Financial evaluation of the Airbus A380Neo program

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Executive summary

Topic

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Abstracta

(Executive summary in Portuguese, requirement by Católica Lisbon)

Num futuro próximo, a fabricante de aviões Airbus terá que tomar a decisão sobre o investimento num A380Neo, um produto sucessor do maior avião de passageiros do mundo, o A380. O custo total do A380 foi de aproximadamente 25 biliões de euros, porém apenas 319 encomendas foram feitas, das quais 193 já foram entregues até Junho de 2016. Na realidade, o mercado de aeronaves de fuselagem larga não se desenvolveu como a Airbus antecipava. Durante a década passada as companhias aéreas estavam especialmente interessadas em aeronaves de fuselagem larga de pequena e media dimensão, que conseguem operar com apenas dois motores mais económicos, têm uma maior flexibilidade operacional e têm menos risco na fase de implementação. O programa A380Neo teria um custo estimado de 3 biliões de euros e o avião poderia estar disponível já em 2021. Devido à sua elevada especialização, esta aeronave tem uma procura limitada e está sujeita a margens reduzidas. Consequentemente, não existindo uma real vantagem competitiva para as companhias áreas estas não estarão dispostas a pagar um valor superior para adquirir este novo modelo. De uma análise baseada no fluxo de caixa descontado, conclui-se que na atual conjetura económica não é financeiramente vantajoso incorrer no investimento do A380Neo. A utilização do modelo de opções reais permite concluir que existe a possibilidade de o investimento ter um VPL positivo caso o adiar do mesmo não signifique incorrer em custos adicionais. No entanto, mesmo com um VPL negativo, os interesses políticos ainda podem resultar numa reconsideração favorável ao investimento.

(Translated by Joana Marcelino)

Executive summary

In the foreseeable future aircraft manufacturer Airbus will face the decision on investing into the A380Neo, a successor product from the world's largest passenger aircraft, the A380. The A380's total costs were approximately € 25 billion, however only 319 orders were gained of which 193 are already delivered until June 2016. The market did not develop as Airbus anticipated towards large wide body aircrafts. In the past decade airlines were much more interested in small and medium wide body aircrafts, which achieve with just two engines better economics, have a higher operational flexibility and are less risky to deploy. The A380Neo program would cost an estimated € 3 billion and the plane could be available as early as 2021.

Due to its high specialization the aircraft faces limited demand while being subject to low margins, as it fails to provide most airlines with a competitive advantage thereby not justifying any willingness to pay a premium for the jet.

A discounted cash flow valuation results' that it is in the current market environment not financially justifiable to commit to the A380Neo investment. A real-option valuation shows that postponing the decision and holding the out-of-the-money call option is only optimal for Airbus if costs associated with waiting are low. Consequently, Airbus should not decrease the production rate in order to win time over the decision. Due to political interests, a revamping of the series is still likely even if the project will be a negative NPV investment.

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List of abbreviations

AR	Annual Report
CPSM	Cost per seat mile
LPD	List price discount
McK	McKinsey & Company
Neo	New engine option
SBC	Soft budget constraint
VLA	Very large aircraft (≥ 500 *Seats*)

Introduction

The Airbus A380 is a four engine wide body aircraft produced by the Airbus Group. It is the world's largest passenger airliner, being able to carry up to 853 passengers. Its development reaches back to 1990, the first flight took place in 2005 and it was first delivered in 2007. In the foreseeable future Airbus faces the decision about the future of the A380 program. The company either has to invest into a successor product, potentially called A380New engine option (Neo), or risk the termination of the aircraft series when the order book is worked off (Prodhan, 2015). Airbus finds itself in a predicament. Only 319 orders were placed for the aircraft and until mid July 2016, 193 aircrafts already were delivered. The order flow dried up, as since 2014 only two aircrafts were sold. At this time it is unlikely that new orders will be placed for the current version of the aircraft. Including all costs the A380 program was an approximately € 25 billion investment, making the A380 one of the most expensive industrial product launches in history (Mouawad, 2014). To disperse the costs per flight to a large amount of passengers and achieve through this an economic advantage was one of the main selling arguments for very large aircrafts (VLA). However, two engine medium wide-body aircrafts, such as Boeing's new 777x as well as Airbus's own product, the A350-1000, managed to achieve lower costs per seat mile (CPSM) by saving on two engines. As a result, the A380 requires to be updated to remain competitive (Cosgrave, 2015). Appendix II displays a cost per seat mile / cost per aircraft mile comparison, appendix III shows a sample drawing of a stretched A380-900. The development of the A380Neo would cost, depending on the scope of modifications, about € 3 billion as of today and a launch is anticipated between 2021 and 2025. The project has significant uncertainties in terms of market demand, excess costs and delays as well as margins per sale. Airbus's public demand projections seem unreasonable high. Most likely only 20% - 40% of the forecasted demand will translate into actual orders.

This thesis aims to financially evaluate the A380Neo investment from the perspective of the Airbus Group. The company's executives and investors debate over the series, as critics see in it an iconic unprofitable project, which will never achieve profitability and should therefore be terminated, the sooner the better. The thesis contributes to this discussion by providing a financial evaluation of the investment. The valuation results that the A380Neo will most likely be a negative NPV investment. Only if the aircraft is launched on time and budget, in addition to a favorable market development, Airbus has a chance to break even with the project. A real-option valuation takes the value of the opportunity into account and derives out of a decision tree an optimal acting for the Airbus Group. However, due to Airbus's political interest the company could still launch the A380Neo as a negative NPV investment.

New information after April 2016 was not considered, financial data was used as of the end of the financial year 2015. Up to now Airbus executives and analysts only expressed intentions, implying that no investments were made until the submission of the thesis.

Part 1 gives an introduction into the market environment, explains all the relevant factors influencing the project valuation and develops assumptions for Part II. The second part describes the Excel model used to carry out the valuation. The third part provides an academic reasoning for the findings of the valuation and explains its implications. The thesis concludes with a discussion about the findings and an argument whether the A380Neo should be launched or not. The excel model can be optained from the link displayed in appendix I. It provides all tables, which are included in this thesis.

Acknowledgement

This thesis applies knowledge gained during the master course to an applied managerial and financial problem. Designing the demand variable imposed a key statistical task. The topic was self selected and reflects my interest in real business challenges. There is no previous work done on this topic. As a result, all ideas, concepts and assumptions in this thesis are from myself.

Part I: Industry environment and implications on the valuation

1 Future of the A380 program

Theoretically Airbus has a variety of options on hand, which are outlined in the following section.

1.1 Termination of the A380 program

Once all orders are filled Airbus can seek to cease producing the A380 series. From 2012 - 2015 an average of 28 A380s were delivered per year. Continuing this trend shows that the order book will be worked off by 2021, stretching A380 delivery over 14 years (2007 - 2021). Airbus announced to cut the output to 20 – 25 planes per year from 2017 onwards, postponing the final delivery up to mid 2022 (Wall, 2016). This could indicate that the company seeks to postpone the decision on the continuation and win time in order to see whether the market environment will change in favour of VLAs. A divestiture would not come at zero costs and therefore has to be part of the valuation of the continuation. A termination would imply a significant change in the companies product range, however could shift funds into more profitable series of the portfolio. Analysts estimate a termination of the A380 series would imply direct financial costs of € 950 million - € 1,3 billion (Cosgrave, 2015).

1.2 Developing new engines

Engine efficiency and total weight are constantly improving through technological progress. In the past years, inter alia through newly available 3D printing technology, engine manufacturers achieved an approximately 1% reduction in fuel consumption per year. For the A380 new engines would reduce the fuel consumption by at least 10%. Fuel is the typically the biggest cost centre for airlines. As an example, 34,6% of Emirates' operating costs in 2014 - 2015 were fuel-costs (The Emirates Group). Jet engine manufacturer Rolls-Royce already signalled that the company would be interested in developing the engines if Airbus decides to revamp the aircraft (Gazzar, 2015). Through using new composite materials, Airbus could also reduce the weight of the A380Neo, resulting a further reduced fuel consumption. However the effective operational value of these fuel savings is a strong function of the oil price developments. As a consequence, at the current oil price level of $ 45 per barrel new engines would have limited value to airlines.

1.3 Developing new engines and stretching the aircraft

The A380 has been designed as a base model for an aircraft family, therefore allowing for the very common stretching of aircrafts. A stretched version would actually make better use of the aircrafts wings. This would add capacity at little extra fuel costs, hence improving the CPSM. It is an ongoing trend that airlines favour the larger variations of aircraft series. The key problem when stretching the A380 is that the capacity has to be justified by the market demand for tickets. As some airlines are focusing on the sale of direct flights or serve routes where frequency is of prime importance for passengers, inter alia European carriers just only have a limited number of routes where demand allows a profitable use of the A380. As a consequence, a too large capacity addition would make the already niche market for the aircraft even smaller. However Emirates is requesting such a stretch, having already diversified their A380 fleet in three configurations with 489, 517 and 615 seats accordingly. The A380Neo stretch is limited to the 80x80 meter box, introduced by the international civil aviation organization in the 1990s. This ensures that the aircraft can use existing taxiways and terminals. In terms of valuation interests, the A380Neo won't require longer turnaround time, additional infrastructure investments or face any additional restrictions. Currently Airbus investigates a stretch offering 50 seats more, statically a stretch to add up to 100 seats is possible (Flottau, 2015).

1.4 Target other segments

In 1973 Boeing produced an all economy version of the 747 for Japan Airlines, responding to increasing short haul domestic demand, inter alia between Tokyo and Osaka. In 2009 Air Austral placed a firm order for two all-economy, also called "high density" versions, however cancelled it in 2012. Low cost carrier could still be interested in such a version for short and medium-haul flights in the future.

Initially Airbus planned a freight version and UPS as well as Fedex ordered 10 aircrafts with an option for an additional 10 each. Due to the delay of the program, both parcel service companies cancelled their orders. At this time Airbus does not intent to add a freight version. The A380 is ineligible for a potential conversion to a freight aircraft, what eliminates the potential for secondary market sales.

1.5 Postpone the decision

Airbus could find it optimal to postpone the investment decision, for example until current aircrafts retire and operators are seeking for replacement. However as stated previously, at the current output rate the order book will already be worked off by 2022. Assuming a minimum commercial service life of 20 years, the first A380s will only retire in 2028. Actually the average age of wide body aircrafts holds steady at around 25 years with a stable outlook, further delaying first retirements(Forsberg, 2015). Offering a successor aircraft only until operators will seek to replace their current A380 fleet implies therefore to shut down the production line and reopen it at a later stage. Chapter 8 treats the option to delay the decision more percisely.

2 Competition

The chapter outlines the competitive environment in the aircraft manufacturing industry. It emphasises the competition beween Airbus & Boeing and suggests that Boeing is most likely to ignore a potential launch of the A380Neo.

As scale became the ultimate competitive advantage after World War II, the commercial aircraft industry basically became a duopoly. Besides volume, the industry is defined by advancing technology and productivity. As competitors, such as the Brazilian manufacturer Embraer, Canadian manufacturer Bombardier, Irkut from Russia and the Commercial Aircraft Corporation of China are only entering into the single aisle market, the very large aircraft market is unlikely to experience changes in the competitive environment. Seeing the product range of Boeing and Airbus shows that the single aisle product series are almost equivalent, while wide body series are differentiated in terms of capacity and range. Both manufacturers offer five aircraft families, officially comprising 14 models at Airbus and 10 models at Boeing. The A380 competes with five other aircrafts in the wide body market. Airbus further produces the new A350 for the medium wide body segment and the A330 for the small wide body segment. Boeing's product range contains the 747-8 as a large wide body, the 777 as a medium wide body and the 787 as a small wide body aircraft. Appendix IV displays a market overview of all sectors and available products.

Previous to the A380 the 747 was the world largest passenger aircraft. Between 1970 to 2010 Boeing delivered a total of 1418 aircrafts of the series and revamped the version four times. The aircraft was a major financial success for Boeing, what gave rise to the market entrance of Airbus. However, Boeing executives claimed that historically for about 60% of the first 1000 747s sold, range trumped capacity as the main selling argument (Esty, 2004). This implies that the past success of the 747 program was not only due to the aircrafts capacity, but also due to performance characteristics, which were industry standard when the A380 entered into service.

As a competitive response to the A380 program Boeing revamped the 747-4 to the 747-8, which had its introduction in 2011. With only 121 orders the 747-8 program was a flop for Boeing. The aircrafts modifications were rather artificial, not offering a fly-by-wire control system nor using new materials. Major 747-4 customers rejected to buy the plane due to out-dated technology. However as a successor product its development costs were with an estimated

$ 4 billion significant lower than for the A380 (Gates, 2010). In 2014 Boeing invested in a 747-8 Performance Improvement Package (PIP), which according to the company improves the airplane's efficiency by 1,8 % through modified engines and weight savings (Berry, 2013).

The in 1995 introduced 777 is a great success for Boeing. About 1412 aircrafts were delivered until today and Boeing currently has 481 more orders for the type. 306 orders of these are for the in 2020 to be introduced new version of the 777, the 777x.

