AIRLINE FLEET PLANNING AND AIRCRAFT INVESTMENT VALUATION

William E. Gibson

AirBusiness Academy, 19 av. Léonard de Vinci, 31700 Toulouse, France

Phone +33 562 121 112, fax +33 562 121 120

william.gibson@airbusiness-academy.com

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Value creation in today's airlines

Are airlines pursuing market dominance at the expense of economic profits? Are the world's airlines generating sufficient profits to sustain private investment? An IATA Economics Briefing (Pearce and Smyth, 2006) analyses the question on a macro basis, and concludes that the answer to the second question is clearly "no". The study looks at investment returns offered by various players in the aviation industry and finding that the airlines produced a staggering $11.1 billion annual shortfall in value creation relative to investor expectations, over the cycle between 1996 and 2004. The authors state that "the airline industry has been unable to generate sufficient returns for existing investors," creating the danger that future investment will be "constrained or delivered inefficiently, or both." To confirm this appraisal at the micro level, we look at a group of 16 listed airlines in various regions, analysed in the spring of 2007 by Bloomberg, presented in Figure 1.

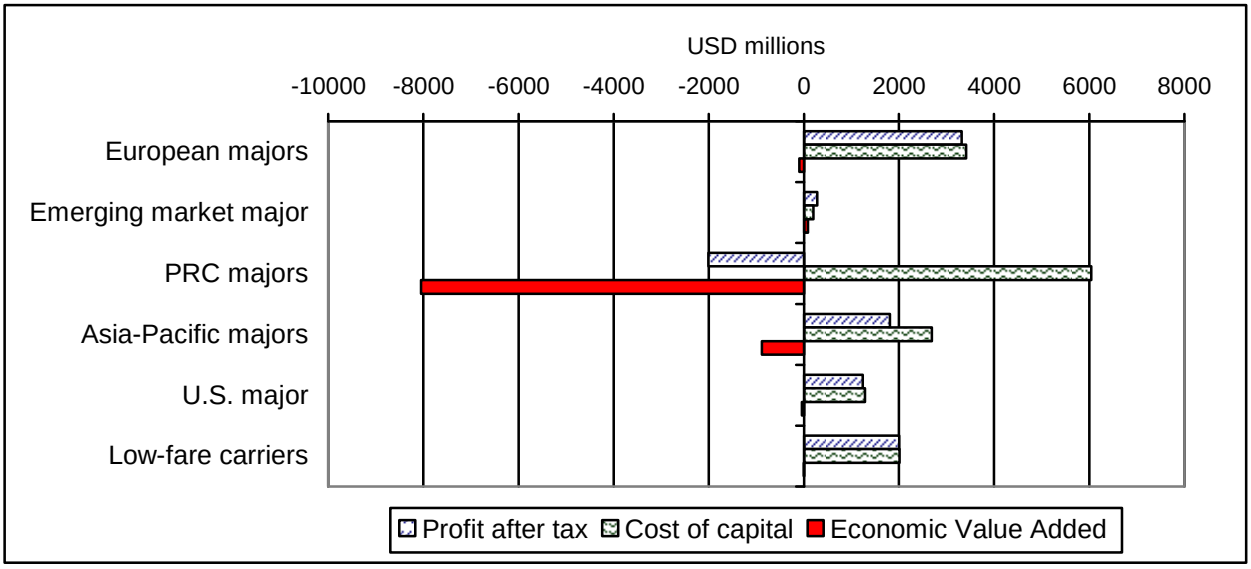

Figure 1: 2006 profit, cost of capital, and EVA among 16 major airlines

The majority of the 16 companies analysed earned close to their cost of capital in 2006, a boom year in the airline industry. The major exception is major (network) airlines in the People's Republic of China, which are experiencing the effects of double-digit traffic growth and attendant investment requirements in what is still a highly-regulated market. A second exception is in the Asia-Pacific region, where the two airlines analysed generated insufficient profits on an operating basis to cover their capital charges. Given the promise of the Asian region for growth and aircraft deliveries, this situation raises questions about investment discipline and analysis techniques.

Low-fare airline performance

In recent years many have countries (including the PRC) have further crowded the market by allowing or encouraging the creation of "low cost", or more accurately low-fare airlines, which

operate linear point-to-point networks with high aircraft utilisation as a central goal, achieve high load factors through demand stimulation, and lower unit costs through optimal utilisation of the aircraft and careful cost management. Figure 2 shows that low-fare carrier performance in 2006 was substantially better than network carriers', though more problematic in emerging markets such as South America and Southeast Asia.

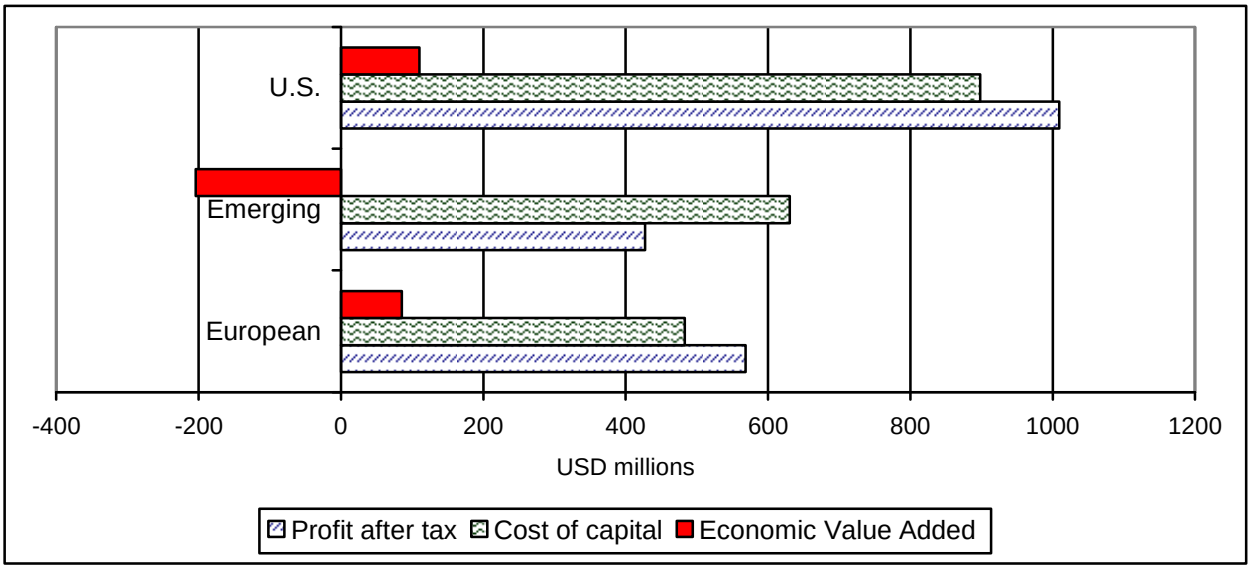

Figure 2: 2006 profit, cost of capital, and EVA among five low-fare carriers

How, then, do today's airlines analyse investments in the context of fleet planning? In this complex industry, is the economic analysis performed with sufficient rigour? Are their new paradigms emerging which can allow managers to improve analytical techniques and financial performance?

