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A Real Option-Based Model to Properly Value Aircraft Purchase Rights: Impact of the coming EU Legislation on Aircraft CO2 emission levels

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Abstract. *– The European Commission issued a legislative proposal in December 2006, suggesting a cap on CO2 emissions for all planes arriving or departing from EU airports, while allowing airlines to buy and sell 'pollution credits' on the EU 'carbon market' (Emissions Trading Scheme). In 2008 the new legislation is expected to be defined and to get the final approval.*

Real options appear to be a convenient methodology to capture the extra value brought by the new legislation on new airplane purchase rights: the airline will surely exercise the right to the new plane if the operation of the plane generates unused pollution credits that the airline can sell at a minimum price in the carbon market.

1. Introduction

An airline can be described as a portfolio of resources –some tangible and many intangible- brought together to fulfil a corporate mission (Holloway, 2003). A fleet can be viewed as a portfolio assembled to complete a number of payload-range missions. The primary objective of fleet planning is to equate production capacity –and the output that capacity is able to produce if efficiently managed- with forecast demand, given certain yield (ticket price) and other marketing assumptions, one of the main ones being passenger load factor (PLF), or percentage of seats occupied by passengers from the total seats available. There are two fundamental reasons for purchasing or leasing an aircraft:

- Replacement of existing capacity. It might be necessary to replace part of the current fleet because of high operating costs, unacceptable noise or emissions, limited remaining structural life, inadequate passenger appeal, or a policy intended to maintain a low average fleet age. The task is to find an aircraft capable of performing the mission more efficiently and effectively than the aircraft to be replaced.

- Capacity growth. Because the demand for air transport services is on the whole continuing to grow, the need to replace ageing aircraft that are becoming expensive to operate or environmentally unsound is often interlaced with the need to increase capacity. Incremental capacity might be needed for growth within the existing network or for new missions, new routes, etc.

Airlines need as much flexibility in their fleets as they can get. Airframe manufacturers have worked hard to improve flexibility by shortening order lead times. Another source of flexibility is the use of purchase rights –or purchase options- which, depending upon market circumstances, manufacturers tend to price far below their real value (Holloway, 2003)

Different manufacturers break down their contract prices in different ways, but most will include the following elements:

- Airframe price at standard specification
- Engines, the price of which will be separately negotiated where there is a choice of power plant
- Additional costs depending on the choice between seller-furnished equipment and buyer-furnished equipment
- Negotiated discounts or inflation indexes, value of credit notes from the OEM (Original Equipment Manufacturer) to support the airline financially
- Product support, such training for engineers, spare parts, etc.

2. Aircraft purchase rights as real options

An option, when purchasing aircraft, allows an airline to purchase additional aircraft in the future at an agreed price and date.(Luftman, 2003)

When placing orders for new aircraft, airlines commonly obtain options from the aircraft manufacturer, for example Airbus or Boeing. These options allow the airline to delay the purchase of additional aircraft until market conditions become clearer and the purchase can be justified. It also reserves the airline a place in the manufacturing queue, for a guaranteed delivery slot. Depending on economic conditions, manufacturers often sell aircraft purchasing options below the real value of the aircraft.(Holloway, 2003)

The use of real options is the valuation technique that comes closest to permitting both delay until certainty increases and a decision is clearer and speed when the decision act can be justified. Real options are investments made to achieve flexibility. In one of their most common forms, they can be purchased options to buy a real or physical asset at or by a specified time; an airline can obtain an option to buy the latest Boeing or Airbus wide-body aircraft at a future date. If market conditions justify expansion, the airline can obtain the aircraft at that date, rather than placing an order and waiting in queue for delivery, which might take years. If the future conditions do not justify expansion the airline has no obligation to purchase the aircraft. Rolling options differ from ordinary aircraft purchase options, in that the delivery slot is assigned at a later date, when the option is exercised or expires.

