AVIATION BENEFITS BEYOND BORDERS

Powering global economic growth, employment, trade links, tourism and support for sustainable development through air transport, despite global crisis.

ATAG
AIR TRANSPORT ACTION GROUP

SEPTEMBER
2020

The air transport industry is the global network of commercial aircraft operators, airports, air navigation service providers and manufacturers of aircraft and their components. It is responsible for connecting the global economy, providing millions of jobs and making the modern, internationally connected quality of life possible. The Air Transport Action Group (ATAG), based in Geneva, Switzerland, represents the full spectrum of this global business. ATAG brings the industry together to form a strategic perspective on commercial aviation's sustainable development and the role that air transport can play in supporting the sustainability of other sectors of the economy.

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INTRODUCTION

Aviation is about connecting people.

Michael Gill
ATAG Executive Director
Geneva, September 2020

For all its technology and economic activity, its global nature and the logistical complexity, what we fundamentally do is bring people together. For quite a big chunk of 2020, that has, sadly, been unable to happen. Covid-19 has had an impact on the whole planet and all sectors of the economy.

We should never forget the primary victims of the pandemic – the more than a million who have lost their lives and the many more around the globe infected. But the second-level impact has also been deeply felt. The shutdown has altered most aspects of our lives, almost universally. This includes the chance for people to travel. It is not an exaggeration to say that, although all aspects of the global economy have been impacted, aviation has been one of the hardest hit.

As a result, this year's *Aviation: Benefits Beyond Borders* report has a slightly different format. It explores the role aviation plays under 'normal' conditions (in the "pre-Covid" world) and outlines the full scope the devastating pandemic has had on our sector.

Importantly, however, it offers a glimpse of the role air transport can play once we are able to get people moving again. With the right precautions in place and keeping vigilant about the way the virus spreads, air transport can rebuild to once again support nearly 88 million jobs. How fast we can do that will rely on close coordination with governments and support to help travel and tourism take off.

As we rebuild the sector there is also a unique opportunity to accelerate some core sustainability advances, balancing recovery of the economy with climate action by supporting the energy transition to sustainable aviation fuels. We can and should deliver new energy jobs across the world whilst securing a lower carbon future for flight.

The companion report *Waypoint 2050* by ATAG shows that our own industry commitments on climate action remain solid, despite cash flow challenges in the next couple of years.

This is an incredibly tough time to be part of the aviation family, but air transport is a business that has a loyal workforce who can't wait to get our passengers back in the air and communities connected once again. We hope to welcome everyone back on board soon.

THE IMPACT OF COVID-19

Impact of the Covid-19 pandemic
on aviation's contributions to economic and social development

THIS SECTION SHOWS THE EXPECTED IMPACT OF COVID-19 ON THE ROLE AVIATION PLAYS IN THE WORLD: THE JOBS AND ECONOMIC IMPACT AIR TRANSPORT WILL LIKELY SUPPORT AT THE END OF 2020. THIS CONTRASTS WITH THE ROLE OF AVIATION IN THE 'NORMAL WORLD', AS SEEN IN THE DATA THROUGHOUT THE REST OF THE REPORT. THE EFFECT OF THE HALT TO TRAVEL HAS BEEN STARK ACROSS THE AIR TRANSPORT SECTOR.

↓ 94.4%
Drop in passenger traffic April 2020 vs April 2019. This includes a 98.9% drop in international passengers and a 90.7% drop in domestic[6].

64%
Proportion of the global fleet in storage at the height of the crisis in April[7].

2.2 billion
Expected number of passengers in 2020, down from 4.5 billion in 2019[8].

57.6%
Airline load factor in June 2020, down from 84.4% in June 2019[9].

The impact of the Covid-19 crisis on all aspects of the economy and society is well known. Aviation has been particularly acutely impacted, accumulating the effects of previous shocks (9/11, SARS, the global financial crisis and Eyjafjallajökull eruption airspace closure) into one 'black swan' event which will have far-reaching implications on the industry for many years.

There have been reductions in passenger traffic caused by shocks in the past, but never a near total shutdown of the global system. At the peak of the stoppage in mid-April 2020, the number of flights operating globally was a quarter the number operating just six weeks earlier[1] (and many of these flights were operating with very limited passengers: revenue passenger kilometres fell some 94% compared with April 2019[2]). This has had a devastating impact on travel and tourism and on the frontline companies operating the aviation system and the rest of the supply chain.

