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FIELD\_LAB Pairs Trade

Pairs Trade and Valuation Analysis in the Aerospace Sector: The Case of Boeing and Airbus

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## **Abstract**

This study investigates the use of pairs trade strategy in the aerospace industry, concentrating on a comparison between Boeing and Airbus. It combines theoretical concepts with practical implementations, employing multiple financial instruments to create a comprehensive trading strategy. The study seeks to balance risk and return in a highly competitive market by giving insights into the two industry leaders' organizational structures, financial health, and market dynamics. The project is a realistic application of financial analysis, risk management, and strategic valuation. Where the Discounted Cash Flow method, the multiples analysis and the dividend discount model are used to find the fair value of both stocks.

**Keywords:** Trading, Financial Markets, Valuation, Corporate Finance, Aerospace Industry, Boeing, Airbus, Risk Management, Hedge Funds

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## **Introduction**

This research initiative is dedicated to a detailed examination of the aerospace and defense sector, with a specific emphasis on industry leaders Airbus and Boeing. Employing rigorous methodologies such as a Porter's Five Forces analysis and a SWOT analysis, this study aims to unravel the complexities inherent in the aerospace industry.

The financial health of both Airbus and Boeing will be subjected to meticulous scrutiny, encompassing critical metrics including liquidity, solvency, profitability (analyzed through a detailed ROE decomposition utilizing Du Pont analysis), and the cash conversion cycle. Subsequently, the project endeavors to establish the fair value of stocks through the implementation of a Discounted Cash Flow (DCF) model. Additionally, a comparative analysis will be conducted, utilizing four key ratios to provide a holistic evaluation of the financial standing of these industry giants. Taking a strategic leap, a pairs trading strategy, a manifestation of statistical arbitrage, will be applied to explore the correlation between Airbus and Boeing stocks. This tactical approach seeks to identify potential investment opportunities by capitalizing on the relationship between these industry frontrunners. To fortify risk management, the pairs trade will undergo a comprehensive analysis, leveraging tools such as Value at Risk (VaR) and alternative risk measures including Conditional Value at Risk (CVaR), stress tests, and drawdown assessments.

The synthesis of these analyses will culminate in the identification of a winning stock, derived from a comprehensive evaluation encompassing financial health, market dynamics, and strategic positioning within the aerospace industry. This initiative aspires to furnish investors with discerning insights and well-informed

recommendations, bridging the divide between theoretical concepts and pragmatic applications in the dynamic and technologically advanced aerospace sector.

## **Financial Analysis and Valuation**

### Historical Financial Performance

#### **Airbus**

##### ***Liquidity***

The liquidity metrics for Airbus, specifically the current ratio and quick ratio, demonstrate a fluctuating yet generally improving capacity to cover short-term obligations from 2015 to 2022 (Appendix 2, Table 3). The current ratio has shown an upward trend, moving from 0.99 in 2015 to 1.20 in 2022, with an average of 1.03. This indicates that Airbus has increasingly been able to cover its current liabilities with current assets over the years, a sign of good liquidity health. The quick ratio, which excludes inventory from current assets, also shows a general increase from 0.44 in 2015 to 0.59 in 2022, with an average of 0.49, suggesting that even without inventory, the company can sufficiently meet its short-term liabilities. The significant disparity between the quick and current ratios suggests that inventory has a significant influence on the computation of current assets. In conclusion, the company's liquidity position is favorable, and it has been able to sustain consistent levels of cash over time.

##### ***Solvency***

Airbus' solvency position, as indicated by the debt-to-equity (D/E) ratio and the long-term debt-to-equity (LT Debt/Equity) ratio, has seen some variability but maintains a general stable trend (slightly above 1), with a couple of peaks. The values in 2016 indicates that the firm increased LT borrowing by 4x, deriving in a much higher D/E and long-term debt-to-equity ratios. The same happened in 2020, with LT that duplicated. From this, the firm indicates a preference for long-term financing. (Appendix 2, Table 4).

The interest coverage ratio, while fluctuating, shows that Airbus has been generally capable of covering its interest expenses, though there was a significant dip in 2020, due to negative EBIT. During these years the ratio is raising due to increasing EBIT with constant interest expenses (Appendix 2, Table 4).

Overall, these indicators show that Airbus is carefully managing its debt levels while maintaining a strong equity base. Reducing the cost of debt and controlling leverage indicate that the company is improving its financial stability and investment attractiveness. The data show a strategic approach to solvency that balances growth with a sound financial structure.

### ***Profitability***

#### **DuPont Analysis**

ROE experienced an upward trend as well, rising from 26% in 2018 to 38% in 2022. During this period the ratio fluctuated a lot passing from 30% in 2018 to 2 consecutive years in negative due to the crisis that the sector went through. In 2021 there was a big recovering touching the highest value on about 53% (Appendix 2, Table 6).

During 2021, the ratio rose from -18% to 53% for the same reason as the ROA: reliefs from COVID restrictions, positive pricing impacts and a favorable sales mix. The main drivers of this upward trend can be investigated through a 5-steps DuPont analysis, which calculates the return on equity as the product of the following 5 ratios:

v Tax burden:  $\text{Net income} / \text{Pretax income}$

v Asset turnover:  $\text{Revenues} / \text{Total assets}$

v Financial leverage: Total assets/Total equity v Interest burden: Pretax income/EBIT

v Operating income: EBIT/Revenues

The tax burden ratio, depicting the impact of taxes on ROE, generally decreases from 2016 to 2022.

An anomaly occurs in 2019 when the tax burden ratio turns negative, due to negative EBIT.

Asset turnover, reflecting the efficiency of asset utilization, experiences a downward trend from 2016 to 2020, followed by a modest recovery. Financial leverage, amplifying the influence of debt on ROE, consistently decreases from 2016 to 2022. This trend indicates a strategic shift towards lower financial risk and reduced reliance on debt financing over the analyzed period.

Interest burden fluctuates, with a spike in 2017 and 2020. The substantial increase in 2020 suggests heightened financial risk due to increased interest expenses. Operating income experiences variations, with a dip in 2016 and a recovery in subsequent years. The negative value in 2020.

### ***Cash Conversion Cycle (CCC)***

Days Sales Outstanding (DSO), Days of Inventory Outstanding (DIO), and Days Payables Outstanding (DPO) are the metrics used to calculate Airbus's Cash Conversion Cycle (CCC). The CCC formula helps determine how effectively a business is managing its working capital; the shorter the cash conversion cycle, the more adept the business is at selling inventory and making money while making supplier payments. Additionally, a short CCC improves the company's investment flows because of the quicker and easier access to funds.

The cash conversion cycle metrics indicate Airbus has a moderately efficient operational cash flow process. Days Sales Outstanding (DSO) remains relatively stable, indicating a consistent average collection period. However, Days of Inventory Outstanding (DIO) increased post-2020, likely due

to pandemic-related disruptions, signaling a longer inventory turnover period. Concurrently, Days Payables Outstanding (DPO) is on an upward trajectory, reflecting an extended payment period to suppliers (Appendix 2, Table 8).

As a result, the CCC went up (from 126 to 158), which made the company's liquidity less available. The results of the analysis of the cash conversion cycle demonstrate the increase in working capital, net of cash and cash equivalents, rising from 2020. Which could signal a need for better working capital management to free up cash flow. This is especially relevant for an industry like aerospace, where the manufacturing and sales cycles can be long and complex.

## **Boeing**

### ***Liquidity***

Boeing's liquidity, as indicated by the current, quick, and cash ratios, presents a varied picture from 2015 to 2022. The current ratio has fluctuated from 1.35 in 2015 to 1.22, touching a minimum of 1.07 in 2019. A value stable above 1 suggests that Boeing has had sufficient current assets to cover its current liabilities. Also, the quick ratio, which excludes inventory from current assets, follows the same trend as current ratio, presenting a quite stable value (from 0.42 to 0.35) with a minimum in 2019. This indicates a tighter liquidity position when inventory is not considered for immediate obligations. These ratios suggest that Boeing's ability to quickly convert assets to cash, excluding inventory, may be less flexible (Appendix 2, Table 11).

### ***Profitability***

Boeing's profitability trajectory demonstrates a declining pattern from 2015 to 2020, primarily attributed to challenging years in 2019 and 2020. Despite ongoing recovery efforts, the company

continues to grapple with losses, as indicated by financial metrics for 2021 and 2022. The only ratio that is already returned positive is gross profit margin, it means that Boeing is still not able to sustain other costs than COGS (Appendix 2, Table 13).

### DuPont Analysis

The Analysis reveals insights into Boeing's Return on Equity (ROE) dynamics. Until 2018, ROE appeared impressive, driven by exceptionally low shareholder equity. Indeed, earnings remain at the same level, but shareholders equity decreased by 93% from 2015 to 2018, making the ratio less reliable. Post-2018, negative earnings and equity rendered ROE unreliable. The tax burden seemed inflated due to negative earnings, while declining asset turnover signaled challenges in asset utilization. Financial leverage lost relevance with negative equity. Despite a stable interest burden, Boeing's post-2018 ROE dynamics are complex, requiring cautious interpretation due to negative earnings and shifting financial components (Appendix 2, Table 14).

### *Solvency*

Boeing's solvency metrics reveal a significant dependence on debt, showcasing a substantial surge in debt exposure over the period under consideration. In 2015, the company started with a relatively low level of debt. The escalation in debt is attributed to two distinct factors: a sixfold surge in long-term debt from 2018 to 2020 and a decline in Shareholders' Equity. Notably, the Shareholders' Equity turned negative in 2019, contributing to an adverse impact on solvency ratios.

The interest coverage ratio follows a similar path, was very good in the first years analyzed, then became negative from 2019, due to the negative EBIT. The interest expenses, at the same time, increased due to, as said before, the large increase in LT debt. Indicating that Boeing has been

capable of covering its interest expenses with its earnings before interest and taxes (EBIT) until 2019. However, the negative figures in 2020 and 2021 highlight periods when the company might have faced difficulties in this regard (Appendix 2, Table 12).

### ***Cash Conversion Cycle (CCC)***

Boeing's Cash Conversion Cycle (CCC) analysis from 2015 to 2022 reveals noteworthy trends. Despite maintaining a remarkably short Days Sales Outstanding (DSO), signaling efficient receivables collection, the major challenge lies in the increasing Days of Inventory Outstanding (DIO). This upward trend suggests growing inefficiency in managing inventory turnover, potentially leading to increased holding costs. On the positive side, Boeing's Days Payables Outstanding (DPO) remains relatively stable, contributing to a more predictable CCC. The overall CCC follows an increasing trend, primarily driven by the mounting DIO. While Boeing excels in rapidly converting sales into cash, the rising CCC underscores the need for strategic measures to streamline inventory processes and enhance overall working capital efficiency (Appendix 2, Table 15).

## **Company Valuation**

The basic goal of every corporation, as is generally known in the corporate and financial world, is to increase shareholder value (Friedman 1970). This value is the present value of the company's future cash flows, appropriately discounted to reflect the inherent risk and opportunity cost connected with these cash flows.

The term 'market value' is used to describe the current value a firm's shares are trading at on the financial markets. This value is affected by supply and demand dynamics, investor sentiment, and market conditions. Short-term market swings, speculations, and market perceptions also influence market value, which often deviates from a company's fair value (Maverick 2022). On the other hand, 'fair value' takes into account a deeper examination of a firm's core attributes, such as financial performance, forecasting, sector trends, and financial considerations. It reflects the business's genuine intrinsic worth and can be determined by several valuation methods such as discounted cash flow (DCF) analysis, price-to-earnings (P/E) ratios, or comparable company analysis (Hwang 2023). The fair value of a company is more accurate when underlying assets, earnings potential, and overall financial health are considered.

The distinction between 'market value' and 'fair value' has significant implications for investors. If the fair value of the stock is greater than the market value, it may be undervalued. This condition

lets investors buy shares at a lower price than their intrinsic value, which could lead to capital gains when the market price eventually matches their fair value. In contrast, if the market value surpasses the fair value, it may indicate that the stock is overpriced. Investors must be careful when buying stocks because the market price may not be supported by the company's fundamentals. Overpriced companies are susceptible to price corrections, and investors may consider waiting for a more favorable market entry point or investigating alternative investing options (Maverick 2022).

### **Discounted Cash Flow (DCF) Analysis**

According to the Corporate Finance Institute, a DCF model is a specialized financial modeling tool used to determine a company's value. DCF, or discounted cash flow, is the process of projecting a company's unlevered free cash flow into the future and then discounted it back to its current worth, known as the net present value (NPV) (CFI Team n.d.). In the context of this project, there will be applied the DCF model analysis for Boeing and Airbus. This is going to be done with the purpose of identifying the differences between the fair and market values of both companies. With the information obtained, it is possible to categorize both companies as undervalued and overvalued.

For both companies, all financial information regarding income statements, balance sheets, and cash flows was collected from Bloomberg. It is noteworthy to mention that the information obtained counts from the year 2015 until 2022, plus Q1 and Q2 of the present year, 2023. The selection of a timeframe spanning from 2015 to 2023 for the financial data on Boeing and Airbus is a matter of strategic importance. The time covers a significant period for examining the alterations and trends in the aerospace sector.

This period covers diverse economic cycles, including expansion phases and obstacles, such as the repercussions of the COVID-19 health crisis on the aviation industry (Appendix 3, table 1-2).

### **Calculation and Forecast**

According to the Boeing Report for fiscal year 2022 and the year 2021, no material part of the business is seasonal. Despite this affirmation, a thorough analysis of semestral data dating back to 2015 has been conducted for both companies. The purpose of looking at quarterly values was to see if there were any trends that could be used to make a more precise estimate for the second semester of 2023. The analysis revealed that there are, in fact, certain yearly patterns for the second semester in comparison to the first terms values. Notably, for Boeing and Airbus the values being close to 1 generally imply stable trends without major seasonal fluctuations (Appendix 3, table 3).

### ***Revenue Growth***

The aerospace industry's future growth forecast, which will be implemented by Boeing and Airbus as a shared driver, is projected to increase by 7.7% annually until 2025 and by 5.9% annually until 2030 (Appendix 3, table 4). It was feasible to arrive at these figures by referring to the report of the business research company on the aerospace market (The business Research Company 2021). The aerospace industry future forecasts are undergoing a positive transformation due to several key variables. Expanded commercial drone operations permits, as demonstrated by regulatory improvements such as the US Federal Aviation Administration's Operations Over People rule, promise

to open new revenue streams for aircraft manufacturers worldwide (Federal Aviation Administration 2021). Furthermore, the incorporation of advanced materials such as graphene and carbon nanotubes are anticipated to enhance aircraft efficiency by reducing weight and fuel consumption, resulting in more environmentally-friendly and economically-sound flights (Andrew and Dhakal 2022). Finally, the widespread adoption of Virtual Reality (VR) technology in aircraft manufacturing, such as Boeing's utilization of VR for design and testing, is anticipated to significantly enhance overall efficiency by expediting training, maintenance, and design processes (Davila Delgado et al. 20

### ***Depreciation and Amortization***

For Boeing and for Airbus, the ratio of Depreciation & Amortization to sales has been utilized to project future cashflow and is a crucial indicator of a company's cost structure, as it reflects the

ratio of non-cash expenses to revenue. A 2.68% average percentage for Boeing spanning from 2015 to 2022 and a 4.18% for Airbus demonstrates a rather constant link between Depreciation & Amortization charges and sales throughout time for both companies, in which is possible to see higher percentages on Airbus but still not extreme values (Appendix 3, table 5). Continuity is critical for anticipating future financial performance since it implies consistent expense allocation and good asset management. In the future, using the average percentage as a starting point is a good way to predict what will happen, assuming that the current trend will continue.

### ***EBITDA***

In the aftermath of the challenging years marked by the Boeing 737 MAX incidents and the global COVID-19 pandemic, Boeing faced significant financial setbacks. In 2018, the company reported revenues of 101.127 billion USD, a benchmark that has not been achieved again until the forecasted year of 2027.

The subsequent years witnessed a decline in revenue, and the company struggled to recover to pre-crisis levels. The forecast for revenue growth indicates a return to the 2018 benchmark in 2027. However, given the extreme values and negative trends observed in the historical data for the years following 2018, it is crucial to carefully calculate and forecast the EBITDA margins.

For the EBITDA margin calculations from 2024 to 2026, and onward from 2027, a meticulous approach is adopted to ensure the reliability of the forecasts. To avoid the undue influence of

extreme values during the pandemic and the 737 MAX incidents, the median EBITDA margin for the years 2015-2022 is considered. This median value, 4.57%, is chosen over the average to mitigate the impact of outliers and provide a more stable representation of Boeing's historical performance.

Furthermore, for the period from 2027 onwards, where the company is anticipated to return to pre-crisis revenue levels, a median EBITDA margin of 11.32% from the pre-crisis period (2015-2018) is utilized. The rationale behind this decision is the belief that Boeing, having regained its pre-crisis revenue, will operate with the same level of efficiency as demonstrated in the years leading up to the crisis (Appendix 3, table 6).

For Airbus, the analysis of the EBITDA margin for Airbus was conducted utilizing historical data. The historical EBITDA margins range from 4.65% to 19.03%, indicating varying levels of performance. Using the historical average EBITDA margin of 10.86%, a consistent approach has been taken for the predicted years (2024-2030). The assumption is that the historical average reflects a realistic future projection, demonstrating confidence in Airbus capacity to maintain a constant EBITDA margin. Unlike Boeing, Airbus historical data does not show negative margins, which makes it easier to make predictions based on the stable historical average (Appendix 3, table 6).