Summary of previous research

Two key surveys of financial managers, Graham and Harvey (2001), Gibson and Morrell (2005) found that managers strongly prefer Discounted Cash Flow (DCF) techniques such as Net Present Value (NPV) and Internal Rate of Return (IRR) to evaluate investments. Figure 2 shows substantial similarity between airline preferences and practices among U.S. corporate financial managers, with three differences.

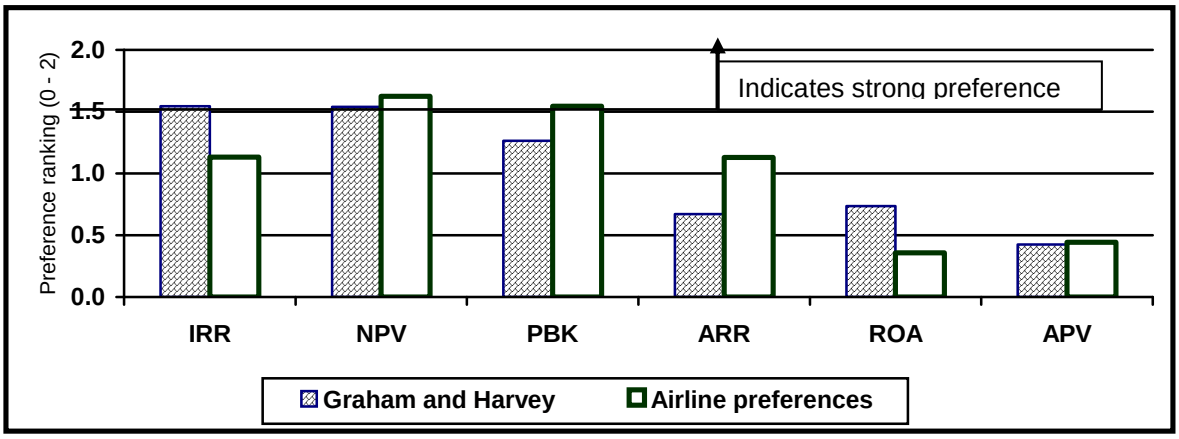

Figure 3: Preferences for valuation techniques in Graham and Harvey (2001), Gibson and Morrell (2005)

First, airline managers have a stronger preference for payback (PBK) and Accounting Rate of Return (ARR) than their colleagues in the general business community. Second, they prefer NPV to IRR, implying that they are willing and able to calculate the airline's cost of capital needed for the NPV calculation. Finally, airline managers show a lower preference for Real Options Analysis (ROA), in spite of the significant and increasing optionality present in the market for civil aircraft. Such options include straight purchase options, family conversion options, and extendible operating leases, as well as return options on purchased aircraft.

For an NPV calculation, companies must have reliable estimates of several parameters:

- up-front investment required (aircraft price and associated EIS costs)
- cash inflows from operations
- cash operating costs (COC)
- terminal value for the project, commonly represented by aircraft Residual Value (RV).

Policy inputs include the length of the investing horizon and the discount rate, or Cost of Capital, used to establish a required rate of return for the project. A method for dealing with uncertainty in the cash flows is the third key policy input.

Gibson and Morrell (2005) identified WACC as the most common method for estimating the cost of capital is WACC, although many "sometimes" use the cost of borrowing as a discount rate. Regarding the cost of equity estimate, airline preferences were evenly divided between the statistical Capital Asset Pricing Model (CAPM) method, and a more subjective method based on experience.

Treatment of risk in the airline community is similarly based on subjective estimates, and preference for 'sensitivity analysis,' varying risky parameters either one by one or in grouped scenarios is surprisingly unpopular among airline managers.

The preferences expressed open the question of how valuation techniques are used in the process of selecting among fleet alternatives and justifying projects to company management and boards of directors. The subjectivity of methods used to estimate key parameters such as discount rate and assess the risk of investment projects brings up the possibility of the types of biases explored in Prospect Theory and behavioural finance. The interviews performed for the current paper attempted to elucidate these two questions.

Interview methodology

We interviewed 12 senior managers working in European airlines, aircraft manufacturers, and financial institutions, using broadly the same questionnaire for each manager, to allow comparison and contrast of views on the topics raised. The airline managers represented both network and point-to-point low-fare carriers. We found the level of willingness to explore valuation methods very high, in spite of the confidentiality of many of the topics raised. Senior airline managers in particular expressed the wish to see more rational valuation methods adopted worldwide in an industry many see as lacking financial discipline.

The interviews covered a list of 40 questions, in three broad areas:

1) Positioning and use of financial evaluation in the fleet planning process
2) Parameter estimation and decision-making processes
3) Treatment of uncertainty in the analysis

An additional set of questions, specifically posed to the financial managers from airlines and financial institutions, explored the interactions between investing and financing decisions.

Three paradigms of economic valuation

Through the interviews, we identified three very distinct approaches to fleet investment valuation. The first is a highly quantified, scientific approach to modelling operations, combined with a classical use of NPV for project justification: we refer to this as the neo-classical method. A second approach, dubbed risk-quantitative, places risk assessment and cash-flow volatility at the heart of the analysis. Finally, we discovered a revolutionary approach to investment appraisal, in which aircraft are viewed as a commodity-like variable input to operations, embedding financing into airline strategy to obviate the need for classical valuation. Adhesion to these paradigms was not necessarily specific to individual companies: rather, we found aspects of each paradigm expressed by managers of the different airlines and financial institutions interviewed. This suggests that the valuation paradigms are not immutable doctrines within companies, but rather form the basis for an on-going debate informing strategic and tactical choices among the various valuation options

available to companies, depending on the company's situation and evolving business strategy. In the following pages, results from the interviews are mixed with findings in prior research to form a picture of the three paradigms.

