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Q-Series

Flying solo – how far are we down the path towards pilotless planes?

Equities

Global

Airlines & Aerospace

Jarrod Castle, CFA
Analyst
jarrod.castle@ubs.com
+44-20-756 88883

Celine Fornaro
Analyst
celine.fornaro@ubs.com
+44-20-7567 9351

Darryl Genovesi
Analyst
darryl.genovesi@ubs.com
+1-212-713 4016

Eric Lin
Analyst
eric-p.lin@ubs.com
+852-3712 3640

David E. Strauss
Analyst
david.strauss@ubs.com
+1-212-713 6185

Thomas Wadewitz
Analyst
thomas.wadewitz@ubs.com
+1-212-713 6116

Dominic Edridge
Analyst
dominic.edridge@ubs.com
+44-20-756 88779

Pilotless planes are technically feasible, and could bring material benefits

UBS analysis of the Aerospace, Airlines and Logistics sectors suggests that reducing the intervention of human pilots on aircraft could bring material economic benefits and improve safety. Technically speaking, remotely controlled planes carrying passengers and cargo could appear by c2025. Further technological progress could lead to a root change in the piloting skillset, making training and the in-flight workload simpler. Last week, Boeing announced that it would step into avionics to make aircraft controls and electronics, underpinning our view on that market's appeal.

A material profit opportunity of over c$35bn p.a. for Aviation and Aerospace

Meaningful savings can be generated via mission optimisation, greater predictability, and reduced flight crew and training costs. We think the aerospace suppliers, OEMs and commercial airlines would retain some of the considerable benefit: (1) more than $26bn in pilot cost savings for the airlines under UBS coverage, up to $3bn in pilot savings for the business jet industry, and $2.1bn for civil helicopters; (2) flight optimisation savings could be significant, e.g. over $1bn, at 1% of global airlines' $133bn 2016 fuel bill; (3) more than $3bn/year in savings from lower insurance premiums (safer flights) and pilot training costs; and (4) a revenue opportunity from increased utilisation rates (cargo and commercial).

Short-term headwinds expected

The regulatory framework will define the waves of technology advancements becoming reality and cargo will likely be at the forefront. Consumer perception could also be a headwind – 54% of respondents to our UBS Evidence Lab survey of c8,000 people would be unlikely to take a pilotless flight, while only 17% of respondents saying they would do so. Younger respondents (aged 18-34), however, were found to be more willing to fly on a pilotless plane (30%), and acceptance should grow with time.

Impact for Aerospace and Transport (commercial airlines, logistics) companies

We believe the biggest potential beneficiaries among suppliers would be those exposed to avionics and communications: Thales, Rockwell Collins and Honeywell. With increased technology breakthroughs and lower costs, Airbus and Boeing could increase the appeal of their future aircraft programmes. We estimate that if commercial airlines retain all of the profit uplift from pilotless planes, those that could see the greatest EBIT uplift are: Thai Airways (c90%), China Eastern (c80%); AA (x2), UA (100%), easyjet (c60%), AFK (c50%). There is also a potential c$1bn upside for Fedex and UPS.

Contents

Jarrod Castle, CFA
Analyst
jarrod.castle@ubs.com
+44-20-756 88883

Celine Fornaro
Analyst
celine.fornaro@ubs.com
+44-20-7567 9351

Darryl Genovesi
Analyst
darryl.genovesi@ubs.com
+1-212-713 4016

Eric Lin
Analyst
eric-p.lin@ubs.com
+852-3712 3640

David E. Strauss
Analyst
david.strauss@ubs.com
+1-212-713 6185

Thomas Wadewitz
Analyst
thomas.wadewitz@ubs.com
+1-212-713 6116

Dominic Edridge
Analyst
dominic.edridge@ubs.com
+44-20-756 88779

Simon Mitchell
Analyst
simon.mitchell@ubs.com
+61-2-9324 3573

Executive summary

"One day, there will not be any pilots in the cockpit"
– Michel Ziegler, former technical director of Airbus (1980)

Commercial jets already take off and land using their on-board computers, and several other in-flight functions are performed or confirmed by computers. Indeed, the pilot's task is increasingly focused on managing and overseeing the aircraft and its systems. However, in the not-too-distant future, we would expect to see a situation where flights are pilotless or the number of pilots shrinks to one, with a remote pilot based on the ground and highly-secure ground-to-air communications. This report looks at the path towards pilotless planes, and the commercial benefit they would bring to the airlines and aerospace industries.

In the not-too-distant future, we expect to see a situation where flights are pilotless or the number of pilots is reduced

The technology is there; two main obstacles are regulation and perception

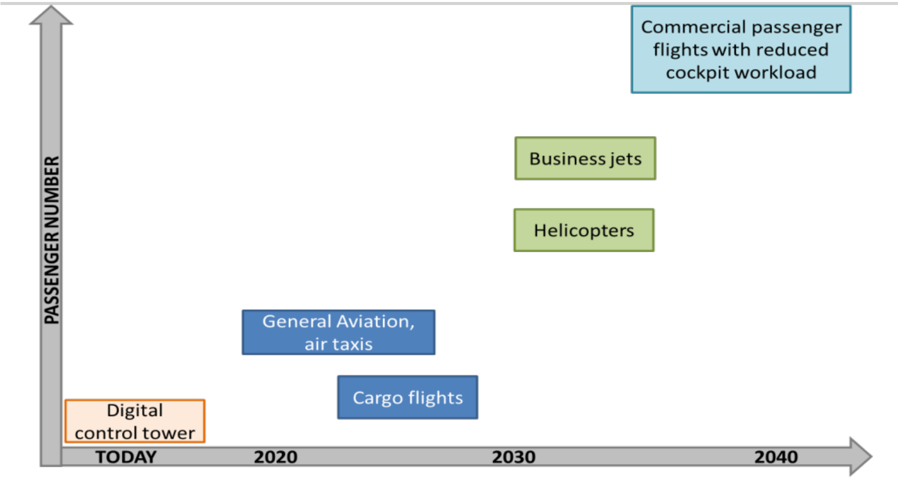
The aerospace and defence (A&D) sector has already explored for two decades the opportunity of unmanned flight and fully autonomous planes (without ground-based control). The technology to remotely control military drones already exists, and this technology could be adapted to control civil applications, such as helicopters, general aviation, small to medium-sized business jets and, eventually, commercial aviation (particularly for segments under seven hours). We see increased scope for remotely controlled flying machines carrying passengers (sky taxis), which may move a limited number of passengers and reduce the need for regional transportation (rail and air). Certain countries are now adopting remote tower controls, with London City Airport among the most recent.

A&D sector has explored unmanned flight for two decades

Indeed, a number of manufacturers are already involved in making pilotless planes a reality. Most recently, Boeing's VP of Product Development said: "The basic building blocks of the technology clearly are available." BA is reportedly set to test pilotless technology in 2018, with artificial intelligence (AI) making some decisions (CNBC, June 2017). Airbus is running three initiatives linked to urban mobility (Vahana, CityAirbus and Skyways) as well as testing an unmanned jet under its Sagitta initiative. Embraer said in 2010 that it is preparing for the possibility of single-pilot operation by as early 2020, following the adoption of next-generation air traffic management in Europe (SESAR) and the US (NextGen). A potential road map to pilotless planes could be:

A number of manufacturers have already begun to make pilotless planes a reality

Figure 1: Flying solo – the path towards pilotless planes



Source: UBS estimates

Implications for the OEMs (original equipment manufacturers)

- The shift by the commercial and civil industry towards a greater reliance on technology is inevitable, in our view. It would result in a tight integration between the airframe OEM and the cockpit/communication/avionics systems providers. Today, the cockpit value is up to c5% of an airplane, but it could grow if its scope grows, due to better flight optimisation. Last week, Boeing announced that it would step-into avionics to make aircraft controls and electronics (Reuters 01/08/2017). Some of the avionics suppliers such as Thales and Rockwell Collins will explore further "collaboration" with the OEMs.

- For the next two decades, we have identified potential for $3bn of operational and capex savings in business jets, $2.1bn in helicopters and up to $26bn in commercial airplanes. Typically, the A&D would share some of the benefits with the airlines.

- The OEMs are exploring new business models to increase their service revenues. Avionics suppliers typically do not have many services contracts. Increased flight optimisation would enable a more "fly by the hour" type of agreement, which would have better economics for the suppliers and OEMs. Typically, "fly by the hour" contract margins are close to 20-25% versus 8-10% for original equipment (OE). We estimate that the current avionics/electronics market size across commercial, business jets, GA and helicopters to be close to c.$9bn across the whole value chain (UBest, Aircraft Electronics association)

- Airlines could save on operating costs through a better optimised mission. For instance, we estimate a 1% saving on Lufthansa's fuel bill could result in a profit uplift of more than €50m, and with a total industry fuel bill of more than $130bn, there would be the potential for material savings. If one member of the flight crew moves from the cockpit, the cost of pilots could be reduced by between one-third and a half in the medium-term.

New generations appear keener to fly "pilotlessly"

We undertook a UBS Evidence Lab survey of c8,000 people to assess customer attitudes to pilotless planes. We found resistance from respondents to flying in pilotless planes. Perhaps to facilitate adoption, a flight could be flown by an autonomous pilot, but with a human pilot taking over in emergencies. The balance between human and computer control of a flight may have to be an evolution rather than a revolution. In summary, our findings are:

A UBS Evidence Lab survey of c8,000 people found some resistance to the idea of pilotless planes. But autonomous car and train adoption can help in increasing consumers' propensity towards fewer pilots in cockpits

- **Consumer response**: The public perception of automated flight, based on our UBS Evidence Lab survey, suggests passenger concerns need to be addressed if wider acceptance of pilotless flight is to be achieved.
  - Some 54% of respondents said they were unlikely to take a pilotless flight, while only 17% said they would likely undertake a pilotless flight. There are slight differences among countries, with a greater percentage of respondents in the US willing to take pilotless flights (27%), compared with other countries. French and German respondents are the most unlikely to take a flight with no pilot.
  - Younger (18-34) and more educated respondents were found to be more willing to fly on a pilotless plane. This bodes well for the technology as the population ages.
  - UBS Evidence Lab also asked respondents how much cheaper a pilotless flight ticket would need to be for them to fly on a regular flight without pilots. Perhaps surprisingly, half of the respondents said that they would not buy the pilotless flight ticket even if it was cheaper.

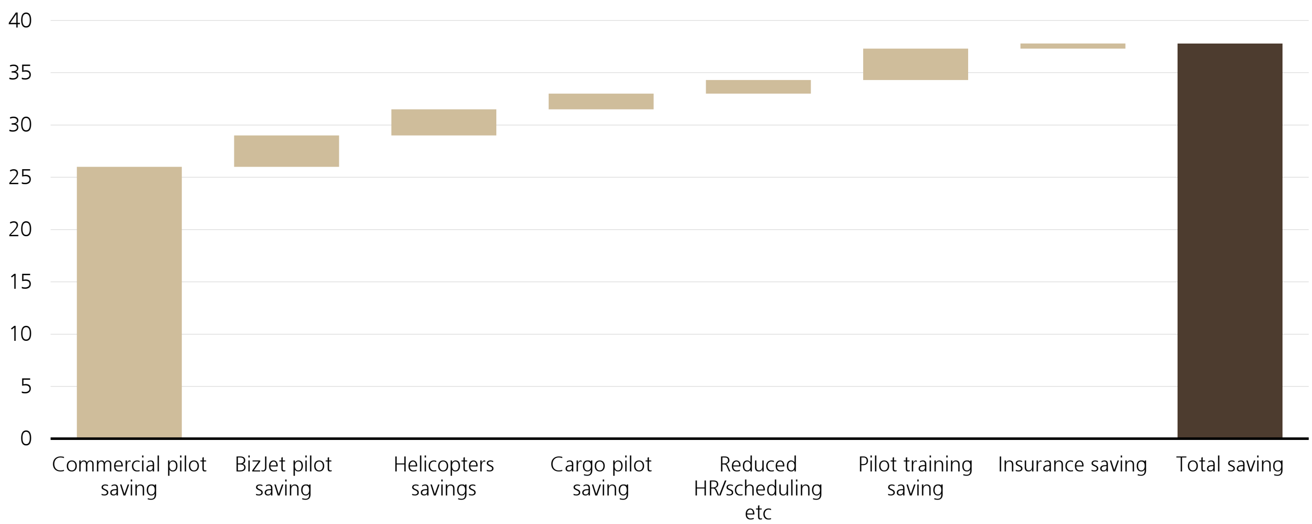
Numerous potential benefits to the aviation industry, which could lead to more passenger and freight growth

- Boeing forecasts that more than 0.6m new pilots will be needed over the next 20 years (2016-35), so pilotless (or reduced pilot numbers) planes could alleviate the pressure to train and recruit pilots. Indeed, the time required to become a pilot in the US is at least 1,500 hours, according to the FAA. In the UK, the British Airline Pilots Association estimates it costs £60-80k (or more) to become a pilot.
- There is also a limit of 100 flight hours per 28-day cycle and 900 flight-hours per fiscal year, so pilotless flight would enable increased aircraft utilisation, given no human flight-time element to uphold. The industry is more likely to embrace this on short/medium-haul flights.
- Potential for pilot error would be removed, along with decisions that at times may be led by emotions. Furthermore, pilotless flight avoids the situation where a pilot of a commercial flight is incapacitated or may not be able to perform their duties.
- It is likely that traffic control of the skies would improve, given the enhanced ability of ground control to monitor flights and communicate with the flight deck. This could result in improved flight planning, and less waiting time at airports before take-off and landing. Airports would also benefit from an ability to handle increased flight movements, boosting returns. Furthermore, greater automated flight path directions would simplify pilots' tasks.

- **In terms of direct economic benefits to the airline industry (assuming 100% of any savings are kept), we highlight a $35bn opportunity, which could mean global airline profitability more than doubling:**
  - Our analysis indicates a material cost saving for the commercial airlines (c30% for European airlines, c45% for Asian airlines and 73% for US airlines). **This could equate to $26bn p.a.** What pilotless planes would mean for airlines' ROIC will depend on how the aerospace industry would charge for pilotless plane technology. For instance, Aerospace manufacturers could charge the system out on a fly-on-demand basis, meaning the cost of the flight becomes increasingly variable for airlines. This would have a different impact for low cost carriers (LCCs) and legacy carriers, depending on utilisation rates and flight length.
  - We see scope for additional savings of more than **$3bn/year on insurance premiums and pilot training costs.**
  - We estimate there is **a potential logistics cost opportunity of $1bn plus.** In addition, a new revenue boost for cargo and commercial airlines might take place, given the ability to increase utilisation rates.
  - The opportunity in the Business jet segment from pilot savings and utilisation could be worth up to $3bn+, and in the civil helicopter market it could be up to $2.1bn, on UBSe.