### ***Tax Rate***

Boeing has been unable to establish an effective tax rate since 2019 due to its negative earnings before taxes (Appendix 2, table 9). As a result, a historical approach was not possible. Nonetheless, from the year 2024, when the company achieves profitability as per the forecast (see table Boeing forecast), a projection based on the sales data from the year 2022 was generated. The method

involved separating corporate taxes into regions based on the revenue generated in each location. The weighted average of corporate tax rates was calculated by combining tax information with sales percentages for each region, yielding a future tax rate of 22.03% for the future effective tax rate (Appendix 3, table 7). This approach permits a thorough examination of the numerous tax environments in which the organization operates, taking into account the implications of different tax environments. The rationale behind this approach stems from the understanding that corporation tax rates have a significant impact on future cash flows and, consequently, the overall valuation of the organization.

The effective tax rate is an essential component for estimating future cash flows in the calculation of Airbus discounted cash flow. The historical tax rate data from 2015 to 2022 shows a significant degree of volatility, with extreme values in 2019 being observed. In order to account for outliers, the median of historical Effective Tax Rate figures has been determined, yielding an estimate of 22.54% for the following year (Appendix 3, table 8). This decision suggests a preference for robustness because the median is less vulnerable to extreme values than the mean. The predicted tax rates for incoming years are rooted in these median levels, giving a more reliable foundation for estimating Airbus future financial performance.

### ***Capital expenditures***

The ratio of capital expenditures to sales has been used for Boeing and Airbus to project future cash flow and is a crucial indicator of a firm's commitment to long-term assets, reflecting the proportion of revenue devoted to capital expenditures. The average percentage of 2.12% for the period 2015 to 2022 for Boeing and 3.91% for Airbus for the same period, values that are over the time stable and do not have extreme values on both companies (Appendix 3, table 9). That average is going to be used as the value for the forecast period, supporting the assumption that the

investment strategy it's not going to change over the years. Since there are signs of recovery all along Boeing company and more advanced in Airbus, continue investing is important in the context of improving the processes and develop new technologies to keep the company improving revenues in the future.

### ***Adjusted Net Working Capital.***

For Boeing, the same process done in the EBITDA margin has been done in the adjusted net working capital to sales ratio, for the reason that there are some extreme values corresponding to the pandemic years and the recovery years. In resume, from 2024 until 2026, the total median (2015–2022) 6.973% (COVID-19 years). However, from 2027 onwards, the median from 2015 until 2018 was used, giving a value of 4.54%. This conclusion is based on the observation of a declining trend that began in 2020, resulting in a decrease of nearly 15 percentage points per year. When sales return to pre-COVID-19 levels, the ratio reverts to pre-COVID-19 levels. The assumption in the computation is essential because it takes into account the unusual influence of the years of the Pandemic. The decision to revert to the pre-pandemic median from 2015 to 2018 demonstrates an acknowledgement that the extreme figures may not accurately reflect the company's regular operational performance (Appendix 3. Table 10).

Across the period 2015–2022, Airbus net working capital ranges from -13,006 million to -2,651 million. On average, net working capital is calculated to be -10.96% of revenues. This value will be employed to project the company's DCF in the future, based on the premise that, even during the COVID-19 and post-pandemic eras, there are no extreme or out-of-trend values. Allowing for the interpretation that Airbus will continue to experience negative net working capital in the long run. In this scenario, the negative Net Working Capital indicates a planned financial strategy rather

than a financial risk, demonstrating Airbus ability to manage the intricacies of its industry and manufacturing processes. The extended production cycle causes Airbus to incur substantial upfront expenses before generating revenue from its customers.

### ***Net Debt to EV Ratio***

It is critical to understand a company's capital structure in order to perform a discounted cash flow assessment. A higher ratio of Net Debt to EV may indicate an elevated level of financial risk and interest payments, thereby affecting the company's cost of capital and, consequently, the discount rate utilized in the DCF model. Boeing's ratio has gone from a negative value in 2015 to a 27.2% value in 2022. In previous years, Boeings negative ratios indicated a higher percentage of cash and equivalents to debt. The ratio began to increase in 2018, indicating a growing dependence on debt to fund operations. From the peak of 2020 the company is in a downward trend. In response, there is an assumption that Boeing will continue this trend by maintaining a target net debt to enterprise value (EV) ratio of 20%.

Over the same period, Airbus has shown a more consistent pattern, with its ratio ranging from -1.08% to 5.91%, excluding an extreme value of 27.36% in 2016, due to an increase in long term debt. For this reason, the Net Debt/EV target is set at 5%, expecting that the company will continue to have the same structure in the following years (Appendix 3. Table 11).

### **DCF– Boeing**

The average ratio of Boeing net debt to EV from 2010 to 2022 was 12.7%, and its historical equity beta is 1.48 (Yahoo Finance 2023b). The company's debt beta is estimated to be 0.1 ((Schaefer & Strebulaev, 2009)), resulting in an unlevered beta of 1.30 (Appendix 3, table 17). The target equity beta of the company is 1.61 if Boeings target net debt-to-enterprise value ratio is 20%, as estimated.

According to (Fernandez, García de Santos, and Fernandez Acin 2022), a market risk premium of 5.6% has been assumed, and the U.S. 10-Year Treasury Yield has been deemed as a proxy for the risk-free rate, currently at 4.57% as of September 29th, 2023. This yields a cost of debt of 5.13% and a cost of equity of 13.57%. By combining these figures with the projected future effective tax rate and the target Net Debt-to-Enterprise Value ratio, a weighted average cost of capital of 11.65% is obtained.

The calculated WACC of 11.65% was utilized to discount future cash flows by utilizing the discounted free cash flow valuation framework. Free cash flows were forecasted and discounted individually for the third and final quarter of 2023 as H2 and for years 2024 to 2030. The long-term revenue growth assumption is set at 2%, that correspond to the long-term inflation target. Being the two companies in their mature phase, it is expected that they grew at this level. Moreover, it is possible to see a certain degree of correlation between inflation and the revenue growth of Boeing and Airbus (Appendix 3, table 16). The terminal value accounting for free cash flows from 2031 onwards was computed and discounted. The aggregate value of all future projected cash flows for Boeing, discounted at a WACC of 11.65%, amounts to \$66,042.20 million, which is the estimated enterprise worth of the company. When subtracted the amount of net debt from the company's books, \$21,028.20 million in equity is obtained and a target price of \$34.47 for each share. Boeing stock is overvalued by 456% through the discounted cash flow valuation method, according to its closing share price on September 29, 2023, of \$191.68 (Appendix 3, table 12).

## **DCF Sensitivity Analysis**

In the concluding phase, the analysis explored the sensitivity of the share price target with regard to two critical assumptions in the model: the revenue growth rate and the risk-free rate. A 1% change in the revenue growth rate was considered. Regarding the risk-free rate, an optimistic view involved utilizing the pre-pandemic value of 1.55% for the U.S. 10-Year Treasury Yield. Conversely, for a pessimistic scenario, the risk-free rate was set to the high observed before the 2007-2008 financial crisis, standing at 5.26%. A comprehensive breakdown of these scenarios and their respective impacts on the share price target can be found in the (Appendix 3, tables 12-15).

### **DCF – Airbus**

The ratio of Airbus net debt to enterprise value from 2010 to 2022 was 5.54%, and its historical equity beta was 1.64 (Yahoo Finance 2023a). The company's debt beta is estimated to be 0.05 (Schaefer & Strebulaev, 2009), which results in an unlevered beta of 1.55 (Appendix 3, table 17). The target equity beta for the company is 1.63 if Airbus' target net debt-to-enterprise value ratio is 5%, as estimated. The U.S. 10-Year Treasury Yield was used as a proxy for the risk-free rate, which is 4.573% as of September 29th, 2023, according to the assumption of a market risk premium of 5.60% (Fernandez, García de Santos, and Fernandez Acin 2022). The summation of these numbers with the projected future effective tax rate and the target Net Debt-to-Enterprise Value yields a weighted-average cost of capital of 14.32%

To discount future cash flows using the discounted free cash flow valuation framework, the calculated WACC was 14.32%. The third and final quarter of 2023, taken as H2, and the years 2024 to 2030, were analyzed and discounted separately. The terminal value accounting for free cash flows from 2031 onwards was computed and discounted under the 2% long-term revenue

growth assumption (as explained above). The total value of all Airbus' future projected cash flows, discounted at a WACC of 14.32%, equals €45,435.83 million, which is the estimated enterprise worth of the company. When subtracted the net debt from the company's books, €42,825.83 million in equity is obtained and a target price of €54.21 for each share. Airbus stock is overvalued by 134.24% through the discounted cash flow valuation method, according to its closing share price on the valuation date of €126.98 (Appendix 3, table 14).

### ***Comparables / Similar – Boeing***

On this project, the multiples method was also used to value Boeing Co, diverging from the discounted free cash flow model by comparing Boeing against industry counterparts rather than solely on its historical data. The primary step involved identifying comparable companies on the sector in which it was chosen, which can be seen in industry (Appendix 3, table 18). From the initial list of peers, the similars that were most akin to Boeing, in terms of Market Cap, D/V, Unlevered Beta and EPS growth were chosen. On these metrics the most similar companies were Spirit AeroSystems Holdings, Textron Inc, Safran SA, and Airbus SE industry (Appendix 3, table 19). After the selection of the similars, various multiples were calculated for Boeing, including the Price-to-Earnings (P/E), Enterprise Value-to-Sales (EV/Sales), Enterprise Value-to-EBITDA (EV/EBITDA), and Price-to-Book (P/B) ratios. For Boeing multiples, it just makes sense to see the values obtained on the Enterprise Value-to-Sales (EV/Sales) because, because of Boeing's high levels of debt and today's financial situation, all other valuations are negative.

Enterprise Value-to-Sales (EV/Sales). When contrasted with the broader set of comparable companies, Boeing's share price appeared overvalued by 76%. However, when benchmarked against the selected similar companies, the valuation was closer to Boeing's actual share price as

of September 29, 2023 (\$191.68), showing an overvaluation of 50%. A Sensitivity analysis was also conducted for the multiple chosen, using the lowest and highest multiples from the similar companies to provide a range of price targets. The analysis revealed that Boeing's actual share price was within this calculated range, suggesting a balanced valuation relative to the industry (Appendix 3, table 20).

### ***Comparables / Similar – Airbus***

It was conducted a valuation of Airbus SE using the multiples method mirroring the one used on Boeing. This method benchmarks Airbus against similar companies in the market, rather than relying exclusively on Airbus's historical data. The initial and most critical step involved selecting a set of comparable companies industry (Appendix 3, table 21). The companies selected as similars to Airbus included Boeing (BA), Spirit AeroSystems Holdings Inc (SPR US), MTU Aero Engines AG (MTX GR), and Bombardier Inc (BBD/B CN) industry (Appendix 3, table 22). Upon selecting the comparable companies, the team calculated four different multiples: Price-to-Earnings (P/E), Enterprise Value-to-Sales (EV/Sales), Enterprise Value-to-EBITDA (EV/EBITDA), and Price-to-Book (P/B) ratios, in which the P/E multiple is not going to be taken in count for the similars negative value, due to the high negative value for Boeing.

When taking into account all companies comparable to Airbus, we find that the company's share price is in general overvalued with EV/EBITDA, EV/Sales, and P/B ratio multiples. On the other hand, considering only the most similar companies which were selected, there are found values that are more reflective of Airbus's actual share price close of \$126.98 as of September 29, 2023. When measured by EV/EBITDA, the company is overvalued for 6.5%. Similarly, the EV/Sales ratio suggests an overvaluation with a price target of \$119.89, this time when compared with all

the sector the prices is closer to market. The P/B ratio indicates that Airbus is trading above the book value of its assets with a price target of \$43.84, signifying an overvaluation of 190%. A sensitivity analysis was done based on the minimum and maximum values of these multiples from similar companies. This gave a range of possible valuations for Airbus. A pessimistic \$66.91 to an optimistic \$230.61 was the price range for EV/EBITDA. According to the EV/Sales ratio, the price range was from \$80.69 to \$166.08. Considering the high variability and uncertainty in book value estimations, the P/B ratio ranged dramatically from -\$144.44 to \$557.12 industry (Appendix 3, table 23).

Additionally, a regression was run with all the comparable companies. The regression was run with P/E as the dependent variable and the log of market capitalization, Debt-to-Enterprise Value, and levered beta as independent variables. When Airbus earnings per share are multiplied by the P/E of 1.88 a negative price target is obtained. Also, in this case the influence of Boeing is still very strong industry (Appendix 3, table 24)..

The industry in which Airbus operates typically shows robust valuations due to its capital-intensive nature and long-term growth prospects in global aerospace and defense sectors. The average price target using the applicable multiples is \$94.32; hence we conclude Airbus's stock price is slightly overvalued by approximately 34.63% industry.

### ***Dividend Discount Model – Airbus***

Airbus pays out yearly dividends, which are assumed to be paid out on April 30th each year for the sake of investigation. The dividend growth model utilized in the investigation provides estimates of both short- and long-term dividend growth rates. During the short term, the average annual dividend growth rate of 16.40% from 2011 to 2023 is used for the dividend growth from 2024 until

2030. Under this prediction, it is assumed that the company will continue to have the same payout strategy that had in the last years, being a mature firm with consistent earnings. The median annual dividend growth rate of 10.56% from 2011 to 2023 is taken into account over the long run. This approach assumes that the company will maintain a solid payout ratio, being mature and so able to generate solid earnings and invest less in the firm. The terminal value is calculated using the long-run rate for years after 2030. It's important to know that the early years (before 2011) and the lack of dividends in 2010 were not included in the calculations. Furthermore, the year 2021 is absent, implying that no information regarding the forthcoming dividend is available for that year.

Dividend growth rates are then utilized to forecast future dividends, and discounted cash flows are calculated to arrive at a terminal value. A price target of \$67.58 is set based on the total of discounted dividends and the terminal value. Compared to the closing price of Airbus stock on September 29, 2023, which was \$126.98, the computed valuation suggests a 87.89% overvaluation.

A sensitivity analysis was conducted on the price target, considering variations in long-term annual dividend growth rates. If the annual dividend growth rate were to increase by 1 percentage point, the corresponding price target would rise to €84.31. Conversely, a 1 percentage point decrease in the growth rate would result in a lower price target of €57.14 industry (Appendix 3, table 25).

### **Boeing DDM**

The analysis of a Dividend Discount Model (DDM) for Boeing is precluded by the company's suspension of dividend payments in 2020, coinciding with the onset of the COVID-19 pandemic. Despite the forecasted return to profitability in 2024 based on the Discounted Cash Flow (DCF) model, the prudent decision has been made to delay the resumption of dividend payouts.

This cautious approach stems from the recognition of the financial challenges the company faced in recent years, including the impact of the pandemic and other adverse events. Rather than immediately reinstating dividends, the focus is on fortifying the company's financial health. The intention is to allow time for a more solid foundation, ensuring that financial metrics and stability are robust enough to sustain consistent dividend payments in the long term.

## **Technical Analysis**

### *Theoretical Contextualization*

#### *Arbitrage*

Arbitrage, the practice of securing guaranteed profits with minimal risk by exploiting asset mispricing, stands as a cornerstone in finance. Despite the assumption in diverse economic and asset pricing models that such opportunities are unavailable, hedge funds and investment banks persist in their pursuit of the elusive "golden pot at the end of the rainbow." This persistence leads to two conclusions: firstly, there are ample arbitrage opportunities to sustain the number of hedge funds engaged in trading, and secondly, the abundance of arbitrageurs means that most opportunities will be short-lived, swiftly discovered by vigilant market participants.

Arbitrage is categorized into two types: pure (deterministic) and statistical (relative). The primary distinction lies in the fact that pure arbitrage profits from the relative mispricing of securities in a riskless manner, whereas statistical arbitrage is rooted in the expected value of assets, involving some level of risk. Statistical arbitrage is a broad term encompassing methods such as merger arbitrage, liquidation arbitrage, and pair trading, among others. Originating in the 1980s, statistical arbitrage is considered an

evolution from the simpler approach of pair trading. The concept behind pair trading is deceptively simple: identify two stocks whose prices "move together" and initiate a position when the relative price of the stocks deviates from the normal level. The goal is to profit from the anticipated correction of prices to the equilibrium level. When the spread between the equities widens, the investor will "sell the winner and buy the loser." Consequently, pair trading is classified as a contrarian strategy, wherein an investor goes against the broad market trend by purchasing underperforming equities and selling outperforming ones. Two major ideas explain the excess return of these strategies, both supported by substantial literature. According to the first theory, contrarian strategies are inherently riskier, yielding adjusted excess returns (Fama and French 1995). In contrast, another perspective posits that the anomalous returns of contrarian strategies result from an overreaction of "naive" investors who overbuy/oversell well/bad-performing equities (Lakonishok, Shleifer, and Vishny 2005).

Pair trading possesses three significant qualities depending on the strategy's refinements: it is self-financing, market-neutral, and focuses on the relative pricing of assets. The investor does not require initial capital to implement this strategy, as it is self-financing. Additionally, the strategy hedges against market-wide volatility, being market-neutral. Most importantly, the assessment of stock values is relative, rather than absolute, mitigating uncertainty and error associated with absolute methods. Relative pricing is considered a less stringent application of the Law of One Price (LOP), which posits that "two investments with the same payoff in every state of nature must have the same current value" (Ingersoll 1987). Relative pricing remains applicable in economic recessions and booms, as the relative price may hold true while the absolute price

cannot.