However, shocks to air traffic growth in the past have always been followed by a rebound in traffic and, while this may take longer than in previous crises, traffic will come back. In order to make that happen more rapidly and get back to the level of jobs and economic activity provided by aviation, governments must ensure that air transport is given appropriate levels of assistance and support so that aviation's benefits can bounce back strongly, once the pandemic is under control. The aviation sector welcomes the support governments around the world have provided to the industry so far to help reduce the impacts of the Covid-19 crisis.

Impact on jobs

The impact on jobs supported by aviation mean that we could see at least a temporary reduction of up to 46 million jobs supported by air transport (a 52% reduction). Within the sector itself (at airports, airlines, air traffic management and the makers of aircraft, engines and components), 4.8 million jobs (43%) may be lost, once government wage support schemes conclude. The actual job losses may be either more or less severe; firms can and often do take short term losses, cut wages, and reduce dividend payments to retain employees during difficult periods, and this would lessen the number of jobs lost relative to those that are at risk due to muted business activity.

Aviation (particularly the airline, airport operator, ANSP and civil aerospace categories) tends to have a relatively high proportion of highly skilled jobs that require constant certification to keep current ratings. These include flight and cabin crews, dispatchers, engineers and airport operations staff. To re-hire and re-train these professional positions can take time and money and a company will likely prefer to take a reduction in profits, or work with staff to lower wages in order to retain employees in anticipation of a near-term rebound in traffic. This can only last so long, however, and the Covid-19 impact has been so severe that there will still be a dramatic reduction in employment within the sector, but more in line with a 43% reduction, rather than a 52% cut that the reduction in business activity would otherwise suggest.

By contrast, other sectors (for example many in the hospitality and tourism space) have a higher proportion of casual labour which can be contracted and expanded much more rapidly as business activity shifts. Many 'other on-airport' jobs are similar to this – with hospitality services at airports or in the immediate vicinity being impacted much more than jobs in airlines or airport operators themselves. The analysis in this section of the report takes these elements into consideration.

Impact on economic activity

The impact on economic activity supported by air transport is likely to be high - a 51.5% reduction compared with a pre-Covid situation, or a $1.8 trillion drop in GDP supported. This is due to a slow recovery impacting the catalytic benefits of aviation-supported tourism, but also a reduction in investment by airports, airlines and other parts of the sector. Runway developments or terminal construction will be paused (partially due to conservative financial behaviour, partially due to a reduction in traffic meaning planned expansions will not be needed as soon). But the flow-on impacts will also be felt as aviation employees who have taken reductions in salaries pull back on spending until the financial situation stabilises.

Around 58% of all tourists arrive at their destination by air and the stop in air traffic has created a massive negative effect on that industry as well. Over $630 billion in reduced GDP benefits from air travel-related tourism will be matched with 26.4 million jobs lost. But tourism in a wider sense is also very hard-hit, with analysis suggesting the pandemic could translate into a drop of 850 million to 1.1 billion international tourists and a loss of $910 billion to $1.2 trillion in export revenues from tourism, putting 100 to 120 million direct tourism jobs at risk[3].

However, despite the impact on aviation-related jobs and those supported by air transport, the role of aviation to the wider economy has been highlighted during the Covid-19 shutdown, with air cargo playing an even more important role than ever. At the height of the pandemic, airlines responded with nearly 46,500 special cargo flights, transporting over 1.5 million tonnes of medical supplies and personal protective equipment. At the same time, airlines are also re-focusing routes based on cargo opportunities to ensure that vital connections for businesses remain intact.

87.7 million → **41.7 million**

Jobs supported by air transport under normal circumstances.

Jobs supported by aviation following Covid-19 impact.

→ **A reduction of 46 million** jobs supported (-52.5%).

$3.5 trillion → **$1.7 trillion**

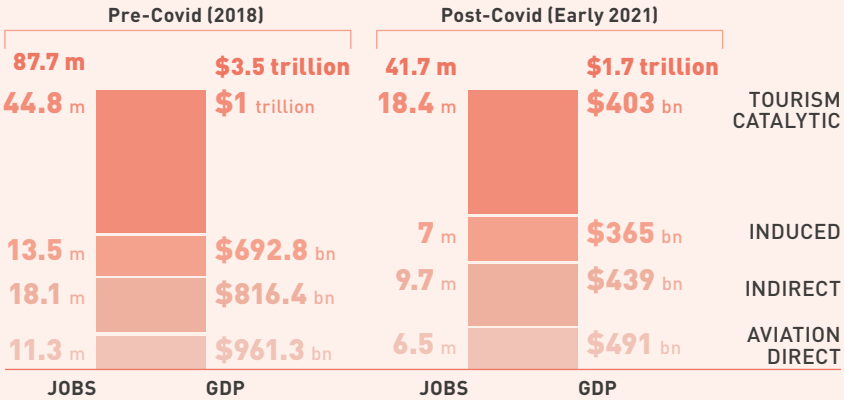
Aviation's global economic impact under normal circumstances.