Below we show a summary of the building **blocks to the $35bn opportunity.**

Figure 2: The $35bn opportunity is across the industry from cargo to commercial to training

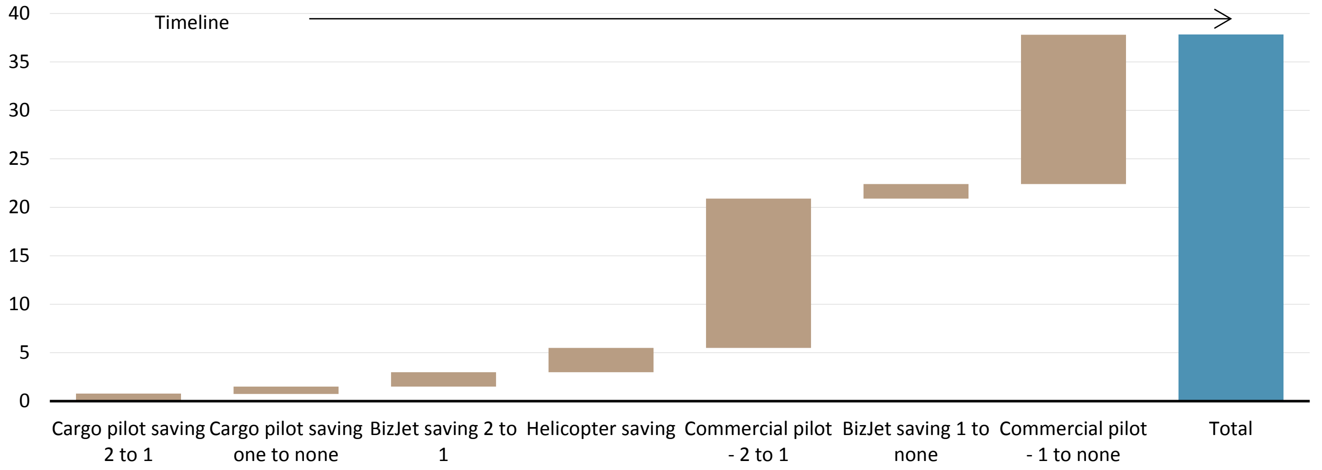


Source: UBS estimates

We believe cargo would likely be the first to go pilotless

The opportunity, we believe, would be dependent on the timing of the roll-out of pilotless planes and we think it is likely we would initially see cargo the first subsector to adopt new related technologies, with the number of pilots falling from two to one and eventually from one to none. Below, we show how the potential waterfall of pilotless plane savings could look over time.

Figure 3: Scenario analysis – ramp-up of savings related to pilotless planes of more than 35$bn



Source: UBS estimates

But a number of potential financial negatives for airlines

- The capital cost to acquire a pilotless system might reduce some of the potential return benefits for the commercial airline operators.
- Barriers to entry might be further reduced, given there will be no need (or less of a need) to find and train qualified pilots. This could lead to increased airline capacity (in an industry that continues to suffer from excess capacity), further reducing returns or removing some of the positive cost-saving benefit.
- The growth in new pilotless plane carriers for local and regional journeys could negatively impact incumbent regional and short-haul carriers, as the pilotless plane network grows. There are already initiatives to make such journeys a reality, such as Volocopter and Lilium jet.

Potential impact on industry players

We do not think the market is currently pricing in any benefit for commercial airlines or aerospace companies from the implications of pilotless technology, as the benefits may be more than five years out. However, especially for A&D companies, the R&D investments of today are addressing some of this, and the best positioned will increase their technology gap against new entrants. For the airlines, we would assume any potential benefit should be across the board, but we highlighted below those that we see materially benefiting versus peers in such a scenario. In addition to the companies below, other impacted names are Honeywell, Garmin, CAE, Thai Airways and Flybe.

Figure 4: Global firms positively and negatively impacted by the theme

Company Name	Sector	Theme Priced In?	Rating	Observations
Positively Impacted By Theme				
Airbus	Aerospace	No	Buy	One of the two largest aircraft and helicopters manufacturer, at the high end of the spectrum in pursuing pilotless technology
Boeing	Aerospace	No	Neutral	One of the two largest aircraft manufacturer, aspiring for more vertical integration in airplanes
Rockwell Collins	Aerospace	No	Buy	Avionics manufacturer that would benefit from higher collaboration with OEMs and increased content in cockpit
Thales	Aerospace	No	Buy	Avionics manufacturer heavily investing in real time capability reducing pilot workload
China Eastern	Airlines	No	Neutral	Chinese airlines have a higher average number of pilot per plane, indicating operating efficiency, which could be greatly improved
American Airlines	Airlines	No	Neutral	American has one of the largest pilots number across the US carriers and would therefore significantly lower its pilots related costs
United Continental	Airlines	No	Buy	It is the second largest beneficiary in terms of profit uplift potential under our coverage
EasyJet	Airlines	No	Buy	The airline would have the largest profit incremental benefit from reduced pilot costs
Air France-KLM	Airlines	No	Buy	AFKL would benefit from reduced pilots cots and reduced pressure from pilot unions which are very strong in France
UPS	Logistics	No	Neutral	Logistics provider, smaller than FedEx with c.2,600 pilots
FedEx	Logistics	No	Buy	Largest logistics provider, employing 4,500 pilots
Negatively Impacted By Theme				
Embraer	Aerospace	No	Sell	The success of regional jets in the US largely relies on pilot scope clauses rules, which would be less compelling if pilots' costs reduce

Source: UBS estimates, company data

The case for building systems less reliant on pilots

Aircraft accidents are fairly rare, but 70-80% of accidents are caused by human error (source: Human Error Analysis, FAA, Feb-01), crew fatigue is behind 15-20% of the overall accident rate. Human error generally implies pilot error. Since the introduction of fly-by-wire technology in 1985, Airbus – in cooperation with Thales – has been a pioneer in reducing pilot intervention and workload, as the technology becomes cleverer and more capable of reacting to the environment. Recent statistics suggest that Boeing and Airbus pilots manually fly the plane for only three to six minutes per flight. The technologies in development today will enable the aircraft to assist and back up the pilot in all the flight phases, removing the pilot from manual control and systems operations in all types of situations.

Building systems less reliant on pilots could improve safety and reduce industry costs. We see a $35bn cost saving opportunity over two decades

Pilot role shifting to mission planning/monitoring

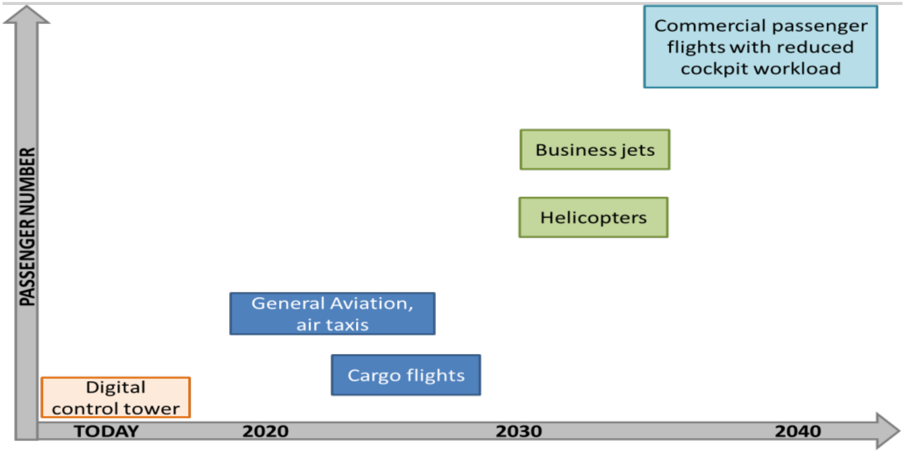
The pilot role is gradually moving away from actually piloting the plane to optimising the flying mission and trajectory: monitoring, managing and programming more complex and automated on-board systems such as flying in four dimensions and advanced weather tracking systems. We see two main mid-term implications of further cockpit automation: (1) greater integration between the aircraft manufacturer and the avionics systems providers; and (2) a lower in-flight workload for the pilot, which – in commercial aviation – could ultimately result in only one pilot being needed rather than the two pilots currently. This would be very similar to the move made in the early 1980s when the on-board flight engineer was removed on aircrafts such as the DC-9, MD-11 and Boeing 747 as technology progressed and alleviated the two pilots' workload.

Pilot role gradually moving from piloting to mission optimisation and monitoring…

Due to regulatory dynamics and consumer concerns/perception, it could be easier for certain sub-segments of civil aviation to reduce, or remove entirely, the role of the pilot. The figure below summarises UBS' vision of different civil applications and their paths towards pilotless technology. Embraer said in 2010 that it is preparing for the possibility of single-pilot operation by as early as 2020, following the introduction of next-generation air-traffic management in Europe (SESAR) and the USA (NextGen). Boeing is to test pilotless technology in 2018, with artificial intelligence making some decisions. Furthermore, Airbus is running three initiatives linked to urban mobility (Vahana, CityAirbus and Skyways) and recently in 2017 tested an unmanned jet under its Sagitta initiative.

…and a number of manufacturers are already progressing with pilotless planes

Figure 4: Flying solo – the path towards pilotless planes



Source: UBS estimates

Digital tower controls are today's reality

The further away aviation is from passengers' eyes, the greater the automation – London City Airport is set to move to a digital tower control in 2018

Airports are adopting remote control towers that rely on a digital system. Instead of sitting in a tower overlooking the runway and the taxiways, the controllers are more than 100km away, getting live footage of airside movements from high-definition cameras. London City Airport is moving to this system by 2018. Other countries have started to test digital tower technology, including the US (Leesburg Airport in Virginia), Australia, Sweden (Ornskoldsvik airport), Norway and Ireland (Cork and Shannon).

Thales, Saab, Lockheed Martin and Leonardo are the largest providers of air traffic management (ATM) systems. ATMs account for c€500m of sales for Thales and c€250m of sales for Leonardo. At present, digital towers are a very limited part of the business, but they could be a new growth segment, as they enable remote regions to create air traffic infrastructure cheaply, fostering economic development, and playing into the expansion of "individual air mobility". Furthermore, digital towers can handle a greater number of airplane movements, which enhances both airport (increased movements) and airline profitability (less circling).

The ultimate endgame – pilotless planes

Capabilities exist today for an automated cockpit: X-47B combat drone

The capabilities are there to make the cockpit more automated. The two most striking examples took place in July 2013 when the US Navy managed to take-off and land a combat drone from Northrop Grumman X-47B on an aircraft carrier (programme cost c.$1.5bn). Another example of unmanned space application is the Neuron, from Dassault Aviation.

Figure 5: Landing of X-47B on USS George H.W. Bush aircraft carrier

Source: Northrop Grumman

Furthermore, in July 2017 Airbus "Sagitta" jet demonstrator used automated take-off and landing capabilities with ground connection via data links.

Figure 6: Airbus Sagitta automated landing and take-off

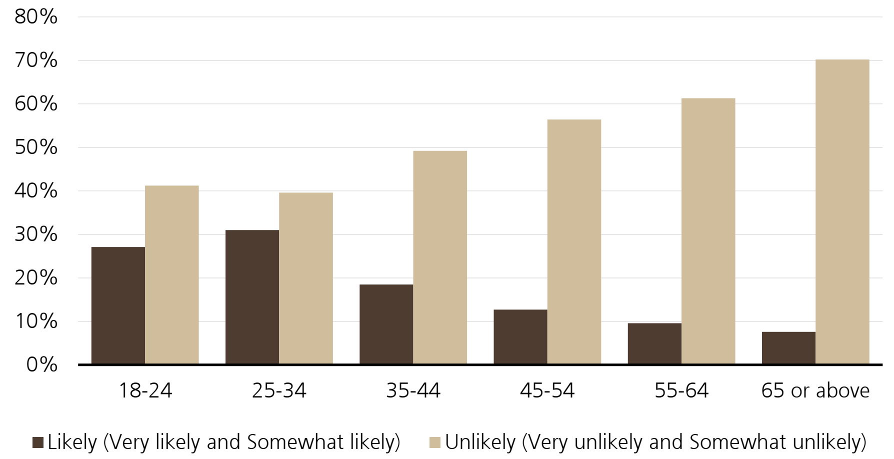
Source: Airbus SAS 2017

In our view, the limiting factors are passengers' perceptions per se, combined with regulatory and union constraints, rather than technology. To quote Matthieu Repellin, investment partner at Airbus Ventures: "Regulations are only a temporary barrier to entry" (*The Manufacturer*, January 2017). Most recently, (per CNBC – 8 June 2017), Boeing's VP of Product Development Mike Sennett said: "The basic building blocks of the technology clearly are available". Boeing is to test pilotless technology in 2018, with artificial intelligence making some decisions. Airbus is running three initiatives all linked to urban mobility, including unmanned aerial delivery (Vahana, CityAirbus and Skyways). Mark Cousin (SVP Head of Flight Demonstrators) says that vertical take-off and landing (VTOL) electric-powered air taxis may be feasible in only five to seven years.

Limiting factors are passenger perceptions, regulatory and union constraints rather than technology

Our UBS Evidence lab survey indicates a widespread reluctance to fly unmanned planes, but we note that – as one might expect with most technological breakthroughs – younger generations are more receptive (Figure 7).

Figure 7: Likelihood of taking pilotless flights, by age range



Source: UBS Evidence Lab

Unlike passengers, cargo is not concerned with the status of its pilots (human or autonomous). For this reason, pilotless cargo aircraft may happen more swiftly than for passengers. In addition, we believe that the 24-hour nature of much of cargo flights (often taking off or landing in the late and early hours) may be well suited to artificial pilots – with the problems of sleeping hours less of an issue. In addition, air hours will be limited by maintenance schedules, which again is less of an issue for cargo versus passenger. Although, at the moment, the focus is on drones (for final-mile delivery), it could well be that the real benefit could come from computers in aircraft as well as trucks.

Highlight initiatives

Initiatives to make pilotless planes a reality

There are several government- and privately-sponsored initiatives to make pilotless planes a reality. We list some of these initiatives below, and outline their progress.

In Europe, we highlight the European research project over 2013-16 called **Across** (Advanced Cockpit for Reduction of Stress and Workload), which is undertaking work on the future passenger aircraft flight decks, examining the feasibility of 'reduced crew' operations and identifying issues for the implementation of single-pilot operations in the future**.**

The EU Clean Sky 2 programme is to build by 2023 a disruptive cockpit demonstrator, including a new crew resource paradigm. In the Small Air Transport segment, Clean Sky 2 is exploring single-pilot operations for cargo aircraft and passenger aircraft for 10-19 passengers – after increasing proven safety levels, pilot workload reduction and control systems. The EU is aiming to finish the tests and demonstration by 2020, with a validation phase in 2021.

NASA, Onera, Boeing, Airbus all working on autonomous flights for fewer than six passengers, and single-pilot operations for up to 19 passengers

NASA is undertaking research into the **Single-Pilot Operations (SPO) concept,** with one pilot in the cockpit and another on the ground. The ground operator would be the dispatcher, and would likely be instrumental in aiding the safe functioning of several flights, but if an issue arose the ground dispatcher would become the first officer. Furthermore, the private sector is very much involved the development and prototype phase.

Increased autonomous technology helps to reduce the workload and the complexity of skills required

In commercial flights, if the move from two to zero pilots may be too abrupt over the next 10-20 years, we could see first a move to having just one pilot in the cockpit and one remotely located on the ground particularly on flights below 6-7hrs (to be under pilots' fatigue). Indeed, today's drones are controlled by remotely based operators.

Thales is developing two concepts for the short (2020), medium and long term (2050). The first is to take the current cockpit architecture a step further, including an almost unlimited field of view for the pilot, head-worn display, and large interactive touch-screens. The other concept – "**Fly by Trajectory**" – enables the pilot to manage the aircraft trajectory more directly, but keeps the autopilot permanently on, while still offering an option to take over manual control if needed.