The future outlook of the 747 program is currently undecided. Boeing could decide to end the production and compete with the to be introduced 777x in the segment for very large aircrafts, which seats in its maximal stretched version about 50 passengers less than the 747-8. In January 2016 Boeing announced that the production for the 747-8 would decline from about 1.3 planes per month to 0.5 planes per month as of September 2016, implying to further move away from break-even targets. Boeing states to keep the production line open to be able to respond to business opportunities, which could arise in the foreseeable future (Johnsson, 2016b). In contrast to this, several industry analysts believe Boeing will end the production in the near future but did not disclose this for now.

Similar to Airbus, Boeing made a major investment into a new aircraft type, the 787 Dreamliner. Having limited resources and Airbus entering the VLA market, the company saw the small wide body market segment as more profitable when announcing the aircraft in 2003. The 787 achieves lower per passenger operating costs as well as provides for more flexibility in terms of operations, as it is easier to balance demand and capacity. The aircraft entered service in 2011 and seats between 242 - 330 passengers. It introduced many innovations to the aircraft manufacturing industry, such as the predominant composite form carbon fibre. The concept of the 787 is tailored to another strategy to supply the needed demand to the air passenger market. Boeing anticipates that by expanding the nonstop route network and increasing frequencies the market can be better served than by the hub and spoke system. In a point-to-point system passengers should no longer be brought together by feeder planes, but instead also take long haul flights direct. As an example, London Heathrow is handling 120.000 long-haul passengers a day, of which many are transit passengers. The Norwegian airline Norwegian Air Shuttle introduce direct flights from Oslo to Bangkok, Boston or Las Vegas using the 787, destinations which could previously only be reached through a transit in London, Frankfurt, Amsterdam or Paris. Airbus's product for this market segment is the 2015 introduced A350

XWB. As the industry is very innovative, it was beneficial for Airbus to be the second mover. Airbus Managers were quoted openly admitting that the company learned a lot from Boeings 787 program for its own A350 program, minimizing excess and delay costs. Orders for the 787, the in 2020 to be introduced 777x and A350 are far higher than the ones for the A380. Appendix V & VI display the order book of both manufacturers, as well the detailed order book for the A380 and 747-8.

2.1 Competitive response from Boeing

In general as a competitive response Boeing could invest in the 747 series again, compete with the 777x in the VLA segment or ignore the A380Neo.

The A380 program eliminated Boeings previous monopolistic control of the VLA market. Before Airbus committed to build the A380 alone, it was Boeings best interest to delay the market entrance. In 1993 both manufacturer collaborated to develop a VLA aircraft together. However when Boeing did not commit to it, Airbus decided to go ahead alone. Boeing then threatened to undercut Airbus by announcing and launching a competitive product, the 747-8. In order to make up the technological and operational disadvantages, the aircraft was priced aggressively. From the beginning benefits of this were limited for Boeing, however competitive implications were great. Through this Airbus was prevented to achieve superior profitability and monopolistic advantages with the A380 in case the aircraft would have been a major success.

Academically both players face the developer's dilemma game-theory model. The market is insufficient to sustain two rival products. If both develop, both suffer a loss, as the market is too small. If only one develops, one has no profit and the counter player superior profits. If both do not develop, the market remains untapped (Kretschmer, 1998). In theory a market entry occurs if an industry is superior profitable, what is at the moment not the case for the VLA segment. Besides profitability, the VLA segment implies great entry barriers, as an entrance is very costly (Schaefer, 2012).

Summing up, an investment into a competitive product, a revamped 747, is very unlikely due to limited demand and profitability of the large wide body segment. Boeing could aim to compete with the largest version of the 777x against the A380. However, as production capacity is limited and already filled for years, a price competition to the A380 is not an optimal strategy for Boeing. As a conclusion, in case Airbus would commit to the A380Neo, ignorance from Boeing is the most likely competitive response.

3 Other factors affecting the program

Chapter 3 treats aspects which influence the valuation choice, however are barely tangible for valuation interests. Section 3.8 introduces political interests to the subject, explaining why and how aircraft manufacturers are receiving state sponsorship.

3.1 Lead customer Emirates

Emirates CEO Tim Clark outlined the airline would be interested in buying between 100 - 200 A380Neo, if Airbus would decide to launch it. He aims at a 10-13% unit cost improvement, a 10% reduction in fuel burn, aerodynamic improvements as well as weight reductions. The aircraft should optimally be available in 2021 (Wall, 2015). Emirates has currently 74 A380 in its fleet and 66 more one order, giving a total of 140 orders.

Seeing industry practices shows that Emirates as key customer is likely to have a very strong buying position. Having such a poor negotiation standpoint and dependency on a single customer diminishes margin opportunities. However having a strong lead customer could also change the risk profile of the project. On the one hand, there is a secured demand, but on the other hand Emirates placed a tremendous bet on future passenger air traffic. In case of upcoming operational distress at Emirates, Airbus would bear additional risks. The fact that no other A380 operator joins Emirates in requesting Airbus to revamp the aircraft could be an indicator for a lack of interest in the product from other airlines.

3.2 Implication of carriers' strategy

The A380 has great implications on a carriers strategy. For now only Emirates adapted its business model to the A380 and achieved a unique strategic advantage through optimising it. From the biggest airlines applying a hub and spoke strategy, Etihad pursues a M&A strategy while Qatar Airways and Turkish Airlines operate small and medium wide body aircrafts. Naturally an A380 order is a great operational as well as financial risk to airlines. The purchase often represents an aggressive fleet capacity expansion, bearing the risk of receiving the aircrafts during a downturn in the industry. As an unknown source put it " No airline ever went bankrupt flying a plane that was too small" , refers the fact that a flight's profitability is defined by the number of passengers, average ticket price and costs. Hence a small aircraft and lucrative ticket fares are likely to achieve greater profitability than a big aircraft filled up with cheap tickets.

Although Emirates is very successful with its strategy, other airlines are unlikely to copy it due to market demand, home airport location and capacity, membership in alliances as well as limited financial strength. Evaluating current operators shows that no plane has been sold in North and South America, Africa and India, as well as only to a single Chinese customer. It can be claimed that the A380 program faced additional difficulties and was subject to more cancellation due to its introduction during the global financial crisis of 2007.

3.3 Sale of current version

As any expectations or investment commitments would undercut the value of the to be delivered planes, Airbus tries to keep the current version in the market. Customer dissatisfaction could lead to order adjustments for the A380. Both Airbus and Boeing offer real-options to customers, supplying them the flexibility to cancel or downsize orders. The development of the A380Neo could also cannibalize investments in smaller, more profitable aircraft series. This could potentially affect the outstanding decision to further stretch the A350 to enter a more direct competition with the 777x. A company internal cannibalization of sales is negligible due to the high distinction of aircraft series.

3.4 Secondary market

The secondary market perspectives for the A380 are unfavourable. In 2017 Singapore Airlines leasing agreement for the world's first A380 will expire, giving the airline the opportunity to return it or keep it a renegotiated leasing rate. Analysts believe Singapore Airlines could achieve a drastically reduced rate (Rothman, 2015). Malaysia Airlines tried to sell or lease out their A380s after the airline suffered two crashes, however after not finding a buyer until 2016 decided to keep the aircraft in operations. Naturally the residual value plays a key role for the owner of the aircraft as well as affects the sale of new aircrafts. About 1/3 of the worlds airline fleet is leased. In terms of aviation finance, leasing companies will take the difficulty of redeploying the asset in case of default and the increased systematic risk of the A380Neo into account and pass it on to their customers (Economist, 2012).

Premium carrier, as which all A380 operators consider themselves, usually pay special attention to the age of their fleet, trying to ensure customer satisfaction by operating newer aircrafts. This effect could put further pressure on the A380 in the secondary market, as a higher percentage of customers might not wish to operate their A380s until retirement.

3.5 Non-financial value driver

The A380Neo program is subject to nonfinancial value drivers, such as political goodwill, stakeholder relationships, technological progress, customer satisfaction, competitive standpoint in the industry and prestige. The financial valuation of this thesis does not cover these value drivers, however they present a value to Airbus. To which extend R&D findings from the A380Neo would be transferable to other product series is uncertain.

3.6 Risk of compensation claims

Operational / execution risks can result in enormous financial compensation claims in case of accidents or potential reworking's. In 2012 detected hairline cracks in the wing of the A380 leaded to € 336 million costs for Airbus (ANNUAL REPORTS, 2015 & 2014). As the factor contributes to the value of the program post investment decision it is part of the value drivers. However a tangible negative value can't be deducted to account for this risk, as a projection of the amount can't be made. Being a modification investment, the A380Neo has significant lower execution risks than the initial A380. In 2006 due to technical issues the first delivery was 20 months delayed and anticipated production output had to be adjusted downwards. The project delay alone was set to cost $ 6.1 billion (CALLEAM-CONSULTING, 2013). Delay costs consist out of customer compensation payments, additional labour and material costs, inventory carrying costs and redesign expenses. Delay payments are usually made in compensation claims as well as discounts on future orders of any series.

Another operating risk is a potential crash. Consumers are very sensitive towards aviation safety, what is reflected in the high percentage of passengers fearing to fly (SPILLER, 2015). In terms of valuation it can't be quantified, but a crash of a A380 could affect the A380Neo program. Causes for the crash and total casualties could change consumer perceptions of the aircraft and affect passenger's preferences.

3.7 Infrastructure investments

One key sales argument Airbus outlines is airport capacity. With 10.000 monthly landings, London Heathrow is the busiest airport in the world. Besides Lufthansa and Air France, all airlines use their A380s to serve this route, seeing Emirates alone offering five A380 services per day. By 2020, 30% of 300 selected airports are expected to surpass their theoretical 100% threshold, with additional 50 airports being at more than 80% of their capacity. Surpassing a 100% threshold is inter alia possible because of improvements in air traffic management systems. In general airlines need to increase aircraft size if demand is present and it is no longer feasible to increase flight frequencies. Terminal and runway capacity, airport closing times, applied technology and travel time preferences define an airports capacity. Capacity can also be added to the market by expanding existing airports or building new airports. This can be either a new primary airport or a secondary airport for low-cost and domestic flights. Londons' secondary airports Gatwick, Luton, London City and Stansted could be further developed to allow additional services. Emirates already operates three daily A380 flights to London Gatwick Airport. On a global base, several large-scale airports are under construction or in the advanced planning. Dubai World Central, fife runways, Istanbul New Airport, six runways, and Beijing Daxing, up to eight runways are just three examples. All of these airports have a capacity of 150 million passengers or more a year. As a comparison, London Heathrow has two runways and handled 75 million passengers in 2015 (Powley, 2016). As a result, infrastructure investments are likely to allow airlines to supply the needed capacity to the market in the most cases, providing a feasible long-term solution to airport congestions.

3.8 Government relations and subsidies

The aircraft manufacturing industry is of special interest for states, as it greatly contributes to defence capabilities, technological development, foreign trade and high quality employment. The Airbus Group has three main business units. Airbus, accounting for about 70% of total revenue, Missile & Space Vehicle Manufacturing, 20% and Airbus Helicopters, 10% of revenues. The company has 136.574 employees and many more jobs depend on the industry. Political support is therefore not only justified by direct equity investments, but also due to labour and economic politics. Appendix VII outlines key suppliers for the A380, the components and their commercial value supplied. Boeing is one of the largest positive contributors to the U.S. national trade deficit by dollar venue, exporting about 80% of its commercial output (Thompson, 2016). The company also obtains the second biggest national defence budget, inter alia producing the B-52 Bomber, C17 transport aircraft and the V-22 conventional helicopter. As a result, the aircraft manufacturing industry is subject to protectionist policies, preferred contracts from inherent military and civilian clients as well as financial aid from host governments. Both companies benefit from this, however Airbus receives sponsorship in a more direct way than Boeing.

The duopoly competition between Airbus and Boeing had been subject to many discussions and regularly complains from the counterparty. Shortly outlined, Boeing accuses Airbus for receiving launch aid, Airbus accuses Boeing for receiving indirect financial assistance through NASA and defence contracts, tax breaks and governmental spending for infrastructure used by Boeing. Launch aid, which Airbus receives, is capital tied to airplane delivery targets, repaid on a per plane basis and interest rates are significantly lower than market charges. If sales targets are not achieved, loans are forgiven. It therefore results in a competitive advantage through lower financing risks. The long-term goal of the subsidies was to establish European competence next to Boeing and the in 1997 with Boeing merged McDonnell Douglas. Today the duopoly split is around 50/50 (Boeing, 2016). Discussions take place on a political stage and are often combined to a bigger picture. So did the U.S. governmental subsidies granted to Chrysler and GM and a questionable competition regarding 179 air tanker for the U.S. Air Force change to political environment (Spiegel, 2010). Sponsors for Airbus are the French, German, Spanish and British government. Boeing receives benefits from the US and Japan due to its subcontracted assemblies, which include inter alia Mitsubishi Heavy Industries as a wing manufacturer. The circumstances are neither likely to change in the future, as Boeing received heavy monetary advantages for its 777x program, nor is it likely that any company is likely to be fined a remarkable penalty (Wilson, 2013).

