

Not all used aircraft are suitable for conversion. Aircraft deemed unsuitable generally include early production units, those certified with low MTOW, lower thrust ratings, and payload-range restrictions.

Recent examples of aircraft that have proved to be ideal passenger-to-freighter candidates are the 757-200 and 767-300ER. Figure 9 illustrates the service life of freighter aircraft relative to both passenger aircraft and the total fleet.



Aircraft that are unlikely to be used in operational roles will be relegated for parting-out. Parting out of rotables, engines and other components can potentially become a lucrative market provided there is a projected large user base for this hardware. In particular, engines with time on-wing remaining can be in high demand given it is more economical to acquire used engines than put them through a shop visit.

## 3.2 Aircraft Performance-Driven Factors

Primary performance-driven factors consist of an aircraft's specification options, its economic cost of ownership advantages, its affiliation to a family of aircraft, and lastly, its technology advantage.

A. Aircraft Specification - Production aircraft are typically offered with optional features such as engines, operating weights, avionics, winglets, and interior configurations. Aircraft equipped with generic and higher specification features tend to retain their values better and are more marketable relative to those with unique and less popular features. The three major specification options that influence an aircraft's value consist of: 1.) Engines and their associated thrust options, 2.) Operating weights, and 3.) Cabin & BFE options.

- I. Engines - Numerous aircraft types are offered with engines from different manufacturers, and more importantly, at different thrust levels. For example, an A330-300 can be fitted with engines from Pratt & Whitney, Rolls-Royce, and GE whereas the 737NGs are offered with one engine type – see Figure 10. When it comes to engine options, fragmentation among multiple manufacturers tends to make remarketing more difficult.

## Basics of Aircraft Market Analysis



In addition to engine options from manufacturers, many of today's popular engine types are offered with a range of thrust ratings to select from. The CFM56-7B engines equipped on the 737NGs have thrust ratings that range from 20,000 lbs to 27,000 lbs. Engine manufacturers set prices for new engines that closely relate to the thrust level being offered and consequently the actual engine thrust level can have a significant effect on value. For example, the cost/value difference between a 737NG equipped with CFM56-7B26 engine rated at 26,300 lbs versus a CFM56-7B24 rated at 24,200 lbs is on the order of \$1.7 - \$1.8 million – see Figure 10.

FIGURE 11 – WEIGHT & THRUST VALUE DIFFERENCES



- II. Operating Weights - In addition to a wide variety of engine choices, higher maximum certified weights significantly enhance an aircraft's utility and airframe manufacturers routinely charge premiums for higher design weights. The 737-800, for example, has Maximum Takeoff Weight (MTOW) options ranging from 155,000 lbs up to 174,000 lbs. For a new aircraft, the value differential between the lower and higher MTOW alternatives is approximately \$1.4 - \$1.5 million – see Figure 10.
- III. Cabin & BFE Options - For lessors and financiers, a major challenge has been dealing with the high number of equipment options available, and correspondingly, the high cost to upgrade each of these equipment packages. Standardized aircraft offering flexible design solutions are easier to lease out, and tend to have a higher resale value. The hard and fast rule for cabin & BFE options is that “generic is good, and unique is bad”. This is particularly true for aircraft with secondary market prospects.

### Aircraft Weight & Thrust Upgrade Cost Perspective

The price to purchase both weight and thrust generally declines with the age of the aircraft. Depending on the OEM, such price generally decreases by approximately 5% per year. One aircraft manufacturer, for instance, applies a 5% decline in the purchase price for operational weights for the first 15 years, followed by a 1% per year decline thereafter.

Although OEMs discount the price to purchase weight & thrust as equipment ages, they generally apply an annual escalation to compensate for inflation. Therefore, the net price reduction is often less than the discount reflected in the decline with age.



## Basics of Aircraft Market Analysis



- a. BFE Options - Buyers of aircraft offering fewer choices (relative to alternative commercial aircraft) in the selection of Buyer Furnished Equipment (BFE) are able to achieve maximum flexibility and reduced transition complexity. For example, on the 787 Boeing is offering six economy seat suppliers versus sixteen on the 777 aircraft. In total, Boeing is projecting in using about 140 BFE suppliers versus over 600 for the 777 aircraft.
- b. Cabin Flexibility - A change in cabin configuration, particularly on widebody aircraft, can be an expensive proposition; often requiring many man-hours of work, several days of down-time, and expensive cabin hardware. Aircraft designed to allow owner/operators to quickly change cabin configurations are generally more valuable.

B. Family & Technology - There are considerable economic and logistic benefits of operating a family fleet of aircraft such as the A320 and 737NG family. Aircraft in these families share common parts, training requirements, and other characteristics. Commonality lowers the cost of operating a fleet of aircraft by reducing the quantity and variety of spare parts needed. Pilots and mechanics may also be very quickly "familiarized" to multiple types of aircraft that share common operating and maintenance procedures, reducing downtime.

Family-affiliated aircraft provide greater investment and remarketability diversification. For example, the Embraer E-Jet family aircraft are operated by Mainline, Low Cost Carrier (LCC), and Regional airlines. Within an aircraft family however, there are generally more liquid variants that are viewed to have superior value in use as a revenue asset, examples being the E190, A320, and 737-800 aircraft.

Modern technology generally improves economic performance and prolongs useful life. Most of the burden in improving economic performance rests with the engine manufacturers. In striving to lower fuel consumption, weight and cost, the jet engine manufacturers are continuously looking for new concepts to introduce a step change in the turbofan engine development. This goes in hand with efforts to reduce engine noise and emissions, which are becoming increasingly more stringent.

Another game changing technology is the increasing use of composites materials. Composites are lighter and stronger than traditional aluminum alloys, and have excellent resistance to high temperatures. From a maintenance perspective, composites have a far better resistance than aluminum to fatigue (or the formation of cracks) and they do not corrode. These properties produce immediate benefits when it comes to the number and frequency of maintenance inspections that have to be performed on an aircraft.

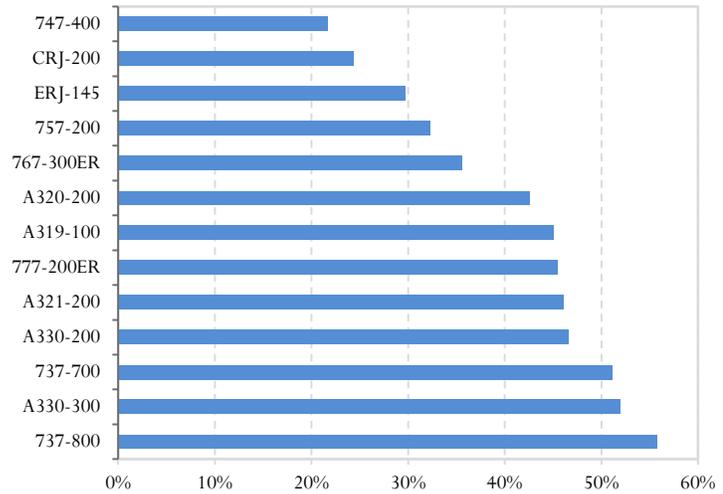
# Basics of Aircraft Market Analysis



## 4. BENCHMARKING AIRCRAFT VALUE RETENTION

The degree of value retention over time is a major factor in determining investment rankings of aircraft. As illustrated in Figure 11, not all aircraft exhibit similar value retention characteristics. The chart compares the market value of a variety of aircraft manufactured in 2001 represented as a percentage of their original base value after 10 years of service. The results indicate a wide disparity in value retention between aircraft types – ranging from a high of 56% for the 737-800 down to 23% for the 747-400.