Passenger perceptions are not a constraint for cargo aircraft

While passenger psychology may be a limiting factor, cargo does not share such reservations. **Airbus is developing Skyways, an unmanned aerial delivery solution (a fully autonomous octocopter),** which will be trialled in Singapore in early 2018. The Skyways project is a delivery solution that aims to provide efficient delivery of small parcels to students and faculties using drones. After this trial, the company is hopeful that it will be possible to launch commercial projects in Singapore and to extend the project to passenger transport. Currently, regulatory constraints do not allow unpiloted flights over cities. Through this project, Airbus aims to demonstrate that Skyways and its associated infrastructure can safely operate over Singapore University campus. In this way, they hope to develop the regulatory framework for self-piloted aircraft systems operations in Singapore, which could then be applied elsewhere.

Autonomous aircraft could generate savings of up to $0.6bn and $0.4bn for FedEx and UPS

In our view, freight and logistics operators could be the first adopters of drones and other types of autonomous aircraft – see the logistics section. While pilotless or single pilot operation of aircraft could provide great flexibility and potential plane utilization gains, the current calibration of Express service would likely be somewhat of a constraint. However, an increase in direct flying (eg avoiding the hub sorts) could allow greater utilisation of aircraft which might be facilitated by reduced pilot intensity, The uplift could be material, we estimate, with implied annual cost savings of up to $0.6bn and $0.3bn for FedEx and UPS, respectively, in such a scenario.

Opportunities for the avionics providers and OEMs

OEMs and suppliers likely to set up "fly-by-the-hour" contracts with airlines, an established contract practice in the industry

If the future cockpit ambition is to increase the reliance on auto-pilot, and focus the pilots' attention on optimising the flight mission, the airlines may transfer greater value to the OEMs, which are likely to set up fly-by-the-hour contracts. Moreover, the relationship between the aircraft's prime manufacturer and the systems provider becomes more intrinsically linked. If the plane is becoming more remotely controlled, there is a higher risk of its being hacked – requiring increased emphasis on security controls. The largest avionics providers, such as **Thales, Rockwell Collins and Honeywell** have been investing heavily in cyber-security and real time data capabilities to improve their commercial offer on cyber-security across their verticals.

Thales, Rockwell Collins positioned to benefit

Implications for Airbus, Boeing, Thales, Rockwell Collins, Honeywell

Overall, a shift to the "flight mission" approach would benefit the avionics systems providers and would increase their "weight" in the aircraft value proposition. Today, an avionics package of systems is typically worth up to 5% of the aircraft value across small business jets, helicopters and large jets. With increased autonomy, the value of the avionics suite could increase as a share of the aircraft value. We estimate that the avionics/electronics market across civilian applications is worth c.$9bn pa (with c.60% in western commercial planes).

The American Institute of Aeronautics and Astronautics thinks that "while fully-automated cars probably will not directly enable fully automated aircraft, their constituent technologies may be critical to improving safety and utility of aircraft" (sourced from the AIAA paper: *Transformational autonomy and personal transportation: Synergies and differences between cars and planes*).

Thales has c€700m of sales (UBS est. 5% of group sales and c.10% op. margins) exposed to civil avionics OE, which includes a majority for Airbus/Boeing, 30% in helicopters and 20% in regional aviation and business jets. The aftermarket is closer to €550m (UBS estimate). Typically, avionics runs a business model with limited aftermarket revenues, and some of the basic components are exposed to surplus/ repairs parts.

Rockwell Collins' Commercial Systems business (~30% of total sales, c$2bn) is primarily exposed to avionics for both large commercial (~60%) and business/regional jets (~40%). In addition to its avionics business, Rockwell Collins Information Management Services group (5-10% of total sales, c$700mn) provides airlines with a communication link between the aircraft and ground operations, and this segment would likely benefit from higher data transmission required for remote aircraft operation.

We estimate that civil aerospace avionics accounts for 5-10% of sales for **Honeywell** (c.$2-3.9bn on 2016 reported sales), including about two-thirds air transport/regional and one-third business jets.

For illustration, we note:

Garmin (not covered) has not entered the large commercial jets market, and is mainly present in general aviation and helicopters. Aviation represents c11% of group sales ie c$330mn on 2016 reported numbers.

CAE (not covered) provides simulators and training for commercial airline and business jet pilots thorough its Civil Aviation Training Solutions segment (~60% of sales, ~C$1.6bn.

Leading OEMs widening the technology gap

Those OEMs that lead in the autonomous debate should be long-term beneficiaries

We believe that the OEMs that remain at the forefront of the autonomous debate should be long-term beneficiaries, especially in relation to low-cost manufacturers.

We see **Airbus and Boeing** as the currently leaders in this space, together with their avionics suppliers. The traditional commercial airplane manufacturers could access new market opportunities, or offset the decline in light helicopter demand by entering the urban mobility market, at the right competitive cost (vs Uber, new business models or other new entrants).

Potential threat to regional jet model

Regional aviation, and the success of the 70- to 100-seat airplane in the US, was based on pilot scope clauses and the crew cost differential between mainline pilots and regional pilots. The reduction of overall operating and crew training costs could pose an incremental threat to manufacturers of regional planes. This could be a threat to the regional jet model of **Embraer** or **Bombardier**.

Urban mobility to trigger a disruptive aviation model

On-demand urban aviation will likely also become a reality

We think on-demand urban aviation will become a reality over the coming decades. We have seen a number of companies undertaking projects to make VTOL aircraft a reality (see below), and we think VTOL will affect not only the automotive industry (See Uber's *Fast-forwarding to a future of on-demand urban air transportation* – October 27, 2016), but also aviation (especially the helicopter market, freight, regional and short-haul aviation carriers, as well as the bus and rail operators). Indeed, Uber believes that long-distance commutes will be the first use for urban VTOLS. Furthermore, as economies of scale in manufacturing kick in and commuters share trips, the cost of use should fall (see the Lilium jet below). **Although the focus of this report is on pilotless planes for commercial aircraft and logistics, we do highlight some related initiatives below.**

The myCopter is an EU-sponsored project which aims to enable personal aviation transport for the general public. There are three areas of research being undertaken under the myCopter umbrella: (1) User-centred human-machine interface and training; (2) automation; and (3) socio-technological assessment.

There is also a European programme called **ASTRAEA** (Autonomous Systems Technology Related Airborne Evaluation & Assessment), which aims to enable the operation of unmanned air systems (UAS) in civil airspace for commercial purposes. The aim is to remove the pilot and operate the aircraft autonomously with ground supervision.

In the private sector, we have seen a number of developments towards making urban mobility a reality.

Airbus Helicopters sees potential market for VTOL urban aerial passenger transport as be 2.5x that for helicopters currently

- **Airbus:** Project **Vahana** and **City Airbus:** Project Vahana is an Airbus initiative which began in 2016 under A³, which is based in Silicon Valley. The planned aircraft would be self-piloted with automated obstacle detection and has a VTOL capability. It would be designed to carry a single passenger or cargo, with the aim of being the first certified passenger aircraft without a pilot. A parachute system would be incorporated as a fail-safe. A prototype is expected before the end of 2017, with a production model by 2020. Airbus is also exploring **CityAirbus**, which would have four ducted fans and would seat 3-4 passengers (c.6t category). Initially, the plane would be operated by a single pilot (as in helicopters), but would evolve to a full autonomous operation once the regulations were in place. Airbus is set to fly the demonstrator in 2018, with a piloted test flight to follow in 2019. The aim is for an air vehicle able to fly at 120km/hr with a range of 60km and with 25% of the operating costs of a twin-engine helicopter (Aerospace, Aug-17).

- **eHang 184:** This is a Chinese-made autonomous aerial vehicle which can carry one passenger on short to medium journeys (100kg, 25 minutes flight time). The aircraft is electrically powered and is connected to a command centre for monitoring and controlling. The passenger selects the route in terms of take-off and landing, and the aircraft will then do the rest. Dubai planned to operate a taxi service using a fleet of eight eHang 184 from July 2017 (as reported by CNN), but given the lack of recent news on the eHang certification, we would expect this initiative to be delayed. The eHang has yet to receive flight safety certification from the US or China.
- **Uber** is also in talks with Dubai and Dallas-Fort Worth to publicly demonstrate its own flying taxi service in 2020. Uber has teamed up with companies such as Bell Helicopter, Aurora, Mooney, Embraer and Pipistrel to make flying taxis.
- **Volocopter:** Although the system is not pilotless (the pilot has to command the aircraft direction via a joystick), one could see a situation where it becomes pilotless. All safety components are replicated multiple times, but there is also a parachute system should there be a critical failure. As per Volocopter, the system is gaining traction, with the Dubai Roads and Transport Authority signing an agreement for the testing of autonomous air taxis in the emirate. The test will start in the fourth quarter of 2017, and the project is expected to run for five years. E-Volvo, which owns Volocopter, succeeded in delivering the world's first manned flight of an electric multi-copter in 2011.
- **The Lilium jet:** Per the company, the mission of the Lilium jet is: "Lilium enables you to travel 5 times faster than a car by introducing the world's first all-electric vertical take-off and landing jet: an air taxi for up to 5 people. You won't have to own one, you will simply pay per ride and call it with a push of a button. It's our mission to make air taxis available to everyone and as affordable as riding a car." Should the company deliver on its mission, it believes a journey from JFK to Manhattan would take 5 minutes and cost $6, which would be materially quicker and cheaper than current taxi services.
- **eSafe**: Diamond Aircraft has developed an auto-land feature called eSafe that is intended as a future safety device, if the pilot becomes incapacitated. The system includes the intelligence to route around weather, deploy flaps and gear, and manage auto throttles and brakes.

The $35bn opportunity

We see considerable scope for cost savings as well as revenue opportunities. Saving can be split into a number of categories:

(1) Fuel gains related to better-optimised flight paths. IATA estimates that its members spent $133bn on fuel in 2016, which represented c20.5% of operating costs (vs $175bn in 2015). A 0.5% reduction in spending on fuel would be equivalent to **c$0.6-0.8bn of savings p.a.** A 0.5% fuel gain in the network of a global carrier such as Lufthansa could save over €25m a year, on our estimates. These benefits could materialise within a fairly short period – around a 2020 timeframe, we believe.

(2) **Airlines could potentially benefit from lower operating and training crew costs**. UBS airlines analysts estimate the benefit to be **c$30bn+ p.a.** We estimate the benefit to be a proportion of that figure over the next 5-10 years, before the full implementation of autonomous flying beyond 2030. See **financial benefit to commercial airline** section.

(3) The OEMs are exploring new business models to **increase their service revenues as a % of sales.** Avionics suppliers typically don't have many services contracts. We would expect increased flight optimisation to enable more "fly by the hour" type of agreement, which would have better economics for the suppliers and the OEMs. Typically "fly by the hour" margins contracts are close to 20-25% vs OE at 8-10%.

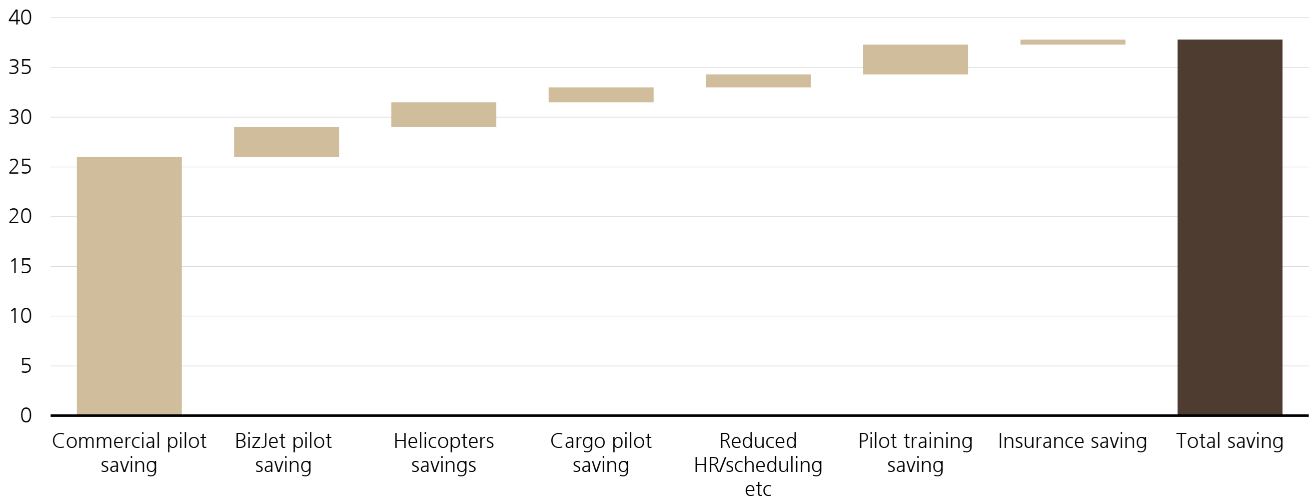
(4) For **business jets**, the installed fleet is roughly 20,000 aircraft on jetnet data, of which we estimate two-thirds are flown by professional pilots (vs owner-flown for recreation), typically with two pilots per plane. Assuming average pilot pay at $70,000 ($80-100,000 for pilot and $40-50,000 for co-pilot) would imply ~$2bn in annual savings. The business jet fleet would also see improved fuel burn on more optimized flight paths, similar to the commercial fleet (~$1bn).

(5) With **an existing fleet of 21,000 civil helicopters worldwide** on jetnet data, assuming 1.5 pilots per craft at $100,000 annual salary, this would ultimate save $2.1bn if pilots were removed totally. If we restrict this to the twin helicopters (c.8,800 fleet) then the "pilotless" benefit to the industry would be $0.6bn (one pilot at c.$60,000).

(6) These technology changes could make the flying experience safer and minimise human cockpit errors. We see an opportunity to reduce the aviation sector's **insurance premium costs by hundreds of millions of dollars**.

On the revenue side we see scope for increased utilisation rates for commercial airline operators as well as cargo operators. Furthermore, commercial airlines with reduced costs could potentially drive additional traffic on routes which were previously not viewed as profitable. However, we have not explored in detail these opportunities.

Figure 8: The $35bn opportunity



Source: UBS estimates

Financial benefit to commercial airlines

Two scenarios examined for financial impact

We looked at two pilotless plane scenarios to access the potential impact on airline profitability, namely: (1) no pilot and aircraft autonomous; and (2) one pilot on-board. Due to automation, we have seen the number of pilots reduce from three (which used to include a navigator) to two over the past few years. We think if pilotless planes become a reality, we would likely see an initial reduction from two pilots to one and then (assuming passengers become more accepting) perhaps fully autonomous flights. We quantify the impact on each of the airlines under UBS coverage should the number of pilots fall from two to one and then to none.

In general, airlines have 10 pilots per plane

Airlines in general have 10 pilots for each aircraft, given that industry standards ask for 5/4 rosters, which consist of 5 days on, followed by 4 days off for pilots, given cycle-hour limitations. For instance, in 2016, EasyJet, per its annual financial statements, said it employed 2,865 pilots and flew 257 planes, equating to c11 pilots per plane. There is also a limit of 100 flight hours per 28-day cycle and 900 flight-hours per fiscal year, which would potentially enable increased airline utilisation, given no human flight time element to uphold.