Final price agreements between an airline and a manufacturer remain confidential. It is known that purchase rights, or purchase options, are normally charged with a premium, although some negotiations end with a global deal on the purchase price of the firm commitments that include purchase rights for free. In any case, the purchase right is always charged at a premium, since it gives an extra flexibility to the airline whereas poses risk on the manufacturer if finally the options are not exercised. The other feature is that the future purchase price of the option is normally determined in advance, so the purchase right is really comparable to a call option with a determined strike or exercise price.

The next table shows a selection of airline orders that were signed during the first half of 2006 showing the expected delivery date. The table shows that some of the deliveries, particularly for larger aircrafts, were expected to take place in 3 to 5 years. The magnitude of the delivery time makes real-options particularly useful when valuing future purchase rights.

Table 1: Commitments and expected delivery schedule for selected airlines. Source, Airfinance Journal; Jul2006 Issue 292, p43-43

Airline	Country	Aircraft orders	2006 Order date	Delivery date
China Southern Airlines	China	50xA320	July 7	2009-2010
Ryanair	Ireland	10x737-800	July 4	2008
TAM	Brazil	15xA319	June 29	2006-2010
TAM	Brazil	16xA319	June 29	2006-2010
TAM	Brazil	6x330	June 29	2006-2010
SkyEurope	Bratislava	5x737	June 28	2008
China Eastern Airlines	China	30xA320	June 27	2008-2010
Cathay Pacific Airlines	China	6x747-600ER	June 22	2008-2009
Singapore Airlines	Singapore	20x787-9	June 14	2011-2013
Gol	Brazil	67x737-800NGs	Jun	2006-2012
Sky Airlines	Turkey	3x737-900ER	June 8	2009
Continental Airlines	US	10x787	June 6	2009
Continental Airlines	US	24x737NG	June 6	2008
Cathay Pacific	China	2x777-300ER	June 2	2008
Alafco	Kuwait	5x737-800	May 31	2006
Virgin Blue	Australia	9x737s	May 10	2008-10
JetBird	Switzerland	50xEmbraer Phenom 100s	May 10	2009
Sale	Singapore	10x737-800s	April 25	2009-10
Kingfisher Airlines	India	5xA340-500	april 24	2008
CopaAirlines	Panama	3xEmbraer 190	April 21	2007-08
Air Europa	Spain	16x737s	april 6	2010
Gecas	US	30x737s	March 31	2010
Royal Jordanian	Jordan	7xEmbraer 195	March 22	2006
Go Air	India	20xA320	March 21	2006
Alaska Airlines	US	39x737-800	March 13	2006
Pegasus	US	6x737	March 9	2008

3. Valuation of aircraft purchase rights

A valuation exercise of purchase rights needs to take into account that the airline will exercise the future purchase right on a new airplane only if the investment in the new unit appears to be profitable at the time of the option exercise, in other words, if the Present Value (PV) of the future net profits provided by the new unit exceed the purchase price plus the additional investment costs described above. The use of real options techniques involve the calculation of the volatility –expressed as standard deviation- of the present value of the future net profits. That in turn requires that the combined uncertainties impacting that profitability are properly accounted for. As we show in the next section, the main elements impacting the profitability of the acquisition of a new aircraft exhibit considerable volatilities. Again, the uncertainty about the future market and cost conditions in the airline industry together with the long timing required for the delivery o a new aircraft turn the use of real options as convenient technique for valuing purchase options.

4. Main sources of uncertainty in the future acquisition of an aircraft

The future profitability of an investment in an aircraft will depend on various factors. Currently, the main parameters usually considered to calculate the approximate value of an aircraft purchase option, are:

- On the revenue side, the main elements are the Yield combined with the Load Factor.
- On the cost side, the most important element is the fuel price.