FIGURE 11 – MARKET VALUE AS PERCENTAGE OF ORIGINAL BASE VALUE



Source: Avitas

Another resource that sheds light on aircraft value retention prospects comes from the AirFinance Journal’s (AFJ) annual investor poll. Each year AFJ polls more than 100 industry experts to assess key value determinants including aircraft residual value retention, investment value, remarketing potential and operational success. The scores from each category are weighted and translated into a rating representing an asset that has the potential to retain its value with relative ease. Although scoring systems have advantages as well limitations, it does enable various generalizations about a specific aircraft types to be translated into an easily absorbed figure. Figure 12 highlights the results from AFJs 2010 investor poll.

FIGURE 12 – AIRFINANCE JOURNAL 2010 INVESTOR POLL



NARROWBODY AND WIDEBODY JETS OVERALL	
737-800	4.95
A320	4.70
777-300ER	4.20
A330-200	3.80
A330-300	3.75
A321	3.70
737-700	3.68
A319	3.65
777-200ER	3.30
777-200LR	3.10
737-900ER	3.05
767-300ER	2.63
A380	2.33
747-400	2.25
767-400ER	2.00
A340-600	1.80
A340-500	1.70
737-600	1.63
767-200ER	1.63
A318	1.37

Maximum score = 5.00

# Basics of Aircraft Market Analysis



## 5. AVIATION VALUE CYCLES

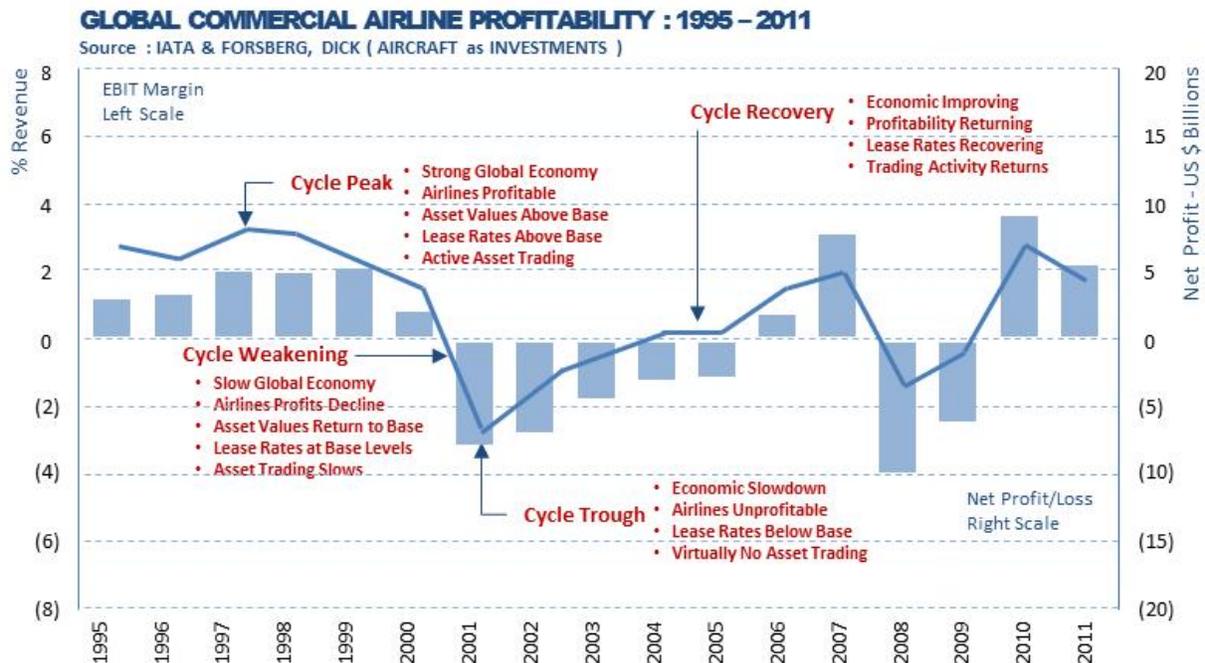
Aircraft investors look to establish a diversified portfolio that optimizes the return on invested capital to be generated from rental income and capital gains. This is especially true of leasing companies, which view an aircraft more as an investment rather than a tool to generate traffic.

Forming a policy to maximize return on invested capital in aircraft requires not only identifying which aircraft make good investments but more importantly identifying the timing of such investment/divestment in relation to the aircraft value cycle.

The history of aviation is replete with cycles that are nothing more than reflections of world economic activity (i.e. global GDP growth rates) as well as reactions to exogenous factors (i.e. war, terrorism, fuel cost, etc.). What distinguishes aviation from other forms of economic endeavor is the extent to which it is cyclical: the magnitude of its volatility and the recurring patterns of its various cycles. That is to say, they are big, they are wide and they tend to repeat themselves each time in disconcertingly familiar way.

As illustrated Figure 13 below; during cycle peaks airlines are generally profitable implying the demand for seats is greater than supply. Under this scenario you'll have a shortage of aircraft leading to increasing values and lease rates. Conversely, during cycle troughs the supply of airplane seats is greater than demand, and during this period you'll see the parked fleet grow, and both lease rates and aircraft values fall.