Neo-classical: NPV as project justification

Positioning of the economic evaluation

Central to this paradigm is a broad strategic view of market segments in terms of origin and destination (O/D): are passengers coming to our hub, or travelling over it to some final destination? The question of whether passengers are willing to pay premium fares for convenient connections over an airline's hub is one which bedevils the airline industry today; aircraft manufacturers have effectively bet billions of dollars to develop aircraft which best suit point-to-point, or alternatively hub to hub, operations.

In the neo-classical model, each segment is analysed in terms of the profit potential for the airline:

- Short haul to short haul (SH:SH): passengers connecting from one short flight of around three hours to another
- Short haul to long haul (SH:LH): locally originating passengers travelling over our hub to a more distant area
- Long haul to short haul (LH:SH): distant travellers seeking a destination within around three hours of our hub
- Finally, the two segments of long-haul (LH) and short-haul (SH) passengers originating or completing their passage at our hub

This is clearly the model of a network carrier, flying predominately round-trip passengers. Implicit in this analysis is the insight that although the passenger flies round-trip, the desirability of our service depends essentially on the specific origin (and of course, destination) of the traveller. A further segmentation is made according to cabin class, and in the most detailed case, to fare class under a revenue management policy.

The neo-classic paradigm thus selects the most desirable traffic to capture, based on market strategy:

	Business/First class	Premium economy/Business	Leisure
SH:SH			
SH:LH			

Profit potential of each segment determined on a strategic (long-term) basis

LH:SH			
LH			
SH			

This analysis has been extended in recent years by "Fifth Freedom" carriers such as Emirates, which add LH:LH traffic over the local hub, re-directing traditional traffic flows (notably Europe-Asia, but also North America-Asia) through small home-market hubs in a rather dramatic way.

Once profitable markets have been selected, the competitiveness of our airline and thus the traffic we capture is seen as a function of the Quality Service Index, discussed (for example) in a recent study of Asian carriers published on the web by Karvy Global Services (2006). The entire O/D network can theoretically be analysed in terms of competing airlines' attributes, according to the following equation:

$$QSI_i = \frac{Index_i}{\sum_{i=1}^{n} Index_i}$$

Where

$$index_i = Freq^{k1} \times Cap^{k2} \times Rank^{k3} \times Time^{k4} \times Dist^{k5} \times Fare^{k6} \times CT^{k7} \times DT^{k8}$$

Where:
n = Total number of O/D services offered on the route
Freq = Frequency offered on each route
Cap = Capacity offered
Rank = a ranking such as those provided by SkyTrax (www.airlinequality.com)
Time = total O/D travel time
Dist = Trip distance
CT = Connection type: direct or connecting
DT = Desirability of departure time

The neo-classical model is characterized by a highly quantitative approach to competitive performance on the routes selected for analysis. In mature markets, a portion of the network can be modelled and results calibrated using historical traffic patterns available from so-called Market Information Data Tape (MIDT) databases. As the Karvy study points out, in many of the world's markets, MIDT data is either scarce or non-existent today.

The output of such a study is O/D market share over the network under consideration, an extremely useful set of data points which then can be applied to traffic estimates to generate revenue for the cash flow study. However, the calculation is fraught with complexity and potential errors. In addition to tremendous complexity of such a route-by-route analysis and the challenges of estimating the QSI market parameters, the calculation requires a particular schedule and capacity

(i.e. fleet assignment to routes) as an input. This leads to an iterative process matching various fleet alternatives to projected airline schedule, with the twin objectives of minimising spill of the most desirable segment of passengers, and minimising the number and cost of fleet in operation for the study. To reduce the complexity, firms often study one portion of the network at a time, but today the more ambitious are moving toward programmes capable of modelling the entire network.

The bulk of the analytical effort in the neo-classical approach is applied to this competitive market and fleet assignment analysis. When the complex iterations have reached a satisfactory balance of spill and investment requirements, the models output cash flows for the years under consideration. The analysis is a point-in-time, rather than time series, view. The model is run for several years over the investment horizon, and the resulting cash flows interpolated to form a time-series view of revenue, costs, and cash flow.

Estimation of the parameters

The QSI market share calculation requires estimation of many competitive parameters, mentioned above. One key uncertainty concerns the evolution of services to be offered over the investment horizon by competitors on each route: do we use current conditions, and if not, how to estimate service offerings from new entrants to the market? Managers interviewed tend to use current conditions, for the very good reason that hard data can be used to validate the parameters. This methodology, however, may not perform well predicting competitive positions with the emergence of new business models, such as point-to-point or fifth-freedom carriers. These airlines have dramatically changed the shape of air traffic networks over the last few years. Their continued success, as well as the emergence of single-class point-to-point long haul carriers appears set to further alter the game in the near future.

Costs tend to be estimated using internal historical data, where available. For new aircraft types, most managers “listen politely” to the claims of aircraft and engine manufacturers regarding cost behaviour, and then develop their own view of the expected unit costs, extrapolating from current performance and manufacturer performance data such as block time and fuel burn.

In the neo-classical paradigm, aircraft residual value (RV) estimates come from third-party providers such as appraisal firms. A common approach of appraisers is to develop “hard” and “soft” values using statistical estimates of historical second-hand aircraft price volatility. Prudent managers include the soft values in sensitivity analysis, to avoid excessively optimistic views.

The up-front investment requirements (aircraft price and entry into service (EIS) costs) are the great equaliser: as the cost is borne at the outset of a project, an unsatisfactory NPV can be made possible

with a suitably reduced aircraft price. The initial price offer from manufacturers is often used as the input to the cash flow, and represents a starting point for negotiations.

Policy issues

Selection of an appropriate investment horizon strongly conditions the attractiveness of investments under NPV rules; the horizon also dramatically affects the importance of the Residual Value assumption in the overall valuation. Large civil aircraft design lives are around 25 years, but the market values of used aircraft show dramatically different patterns, depending on the success of the aircraft type around the world. As the graph below demonstrates, in a typical valuation for an European narrow body operation, the present value of aircraft RV can represent nearly 45% of the total value creation for a 7-year study, decreasing to 18% if the horizon is extended to 15 years.