### ***Dataset***

The dataset employed in this research encompasses the closing prices of Boeing (BA) and Airbus (AIR.PA) stocks, spanning from January 1, 2010, to September 30, 2023—marking the conclusion of our valuation period. The rationale behind selecting this timeframe is rooted in its capacity to furnish a robust historical dataset, thereby facilitating a comprehensive analysis of the historical performance of both companies. This temporal span enables the examination of the strategy's efficacy across diverse economic cycles, encompassing periods of expansion, recession, and recovery.

All data points underwent meticulous adjustments to account for dividends and stock splits, mitigating potential distortions that could arise from pronounced price fluctuations induced by these corporate actions. Such adjustments are imperative to ensure the strategy's reliability, as unadjusted data might yield erroneous buy or sell signals.

Furthermore, a critical consideration pertained to the disparate trading calendars observed in the United States (Boeing) and Europe (Airbus). To harmonize the datasets and enhance comparability, the strategy exclusively incorporated common trading dates. This standardization was essential for the accurate evaluation of the strategy's performance across both entities, thus contributing to the rigor and integrity of the analytical framework.

### **Methodology**

#### ***Signal Construction***

The signal is derived from the ratio of the closing price of Airbus (PX\_LAST (Airbus))

to that of Boeing (PX\_LAST (Boeing)), denoted as "Spread." This metric serves as a critical indicator in discerning deviations from the historical relationship between the two stocks, thereby presenting potential opportunities for mean reversion. The formulation of the spread is expressed as:

$$\text{Spread} = \text{PX\_LAST (Airbus)} / \text{PX\_LAST (Boeing)}$$

To enhance the strategy's realism and guard against forward-looking bias, a deliberate lag of one day is introduced in the signal execution. This precaution is particularly relevant given the disparate time zones in which the companies operate. The one-day lag ensures that the signal generation process appropriately incorporates available information, fostering a more accurate representation of market conditions.

### ***Position Opening Criteria***

The strategy employs specific rules for initiating positions based on the calculated spread. Two distinct scenarios dictate the opening of positions:

v Sell Spread (short-sell the first (Airbus) and buy the second stock (Boeing) of the pair):  $\ln t+1 \Delta \text{Spread} > \text{Spread}_5 + \sigma_5 \text{Spread}$

v Buy Spread (buy the first (Airbus) and short-sell the second stock (Boeing) of the pair):  $\ln t+1 \Delta \text{Spread} < \text{Spread}_5 - \sigma_5 \text{Spread}$

In the absence of satisfaction of either condition, no position is established in the market. The determination of the historical mean and standard deviation is conducted over a brief one-week look-back period (5 trading days), in order to be able to quickly capture shocks in the relationship between the pairs.

### **Strategy Construction**

### ***Simple mean reverting***

Utilizing the previously outlined signal, a straightforward mean reversion strategy is devised, involving an equal investment in each stock of the pair.

### ***Betas Adjustment***

To enhance strategy performance, an adjustment based on betas is introduced, leveraging the inter-company betas derived from a regression of one company's returns against the other's. This adjustment reflects the intrinsic relationship between their returns, allowing for a more nuanced allocation of investment. Specifically, the investment in each leg of the pair is no longer uniform. For instance, for a €1 investment in the long leg, the fund shorts Beta € (e.g., 0.8€) on the other leg. The regression, performed over a one-month look-back period (20 trading days), considers Boeing as the dependent variable and Airbus as the independent variable, seeking to elucidate Boeing's performance based on changes in Airbus's performance. The reverse regression is also conducted, where Boeing becomes the explanatory variable, resulting in the economic interpretation of a €1 long position in Airbus corresponding to a Beta € short in Boeing.

### **Transaction costs and calculation of returns**

In mean-reverting strategies, a significant portion of profits may originate from bid-ask bounce dynamics (Asparouhova, Bessembinder, and Kalcheva, 2010). Furthermore, arbitrage opportunities only yield profitability if transaction costs, encompassing brokerage fees and bid-ask spreads, remain lower than the potential gains arising from security mispricing. Notably, transaction costs constitute nearly 25% of total investment expenses, averaging 20.2 basis points, according to a study by CEM Benchmarking.

Institutional investors typically incur in lower commissions, ranging from 5 to 6 cents per share, with a potential range from 1 to 12 cents per share. Given the high liquidity and market activity of Boeing and Airbus, an assumption of 0.03% of the amount traded is adopted for this strategy, because due to the stocks' prices allow to stay in that range. The calculation of returns typically involves a straightforward procedure, where returns are expressed as cash flows relative to the initial invested capital. However, pair trading, being inherently self-financing and devoid of an initial capital requirement, complicates the traditional returns calculation. To address this, the prevalent method in existing literature is employed, entailing the multiplication of the signal by the returns of the subsequent day. Given the market- neutrality inherent in the strategy, the computed returns can be construed as excess returns. This characteristic underscores the strategy's independence from broader market movements, affirming its capacity to generate returns irrespective of overall market direction.

## **Results**

The primary metric utilized to assess the efficacy of the strategy is the Information Sharpe Ratio (ISR), providing a measure of risk-adjusted return. An ISR around 1 is indicative of a well- performing strategy.

The results reveal that the beta-adjusted strategy is indeed effective, with the variant employing Boeing as the explanatory variable demonstrating the most promising outcomes. This particular strategy exhibits the highest annualized return coupled with a relatively robust Info Sharpe Ratio.

Analyzing the path to construct the pairs trade is it possible to demonstrate the optimization of the beta adjusting. The strategy commences with an Info Sharpe Ratio

of 0.51 in the simple mean reversion approach (Appendix 4, Table 5). Notably, attempts to elucidate or predict Boeing's performance based on changes in Airbus's performance yield a limited ISR of 0.12 (Appendix 4, Table 5). Conversely, exchanging the roles of x and y (Boeing as x and Airbus as y) yields superior results, showcasing a return of 13.61%, volatility of 21.36%, and an Info Sharpe Ratio of 0.64 (Appendix 4, Table 1). This outcome suggests that alterations in Boeing's performance may precede and predict changes in Airbus's performance. Liquidity considerations further contribute to the effectiveness of beta adjustment strategies, as the greater liquidity of Boeing enhances the accuracy of beta estimates and adjustments, leading to improved predictions of Airbus's performance.

The strategy exhibits notably high kurtosis (approximately 35), indicating pronounced "tailedness" in the return distribution. This characteristic implies the potential for extreme positive or negative returns, substantiated by the observed maximum day return hovering around 20% and minimum at -7.69%. Additionally, a slightly positive skewness (2.44) suggests a tendency for the strategy to generate more positive returns than negative returns. (Appendix 4, Table 5).

A consistent feature is the market-neutral attribute, as evidenced by the proximity of the beta market to zero. This characteristic holds substantial importance, particularly for hedge funds, as market neutrality serves as a pivotal tool.

The annual returns from the strategy exhibit significant volatility and variability, characterized by distinct peaks in 2010, 2014, 2020, 2021, and 2023, alongside notable troughs in 2012, 2016, 2018, and 2019. The strategy's tendency towards extreme highs and lows emphasizes the potential for substantial drawdowns. (Appendix 4, Table 3).

## **Impact of Transaction Costs**

Upon incorporating adjustments for transaction costs, the observed excess returns exhibit a notable decrease. Despite the similarity in volatility, the introduction of low transaction costs for institutional investors imparts a substantial adverse effect on profitability. The frequency of high-frequency trades becomes a mitigating factor, significantly diminishing the strategy's overall profitability and exerting a pronounced negative influence on the Information Sharpe Ratio.

This discernible impact is further evident when examining the proportion of positive days, which is expected to diminish to values approximately proximate to 50%. The distribution of returns, however, remains relatively unaffected, retaining its characteristic high kurtosis and slightly positive skewness. Moreover, the correlation with the market is anticipated to persist close to null (Appendix 4, Table 4 vs Table 5).

## **Load on Standard Factors (FF3 & FF5)**

In the context of the pair trading analysis, an exhaustive examination was conducted, encompassing load factor assessments for both the Fama-French three-factor model (FF3) and the Fama-French five-factor model (FF5). The findings revealed exceptionally low and negatively skewed beta coefficients between the trading strategy and the aforementioned factors. This observation is indicative of a limited association between the pair trading strategy and the market factors considered, as suggested by the markedly small and negative beta values. (Appendix 4, Table 14).

Furthermore, the resultant Fama and French factor loadings exhibited remarkably low magnitudes. These outcomes collectively underscore a substantive departure from the influence of conventional market factors on the pair trading strategy. Consequently, it

can be inferred that the returns generated from the pair trading endeavors predominantly emanate from sources of pure alpha, attesting to the strategy's capacity to achieve excess returns independent of systematic market factors (Appendix 4, Table 13).

### **Correlation**

In the context of a pairs trade, the correlation analysis plays a crucial role in understanding the relationship between their price movements. The prices correlation of 0.83 indicates a strong linear connection in the absolute price levels of the two stocks. This positive correlation suggests that, generally, when one stock's price rises, the other tends to follow suit.

On the other hand, the returns correlation is 0.45, indicating a positive but somewhat weaker relationship in the percentage changes of Boeing and Airbus prices. This suggests that, on average, the stocks' percentage changes in prices move in the same direction, though not as closely as their absolute price levels.

The correlation of the pairs' returns showcases noteworthy variability over the years. In 2010 (0.15) and 2021 (0.19), notably low correlation values suggest periods of desynchronized returns among the pairs. Conversely, higher correlation values in 2013 (0.96), 2016 (0.83), 2017 (0.89), 2019 (0.86), and 2020 (0.94) indicate phases characterized by stronger alignment in the pairs' return movements.

### **Volatility**

The correlation between Boeing and Airbus fluctuates across various market regimes, notably in relation to market volatility. During years of high volatility, such as 2011, 2020, and 2022, the correlation varies, with values like 0.23, 0.94, and 0.85, respectively. Conversely, in years characterized by lower volatility, like 2017 and 2018,

the correlation remains consistently high at 0.89 and 0.65. However, during moderate volatility years, such as 2014 and 2019, the correlation shows variability, with values like 0.27 in 2014 and 0.86 in 2019. These observations suggest that the correlation between Boeing and Airbus has not the same behavior in different market volatility scenarios.

### **Sensitivity Analysis**

The range of transaction costs examined in this analysis extends up to 0.13%, a level reached when the 5-day lookback period results in negative returns. This particular threshold signifies a point where the strategy's performance turns unfavorable, indicating a critical level of transaction costs that adversely impacts returns, especially for shorter loopback periods. (Appendix 4, Table 6).

Furthermore, the noticeable impact of transaction costs is mitigated when employing a longer lookback period, such as 50 days, for signal trade construction. In this context, the reduced sensitivity to short-term market fluctuations associated with longer observation periods results in fewer changes in portfolio positions. Consequently, the impact of transaction costs becomes smaller due to the strategy's slower reaction to market changes. Notably, despite the increased robustness to transaction costs with longer lookback periods, the analysis underscores that the 5-day strategy performs the best when transaction costs are lower. This implies that, in environments where transaction costs are relatively modest, the shorter lookback period provides an optimal balance between responsiveness to market conditions and minimizing trading expenses.

### **Risk Management Analysis**

Value at Risk (VaR) is a widely used risk management metric that provides an estimate

of the potential loss in the value of a portfolio over a certain time horizon and at a specified confidence level. It plays a crucial role in assessing and managing financial risk, enabling investors and financial institutions to make informed decisions about their portfolios. However, like any risk metric, VaR has its advantages and drawbacks, and its interpretation requires careful consideration of the underlying assumptions and limitations.

VaR is defined as the potential expected loss over a certain period with a given confidence level. For instance, at a 95% confidence level, the VaR represents the potential loss that is expected to be exceeded only in 5% of cases over the defined time horizon.

### **Empirical Approach**

One method of calculating VaR is the empirical approach, often referred to as the historical method. It relies on historical observations of returns and involves ranking them to determine the critical level for the desired confidence level.

### **Parametric Approach**

Another approach is the parametric method, assuming that returns follow a normal distribution. This approach uses statistical parameters such as mean and standard deviation to estimate VaR. It is based on the central limit theorem and assumes independent and identically distributed (i.i.d.) returns.

### **Calculation and Interpretation**

In the provided pair trade, the empirical VaR at a 95% confidence level is calculated as €19,478. This implies that, under normal market conditions, there is a 5% chance that the portfolio will incur a loss exceeding €19,478 over a one-day horizon (Appendix 5,

Table 1).

Using the parametric approach, the VaR at a 95% confidence level is calculated as €21,777, with a confidence interval providing a range of possible VaR values [21,260;22,294] (Appendix 5, Table 2).

### **Alternatives to VaR**

While VaR serves as a valuable measure of potential losses at a specified confidence level, the incorporation of alternative risk measures, such as Modified Value at Risk (MVaR), Conditional Value at Risk (CVaR), stress testing, and drawdown analysis, provides a more nuanced understanding of strategy risk. These alternative metrics offer insights into the impact of extreme events, the magnitude of potential losses, and the duration of underperformance.

One such alternative, Modified Value at Risk (MVaR), stands out by extending the conventional VaR metric. MVaR seeks to improve upon traditional VaR by adjusting the estimation of the critical value ( $z$ ) and incorporating additional distribution moments beyond the mean and standard deviation. The Cornish-Fisher expansion is employed to include skewness and kurtosis in the calculation. In this analysis, MVaR is meticulously computed, taking into account the skewness and kurtosis of the portfolio returns. This nuanced approach yields an MVaR of €4,694 at a 95% confidence level, representing a 0.47% loss (Appendix 5, Table 3).

Conditional Value at Risk (CVaR), also known as Expected Shortfall, emerges as another vital alternative to VaR. Unlike VaR, CVaR delves deeper into the expected value of losses beyond the VaR threshold. This analysis encompasses both parametric (given by the expected value of losses beyond VaR) and historical (calculated by taking

the mean of losses that exceed the VaR level) calculations of CVaR at a 95% confidence level, resulting in values of €27,309 (2.73%) and €32,878 (3.29%), respectively (Appendix 5, Table 4).

The exploration extends further into stress testing, a methodology designed to scrutinize the impact of various scenarios on pertinent risk factors influencing portfolio value. A comprehensive evaluation involves hypothetical and historical scenarios. Hypothetical scenarios introduce specific changes in risk factors, while historical scenarios assess the repercussions of real but rare events. A noteworthy illustration for the hypothetical scenario is the worst one-day observation in the historical distribution, revealing a stress loss of -7.66% (€76,636) (Appendix 5, Table 5).

For the historical scenario were selected some events that had a strong negative impact on the financial markets (Flash Crash, Black Monday 2015, Brexit, Black Monday 2018 and Covid-19). It is evident that this pairs trade strategy is not correlated with the market, presenting positive or slightly negative returns in bad times.

Drawdown analysis, an indispensable risk management tool, unveils the decline from the highest peak to the current trough in the investment. This analysis provides profound insights into the worst losses and the duration of underperformance. In the context of the pair trade strategy, the worst drawdown manifests as -32.48%, persisting for 909 days. Significantly, the longest drawdown period spans from November 18, 2011, to May 15, 2014, indicating a prolonged phase of underperformance.

Validating the accuracy of Value at Risk (VaR) models is crucial to ensuring their effectiveness in estimating market risk. This validation process involves backtesting, a method that compares hypothetical returns predicted by the VaR model with the realized

returns over a specific historical period. The objective is to assess the model's performance by calculating the number of exceptions, instances where actual losses exceed the previously estimated VaR. A formal statistical test, such as the Unconditional Coverage Test proposed by Kupiec in 1995, is then applied to determine the model's reliability. VaR Backtesting

The calculated Unconditional Coverage Test statistic (LRuc) is 1.42, which falls below the critical value of 3.84 at the 5% significance level. Consequently, the decision is "Don't reject VaR model." This suggests that, based on historical comparisons, there is no statistically significant evidence to reject the VaR model. The exception rate of 4.55% implies a reasonable alignment between predicted and actual losses (Appendix 5, Table 6).

### **Pairs Trade NPV**

The objective of this analysis is to establish a correlation between discounted cash flow (DCF) calculations and the pair trade strategy, elucidating the net present value (NPV) of the pairs trade and its sensitivity to a pivotal driver – industry growth. The methodology involves employing DCF-derived fair values for the stocks, adhering to the pair value rationale (shorting the most overvalued and longing the less overvalued). Subsequently, the determination of the number of stocks bought/sold culminates in an assessment of the theoretical NPV of the strategy, based on a notional of €1,000,000.

In the base scenario, assuming an EUR/USD conversion rate of 1.0586 to convert Boeing's price into euros, the fair values of the stocks are ascertained through DCF

calculations. This results in values of €36.49 (indicating a 456% overvaluation, prompting a short position) for Boeing and €54.21 (reflecting a 134% overvaluation, warranting a long position) for Airbus. With a notional value set at €1 million, the calculation of the number of shares bought/sold enables the determination of a theoretical NPV for the portfolio, resulting in €247,073.13. This figure suggests a notably low NPV, primarily attributed to the overpriced nature of the stocks (Appendix 6, Table1). In exploring the sensitivity of NPV to changes in revenue forecasting within the DCF, considering variations of plus or minus 3% annually, the analysis reveals a remarkable stability in NPV. This indicates a low sensitivity to fluctuations in revenue growth, underscoring the resilience of the strategy to changes in this key parameter (Appendix 6, Table 2-3).