FIGURE 13- VOLATILITY & THE AVIATION CYCLE

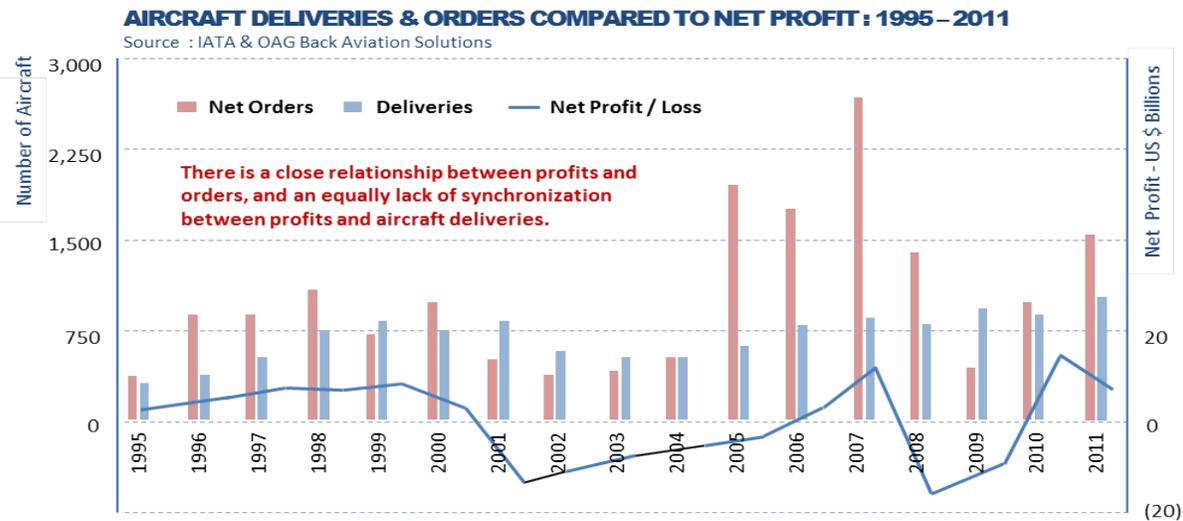


# Basics of Aircraft Market Analysis



Figure 13 merely tells part of the story. Added to the aviation cycle volatility is the asynchronous timing between orders for new aircraft, deliveries, and operating profits – Figure 14 illustrates the lead and lag relationship between orders and deliveries, and between deliveries and profits. Not surprisingly, airlines tend to order aircraft when economic times are good, and manufacturers tend to deliver the bulk of those ordered aircraft during an economic downturn. In fairness to the traffic forecasters, this is purely a function of the long lead-time required for fleet planning and the flexibility to respond to changes in the business cycle.

FIGURE 14- ASYNCHRONICITY & THE AVIATION CYCLE



While economic activity is a key driver of the aircraft valuation cycles, the role of inflation should also be considered by aircraft investors. Aircraft residual values cannot be assessed as a function of original market value instead it is a function of the real future asset value and the rate of inflation over periods of time. In general, falling inflation rates depress nominal residual values while accelerating inflation represents a positive dynamic for aircraft investments.

## Aircraft Investment Perspective

Given that lessors will finance most of their aircraft transactions with a combination of equity and debt, the aircraft's value retention will have a strong influence on both the level of debt advanced and the cost of debt. In general, higher debt portions subject to lower interest rate margins will be advanced for aircraft with lower re-sale value risk.

Furthermore, many lessors will opt for a debt balloon option, which effectively reduces debt repayment during the term. The size of the balloon in relation to the debt portion is considered against the residual value risk of the aircraft. Aircraft with lower residual value risk profiles will generally warrant higher debt balloons than those with higher risk.



# Basics of Aircraft Market Analysis



## 6. BENCHMARKING WHEN TO INVEST IN THE AVIATION CYCLE

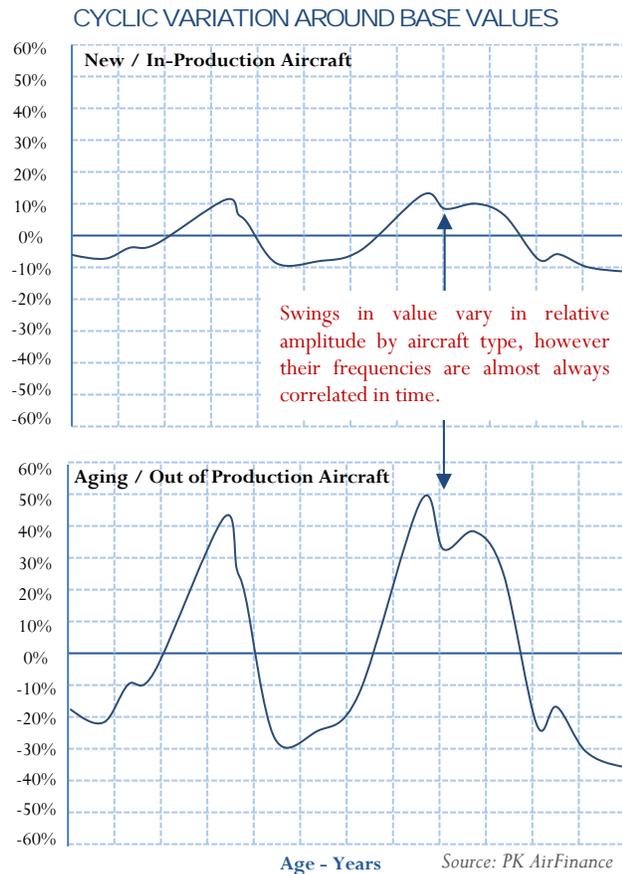
As discussed in the previous section, the economic result from buying and selling aircraft will be greatly influenced by the timing of an investment or divestment in relation to the aircraft value cycle. Aircraft are likely to be in high demand and thus have high values at times when demand for air transportation is high.

To get a sense of the magnitude of cyclical swings in aircraft values, the cyclical variation can be expressed as a percentage of the Base Value. Figure 15 illustrates the volatility among value swings between liquid / in-production aircraft (i.e. 737-800, A320, 777-300ER, A330-300, etc.) versus niche / out-of-production aircraft (i.e. MD-80, 737-300, A310, etc.).

The cyclical variation for popular / in production aircraft exhibit a calmer pattern whereas that of an aging, out of production aircraft tend to be much more volatile over time.

Although the swings in value vary in relative amplitude by type, their frequencies are almost always correlated in time. That is, events affecting individual aircraft value are somewhat linked; the values of all aircraft will tend to go up at times where demand in passenger air traffic increases and airline profitability is strong.

FIGURE 15 – AIRCRAFT VALUE CYCLE VARIATIONS



### Aviation Cycle Perspective – Signals Pointing to an Upturn

- Capital markets opening up
- IATA revising upward profit forecast
- OEMs increase production
- Improvement in international freight traffic
- Capacity increase to outpace demand
- Improving economic recovery in emerging markets
- Overall improving load factors
- Asset values above base values

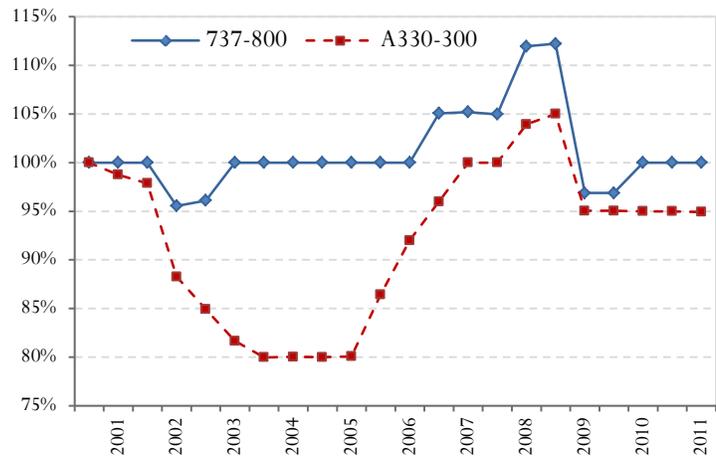


## Basics of Aircraft Market Analysis



For popular, in-production aircraft, one of the most useful metrics that serves as a compelling indicator for an investment entry/exit point is the Market Value / Base Value ratio. Figure 16 illustrates the value movement through the cycle between a 2000-build 737-800 and A330-300 aircraft. Consistent with the volatility in value swings, both aircraft values rise and fall broadly in phase with each other. Both aircraft market values were tracing lows following 2001; however the A330-300 clearly exhibited a more volatile cyclical variation.