However, we highlight some caveats to our analysis:

- We have not factored into our analysis the potential increased capital outlay for pilotless planes. Indeed, we would expect the aerospace industry to keep some of the "cost saving" gains for themselves. Hence, we have not undertaken a ROIC analysis.
- We have assumed that none of the cost benefits accrue to customers, although this is highly unlikely, as airlines will likely use some of the savings to drive market share gains and reduce ticket fees.
- We have not factored any potential pilot redundancy cost or potential for disruption caused by the possibility of strikes with the implementation of this new technology. Perhaps, airlines might also add an extra flight attendant from the perspective of passenger health and safety.
- We have not adjusted our base-case airline profits, but there could be passenger resistance to a airline reducing or not having any pilots. Indeed resistance could result in reduced passenger volumes for an airline.

Our analysis suggests the potential saving for the airlines under our coverage (Asia, US and Europe) could amount to more than $26bn in 2017

Below, we show the scenario analysis for each European, USA and Asian airline under our coverage. The potential saving for the airlines under our coverage (Asia, US and Europe) would amount to **more than $26bn in 2017** (see appendix). **Overall, we find that, on average among the regions, the European airlines under our coverage would see a c30% uplift in profitability, the US could generate a c73% gain and Asia a c45% uplift from operating pilotless planes.** Potentially, if 100% of the benefit was held by the airlines under our coverage, we would see a corresponding uplift in price targets for those airlines we value on earnings multiples. We also see what the potential time value of money benefit would be if we assume a 10 and a 20 year time horizon of going pilotless.

European findings: The average implied percentage EBIT uplift for the European airlines under **our coverage is c30%** (assuming 100% of the benefit accrues to the airline and the flight is pilotless). In terms of the European airlines under our coverage, we estimate the greatest uplift to profitability from pilotless planes would accrue to easyJet (an average uplift of 56%, partly due to depressed profits, in our view), while the smallest uplift would accrue to IAG (c21% uplift). The percentage uplift to EBIT varies due to changes in the cost base of the European airlines, given cost saving programmes, the relative cost basis as it relates to pilots, and fluctuations in fuel and currency.

A 30% EBIT implied uplift on average for European airlines

Figure 9: Implied profit uplift for European airlines assuming one and no pilots in the cockpit

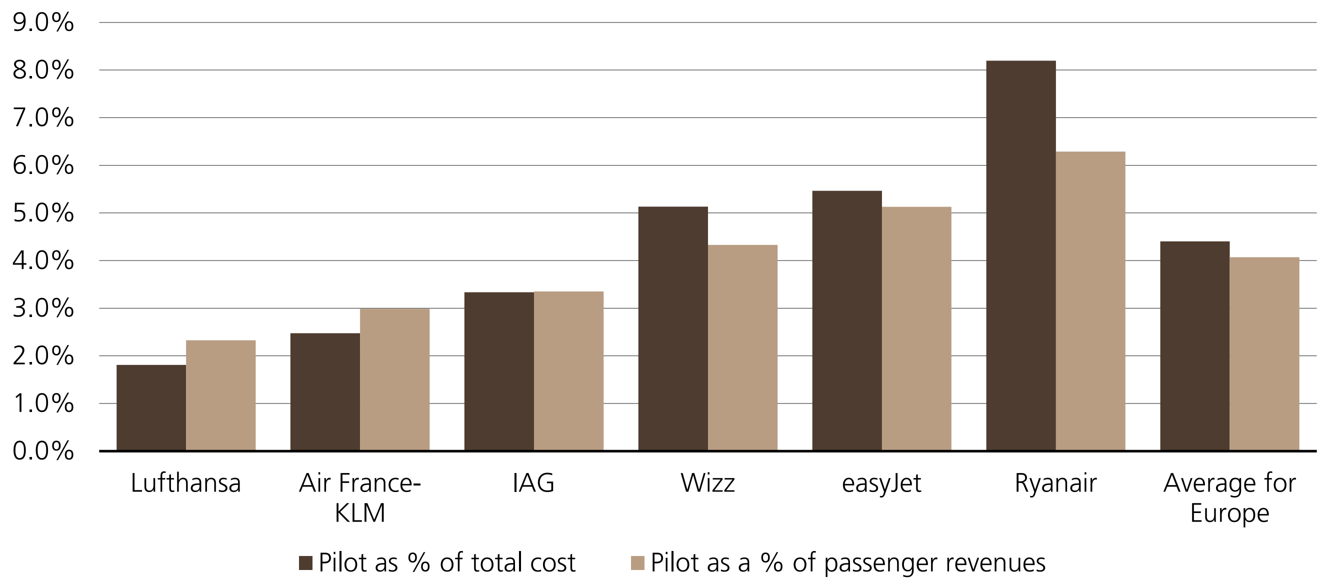
	Rating	PT	1 pilot	No pilots	No pilot 10yr TVM	No pilot 20 TVM
easyJet	Buy	£15.55	28%	56%	22%	9%
Air France-KLM	Buy	€ 15.75	26%	52%	20%	8%
Ryanair	Neutral	€ 18.85	15%	29%	12%	4%
Wizz Air	Buy	£29.50	13%	25%	10%	4%
Lufthansa	Neutral	€ 20.75	13%	25%	10%	4%
IAG	Buy	£6.30	11%	21%	8%	3%

Source: UBS estimates

Alternatively, we have also looked at what percentage of cost pilots represent (based on last full year of published results) as well as what saving could be passed onto airline passengers if 100% of the pilot cost saving passed onto passengers. The average percentage of total cost and average benefit that could be passed onto passengers in price reduction for the European airlines is c4% (assuming no additional cost for flying pilotless and none of the benefit is retained by European airlines). Clearly any price reduction would stimulate traffic.

A 4% saving could be passed onto European passengers if none of the benefit was retained from a pilotless plane

Figure 10: Percentage of total cost and passenger revenues US pilots represent (%)



Source: UBS and company

US findings: The average percentage profit uplift for the USA airlines under our **coverage is c73%** (assuming 100% of the benefit accrues to the airline and the flight is pilotless). In terms of the US airlines under our coverage, we estimate the greatest uplift in profitability from pilotless planes would accrue to USA Airlines (c101% uplift, partly due to depressed profits, in our view), while the smallest increase would accrue to Alaska Air (43%uplift).

More than 70% EBIT uplift on average for US airlines

Figure 11: Implied profit uplift for US airlines assuming one and no pilots in the cockpit

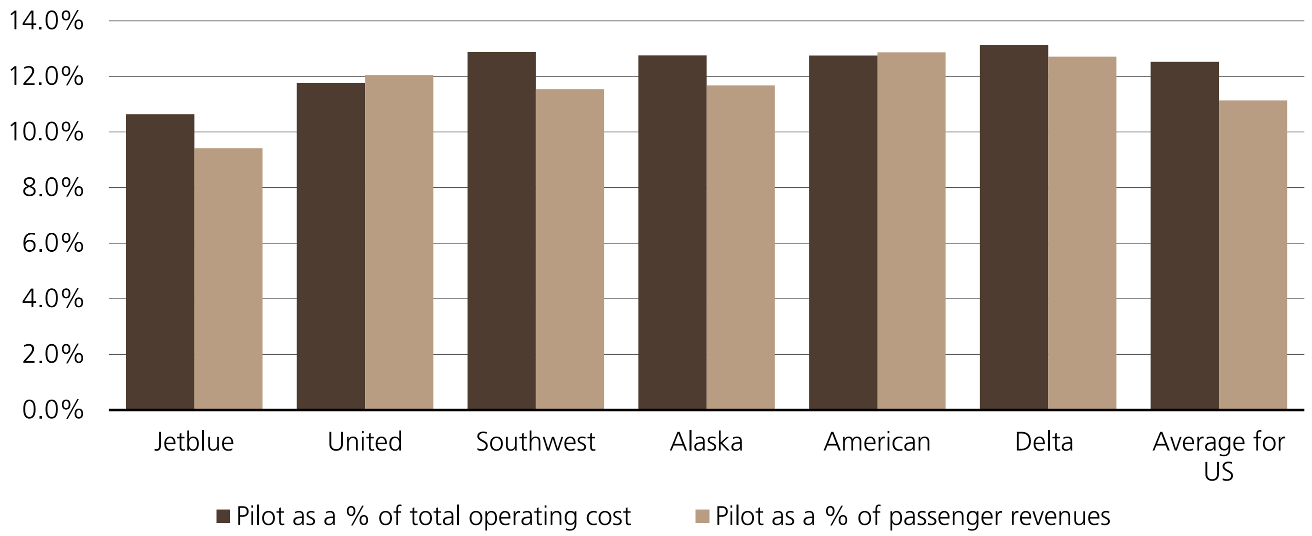
	Rating	PT	1 pilot	No pilots	No pilot 10yr TVM	No pilot 20 TVM
American Airlines	Neutral	$45	56%	101%	38%	17%
United Airlines	Buy	$105	48%	97%	38%	16%
Delta Airlines	Buy	$70	39%	77%	25%	13%
Southwest Airlines	Buy	$70	27%	63%	44%	11%
Alaska Air	Buy	$100	22%	43%	17%	7%
JetBlue Airways	Buy	$24	32%	62%	24%	10%

Source: UBS estimates

For the US airlines, we have also looked at what percentage of cost pilots represent as well as what saving could be passed onto passengers if 100% of the pilot cost saving passed onto passengers. **The average percentage of total cost and average benefit that could be passed onto passengers in price reduction for the US airlines is 11% (assuming no additional cost for flying pilotless and none of benefit is retained by the airlines).** In reality, we believe the airlines would likely earn elevated returns for a short period before competing away the benefit through accelerated capacity growth and strategic pricing in anticipation of future growth. This would yield higher earnings but on a higher capital base, and returns might quickly return to historical levels, similar to what happened following the 2014-15 oil decline.

An 11% saving could be passed onto US airline passengers if none of the benefit was retained from a pilotless plane

Figure 12: Percentage of total cost and passenger revenues US pilots represent (%)



Source: UBS and company

Asia findings: The average percentage uplift to EBIT for the Asian airlines under our **coverage is c45%,** assuming 100% of the benefit accrues to the airline and the flight is pilotless. Airlines we estimate that would have the greatest uplift from operating pilotless plans would be Thai Airways (up to c88%), China Eastern (c83%), and Garuda (up to 69%). Thai Airways and Garuda maintain high salary pay-out, making cutting pilot numbers beneficial. The average number of pilots per plane for China Eastern and China Southern are as high as 12, indicating operating inefficiency. In contrast with these airlines, Korean Air, AirAsia, and Air China operate more efficiently in terms of their ability to control staff costs, leading to the least savings to EBIT.

c45% EBIT uplift on average for Asian airlines

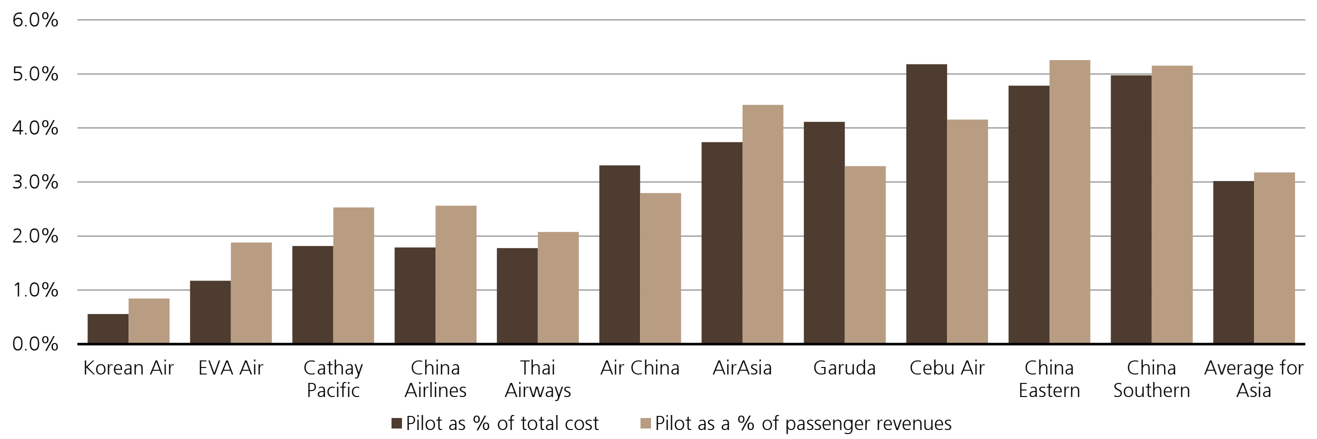
Figure 13: Implied profit uplift for Asian airlines assuming one and no pilot in the cockpit

	Rating	PT	1 pilot	No pilots	No pilot 10yr TVM	No pilot 20 TVM
Thai Airways	Sell	Bt 13.5	44%	88%	34%	13%
China Eastern	Neutral	HK$4.6	41%	83%	32%	12%
Garuda	Neutral	Rp395	35%	69%	27%	10%
China Southern	Neutral	HK$5.7	31%	61%	24%	9%
Cathay Pacific	Sell	HK$11	26%	51%	20%	8%
China Airlines	Neutral	NT$9.8	22%	45%	17%	7%
Cebu Air	Neutral	P105	16%	33%	13%	5%
EVA Air	Neutral	NT$16.1	16%	32%	12%	5%
Air China	Neutral	HK$7.5	9%	18%	7%	3%
AirAsia	Buy	RM3.65	6%	13%	5%	2%
Korean Air	Sell	Won 27,000	3%	6%	2%	1%

Source: UBS

For the Asian airlines, we have also looked at what percentage of cost pilots represent (based on last full year of published results) as well as what saving could be passed onto airline passengers if 100% of the pilot cost saving passed onto passengers. **The average % of total cost and average benefit that could be passed onto passengers in price reduction for the Asian airlines is c3%.**

Figure 14: Percentage of total cost and passenger revenues Asian pilots represent (%)



Source: UBS and company

Further potential areas of commercial airline savings

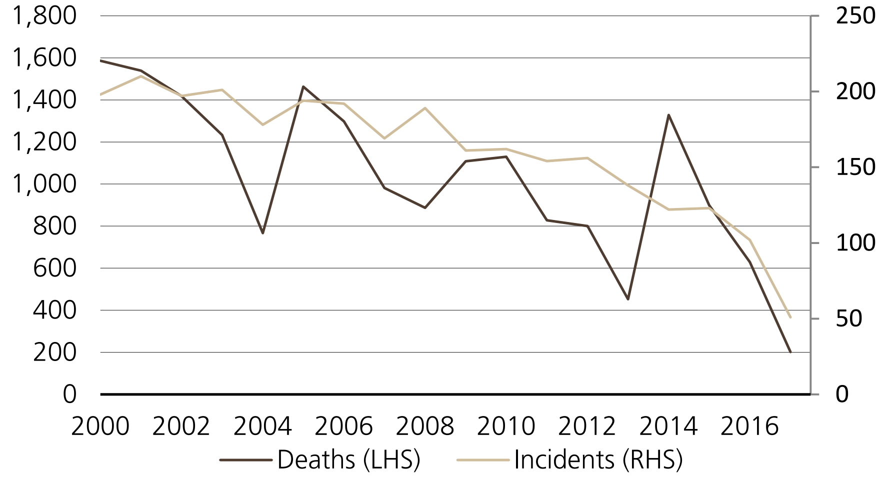
We also see a number of other areas in which pilotless planes could result in savings for the aviation industry.