## Conclusion

From a hedge fund perspective, a comprehensive evaluation of Airbus and Boeing indicates that Airbus holds a more favorable financial position and overall health in the aerospace industry. Airbus has demonstrated robust liquidity patterns over time, ensuring its ability to meet short-term obligations efficiently. This contrasts with Boeing, which, while maintaining stability, shows limitations in quickly converting assets into cash. In terms of solvency, Airbus adopts a judicious balance between debt and equity management, maintaining stability in its financial structure. Conversely, Boeing has experienced fluctuations, particularly with a surge in long-term debt between specific periods. Notably, Airbus has proven to be more resilient and efficient in navigating industry challenges, such as aircraft incidents and the impact of the COVID-19 pandemic. The company has not only recovered but has also returned to profitability, showcasing its adeptness in overcoming sector-wide crises.

Additionally, Airbus demonstrates superior efficiency, particularly in its cash conversion cycle, reflecting a streamlined process of converting sales to cash and enhancing overall financial agility. The Discounted Cash Flow (DCF) research found a significant gap between Boeing and Airbus in the market valuation arena, contributing to Airbus's position as the strategic winner. Boeing's stock had a 456% overvaluation as of September 29, 2023, with a DCF-derived target share price of \$34.47, which was much lower than its market trading price. Boeing's enterprise value was estimated to be \$66,042.20 million, indicating a significant gap between market perception and underlying value. Airbus' stock, on the other hand, was overvalued, albeit to a smaller amount. Airbus' enterprise worth was evaluated at €45,435.83 million using a weighted-average cost of capital of 14.32%, resulting in an intrinsic share price of €54.21. However, based on the valuation date's closing share price at €126.98, Airbus's stock was overvalued by 134.24%. While this number suggests an overestimation, it's still significantly lower than Boeing's, indicating a more reasonable market estimation of Airbus. The comparatives using financial multiples further affirmed this perspective, showing Airbus's overvaluation against an industry average price target

to be around 34.63% while for Boeing it was 50% just taking in count one multiple. These valuation discrepancies clearly illustrate why Airbus emerges as the preferable investment choice in the aerospace sector: while both companies are overvalued, Airbus's market valuation is comparatively closer to its fundamental value, indicating a more grounded approach to its financial assessment.

The trading strategy employed paints a compelling picture of Airbus as the market leader over Boeing. Our signal construction, which is integral to the strategy, dictates that going long the spread involves buying Airbus and shorting Boeing. In contrast, going short the spread involves the opposite positions. Over a period spanning 14 years, our strategy executed a total of 3,408 positions. The breakdown of these positions consisted of 785 long positions, 1,917 instances where no position was taken, and 706 short positions. This distribution of positions indicates a tendency for Airbus to be undervalued more frequently relative to Boeing, which, conversely, was more often overvalued. This pattern is further substantiated by the total returns over the same timeframe, with Airbus yielding an impressive 1049% return, significantly surpassing Boeing's return of 338%. The predominance of long positions in Airbus and the substantial return difference reflect Airbus's consistent undervaluation compared to Boeing, suggesting a more attractive valuation and financial performance. Hence, in the context of our hedge fund strategy, Airbus emerges not only as the strategic winner due to its sound financial and market valuations but also as the preferred investment choice, demonstrating a greater propensity for undervaluation and a higher return on investment.

Boeing			
Approach	estimate	pessimisti	optimistic
DCF	34,47	22,02	96,09
Multiples - EV/Sales	128,13	47,45	268,07
<b>Average</b>	<b>81,3</b>	<b>34,735</b>	<b>182,08</b>
	191,68		
	-58%		

Airbus			
Approach	estimate	pessimistic	optimistic
DCF	54,21	48,41	76,32
DDM	67,58	57,14	84,31
Multiples - P/E	19,29	-76,70	51,20
Multiples - P/B	43,84	-144,44	557,12
Multiples - EV/EBITDA	119,23	66,91	230,61
Multiples - EV/Sales	119,89	80,69	166,08
<b>Average</b>	<b>70,67</b>	<b>5,34</b>	<b>194,27</b>
	126,98		
	-44,34%		

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# Appendix

## Appendix 1: Financial Analysis Data

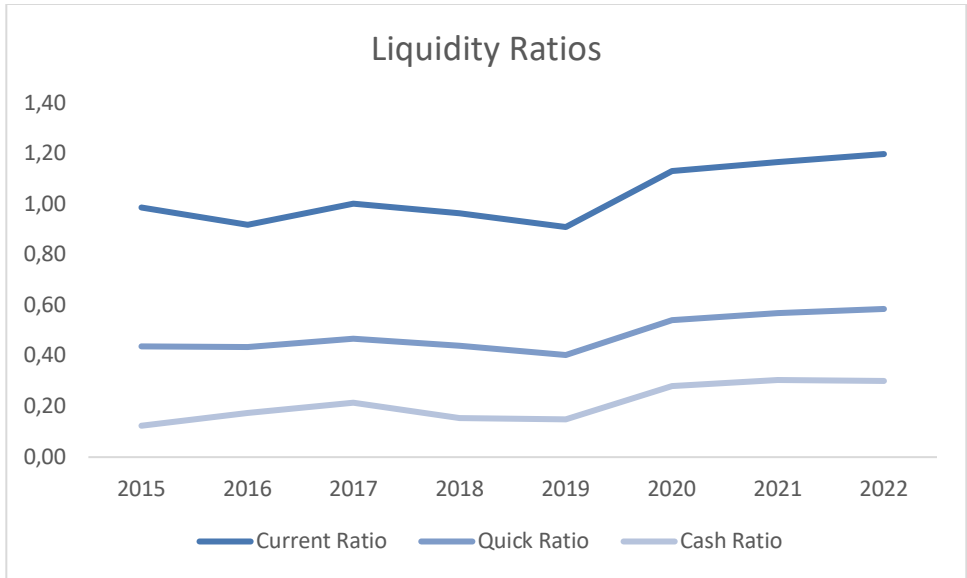
Table 1 - Airbus Historical Financial Data

	2015	2016	2017	2018	2019	2020	2021	2022	Q1 2023	Q2 2023
<b>Revenue</b>	€ 64.450,00	€ 66.581,00	€ 66.767,00	€ 63.707,00	€ 70.478,00	€ 49.912,00	€ 52.149,00	€ 58.783,00	€ 11.763,00	€ 15.900,00
Revenue growth		3%	0%	-5%	11%	-29%	4%	13%	-80%	35%
Inflation rate	0,7%	2,1%	2,1%	1,9%	2,3%	1,4%	7,0%	6,5%		
Cost of Goods Sold	55599	61317	52149	54920	59973	44250	42518	48192	10103	13043
<b>Gross Profit</b>	€ 8.851,00	€ 5.264,00	€ 14.618,00	€ 8.787,00	€ 10.505,00	€ 5.662,00	€ 9.631,00	€ 10.571,00	€ 1.660,00	€ 2.857,00
R & D Expenditures (inc. D&A)	3460	2970	2807	3217	3358	2858	2746	3079	683	748
RORC		152%	492%	313%	327%	169%	337%	385%	54%	418%
Selling General and Administrative Expenses (inc. I	2651	2723	2439	2435	6125	2140	2052	2240	587	663
Other Operating Profits (Losses)	-1322	-2687	-1038	-1913	-317	1174	-509	-73	0	-51
<b>EBITDA</b>	€ 6.528,00	€ 4.552,00	€ 12.708,00	€ 7.492,00	€ 4.266,00	€ 2.321,00	€ 7.667,00	€ 8.041,00	€ 885,00	€ 2.044,00
EBITDA / Revenue	10%	7%	19%	12%	6%	5%	15%	14%	8%	13%
<b>Depreciation &amp; Amortization</b>	2466	2294	2298	2444	2927	2831	2325	2716	495	547
D&A / Revenue	4%	3%	3%	4%	4%	6%	4%	5%	4%	3%
<b>EBIT</b>	€ 4.062,00	€ 2.258,00	€ 10.410,00	€ 5.048,00	€ 1.339,00	-€ 510,00	€ 5.342,00	€ 5.325,00	€ 390,00	€ 1.497,00
Effective Tax Rate	20,06%	22,54%	38,21%	29,73%	224,53%		16,97%	18,50%	18,74%	30,07%
<b>Capital Expenditures</b>	- 2.924,00	- 3.060,00	- 2.558,00	- 2.285,00	- 2.340,00	- 1.759,00	- 1.928,00	- 2.464,00	- 497,00	- 593,00
CAPEX / Revenue	-4,54%	-4,60%	-3,83%	-3,59%	-3,32%	-3,52%	-3,70%	-4,19%	-4,23%	-3,73%
Total Current Assets	52.344,00	53.303,00	55.924,00	58.634,00	56.723,00	58.400,00	55.694,00	63.002,00	64.846,00	65.449,00
Cash and Equivalents	6.590,00	10.143,00	12.016,00	9.413,00	9.314,00	14.439,00	14.572,00	15.823,00	14.512,00	14.533,00
Total Current Liabilities	53.109,00	57.988,00	55.885,00	60.786,00	62.374,00	51.605,00	47.807,00	52.595,00	55.063,00	54.529,00
ST Borrowings and Current Portion of LT Debt	2.790,00	7.331,00	2.212,00	2.302,00	1.959,00	3.013,00	2.555,00	2.765,00	2.754,00	2.782,00
<b>Adjusted Net working capital</b>	- 4.565,00	- 7.497,00	- 9.765,00	- 9.263,00	-13.006,00	- 4.631,00	- 4.130,00	- 2.651,00	- 1.975,00	- 831,00
Adj. NWC / Revenue	-7,08%	-11,26%	-14,63%	-14,54%	-18,45%	-9,28%	-7,92%	-4,51%	-16,79%	-5,23%

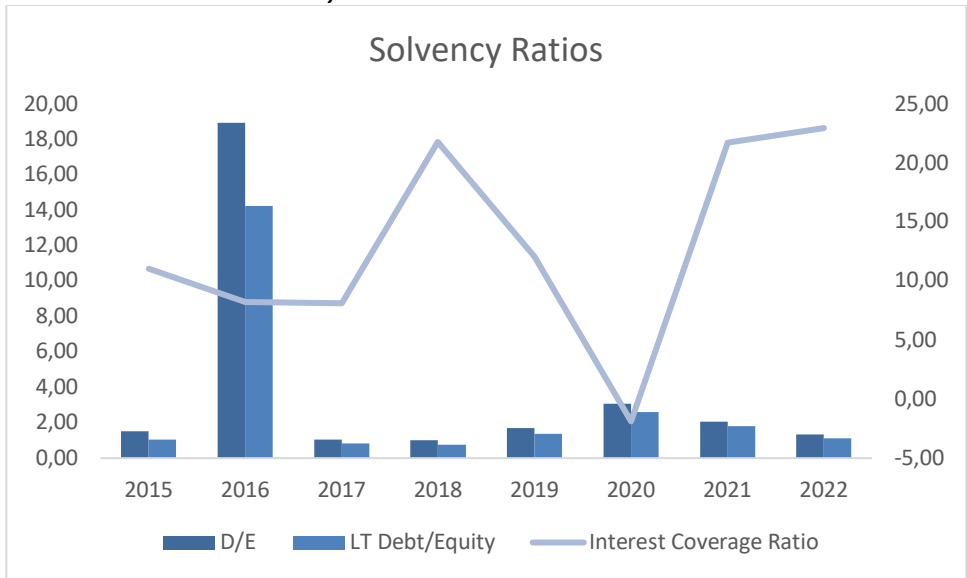
Table 2 - Airbus Financial Ratios

Airbus	2015	2016	2017	2018	2019	2020	2021	2022	Average
<b>Liquidity</b>									
Current Ratio	0,99	0,92	1,00	0,96	0,91	1,13	1,16	1,20	1,03
Quick Ratio	0,44	0,43	0,47	0,44	0,40	0,54	0,57	0,59	0,49
Cash Ratio	0,12	0,17	0,22	0,15	0,15	0,28	0,30	0,30	0,21
<b>Profitability</b>									
Gross Profit Margin	14%	8%	10%	14%	15%	11%	18%	18%	14%
EBITDA Margin	10%	7%	19%	12%	6%	5%	15%	14%	11%
EBIT Margin	6%	3%	4%	8%	2%	-1%	10%	9%	5%
Net Profit Margin	4%	1%	4%	5%	-2%	-2%	8%	7%	3%
ROA	█	1% █	3% █	3% █	-1% █	-1% █	4% █	4%	2%
ROIC		8%	8%	12%	-6%	-2%	13%	11%	6%
<b>DuPont Analysis</b>									
ROE	█	26% █	47% █	30% █	-17% █	-18% █	53% █	38%	23%
Tax Bureden	█	0,77	0,75	0,71	-1,28	1,00	0,84	0,84	0,52
Asset Turnover	█	0,62	0,62	0,57	0,61	0,44	0,48	0,53	0,55
Financial Leverage	█	28,35	17,65	10,98	14,62	18,04	13,62	9,92	16,17
Interest burden		0,57	1,44	0,85	0,79	2,22	0,94	0,95	1,11
Operating Income		0,03	0,04	0,08	0,02	-0,01	0,10	0,09	0,05
<b>Solvency</b>									
D/E	1,53	18,94	1,04	1,00	1,69	3,08	2,06	1,34	3,84
LT Debt/Equity	1,06	14,23	0,84	0,77	1,37	2,61	1,79	1,12	2,97
Interest Coverage Ratio	11,04	8,21	8,13	21,76	12,06	-1,88	21,72	22,95	13,00
<b>Cash Conversion Cycle</b>									
Days Sales Outstanding (DSO)		34,51	29,59	34,35	28,98	37,02	34,22	30,34	32,72
Days of Inventory Outstanding (DIO)	█	167,79	199,66	201,99	190,41	252,00	249,52	226,87	212,61
Days Payables Outstanding (DPO)		75,86	92,55	106,43	88,89	70,96	82,07	99,06	87,97
Cash Conversion Cycle (CCC)		126,44	136,70	129,90	130,50	218,06	201,67	158,15	157,35