FIGURE 16 – MARKET VALUE / BASE VALUE RATIO



# Basics of Aircraft Market Analysis



## APPENDIX A: CASE STUDY – A330-300 MARKET ANALYSIS & COMMENTARY

### 1. Background

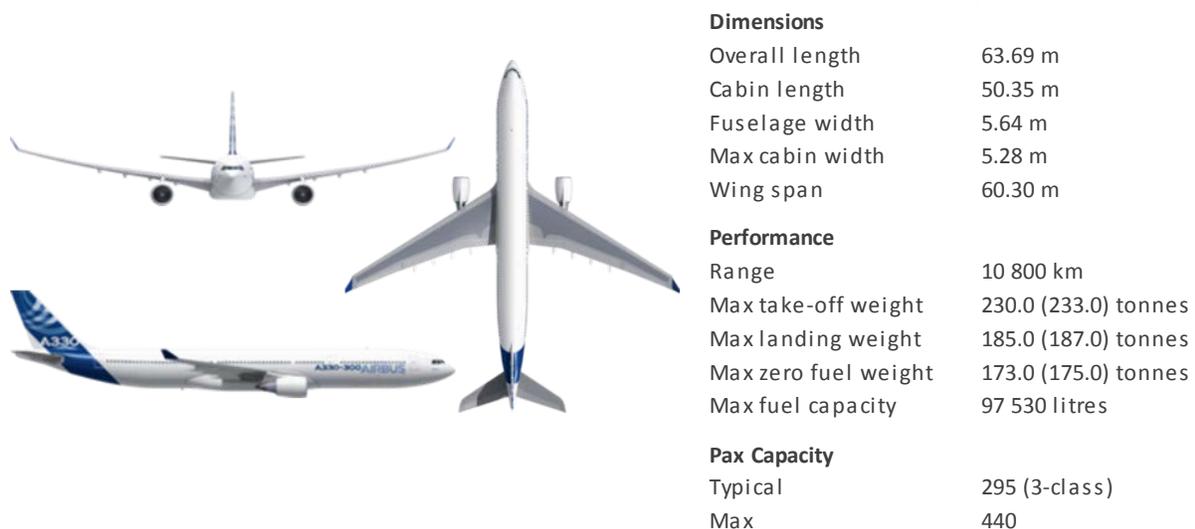
The A330-300 (Figure A1) is a member of the A330 family of twin-engine, medium to long-range widebody aircraft. Both variants are twin-aisle passenger aircraft available with three engine choices: the General Electric CF6-80E1; Pratt & Whitney PW4000-100; and Rolls-Royce Trent 700. The shorter A330-200 is capable of flying up to 6,450nm with about 240 passengers. The longer -300 has a range of up to 5,400nm with 300 passengers.

The A330-300 has been in operation for over 18 years and even today the aircraft has experienced a renaissance due mainly to the general shortage of widebodies, delays in new widebody programs, and limited types to choose from. The delays and lack of choices in new widebody programs has coincided with continued high levels of traffic growth on all long-haul markets, which has increased demand for the A330-300.

While it was originally intended as a regional and medium-haul aircraft for high-density operations, later variants of the A330-300 have been used as long-haul workhorses by several operators. Since entering service the A330-300s gross weight has increased several times; the original maximum take-off weight (MTOW) was 467,460lbs, which has been increased twice, to 507,000lbs and 513,765lbs.

The A330-300 is categorized as a medium twin-aisle aircraft, with two-class seating capacities of 340-380 seats, and three-class capacities 260-280 seats. The aircraft's current primary competitor is the 777-200ER series aircraft. Future competitors of the -300 are the 787-900 and A350-900. Today, the A330-300 remains one of the favorite widebody aircraft among lessors, investors and operators.

FIGURE A1- A330-300 TECHNICAL SPECIFICATION



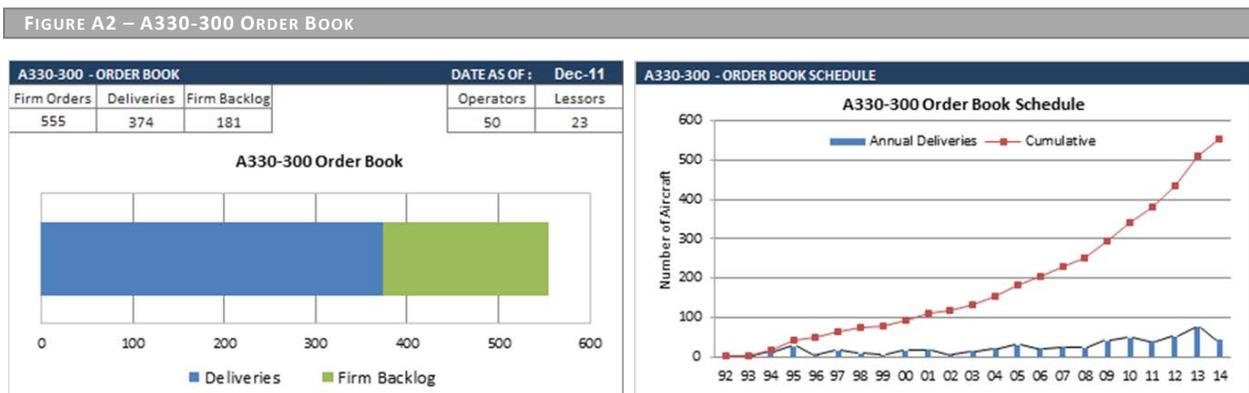
# Basics of Aircraft Market Analysis



## 2. A330-300 Market Metrics

### A. Order Book

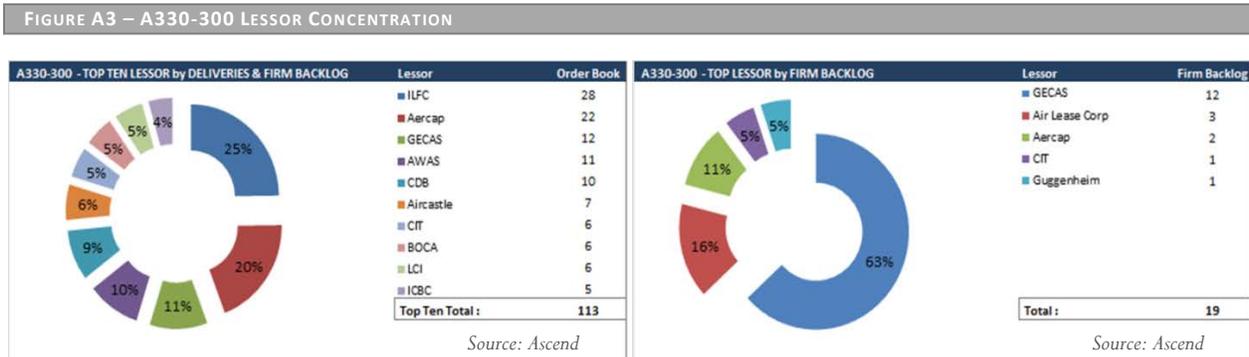
As illustrated in Figure A2, firm orders for A330 300s stood at 555 aircraft as Dec-2011, composed of 374 deliveries and 181 firm backlogs – a good spread for a widebody type. The aircraft is well diversified among operators (55 totals) and lessors (23 totals). The market outlook still looks promising as orders are still being placed for this aircraft type and none have been cancelled or deferred so far.