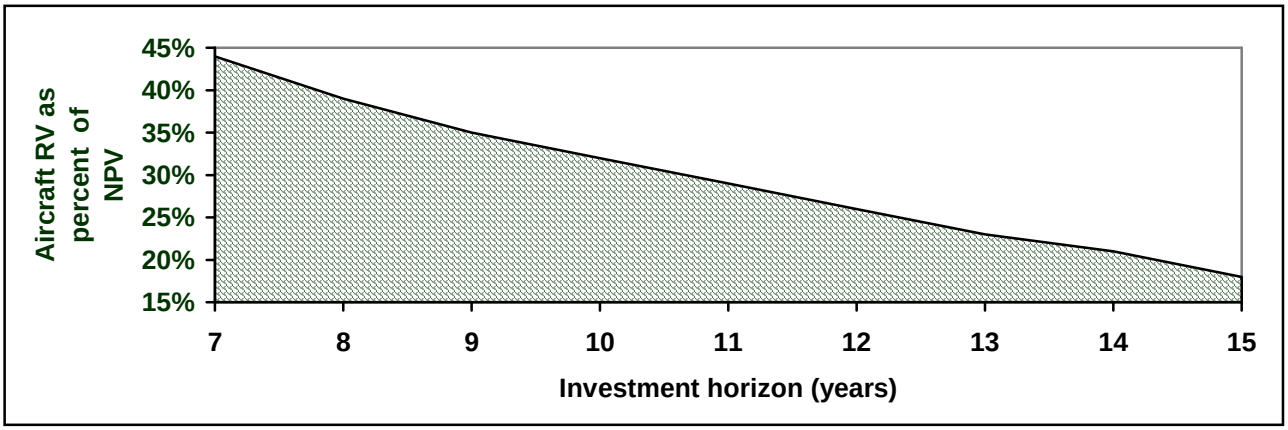

Figure 4: Impact of Residual Value on Net Present Value

Airlines using very short investment horizons might ask themselves whether they are primarily in the business of operating aircraft, or trading them. Depending on the fleet under consideration, companies using the neo-classical paradigm tend to adopt 10-15 year investment horizons, implying that the airline will renew its fleet sometime toward the end of this horizon. Even at 15 years, the RV assumption can “make or break” an investment justification.

The other major policy input to the decision is the discount rate or cost of capital. Very much in line with traditional valuation theory, the neo-classical paradigm uses the weighted-average cost of capital (WACC) as the cost of capital. Managers interviewed stressed the importance of using target (presumably lower than current) debt ratios to avoid under-estimating the cost of capital by over-weighting the cheaper cost of debt in the calculation, relevant advice to the highly-leveraged airline industry. Secondly, they tend to look to other industries’ shareholder returns to estimate equity investors’ expected returns, rather than use historic, often low or negative, airline returns. Finally, the WACC is adjusted upward to reflect the specific risk of the project, based on a subjective estimate. These practices imply that there is a great deal of subjectivity in the WACC

estimation.

Decision-making

In this paradigm, various fleet alternatives are always compared with the "do-nothing" scenario of continuing with the current fleet. This has the advantage of using hard revenue and cost data from existing operations as a benchmark to which alternatives can be compared. Preliminary decisions are made by committee made up of Commercial, Network Planning, Operations Planning, and Engineering departments.

The final calculation of cash flow and NPV is often done by a group of financial analysts embedded in the Fleet Planning department, raising interesting questions about asymmetries of information between Fleet Planning and Finance. Several managers stated that they often discovered errors in this analysis. The analysis is then typically reviewed and discussed with Finance, whose primary concerns include the marketability and thus the "bankability" of the aircraft. The details of the analysis are rarely examined by the Finance group, which is mainly responsible for treasury, business planning, and financing of the aircraft. A board paper is prepared, including a business rationale and key investment analysis results including both NPV and payback, and presented to the board of directors.

Financing arrangements for the aircraft eventually approved for acquisition are kept strictly separate in this paradigm, consistent with classical finance theory. Managers expressed the opinion that fleet financing is rather tactical and pragmatic than strategic, based on concrete concerns such as availability and cost of financing alternatives, which may change dramatically based on market conditions and airline performance as deliveries approach. Further, fleet financing decisions combine quantification (comparing NPV of term sheets) with qualitative judgement and intuition. The judgement and experience comes into play particularly in the area of choosing between fixed and floating-rate debt, because interest-rate movements are rarely amenable to quantitative forecasting techniques in the medium-term.

Treatment of risk in the analysis

Gibson and Morrell (2005) found that the most common way to account for risk in airline investment analysis was to "artificially" raise the discount rate, making investment projects more difficult to justify. This is indeed the approach preferred in this paradigm.

In the neo-classical approach, sensitivity analysis of critical parameters such as fuel price, currency rates, and maintenance cost is performed. The analysis is thus subjected to "stress testing," that is,

application of worst-case parameters to the model. The project will be rejected if the NPV does not hold up under worst case scenarios. The parameters are identified for sensitivity analysis by testing the impact each had on the result, with a second criteria of likelihood, a practice consistent with modern risk management practice.

None of the managers interviewed took an explicit view of the impact of the economic cycle on cash flow or aircraft values, but rather, assumed a mean-reverting cycle with a clear central tendency or average growth rate. This approach is very much at odds with current practices in the financial community (particularly among operating lessors), who model cyclical trends and market timing as a central aspect of their business models.

When asked about the use of Monte Carlo (MC) analysis to quantify risk, managers expressed a clear preference for an approach which allowed them to build a "mental model" of the potential outcomes. This is usually done by running the model with a number of intermediate data points between the extreme high and low values for the sensitive parameters, generate a scatter diagram or radar graph to represent the risk visually in a scatter plot to show the outcomes graphically. No central tendency is used to create these charts, that is, each data point is considered equally probable. The claim was consistently made that this type of sensitivity approach was less of a black box than Monte Carlo, and easier to grasp than such probabilistic techniques. Several managers in various airlines expressed a pronounced hostility to MC, saying that using it was akin to abdicating responsibility for the analysis and resulting recommendations. Assumptions of positive or negative correlations are often used in the analysis, the most common being to consider demand as negatively correlated with fare or yield.

The neo-classical approach to modelling risk is thus a sort of intuitive statistical approach, where dispersion and correlations are applied to potential outcomes, which are used to capture visually the risks of the project, as opposed to a quantitative, MC-type approach.

Real options analysis is similarly only used in a limited and intuitive way under this paradigm. These managers often use decision trees, for example, to value aircraft family conversion options under different market growth and traffic scenarios. Each market scenario is weighted with probabilities and matched with various aircraft choices: the result is an expected NPV for each aircraft choice, used to guide the process of final aircraft type selection among narrow body aircraft families. This approach is certainly close to valuing flexibility using real options, although flexibility is valued implicitly by comparing expected NPV under various fleet scenarios, rather than assigning a specific dollar figure as in real options analysis.