4.1. Yield per passenger and load factor

In the particular case when the acquisition of a new aircraft is aimed at increasing the airline's capacity, the future profitability of the new capacity added will depend, among other things, on the airline's ability to secure the corresponding slots at the departure and arrival airports, the overall operations capacity in new airports or new construction of runways in the existing markets, the abandonment of routes by competitor airlines, etc. But at the end, the concrete financial return of the new capacity added will materialize depending on:

- Yield per passenger and kilometre (Revenue Passenger Km, or RPK)
- Passenger Load Factor (or PLF), expressed as percentage of seats occupied by passengers over total seats offered.

The chart below shows the evolution of the yearly average PLF since 2000:

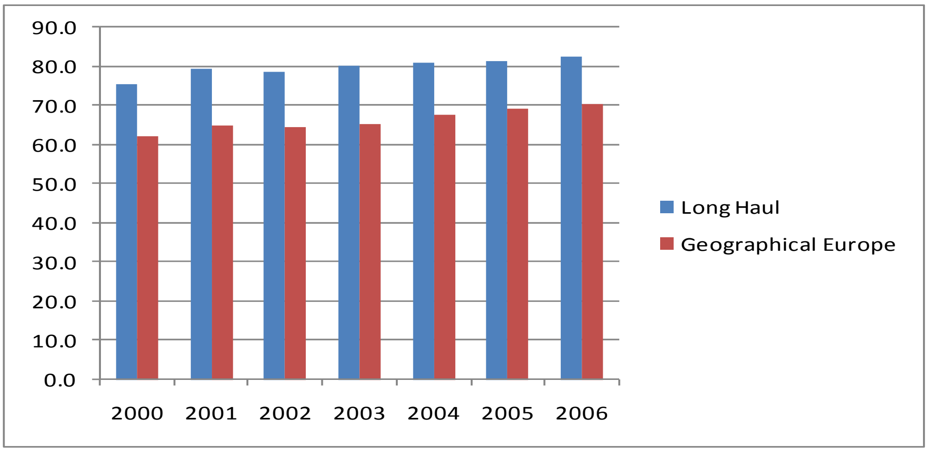

Chart 1: Passenger Load Factor in % for full service European carriers. Source: Association of European Airlines, 2008

The next chart shows the evolution of Yield per passenger expressed as per RPK. In this case the yearly data provided can be taken as a reference to calculate the volatility of RPK:

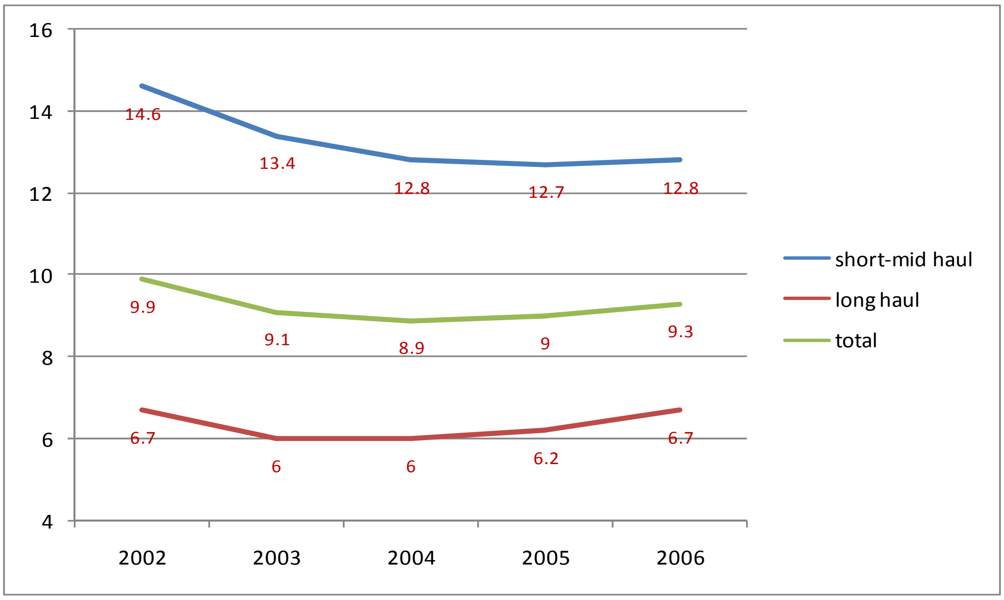

Chart 2: €cents/RPK. Source: Association of European Airlines, 2008

4.2. Fuel price

The other side of the profitability equation is the cost of flying the passenger. The recent escalation of fuel costs has dramatically changed the typical cost structure of an average airline, creating a new source of uncertainty that is becoming increasingly important. This can be seen in the following chart showing the evolution of the kerosene price and its recent escalation to more than 5 times of its 1999 levels.

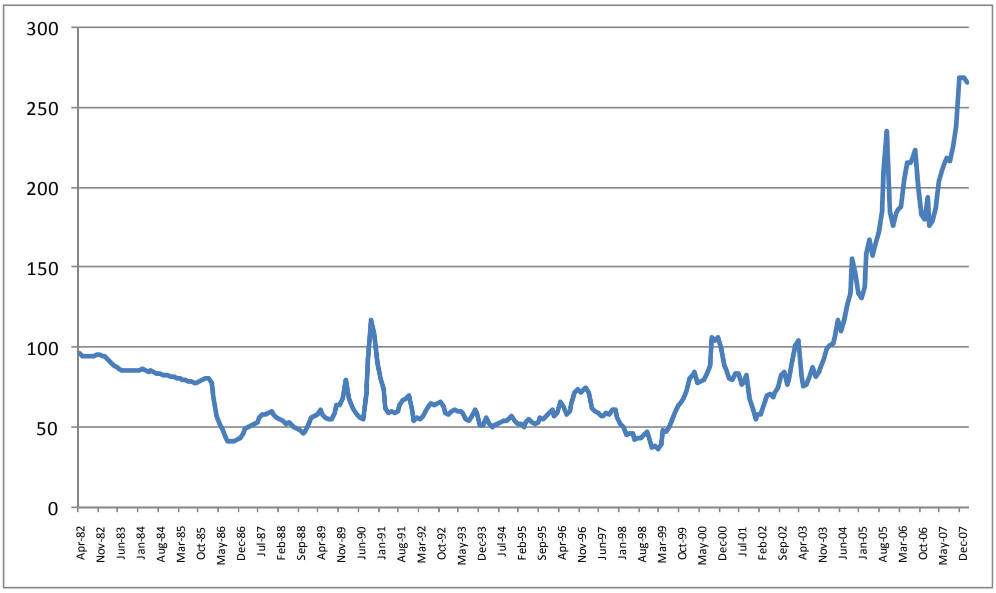

Chart 3: Refiner Price of Kerosene-Type Jet Fuel to End Users; Nominal Cents per Gallon Excluding Taxes. Source: Economagic 2008

The Association of European Airlines estimates that fuel cost has doubled its weight on the total operating costs for an average airline over the last 3 years.

5. Expanded EU legislation on Carbon Emissions

In an effort to tackle aviation's small but fast-growing contribution to climate change, the Commission issued a legislative proposal in December 2006, suggesting a cap on CO2 emissions for all planes arriving or departing from EU airports, while allowing airlines to buy and sell 'pollution credits' on the EU 'carbon market' (Emissions Trading Scheme). In 2008 the new legislation is expected to be defined and to get the final approval.

5.1. Uncertainties of the new legislation

The new EU legislative scheme has still many uncertainties that create an opportunity for a Real-option valuation scheme. The uncertainties of the new legislation can be grouped in 3 main blocks:

- The level of emissions that will be finally approved by the EU. According to the latest information, the EU will impose the need to acquire carbon permits for emissions above the average emission volume of the airline over the last 5 years. In case the airline manages to reduce that emission volume, it will be able to sell the extra, unused carbon emission permits into the Carbon Pool.