Source: Ascend

Source: Ascend

As illustrated in Figure A3, the A330-300 is popular with lessors, which are acquiring the aircraft through both speculative orders and through sale and leaseback transactions. There are currently 23 lessors with A330-300 in their portfolios with ILFC being the largest with a total of 28 A330-300s in operation, AerCap (22), GECAS (12), AWAS (11), and China Development Bank (CDB) (10). Those lessors with outstanding speculative orders consist of GECAS (12), Air Lease Corporation (3), AerCap (2) and both CIT & Guggenheim (1). Since lessors generally focus on investing in aircraft with good value retention, a large lessor base helps validate the economic prospects an aircraft can achieve.



# Basics of Aircraft Market Analysis



## Order Book – Commentaries

- Gulf Air ordered 20 A330-300s instead of additional A330-200 aircraft it currently operates.
- China Eastern and its Shanghai Airlines subsidiary reported they cancelled their cumulative order for 24 787-8s while reportedly ordering 15 A330s
- JetStar Asia is increasing its medium-haul fleet this year to four A330s from two.
- Singapore Airlines (SIA) has reached a deal with Airbus to lease 15 Airbus A330-300s, a move that limits its immediate reliance on A350-900s and Boeing 787-9s on order.
- Iberia is buying eight Airbus A330-300s with options for eight more as replacements for 16 higher-fuel-burn A340s.
- Garuda Indonesia has placed an order for four Airbus A330-300s, which it plans to use for routes within Asia, and is converting three previously ordered A330-200s into -300 versions.
- CIT Leasing switched an existing order for an A330-200 to a -300.
- In December, BOC Aviation signed for one A330-300
- GECAS ordered 12 more A330-300 and now has 32 on order.

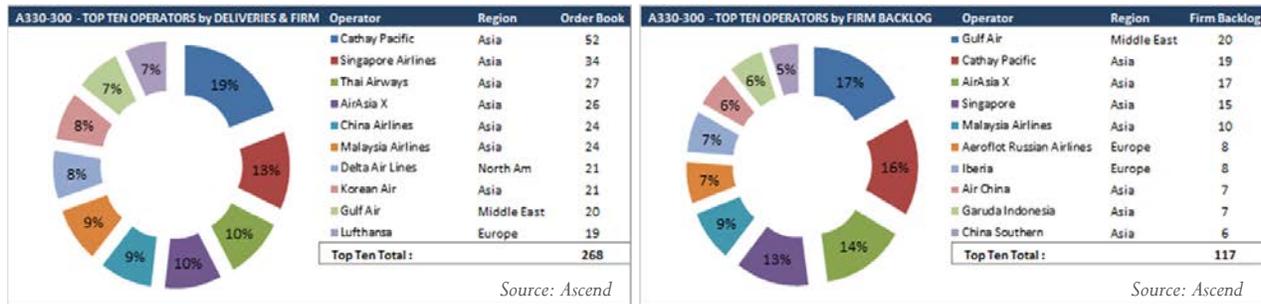
# Basics of Aircraft Market Analysis



## B. Market Penetration

There are currently 55 airline operators with A330-300 aircraft in-service and on-order - Figure A4 illustrates the top ten operators by deliveries and order backlog. Several carriers in the Asia Pacific have large fleets, particularly Cathay Pacific with a total of 52 A330-300s in operation and on firm order, Singapore (34), Thai Airways International (27), AirAsiaX (26), China Airlines (24), and Malaysia Airlines (24). The A330-300 is also popular in the Middle East, with Gulf Air Airways (20) and Saudi Arabian Airlines (16), Qatar (13), Etihad (6). Large orders are still being placed and none have been cancelled so far, which contributes to a stable backlog of 181 aircraft.

FIGURE A4- A330-300 TOP TEN OPERATORS BY DELIVERIES & FIRM BACKLOG



As illustrated in Figure A5, the A330-300 has proven to be a globally popular widebody aircraft. The most prominent region of in-service/on-order A330-300s is found within the Asia-Pacific region with 321 aircraft followed by Europe with 113 aircraft. With a large geographic spread the A330-300 should have good secondary market prospects. The expectation is for the A330-300 to continue being a major player in throughout the intra-Asia region and remain a long-haul flagship of many operators.

FIGURE A5- GEOGRAPHICAL DISPERSION BY DELIVERIES & FIRM BACKLOG



# Basics of Aircraft Market Analysis



## C. Production Stages

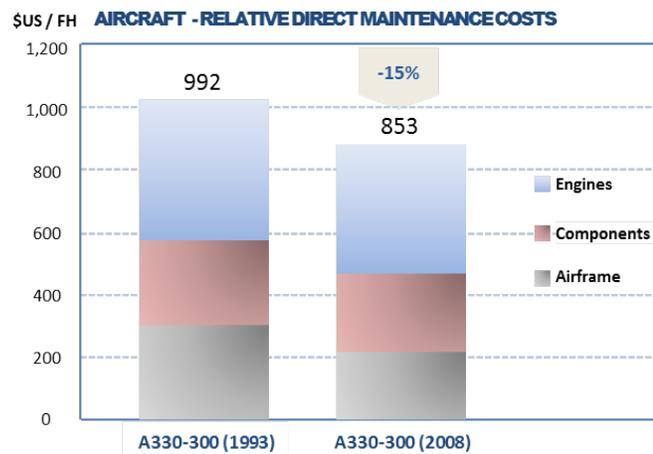
Production rates are currently stable, and the firm backlog highlights that the A330-300 is still proven to be a popular medium-long-haul twin-engine widebody aircraft globally.

**Production Runs** - Initial service entry for the A330-300 took place in December 1994 and forecast is for the aircraft to remain in production until the middle to later part of this decade. Thus, the product life cycle of the aircraft is such that there a significant number in service. Ascend expects the A350-900 to start to replace the A330-300 post 2020. Thus, the next five to seven years will be characterized by a change in the product line.

**Production Cycles** - The A330-300 has had both its weights and thrust increased since its introduction into service, improving its range / performance characteristics. Today Airbus offers two ‘basic’ factory production maximum take-off weight (MTOW) options for the A330-300. These are marketed in European metric units as the standard ‘230-tonne’ aircraft (507,000lbs) and ‘233-tonne’ aircraft (513,700lbs).

In addition, Airbus points out that while the lower take-off weights still exist as certificated options, all recent customers have taken delivery of only the higher weight variants. Figure A6 contrasts the fuel burn and maintenance costs between older and younger production variants.