Consensus among these managers in various airlines is that risk analysis is primarily used to build understanding and the dynamics and "get a mental sense of the trade-offs" a benefit many find absent in statistical and options pricing approaches. The intensive quantification of the market analysis phase is absent in the valuation. One manager made the comment that simplicity of analysis can be an advantage "in a world of imponderables" that characterizes today's airline business.

Risk quantification as a negotiating strategy

The second paradigm identified is dramatically different from the neo-classical approach in three ways. First, there is a far higher level of information-sharing between the airline and its potential suppliers regarding the valuation; second, there is no detailed market analysis or route-by-route build-up of revenue and cost. Rather, an assumed average stage length is used throughout the cash flow model; and third, statistical risk modelling is placed at the centre of the analysis. This paradigm is often associated with start-up airlines, whose initial operating strategy is based on a business plan rather than historical data and previous company experience. We note in passing that airlines of this sort in every region of the world form an important part of new orders for jet aircraft every year, particularly in the booming market for short to medium-range aircraft of 125-175 seats.

<u>Positioning of the economic evaluation</u>

In this paradigm, the fleet plan and valuation is one aspect of the company's business plan. A typical airline business plan format might contain the following headings which broadly cover strategy, operations, and financial forecasts.

- Business model – a simple formulation which defines the programme for growth
- Market segmentation and service concept
- Industry analysis in the regions to be served
- Marketing strategy and SWOT analysis
- Route structure and schedule development
- **Fleet plan and aircraft evaluation**
- Market share & revenue forecast
- Operating plan and expense forecast
- **Financial model: pro-forma financial statements and valuation**

This list is a more or less sequential "step-by-step" approach, with various steps iterated based on refinement of the financial projections. Since the fleet plan *follows* the route and schedule development, the implicit assumption of is that aircraft of various sizes and ranges are available to suit any particular market strategy. The aircraft evaluation is an element of the overall business plan and performance is reflected in the company financial forecast, rather than being a separate analysis as in the neo-classical paradigm.

Many recent airline start-ups have applied a rigorous "commoditization" of the airline product, offering dramatically simpler services and unbundled pricing, charging all ancillary services to those who are willing to pay for them. This type of business model is best suited to an aircraft which is also a "commodity," well-proven and available in large quantities in relatively standardised configurations. The selection of potential aircraft to suit the strategy is often one of the first steps for these airlines, with a narrow range of potential aircraft and specific configurations identified (maximum seat count, no hot galley for example) forming part of the business model itself.

In this type of operation, the evaluation of the aircraft (resulting in an NPV) is not used primarily for financial justification of the acquisition inside the airline. Rather, its essential use as a bargaining tool to obtain the lowest possible investment needed to fulfil the business model requirements. The risk assessment is used to demonstrate the variability of project returns to the manufacturers, and to extract concessions (in price and performance guarantees) aimed at limiting the downside risk for the airline investors.

Managers adopting the risk quantification paradigm emphasise the need to level the playing field between different aircraft, that is, to get to operational figures at a sufficient level of detail to correctly assess the risks. To prepare the negotiation, these managers work closely with manufacturers in order to gain agreement (more or less grudging) on the fundamental parameters driving the cash flow, and establish a base case NPV for the project, used as the first "bargaining chip" with the manufacturers.

The sensitivity analysis is at the heart of this paradigm. One manager cited an example where over ten risk factors were identified and quantified one by one, with the impact and probability of each high and low scenario estimated by the airline's management. In addition to analysing classic cost items such as fuel cost and maintenance cost, the risk quantification paradigm includes quantification of revenue items such as the projected growth rate, and the value of the last available seat in the aircraft. This points up another difference with the neo-classical model, which tends to concentrate on cost comparisons between aircraft to establish valuation differences. Marginal revenue from the last seat of the aircraft is usually either ignored because the maximum load factor or spill calculation precludes a full aircraft, or assumed to be very low, since traditional airlines often sell "excess" capacity at a low cost to "bucket shop" agencies which sell the seats on at bargain rates. On the other hand, most of today's airlines, and certainly the point-to-point low-fare carriers, are strong revenue managers in the sense that their scheduling and reservation systems tend to increase the fare as the date of travel approaches. The sensitivity NPV for the last seat in the

aircraft generates two NPVs, one assuming that the seat is sold at a relatively high fare under revenue management principles, and a second assuming that this seat is sold at the overall average fare.

Each risk factor is thus quantified with probabilities, yielding an expected NPV benefit or penalty to the manufacturer's aircraft, based on the fact that NPV is perfectly comparable to aircraft price. They are openly discussed with the manufacturers, another major difference from the neo-classical paradigm. The final assessment (benefit or penalty, and how much) is a matter of judgement of the airline management, and discussed with the manufacturer to justify the bargaining position.

To keep costs low and the service level consistent, many point-to-point carriers operate a single aircraft type when possible. A manufacturer who wishes to penetrate one of these carriers is often subject to a third difference in the valuation, in the form of an explicit switching cost.

Thus, the discussion with the manufacturers has three pillars: the base case NPV difference, sensitivity NPV difference, and switching cost all form the basis for discussion and negotiation.

Estimation of the parameters

While there is a high level of information sharing with suppliers for the purposes of validating aircraft performance and cost assumptions, the primary sources for aircraft operational cost data are not the manufacturers themselves, in spite of the fact that the airlines frequently have no operational experience of the various aircraft under consideration. Rather, offers are sought directly from suppliers of inputs such as maintenance based on on-going negotiations with these suppliers. Internal operating costs and revenue, and the associated risk probabilities and impacts, are derived from management experience and brainstorming. Finally, aircraft residual value estimates are sought from appraisers and/or official aircraft trading organisations. Parameter estimation is thus similar to the neo-classical approach (i.e., use manufacturer data only for aircraft performance-related parameters), but without the benefit of extensive operating experiences to validate the figures. Room for error is presumably larger, and the risk quantification all the more relevant for these airlines.

Managers using the risk-quantitative paradigm declined to comment on the cost of capital and investment horizon used for the study: even in this transparent approach, certain parameters are not discussed.

Decision-making & treatment of risk

After reaching a consensus with the vendors regarding risk parameters, an internal analysis is performed and presented to the board. Based on the high, low and most likely parameter states, a Monte Carlo (MC) analysis is performed putting all the variables together. The output of the MC analysis is a cumulative probability chart, with project value (NPV) charted against cumulative probability, as shown below.