Global economic impact following Covid-19.

→ **A reduction of $1.8 trillion** in economic activity supported by aviation (-51.5%).

The impact of Covid-19

Jobs in aviation, throughout the supply chain and in the wider economy will be impacted by Covid-19[4].



4.8 million

Direct aviation jobs may be lost due to Covid-19 impact (a 43% reduction from pre-Covid levels)[5]:

- **1.3 million at airlines (-36% compared with pre-Covid)**
- **220,000 at airport operators (-34%)**
- **3.2 million other on-airport (-55%)**
- **151,000 in civil aerospace (-11%)**

56.7%

Drop in airport revenues predicted for 2020, reaching a year-on-year peak of 90% globally in the second quarter of 2020 (the hardest hit region is Europe losing close to $37 billion in revenue).

50%

Drop in revenue for airlines expected for 2020: around $419 billion, for total losses of $84.3 billion by the world's airlines[12].

Regional impacts

	Africa	Asia-Pacific	Europe	Latin America and Caribbean	Middle East	North America	World
Employment supported							
Pre-Covid	7.7 m	46.7 m	13.5 m	7.6 m	3.3 m	8.8 m	87.7 m
Post-Covid	3.2 m	22.2 m	6.5 m	3.7 m	1.6 m	4.5 m	41.7 m
% change	**-58%**	**-53%**	**-52%**	**-52%**	**-51%**	**-49%**	**-52%**
Economic activity supported							
Pre-Covid	$63 billion	$944 billion	$991 billion	$187 billion	$213 billion	$1.1 trillion	$3.5 trillion
Post-Covid	$26 billion	$453 billion	$465 billion	$93 billion	$108 billion	$553 billion	$1.7 trillion
% change	**-58%**	**-52%**	**-53%**	**-50%**	**-49%**	**-50%**	**-52%**
Direct aviation jobs supported							
Pre-Covid	440,000	4.2 m	2.7 m	722,000	595,000	2.7 m	11.3 m
Post-Covid	267,000	2.4 m	1.5 m	408,000	323,000	1.6 m	6.5 m
Jobs at risk	**172,000**	**1.8 m**	**1.2 m**	**314,000**	**272,000**	**1.1 m**	**4.8 m**

39,200

Special repatriation flights by airlines transported nearly **5.4 million citizens** to their homes after borders were closed around the world in March 2020[10].

46,400

Special cargo flights transported some **1.5 million tonnes** of cargo, mostly medical equipment, to areas in need during the height of the pandemic response[11].

254,500

Free tickets made available to medical staff to allow transfer of resources between hospitals.