The academic discussion about this has many similarities to bailing out banks during the financial crisis. The government financed Airbus from the beginning and continuously injected capital over decades, so that expectations about future fundings are already present. This has the consequence that the manufacturer have little motivation to change their uneconomical or risky policies (Spiegel, 2011). Chapter 9 discusses this matter in more detail. Airbus did not officially disclose whether they seek government loans for the A380Neo project. If requested it will be a political decision whether the loans are granted to the company. Due to industry practice, it is justifiable to argue that Airbus is likely to request and be granted launch aid, or other monetary advantages, for the A380Neo program. Reliable figures how high these subsidies are in reality can't be obtained, as they are kept as a secret. Depending on what all to include as subsidy, R&D allowances, infrastructure investments, direct capital injections, tax breaks and launch aid, analysts estimate all of these cover up to 33% of total costs. In case of the A380 this would add up to € 8,25 billion. Just as in the originally A380 development, Boeing already stated to address the issue of governmental aid " as it comes along" , however saying this would not be in line with the WTO rulings (Hepher, 2015).

Part II: Valuation

Part II starts with a demand analysis, which combines a stochastic and scenario approach in order to derive the most likely demand for the A380Neo. Three variables were created and are used as probability distributions of demand. To estimate the nature of the variables, forecasts of Boeing, Airbus and analyst opinions were considered as well as a bottom up demand analysis was implemented. The model covers a total orders (pre orders + normal orders) range of 30 - 840. The demand will most likely be between 250 - 500 orders. An argument about the timing of orders shows that in the past on average 69% of total orders were made before an aircrafts' market launch.

Chapter 5 describes the created Excel model and covers inputs, which had to be made by the author. Section 5.4 treats one key difficulty of the valuation, the list price discount. As the model is very sensitive towards the applied discount, two simulations were set up in order to allow different perspectives on the input. Chapter 6 treats relevant inputs, which could be gained from financial data providers, such as Airbus's WACC and tax rate. The part concludes with the valuation results, which indicate that the A380Neo will most likely be negative NPV investment. Chapter 7 also includes a break-even and sensitivity analysis. A real-option valuation derives an optimal decision path for Airbus and indicates that it is only optimal for Airbus to postpone the investment decision if costs associated with waiting are low. It is therefore not optimal for Airbus to reduce the production rate in order to win time over the decision, as costs associated with this are too high.

In general project valuations are based on its cash flows, not accounting profits. Out of Airbus's perspective, cash flows and general expenses such as overhead costs have to be considered on a with / without the investment base. Projects should be considered as a differential project, making past cash flows are irrelevant. Opportunity costs, such as the sale of an asset, which is not realized, have to be included. The investment decision should be separated from the financing decision (e Brito, 2015).

Any valuation is based on three fundamentals, 1. Cash (FCF in the future), 2. Risk (reflected in the discount rate WACC), 3. Growth (inflation / terminal value) (Rothschild, 2008). For the A380Neo project seven key value drivers were defined which are graphically displayed in *figure 3.1 [page: 17]* . Before the investment decision the amount of pre orders, market penetration and political support can be observed. The amount of the investment itself is set during the development process. After a potential market launch total demand, execution risks and non-financial value driver influence the total value post investment.

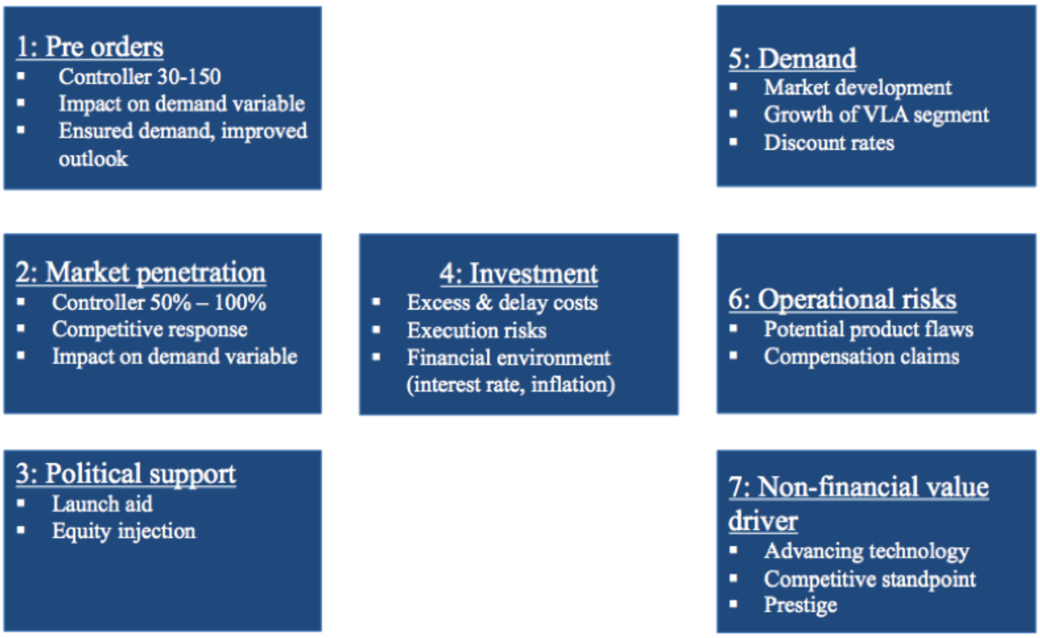


Figure 3.1: Seven key value drivers

This valuation focuses on for an outsider quantifiable value drivers. These are 1: Pre orders, 2: Market penetration, 4: Investment and 5: Demand. Political support, operational risks and non-financial value drivers are present, however difficult to quantify.

4 Demand analysis

McKinsey (McK) suggest for companies in industries where price and volume risks are great it is beneficial to replace the use of scenarios by using stochastic simulation techniques to estimate the probability of various scenarios (WESSELS, 2015). Contrary to commodity tickers, price risks for aircrafts are limited and therefore only volume is treated stochastic. Growth forecasts about worldwide passenger traffic are ignored in the demand analysis, due to a uncertain correlation of growth and orders for the aircraft. Airbus / Boeing forecast an annual air traffic growth rate of 4,6% / 4,9% over the next 20 years. How much of this growth translates into A380Neo orders is debateable (AIRBUS, 2015) (BOEING, 2015).

4.1 Demand variables

The demand variables combine a scenario and stochastic approach. Three probability distributions were created using R and excel, having different configurations in terms of mean, standard deviation and skewness. Depending on quantity of pre orders and market penetration, one out of three probability distribution is applied. Less than 50 pre orders and 75% market penetration will apply the unfavourable probability distribution to the NPV simulations, above 100 pre orders and 75% market penetration the favourable distribution is applied. In-between the expected variable is used.

As *figure 4.1 [page: 18]* shows, the variables differ in terms of expected value and skewness. *Figure 4.2 [page: 19]* displays the demand distribution of the unfavourable variable as an example, for which in appendix VIII the R-code can be found. *Equation 4.1 [page: 19]* displays the applied formula. As the expected as well as favourable distribution contain outliers above 800, the probability mass of 800+ is assigned to a demand of 800. In the unfavourable and expected variables positive skewness is incorporated. In a favourable scenario a normal distribution is used to account for a higher expected value.

Description demand probability variables			
	Unfavourable	Expected	Favourable
Expected value	294	413	465
Covered probability mass	99,13%	100,00%	100,00%
(In 150 - 800 area)		*94,49%*	*96,77%*
Skewness	0,528	0,081	-0,011

Figure 4.1: Configuration demand distribution variables

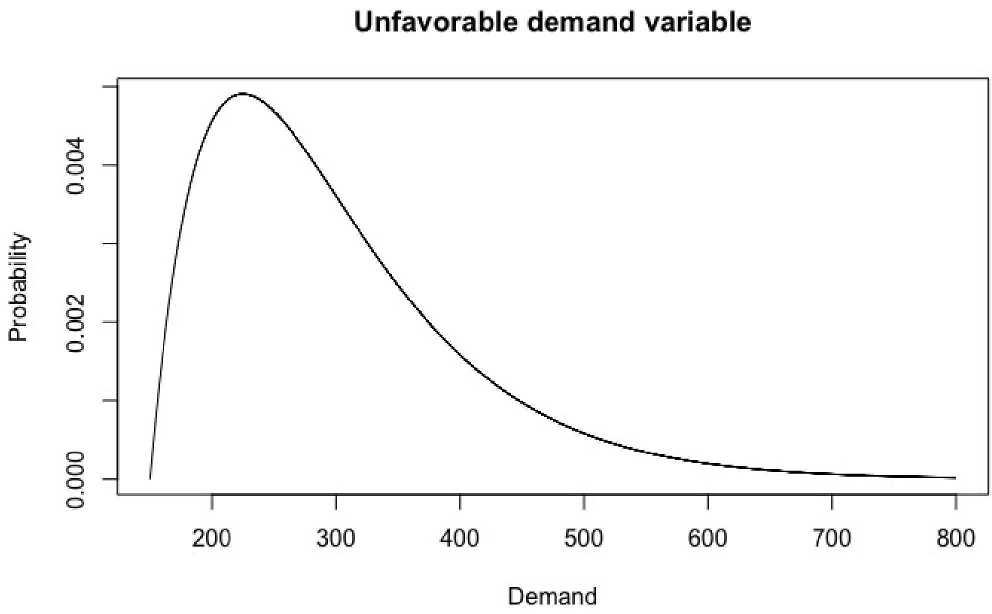


Figure 4.2: Probability distribution unfavourable scenario

$$-\frac{1}{a} * \frac{x-b}{a} * e^{-\frac{x-b}{a}} \quad (4.1)$$

$$a = 75, b = 150, Expected\ value = 294$$

4.2 Setting the boundaries

150 planes represent the minimum demand excluding pre orders. As pre orders are set before the investment decision, normal orders are treated independently from pre orders. 150 aircrafts is less than half of the jets Airbus sold from the current version and the mean demand Emirates signalled alone. 800 is used as a maximum due to market conditions and production limitations. If in a favourable scenario 35 aircrafts would be produced per year, Airbus could deliver up to 525 units in 15 years. To produce 800 aircrafts in 15 / 20 years, 53 / 40 aircrafts would have to be produced per year. This would imply additional investments in A380 production facilities. It can be assumed that after 15 years customers would start to call for a revamped version again. This is noteworthy as it doubts Airbus's own forecast of a demand for 1275 VLA aircrafts over the next 20 years. The company would barely have the capacity to supply this demand at any market penetration and production duration scenarios.

The nature of the variables is set based on educated guesses and trend continuation. Both manufacturer forecasts provide detailed information about demand by region. Airbus estimates the VLA demand of Middle Eastern airlines at a slight 377 aircrafts (30% of total demand), while Boeing estimates that 300 (56% of total demand) planes are sold to the region. Due to the delivery schedule we can say that pre order reflect the demand for the first quarter of the forecast period, five years. If Middle Eastern Airlines would pre order over 100 aircrafts alone and the trend is continued, 400 planes are sold which represents a plus of 6%; 33% accordingly. Weighting Airbus's forecast 3/4 and Boeings' forecast 1/4 results that a pre order of 100 aircrafts or more has a positive effect of 12,75% on the expected total demand. As a result the expected value from the favourable variable is: Expected variable * 1,1275 = expected value favourable variable. Similarly the expected value from the unfavourable distribution is chosen.

4.3 Bottom up demand analysis

A bottom up demand analysis relies on demand from the customer base. It examines existing customers, customer turnover, customer preferences and potential new customers. It is based on market conditions and it is driven by replacement as well as a growth rate assumption. As the A380Neo does not represent a significant innovation in the product range, a general connection to historic trends can be established. The first part of the paragraph clarifies how airlines strategy and a change in the competitive landscape affect the A380 demand. The second part derives out of retirement, replacement and growth rate scenarios a bottom up driven demand assumption. Appendix IX contains the analysis and displays inter alia all A380 operating airlines, their total firm orders, deliveries already received and a selection of destinations the plane is deployed on.

All carriers operate their A380s to key destinations, sometimes served twice a day by an additional medium wide body plane. The investments from airlines and airports into facilities to accommodate the A380 are sunk costs. Due to fleet uniformity benefits, it is unlikely that carriers operating six or less A380s would further cut on their quantity, but rather make a continuation and potential enlargement or an exclusion from the fleet decision. Only Lufthansa, Korean Air and Air China operate the 747-8, assuming that all other A380 customers once made a decision against buying Boeing's product. Estimating customer satisfaction is based on qualitative comments from individual airlines on the A380 performance. Summing it up, Air France and Lufthansa waived buying options in the past, Virgin Atlantic could do so in the future. When debating on how many existing customers are likely to renew their A380 fleets with a successor product, Airbus's argument about traffic density receives its full validity. Airlines can only chose to buy the product or cut capacity. To add capacity by increasing frequency is equivalently very expensive. As an example, auctions for landing slots at London Heathrow recently reached values up to $ 75 million (O'Connell, 2016).

4.3.1 Retirement & Replacement

When analysing the demand bottom up it is key to account for retirements. Factors, which drive replacement of aircrafts, are primary age, airplane economics, maintenance requirements and overall market environment. Seeing the average age as the primary factor, the current A380 fleets will be at least in service until 2028 – 2038.

Between 1968 and April 2016 Boeing built 1520 747s and has 21 orders left to work off. By March 2015, 664 Boeing 747s retired from service. 107 of these belonged to the newer 747-400 series, referred to the second wave of fleet retirements. Between 1994 and April 2016 1392 777s were delivered, of which 19 retired until March 2015 (Forsberg, 2015).