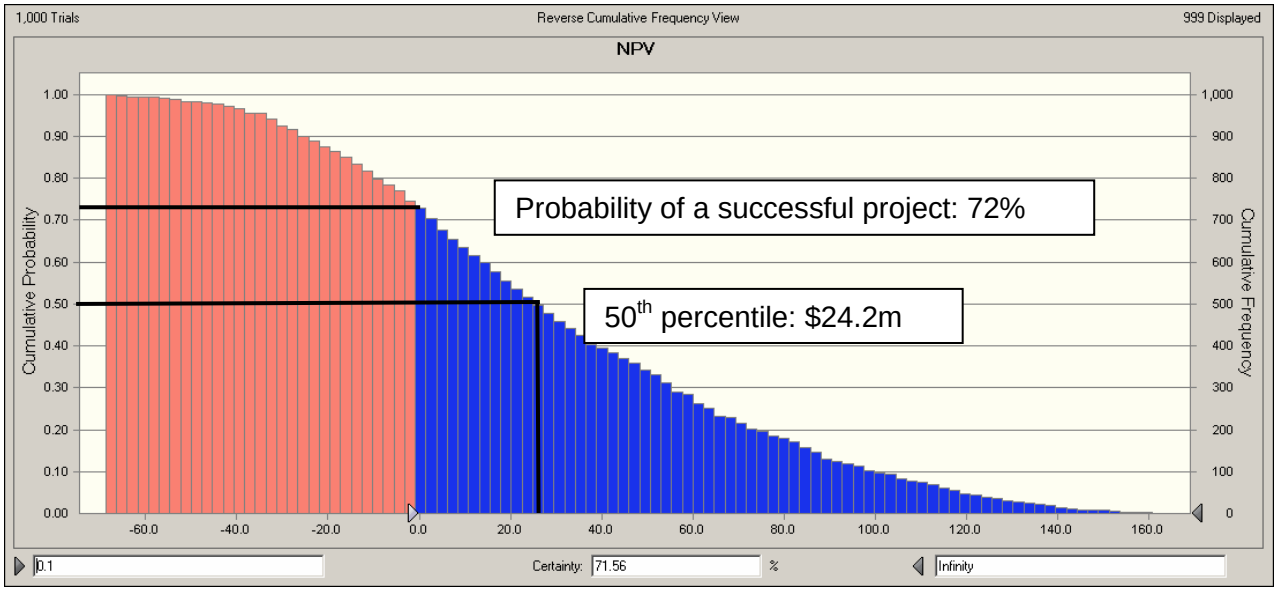

Figure 5: Reverse cumulative distribution of Net Present Value

This analysis has two purposes. Internally, the project with its uncertainties is presented to airline's board, which is thereby queried regarding its appetite for risk. Using the example shown in Figure 5, two questions emerge: is a 72% probability of success acceptable? Is $24.2m sufficient shareholder value creation with an even chance of success? The criterion for acceptance or rejection of the project is fundamentally different here from the neo-classical model, in which the project's risk characteristics are "captured" in the discount rate, an estimate of the companies WACC inflated with a risk premium estimated more or less scientifically. In the risk-quantitative paradigm, the analytical output is a probability of success given the risk assessment. It is no surprise that this method is typically used in start-up operations where there is a paucity of hard data underlying the analysis, particularly in the crucial areas of growth potential and revenue (yields). Depending on the board's decision based on its appetite for risk, the airline's managers may return to the bargaining table, demanding compensation (in the form of price reduction or guarantees to limit downside risk), until a satisfactory balance is achieved.

As in the neo-classical model, real options are not quantified by the managers interviewed; however, comparing the options proposed under different offers is a significant qualitative input to the selection process. Among the options compared are:

- Aircraft price protection (for any new orders) through a specified date
- Ability to switch aircraft type (family conversion)
- Ability to increase order size (purchase options)
- Ability to defer deliveries
- Ability to accelerate deliveries
- Price escalation cap

This intuitive and qualitative comparison of options offered is common to the three paradigms we identified during the interviews.

Aircraft as commodity: breaking down the value chain

The third paradigm we identified in the interviews is a revolutionary and integrated approach, in which aircraft are not viewed as investments in the traditional "buy-fly-sell" approach. In this paradigm, the aircraft investment cycle and value chain are broken down into their components; managers seek to locate each function – buying, financing, and selling – in the entity which can perform the function most efficiently. Rather than evaluating cash flow and NPV for the fleet alternatives, the objective is to operate the aircraft flexibly - with a minimum of ownership commitments - and to minimise the capital cost by integrating and comparing all ownership and financing costs of the various alternatives. The valuation is based on optimising the capital cost per unit of capacity, including and comparing lease rentals (for operating leases), principal and interest (for finance leases), and depreciation (for on balance-sheet aircraft). This approach cuts across accounting distinctions among the different cost categories. It is fundamentally different from either the neo-classical or risk-quantification paradigms, which are based on a cash-flow analysis and NPV. Among many advantages is that the traditional distinction between cash flow and Profit and Loss items which bedevils users of NPV is erased: the firms earnings forecasts directly reflect the outcome of the analysis.

The precedent for this paradigm is the extensive use of operating leases to increase fleet flexibility, a practice which is an integral part of fleet management in all three paradigms. In traditional operating leasing, this objective is in contradiction to the objective of minimising capital costs, because operating leases have traditionally been an expensive way to acquire capacity, compared to long-term financing. By breaking the value chain into its component parts, the aircraft as commodity paradigm seeks to reconcile these contradictory goals.

<u>Breaking down the value chain</u>

The managers interviewed suggested that straight operating leases are expensive because lessors justifiably seek financial compensation for both airline credit risk and aircraft residual value risk, building risk premiums for both into the operating lease rate. This paradigm seeks to separate these

two risks and place each with the most appropriate (or willing) counter-party, an approach analogous to recent financial innovations such as securitisation and credit default swaps, where financial risks are compartmentalised and sold down to counterparties.

The first step in this paradigm is to assign each activity and risk – evaluating, ordering, operating, financing, selling - to the most efficient player for that particular activity. We discuss each in turn.

Evaluating and ordering: airlines are quite logically the best equipped to evaluate the fit of aircraft types into their network, from operational, revenue and cost standpoints. The firm best equipped to order aircraft will be the one with the best bargaining power with the manufacturers, both in terms of pricing and obtaining performance guarantees, often not transferable from one aircraft owner to another.