**FIGURE A6 – A330-300 RELATIVE DMC BY VINTAGE**



Source : Airbus / 2008 Economic Condition, 4.20 FH/FC, 4,000 FH/year

## Production Stage – Commentaries

- Airbus is currently reviewing boosting output of A330s to an increase of 11 aircraft a month from the current 9-10 units a month. The move comes as Airbus sees sustained demand for the A330, even as the A350 development advances. While the aircraft maker once expected A330 demand to soften as A350 entry-into-service approached, that trend has not appeared.

## Basics of Aircraft Market Analysis



### D. Surplus / Shortages

Not surprisingly, the number of A330-300s parked over the past year, only one aircraft that is scheduled to be reinstated in the next couple of months. Historically, A330-300s that have been in storage in the past were for a very short period of time - an indication of the demand for aircraft.

### E. Secondary Market Prospects



At the 2012 Singapore Airshow, Airbus, Singapore Technologies Aerospace, and EADS EFW made a joint announcement launching a passenger-to-freighter conversion program for the Airbus A330 aircraft family. The three said they had "signed a strategic partnership agreement to develop the A330 Passenger-to-Freighter (P2F) conversion program," and that the agreement granted authorization to offer the program. Such a program is expected reignite continued long-term interest in the A330-300 aircraft.

## 3. A330-300 Performance Metrics

### A. Aircraft Specifications

Aircraft Engine Options : The A330-300 aircraft is available with three engine model choices: the General Electric CF6-80E1; Pratt & Whitney PW4000-100; and Rolls-Royce Trent 700 – Figure A7. As illustrated in Figure A8 on the following page, the order book is split between 83 aircraft equipped with General Electric CF6-80E1 engines, 112 with Pratt & Whitney PW4000-100 engines, and 339 powered by Rolls-Royce Trent 700 engines.

FIGURE A7 – A330-300 ENGINE OPTIONS



# Basics of Aircraft Market Analysis



Most of the earlier build A330-300 aircraft were equipped with lower thrust engine models (64,000 lb. – 67,000 lb.), and these variants tend to be overshadowed by the later, more popular higher thrust models (68,000 lb. – 71,000 lb.). Thus, the A330-300s multiple engine variant options divide the fleets into smaller sub-fleets creating market fragmentation, which dilutes remarketability potential.

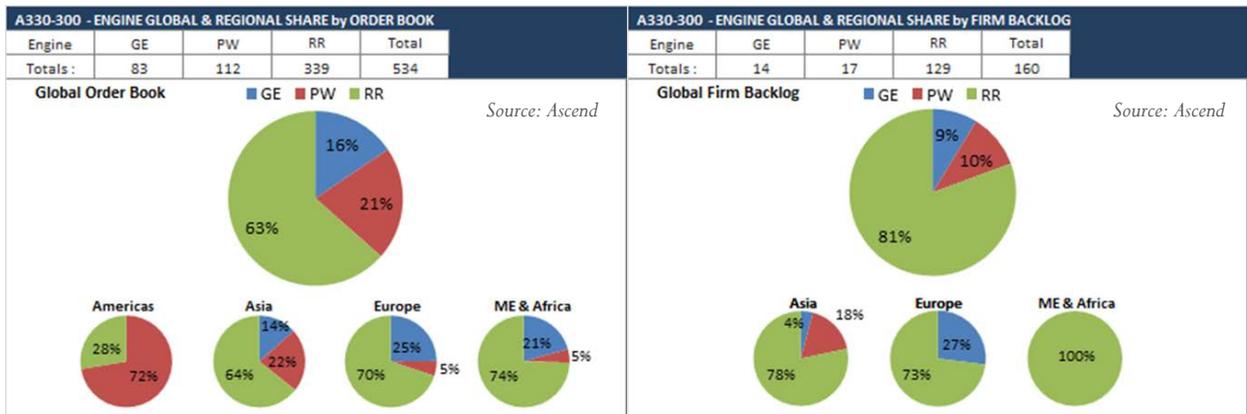
FIGURE A8 – ORDER-BOOK BY ENGINE VARIANT

A330-300 - ORDER BOOK by ENGINE VARIANT													Engine Totals
Aircraft Variant	CF6 -80E1A2	CF6 -80E1A4	CF6 -80E1A4B	CF6 -80E1A3	PW 4164	PW 4168	PW 4168A	PW 4170	Trent 768-80	Trent 772-60	Trent 772B-60	Trent 772C-60	
TO Thrust (lb)	64,350	66,870	68,870	68,350	64,500	68,600	68,600	70,000	67,500	71,000	71,000	71,000	
A330-300	15	18	36	14									83
A330-320					8	23	75	6					112
A330-340									6	29	288	16	339
Sub-Totals :	15	18	36	14	8	23	75	6	6	29	288	16	534

Source: Ascend

Figure A9 below highlights both the global and regional share of each engine model by order book and firm backlog. The most popular global sub-fleet for both categories is the Trent 700, which commands over 63% of the global order book and an impressive 81% of the global backlog. Furthermore, in the two regions where the A330-300 is most prominent (Asia-Pacific & Europe), the Trent 700 has a substantial lead in market share versus its competitors.

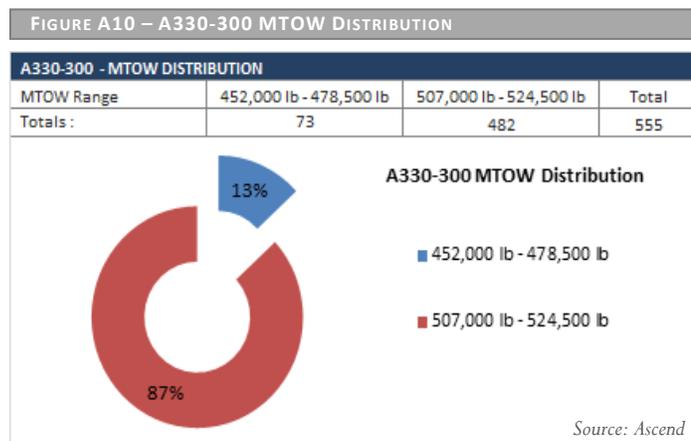
FIGURE A9 – ENGINE GLOBAL & REGIONAL SHARE BY ORDER-BOOK AND FIRM BACKLOG



## Basics of Aircraft Market Analysis



MTOW Categories : The A330-300 was originally pitched as a regional and medium-haul aircraft intended for high-density operations, however since the A330-300 first entered service the gross weight has increased several times; the original Maximum Take-Off Weight (MTOW) was 467,460lbs, which has been increased twice, to 507,000lbs and 513,765lbs. The latter two are 'high gross weight' (HGW) options, which have helped boost payload & range offerings. And while the lower MTOW options still exist as certified options, all recent orders have been for the HGW option. Figure xx illustrates the HGW option as being the most prominent by far, representing 87% of the fleet.



As illustrated in Figure A10, the fragmentation in both the A330-300 MTOW & thrust is heavily skewed toward the earlier variant A330-300 aircraft – the early specification aircraft. In general, these aircraft will tend to be less marketable, and tend have both poorer value retention as well as secondary market prospects.