Table 3 - Airbus Liquidity Ratios



**Table 4 - Airbus Solvency Ratios**



**Table 5 - Airbus Profitability Ratios**

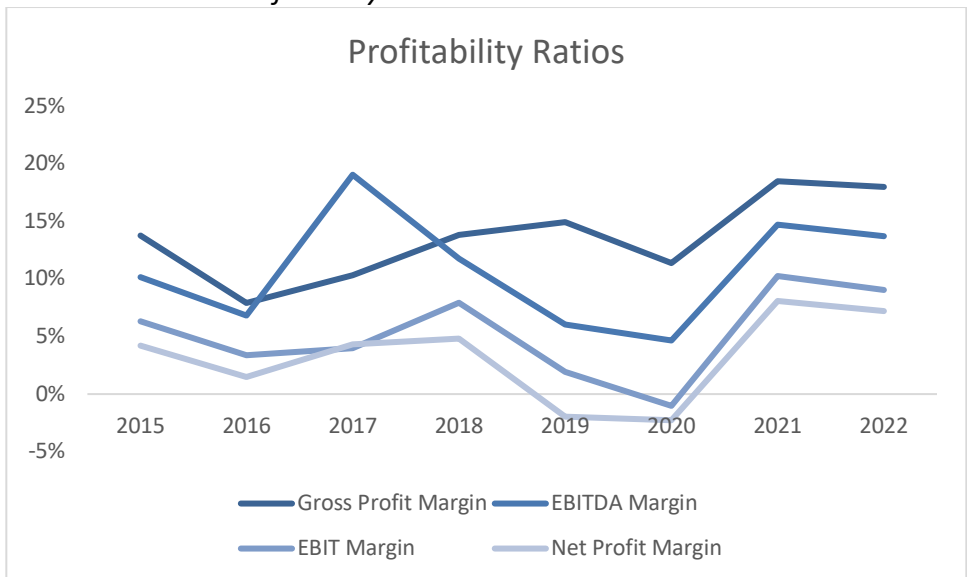


Table 6 - Airbus ROE

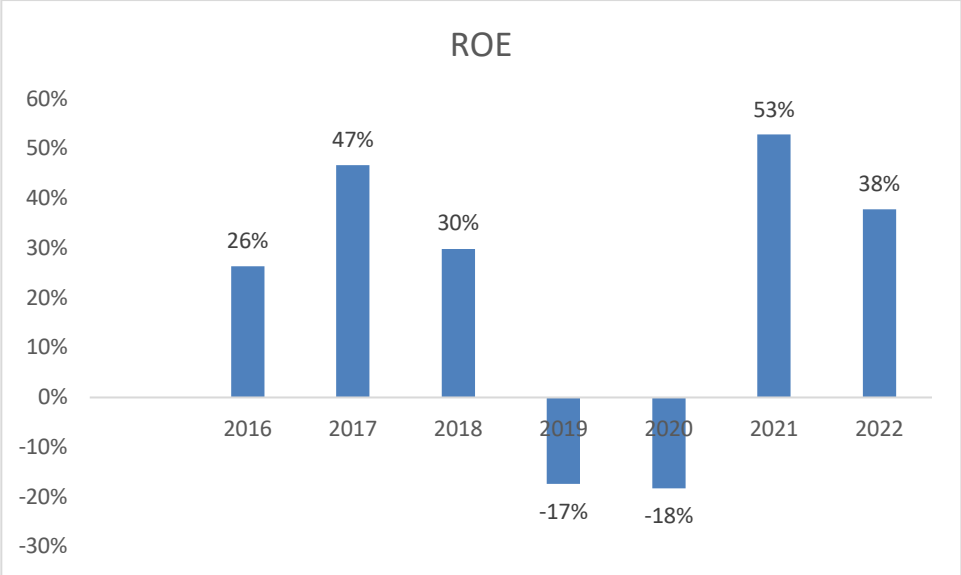


Table 7 - Airbus ROA & ROIC

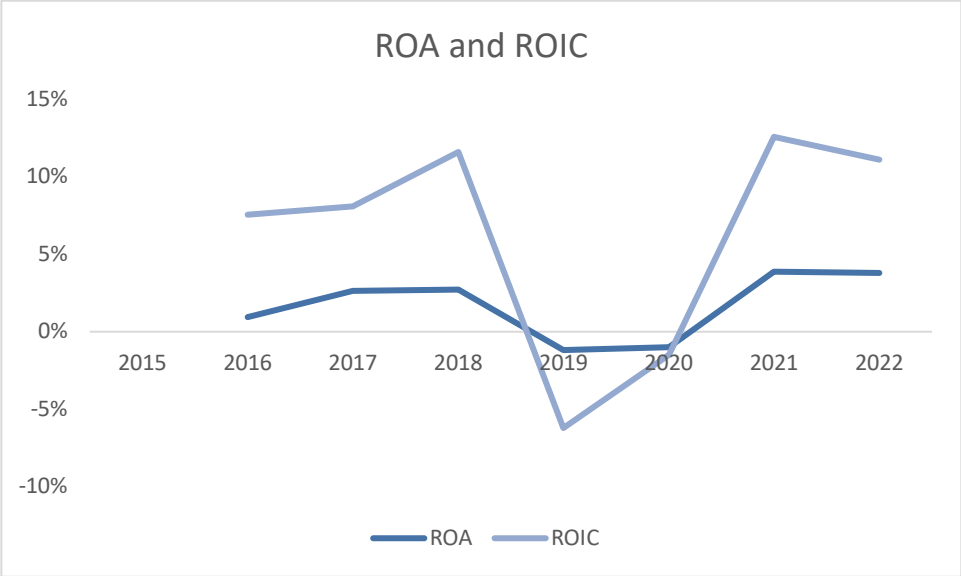
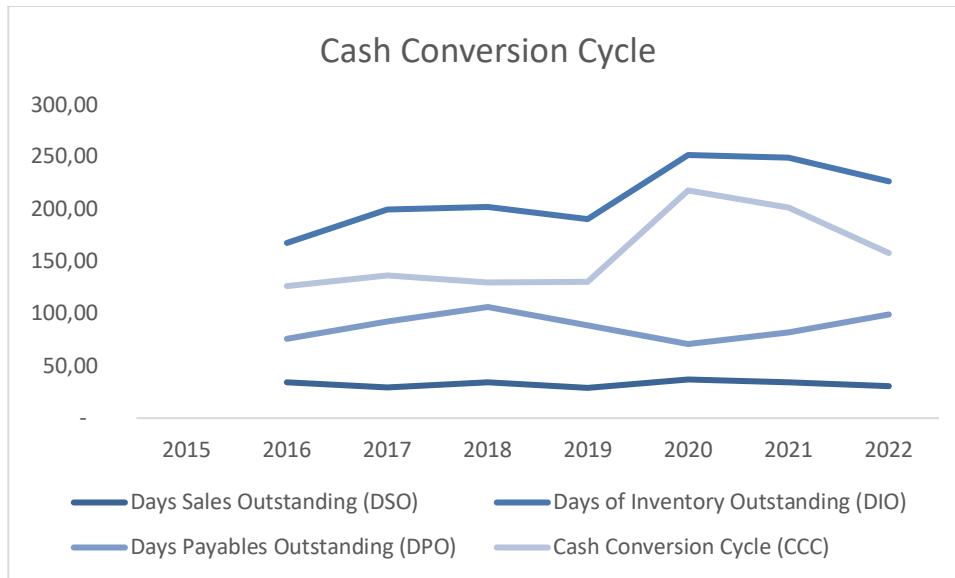


Table 8 - Airbus Cash Conversion Cycle



**Table 9 - Boeing Historical Financial Data**

	2015	2016	2017	2018	2019	2020	2021	2022	Q1 2023	Q2 2023
<b>Revenue</b>	\$ 96.114	\$ 94.571	\$ 93.392	\$ 101.127	\$ 76.559	\$ 58.158	\$ 62.286	\$ 66.608	\$ 17.921	\$ 19.751
Revenue growth		-1,61%	-1,25%	8,28%	-24,29%	-24,04%	7,10%	6,94%		
Inflation rate	0,7%	2,1%	2,1%	1,9%	2,3%	1,4%	7,0%	6,5%		
Cost of Goods Sold	\$ 82.088	\$ 79.026	\$ 76.612	\$ 81.490	\$ 72.093	\$ 63.843	\$ 59.269	\$ 63.106	\$ 15.998	\$ 17.812
<b>Gross Profit</b>	\$ 14.026	\$ 15.545	\$ 16.780	\$ 19.637	\$ 4.466	\$ (5.685)	\$ 3.017	\$ 3.502	\$ 1.923	\$ 1.939
R & D Expenditures (inc. D&A)	\$ (3.331)	\$ (4.626)	\$ (3.179)	\$ (3.269)	\$ (3.219)	\$ (2.476)	\$ (2.249)	\$ (2.852)	\$ (741)	\$ (797)
RORC		4,67	3,63	6,18	1,37	-1,77	1,22	1,56	0,67	2,62
Selling General and Administrative Expenses (inc. D&A)	\$ (3.525)	\$ (3.613)	\$ (4.095)	\$ (4.567)	\$ (3.909)	\$ (4.817)	\$ (4.157)	\$ (4.187)	\$ (1.304)	\$ (1.286)
Other Operating Profits (Losses)	\$ 274	\$ 303	\$ 204	\$ 111	\$ (4)	\$ 9	\$ 210	\$ (16)	\$ (27)	\$ 44
<b>EBITDA</b>	\$ 9.277	\$ 9.498	\$ 11.757	\$ 14.026	\$ (395)	\$ (10.723)	\$ (1.035)	\$ (1.574)	\$ 308	\$ 356
EBITDA / Revenue	9,7%	10,0%	12,6%	13,9%	-0,5%	-18,4%	-1,7%	-2,4%	1,7%	1,8%
<b>Depreciation &amp; Amortization</b>	\$ 1.833	\$ 1.889	\$ 2.047	\$ 2.114	\$ 2.271	\$ 2.246	\$ 2.144	\$ 1.979	\$ 457	\$ 456
D&A / Revenue	1,9%	2,0%	2,2%	2,1%	3,0%	3,9%	3,4%	3,0%	2,6%	2,3%
<b>EBIT</b>	\$ 7.444	\$ 7.609	\$ 9.710	\$ 11.912	\$ (2.666)	\$ (12.969)	\$ (3.179)	\$ (3.553)	\$ (149)	\$ (100)
Effective Tax Rate	27,66%	12,95%	16,32%	9,86%						
<b>Capital Expenditures</b>	-2450	-2613	-1739	-1722	-1834	-1303	-980	-1222	-468	-296
CAPEX / Revenue	-2,5%	-2,8%	-1,9%	-1,7%	-2,4%	-2,2%	-1,6%	-1,8%	-2,6%	-1,5%
Total Current Assets	68234	62488	85194	87830	102229	121642	108666	109523	108811	107412
Cash and Equivalents	\$ 11.302	\$ 8.801	\$ 8.813	\$ 7.637	\$ 9.485	\$ 7.752	\$ 8.052	\$ 14.614	\$ 10.812	\$ 7.254
Total Current Liabilities	50359	50077	73119	79875	95583	87280	81992	90052	93510	92076
ST Borrowings and Current Portion of LT Debt	1181	327	1335	3190	7340	1693	1296	5190	7926	4609
<b>Adjusted Net working capital</b>	\$ 7.754	\$ 3.937	\$ 4.597	\$ 3.508	\$ 4.501	\$ 28.303	\$ 19.918	\$ 10.047	\$ 12.415	\$ 12.691
Adj. NWC / Revenue	8,1%	4,2%	4,9%	3,5%	5,9%	48,7%	32,0%	15,1%	69,3%	64,3%

**Table 10 - Boeing Financial Ratios**

Boeing	2015	2016	2017	2018	2019	2020	2021	2022	Average
<b>Liquidity</b>									
Current Ratio	1,35	1,25	1,17	1,10	1,07	1,39	1,33	1,22	1,23
Quick Ratio	0,42	0,39	0,33	0,32	0,27	0,46	0,36	0,35	0,36
Cash Ratio	0,22	0,18	0,12	0,10	0,10	0,09	0,10	0,16	0,13
<b>Profitability</b>									
Gross Profit Margin	15%	15%	19%	19%	6%	-10%	5%	5%	9%
EBITDA Margin	10%	10%	13%	14%	-1%	-18%	-2%	-2%	3%
EBIT Margin	8%	7%	11%	12%	-3%	-22%	-5%	-5%	0%
Net Profit Margin	5%	5%	9%	10%	-1%	-21%	-7%	-8%	-1%
ROA		5%	8%	9%	-1%	-8%	-3%	-4%	1%
ROIC		-726%	-272%	-522%	-321%	-3%	-27%	-8%	-268%
<b>DuPont Analysis</b>									
ROE		138%	653%	985%	16%	91%	26%	33%	278%
Tax Bureden		87%	84%	90%	28%	82%	85%	101%	80%
Asset Turnover		103%	92%	88%	61%	41%	43%	48%	68%
Financial Leverage		2535%	7813%	10821%	-3181%	-1083%	-883%	-898%	2160%
Interest burden		89%	98%	97%	114%	113%	173%	142%	118%
Operating Income		7%	11%	12%	-3%	-22%	-5%	-5%	-1%
<b>Solvency</b>									
D/E	1,55	11,28	6,49	33,77	-3,29	-3,52	-3,91	-3,60	4,85
LT Debt/Equity	1,36	10,91	5,71	25,99	-2,41	-3,42	-3,83	-3,27	3,88
Interest Coverage Ratio	27,07	21,33	28,73	25,24	-2,74	-5,92	-1,08	-1,40	11,40
<b>Cash Conversion Cycle</b>									
Days Sales Outstanding (DSO)		33,62	11,16	13,81	15,36	12,10	15,26	13,60	16,42
Days of Inventory Outstanding (DIO)		206,19	245,95	274,03	347,82	446,72	487,82	447,94	350,92
Days Payables Outstanding (DPO)		51,01	57,39	57,11	77,73	72,95	56,28	58,21	61,53
Cash Conversion Cycle (CCC)		188,80	199,72	230,73	285,45	385,87	446,80	403,33	305,81

Table 11 - Boeing Liquidity Ratios

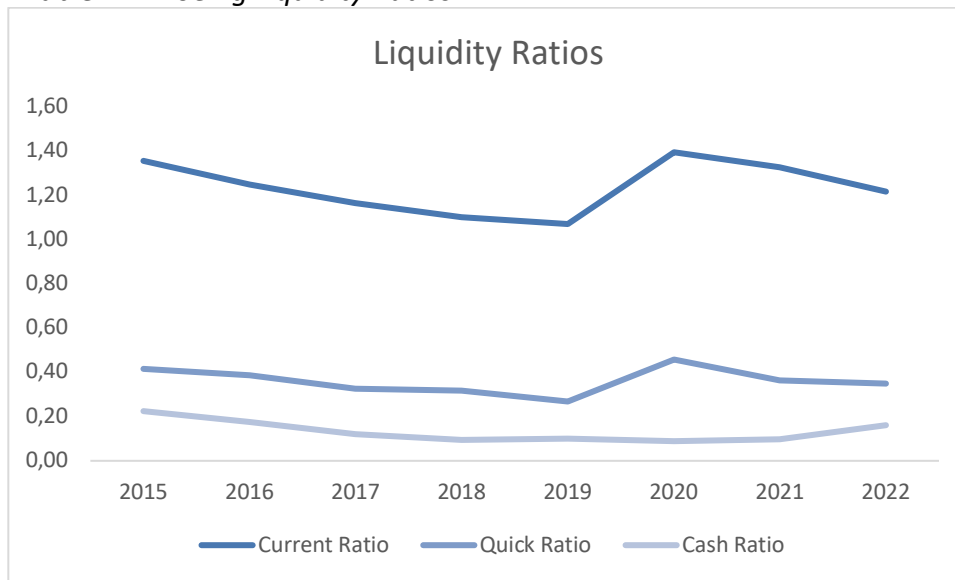


Table 12 - Boeing Solvency Ratios

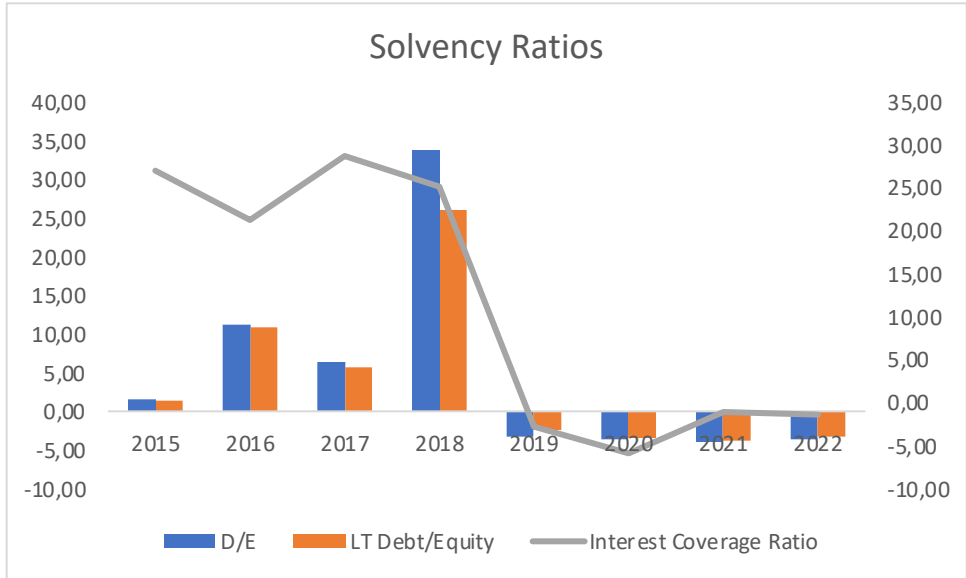


Table 13 - Boeing Profitability Ratios

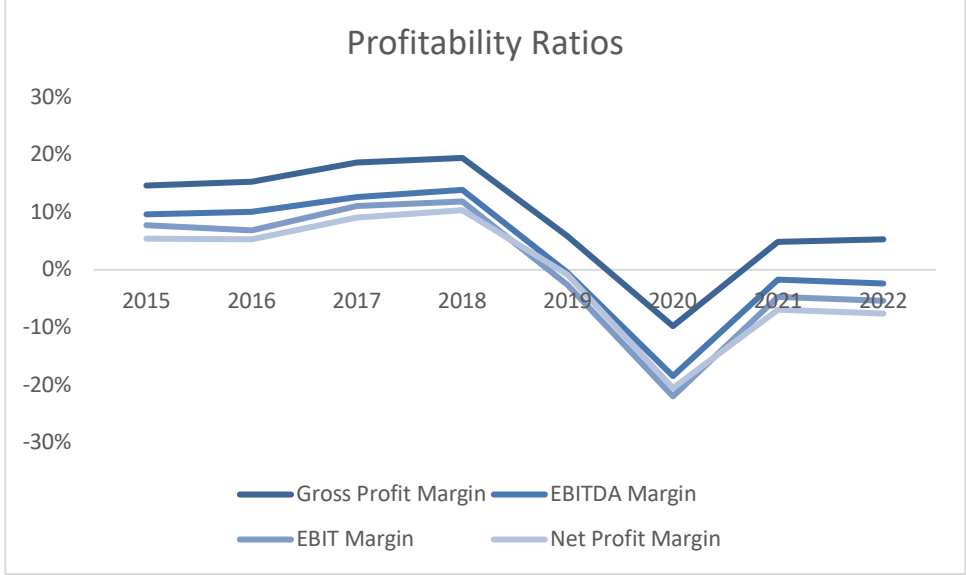


Table 14 - Boeing ROE

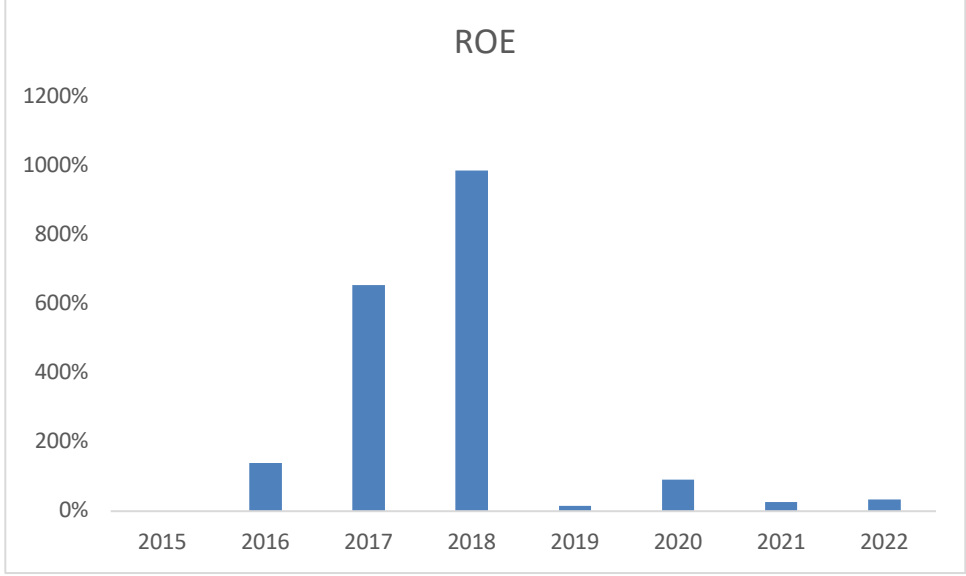
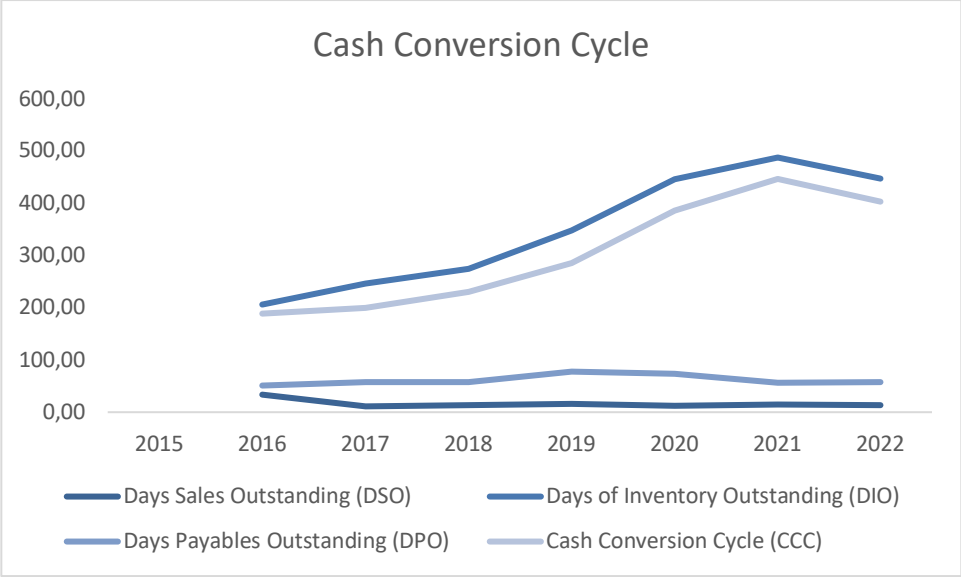