- The scope of the airlines that will have to comply with the new scheme and the possibility that non-EU carriers flying to or from the EU will be forced to join the scheme.

- The evolution and volatility of prices the Carbon Emission Trading Market (Carbon Pool).

Our paper focuses on the third one –pricing of carbon emissions-, since the other two correspond to legislative decisions that will be cleared up in 2008.

5.2. Changing price of the Carbon Permits in the European Pool as a new source of uncertainty.

In case the EU Carbon legislation is finally enforced, airlines and aircraft manufacturers will need to capture the extra value of new airplanes purchase rights: the airline will surely exercise the right to the new plane if the operation of the plane generates unused pollution credits that the airline can sell at a minimum price in the carbon market.

The chart below shows the evolution of the carbon permits over the last 3 years. It shows a significant volatility.–Interestingly enough, fuel price and CO2 emission permits show no correlation. This is consistent with the fact that CO2 emission permits depend on a supply and demand coming from "polluting" industries with practically no correlation with oil supply and demand dynamics.

The volatility of the daily prices has been estimates as the lognormal returns, with an average value of Sigma = 0.082 over the period from Sep 2006 to May 2008. Considering that an average year has 252 trading days, that yields an annual volatility of 1.30.

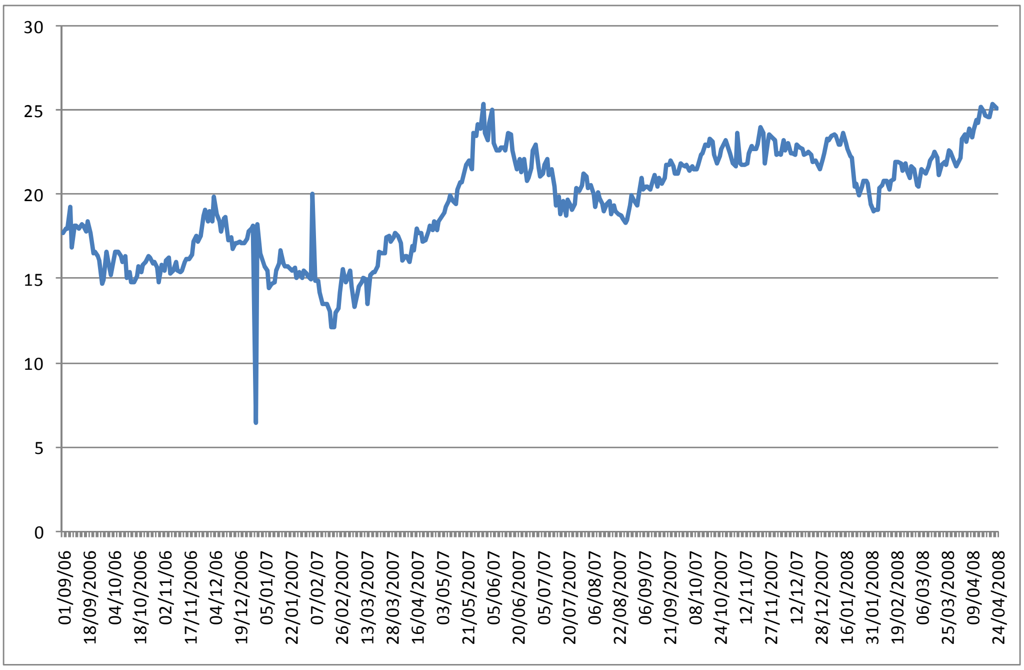

Chart 4: Trading Price of Carbon Permits in the European Pool, in €/Ton of CO_2, opening position. Source: CO2solutions.com, May 2008

6. Additional value brought by the new purchase of low emission aircrafts

New commercial aircrafts are designed to reduce polluting emissions to significant levels. Some of the newest releases from Boeing and Airbus reduce emissions to up to 10% of the levels of traditional aircrafts. Once the new legislation is enforced, airlines operating newer aircrafts will obtain a portfolio of unused pollution credits that can be sold in the Carbon Pool for a profit.