The insurance opportunity could be material

Since 1959, there have been fewer than 32,000 fatalities involving scheduled commercial airline flights, with safety continuing to improve. Commercial aviation remains a relatively safe means of transport with less than 175 passenger deaths for every billion passengers that fly.

Commercial aviation remains a safe means of transport

Figure 15: Airline fatalities (LHS) and incidents, 2000-17



Source: Bureau of Aircraft Accidents Archives and UBS

However, we think, with the introduction of pilotless planes, there could be a further improvement in safety, given that the majority of accidents are due to human error. Indeed, 15-20% of the overall accident rate is related to operating crew fatigue. In the 2014 report by AGI (Global Aviation Safety Study – A review of 60 years of improvement in aviation safety), it was estimated that aviation insurance exposure had grown from $576bn in 2000 to $896bn in 2014 and should break $1 trillion by 2020 (if not sooner). Per Aon (Airline Insurance Market Outlook 2016 – Uncharted skies), airline hull and liability insurance premiums were $1.3bn in 2015 (from just more than $2bn in 2005) with losses at c$1.5bn. Clearly, premiums need to exceed losses over time for the insurance sector to remain healthy, but should accident rates reduce, we would expect premiums to follow. If conservatively more than 70% of known error is human, a material reduction in accident rates would mean hundreds of millions of dollars in savings for the commercial aviation sector. Part of these savings could then be recycled to consumers as well as shareholders.

A reduction in accidents caused by human error could suggest hundreds of millions of dollars in insurance premium savings

Pilot training cost

It is forecast by Boeing that more than 0.6m new pilots will be needed over the next 20 years (2016-35), so pilotless planes could alleviate the pressure to train and recruit pilots. In the UK, the British Airline Pilots Association estimates it can cost between £60k and £80k (or more) to become a pilot, so the cost saving just in training costs could be more than $60bn over 20 years (c$3bn p.a.)

Potential savings from pilot training could run into the billions

The logistics opportunity

Likely pilotless planes would see quicker acceptance from cargo carriers

New technology, such as pilotless planes, can provide a lever for new entrants to compete with existing players. While pilot costs are not a dominant factor for UPS or FDX, a reduction in pilot intensity could encourage an even more aggressive move into the transport arena by Amazon or other non-traditional players in transport markets. Pilotless technology could also lower the bar for mid-sized companies to offer more narrow services, targeted at certain verticals that require control. The pharma/healthcare market could be an area where more airfreight capacity would be of sufficient value that it could attract niche/vertical-focused new transport competitors.

Below, we show our analysis of the potential profit uplift for two of the largest pure-play express carriers, namely, FedEx and UPS. Regulatory constraints are likely to be a factor and there could first be a transition from two pilots to one pilot before the move to pilotless planes. The move from two to one would also be a source of meaningful cost-savings potential for UPS and FDX, as evidenced below, based on the last full-year results.

FedEx – a potential 11% uplift (from pilot cost savings) to 2017A EPS

We believe FedEx employs about 4,500 pilots. With average all-in annual compensation that we estimate at about $250,000, and assuming that 50% of the opportunity would be shared with the aircraft OEM, this could equate to annual compensation **cost savings of about $563 million ($1.37/share, or ~11% of 2017A EPS)**. The sensitivity to $25,000 of average all-in annual compensation, assuming the 50% sharing with aircraft OEM as above, would be $57 million ($0.14/share, or ~1% of 2017A EPS).

UPS – a potential 4% uplift (from pilot cost savings) to 2016A EPS

We believe that UPS employs about 2,600 pilots. With average all-in annual compensation that we estimate at about $250,000, and assuming that 50% of the opportunity would be shared with the aircraft OEM, this could equate to annual compensation **cost savings of about $325 million ($0.24/share, or ~4% of 2016A EPS)**. The sensitivity to $25,000 of average all-in annual compensation, assuming the 50% sharing with aircraft OEM as above, would be $33 million ($0.02/share, or ~0.5% of 2016A EPS).

Figure 16: Implied saving for FDX and UPS, assuming one and no pilots in the cockpit

						Total cost savings ($m)		After-tax savings per share	
	Rating	PT	Total pilots	Avg. pilot compensation	@ 50% sharing of savings	1 pilot (of 2)	Both pilots	1 pilot (of 2)	Both pilots
FDX	Buy	$235	4,500	$250,000	$125,000	$281	$563	$0.68	$1.37
UPS	Neutral	$117	2,600	$250,000	$125,000	$163	$325	$0.12	$0.24

Source: Company reports, UBS analysis and estimates

FedEx – a potential 0.3% uplift (from fuel savings) to 2017A EPS

FedEx Express consumes about 1.2 billion gallons of jet fuel annually. At an average jet fuel price of about $1.50/gallon, a 1% fuel efficiency gain from pilotless flying could equate to annual **cost savings of about $17 million ($0.04/share, or ~0.3% of 2017A EPS)**.

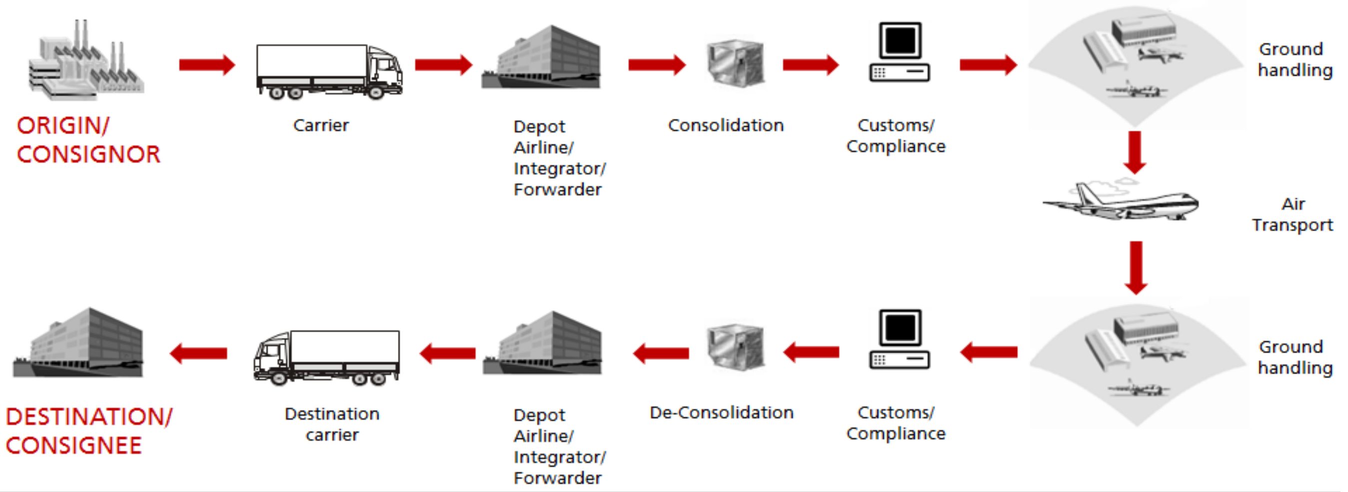
UPS – a potential 0.1% uplift (from fuel savings) to 2016A EPS

UPS's aircraft fleet is about 60% (UBS estimate) of the size of that of FedEx, so we estimate that UPS consumes about 720 million gallons of jet fuel annually. At an average jet fuel price of about $1.50/gallon, a 1% fuel efficiency gain from pilotless flying could equate to annual **cost savings of about $11 million ($0.01/share, or ~0.1% of 2016A EPS)**.

Express configuration could constrain utilisation gains

FDX and UPS have domestic and international express networks, which are tuned to allow the latest possible cut-off times in order to be able to flow traffic into their primary hubs (Memphis for FDX and Louisville for UPS) for a late-night sort (~midnight – 3:00 am) with the return leg arriving in time to meet the morning delivery time commitments in the delivery destination. Deferred air traffic (two- and three-day delivery time) typically runs on the day network with an afternoon sort at the global hubs, but, due to the larger size of the overnight/express volume, only a portion of the aircraft fleet is double turned. While pilotless or single pilot operation of aircraft could provide great flexibility and potential plane utilization gains, the current calibration of the Express service would likely be a constraint. An increase in direct flying (eg, avoiding the hub sorts) could allow greater aircraft utilization, which might be facilitated by reduced pilot intensity.

Figure 17: Process for an international air cargo shipment



Source: UBS

Impediments to making pilotless planes a reality

There are a number of impediments and challenges to overcome before pilotless planes become a reality. These include: (1) customer attitudes to pilotless flight; (2) regulation that currently is not sufficient for such a reality; and (3) design, security and technological challenges.

Material customer resistance to flying on pilotless planes

In terms of customer attitudes, we undertook a UBS Evidence Lab survey to access customer attitudes to pilotless planes. Our UBS Evidence Lab survey suggests material resistance from respondents to flying on pilotless planes. Perhaps, with time, this perception will change, but we could see any early adopter of such technology facing customer resistance, and, hence, enduring a negative revenue impact. However, one way to overcome such resistance is for airlines to go from two pilots in the cockpit to one, so that the flight is flown with an autonomous pilot, but a human pilot remains on the flight and can take over in emergencies. The balance between human and computer control of flight might have to be one of evolution rather than a revolution. A summary of our findings is as follows:

- **Consumer response**: The public perception of automated flight is not encouraging, based on the findings from our UBS Evidence Lab survey, which shows respondent reluctance to fly on a pilotless flight.
  - 54% of respondents are unlikely to take a pilotless flight, while only 17% stated that they would be likely to take a pilotless flight. There are slight differences between countries with a greater percentage of respondents in the US willing to take pilotless flights (27%) compared with other countries. French and German respondents are the most unlikely to take a flight with no pilot.
  - UBS Evidence Lab asked respondents how much cheaper would a pilotless flight ticket need to be for them to fly a regular flight without pilots. Surprisingly, half of the respondents said that they would not buy the pilotless flight ticket even if it were cheaper.
  - We think it is likely that there would be cultural differences in terms of adoption and willingness to fly on pilotless planes. For instance, our UBS Evidence Lab survey found that a greater percentage of respondents in the US would be willing to take a pilotless flight than respondents in the UK, Australia, France and Germany.

Regulation: Currently regulators (Federal Aviation Authority (FAA) in the US and European Aviation Safety Agency (EASA)) are unlikely to possess the framework to certify such planes and would need to develop this framework.

The FAA does have an Unmanned Aircraft Systems area as it relates to the registration of drones. However, the full FAA registration of a commercial plane would need to cover a number of areas around the current design certification process, such as aircraft certification software, automated conformity inspection, original design approval, technical standards, and safety and product certification, which, we believe, would need to be expanded on to allow for pilotless planes.

- In Europe, since 2003, EASA is responsible for the certification of aircraft in the EU and some European non-EU countries. There are four steps to the certification of a new aircraft, namely: (1) technical familiarisation and certification basis; (2) establishment of the certification programme; (3) compliance demonstration; and (4) technical closure and issue of approval. Again, certification would need to be enhanced.

Technology and security systems still need to be developed or enhanced to enable pilotless planes to be used as commercial aircraft. There is the potential for the system to be "hacked", so fail-safes would need to be put in place to prevent or, should it occur, protect the integrity of the airplane. Civil aviation communications would have military levels of security. Reliability would need to be guaranteed to alleviate any passenger fears. Indeed, the threat of cyber-attack is emerging as a key risk challenge for the aviation industry with the industry extremely reliant on computer systems (as evidenced in May 2017 when the systems of British Airways were impacted over the bank holiday weekend).

Health and safety: Noise (although there is likely to be a positive impact, given less circling time) and safety issues will need to be addressed. We think noise will likely be more of an issue for urban air transportation. Carbon emissions are also likely to fall, given less circling time, which will benefit the environment. In the case of an unmanned flight, the liability in the event of an accident would logically be transferred from the flight crew to the system designers.

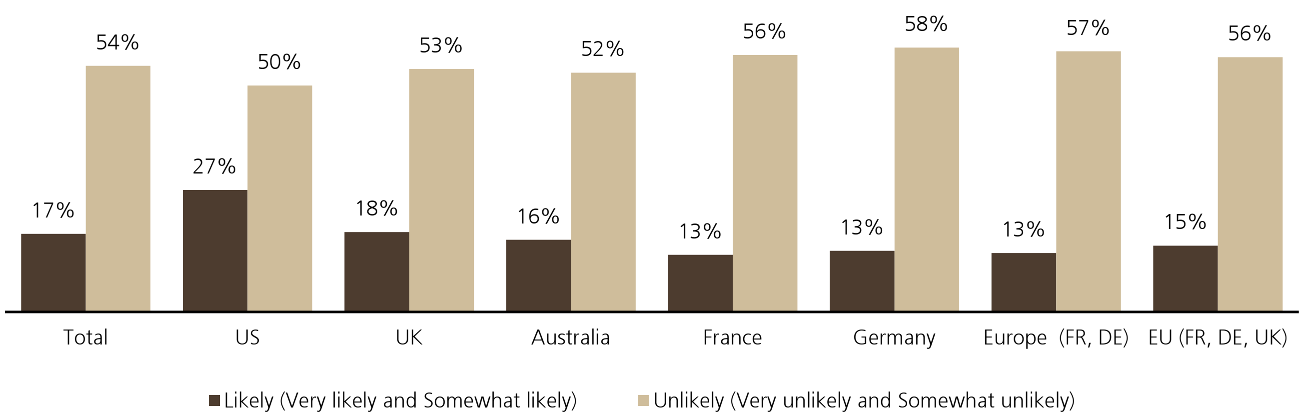
Airline pilots and unions: It is likely that there will be resistance to pilotless planes, given the potential for job losses. Nevertheless, pilotless planes would likely reduce the pressure to find future pilots.

Younger and educated appear likely to fly on pilotless planes

We undertook a UBS Evidence Lab survey where we asked c8,000 respondents their views on pilotless planes. Overall, respondents appear to be reluctant to fly on pilotless planes. Indeed, 54% of respondents are unlikely to take a pilotless flight, while only 17% stated that they would be likely to take a pilotless flight. There are slight differences between countries with a greater percentage of respondents in the US likely to take pilotless flights (27%) compared with other countries. French and German respondents appear the most unlikely to take a flight with no pilot. We think cultural differences could also explain differences in the willingness to adopt pilotless flight (see related section).