The analysis also shows the major 747-4 passenger version operator. In 2015, 258 747-400 were in service, of which most of them are about to retire until 2021. British Airways (40), Lufthansa (13) and Thai Airways (12) are major 747-4 operators. British Airways already signalled interest in buying used A380s to replace some of its 747s if they hit the market. Other major 747-4 operator, such as Delta Air Lines (13), United Airlines (24) and KLM (22) are unlikely to order A380Neo's due to an inexistent strategic fit for the aircraft. Saudia Airlines (15) could potentially become a A380Neo customer. The rest of the operated 747-400 are very diversified, as most airlines are operating 1-4 aircrafts and only China Airlines operates more than 10 aircrafts (Morrison, 2015).

The to be introduced 777x is the closest competition in terms of capacity, offering 406 seats in a three class configuration. This is almost as much seats as the 747-8, offering 410 seats. Looking at the order book for the 777x shows that Emirates accounts for 150 of the 306 present orders. Besides Cathay Pacific all other pre orderer are also A380 customers. Therefore can no clear trend towards the 777x can be derived out of the order book for now.

Summing up the analysis shows that if Lufthansa, Air France as well as Malaysia Airlines would remove the A380 from their fleet, however all other existing customers replace 85% of their A380 with A380Neos, 245 orders would be gained. Airlines operating the A380 currently operate 83 747-4. Assuming that a conservative 42% of these are replaced by an A380Neo, a replacement driven demand for another 35 A380Neos is present. Taking the sum of the figures results a demand for 280 A380Neo aircrafts. Both demand indicators are post market penetration and are replacement driven, hence are not subject to any growth rate assumptions.

Appendix X displays the total growth rate the pessimistic, average, optimistic bottom up analysis demand requires to meet the expected values from the unfavourable, expected and favourable demand distribution accordingly.

4.4 Demand forecasts by Airbus and Boeing

In 2000 Airbus forecasted a 20 years market demand for 1500 VLA aircrafts and aimed to capture 50% of the market. Break-even was set at 250 planes (Esty, 2004). The valuation only takes total segment demand forecasts into account and saves out on justifying trends and aspects.

The reports share many similarities, except regarding the need of large wide body aircrafts. In the result Boeing's forecast consistently minimizes the market segment, while on the other side Airbus's report concludes a bright future for it. Both reports forecast the period 2015 - 2034. Airbus estimates a VLA demand of 1275, having a market value of $ 500 billion or 10,6% of total market value. Boeing estimates a VLA demand of 540 units in this time frame, having a market value of $ 230 billion or 4% of total market value.

The following paragraph shortly explains the official manufactures argumentation about the VLA segment. Airbus outlines the demographic and wealth distribution in its report, saying that wealth and air transport will be increasingly dispersed, accounting for a broader verity of people to fly. Demographic change and urbanisation will lead to the fact that by 2050, more then 2/3 of the world population will live in an urban environment, comparing to about 55% today. At a global level, 47 Aviation-Mega-Cities (AMC) account for more than 90% of all long-haul passengers. Airbus estimates, that by 2034 77% of all long haul traffic represents the AMC to AMC flights, with very low numbers for AMC to secondary city or secondary city to secondary city. Boing argues that comparing one month in 2013 and 2014 shows that 14 million seats have been globally added over one year. 70% of this was achieved by frequency increases, 17% by new routes and 13% by larger airplanes (Airbus, 2015) (Boeing, 2015). The future of long haul traffic sees Boeing in connecting secondary cities to each other and through this decrease the traffic from AMC to AMC

In 2000 Airbus Marketing director John Leahy assumed that the Asian region will account for half of the sales. This did not turn out to be the case, as only 60 orders can be assigned to airlines located in the geographical definition of Asia from Airbus. Even if Emirates was the first customer to buy the original A380, the record-breaking orders and infrastructure investments by Middle East carriers mainly appeared after the A380's program start. Noteworthy, Airbus still forecast a VLA aircraft demand of 377 for the Middle Eastern region and a demand of 624 jets for the Asian region.

Both reports forecast the demand of the industry the sponsor is in, aircraft manufacturing. This exposes the reports to conflict of interest and behavioural biases, such as the theories of overconfidence and bounded rationality. Data regarding the accuracy of the forecasts is not available, analysts however describe the forecasts as good. The market forecasts until 2034 by Airbus and Boeing cover about 3/4 of the potential project life of the A380Neo. Appendix XI displays a historical comparison of the forecasts.

4.5 Morgan Stanley Research

Morgan Stanley published the opinions of two industry experts about the A380 in 2006. Favourable tempted Professor Philip Lawrence picks up Airbus's arguments about urbanisation and wealth distribution in terms of a growing middle class. Economic development first triggers domestic air travel, what can be already observed in China, India and other regions, and secondly international travel. He adds dimensions such as truistical preferences. Seeing the distribution of trip purpose today shows that 52% are due to leisure, 27% visiting friends and relatives, 14% business and 7% unspecified. Travellers are keen to visit major centres of population connected by key long haul routes, such as London, New York and Shanghai, but are highly price sensitive regarding their ticket purchase. Lawrence concludes the Airbus's forecast is broadly correct, only being slightly optimistic on total demand and pessimistic on the market penetration of only 50%.

Looking at an unfavourable analysts opinion from Richard Aboulafia brings up new arguments. Smaller aircrafts allow airlines to optimize their passenger loads, shifting their focus away from market share and towards profitability.

This implies to get rid of the lowest fare passengers. Aboulafia also interprets the tremendous up-front interest for the 787, 777x as well as the A350 as an argument that airlines do not wait to order until a series is about to launch. If airlines are really interested in a plane, they rather order it as early as they can. With a 20-years demand estimate of 300-400 the forecast of Aboulafia turned out to be right (Babka, 2006).

4.6 Timing of orders

Figure 4.3 [page: 24] displays the timing of orders from the four most recent launches, the A380, 787, 747-8 and the A350. It supports the finding that if airlines are interest in an aircraft they order it years ahead. Not counting for the A350, on average 69% of total orders were made pre launch. This is a key insight, as it could indicate a lack of market interest in the A380Neo. Airlines know the product could be launched as early as five years from now and still besides Emirates there are no public buying intentions from other airlines present. The A350 is dotted due to limited post launch data. Appendix XII displays the corresponding data.

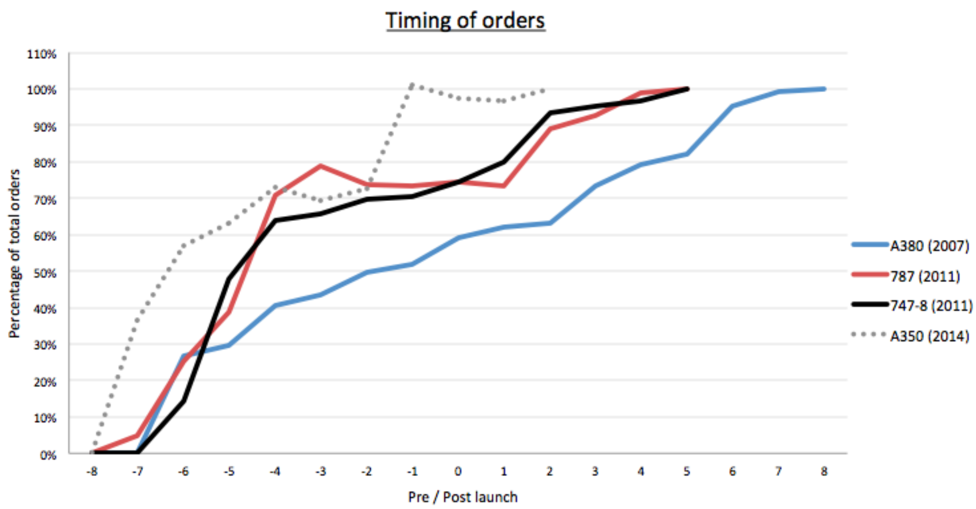


Figure 4.3: Timing of orders

5 Forecasting model

5.1 Methodology summary simulation 1

Three controllers allow to adjust key inputs to the valuation which are known or are foreseeable to a certain extent before investment decision.

1. “ Investment & delay“ controller between € 3 and € 5 billion.
2. “ Amount of pre orders“ controller between 30 and 150 aircrafts
3. “ Market penetration“ controller between 50% and 100%

Afterwards a VBA code injects every number between 150 - 800 in the demand excluding pre orders field of the DCF calculation and reads out the associated NPV. The NPV value is then multiplied with the allocated probability of this demand. The probabilities are collected from three created variables, described in paragraph 4.1, and applied depending on how controller 2 and 3 are set. Appendix XIII shows a screenshot of the controllers.

5.2 Controller settings

5.2.1 Investment & delay

Required investment

The “ Investment & delay“ controller allows to increase the estimated € 3 billion program budget to up to € 5 billion. This allows to include potential excess costs to the model. Research and development costs are timed based on allocation key of Dresdner Kleinwort Benson (Esty, 2004).

Excess costs

Due to the complexity and the dependency on high technological developments, aircraft manufacturer have a history of delays and escalating costs. An educated guess is made, that a one billion cost overrun is set to cause a one-year delivery delay. In the FCF file excess costs are allocated equally between 2019 and the anticipated first delivery as well as the DCF valuation is adjusted to its correct timing.

5.2.2 Amount of pre orders

Before making the decision about lunching an aircraft, it is a common practice that a certain amount of aircrafts are already ordered by airlines. Appendix XIV clarifies the sales process in six steps. Launch orders change the risk profile of a project, as a base demand is secured before the investment decision is made. They are particular valuable as they represent A380Neo orders only, therefore being an after market penetration measure. When deciding on the A380 program, the board of Airbus required at least five top-class airlines and 30 firm orders to proceed with the investment (Economist, 2000). In 2001 Airbus had 85 orders secured. As Emirates intends to buy 100 - 200 planes, the controller allows a choice between 30 and 150 pre orders. Depending on how the controller is set, the annual output is set at 28, 32 or 35 aircrafts. This allows to account for the effect that a costly signal indicating a high demand would lead to a drive up of the production capacities. The buying intention of Emirates is a good sign, however a launch has to be justified by sufficient long-term demand.

5.2.3 Market penetration

The controller for market penetration of the VLA segment ranges from conservative 50% to 100%, in order to account for the possibility of a market exit of the 747. Comparing the orders of the A380 (319) with the 747-8 (125) results a market penetration of 72%. However du to the different launch dates, 2007 and 2011, one could argue to include the 38 by Boeing delivered 747-4 in-between. This results a market penetration of 66%. One should also take into account that 74 out of the 125 747-8 orders were for the freight version. The demand for VLA freighter would shift to smaller aircrafts in case of a market exit of the 747. Accounting only for passenger versions, the market penetration of the A380 is 86%. The amount of pre orders, in combination with market penetration, selects which probability distribution of demand is chosen. If set below 75% the favourable scenario can't be achieved. When set above 75%, consequences of a low amount of pre orders are partially offset.

5.3 List price

The list price for a A380 in 2016 is $ 432,6 million (Airbus, 2016). Over the past five years the annual price increase ranged from +3,89% in 2011 to +1,07% price increase in 2016. Evaluating historical inflation rates in the U.S. in appendix XV turns out a correlation coefficient of 0,94 for increase in list price and annual inflation in the 2011 - 2016 period. Therefore the list price is continued by long-term inflation.

5.4 List price discount

The list price discount (LPD) assumption is besides demand the key value driver of the A380Neo program. It is a common practice in the aircraft manufacturing industry to grant significant discounts on orders. Airbus and Boeing state official list prices, however no customer pays them. Actual prices are kept secret. Analysts state that discounts vary between 20 – 60%, with an average around 45% (Michaels, 2012). According to industry analysts Airbus was pressured to cut prices for the A380 as much as 50% (Mouawad, 2014). Naturally LPD consistent out of two factors, the original list price and the discount percentage. As stated before, the list price development reflects inflation to the most degree. The LPD reflects the bargaining power of customers in a negotiation. Factors defining the bargaining power are the quantity the customer is keen to buy, an airlines' need for the plane, previous business relationships and manufacturers urge to generate orders.

In 2006 Morgan Stanley forecasts assumed decreasing discounts for the A380, from 45% in 2007 to 32% in 2012. The decrease in LPD could be due to a lower uncertainty of the product. Contrary to the Morgan Stanley forecasts of a LPD around 31% are reported discounts of 52% / 45% in 2013 and 2016 respectively. In the matter of fact these numbers are unverified, however could reflect the difficult standpoint of the A380 series. Appendix XVI displays tables regarding list price discounts.

A two years introduction discount assumption of -30% for 2006 and 2007 is made on the lecture slides treating the A380 Harvard Business School case. It is unrealistic to achieve this in the current market environment. However, this is not irrelevant as it reflects typical discounts given to first and high volume customers, what is most likely to be Emirates. Due negotiation power, the discount rate for Emirates' order is likely to be higher than average. A combination of current discount rates and historic launch discounts provide a valid estimate for the discount rate of pre orders. In simulation 1 any LPD can be entered.

5.4.1 Simulation 2: List price discount sensitive towards demand

As the model is very sensitive towards list price discounts, a second option to treat this input is considered. In simulation 2 the LPD on normal orders is sensitive to the demand the variable. This is set to take the effect into account that slacking demand will lead to higher discounts granted to customers, while a demand surpassing production contingents provides Airbus the ability to charge a higher premium. Pre orders are not demand sensitive, as they occur in a short time frame from now. The LPD reaches from 62 % in case of a normal order demand of 150, and 40% in case of a normal order demand of 800. Using solver, the LPD is uniformly decreased over the demand mass. As in simulation two, a probability distribution of demand is chosen based on present pre orders and market penetration.