Purchase rights on airplanes can therefore be assimilated to a call option on an investment –a plane- that will produce positive present values, both in terms of fuel savings and in terms of profits coming from the sale of pollution rights. While fuel savings are supposed to be already captured in the net price of the new plane, carbon emissions surcharges and the Carbon Pool potential benefits are not.

7. Methodology

Since the purpose of this paper is to determine the extra value of the new legislation, we have found convenient to use a closed-formula model.

7.1. Real Option valuation of aircraft purchase rights and the carbon credit pool.

We can assimilate the carbon credit as a security with a price St which follows a geometric Brownian motion with constant drift μ and volatility σ:

$$dS_t = \mu S_t \, dt + \sigma S_t \, dW_t \qquad (1)$$

The volatility σ of the permit prices S as well as the time T to exercise the option are the key parameters that will determine the extra value of the plane purchase right. In that case, if Φ is the standard normal cumulative distribution function and *r* the risk free rate, the purchase right can be modelled as a European call option with strike price K, according to the Black-Scholes formulation:

$$C(S,T) = S\Phi(d_1) - Ke^{-rT}\Phi(d_2) \tag{2}$$

where

$$d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}} \quad d_2 = \frac{\ln(S/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}. \tag{3}$$

7.2. Field work and data gathering

The calculation of the option value has required the gathering of field data and, in some case, the estimation of some parameters according to the available information.

- As per Table 1, we have estimated a time to exercise of 5 years, in line with the average delivery time of the new models, Boeing Streamliner and Airbus A380.

- The risk free rate, needed to feed the equations (2) and (3) has been estimated at 4.77%, taking some European long term treasury bonds as of May 2008.

- From the carbon pool data shown in Table 5, the daily volatility is 0.082, equivalent to a yearly volatility of 1.30. One of the open questions is the validation of the Gauss-Wiener type of behaviour of CO_2 prices. In fact this is one of the weaker hypothesis given the influence of European governments on the Carbon Pool prices over the past years.

- The data on aircraft consumptions have been retrieved from different sources. All confirm that new models are capable of reducing fuel consumption between 20 an 30%. For the testing of our model we have chosen an average reduction of 25%. Every kg of fuel saved reduces CO_2 emissions by 3.16 kg. This figure indicates the range of present value of future savings for an airline due to the reduction in the use of carbon permits. At an average 10% discount rate and a CO_2 price of €25 per tone, the present value of the savings due to less CO_2 emissions amount to appr. €1.4 million.

- On top of the above, we required to gather data on fuel price evolution, yield per passenger and passenger load factors for European airlines, the most impacted by the new legislation on emissions.

- Other data such as the catalogue purchase price for commercial aircrafts.

8. Results

One of the assumptions of this study is that the calculation of the value of purchase options in the industry are calculated including the most relevant uncertainties impacting the future profitability of the investment (yield, PLF, fuel price) so that the airline, once the right expires will take the decision to exercise it –purchase the plane- if the future returns exceed the investment at the time of the decision. If the present value is less than the investment, the decision will not be taken unless the difference is offset by another source of savings, in this case, the reduced CO_2 emissions.

The additional present value brought by the CO2 permits will in turn be more important the higher the CO2 price is at the time of exercise. The additional value –which we can name "window of additional present value required to purchase the aircraft"- can be assimilated to the excercise price of the CO2 related option, since it will trigger the purchase of the aircraft at the end.

The chart below shows the value of the CO2- related option for various scenarios of fuel consumption of the plane to be replaced with the new aircraft and different values of the "window of additional present value required to purchase the aircraft", as we have describe it above.