Table 15 - Boeing Cash Conversion Cycle



## Appendix 2: Valuation Models and Calculations

Table 1 - Forecasted Cash Flow of Boeing

	Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	
	Q1 - Q2 2023	Q3 - Q4 2023	2023	2024	2025	2026	2027	2028	2029	2030	
	30/06/2023	31/12/2023	31/12/2023	31/12/2024	31/12/2025	31/12/2026	31/12/2027	31/12/2028	31/12/2029	31/12/2030	
Revenue		37.672,00	39.377,45	77.049,45	82.982,26	89.371,90	94.644,84	100.228,88	106.142,39	112.404,79	119.036,67
Revenue growth					7,70%	7,70%	5,90%	5,90%	5,90%	5,90%	5,90%
EBITDA		664,00	706,8066716	1.370,81	3.792,29	4.084,30	4.325,27	11.345,91	12.015,32	12.724,22	13.474,95
EBITDA margin		1,76%	1,79%	1,78%	4,57%	4,57%	4,57%	11,32%	11,32%	11,32%	11,32%
Depreciation And Amortization		913	963,8745559	1876,874556	2.223,92	2.395,17	2.536,48	2.686,13	2.844,62	3.012,45	3.190,18
D&A / Revenue		2,42%	2,45%	2,44%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%
EBIT		-249,00	-257,07	-506,07	1.568,36	1.689,13	1.788,79	8.659,78	9.170,70	9.711,77	10.284,77
Income Tax Expenses (Benefits)		-322	-322,00	-644	345,5107582	372,1150865	394,0698766	1907,748569	2020,305734	2139,503772	2265,734495
Effective Tax Rate				22,03%	22,03%	22,03%	22,03%	22,03%	22,03%	22,03%	22,03%
NOPLAT		73,00	64,93	137,93	1.222,85	1.317,01	1.394,72	6.752,03	7.150,40	7.572,27	8.019,03
Capital Expenditures		764	699,5381003	1463,5381	1759,223971	1894,684217	2006,470536	2124,852351	2250,218639	2382,981539	2523,57745
CAPEX / Revenue		2,03%	1,78%	1,90%	2,12%	2,12%	2,12%	2,12%	2,12%	2,12%	2,12%
Adjusted Net working capital		12.691,00	28.022,65	28.022,65	5.786,61	6.232,18	6.599,88	4.553,03	4.821,66	5.106,14	5.407,40
Adj. NWC / Revenue		34%	36%	36,37%	6,97%	6,97%	6,97%	4,54%	4,54%	4,54%	4,54%
Increases in Adjusted Net working capital			15.331,65	-	-22.236,04	445,57	367,70	-2.046,85	268,63	284,48	301,26
Free Cash Flow			-15.002,38		23.923,59	1.371,93	1.557,03	9.360,16	7.476,17	7.917,26	8.384,38

Source: Developed by the group

Table 2 - Forecasted Cash Flow of Airbus

	Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
	Q1 - Q2 2023	Q3 - Q4 2023	2023	2024	2025	2026	2027	2028	2029	2030
	30/06/2023	31/12/2023	31/12/2023	31/12/2024	31/12/2025	31/12/2026	31/12/2027	31/12/2028	31/12/2029	31/12/2030
Revenue	27.663,00	37.142,66	64.805,66	70.443,75	76.572,35	81.855,85	87.503,90	93.541,67	99.996,04	106.895,77
Revenue growth				8,70%	8,70%	6,90%	6,90%	6,90%	6,90%	6,90%
EBITDA	2.929,00	3874,5003	6.803,50	7.650,19	8315,76	8889,54	9502,92	10158,63	10859,57	11608,88
EBITDA margin	10,59%	10,43%	10,50%	10,86%	10,86%	10,86%	10,86%	10,86%	10,86%	10,86%
Depreciation And Amortization	1.042,00	1.042,00	2.084,00	2944,55	3200,72	3421,57	3657,66	3910,04	4179,83	4468,24
D&A / Revenue	3,77%	3,28%	3,22%	4,18%	4,18%	4,18%	4,18%	4,18%	4,18%	4,18%
EBIT	1.887,00	2.832,50	4.719,50	4.705,64	5.115,03	5.467,97	5.845,26	6.248,58	6.679,74	7.140,64
Income Tax Expense	537	754,16718	1291,1672	1060,65	1152,93	1232,48	1317,52	1408,43	1505,61	1609,50
Effective Tax Rate	28,46%	26,63%	27,36%	22,54%	22,54%	22,54%	22,54%	22,54%	22,54%	22,54%
NOPLAT	1.350,00	2.078,33	3.428,33	3.644,99	3.962,10	4.235,49	4.527,74	4.840,15	5.174,12	5.531,14
Capital Expenditures	1.090,00	1.599,02	2.689,02	2754,35	2993,98	3200,56	3421,40	3657,48	3909,85	4179,62
CAPEX / Revenue	3,940%	4,31%	4,15%	3,91%	3,91%	3,91%	3,91%	3,91%	3,91%	3,91%
Adjusted Net working capital	-2.806,00	-8.693,06	-8.693,06	-7720,63	-8392,33	-8971,40	-9590,43	-10252,17	-10959,57	-11715,78
Adj. NWC / Revenue	-10,14%	-13,41%	-13,41%	-10,96%	-10,96%	-10,96%	-10,96%	-10,96%	-10,96%	-10,96%
Increases in Adjusted Net working capital		-5.887,06		972,42	-671,70	-579,07	-619,03	-661,74	-707,40	-756,21
Free Cash Flow		7.408,37		2.862,77	4.840,55	5.035,57	5.383,03	5.754,45	6.151,51	6.575,97

Source: Developed by the group

Table 3 - Boeing and Airbus Seasonality Factors

Boeing seasonality factors

<b>Sales Revenue Turnover</b>	<b>EBITDA to Revenue</b>	<b>Depreciation and Amortization to Sales</b>	<b>Capital Expenditure to Sales</b>	<b>Working Capital to Sales</b>	<b>Effective Tax Rate</b>
1.05	1.02	1.01	0.88	1.08	1.07

Airbus seasonality factors

<b>Sales Revenue Turnover</b>	<b>EBITDA to Revenue</b>	<b>Depreciation and Amortization to Sales</b>	<b>Capital Expenditure to Sales</b>	<b>Working Capital to Sales</b>	<b>Effective Tax Rate</b>
1.34	0.99	0.87	1.09	1.32	0.94

Source: Developed by the group

Table 4 - *Boeing and Airbus Revenue Forecast*

<b>Year</b>	<b>Growth Rate (%)</b>
2023	7.7%
2024	7.7%
2025	7.7%
2026	5.9%
2027	5.9%
2028	5.9%
2029	5.9%
2030	5.9%

Source: Developed by the group with data from (The business Research Company 2021)

Table 5 - *Boeing and Airbus Historical Depreciation & Amortization*

Boeing

<b>Year</b>	<b>Depreciation and Amortization (in million units)</b>	<b>Percentage of Sales</b>
2015	1,833	1.91%
2016	1,889	2.00%
2017	2,047	2.19%
2018	2,114	2.09%
2019	2,271	2.97%
2020	2,246	3.86%
2021	2,144	3.44%
2022	1,979	2.97%
Avg.	-	2.68%

Airbus

<b>Year</b>	<b>Depreciation and Amortization (in million units)</b>	<b>Percentage of Sales</b>
2015	2,466	3.83%
2016	2,294	3.45%
2017	2,298	3.44%
2018	2,444	3.84%
2019	2,927	4.15%
2020	2,831	5.67%
2021	2,325	4.46%
2022	1,716	4.62%
Avg.	-	4.18%

Source: Developed by the group.

Table 6 - Boeing and Airbus Historical EBITDA and EBITDA Margin

Boeing

<b>Year</b>	<b>EBITDA (in millions)</b>	<b>EBITDA Margin</b>
2015	9,277	9,65%
2016	9,498	10,04%
2017	11,757	12,59%
2018	14,026	13,87%
2019	-395	-0,52%
2020	-10,723	-18,44%
2021	-1,035	-1,66%
2022	-1,574	-2,36%
Avg.	-	2,90%
Median (2015-2018)	-	11,32%
Median (2015-2022)	-	4,57%

Airbus

<b>Year</b>	<b>EBITDA (in millions)</b>	<b>EBITDA Margin</b>
2015	6,528	10.13%
2016	4,552	6.84%
2017	12,708	19.03%
2018	7,492	11.76%
2019	4,266	6.05%

<b>Year</b>	<b>EBITDA (in millions)</b>	<b>EBITDA Margin</b>
2020	2,321	4.65%
2021	7,667	14.70%
2022	8,041	13.68%
Avg.	-	10.86%

Source: Developed by the group

Table 7 - Boeing Calculation of Tax Rate

<b>Regions</b>	<b>Revenues</b> <i>in mil \$</i>	<b>%</b>	<b>Tax %</b>
<i>United States</i>	\$ 39.234	58,90%	21,00%
<i>Asia</i>	\$ 8.393	12,60%	24,52%
<i>Europe</i>	\$ 7.916	11,88%	23,68%
<i>Middle East</i>	\$ 5.047	7,58%	15,18%
<i>Canada</i>	\$ 1.612	2,42%	25,00%
<i>Oceania</i>	\$ 1.576	2,37%	29,72%
<i>Africa</i>	\$ 418	0,63%	27,27%
<i>Latin America, Caribbean</i>	\$ 2.412	3,62%	31,12%
	<b>\$ 66.608</b>	<b>100,00%</b>	<b>22,03%</b>

Source: Developed by the group

Table 8 - Airbus Historical Tax Rate

<b>Year</b>	<b>Effective Tax Rate</b>
2015	20.06%
2016	22.54%
2017	38.21%
2018	29.73%
2019	224.53%
2020	-
2021	16.97%
2022	18.50%
Median	22.54%

Source: Developed by the Group

*Table 9 - Boeing and Airbus Historical CAPEX*

Boeing

<b>Year</b>	<b>Capex (in millions)</b>	<b>Capex as % of Revenue</b>
2015	2,450.00	2.55%
2016	2,613.00	2.76%
2017	1,739.00	1.86%
2018	1,722.00	1.70%
2019	1,834.00	2.40%
2020	1,303.00	2.24%
2021	980.00	1.57%
2022	1,222.00	1.83%
Avg.	-	2.12%

Airbus

<b>Year</b>	<b>Capital Expenditures (in millions)</b>	<b>Capex as a Percentage of Sales</b>
2015	2,924	4.54%
2016	3,060	4.60%
2017	2,558	3.83%
2018	2,285	3.59%
2019	2,340	3.32%
2020	1,759	3.52%
2021	1,928	3.70%
2022	2,464	4.19%
Avg.	-	3.91%

Source: Developed by the group

*Table 10 - Boeing and Airbus Historical Adjusted Net Working Capital*

Boeing

<b>Year</b>	<b>Net Working Capital (in millions)</b>	<b>NWC as % of Sales</b>
2015	7,754.00	8.07%
2016	3,937.00	4.16%
2017	4,597.00	4.92%
2018	3,508.00	3.47%

Year	Net Working Capital (in millions)	NWC as % of Sales
2019	4,501.00	5.88%
2020	28,303.00	48.67%
2021	19,918.00	31.98%
2022	10,047.00	15.08%
Avg.	-	15.28%
Median (2015-2018)	-	4.54%
Median (2015-2022)	-	6.97%

Airbus

Year	Net Working Capital (in millions)	Net Working Capital as a Percentage of Sales
2015	-4,565	-7.08%
2016	-7,497	-11.26%
2017	-9,765	-14.63%
2018	-9,263	-14.54%
2019	-13,006	-18.45%
2020	-4,631	-9.28%
2021	-4,130	-7.92%
2022	-2,651	-4.51%
Avg.	-	-10.96%

Source: Developed by the Group

Table 11 - *Net Debt to EV Ratio*

Boeing

	2015	2016	2017	2018	2019	2020	2021	2022
Net Debt	-1.391,00	1.094,00	2.304,00	6.210,00	17.817,00	55.831,00	50.050,00	42.387,00
Market Capitalization	96.380	96.080	175.640	183.060	183.370	120.840	118.560	113.520
<b>Net Debt / (Net Debt + Equity)</b>	<b>-1,5%</b>	<b>1,1%</b>	<b>1,3%</b>	<b>3,3%</b>	<b>8,9%</b>	<b>31,6%</b>	<b>29,7%</b>	<b>27,2%</b>

airbus

	2015	2016	2017	2018	2019	2020	2021	2022
Net Debt	2.535,00	19.333,00	- 820,00	352,00	834,00	5.436,00	4.999,00	1.527,00
Market Capitalization	53.130	51.330	76.750	74.500	114.340	86.540	99.960	93.300
<b>Net Debt / (Net Debt + Equity)</b>	<b>4,6%</b>	<b>27,4%</b>	<b>-1,1%</b>	<b>0,5%</b>	<b>0,7%</b>	<b>5,9%</b>	<b>4,8%</b>	<b>1,6%</b>

Source: Developed by the group

Table 12 - DCF for Boeing

Net Debt/ (Net Debt + Equity)_2015-2022	12,70%
Beta_e_historical	1,48
Beta_d	0,1
Beta_u	1,30
Net Debt/ (Net Debt + Equity)_target	20%
Beta_e_target	1,61
Risk-free rate	4,57%
Market risk premium	5,60%
Tax rate	22,03%
Cost of debt	5,13%
Cost of equity	13,57%
After-tax WACC	11,65%
Long-term growth	2%
Valuation date	1/10/2023

Discounted Free Cash Flow		-14594,59	20844,18	1070,57	1088,20	5858,98	4191,26	3975,28	3770,48
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Sum (dFCF)	26.204,32
Terminal Value	39.887,88
Enterprise Value	66.042,20
Net Debt	45.014,00
Equity Value	21.028,20
# common shares outstanding	610,00
Sboeing_Target (date)	34,47
Sboeing_Close (29/09/2023)	191,68
SBoeing Overvaluation/(Undervaluation)	456%

Source: Developed by the group

Table 13 - Sensitivity Analysis DCF Boeing

Boeing Sensitivity Analysis		revenue growth		
		-1,0%	0,0%	1,0%
risk-free rate	1,55%	79,79	87,74	96,09
	4,57%	29,50	34,47	39,73
	5,26%	22,02	26,56	31,32

Source: Developed by the group

Table 14 - DCF for Airbus

Net Debt / (Net Debt + Equity)_2010-2021	5,54%
Beta_e_historical	1,64
Beta_d	0,05
Beta_u	1,55
Net Debt / (Net Debt + Equity)_target	5%
Beta_e_target	1,63
Risk-free rate	4,573%
Market risk premium	5,60%
Tax rate	23,22%
Cost of debt	4,89%
Cost of equity	14,88%
After-tax WACC	14,32%
Long-term growth	2%
Valuation date	1/10/2023

Discounted Free Cash Flow		7164,55		2331,76	3464,05	3119,70	2389,85	2676,93	2479,69	2296,99
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Sum (dFCF)	26423,51
Terminal Value	19012,31
Enterprise Value	45435,83
Net Debt	2610
Equity Value	42825,83
# common shares outstanding	790
\$airbus_Target (date)	54,21 €
\$airbus_Close (date)	126,98
\$Airbus Overvaluation/(Undervaluation)	134,24%

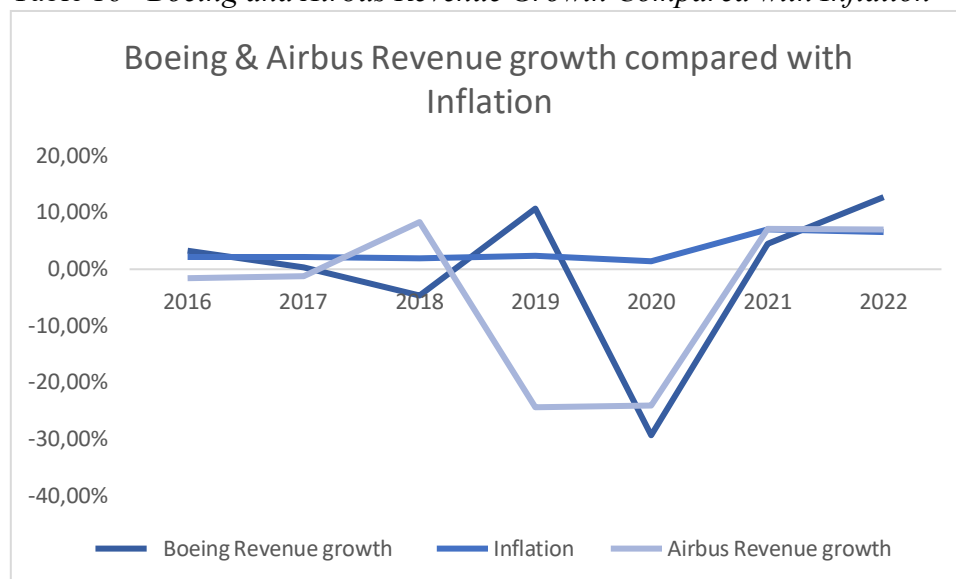
Source: Developed by the group

Table 15 - Sensitivity Analysis DCF Airbus

Airbus Sensitivity Analysis		revenue growth		
		-1,0%	0,0%	1,0%
risk-free rate	1,55%	67,04	71,54	76,32
	4,57%	51,02	54,21	57,60
	5,26%	48,41	51,40	54,55

Source: Developed by the group

Table 16 - Boeing and Airbus Revenue Growth Compared with Inflation



Source: Developed by the group

Table 17 - Beta\_d by Rating and Maturity

By Rating	A and above	BBB	BB	B	CCC
Avg. Beta	< 0.05	0.10	0.17	0.26	0.31
By Maturity	(BBB and above)	1-5 Year	5-10 Year	10-15 Year	> 15 Year
Avg. Beta		0.01	0.06	0.07	0.14

Source: S. Schaefer and I. Strebulaev, "Risk in Capital Structure Arbitrage," Stanford GSB working paper, 2009.