5.5 Costs

5.5.1 Unit costs

In order to determine direct unit costs, the LPD of 2015 is deducted from the average list price in 2015. Selling and administrative expenses are deducted and treated independently in subsection 5.5.2. In its financial statement Airbus states a first time break-even in 2015, having a production rate of 27 planes in 2015. The report also highlights accomplished productivity gains, hence these can be assumed to be limited in the future. *Figure 5.1 [page: 28]* displays the calculation of direct unit costs and results direct unit costs of € 191 million for an A380Neo in 2021. The table takes fixed costs proportional into account. Fixed costs are set to be € 2,1 billion which are allocated to the 28-35 planes output. Variable costs per plane are an estimated € 100 million. As a result direct unit costs vary around € 15 million depending on the output rate. Unit costs increase at +1,5% per year, a rate below inflation of 2,3% to account for future productivity gains. The model is based on the assumption that Airbus breaks even on the production, hence the unit costs are lower than the sales price. This is remarkable, as until 2015 an operational loss was realized.

Direct unit costs			
Average list price in 2015	386	m. euro	
Discount rate in 2015	52%		
Selling espenses	-3,53	m. euro	*Added back as % of revenue to account for production rate shift*
Administrative expenses	-5,11	m. euro	
	175	m. euro	
Production rate	27	aircrafts in 2015	
margin			
Fixed costs percentage	2100	m. euro	
Production rate	28		*Depending on pre orders*
Fixe cost allocation	75,0	m. euro	
Variable cost per plane	100	m. euro	
Total costs pr plane	175,0	m. euro	
Future increasement rate	1,50%		*Due to productivity gains less than inflation*

Direct unit costs in year	2016	2017	2018	2019	2020	2021	2022
m. euro	177,63	180,29	182,99	185,74	188,52	191,35	194,22

Figure 5.1: Direct unit costs calculation

5.5.2 Operating expenses

For operating expenses, such as selling, general and administrative expenses (COGS), McK recommends to generate forecasts based on revenues. Appendix XVII shows the income statements of the Airbus Group, which is used to estimate indirect costs associated with the project. Selling expenses were 1,75% of revenue in 2014; on average -0,12% per year in 2010 - 2014. Administrative expenses were 2,53% of revenue in 2014; on average -0,07% per year in 2010 - 2014. The trend is smoothed over years and given a lower limit of 1,14% for selling expenses and 2,04% for administrative expenses in the DCF calculation.

6 Valuation inputs

6.1 Weighted average cost of capital

Bloomberg states a current WACC of 8.59%, what is used as the discount rate. This assumes the company uses corporate capital structure for the project. Airbus is 79.7% equity funded at a cost of equity of 10.65%. For the 20.3% debt, of which 9.2% are short term and 11.1% are long term, a cost of debt of 0,3% are reported. Bloomberg states a risk free rate of 0.52% and a equity risk premium of 10.14%.

6.2 Tax

Mck suggest to convert taxes from a marginal rate to a cash basis, as the statutory corporate tax rate typically does not reflect the cash tax actually paid. Bloomberg states an effective tax rate of 24,9% for the Airbus Group. Using this tax rate as an estimator for future tax rates implies the assumption that actions to reduce the effective tax rate below statutory tax rate exist over the forecast period. Losses are cumulative carried forward to offset potential taxation of capital gains by previous capital losses.

6.3 Inflation

For developed economies, McK suggests a 2 - 3% inflation assumption per year. Looking at various long-term inflation forecasts shows distribution around 2,3% annual inflation.

6.4 General terms agreement

The information about the general terms agreement is important to correctly time cash flows and define a risk profile in terms of commodity, labour and exchange rate risks. Appendix XVIII shows the terms of an airplane purchase of Copa Airlines. The contracts usually contains a 1: Airframe price; 2: Optional feature prices; 3: Engine price; 4: Aircraft basic price defined as the sum of 1; 2 & 3; 4. 5: The anticipated advanced payment base price and 6: Aircraft price, which is due at the time of delivery. Escalation adjustment clauses take commodity and labour cost developments into account. Due to this information the assumption is made that Airbus is only able to pass on labour and commodity price escalations. Furthermore prices are fixed at the moment of sale and cash inflow occurs at delivery.

6.5 Working capital investment

One key driver of working capital needs is the lead-time between sale and cash inflow. Payment terms can be observed in the by airlines published purchase agreements and Airbus's balance sheet. Subtracting current liabilities from current assets shows that Airbus states a negative net working capital. € 25,3 billion of inventories, containing € 17,3 billion of work in progress, are offset by € 12,2 non-current and € 22,2 billion in current customer advance payments. Due to this industry practice and minimal working capital opportunity costs owing to low interest rates, working capital investment is set to be zero. Appendix XIX shows the in the AR reported balances affecting working capital.

6.6 Further assumptions

- The residual value of the investment is set to be zero after the 20 years program life.
- After-sale services are a seperate business unit of the Airbus Group and are therefore ignored.
- Direct costs to terminate the series (section 1.1) are carried forward with the A380Neo.

7 Results

Figure 7.1 [page: 32] displays the key findings of the thesis. It displays that the A380Neo would only be in three scenarios a positive NPV investment. If a punctual development without excess costs is achieved and 1: the expected or 2: the favourable demand variable applies. For this at least 50 pre orders have to be present and market penetration has to be above 75%. In case development costs are set at € 4 billion, the program is profitable if the demand is favourable. In all other scenarios the investment's NPV is negative.

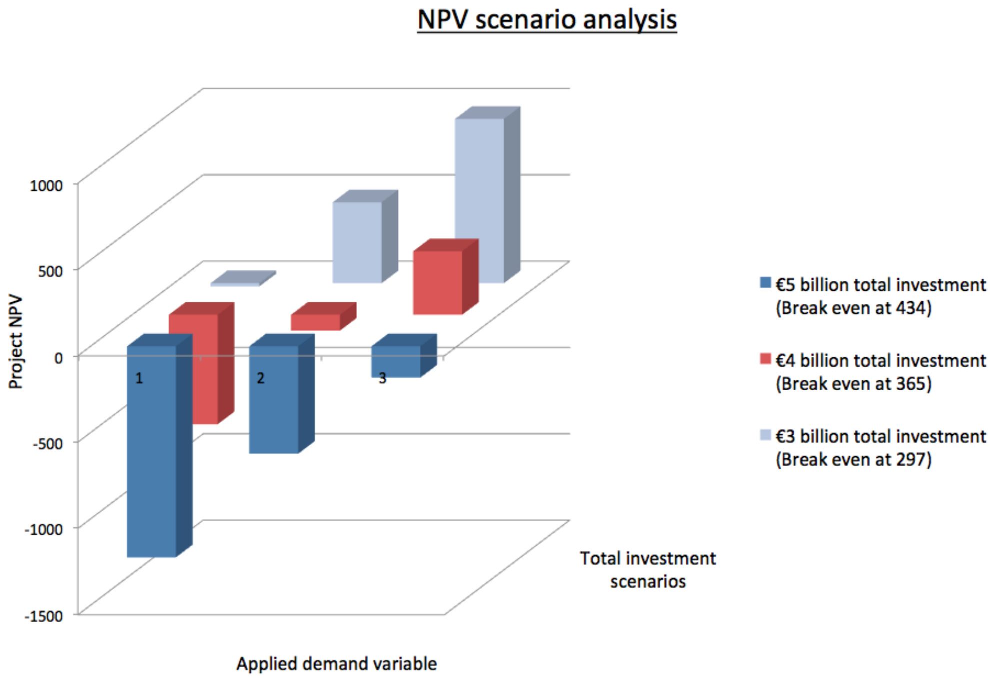


Figure 7.1: Results simulation 1 (50% list price discount)

Figure 7.2 [page: 33] displays the results of simulation 2. The first average field is before weighting the results using the created demand variables. The table shows the outcome for all three variables, unfavourable, expected & favourable. Only in a favourable demand scenario the investment would result a positive NPV. The last field of the table represents the average of the three outcomes.

As a result, the A380Neo investment will most probably be a negative NPV investment. Even in case of a positive NPV, other investments could grant a higher internal rate of return.

List price discount sensitive towards demand						
	Simulate 2					
Applied Distribution:	Average	Selector	*Unfavorable*	*Expected*	*Favorable*	*Average*
Simulated NPV:	1842	-3514	*-3514*	*-144*	*1380*	-759
List price discount at 150	62,00%					
List price discount at 800	40,00%					

Figure 7.2: Results simulation 2

7.1 Break-even analysis

Break-even is achieved at the first demand returning a positive NPV in the simulation. As displayed, depending on the scenario this is at 297, 365, 434 normal orders. When announcing the project the break-even target was set at 250 planes. In 2007 Airbus stated that 420 planes needed to be sold to break even. Since then Airbus denied to state a specific number, however saying that the number further increased (Robertson, 2006). As the project is valuated on a differential base, past realities do not matter. In general a break-even analysis is driven by margin and quantity.

7.2 Sensitivity analysis

The sensitivity analysis displayed in *figure 7.3 [page: 33]* determines the models' sensitivity towards set in list price discount and WACC as the discount rate.

Interpreting the table, on average a 1% decrease in the list price discount on normal orders increases the in simulation 1 calculated NPV by 366%. Simulation 2 is less sensitive, with a 157% average NPV increase. A 1% decrease in LPD decreases the break-even point on average by -37%.

On a range between 10,59% and 6,59%, decreasing WACC 1% on average increased the in simulation 1 calculated NPV by 202%. In simulation 2 the decreased WACC increases the average NPV on average by 152%. Break-even was little sensitive towards changes in WACC, a 1% decreased WACC decreases break-even on average by -7%.

Sensitivity analysis			
Variables	Simulation 1	Simulation 2	Break even
List price discount	3,66	1,57	1,37
WACC	2,03	1,52	1,07

1% change in LPD affect on dependend variables
1% change in WACC affect on dependend variables

Figure 7.3: Sensitivity analysis

8 Real-option valuation

A real option is defined as the right to make a particular business decision, such as the option to delay an investment decision, the option to expand and the option to abandon an investment opportunity. Real options, and the underlying assets on which they are based, are as a key distinction to financial options, not traded in competitive markets.

The real option valuation approach does not only focus on the initial investment decision as of today, but also explicitly considers opportunities which could arise out of changing market environment over the life of a project (DeMarzo, 2014).

Airbus could find it optimal to wait on the decision. Logically in case of a negative NPV valuation, parameters may change over time and the project becomes profitable in the future. In case the time premium of the options exceeds the cash flows that can be generated in the next period by launching the project, a firm may also find it optimal to wait on a positive NPV project. As barriers to entry the market segment are very high, this option is valuable for Airbus (Damodaran, 2002).

Figure 8.1 [page: 34] displays a decision tree outlining the different choices available to Airbus. As discovered in chapter 7 Results, currently the investment decision is a out-of-the-money a call option.

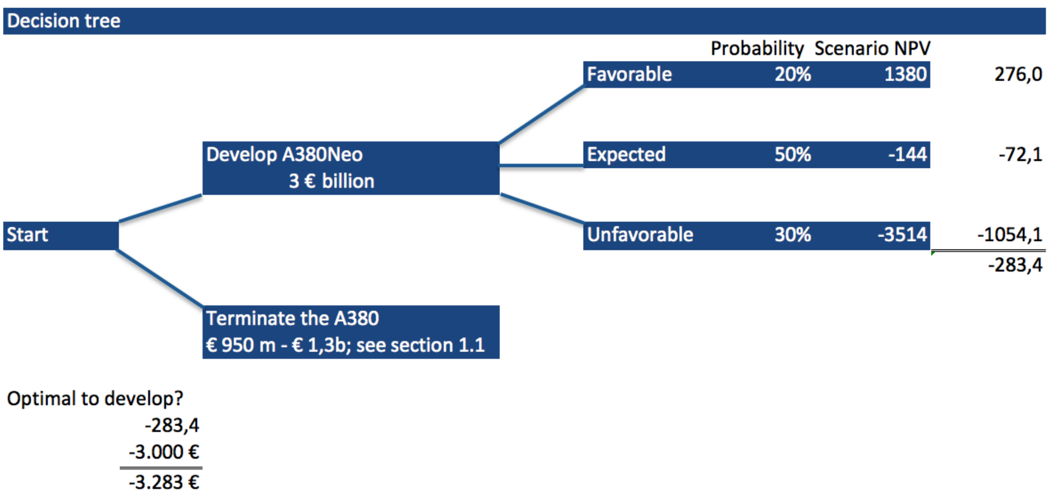


Figure 8.1: Decision tree Airbus A380Neo investment

In the first step Airbus has the decision between developing or abandoning the A380Neo. Once Airbus finds out about the total demand in the second step, the development cost of € 3-5 billion are sunk. Whether it is optimal for Airbus to invest into the development of the aircraft at the first hand depends on probabilities and NPVs assigned in the decision tree, as well as the in the next paragraph treated option to abandon. As the project has limited upside at a small probability and a significant downside at a higher probability, it is not optimal to develop in the present example. However, it can be optimal to hold the option.