Overall, respondents are not likely to fly on a pilotless plane

Figure 18: Likelihood of taking pilotless flights by country and region (%)

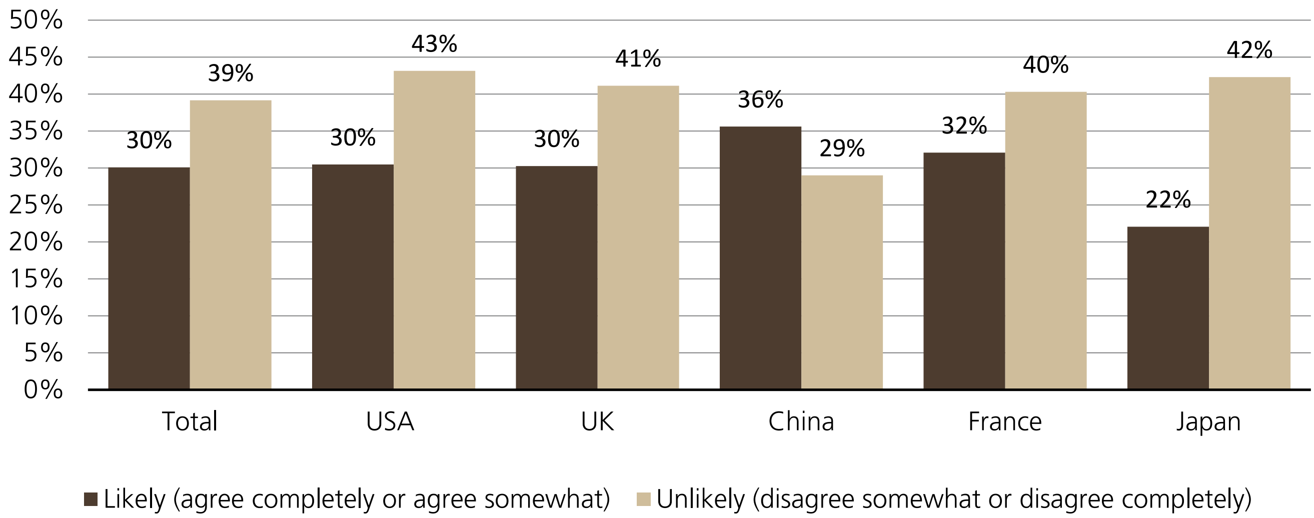


Source: UBS Evidence Lab

We also undertook a 2015 UBS Evidence Lab survey of 7,500 respondents looking at autonomous/driverless cars. In terms of attitudes towards car usage/ownership it was found that more respondents would be willing to take a driverless/autonomous car (c30% in total) than a pilotless plane (per above 17%). Furthermore, results were more positive in all regions as per the below.

In terms of attitudes towards car usage/ownership it was found more respondents willing to take a driverless/autonomous car than a pilotless plane

Figure 19: Likelihood of taking a driverless/autonomous car – 2015 results

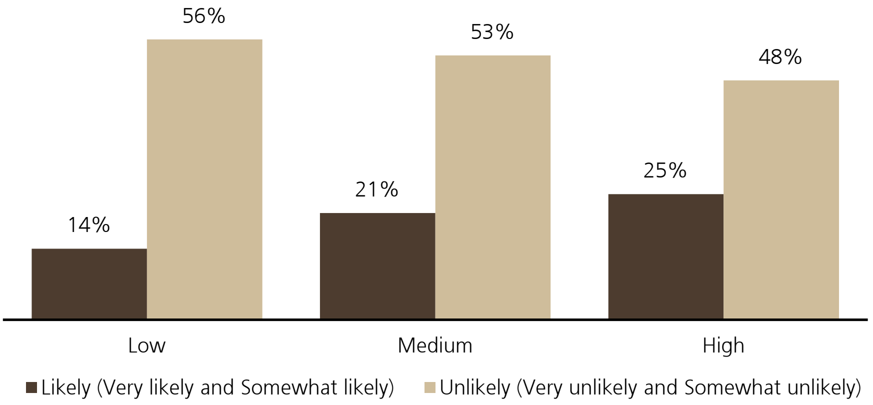


Source: UBS Evidence Lab

In terms of responses by income, we observe that high-income respondents are more willing to fly on pilotless flights (25%) than low- and medium-income respondents (14% and 21%, respectively). To some extent, this is surprising to us, as high-income respondents have greater disposal income, so one might have thought the passing of any saving from taking a pilotless flight would have generated greater motivation to fly using a pilotless plane among low- and medium-income respondents. The figure below splits responses by income where low income refers to less than 50k in income (local currency), medium income represents income between 50k and 80k (local currency), while high income represents more than 80k in the local currency.

High-income respondents are more likely to take a pilotless flight than other income group respondents

Figure 20: Likelihood of taking pilotless flights by income (%)

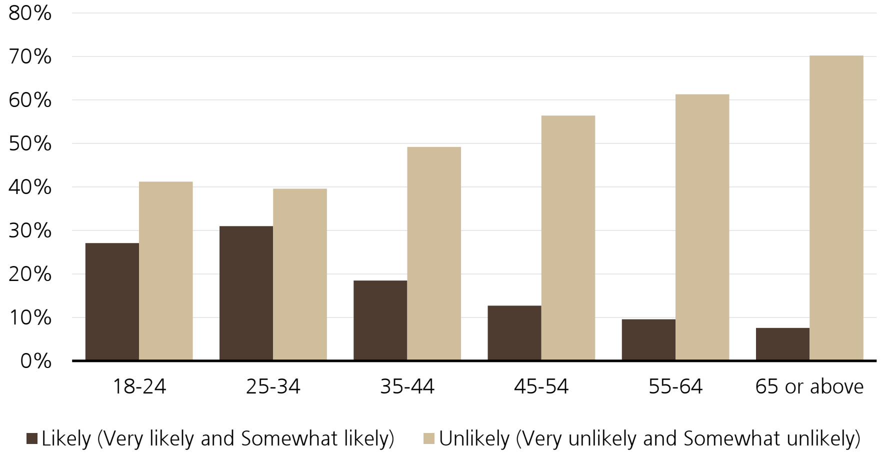


Source: UBS Evidence Lab

In terms of age range, 18-24 and 25-34-year-old respondents were the most likely to take pilotless flights compared with other age ranges with 27% and 31%, respectively, willing to fly pilotless, while only 41% and 40% were unlikely to do so – the lowest reluctance among all age ranges. This may bode well for the future development of such technology, as the 18-34 age group grows older and maintains such an attitude towards flying on pilotless planes. Clearly, such a reality remains some years away, but both manufacturers are undertaking work in this field.

18-34-year-old respondents are the most likely to take pilotless flights

Figure 21: Likelihood of taking pilotless flights by age range

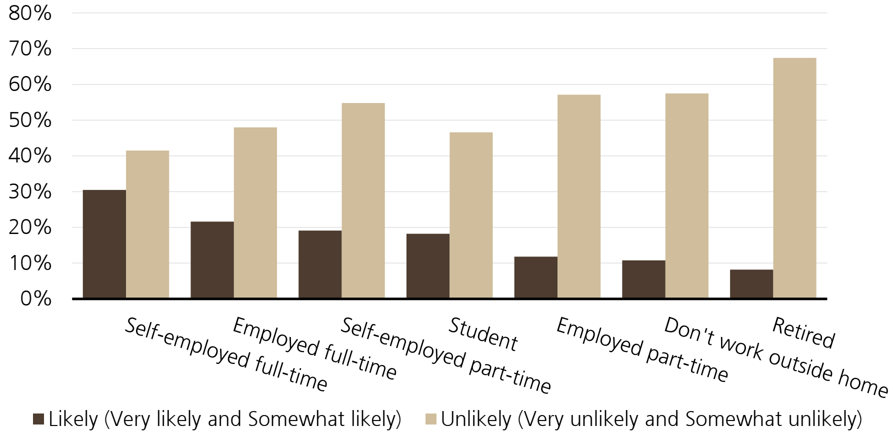


Source: UBS Evidence Lab

Self-employed full-time respondents showed the greatest interest in taking pilotless flights (31%) and less reluctance to do so (42%) compared with other employment status. Retired respondents appear the most unlikely to book a pilotless flights (67% said they would not), which is not surprising, given the age bracket and the reluctance to embrace such future technology (see the figure above).

Self-employed are the most likely to take a pilotless plane

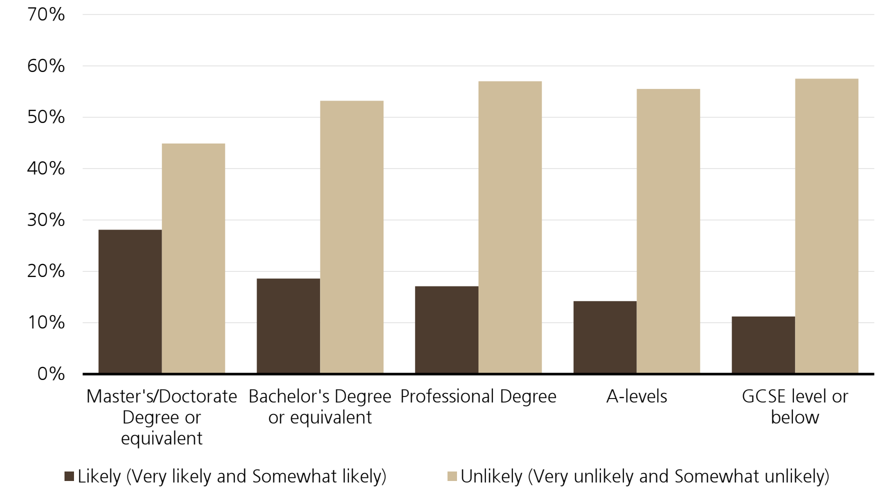
Figure 22: Likelihood of taking pilotless flights by employment status



Source: UBS Evidence Lab

In terms of education background, respondents that possess a master's degree or doctorate or equivalent are the most likely (28%) and least unlikely (45%) to take pilotless flights. We are not surprised by this finding.

Figure 23: Likelihood of taking pilotless flights by education



Source: UBS Evidence Lab

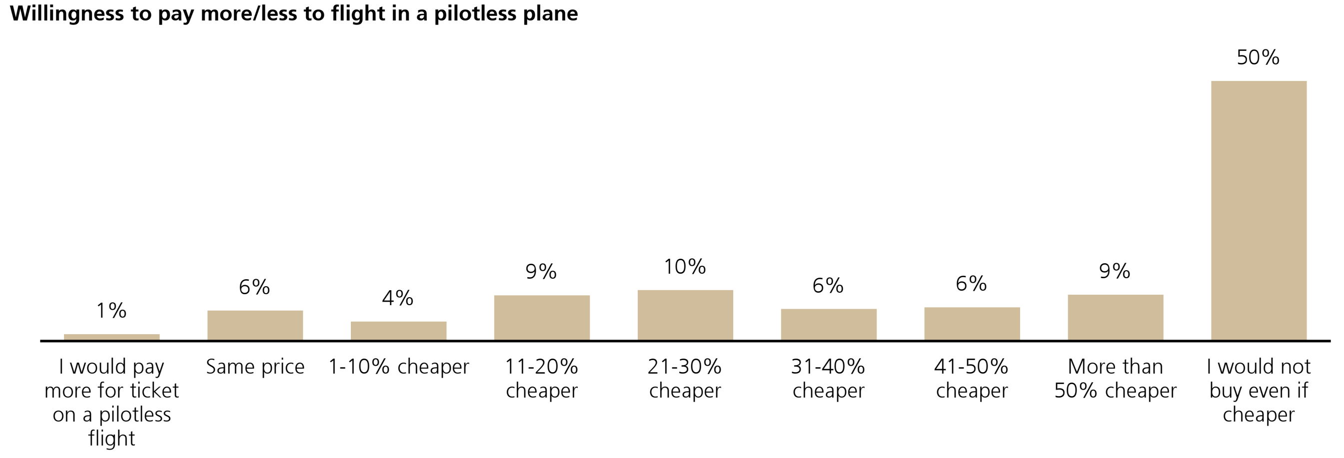
50% would not buy a pilotless flight ticket even if cheaper

UBS Evidence Lab also asked respondents how much cheaper would a pilotless flight ticket need to be for them to fly a regular flight without a pilot. Half of the respondents said that they would not buy the pilotless flight ticket even if it was cheaper. Results are similar across countries, and vary from 46% of respondents in

Price alone is unlikely to convince certain respondents to fly a pilotless plane

France and the US not buying the pilotless flight ticket even if it was cheaper to 55% in the case of German respondents.

Figure 24: How much cheaper should the pilotless flight ticket be so that the respondent would buy it? All respondents

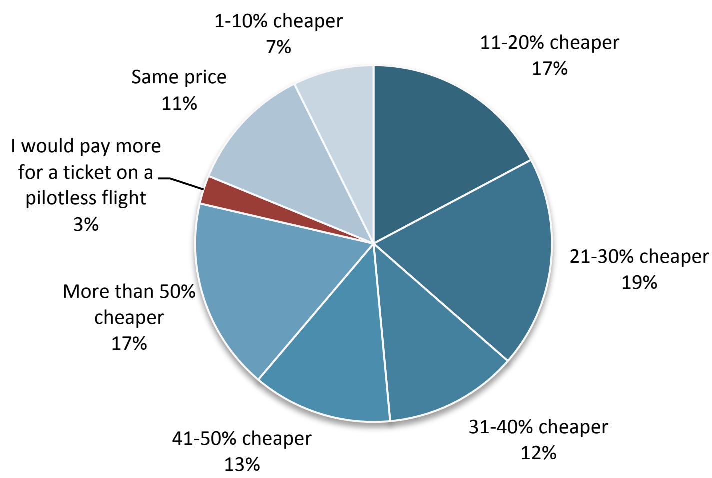


Source: UBS Evidence Lab

Out of those respondents who said they would buy a ticket on a pilotless plane, only 3% would agree to pay more than a regular ticket fare. 61% of respondents said that the ticket should be more than 20% cheaper for them to fly on a pilotless plane.

Of the respondents who would buy a pilotless plane ticket, more than 60% said only if the ticket is more than 20% cheaper

Figure 25: Willingness to pay more or less among all respondents who would buy the pilotless flight ticket



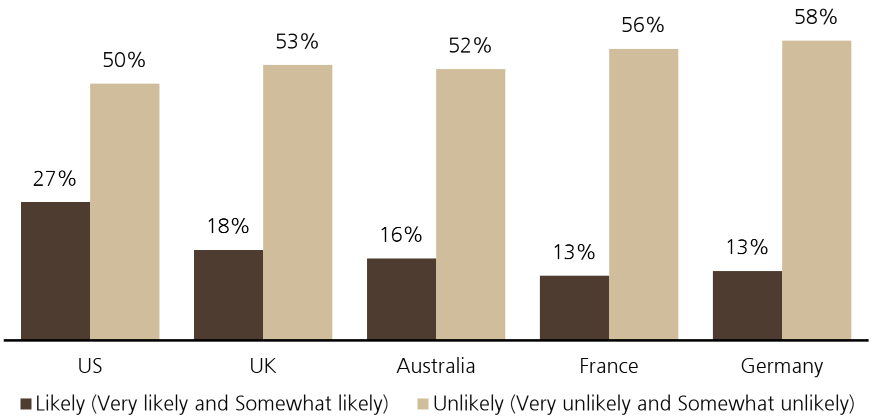
Source: UBS Evidence Lab

Cultural differences may explain differences in willingness

Interestingly enough, the geographical differences in the Evidence Lab survey results are in the line with the findings from Professor Geert Hofstede's study on uncertainty avoidance.

UK and US respondents show less distrust in the unknown

Figure 26: Likelihood of taking pilotless flights by country (%)



Source: UBS Evidence Lab

Those countries showing the greatest likelihood of taking pilotless flights as well as the lowest unlikelihood of taking pilotless flights, namely, the US (27% and 50%, respectively) and UK (18% and 53%, respectively), are the ones showing the lowest "Uncertainty Avoidance". French and German respondents were the least likely to take pilotless flights and the most unlikely to take pilotless flights.

Appendix

Airlines in detail

US airlines in detail

For American Airlines the forecast improvement in operating profit assuming one pilot is 45-55% on average and double that for no pilots, as evidenced by the below.