### Aircraft Specification - Commentaries

- In addition to looking at a possible winglet upgrade for its A330s, Airbus also expects later this year to decide whether to pursue a modification to boost the maximum takeoff weight of the -300 model. The modification would boost the A330-300's maximum takeoff weight to 240 metric tons from 235, and enable a range or payload increase.

### A330-300 Market Summary

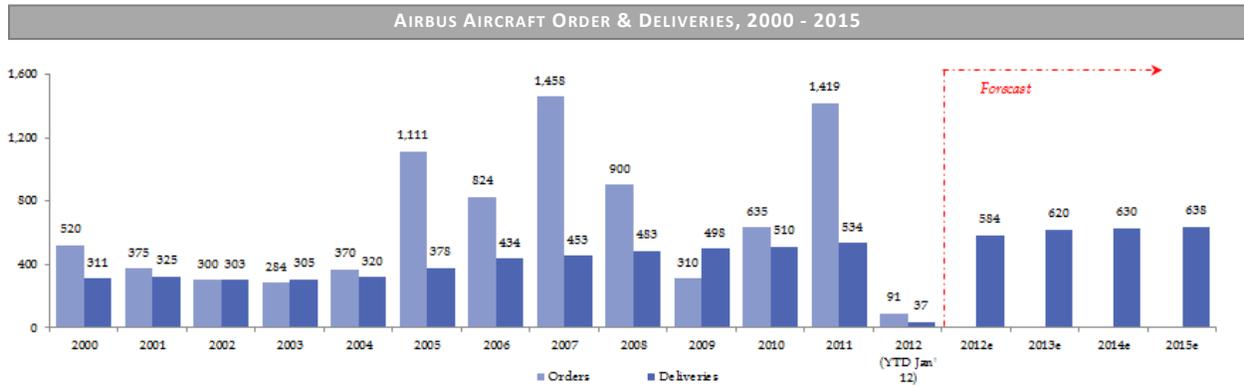
- Cost of ownership, market penetration and acceptance, robust residual value, long product lifecycle, a broad geographical spread of airlines and lessors, and stable production rates
- Cargo conversion opportunities is expected to prolong demand for the aircraft
- Only a few aircraft in storage temporarily and no availability on the secondary market
- If developed, higher MTOW should give true long range & enhanced remarkability
- Family commonality with the A330-200
- Fragmentation when it comes to engine choices and weights.
- A350 coming into the market by mid 2010s, will eventually start to replace post 2020.
- Early production units less marketable due to lower MTOW & thrust

# Basics of Aircraft Market Analysis

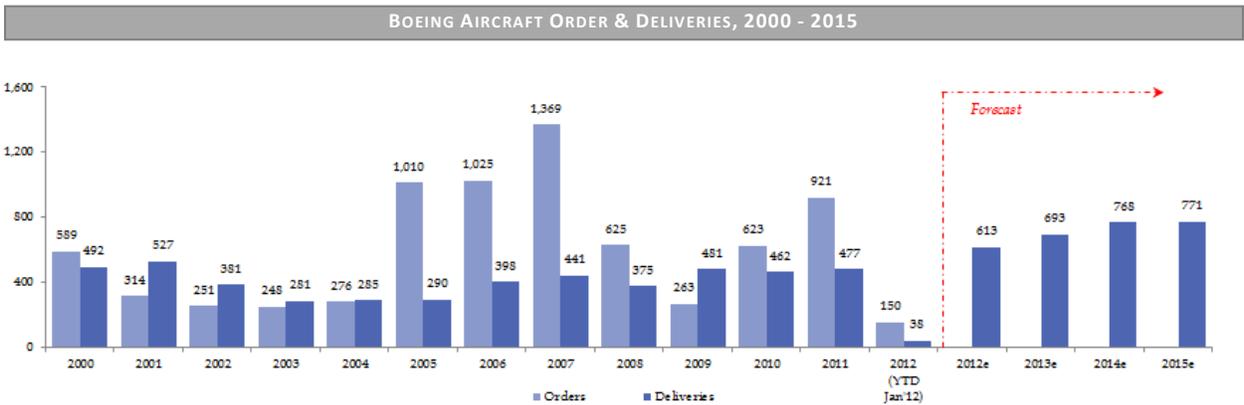


## APPENDIX B: AIRCRAFT MARKET VALUE INDICATORS

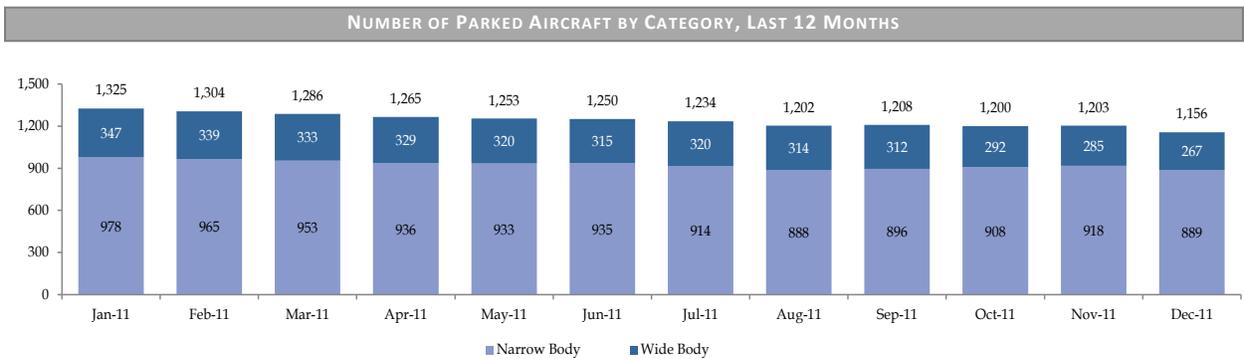
### A. Aircraft Orders and Deliveries as of Qtr 4, 2011