Theoretically Airbus is not forced to lose anything beyond the development costs, hence as soon information about too little total demand is present they have the option to abandon the project. In practice, this is not the case. Airlines are not providing real-options to manufacturers, but manufacturers are providing real-options to airlines. In the past it would have been optimal to abandon the production of the A380, as Airbus did not break-even on the production costs for most of the projects life. If ordered, Airbus had the obligation to deliver the aircraft. To solve this, theoretically could Airbus try to establish a new sales process, providing the company with the right to call off a sale and potentially deliver other aircrafts to a customer. But even then, the costs associated with terminating the project are existent in the future.

Uncertainty over market demand is unlikely to resolve in a short term. As volatility is also minimal, benefits arising from delaying are minimal. In order to experience a shift in the market environment, Airbus would need to wait longer, what however would imply a shut down of the production line.

The decision to wait is a trade-off between associated costs and the benefit of remaining flexible. Theoretically it is optimal to wait unless there is a cost associated with it. For now, holding the out-of-the-money real option provides value to shareholders, as the chance that the investment opportunity could have a positive NPV in the future is worth something today. However, holding this call option becomes costly for Airbus if the production rate is decreased in order to win time. Section 5.5.1 extracts fixed costs of € 2,1 billion per year, which are allocated on a per plane basis. In 2015 Airbus broke even for the first time with a production rate of 27 aircrafts. If the company would decide to cut the production rate by 50% in order to win time, fixed costs of € 1,05 billion would have to be reallocated. Therefore, keeping all other measures stable, the option to delay in this scenario would result in a negative dividende of € -1,05 billion per year. This leads to the conclusion, that delaying the investment decision by lowering the production rate is very costly. However, as mentioned in chapter 2, Boeing is doing the same with the 747-8. The company decreased the production rate to an uneconomical level.

As of today, to cancel the project does not provide any value to Airbus. A commitment to a negative NPV project neither does. Seeing the A380Neo or an investment to further stretch the A350 mutually exclusive, uncertainty with which product to compete against Boeing's 777x might be resolved by new available information in the future. For instance, a technological break through could make a two engine A380Neo possible, which is however very unlikely. In this case, the aircraft would be at the forefront of economization again.

In practice it is optimal for Airbus to postpone the decision as long as no costs are associated with delaying the decision. This would imply to continue to produce the A380 at current output rate and make the investment decision at the latest possible moment. This moment is defined by the lead-time of the A380Neo, aiming to launch the aircraft as soon the order book for the A380 is worked off.

However, there is still the possibility that the Airbus Group is trading at a discount, as investors account for the possibility of a irrational investment decision due to political interests. If this discount is greater than the benefits of holding the out-of-the-money option, it would be optimal to cease the A380 series right away. An argument in favour of this is that the market capitalization of Airbus is with $ 38,64 billion significant lower than the market capitalization of Boeing, $ 84,22 billion (YahooFinance, 2016a) (YahooFinance, 2016b).

Part III: Academic reasoning

The last part of the thesis is dedicated to the theoretical reasoning, explaining why the Airbus Group might takes on such a high risk, most likely negative NPV investment. It focuses on relevant research and literature regarding inefficient investments. The key finding of the chapter is that Airbus operates with soft budget constraints. Due to the large amount of subsidies manufacturer receive, a competitive equilibrium is not present in the industry.

Most referred to academic theory is written on a firms' level and is in this thesis applied to the scale of a major project. Relevant theories are only mentioned, as research fields such as soft budget constraints are considerably large.

9 Theoretic interpretation

9.1 Long run projects

The A380Neo upgrade is in valuation terms a long run project extension. Technological flexibility is limited to cabin and related systems upgrades, such as the layout change to install the now popular premium economy class. As industry trends are only visible in the long term, the likelihood of an abrupt change in the market environment is low. In 2014 the Airbus group reported total assets of € 96,1 billion in its financial statements. With € 3 - € 5 billion the A380 Neo program reflects 3,1% – 5,2% of total assets. The profit for the period was set at € 2,35 billion. The original A380 program reflected a significant risk to the Airbus Group, referred to " betting the farm" . The project did not become a success for Airbus and the company is still accomplishing good operating results in relation to its own historic performance. It is therefore unlikely that a failure of the A380Neo project would terminate the resistance to financial losses and risks Airbus's standpoint in the industry.

9.2 Ownership

The two top holder of the Airbus Group SE are the French and German governments, holding each 10.97% of the company's equity. Sorted by ownership type, 57.64% are hold by private investments management corporations. Capital Group Companies and Blackrock are the largest private single holder, holding 5% and 4% respectively. 41.05% of the company are hold by governments and 0.84% by pension funds. Due to Airbus's capital structure of very little debt and its state ownership, financial distress is unlikely.

Theoretically this makes Airbus a shareholder conscious company, which ideally should allocate internal funds most profitable or pay out to shareholders. Research suggests that a payout can be used to self-impose discipline. By reducing the cash that management controls means to invest in negative NPV projects are minimized (Brav, 2003).

Noteworthy, the French state also holds 17,6% of the equity of A380 customer Air France - KLM (KLM, 2016). The influence of the political backing of Airbus can be observed in its extensive production line. Not counting for suppliers facilities, 16 Airbus sites across Europe are involved in the construction of A380 components. This adds further complexity, as industry experts claim that this encourages to do processes in sequence instead of parallel, what adds time and costs. The non-optional splitting between production sites inter alia caused delays of the A380 launch in 2006, as sites were using different versions of an engineering software.

Research separates companies in state-owned enterprises, mixed enterprises and private corporations. Most papers in this field are from 1980-2000, as governments privatised many industries and researchers were keen to investigate effects from this. Boardman and Vining compare the performance of the three ownership types and find that large industrial mixed enterprises and state owned enterprises perform substantially worse than comparable private corporations. In terms of all profitability indicators, mixed enterprises perform no better and often worse than state-owned enterprises. The results indicate that partial privatization is worse than complete privatization or continued state ownership (Vining, 1989).

9.3 Soft budget constraints & the sunk costs fallacy

The Airbus group acts with soft budget constraints, without the company would not exists in its present state. Soft budget constraint (SBC) develops if hard consequences, such as bankruptcy, are eliminated by a sponsor, which is typically the state. Susceptible to this are not just state owned firms, but also indispensable private firms, banks, large priority projects and individual producers. In the SBC theory ownership is irrelevant, seeing that even football clubs such as Real Madrid managed to enjoy SBC (Barker, 2016). The SBC symptom refers to the changing behaviour of affected companies. As known, typically the willingness to take risks increases. Arguments about moral hazard and "too big to fail" further contribute to the soft budget constraint research (Fischer, 2013) (Kornai, 2014).

The sunk costs fallacy theory refers to the tendency of decision makers to be influenced by sunk costs. Irrationally capital is invested in a negative NPV project due to the sentiment that prior investment otherwise will be wasted. However, prior investments are already sunk. Well-fitting to the subject of this thesis, the sunk cost fallacy is also called "Concorde effect"(DeMarzo, 2014).

9.4 Inefficient investments

Surprisingly aircraft manufacturers have a long history of unprofitable investments, raising concerns about the ability of the industry to achieve profitability without governmental subsidies.

The from the scratch new developed 787 and A380 aircrafts share a fate. Due to escalating development and delay costs both programs might not ever be profitable. Boeings 787 program cost an estimated $ 29 billion (Johnsson, 2016a). However the long-term market demand at least justifies the aircraft-series and achieved innovations can be used in the future. Due to a escalated competition the air tanker contract as well as the 747-8 continuation is not profitable. In 2016 an accounting loss of $ 393 million for the KC-46 air tanker and $ 814 million for the 747-8 was recognized (FAZ, 2016b). The A400M program, a military cargo aircraft from Airbus, is also subject to excess costs in the range of € 1 billion (Magazin, 2016).

Theoretically an investment in a negative NPV project can be justified by tax reasons and strategic considerations. This could be on the negative NPV project depending future positive NPV projects. However the A380Neo is in contrast to the A380 a follow up investment, hence strategic considerations are limited as the product market can be defined much better. For a positive investment decision, the project should surpass the hurdle rate of a positive NPV and optimally have the highest internal rate of return of all alternatives.

Any firm has the choice of continuing with an existing project, liquidating or seeling it so another entity. Depending upon which of the three is the highest, the firm should make a decision. In case the continuing value is the highest, it is optimal to continue with the project even if the earnings are less than the cost of capital (Damodaran, 2002).

A successful divested asset must have a higher value to the buyer than for the seller, hence have either higher free cash flows or a lower risk profile. As a result, a divesture of the A380 is unlikely due to a lack of potential buyer. A liquidation is optimal if the liquidation proceeds exceed the continuing value. Stated differently, a termination is optimal if the loss occurring as a result of the termination is smaller than the loss associated with a continuation of the series.

However even if a termination is optimal out of a financial perspective, it does not necessary imply that Airbus will abandon the project. As stated before, states are a minority investor of the Airbus Group. In case of a termination governments have to take on the political responsibility for the waste of resources. However the majority of Airbus is owned by private investors, who are not sensitive to political pressure and who should therefore ensure rationality of investments. In order to pass over the rationality of private investors the subsidies from governments, which are at the same time investors, for carrying out the project have to grant private investors a higher return than the termination would. This implies that as long private investors are incentivised through financial returns they will act in the interest of the minority investors. As a result, the A380Neo project does not have to be the optimal choice out of a financial perspective, as non-financial value driver could justify the continuation of it.

9.4.1 Implications of inefficient investments

Business economic theory sets a short-term lower price limit at variable costs. However as prices are negotiated years before delivery, aircraft manufacturers partially could not even recover these in the past. There is no academic reasoning why a shareholder conscious company should sell below variable costs. The growing market provides a favourable environment for aircraft manufacturers. Game theory can be used to explain why airlines are encouraged to place big orders. An order can be interpreted as a costly signal, indicating competitors that the ordered capacity is going to be deployed. Deep pockets, high profitability and state support are factors further validating the signal send out by the orderer. Having a fuel burn advantage with the new planes, hence a competitive advantage, further increases this effect. Other market forces, such as great economies of scale, motivates manufacturers to deploy excess capacity to the market. Analysts already outlined a possible jet bubble, having many similarities to the overcapacity crisis in the container shipping industry (Holman, 2016). However limited profitability is surprisingly not only a result of overrunning costs of certain series, but rather a problem of the entire industry. Despite the now challenged Airbus-Boeing duopoly, political motivation prevents a competitive equilibrium and results in the incapability of manufacturers to discipline themselves. As no government desires to be blamed to let down a local corporation due to “ unfair“ foreign competition, this is likely to remain the steady stage.

As an example, Bombardier launched its new C series to compete in the small single aisle segment, receiving subsidies from the Canadian and Quebec government (Hollinger, 2016). After struggling to gain market acceptance, 75 planes of the type were sold to Delta Air Lines. Analysts called the very aggressive pricing approach Bombardier applied unsustainable. Bombardier executives called it “ typical“ (Lampert, 2016). Russian Prime Minister Dmitri Medwedew participated at the launch event of the MC-21, Irkut’s new airliner for the market entry in the single aisle segment in 2018. The Russian government supported to program with about $ 3,5 billion. In his speech he outlined the importance for Russia to pursue an aircraft manufacturing industry, calling the aircraft the pride of Russian civil aviation (OSBORN, 2016).

As a result of this, between Q2 2006 and Q2 2016 Airbus only managed to achieve a ROIC greater than WACC between mid 2012 and end of 2014. The development peaked in 2010, with a ROIC of -15% and a WACC of around 13% (BLOOMBERG, 2016). Appendix XX displays the Bloomberg chart.

9.5 Theory regarding divestitures

Academic research shows that divestitures have to potential to create value and improve operating performance. Active portfolio managing companies outperform the ones with a passive portfolio approach (ROSENFELD, 1983). This especially applies to dynamic industries with growth and technological change. Research also shows that executives shy away from divestments, implying that companies tend to hold on to underperforming businesses to long (MYEONG-HEYEON CHO, 1997). Most divestitures do not take place out of internal strategic initiatives, but rather as a reaction to outside active investors. This pressure from outside usually peaks when underperformance becomes transparent to the market.

Divesting the A380 implies writing off development expenses and taking the responsibility that the biggest investment in the company's history failed. When valuing a divestiture, lost benefits of having the business have to be taken into account. These could be financial measurable implications such as synergies, cross–selling & bundle opportunities and tax impacts as well as non-financial value driver such as political support. Direct divestment costs for the closure of the A380 series include cost of sale of unneeded assets and retention bonuses for employees which can't be immediately transferred to other operations. Indirect, stranded costs, includes shared services such as marketing, IT infrastructure, shared production assets and overhead personal. McKinsey research found that it often takes up to three years for the parent company to recover stranded costs.

To further research to topic it would be interesting to incorporate how the market reacts when new information about the A380 becomes public. Through an event study, stock returns contemporary to newly available information could be used to determine investors sentiment about the investment. When Airbus announced to half production of the A380 from 2018 onwards, the shareprice fall as much as 4,5% (BBC, 2014).