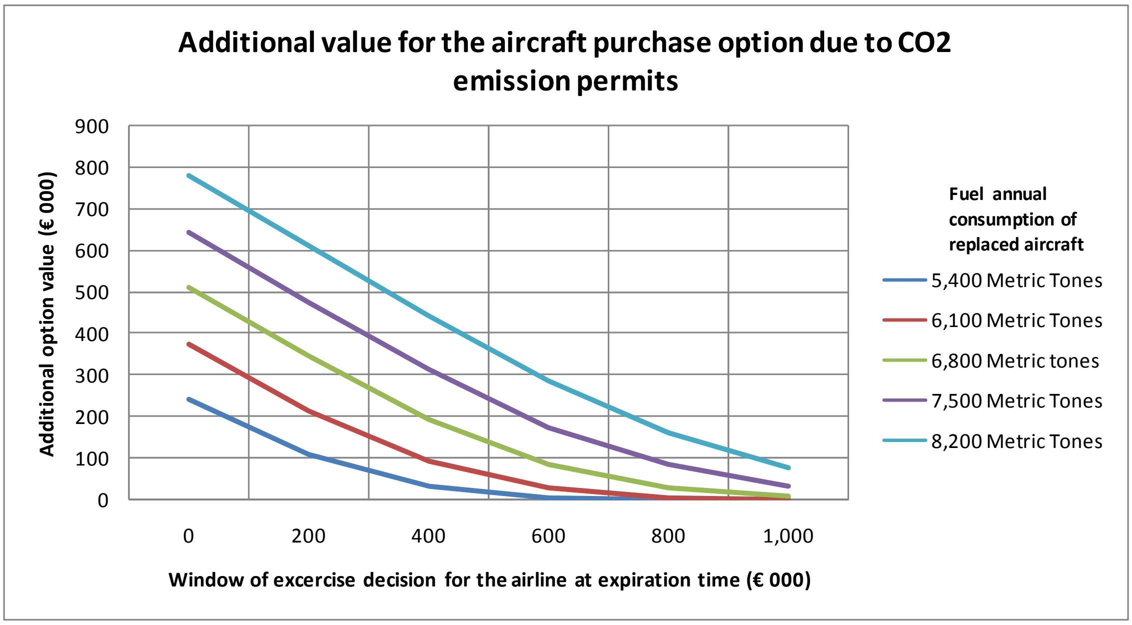

Chart 5: Additional value for the purchase option due to CO2 emission permits in € 000, depending on the annual fuel consumption of the aircraft being replaced.

Using the historical volatility of the CO2 permits, the risk free interest, and a time to maturity of the option of 5 years, we show that the extra option value of the potential incremental savings ranges between €100,000 and roughly € 1 million.

9. Conclusions and contribution of this study

The values obtained in our research show that the new legislation on CO2 emission levels can have a significant impact in the negotiation of aircraft purchase rights between an airline and an aircraft manufacturer. The decreasing margins for airlines due to higher fuel prices and the pressure on yields and load factors due to low cost carriers will easily turn the additional present values -in the range of thousands of Euros- into a go/no go when the time comes to exercise the purchase right.

The negotiation process between an airline and a manufacturer are long and complex. In both sides of the negotiation table there are important investments and strategic decisions at stake. A single unit of one of the newest commercial aircrafts have catalogue prices in the range of

$200 million (euro € 135 million) and important implications in terms of capacity planning and manufacturing planning.

Any additional element that can help a negotiating party to close a successful negotiation – including the correct and accurate valuation of possible tradeable items - will be a significant advantage for the party trying to close an advantageous deal.

According to the recent literature, this work is the first attempt to the date which uses real options to link a newly created "Carbon Pool" to the commercial aircraft industry and the value of purchase rights on new airplanes. The impact of a new legislation to reduce CO2 emissions deserves a careful analysis of the additional valuation of future purchase rights.

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