In the post 9/11 aircraft market, many operating lessors reduced their former leadership role in placing large, speculative orders for aircraft, preferring to offer financing capacity for aircraft originally ordered by airlines to reduce their risk of not placing the aircraft profitable. Lead by large orders placed by low cost carriers during the recent downturn, airlines have shown an increased willingness to place large aircraft orders in recent years, garnering both volume discounts and pricing based on competition among manufacturers, which are eager to maintain order books and market share in a difficult market.

Because of the expertise in evaluating the equipment and these new ordering trends, airlines are the most efficient entities to evaluate, order, and of course operate the aircraft in this paradigm. On the other hand, managers emphasised that airlines are not the best entity to sell the equipment at the end of the investment horizon, being relatively small players with limited visibility on the complex world of used aircraft trading.

Financing and selling: operating lessors are better equipped than airlines to place used aircraft into second operators, this is after all their business. However, the residual value risk leads them to charge high lease rates. Further, many smaller operating lessors do not have the lowest-cost access to financing for the aircraft, and the larger lessors offer very handsome equity returns to their own shareholders: in both cases, they pass on the additional funding costs to the lessee. Resolving this dilemma is at the heart of the aircraft as commodity paradigm.

The derivative-like structures used in this paradigm seek to separate the credit risk from the residual value risk, assigning the former to banks or investors with relatively low funding costs, and the latter to providers of residual value insurance. The airlines thus optimise the cost of borrowing by isolating the credit risk, and by seeking tax-efficient structures with their financing partners and

"tax investors", who share benefits from income tax reductions (based on ownership and financing tax deductions) with the operators. In the tax area, banks, lessors and private investors have varying capabilities to achieve benefits, and offers from multiple sources can be compared to achieve the lowest overall cost.

The residual value risk is laid off on insurers, who may be third parties to the transaction explicitly providing the coverage, or manufacturers offering return options at the end of the lease term. Concretely, the residual value arrangements tend to be structured in two parts: as purchase options at fair market value for the airline, thus allowing operating lease treatment for accounting purposes; as return options, or outright residual value insurance, offered to the nominal owners of the aircraft, i.e., the financing entities.

The value chain is thus broken down, and risk distributed to those most capable of mitigating them, as shown in Table 1.

Activity	**Entity**	**Associated risk**	**Risk mitigation**
Evaluating	Airline	Performance Reliability	Guarantees from manufacturers
Ordering	Airline or lessor	Availability of aircraft	Order during downturn Large, multi-year orders
Operating	Airline	Cycle in demand for transport Catastrophic events Competition/new entrants	Return options Wet leases, subcontracting As in neo-classical paradigm
Owning & Financing	Financial institutions Tax investors	Credit risk	Evaluation and monitoring of airline financial health
Selling/placing with second operator	Residual Value Insurer or lessor	Asset value risk	Aircraft return conditions Internal capacity to place aircraft

Table 1: Distribution of activities and risks in the value chain

Managing the first four activities, and mitigating the associated risks, lies well within the competences of the entities involved. On the other hand, various managers interviewed pointed out that the most problematic risk in the table is aircraft residual value. In the synthetic operating lease structure, this risk is explicitly stripped away from ownership and financing, to lower the cost of financing to the airline. Is this residual value risk correctly priced in today's market? There are several factors which lead us to doubt this:

- Liquidity of the market for residual value risk: the market for this risk is highly illiquid, as no

viable market for the risk has as yet evolved;

- Data points for analysis: there are a limited numbers of buyers and sellers of used aircraft at any one time, creating inefficiencies in pricing. In addition, the aircraft covered by residual value insurance tend to be larger, lower-volume products with even fewer transactions;
- Information availability: sales prices for used aircraft are confidential between buyer and seller, so that pricing information is not widely available for analysis;
- Lease valuation: often used aircraft are placed with second operators upon return, making comparison of outright sales and re-leases difficult;
- Organisational inefficiencies: given the current high level of competition among the manufacturers of civil aircraft, the organisational expediency of "kicking the ball (the risk) forward" in time, to be dealt with by another area of the insuring company, in the more or less distant future.
- Valuation methods: techniques such as real options have yet to be adopted in many companies. Although substantial research and valuation techniques are available (see Gibson and Morrell (2004), Otero (2006), the lack of reliable data points regarding actual transactions make them difficult to apply in practice.

For all these reasons, residual value risk can easily be either overpriced (by operating lessors seeking excess returns, as discussed above), or underpriced (as a sweetener placed in an aircraft deal by manufacturers), in the aircraft market. The managers interviewed suggest that the latter condition reflects the current competitive situation in the market for large civil aircraft.

As a final strategic input to evaluating fleet alternatives and residual values, the managers interviewed take an explicit and long-term view of aircraft value potential in light of expected new product introductions in the civil aircraft market. Residual value insurance could be deemed appropriate in two specific cases: first for large, illiquid aircraft, and second, for aircraft which are expected to be superseded by new products during the investment horizon. In the case of small current-generation (and hence liquid) aircraft, the managers suggest that explicit residual value insurance may not be necessary, as financing entities appear to accept the residual value risk without building price premiums into the aircraft lease rates.

This is strategic arbitrage, building on the intuition that the residual value risk for current aircraft types may be underpriced by financiers in the market, given expected evolutions in aircraft product offerings. Taking a view on aircraft market conditions in the future exposes these companies to a potential shortage of inexpensive capacity as leases on existing aircraft expire. No strategy comes without its risks.

The aircraft as commodity paradigm is complementary to other two and shares many of their characteristics, particularly in the area of evaluating the aircraft and its operation. As in the risk-quantification paradigm, the analysis of the aircraft costs is fully embedded in the airline business

plan. Risks beyond the business plan horizon are "insured away" with third parties. The competitive analysis underlying the business plan presumably borrows substantially from the neo-classical model. However, this approach is in stark contrast to classical valuation techniques common to the other two paradigms. Aircraft capacity is viewed very nearly as a commodity to be acquired and used with the greatest possible contractual flexibility, and the lowest unit cost, rather than as an asset with an intrinsic value to be exploited by the airline.

Financial community views of the valuation question

Financiers analyse the business plans and fleet development strategies of airline customers seeking financing with information provided by the airlines themselves as well as data provided by trade associations, ratings agencies, and regulatory bodies. Our interviews with providers of finance revealed consistencies with the three airline paradigms, but also a certain scepticism about the rigour of analysis within airlines. These financiers are today invited to provide funding for both new entrants and established carriers who often operate in riskier, emerging markets, warranting substantial questioning of the rigour of analysis within the airlines.