Figure 27: Implied saving for American Airlines Group assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total (all)	1551	1529	1549	1533	1536	1558	1589	1621	1653	1686
# Pilots	15,806	15,400	15,800	16,250	16,550					
Pilot cost $m	3,590	3,595	3,583	3,962	4,450	4,604	4,790	4,983	5,185	5,394
Actual and forecast EBIT €$m	1,418	3,252	5,074	7,283	6,008	5,264	5,259	5,070	4,903	4,690
Savings on EBIT ($m)										
Assuming 1 pilot in cockpit	1,795	1,798	1,792	1,981	2,225	2,302	2,395	2,492	2,592	2,697
Assuming no pilot in cockpit	3,590	3,595	3,583	3,962	4,450	4,604	4,790	4,983	5,185	5,394
Saving as a % of EBIT ($m)										
Assuming 1 pilot in cockpit	127%	55%	35%	27%	37%	44%	46%	49%	53%	58%
Assuming no pilot in cockpit	253%	111%	71%	54%	74%	87%	91%	98%	106%	115%

Source: Company data, UBS estimates

For United Airlines the forecast improvement in operating profit assuming one pilot is 40-50% on average and double that for no pilots, as evidenced by the below.

Figure 28: Implied saving for United Airlines assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total (all)	1253	1265	1257	1236	1231	1274	1299	1325	1352	1379
# Pilots	10,058	10,370	10,583	10,908	11,329					
Pilot cost $m	3,060	3,278	3,369	3,619	3,791	4,002	4,164	4,332	4,507	4,689
Actual and forecast EBIT €$m	2,247	2,618	2,828	5,163	4,971	4,498	4,808	4,896	4,629	4,366
Savings on EBIT ($m)										
Assuming 1 pilot in cockpit	1,530	1,639	1,685	1,810	1,896	2,001	2,082	2,166	2,253	2,344
Assuming no pilot in cockpit	3,060	3,278	3,369	3,619	3,791	4,002	4,164	4,332	4,507	4,689
Saving as a % of EBIT ($m)										
Assuming 1 pilot in cockpit	68%	63%	60%	35%	38%	44%	43%	44%	49%	54%
Assuming no pilot in cockpit	136%	125%	119%	70%	76%	89%	87%	88%	97%	107%

Source: Company data, UBS estimates

For Delta Air Lines the forecast improvement in operating profit assuming one pilot is 35-40% on average and double that for no pilots, as evidenced by the below.

Figure 29: Implied saving for Delta Air Lines assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total (all)	1285	1275	1271	1291	1301	1311	1337	1364	1391	1419
# Pilots	11,170	11,610	12,675	13,135	13,915					
Pilot cost $m	3,137	3,342	3,634	3,956	4,293	4,413	4,591	4,777	4,970	5,170
Actual and forecast EBIT €$m	2,601	3,526	5,268	6,536	6,502	6,533	6,802	6,869	6,395	5,943
Savings on EBIT ($m)										
Assuming 1 pilot in cockpit	1,569	1,671	1,817	1,978	2,146	2,206	2,296	2,388	2,485	2,585
Assuming no pilot in cockpit	3,137	3,342	3,634	3,956	4,293	4,413	4,591	4,777	4,970	5,170
Saving as a % of EBIT ($m)										
Assuming 1 pilot in cockpit	60%	47%	34%	30%	33%	34%	34%	35%	39%	44%
Assuming no pilot in cockpit	121%	95%	69%	61%	66%	68%	67%	70%	78%	87%

Source: Company data, UBS estimates

For Southwest Airlines Co the forecast improvement in operating profit assuming one pilot is 30-35% on average and double that for no pilots, as evidenced by the below.

Figure 30: Implied saving for Southwest Airlines Co assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total	694	680	665	704	723	747	799	831	864	890
# Pilots	6,000	6,100	6,850	7,550	7,750					
Pilot cost $m	1,583	1,679	1,808	2,017	2,147	2,261	2,468	2,618	2,777	2,917
Actual and forecast EBIT €$m	839	1,448	2,334	3,957	3,959	3,800	4,736	4,568	4,294	3,970
Savings on EBIT ($m)										
Assuming 1 pilot in cockpit	792	839	904	1,008	1,073	1,130	1,234	1,309	1,388	1,459
Assuming no pilot in cockpit	1,583	1,679	1,808	2,017	2,147	2,261	2,468	2,618	2,777	2,917
Saving as a % of EBIT ($m)										
Assuming 1 pilot in cockpit	94%	58%	39%	25%	27%	30%	26%	29%	32%	37%
Assuming no pilot in cockpit	189%	116%	77%	51%	54%	60%	52%	57%	65%	73%

Source: Company data, UBS estimates

For Alaska Air Group Co the forecast improvement in operating profit assuming one pilot is 20-23% on average and double that for no pilots, as evidenced by the below.

Figure 31: Implied saving for Alaska Air Group assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total	224	235	249	272	285	309	328	347	368	390
# Pilots	2,511	2,575	2,681	2,872	3,073					
Pilot cost $m	434	463	503	555	585	647	700	756	818	884
Actual and forecast EBIT €$m	539	717	1,030	1,542	1,694	1,616	1,658	1,645	1,808	1,921
Savings on EBIT ($m)										
Assuming 1 pilot in cockpit	217	231	252	277	292	323	350	378	409	442
Assuming no pilot in cockpit	434	463	503	555	585	647	700	756	818	884
Saving as a % of EBIT ($m)										
Assuming 1 pilot in cockpit	40%	32%	24%	18%	17%	20%	21%	23%	23%	23%
Assuming no pilot in cockpit	81%	65%	49%	36%	35%	40%	42%	46%	45%	46%

Source: Company data, UBS estimates

For JetBlue Airways Corp the forecast improvement in operating profit assuming one pilot is 29-33% on average and double that for no pilots, as evidenced by the below.

Figure 32: Implied saving for JetBlue Airways Corp assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total	180	194	203	215	227	240	255	270	286	303
# Pilots	2,186	2,306	2,508	2,733	2,947					
Pilot cost $m	348	378	431	513	566	611	661	714	772	835
Actual and forecast EBIT €$m	376	428	515	1,216	1,312	1,114	1,139	1,182	1,153	1,217
Savings on EBIT ($m)										
Assuming 1 pilot in cockpit	174	189	216	257	283	305	330	357	386	417
Assuming no pilot in cockpit	348	378	431	513	566	611	661	714	772	835
Saving as a % of EBIT ($m)										
Assuming 1 pilot in cockpit	46%	44%	42%	21%	22%	27%	29%	30%	33%	34%
Assuming no pilot in cockpit	93%	88%	84%	42%	43%	55%	58%	60%	67%	69%

Source: Company data, UBS estimates

European airlines in detail

For easyJet the forecast improvement in operating profit assuming one pilot is 26-30% on average and double that for no pilots, as evidenced by the below.

Figure 33: Implied saving for easyJet assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
A319	160	153	153	148	144	142	127	112	111	93
A320	54	64	73	93	113	137	166	183	187	220
Total	**214**	**217**	**226**	**241**	**257**	**279**	**293**	**295**	**298**	**313**
# Pilots	**1,868**	**1,957**	**2,207**	**2,497**	**2,865**	**3,069**	**3,223**	**3,245**	**3,278**	**3,443**
Pilot cost £m	**142.7**	**153.3**	**177.3**	**205.6**	**241.8**	**265.4**	**285.7**	**294.9**	**305.3**	**328.7**
Actual and forecast EBIT £m	**331**	**497**	**581**	**688**	**498**	**403**	**476**	**562**	**572**	**608**
Savings on EBIT £m										
Assuming 1 pilot in cockpit	71	77	89	103	121	133	143	147	153	164
Assuming no pilot in cockpit	143	153	177	206	242	265	286	295	305	329
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	21.6%	15.4%	15.3%	14.9%	24.3%	32.9%	30.0%	26.3%	26.7%	27.0%
Assuming no pilot in cockpit	43.1%	30.9%	30.5%	29.9%	48.5%	65.8%	60.0%	52.5%	53.3%	54.1%

Source: Company data, UBS estimates

For Ryanair the forecast improvement in operating profit assuming one pilot is 14-15% on average and double that for no pilots, as evidenced by the below.

Figure 34: Implied saving for Ryanair assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017	2018e	2019e	2020e	2021E
Fleet										
B737	294	305	297	308	341	383	427	448	481	516
Total	**294**	**305**	**297**	**308**	**341**	**383**	**427**	**448**	**481**	**516**
# Pilots	**2,429**	**2,625**	**2,665**	**2,804**	**3,424**	**3,830**	**4,270**	**4,480**	**4,810**	**5,160**
Pilot cost €m	**234.5**	**259.9**	**270.4**	**291.6**	**365.0**	**418.5**	**478.3**	**514.3**	**566.0**	**622.4**
Actual and forecast EBIT €m	**618**	**718**	**659**	**1,043**	**1,460**	**1,534**	**1,738**	**1,835**	**2,024**	**2,077**
Savings on EBIT €m										
Assuming 1 pilot in cockpit	117	130	135	146	183	209	239	257	283	311
Assuming no pilot in cockpit	234	260	270	292	365	419	478	514	566	622
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	19.0%	18.1%	20.5%	14.0%	12.5%	13.6%	13.8%	14.0%	14.0%	15.0%
Assuming no pilot in cockpit	37.9%	36.2%	41.1%	28.0%	25.0%	27.3%	27.5%	28.0%	28.0%	30.0%

Source: Company data, UBS estimates

For Wizz the forecast improvement in operating profit assuming one pilot is 11-14% on average and double that for no pilots, as evidenced by the below.

Figure 35: Implied saving for Wizz assuming one and no pilots in the cockpit

	2012	2013	2014	2015	2016	2017	2018e	2019e	2020e	2021E
Fleet										
A320	36	40	46	55	63	63	66	65	52	47
A321	0	0	0	0	4	16	25	34	52	74
Total	36	40	46	55	67	79	91	99	104	121
# Pilots	324	360	460	550	670	790	910	990	1,040	1,210
Pilot cost €m	24.8	28.2	36.9	45.3	56.5	68.3	80.7	90.0	96.9	115.5
Actual and forecast EBIT €m	44	38	110	167	236	247	306	348	428	478
Savings on EBIT €m										
Assuming 1 pilot in cockpit	12	14	18	23	28	34	40	45	48	58
Assuming no pilot in cockpit	25	28	37	45	57	68	81	90	97	116
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	28.0%	37.1%	16.8%	13.5%	12.0%	13.8%	13.2%	12.9%	11.3%	12.1%
Assuming no pilot in cockpit	56.0%	74.3%	33.7%	27.1%	24.0%	27.7%	26.4%	25.8%	22.6%	24.2%

Source: Company data, UBS estimates

For Lufthansa the forecast improvement in operating profit assuming one pilot is 12-13% on average and double that for no pilots, as evidenced by the below.

Figure 36: Implied saving for Lufthansa assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total	513	524	518	510	543	568	577	585	593	601
# Pilots	5,130	5,240	5,180	5,100	5,400	5,680	5,770	5,850	5,930	6,010
Pilot cost €m	495.2	518.8	525.6	530.5	575.7	620.7	646.3	671.6	697.8	724.9
Actual and forecast EBIT €m	1,622	857	879	1,555	2,190	2,495	2,618	2,653	2,736	2,820
Savings on EBIT €m										
Assuming 1 pilot in cockpit	248	259	263	265	288	310	323	336	349	362
Assuming no pilot in cockpit	495	519	526	530	576	621	646	672	698	725
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	15.3%	30.3%	29.9%	17.1%	13.1%	12.4%	12.3%	12.7%	12.8%	12.9%
Assuming no pilot in cockpit	30.5%	60.5%	59.8%	34.1%	26.3%	24.9%	24.7%	25.3%	25.5%	25.7%

Source: Company data, UBS estimates

For IAG the forecast improvement in operating profit assuming one pilot is 10-11% on average and double that for no pilots, as evidenced by the below.

Figure 37: Implied saving for IAG assuming one and no pilots

	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet									
Total	577	571	564	552	557	562	567	572	577
# Pilots	5,431	5,694	5,906	6,257	5,570	5,620	5,670	5,720	5,770
Pilot cost €m	537.7	577.8	614.3	667.1	608.7	629.5	651.0	673.1	696.0
Actual and forecast EBIT €m	770	1,390	2,335	2,535	2,895	3,033	3,105	3,409	3,610
Savings on EBIT									
Assuming 1 pilot in cockpit	269	289	307	334	304	315	325	337	348
Assuming no pilot in cockpit	538	578	614	667	609	629	651	673	696
Saving as a % of EBIT (€m)									
Assuming 1 pilot in cockpit	34.9%	20.8%	13.2%	13.2%	10.5%	10.4%	10.5%	9.9%	9.6%
Assuming no pilot in cockpit	69.8%	41.6%	26.3%	26.3%	21.0%	20.8%	21.0%	19.7%	19.3%

Source: Company data, UBS estimates

For Air France-KLM he forecast improvement in operating profit assuming one pilot is 24-27% on average and double that for no pilots, as evidenced by the below.

Figure 38: Implied saving for Air France-KLM assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021E
Fleet										
Total	605	577	571	564	552	557	562	567	572	577
# Pilots	5,445	5,193	5,710	5,640	5,520	5,570	5,620	5,670	5,720	5,770
Pilot cost €m	525.6	514.1	579.4	586.6	588.5	608.7	629.5	651.0	673.1	696.0
Actual and forecast EBIT €m	-731	-227	-129	780	1,049	1,146	1,266	1,346	1,349	1,343
Savings on EBIT (€m)										
Assuming 1 pilot in cockpit	263	257	290	293	294	304	315	325	337	348
Assuming no pilot in cockpit	526	514	579	587	588	609	629	651	673	696
Saving as a % of EBIT (€m)										
Assuming 1 pilot in cockpit	nm	nm	nm	37.6%	28.1%	26.6%	24.9%	24.2%	25.0%	25.9%
Assuming no pilot in cockpit	nm	nm	nm	75.2%	56.1%	53.1%	49.7%	48.3%	49.9%	51.8%

Source: Company data, UBS estimates

Asian airlines in detail

For Air China the forecast improvement in operating profit assuming one pilot is 8-11% on average and double that for no pilots, as evidenced by the below.

Figure 39: Implied saving for Air China assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	461	497	540	578	623	673	715	770	814	861
# Pilots	3,702	4,071	3,656	4,713	4,952	5,384	5,720	6,160	6,512	6,888
Pilot cost RMBm	2,175	2,453	2,259	2,987	3,219	3,587	3,906	4,312	4,672	5,066
Actual and forecast EBIT RMBm	8,108	4,857	7,206	15,818	17,867	16,242	21,211	24,682	28,372	32,758
Savings on EBIT RMBm										
Assuming 1 pilot in cockpit	1,087	1,226	1,130	1,493	1,609	1,794	1,953	2,156	2,336	2,533
Assuming no pilot in cockpit	2,175	2,453	2,259	2,987	3,219	3,587	3,906	4,312	4,672	5,066
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	13.4%	25.2%	15.7%	9.4%	9.0%	11.0%	9.2%	8.7%	8.2%	7.7%
Assuming no pilot in cockpit	26.8%	50.5%	31.4%	18.9%	18.0%	22.1%	18.4%	17.5%	16.5%	15.5%

Source: Company data, UBS estimates

For China Southern the forecast improvement in operating profit assuming one pilot is 22-42% on average and double that for no pilots, as evidenced by the below.