10 Discussion

Not committing to a launch already could also be a strategic target. Airbus creates political pressure when the termination of the A380 is discussed, potentially increasing the political will to keep the series in production. In 2015 industry analyst Kevin Michaels shared his thoughts, saying a re-engined and updated A380 makes little sense, and from an economic standpoint probably no sense at all. “ However cancelling the project after just a decade of production would be a political catastrophe, not only for Airbus but also for Europe“ (HAMLIN, 2015). Political targets typically aim to the overall well being of society, with financial profitability being a subordinated goal. Whether it is beneficial for the society to grant public funds to a civil aircraft as the A380Neo is controversial on the political view. Left wing parties, such as the in office Parti socialiste in France, were at least in the past tempted to avoid any layoffs. In general other types of defence equipment, such as vehicles, are also provided by public or private enterprises. It is therefore not arguable that a state investment into Airbus is justified by defence interests, what itself represents a higher aim of the society. Optimally political interests in the aircraft manufacturing industry should be reduced, a process which is already ongoing since decades, however obviously with limited success.

As the aircraft manufacturing industry is experiencing to a certain extend a subsidies competition, many economic principles are ignored. It is still alarming that even if the A380 would now achieve a margin of 12,5% (€ 25 million per plane) and without accounting for time value of money, it would take another 1000 orders to reach overall program profitability. As the A380 only broke even on production costs, past deliveries almost not at all contributed to incurred development costs. The current low oil price level is also a windfall advantage for the A380. It reduced the pressure on the A380, however in a long-term perspective it does not solve the problem of uncompetitive fuel consumption.

However it will at last depend on the political will to keep the model in production. As a result, the A380Neo is likely to be built at some point in the future. If launched, the A380Neo will be most likely a negative NPV investment. In the long run, if the market does not justify the product’s existence a termination can be the only choice. If the movement of the market is ignored, the A380Neo risks to become the next example of failed subsidies for iconic projects.

The history of the Concorde reads many similarities, particularly as involved companies are part of today's Airbus Group. The Anglo-French developed aircraft was the flagship of European aircraft manufacturing, but a financial failure. Contrary to manufactures believes, the market did not shift towards supersonic transportation due to the high costs associated with travelling at high speed. Despite this, Boeing as well as Tupolev moved into the market, spending vast amounts on the development of the Boeing 2707 and the Tu-144. The associated governments mainly funded the aircrafts. Only 14 Concords ever entered commercial service, the Tu-144 flew only 55 passenger flights and the U.S. Senate rejected further funding of the Boeing 2707 in 1971 (Time, 1971). Between 1970-2000 VLA aircrafts were the main margin contributor, but the market shifted again and today both manufacturers make a loss on their large wide body series.

In the past years the industry developed fast due to technological progress. If the markets' preference towards small and medium wide body aircrafts does not change, the A380 should be abandoned the earlier the better. A key indication for a lack of interest from airlines is the timing of orders treated in section 4.6. The 319 orders officially disclosed even have to be seen with care, as several orders are likely not to be filled. The order book includes ten orders from undisclosed customers and 20 orders from a leasing company, Amedeo. It also includes six orders from Virgin Atlantic, which are basically cancelled (Airbus, 2016) .This would reduce the number of total orders to 283 and the remaining deliveries to 90.

The market entrances of four new manufacturers in the single aisle market will further tight competition in the future. Airbus has to ensure that it stays at the top of technological developments and achieves a short time to market. Therefore the company should allocate funds into profitable projects or engage in a pay out.

11 Conclusion

Airbus considers to invest into the A380Neo, a successor product of the A380. Industry analysts consider this to be an iconic negative NPV investment, what is consistent with the findings of the thesis. The market did not develop how Airbus anticipated and this is not likely to change in the short term. The initial A380 program was a qualified and quantified idea, but the aircraft appears to be too specialized in terms of operational flexibility. Due to this the aircraft faces limited demand while being subject to low margins, as it fails to provide customers with a competitive advantage justifying customers willingness to pay a premium for the aircraft.

The thesis contributes to the progressive discussion whether an investment to revamp the A380 is reasonable or not. The market developed towards smaller aircrafts and infrastructure investments prevent a demand for bigger planes caused by airport congestions. A demand analysis detects that the total orders for the A380Neo are most likely to be between 250 - 500 aircrafts, just 17% - 33% of the by Airbus forecasted demand. As a result, the A380Neo will most likely be a negative NPV investment.

The objective of this thesis is to deliver a financial evaluation of the Airbus A380Neo program. The valuation shows that in the current market environment it is financially not justifiable to commit to the A380Neo program. Due to the high costs associated with postponing the investment decision, Airbus is recommended to continue to produce the A380 at a profit-maximizing rate. If the valuation is negative at the latest possible decision day, rationally the A380 should be terminated after the order book is worked off. Due to the notable lead time for an aircrafts' development and the small amount of orders left, the latest possible decision day is anticipated to be in the near future.

12 New available information

In mid-July 2016 Airbus announced to further cut production to 12 aircrafts per year from 2018 onwards. This implies to not reach break-even anymore, however keeping the production line open (Jasper, 2016). This could be interpreted as a “ wait and see“ real option. Appendix 21 displays the output rates for 2016-2018 onwards, showing Airbus’s intention to stretch deliveries up to 2025. As the A380 will become out-dated over time and a revamped version would have a protracted time to market, at latest in 2021 Airbus has to make a decision about the A380Neo. Until the decision is made, Airbus will bear considerable costs to keep the production line open. Only one day before the announcement of future output rates, Airbus sales president John Leahy predicted a VLA demand of 1500 aircrafts over the next 20 years (FAZ, 2016a).

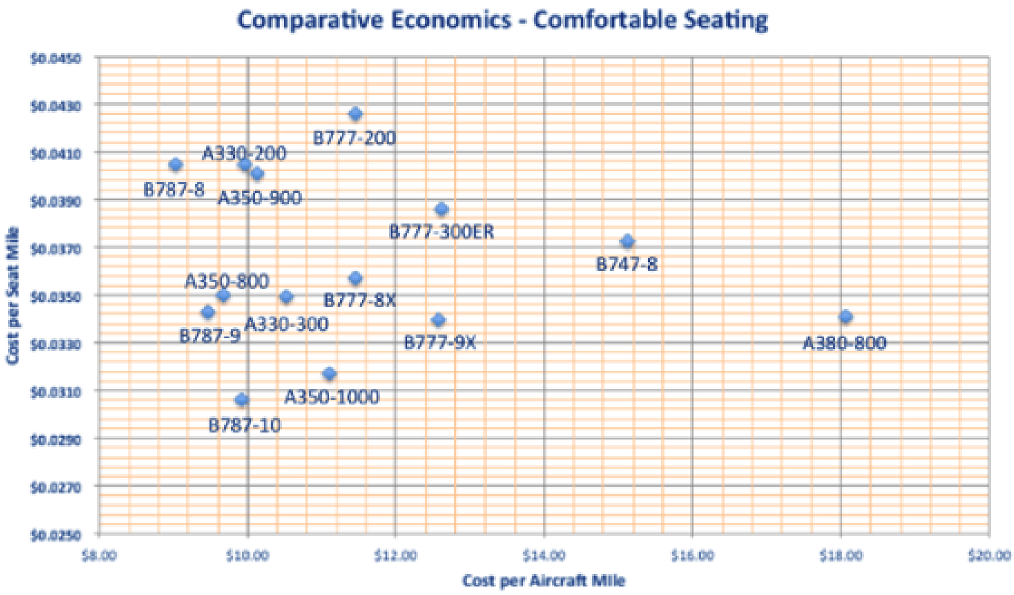
Furthermore did Qantas Airways express its intention to cancel eight remaining orders the airline committed on (Rothman, 2016). This reduces the amount of total hard orders left to just 82. Following the announcement, the share price of Airbus decreased by 1,3%.

Appendices

Appendix I - Download link excel file

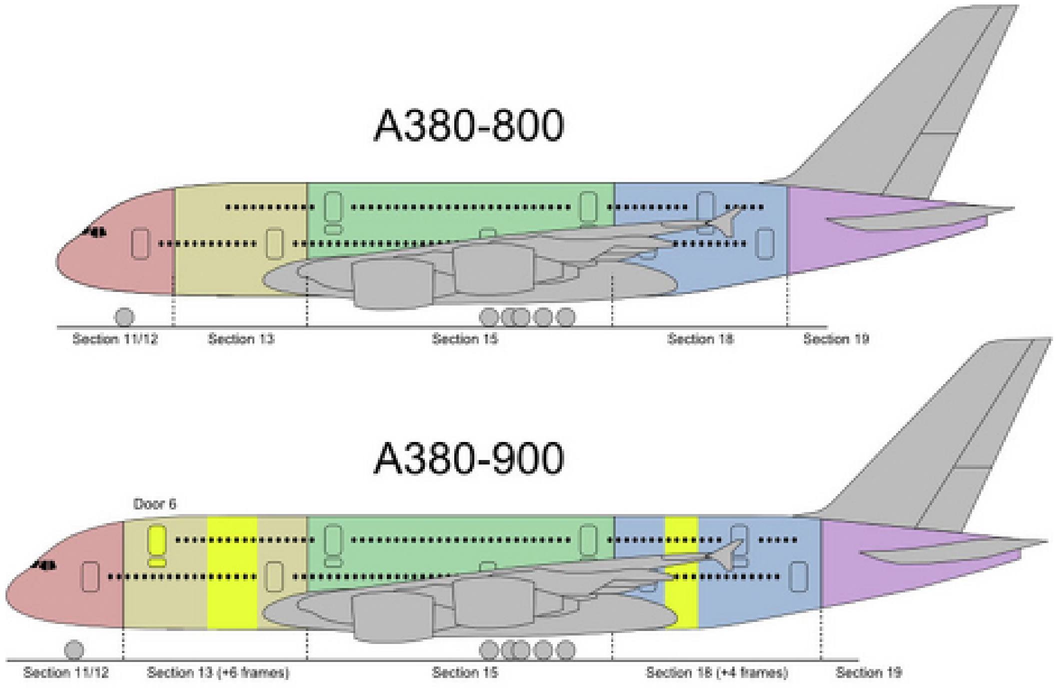
https://www.dropbox.com/sh/0mr3fjfzceywirj/AAAKBhVgFpESrN-C7pNlXWr1a?dl=0

Appendix II - Cost per seat mile comparison



Competing widebody aircrafts achieve lower CPSM and CPAM

Appendix III - A380 strech sample drawing



Appendix IV - Market overview: Segments and products

Market overview - Sectors and products		
Single asile passanger airplanes		
Boeing and Airbus	Other producer	Regional Jets
Boeing 707, 757	**AVIC ARJ-900**	**Antonov An-148, -158**
Boeing 717, 727	BAe 146-300, Avro RJ100	**AVIC ARJ-700**
Boeing 737-600, -700, -800, 900ER	**Bombardier CRJ-1000**	Avro RJ70, RJ85
Boeing 737-MAX7, -MAX8, MAX9	**Bombardier CS100, CS300**	BAe 146-100, -200
Airbus A318, A319, A320, A321	**Embraer 190, 195**	**Bombardier CRJ**
Airbus A319neo, A320neo, A321neo	**Comac C919**	Dornier 328JET
Boeing/MDC DC-9,MD-80, -90	Fokker 100	**Embraer 170, 175**
	UAC MS 21-200/300	Embraer ERJ-135/140/145
	Illyushin IL-62	Fokker 70, F28
	Tupolev TU-154, **TU-204, TU-214**	**Mitsubishi MRJ**
	Yakovlev Yak-42	**Sukhoi Superjet 100**
Widebody passanger airplanes		
Large *Three class: more than 400 seats*	**Medium** *Two class: 340 to 450 seats* *Three class: 300 to 400 seats*	**Small** *Two class: 230 to 340 seats* *Three class: 200 to 300 seats*
Boeing 747-8	**Boeing 777, 777X**	**Boeing 767, 787-8, -9**
Boeing 747-100 through -400	**Boeing 787-10**	Boeing/MDC DC-10
Airbus A380	Boeing/MDC MD-11	Airbus A300, A310
	Airbus A340	**Airbus A330-200, -300, -800, -900**
	Airbus A350-1000	**Airbus A350-800, -900**
	Illyushin IL-86	Lockheed L-1011
		Illyushin IL-96

Bold: Airplanes in production or launched

Appendix V - Order books overview

Orderbooks overview of Boeing and Airbus					
Airbus			Boeing		
Type	Orders	Deliveries	Type	Orders	Deliveries
A319neo	60		737-9ER	515	377
A320neo	3342	5	737-8	5011	3981
A321neo	1108		737 MAX	3090	
A330-8neo	10		other 737	121	
A330-9neo	176		787-8	435	295
A350-8	16		787-9	551	98
A350-9	580	19	787-10	153	
A350-10	181		777X	306	
A380	319	184	747-8	125	102

Appendix VI - A380 and 747-8 order books

A380 orders				
Year	Total orders	Total deliveries	Annual deliveries	Remaining orders
2001	85			85
2002	95			95
2003	129			129
2004	139			139
2005	159			159
2006	166			166
2007	189	1		188
2008	198	13	12	185
2009	202	23	10	179
2010	234	41	18	193
2011	253	67	26	186
2012	262	97	30	165
2013	304	122	25	182
2014	317	152	30	165
2015	319	179	27	140
2016	319	193	*14*	126
4y average			28	

747-8 orders				
Year	Total orders	Total deliveries	Annual deliveries	Remaining orders
2001				
2002				
2003				
2004				
2005	18			18
2006	60			60
2007	80			80
2008	82			82
2009	87			87
2010	88			88
2011	93	9	9	84
2012	100	40	31	60
2013	117	64	24	53
2014	119	83	19	36
2015	121	101	18	20
2016	125	104	3	21
4y average			23	