Source: Ascend



Source: Ascend



Source: Ascend

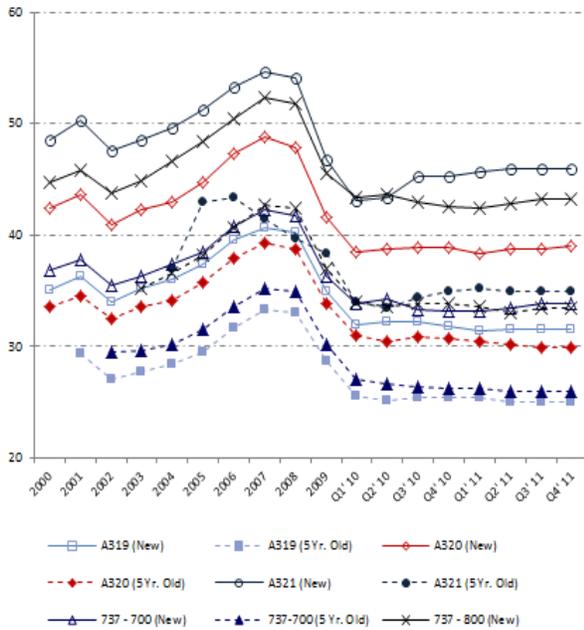
# Basics of Aircraft Market Analysis



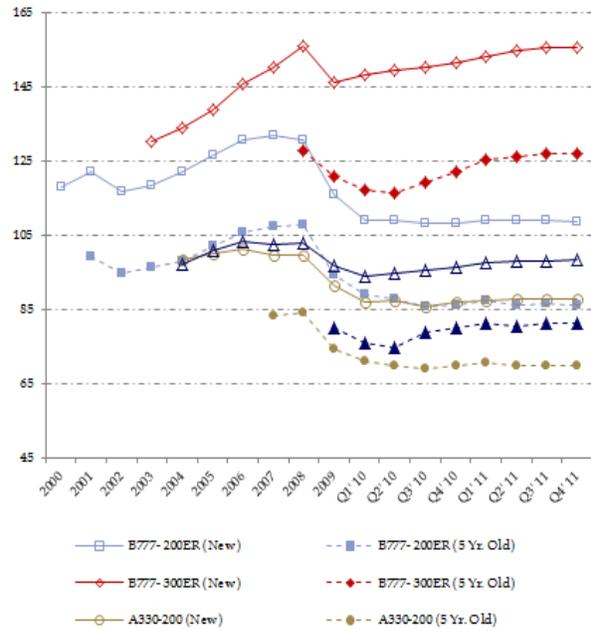
## Aircraft Current Market Values (CMVs) & Lease Rates

Source: AVAC

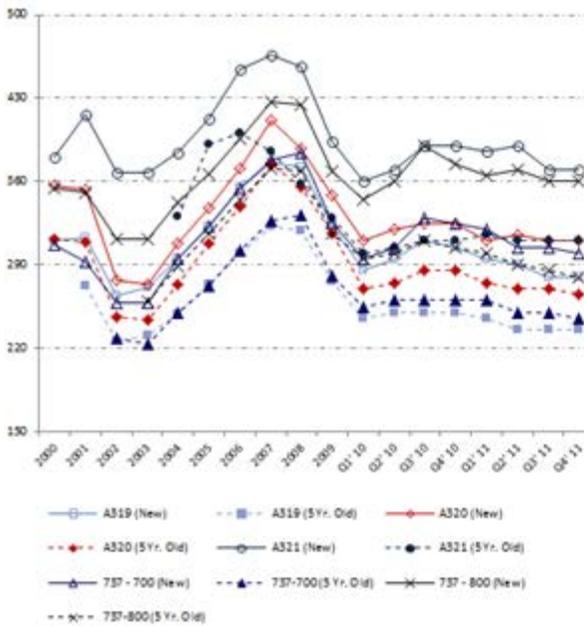
**NARROWBODY – CMV TRENDS (\$M) 2000 – Q4 2011**



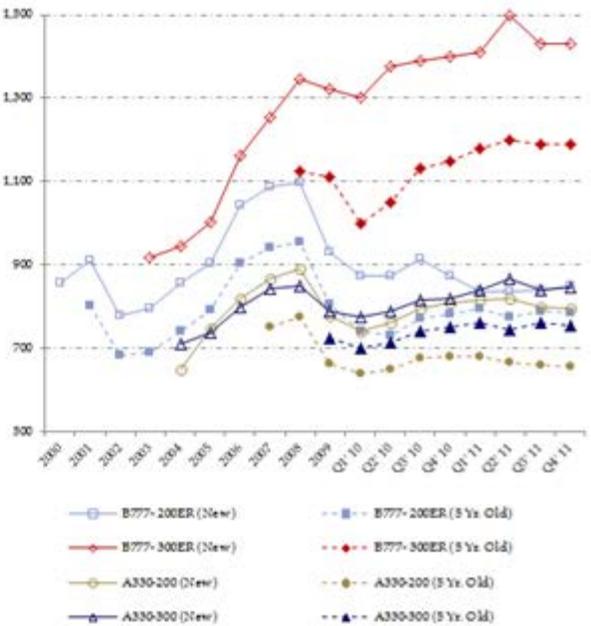
**WIDEBODY – CMV TRENDS (\$M) 2000 – Q4 2011**



**NARROWBODY – Mo RENT TRENDS (\$K) 2000 – Q4 2011**



**WIDEBODY – Mo RENT TRENDS (\$K) 2000 – Q4 2011**



# Basics of Aircraft Market Analysis



## REFERENCES

1. **Forsberg, D.** , *Aircraft as Investments*, <http://www.avolon.aero/ourthoughts.htm>
2. **Leighton, P (The Aircraft Value Analysis Company)**. Assessment of Aircraft Values – Current Market Conditions versus Historical Trends, May 2009
3. **Gallagher, T.** Aircraft Finance and Airline Financial Analysis in the Fifth Cycle of the Jet Age. *The Handbook of Airline Economics*. Section 4, PP 223-234
4. **Hallerstrom, N (PK AirFinance)**. (2000). The Aircraft Value Cycle, pp. 8-12.
5. **Ascend Glossary** <http://www.ascendv1.com/info/glossary.asp>
6. **AirFinance Journal**. *2010 Aircraft Investor Poll*.
7. **Sheridan, M. & Pieniasek**. Residual Values – Forecasting with Confidence, *Aircraft Finance Annual*
8. **Kelly, D (Avitas)**. Forecasting Aircraft Values: An Appraiser's Perspective, *AirFinance Annual*. pp. 24-30
9. **Handbook of Airline Economics**. *Aircraft Finance and Airline Financial Analysis in the Fifth Cycle of the Jet Age*, Gallagher, T. First Edition, 1995, pp. 223-234
10. **Handbook of Airline Economics**. *The Challenge of Airline Finance*, Arpey, G. First Edition, 1995, pp. 235-238
11. **Aircraft Commerce**. *Aircraft Owners & Operator Guide – A330-200/-300*, Issue 457 Apr/May, 2008, pp. 8-39.
12. **Aircraft Commerce**. *Forming a policy to maximize aircraft residual values*, Issue 19 Oct/Nov, 2001, pp. 6-12.
13. **Aircraft Commerce**. *Risks & Rewards of Sale & Leasebacks*, Issue 15, Feb/Mar 1999, pp. 6-10
14. **Aircraft Commerce**. *Stored Aircraft, How Serious is the Industry Surplus*, Issue 37, Oct/Nov 2004, pp. 7-14

About the author:



Shannon Ackert is currently Senior Vice President of Commercial Operations at Jackson Square Aviation where he has responsibility of the firm's commercial activities including technical services, contract development & negotiation, and asset selection & valuation. Prior to joining Jackson Square, Shannon spent over ten years working in the aircraft leasing industry where he presided over technical asset management roles as well as identifying and quantifying the expected risk and return of aircraft investments. Shannon started his career in aviation as a flight test engineer for McDonnell Douglas working on the MD-87/88 certification programs, and later worked for United Airlines as systems engineer in the airlines 757/767 engineering organization. He has published numerous industry reports dealing with aircraft maintenance economics and market analysis, and is a frequent guest speaker at aviation conferences. Shannon received his B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University and MBA from the University of San Francisco.