Figure 40: Implied saving for China Southern assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	496	561	612	667	702	758	817	862	892	923
# Pilots	5,456	6,171	6,908	7,465	8,126	9,096	9,804	10,344	10,704	11,076
Pilot cost RMBm	3,205	3,718	4,268	4,731	5,282	6,060	6,695	7,241	7,680	8,145
Actual and forecast EBIT RMBm	3,637	803	2,773	10,250	8,848	7,141	10,074	12,141	14,950	18,449
Savings on EBIT RMBm										
Assuming 1 pilot in cockpit	1,602	1,859	2,134	2,365	2,641	3,030	3,348	3,620	3,840	4,073
Assuming no pilot in cockpit	3,205	3,718	4,268	4,731	5,282	6,060	6,695	7,241	7,680	8,145
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	44.1%	231.5%	77.0%	23.1%	29.8%	42.4%	33.2%	29.8%	25.7%	22.1%
Assuming no pilot in cockpit	88.1%	463.0%	153.9%	46.2%	59.7%	84.9%	66.5%	59.6%	51.4%	44.2%

Source: Company data, UBS estimates

For China Eastern the forecast improvement in operating profit assuming one pilot is 39-44% on average and double that for no pilots, as evidenced by the below.

Figure 41: Implied saving for China Eastern assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	416	465	503	535	581	636	688	760	810	863
# Pilots	5,562	5,841	6,205	6,386	6,759	7,632	8,256	9,120	9,720	10,356
Pilot cost RMBm	3,267	3,519	3,834	4,047	4,393	5,085	5,638	6,384	6,974	7,616
Actual and forecast EBIT RMBm	2,481	(981)	2,374	7,578	7,044	5,844	7,229	7,380	8,276	9,824
Savings on EBIT RMBm										
Assuming 1 pilot in cockpit	1,634	1,759	1,917	2,024	2,197	2,542	2,819	3,192	3,487	3,808
Assuming no pilot in cockpit	3,267	3,519	3,834	4,047	4,393	5,085	5,638	6,384	6,974	7,616
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	65.8%	nm	80.8%	26.7%	31.2%	43.5%	39.0%	43.3%	42.1%	38.8%
Assuming no pilot in cockpit	131.7%	nm	161.5%	53.4%	62.4%	87.0%	78.0%	86.5%	84.3%	77.5%

Source: Company data, UBS estimates

For AirAsia the forecast improvement in operating profit assuming one pilot is 6-7% on average and double that for no pilots, as evidenced by the below.

Figure 42: Implied saving for AirAsia assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	75	91	107	103	101	108	111	114	114	123
# Pilots	662	714	739	778	904	972	999	1,026	1,026	1,107
Pilot cost RMm	129.2	142.9	151.7	163.8	195.3	215.2	226.7	238.7	244.6	270.5
Actual and forecast EBIT RMm	894	714	639	903	1,700	1,870	1,886	1,931	1,891	1,911
Savings on EBIT RMm										
Assuming 1 pilot in cockpit	65	71	76	82	98	108	113	119	122	135
Assuming no pilot in cockpit	129	143	152	164	195	215	227	239	245	271
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	7.2%	10.0%	11.9%	9.1%	5.7%	5.8%	6.0%	6.2%	6.5%	7.1%
Assuming no pilot in cockpit	14.5%	20.0%	23.7%	18.1%	11.5%	11.5%	12.0%	12.4%	12.9%	14.2%

Source: Company data, UBS estimates

For Cathay Pacific the forecast improvement in operating profit assuming one pilot is 14-59% on average and double that for no pilots, as evidenced by the below.

Figure 43: Implied saving for Cathay Pacific assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	184	192	200	197	196	201	205	212	209	206
# Pilots	2,103	2,167	2,271	2,365	2,352	2,412	2,460	2,544	2,508	2,472
Pilot cost HK$m	1,368	1,446	1,554	1,660	1,693	1,780	1,861	1,973	1,993	2,014
Actual and forecast EBIT HK$m	2052	3770	4435	6173	-525	-677	1591	6018	6817	7461
Savings on EBIT HK$m										
Assuming 1 pilot in cockpit	684	723	777	830	847	890	930	986	997	1,007
Assuming no pilot in cockpit	1,368	1,446	1,554	1,660	1,693	1,780	1,861	1,973	1,993	2,014
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	33.3%	19.2%	17.5%	13.4%	nm	nm	58.5%	16.4%	14.6%	13.5%
Assuming no pilot in cockpit	66.7%	38.4%	35.0%	26.9%	nm	nm	117.0%	32.8%	29.2%	27.0%

Source: Company data, UBS estimates

For Cebu Air the forecast improvement in operating profit assuming one pilot is 15-18% on average and double that for no pilots, as evidenced by the below.

Figure 44: Implied saving for Cebu Air assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	41	48	52	55	57	58	64	69	72	79
# Pilots	461	484	508	533	570	580	640	690	720	790
Pilot cost Peso m	1,880	2,024	2,179	2,345	2,572	2,682	3,034	3,353	3,586	4,033
Actual and forecast EBIT Peso m	2,663	2,404	4,157	9,700	12,251	8,784	9,311	10,151	10,822	11,523
Savings on EBIT Peso m										
Assuming 1 pilot in cockpit	940	1,012	1,089	1,172	1,286	1,341	1,517	1,676	1,793	2,016
Assuming no pilot in cockpit	1,880	2,024	2,179	2,345	2,572	2,682	3,034	3,353	3,586	4,033
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	35.3%	42.1%	26.2%	12.1%	10.5%	15.3%	16.3%	16.5%	16.6%	17.5%
Assuming no pilot in cockpit	70.6%	84.2%	52.4%	24.2%	21.0%	30.5%	32.6%	33.0%	33.1%	35.0%

Source: Company data, UBS estimates

For Thai Airways the forecast improvement in operating profit assuming one pilot is 19-99% on average and double that for no pilots, as evidenced by the below.

Figure 45: Implied saving for Thai Airways assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	110	120	130	131	131	129	133	137	141	145
# Pilots	1,252	1,279	1,343	1,321	1,280	1,290	1,330	1,370	1,410	1,450
Pilot cost THBm	2,715	2,845	3,064	3,091	3,072	3,173	3,354	3,541	3,735	3,937
Actual and forecast EBIT THBm	5,727	(3,657)	(19,921)	(2,675)	5,423	1,602	3,467	6,069	8,067	10,164
Savings on EBIT THBm										
Assuming 1 pilot in cockpit	1,358	1,423	1,532	1,546	1,536	1,587	1,677	1,770	1,868	1,969
Assuming no pilot in cockpit	2,715	2,845	3,064	3,091	3,072	3,173	3,354	3,541	3,735	3,937
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	23.7%	nm	nm	nm	28.3%	99.0%	48.4%	29.2%	23.2%	19.4%
Assuming no pilot in cockpit	47.4%	nm	nm	nm	56.7%	198.0%	96.7%	58.3%	46.3%	38.7%

Source: Company data, UBS estimates

For Garuda Indonesia the forecast improvement in operating profit assuming one pilot is 16-62% on average and double that for no pilots, as evidenced by the below.

Figure 46: Implied saving for Garuda Indonesia assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	106	141	169	187	197	207	217	227	238	249
# Pilots	1,216	1,350	1,445	1,600	1,550	1,656	1,736	1,816	1,904	1,992
Pilot cost $m	89	101	111	126	125	137	147	158	170	182
Actual and forecast EBIT Rp $m	178	13	-359	83	68	111	160	275	416	568
Savings on EBIT $m										
Assuming 1 pilot in cockpit	44	51	56	63	63	69	74	79	85	91
Assuming no pilot in cockpit	89	101	111	126	125	137	147	158	170	182
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	25.0%	401.1%	nm	75.8%	92.1%	61.5%	46.1%	28.7%	20.4%	16.0%
Assuming no pilot in cockpit	49.9%	802.3%	nm	151.5%	184.1%	123.1%	92.2%	57.4%	40.8%	32.0%

Source: Company data, UBS estimates

For Korean Air the forecast improvement in operating profit assuming one pilot is 3-4% on average and double that for no pilots, as evidenced by the below.

Figure 47: Implied saving for Korean Air assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	157	155	161	158	170	177	187	198	209	221
# Pilots	1,553	1,567	1,600	1,638	1,700	1,770	1,870	1,980	2,090	2,210
Pilot cost Won b	49	50	53	55	59	63	68	74	80	87
Actual and forecast EBIT Won m	229	(20)	395	883	1,121	1,011	1,076	1,280	1,261	1,117
Savings on EBIT Won m										
Assuming 1 pilot in cockpit	24	25	26	28	29	31	34	37	40	43
Assuming no pilot in cockpit	49	50	53	55	59	63	68	74	80	87
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	10.6%	nm	6.7%	3.1%	2.6%	3.1%	3.2%	2.9%	3.2%	3.9%
Assuming no pilot in cockpit	21.3%	nm	13.3%	6.3%	5.3%	6.2%	6.3%	5.8%	6.3%	7.8%

Source: Company data, UBS estimates

For China Airlines the forecast improvement in operating profit assuming one pilot is 10-59% on average and double that for no pilots, as evidenced by the below.

Figure 48: Implied saving for China Airlines assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	80	84	89	97	115	109	109	109	109	109
# Pilots	956	980	996	1,094	1,150	1,090	1,090	1,090	1,090	1,090
Pilot cost NT$ m	1,835	1,929	2,011	2,265	2,441	2,371	2,430	2,491	2,553	2,617
Actual and forecast EBIT NT$ m	3397	3410	2337	9163	2543	2013	6446	9216	11274	13516
Savings on EBIT NT$ m										
Assuming 1 pilot in cockpit	917	964	1,005	1,133	1,220	1,186	1,215	1,246	1,277	1,309
Assuming no pilot in cockpit	1,835	1,929	2,011	2,265	2,441	2,371	2,430	2,491	2,553	2,617
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	27.0%	28.3%	43.0%	12.4%	48.0%	58.9%	18.9%	13.5%	11.3%	9.7%
Assuming no pilot in cockpit	54.0%	56.6%	86.0%	24.7%	96.0%	117.8%	37.7%	27.0%	22.6%	19.4%

Source: Company data, UBS estimates

For EVA Air the forecast improvement in operating profit assuming one pilot is 11-23% on average and double that for no pilots, as evidenced by the below.

Figure 49: Implied saving for EVA Air assuming one and no pilots

	2012	2013	2014	2015	2016	2017e	2018e	2019e	2020e	2021e
Fleet										
Total	75	75	67	69	76	83	85	89	93	97
# Pilots	3,702	4,071	3,656	4,713	4,952	830	850	890	930	970
Pilot cost NT$ m	7,104	8,013	7,380	9,758	10,509	1,805	1,895	2,034	2,179	2,329
Actual and forecast EBIT NT$ m	4190	3182	1151	8273	6837	3880	4994	7513	9007	10574
Savings on EBIT NT$ m										
Assuming 1 pilot in cockpit	3,552	4,006	3,690	4,879	5,255	903	948	1,017	1,089	1,165
Assuming no pilot in cockpit	7,104	8,013	7,380	9,758	10,509	1,805	1,895	2,034	2,179	2,329
Saving as a % of EBIT										
Assuming 1 pilot in cockpit	84.8%	125.9%	320.7%	59.0%	76.9%	23.3%	19.0%	13.5%	12.1%	11.0%
Assuming no pilot in cockpit	169.5%	251.8%	641.3%	117.9%	153.7%	46.5%	37.9%	27.1%	24.2%	22.0%

Source: Company data, UBS estimates

UBS Evidence Lab Travel Intention Survey - Methodology

The UBS Evidence Lab Travel Intention survey was sent out to a representative panel of consumers across the US, UK, France, Germany and Australia in April and May, 2017. Representation was on the basis of gender, income and location of residency. In total 7940 consumers completed the survey with approximately 1/5 in each of the five countries (US N=1507; UK N=1602; France N=1601; Germany N=1601; Australia N=1629). The margin of error for responses is between +/-1.1 (total sample) and +/-2.45 (individual countries).

Caveats:

This marks the third iteration of the survey. The first was run in May 2015 (and was limited to respondents who had travelled for leisure or business in the past 12 months), the second in June 2016. In 2016, Japan and Australia were included in the survey. In 2017 Japan is not included. Within the data, consumers are categorized as 'leisure' or 'business' travellers; this is a self-classification.

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Company Name	Reuters	12-month rating	Short-term rating	Price	Price date
Air China	0753.HK	Neutral	N/A	HK$7.07	04 Aug 2017
Air France - KLM[2, 4]	AIRF.PA	Buy	N/A	€12.12	03 Aug 2017
AirAsia	AIRA.KL	Buy	N/A	RM3.29	04 Aug 2017
Airbus Group SE[2, 4, 5, 7]	AIR.PA	Buy	N/A	€71.28	03 Aug 2017
Alaska Air Group[4, 6a, 16b]	ALK.N	Buy	N/A	US$84.99	03 Aug 2017
American Airlines Group[6b, 7, 16b]	AAL.O	Neutral	N/A	US$50.55	03 Aug 2017
Boeing Co.[8, 16b]	BA.N	Neutral	N/A	US$238.25	03 Aug 2017
Cathay Pacific[16a]	0293.HK	Sell	N/A	HK$12.24	04 Aug 2017
Cebu Air	CEB.PS	Neutral	N/A	P102.00	04 Aug 2017
China Eastern Airlines[16b]	0670.HK	Neutral	N/A	HK$4.28	04 Aug 2017
China Southern Airlines[1, 3, 5, 16a, 16b]	1055.HK	Neutral	N/A	HK$5.96	04 Aug 2017
Deutsche Lufthansa AG[2, 4, 7]	LHAG.DE	Neutral	N/A	€19.30	03 Aug 2017
easyJet	EZJ.L	Buy	N/A	1,263p	03 Aug 2017
EVA Air	2618.TW	Neutral	N/A	NT$14.75	04 Aug 2017
FedEx Corporation[16b]	FDX.N	Buy	N/A	US$209.36	03 Aug 2017
Garuda Indonesia	GIAA.JK	Neutral	N/A	Rp340	04 Aug 2017
International Airlines Group[7]	ICAG.L	Buy	N/A	608p	03 Aug 2017
JetBlue Airways[16b]	JBLU.O	Buy	N/A	US$22.13	03 Aug 2017
Korean Air	003490.KS	Sell	N/A	Won36,100	04 Aug 2017
Lockheed Martin Corp.[6b, 7, 16b]	LMT.N	Neutral	N/A	US$295.82	03 Aug 2017
Rockwell Collins Inc.[8, 13, 16b]	COL.N	Buy	N/A	US$118.44	03 Aug 2017
Southwest Airlines[16b]	LUV.N	Buy	N/A	US$56.11	03 Aug 2017
Thai Airways	THAI.BK	Sell	N/A	Bt19.10	04 Aug 2017
Thales[7]	TCFP.PA	Buy	N/A	€94.12	03 Aug 2017
United Continental Holdings[5, 16b]	UAL.N	Buy	N/A	US$68.19	03 Aug 2017
United Parcel Service, Inc.[2, 4, 5, 6a, 6b, 6c, 7, 16b]	UPS.N	Neutral	N/A	US$111.52	03 Aug 2017
Wizz Air Holdings[5, 7, 13]	WIZZ.L	Buy	N/A	£27.27	03 Aug 2017

Source: UBS. All prices as of local market close.
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