\*Note that these are average debt betas across industries. We would expect debt betas to be lower (higher) for industries that are less (more) exposed to market risk. One simple way to approximate this difference is to scale the debt betas in Table 12.3 by the relative asset beta for the industry (see Figure 12.4 on page 425).

Source: Schaefer & Strebulaev, 2009

Table 18 - Comparables for Boeing

Title	Similar	Name	Mkt Cap	Net Debt	Currency Adjusted Enterprise	Total Debt	Total Debt to Unlevered E	EPS	EV/EBITDA	P/E	P/B	EV/Sal	Bk per share				
SPP:US	Similar	Spirit AeroSystems Holdi	1,699.37	3,594.40	5,297.47	3,362.30	0.75	0.83	-13%	9.81	-	1.81	13.67	0.88	-	6.16	
TXT:US	Similar	Textron Inc	15,477.24	1,557.00	17,034.24	3,182.00	0.23	1.11	-4%	9.46	-	16.84	2.17	1.16	-	3.47	
EMBR:3BZ		Embraer SA	2,525.63	1,190.10	3,763.70	3,274.20	0.74	-	0.16	-1%	6.96	65.42	0.93	0.74	-	33.88	
BBD:CN		Bombardier Inc	3,475.74	5,025.00	8,847.74	5,980.00	0.73	0.71	-8%	6.79	-	5.36	-	1.46	1.10	-	33.88
MTX:GR		MTU Aero Engines AG	9,741.67	798.64	10,540.31	1,302.00	0.16	0.72	-8%	9.06	-	27.23	3.42	1.53	-	52.85	
SAF:FP	Similar	Safran SA	67,178.77	263.00		6,957.00	0.11	1.17	-44%	13.31	-	20.08	5.60	2.63	-		
AIR:FP	Similar	Airbus SE	106,165.50	-	6,687.41	99,517.23	10,983.00	0.18	0.34	0%	10.03	24.99	6.57	1.41	-	20.46	
RR:LN		Rolls-Royce Holdings PL	22,660.00	3,584.70		5,955.00	0.35	1.00	-10%	9.46	-	6.38	-	1.30	1.47	-	
		Boeing	116,924.80	38,900.00	154,534.06	57,001.00	0.34	1.30	-28%	25.79	-	40.80	-	7.06	1.92	-	27.67
<b>Average (no Boeing)</b>			28,615.49	1,165.68	24,200.11	5,199.44	0.41	0.80	-37%	9.36	-	18.97	3.71	1.37	-	6.95	
<b>Average Similar</b>			47,630.22	-	318.25	40,616.31	6,271.08	0.32	1.03	-	0.17	10.65	15.03	7.00	1.52	-	6.15

Source: Developed by the group with Bloomberg information

Table 19 – *Similar for Boeing*

Boeing Similar	
Mkt Cap	Airbus
D/V	Textron
Beta_u	Safran
EPS Growth	Spirit AeroSystems

Source: Developed by the group

Table 20 – *EV/SALES Calculation and sensitivity Analysis*

	EV/SALES BA Valuation			
	ALL AVG	SIMILAR AVG		
BA SALES	77.049	77.049		
BA EV	105.183	117.059		
BA EQUITY	66.283	78.159		
BA #share	610	610		
<b>PRICE</b>	<b>108,66</b>	<b>128,13</b>		
\$BA_Close (as of 30/09/2023)	191,68	191,68		
<b>\$BA Overvaluation/(Undervaluation)</b>	<b>76%</b>	<b>50%</b>		
<b>SENSITIVITY ANALYSIS BASED ON SIMILARS MIN AND MAX VALUES</b>				
	Similar Avg	Similar Min	Similar Max	
EV/Sales		1,52	0,88	2,63
Price		128,13	47,45	268,07
		<i>Pessimistic</i>	<i>Optimistic</i>	

Source: Developed by the group

Table 21 - *Comparables for Airbus*

Ticker	Name	Mkt Cap	Net Debt	Currency Adjusted Enterprise Total Debt	Total Debt to Unlevd Bet	EPS - 5 A EV/ EBITD P/E	P/B	EV/ Sales	Bk per share						
SFR US	Spirit AeroSystems Hol	1.699,37	3.594,40	5.297,47	3.962,30	0,75	0,89	-19%	9,81	-	1,81	13,67	0,88	-	8,16
TXT US	Textron Inc	15.477,24	1.557,00	17.034,24	3.182,00	0,23	1,11	-4%	9,46	16,84	2,17	1,16	-	-	-
EMBR3 BZ	Embraer SA	2.525,63	1.190,10	3.963,70	3.274,20	0,74	0,16	-1%	6,96	65,42	0,99	0,74	-	-	3,47
BEDB CN	Bombardier Inc	3.475,74	5.025,00	8.847,74	5.980,00	0,73	0,71	-18%	6,79	5,36	-	1,46	1,10	-	33,88
MTX GR	MTU Aero Engines AG	9.741,67	798,64	10.540,31	1.302,00	0,16	0,72	-8%	9,06	27,23	3,42	1,53	-	-	52,85
SAF FP	Safran SA	67.178,77	263,00	-	6.957,00	0,11	1,17	-44%	13,31	20,08	5,60	2,63	-	-	-
BA	Boeing	116.324,80	38.900,00	154.534,06	57.001,00	0,34	1,30	-23%	25,79	40,80	-	7,06	1,92	-	27,67
RRF LN	Rolls-Royce Holdings F	22.660,00	3.584,70	-	5.955,00	0,35	1,00	-11%	9,46	6,38	-	1,30	1,47	-	-
AIR FP	Airbus SE	106.165,50	- 6.687,41	99.517,23	10.983,00	0,18	0,94	0,08%	10,03	24,99	6,57	1,41	-	-	20,46
<b>Average (no Airbus)</b>		29.960,40	6.864,10	33.369,59		0,43	0,84		11,33	10,74	2,00	1,43	-	-	2,68
<b>Average Similar</b>		32.960,40	12.079,51	44.804,90	17.061,33	0,49	0,91	- 0,19	12,86	10,26	2,14	1,36	-	-	4,21

Source: Developed by the group with Bloomberg information

Table 22 - *Similar for Airbus*

Airbus Similar	
Mkt Cap	Boeing
D/V	MTU Aero Engines AG
Beta_u	Spirit AeroSystems Holdings In
EPS Growth	Bombardier Inc

Source: Developed by the group

Table 23 – Multiples Calculation for Airbus

	EV/EBITDA AIR Valuation	
	ALL AVG	SIMILAR AVG
AIR EBITDA	6.803,50	6.803,50
AIR EV	77.077,62	87.503,22
AIR EQUITY	83.765,03	94.190,63
AIR #share	790,00	790,00
<b>PRICE</b>	106,03	119,2286467
Airbus (as of 30/09/2023)	126,98	126,98
<b>\$AIR Overvaluation/(Underv.</b>	<b>20%</b>	<b>6,5%</b>

SENSITIVITY ANALYSIS BASED ON SIMILARS MIN AND MAX VALUES				
	Similar Avg	Similar Min	Similar Max	
EV/EBITDA		12,86	6,79	25,79
Price		119,23	66,91	230,61
		<i>Pessimistic</i>		<i>Optimistic</i>

	EV/SALES Valuation	
	ALL AVG	SIMILAR AVG
AIR SALES	64.806	64.806
AIR EV	92.582	88.024
AIR EQUITY	99.270	94.711
AIR #share	790	790
<b>PRICE</b>	<b>125,66</b>	<b>119,89</b>
\$AIR_Close (as of 30/09/2023)	126,98	126,98
<b>\$AIR Overvaluation/(Undervaluation)</b>	<b>1%</b>	<b>6%</b>

SENSITIVITY ANALYSIS BASED ON SIMILARS MIN AND MAX VALUES				
	Similar Avg	Similar Min	Similar Max	
EV/SALES	1,36	0,88	1,92	
Price	119,89	80,69	166,08	
		<i>Pessimistic</i>		<i>Optimistic</i>

	Book value AIR Valuation	
	ALL AVG	SIMILAR AVG
Price/Book value	2,00	2,14
Book value per share of Airbus	20,46	20,46
<b>PRICE</b>	41,00	43,8385567
\$Air_Close (as of 19/10/2022)	126,98	126,98
<b>\$Air Overvaluation/(Undervaluation)</b>	<b>210%</b>	<b>190%</b>

SENSITIVITY ANALYSIS BASED ON SIMILARS MIN AND MAX VAL				
	Similar Avg	Similar Min	Similar Max	
Book Value	2,14	-7,06	27,23	
Price	43,84	-144,44	557,12	
		<i>Pessimistic</i>		<i>Optimistic</i>

Source: Developed by the group



Discrepancies in Betas, such as  $\beta_{\text{Boeing}} = 0.9$  and  $\beta_{\text{Airbus}} = 0.7$ , may result in imbalanced investments (e.g., long 0.9 in Boeing and short 0.7 in Airbus). To rectify this, adjustments for the betas differential are made, and a hedge with market returns is employed (e.g.,  $0.7 - 0.9 = -0.2$  short in the market).

Table 1 - *Beta Adjustment*

Key Metrics Summary	
Ann Ret	13,61%
Ann Vol	21,36%
IS	0,64
Kurtosis	35,17
Skewness	2,44
Positive days	48,93%
Cumulative return	178,26%
Maximum	20,53%
Minimum	-7,69%
Market Beta	-0,02

Table 2 - *Annual Returns Of the Strategy*

Year	Retun
2010	47,65%
2011	14,06%
2012	-22,08%
2013	10,75%
2014	31,48%
2015	10,76%
2016	-11,25%
2017	19,00%
2018	-0,13%
2019	-7,76%
2020	80,56%
2021	33,34%
2022	-10,73%
2023	34,90%

#### Further Analysis 2 - *Beta Market & Sector Adjustment*

This experimental iteration, incorporating market and sector adjustments, exhibits comparatively

diminished efficiency. Specifically, the sector adjustment strategy presents a marginally positive Info Sharpe Ratio, while the market adjustment strategy yields a negative result, coupled with a high kurtosis and negative skewness. Notably, the strategy's low volatility is a consequence of the implemented hedge.

Table 3 - Correlation Between Boeing and Airbus on Different Market Volatility Scenarios

Year	Correlation	Volatility
2010	0,15	1,14%
2011	0,23	23,76%
2012	0,42	13,15%
2013	0,96	11,71%
2014	0,27	11,62%
2015	0,58	15,83%
2016	0,83	13,50%
2017	0,89	6,80%
2018	0,65	17,54%
2019	0,86	12,77%
2020	0,94	35,25%
2021	0,19	13,33%
2022	0,85	24,62%
2023	0,53	13,86%

Table 4 – Strategies without Transaction Cost

No transaction costs	Beta adjusted Airbus		Beta Adjusted Boeing		Sector Beta Adjusted	Market Beta Adjusted
	Simple Mean Reversion	Explanatory	Explanatory			
Ann Ret	16,54%	6,53%	17,60%	4,23%	3,56%	
Ann Vol	24,59%	21,47%	21,35%	9,09%	8,15%	
IS	0,67	0,30	0,82	0,47	0,44	
Kurtosis	40,03	46,56	35,31	92,41	115,13	
Skewness	1,21	0,50	2,45	0,00	-0,32	
Positive days	79,43%	78,71%	79,03%	79,21%	79,24%	
Cumulative return	216,85%	85,54%	230,55%	0,00%	0,00%	
Maximum	25,40%	19,46%	20,56%	10,18%	9,34%	
Minimum	-19,80%	-19,45%	-7,66%	-11,45%	-10,89%	
Market Beta	0,08	0,09	-0,02	0,01	0,00	

Table 5 – Impact of Transaction Costs

0,03% Transaction Costs	Beta adjusted Airbus		Beta Adjusted Boeing		Sector Beta Adjusted	Market Beta Adjusted
	Simple Mean Reversion	Explanatory	Explanatory	explanatory		
Ann Ret	12,43%	2,41%	13,49%	0,11%	-0,56%	
Ann Vol	24,60%	21,49%	21,35%	9,09%	8,16%	
IS	0,51	0,11	0,63	0,01	-0,07	
Kurtosis	39,95	46,47	35,20	91,79	114,23	
Skewness	1,21	0,49	2,44	-0,01	-0,33	
Positive days	55,25%	54,36%	48,87%	54,52%	54,32%	
Cumulative return	162,88%	31,60%	176,61%	0,00%	0,00%	
Maximum	25,37%	19,43%	20,53%	10,15%	9,31%	
Minimum	-19,80%	-19,45%	-7,69%	-11,45%	-10,89%	
Market Beta	0,08	0,09	-0,02	0,01	0,01	