The managers interviewed made a clear distinction between replacement aircraft and expansion fleet analysis. Replacements tend to be carefully analysed in terms of operating costs per seat, as opposed to a more global analysis including new prospects for revenue generation. Expansion fleet tends to be viewed and valued more comprehensively (i.e., including cabin product and revenue opportunities). The strategic goals sought by managers centre around first-mover benefits and QSI-type analysis, as in the neo-classical model.

A second distinction is made based on the size of the aircraft. The financiers interviewed recognise that the market for narrow body aircraft has become commoditized, with unit costs and aircraft price being the primary analytical focus. Wide-body aircraft analysis tends to be more sophisticated, taking seat-class and fare-class (revenue management) and cargo potential into account. These distinctions can be summarised along two axes:

	Replacement	Expansion
Narrow-body	Cost (commoditisation)	Cost (due to low-fare entrants)
Wide-body	Cost (revenue continuity assumed)	Revenue and cost

Is there excessive emphasis on cost, with revenue continuity either assumed or ignored, when airlines analyse replacement wide-body aircraft? The managers noted that cost data is more reliable

than revenue projections, raising the risk level for airlines forecasting high levels of growth and/or "exotic" revenue generation models.

The financiers stated that there is extensive interaction between airline business plans and fleet plans, as we discovered with the risk-quantitative and aircraft as commodity paradigms. New business models and start-up airlines, a major source of aircraft orders today, are often dealing with highly risky assumptions in their business plans. The financiers often have to push potential customers to provide more than a very short-term view of the financial impacts of fleet investments. They stated as well that the depth of research they observe in aviation is far less than for other types of project finance. The managers also stated that cash-flow analysis in general is "narrow" in scope, that "the answer is not in the spreadsheet." The primary use of cash flow analyses they have observed is evaluating the different aircraft prior to ordering, rather than justifying the investment to shareholders.

The up-front financial evaluation is thus placed in a strategic context: a qualitative view of the strategic vision of the airline managers is paramount in the credit risk analysis. For the financiers, the approach to strategic questions of market coverage (network structure) and QSI (notably the frequency parameter) is paramount. The managers noted that barriers to entry have been dramatically lowered in recent years by the availability of operating leased aircraft and state that a lack of capital in the market "forces a more intuitive approach to planning." Finally, "extraneous" influences such as domestic and international political considerations often form part of this qualitative and strategic view of the airline's prospects. The analytics frequently are secondary in this approach; frequently, the most extensive financial analysis takes place in the case of an airline default.

In terms of the risk evaluation, the financiers use, and recommend, statistical risk estimation measures proper to the financial community, such as Value at Risk (VaR), a near-universal risk metric in banking which is based on a Monte Carlo analysis using historical volatilities to estimate future risks. One financier suggested that airlines should raise equity to cover the value at risk for an aircraft investment at a 99% confidence level. This view is in stark contrast to the approach of the neo-classical and aircraft as commodity paradigms. Managers in these airlines expressed four reservations about this type of metric. First is the assumption that historical trends remain constant in a volatile industry. The second critique, that VaR analysis does not take catastrophic events into account, is not strictly true: input distributions of economic parameters can encompass these types of events, even if they rarely are in fact included in VaR analyses. Third, the airline managers view a statistical approach as "abdicating responsibility" for managing the risks of the business. Finally,

there is a pronounced reluctance to present and explain these methods to boards of directors: risk is to be captured in the discount rate and sensitivity analysis for the neo-classicists, and individual risks must be carefully divided up and actively managed by the entities most able to do so, in the aircraft as commodity paradigm.

Regarding real options, the financiers expressed the view that such sophisticated analysis is taking place, if at all, at lower management levels of the airlines, and are used to "guide" the risk assessment, a view strikingly similar to that expressed by practitioners of the neo-classical approach. The financiers suggested that the operating lessors are the most appropriate users of such techniques to manage residual value risk.

Conclusions

Our interviews of European practitioners of fleet planning and investment valuation revealed a vibrant debate about the proper way to value investments and capture risk in airlines. In the most traditional neo-classical paradigm, the energy and effort of quantification is placed in analysing the airline's competitive position and optimising the operation to capture the most desirable passengers. The financial valuation in this paradigm is an investment, buy-fly-sell view extremely close to that recommended by academic writers since the sixties. Risk quantification takes the place of classic sensitivity analysis, where results are subjected to stress tests to demonstrate project viability. The only major deviation from classical valuation theory is the "padding" of the discount rate by adding a more or less intuitively estimated risk premium, a practice which prior research revealed as nearly universal in aircraft valuation.

The debate on the use of statistical risk estimation techniques Monte Carlo was striking. It seems impossible to remain indifferent to this technique, which while reviled by many airline managers, is at the heart of the risk quantification paradigm. This paradigm tends to be practiced in companies who are either new entrants, have double-digit growth forecasts, or both: their emerging presence in a dynamic airline world is "filled with imponderables," obliging responsible managers and boards to explicitly recognise that success is only probable, not certain. The managers using this paradigm have a sharp focus on the usefulness of the analysis, that is, as a way to enhance the quality of dialogue with aircraft manufacturers, and to bargain for concessions in price and aircraft performance guarantees.

Equally sharp is the focus of the third paradigm, which breaks down and assigns risk in a way very much like recent financial derivative instruments, separating credit risk from ownership risk to reduce the unit cost of operating the aircraft. A careful analysis of the risk-management

competences in the value chain is exploited as the best way to decrease the costs, and risks, of airline operations. Arbitrage opportunities deriving from the perceived underpricing of risk are fully exploited. This risk pricing takes place in a clear segmentation of aircraft types by liquidity class, and is driven forward in light of expected near and medium term evolutions in the market for new capacity.

The financiers revealed substantial scepticism about the valuation processes within airlines and manufacturers. They suggested that operating cost is in many cases the metric most frequently used to evaluate aircraft, and that valuation is mostly used to compare aircraft types, rather than as a project justification method. Senior management intuition and experience, market-leadership strategy objectives and extraneous influences are seen as more important than valuation techniques and quantitative rigour. While the financiers both use and recommend statistical risk metrics, they confirmed the view that, most of the airlines they work with are not in fact using these techniques at the highest management levels.

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