Appendix VII - Key supplier of A380 components

Major Suppliers Exposure to the A380

Company	Major Components Supplied	Est. Shipset Value per A380 (USD mm)	After-market Multiplier	Value Including After-market	Annual A380 Revenue			A380 A380 EBIT*			% Impact on Consol. Revenue		% Impact on Consol. EBIT	
					Bull	Base	Bear	Bull	Base	Bear	Bull	Bear	Bull	Bear
Rolls Royce	Trent 900 engine **	18.0	100%	36.0	1,800	1,080	720	180	108	72	4.5%	-2.3%	4.3%	-2.1%
Safran	Nacelles, braking controls, nose landing gear, comm. & data systems; 10% share of GP7200 engine	15.0	50%	22.5	1,125	675	450	158	95	63	2.5%	-1.2%	4.1%	-2.1%
United Technologies	APU (Auxiliary Power Unit), air conditioning system; GP7200 engine (JV with GE)	10.0	80%	18.0	900	540	360	135	81	54	0.7%	-0.3%	0.7%	-0.3%
General Electric	GP7200 engine (JV with Pratt & Whitney) **	9.0	100%	18.0	900	540	360	90	54	36	0.2%	-0.1%	0.1%	0.0%
Goodrich	Landing gear, fight control systems, evacuation systems, cargo loading, aerostructures, engine components	8.0	50%	12.0	600	360	240	90	54	36	3.4%	-1.7%	5.1%	-2.6%
Finmeccanica	4% share of airframe production; air conditioning, humidifaction, insulation systems	5.0	10%	5.5	275	165	110	41	25	17	0.6%	-0.3%	1.1%	-0.5%
Alcoa	Aluminium, fasteners, fuselage sections, fuselage stringers and skins, support structures, fittings	3.5	25%	4.4	219	131	88	33	20	13	0.3%	-0.1%	0.2%	-0.1%
Thales	Cockpit control and displays, In Flight Entertainment (IFE) system, radio altimeter	3.5	25%	4.4	219	131	88	33	20	13	0.5%	-0.2%	1.0%	-0.5%
MTU	22.5% share of GP7200 engine	3.2	100%	6.5	324	194	130	32	19	13	3.4%	-1.7%	3.5%	-1.7%
Honeywell	Flight management system, SATCOM, navigation systems, wheels & brakes	2.5	25%	3.1	156	94	63	23	14	9	0.2%	-0.1%	0.2%	-0.1%
Smiths Group	Actuation, landing gear systems, fabrications	1.5	50%	2.3	113	68	45	17	10	7	0.6%	-0.3%	0.6%	-0.3%
Rockwell Collins	Avionics & navigation equipment, communications infrastructure	0.5	25%	0.6	31	19	13	5	3	2	0.2%	-0.1%	0.2%	-0.1%

** At 15% assumed incremental margin for equipment and components, and 10% for aero engines suppliers.*

*** Assume 50-50 split of engine deliveries to Rolls Royce (Trent 900) and Engine Alliance (GP7200)*

Source: Company data, Morgan Stanley Research

Appendix VIII - R code demand variables

```
setwd("~/Desktop")
a <- 102
b <- 150
curve(
        a^(-1)*( (x-b)/a*exp(-(x-b)/a)),
        from=150,
        to=800,
        n=10000,
        main  = "Unfavorable distribution",
        ylab  = "probability",
        xlab  = "demand"
      )

funktionsgleichung <- function(x) a^(-1)*( (x-b)/a*exp(-(x-b)/a))
integrate(funktionsgleichung, 150, 1000)
erwartungswert <- function(x)   x * a^(-1)*( (x-b)/a*exp(-(x-b)/a))
integrate(erwartungswert, 150, 1000)

x <- 300

y <- a^(-1)*( (x-b)/a*exp(-(x-b)/a))

x <- c(150:800)

y <- a^(-1)*( (x-b)/a*exp(-(x-b)/a))

table <- cbind(x,y)
write.csv(table, "unfavorable_distribution.cvs")
plot(table)
```

Appendix IX - Bottom up demand analysis 1

Bottom up demand analysis						
Customer	Orderbook		Destination served by A380			
	Firm orders	Deliveries	London	Dubai	Los Angles	Hongkong
Singapore Airlines	24	19	X		X	X
Emirates	142	79	X	X	X	X
Qantas	20	12	X	X	X	X
Air France	12	10			X	
Lufthansa	14	14			X	X
Korean Air	10	10	X		X	X
China Southern Airlines	5	5			X	
Malaysia Airlines	6	6	X			
Thai Airways International	6	6	X			
Brithish Airways	12	11	X		X	X
Asiana Airlines	6	4			X	X
Qatar Airways	10	6	X			
Ethihad Airways	10	8	X			
Unidentified	10					
Virgin Atlantic	6					
All Nippon Airways	3					
Air Accord	3					
Amedeo	20					
Sum firm oders & Delivery	319	190				
Sum Firm orders by operators	277					

Appendix X - Bottom up demand analysis 2

Calculation		
Optimistic		
Complete replacement for all orders	100%	319
Replacement of 747-4	50%	45,5
Sum		365
Pesimistic		
Replacement by current A380 operator	88%	244
Replacement of 747-4	42%	38
Sum		282
Average		323

Total growth rate required to reach expected value from demand distributions				
	Growth rate	Unfavorable	Expected	Favorable
Pure replacement demand	0,00%	282		365
Pessimistic	4,26%	294		
Average	27,77%		413	
Optimistic	27,57%			465

Appendix XI - 20 year forecasts comparison

20 year forecast comparison				
Period	2000 - 2019	2006 - 2025	2011 - 2030	2015 - 2034
New passanger aircraft deliveries	14661	21860	27848	32585
	22315	27200	33500	38050
VLA (excluding freighters)	1235	1263	1331	1275
	1010	816	670	540
Business volume		16%	14%	12%
			6,70%	4,10%
Growth Airline traffic	4,80%		5,10%	4,9%
Growth Airplane fleet			3,60%	3,6%

Grey: Airbus; light blue: Boeing

Appendix XII - Timing of orders

Timing of orders:												
Year to launch	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3
A380 (2007)			85	10	34	10	20	7	23	9	4	32
% of all orders		0,00%	26,65%	3,13%	10,66%	3,13%	6,27%	2,19%	7,21%	2,82%	1,25%	10,03%
Cummulative %	0	0,00%	26,65%	29,78%	40,44%	43,57%	49,84%	52,04%	59,25%	62,07%	63,32%	73,35%
787 (2011)		56	235	157	369	93	-59	-4	13	-12	182	41
% of all orders		4,85%	20,35%	13,59%	31,95%	8,05%	-5,11%	-0,35%	1,13%	-1,04%	15,76%	3,55%
Cummulative %	0	4,85%	25,19%	38,79%	70,74%	78,79%	73,68%	73,33%	74,46%	73,42%	89,18%	92,73%
747-8 (2011)			18	42	20	2	5	1	5	7	17	2
% of all orders			14,40%	33,60%	16,00%	1,60%	4,00%	0,80%	4,00%	5,60%	13,60%	1,60%
Cummulative %	0	0	14,40%	48,00%	64,00%	65,60%	69,60%	70,40%	74,40%	80,00%	93,60%	95,20%
A350 (2014)	*2*	*292*	*163*	*51*	*78*	*-31*	*27*	*230*	*-32*	*-3*	*25*	
% of all orders	*0,25%*	*36,41%*	*20,32%*	*6,36%*	*9,73%*	*-3,87%*	*3,37%*	*28,68%*	*-3,99%*	*-0,37%*	*3,12%*	
Cummulative %	*0,25%*	*36,66%*	*56,98%*	*63,34%*	*73,07%*	*69,20%*	*72,57%*	*101,25%*	*97,26%*	*96,88%*	*100,00%*	
A380, 787,747 average									69,37%			

Complete table in excel file

Appendix XIII - Controller

Controller			Selected value	Delivery start
	3	5		
Investment & delay			3	2021
	30	150		
Amount of pre orders			30	
	50%	100%		
Market penetration			50%	

Simulate

Appendix XIV - 6 steps sales process

Sales Process	
1.	Coordination with airlines
2.	Secure pre oders
3.	Commit to launch
4.	Start to gather normal orders
5.	Build
6.	Launch

Appendix XV - List price development 2011 - 2016

List price development history						
Year	2016	2015	2014	2013	2012	2011
Airbus list price in mln USD	432,6	428	414,4	403,9	389,9	375,3
% increase to t-1		1,07%	3,28%	2,60%	3,59%	3,89%
Annual inflation in the US		0,10%	1,60%	1,50%	2,10%	3,20%
Correlation	0,937					
5 year average	2,89%					

Appendix XVI - List price discounts

List price discount									
Aircraft type	A380	777-300ER	787-9	787-8	737	A330-3	A330-2	A350-900	A321
Estimated discount:	**45%**	54%	46%	48%	53%	57%	63%	51%	54%
Estimated discount 2013	**52%**								
Average	**52%**								

Airinsight 2016 data
Callenges fr. 2013

Analyst opinion							
Year	2007	2008	2009	2010	2011	2012	Long Term
MS base case	45%	41%	37%	34%	32%	32%	32%
MS good case	45%	44%	41%	37%	34%	32%	30%
MS poor case	45%	43%	40%	37%	35%	33%	33%
Slides	30%	30%					

Morgan Stanley 2006 (forecast)
Applied valuation Sliedes

Appendix XVII - Income statements Airbus 2010 - 2015

Airbus income statement							
Year	2010	2011	2012	2013	2014	2015	Current
Free cash flow to the firm		2412,96	998,25	-569,98	492,91	1150,47	-608,46
Revenue	45752	49128	56480	57567	60713		
Cost of sales	-39528	-42351	-48582	-49613	-51776		
Gross margin	6224	6777	7898	7954	8937		
Selling expenses	-1024	-981	-1192	-1140	-1063		
Administrative expenses	-1288	-1433	-1677	-1622	-1538		
Research and development	-2939	-3152	-3142	-3118	-3391		
Other income	171	359	184	272	330		
Other expense	-102	-221	-229	-259	-179		
Share of profit from investments accou	127	164	241	434	840		
Other income from investments	18	28	6	49	55		
Profit before financial costs and income	**1187**	**1541**	**2089**	**2570**	**3991**		
Selling expenses % of revenue	2,24%	2,00%	2,11%	1,98%	1,75%		
Administative expenses % of revenue	2,82%	2,92%	2,97%	2,82%	2,53%		
Decrease per year average (1)						-0,12%	
Decrease per year average (2)						-0,07%	

Smoothed						Long term value	
Year	2021	2022	2023	2024	2025	2026	2027
Selling expenses % of revenue	1,50%	1,44%	1,38%	1,32%	1,26%	1,20%	1,14%
Administative expenses % of revenue	2,25%	2,22%	2,18%	2,15%	2,11%	2,08%	2,04%

Appendix XVIII - Copa Airlines Boeing general terms

2.1 Price.

2.1.1 AIRFRAME PRICE is defined as the price of the airframe for a specific model of aircraft described in a purchase agreement. (For Models 717-200, 737-600, 737-700, 737-800 and 737-900, the Airframe Price includes the engine price at its basic thrust level.)

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2.1.2 OPTIONAL FEATURES PRICES are defined as the prices for optional features selected by Customer for a specific model of aircraft described in a purchase agreement.

2.1.3 ENGINE PRICE is defined as the price set by the engine manufacturer for a specific engine to be installed on the model of aircraft described in a purchase agreement (not applicable to Models 717-200, 737-600, 737-700, 737-800 and 737-900).

2.1.4 AIRCRAFT BASIC PRICE is defined as the sum of the Airframe Price, Optional Features Prices, and the Engine Price, if applicable.

2.1.5 ESCALATION ADJUSTMENT is defined as the price adjustment to the Airframe Price (which includes the basic engine price for Models 717-200, 737-600, 737-700 and 737-800) and the Optional Features Prices resulting from the calculation using the economic price formula contained in Exhibit D, Escalation Adjustment to the AGTA. The price adjustment to the Engine Price for all other models of aircraft will be calculated using the economic price formula in the Engine Escalation Adjustment to the applicable purchase agreement.

2.1.6 ADVANCE PAYMENT BASE PRICE is defined as the estimated price of an aircraft, as of the date of signing a purchase agreement, for the scheduled month of delivery of such aircraft using commercial forecasts of the Escalation Adjustment.

2.1.7 AIRCRAFT PRICE is defined as the total amount Customer is to pay for an aircraft at the time of delivery, which is the sum of the Aircraft Basic Price, the Escalation Adjustment, and other price adjustments made pursuant to the purchase agreement.

Appendix XIX - Working capital

Working capital		
Year	2014	2013
Current assets	46932	44748
Current liabilities	47497	46351
WC:	-565	-1603
Customer advanced payments non-curr	12231	
Customer advanced payments current	22174	

Appendix XX - Bloomberg chart WACC / ROIC Airbus Group

Appendix XXI - Implication of output slowdown

Output planned				
	2016	2017	2018	2019
Output rate	27	20	12	
Oders left	113	93	81	69
Last plane produced in:	2025			

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