Table 6 - Sensitivity Analysis

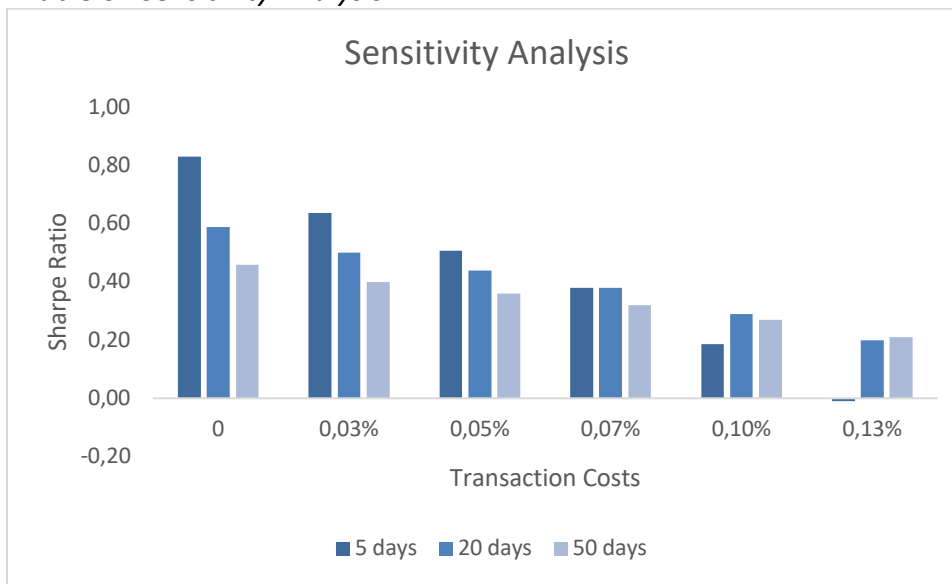


Table 7 - Pair Trade Strategy Returns by Year

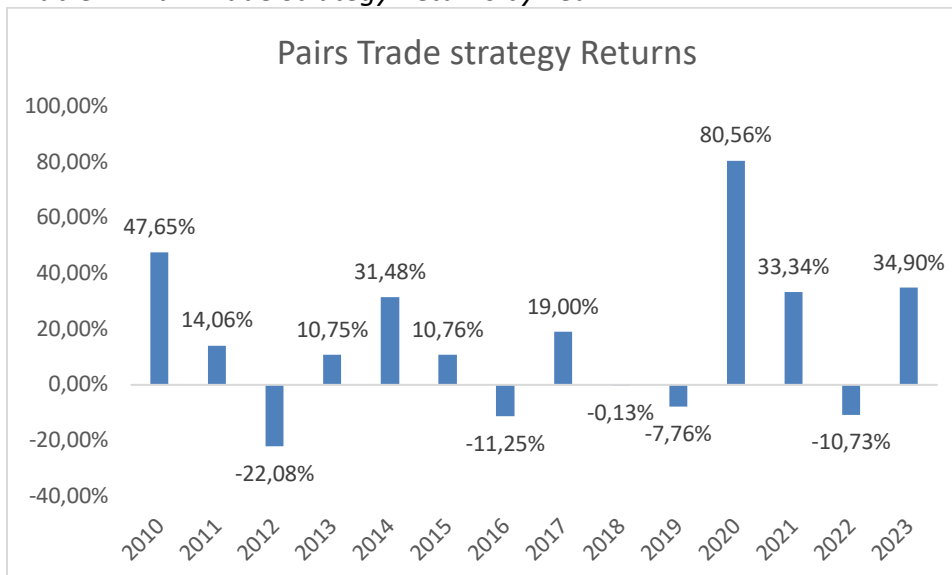


Table 8 – *Pair Trade Strategy Cumulative Return*

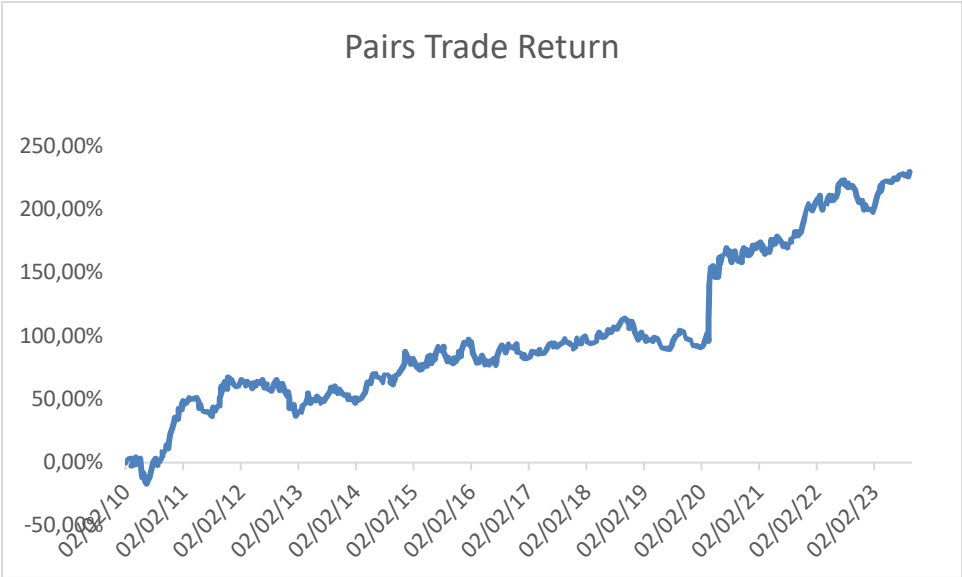


Table 9 – *Airbus and Boeing Return*

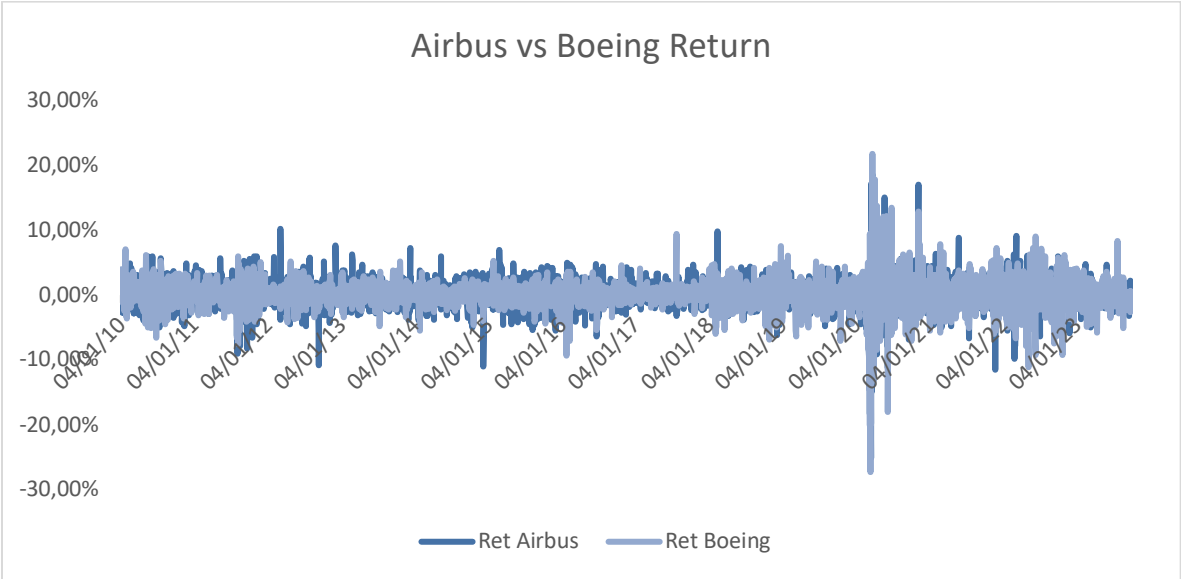


Table 10 - *Returns Market, Sector, Pairs Trade by Years*

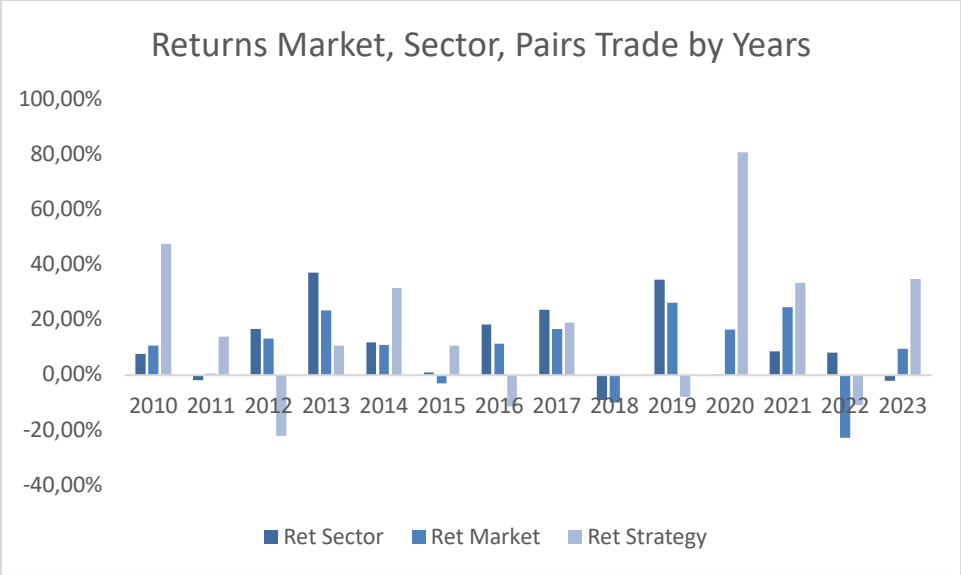


Table 11 - Airbus and Boeing Prices

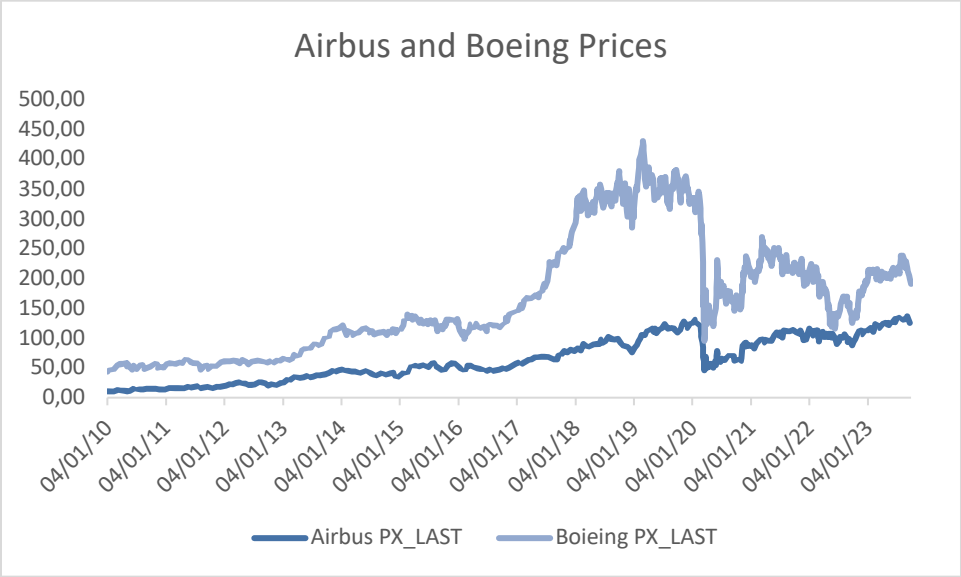


Table 12 - Pairs trade vs Market vs Sector

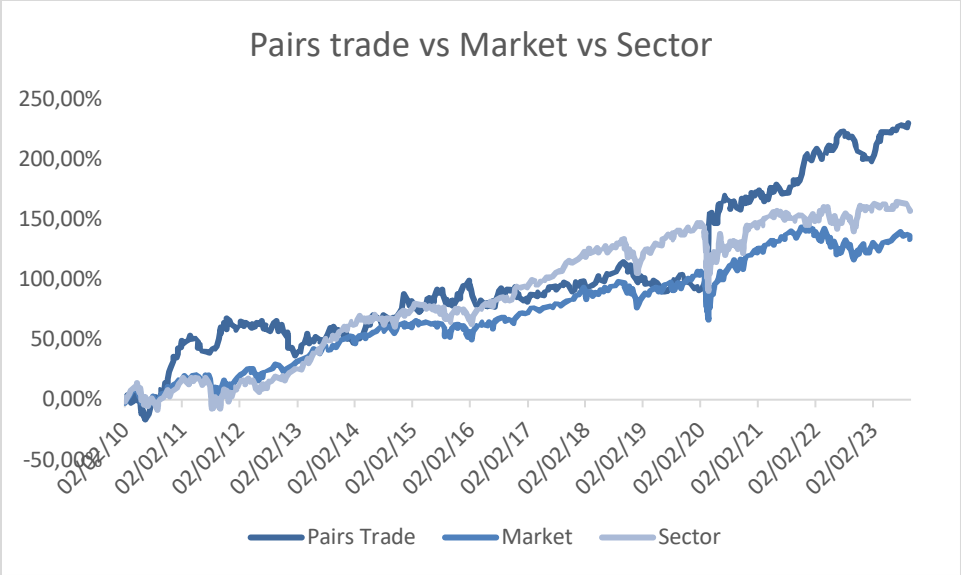


Table 13 – Pair Trade vs FF3

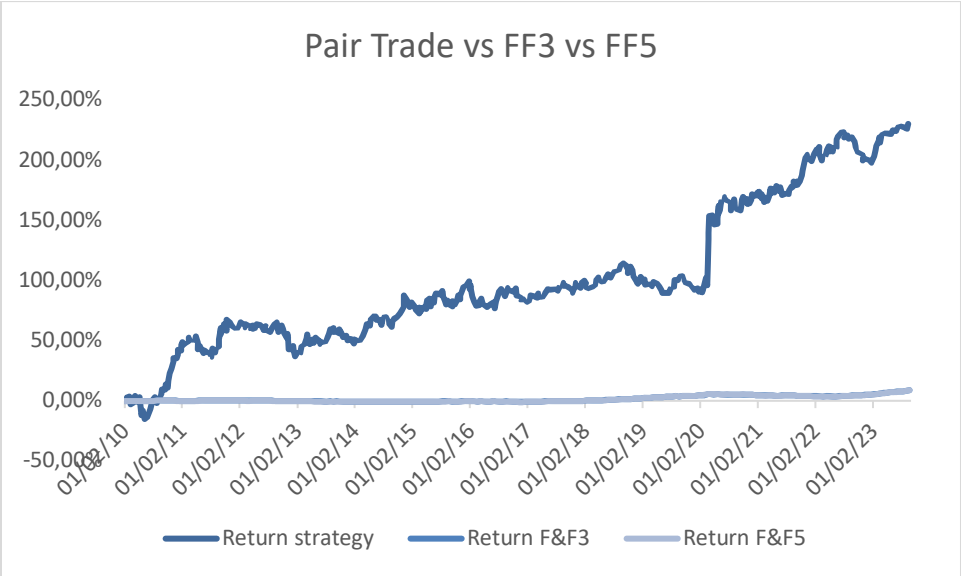


Table 14 – Beta FF3 & FF5

bi,M	bi,SMB	bi,HML	bi RMW	bi CMA
-0,01	-0,01	-0,03	0,00	-0,01

## Appendix 4: Risk Management

Table 1 – VaR Empirical Approach

<b>Notional</b>	1.000.000,00 €
<b>Critical level</b>	5%
	<b>Daily</b>
<b># observations</b>	3405
<b>Critical</b>	171
<b>R*</b>	-1,90%
<b><math>\mu</math></b>	0,07%
<b><math>V_t^*</math></b>	981.199,61 €
<b><math>E(V_t)</math></b>	1.000.677,32 €
<b>VaR @ 95%</b>	19.477,71 €
<b>VaR @ 95%</b>	19.477,71 €

Table 2 - VaR Parametric Approach

<b>Notional</b>	1.000.000,00 €
<b>Critical level</b>	5%
	<b>Daily</b>
$\sigma$	1,32%
$z_\alpha$	-1,645
<b>VaR @ 95%</b>	-2,18%
<b>VaR @ 95%</b>	<b>21.776,76 €</b>
$\sigma(\text{VaR})$	263,89

### 95% confidence interval for VaR

Upper Limit	\$	22.294
Lower Limit	\$	21.260

Table 3 - MVaR

MVaR	
<b>Notional</b>	1.000.000,00 €
<b>Critical level</b>	5%
skew	2,53
kurt	37,27
excess kurt	34,27
$z_{\alpha}^{CF}$	-0,355
Term 1	0,72
Term 2	0,69
Term 3	-0,12
<b>MVaR @ 95%</b>	<b>4.693,69 €</b>
	<b>0,47%</b>

Table 4 - CVaR

CVaR	
<b>Notional</b>	1.000.000,00 €
<b>Critical level</b>	5%
	<b>Daily</b>
$\sigma$	1,32%
$z_{\alpha}$	-1,645
$E(z z<0)$	-2,063
VaR @ 95%	-2,18%
<b>CVaR @ 95% (parametric)</b>	<b>27.308,93 €</b>
	<b>2,73%</b>
<b>CVaR @ 95% (historical)</b>	<b>32.877,82 €</b>
	<b>3,29%</b>

Table 5 - Stress Testing

Stress Testing			
<b>Notional</b>	1.000.000,00 €		
<b>Critical level</b>	5%		
<b>Hypothetical</b>			
# observations	3405		
Worst 1d obs	1		
Worst 1d obs %	-7,66%		
<b>Stress Loss</b>	<b>- 76.636,45 €</b>	<b>-7,66%</b>	
<b>Historical</b>			
<b>Date</b>	<b>Observation</b>	<b>Stress Loss</b>	
06/05/10	Flash Crash	- €	0,00%
24/08/15	Black Monday	10.048,38 €	1,00%
24/06/16	Brexit	39.481,73 €	3,95%
05/02/18	Black Monday	- 8.297,86 €	-0,83%
09/03/20	Covid-19	65.276,76 €	6,53%

Table 6 - *The Unconditional Coverage Test*

Significance level ( $\alpha$ )	5,00%
Observations (T)	3168
Number of exceptions (N)	144
Exception rate (N/T)	4,55%
Unconditional coverage test (LRuc)	1,42
Critical value chi-square (1) 5%	3,84

**Don't reject VaR model**

## Appendix 5: Pair Trade NPV

**Table 1** - Base scenario NPV

<b>Base Scenario</b>		EUR/USD	1,0586
Price Boeing	202,91 €		
Price Airbus	126,98 €		
Value Boeing	36,49 €	456% short	
Value Airbus	54,21 €	134% long	
Notional	1.000.000,00 €		
Shares Boeing sold	4928		
Shares Airbus bought	7875		
<b>Theoretical NPV portfolio</b>	<b>247.073,13 €</b>		

**Table 2** - Revenue Increase Scenario

<b>Industry Revenues Increase</b>	3%	EUR/USD	1,0586
Price Boeing	202,91 €		
Price Airbus	126,98 €		
Value Boeing	53,88 €	277% short	
Value Airbus	64,94 €	96% long	
Notional	1.000.000,00 €		
Shares Boeing sold	4928		
Shares Airbus bought	7875		
<b>Theoretical NPV portfolio</b>	<b>245.872,38 €</b>		

**Table 3** - Revenue Decrease Scenario

<b>Industry Revenues Decrease</b>	-3%	EUR/USD	1,0586
<b>Price Boeing</b>	202,91 €		
<b>Price Airbus</b>	126,98 €		
<b>Value Boeing</b>	21,45 €	846% Short	
<b>Value Airbus</b>	45,16 €	181% Long	
<b>Notional</b>	1.000.000,00 €		
<b>Shares Boeing sold</b>	4928		
<b>Shares Airbus bought</b>	7875		
<b>Theoretical NPV portfolio</b>	<b>249.949,56 €</b>		