Getting home

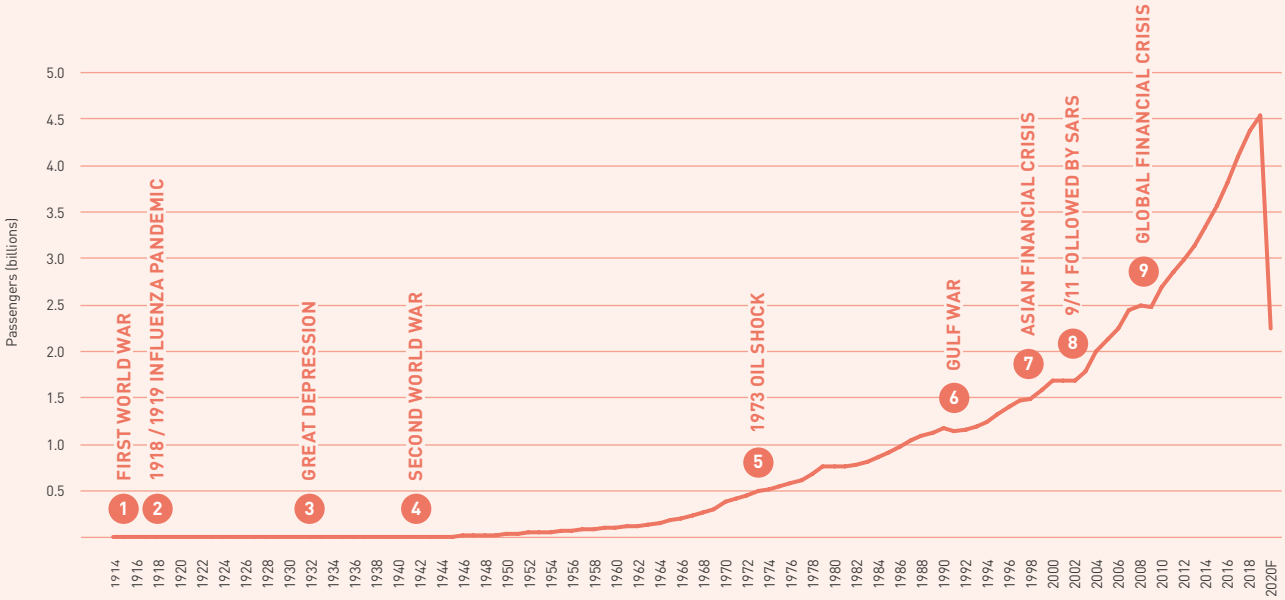
An unprecedented wave of travel restrictions in the wake of the coronavirus pandemic, in some instances put in place overnight, left hundreds of thousands of travellers stranded abroad. Working to bring them back home as quickly as possible, airlines operated thousands of repatriation flights in just over a few months.

Navigating the globe for the repatriation effort in such an uncertain environment resulted in extended flights, new stopovers and missions to airports that airlines don't regularly service. This required maximum flexibility from planning, ground and flight personnel. During these repatriation missions, a number of airlines operated the longest flights in their history, including Austrian Airlines, SAS, ElAl and others.

Repatriation flights were largely made possible through cross-collaborative efforts in the industry and with Governments. For instance, Air India operated domestic flights to collect US nationals who were carried overseas by Delta Air Lines in a series of long-haul flights. And the Indian Government has worked with Air India, Vistara, IndiGo and other airlines on the Vande Bharat Mission which has repatriated over 800,000 Indian citizens on 5,000 flights.

Global air passengers 1914-2020F[13]

Previous crises have resulted in a fairly rapid return to trend. The Covid-19 situation may see a slower recovery.



Supporting delivery of medical equipment

To help in the global response to the coronavirus pandemic, airlines, airports and aircraft manufacturers have mobilised resources in novel ways to ensure the delivery of critical medical equipment. In the course of a few months, over two million tonnes of medical and Covid-specific cargo has been transported worldwide, with some airlines operating all-cargo flights for the first time in their history, or using passenger aircraft for cargo-only services.

In the midst of these operations Avianca and Qatar Airways each transported over 50,000 tonnes of cargo, while millions of donated face masks and medical supplies were distributed across Africa by Ethiopian Airlines. At London Heathrow Airport, cargo surged to five times its normal rate, requiring ground handlers and airport crew to cater to airlines arriving at the airport for the first time.

To keep the supply chain moving, Aer Lingus established a historic airbridge with a convoy of flights between Dublin and Beijing, while All Nippon Airways operated over 380 special cargo flights. Air Baltic and Wizz flew special flights to China with their narrowbody aircraft to pick up personal protective equipment.

For a number of airlines, these unorthodox missions have called for unconventional methods of travel. It required augmented crew compositions instead of the usual rest time after a flight, in order to comply with travel restrictions, and it also meant the reconfiguration of passenger aircraft by removing seats and introducing new safety standards onboard to cater to the unprecedented intake of medical equipment.

In support of these operations, aircraft manufacturers have also been an integral part of the relief effort. Among the range of initiatives, Airbus deployed its aircraft to collect medical supplies from China and donate them to several governments, while Boeing volunteered three of its sizeable Dreamlifters for cargo missions to Asia.

Stepping up as manufacturers

To alleviate the strain on medical supplies during the Covid-19 pandemic, aerospace manufacturers redirected their technical expertise, infrastructure and resources to develop life-saving equipment for the healthcare community.

Widespread efforts throughout the aviation industry have led to a range of medical solutions involving the construction of ventilators, enhanced filtration systems and 3D printed face shields. As part of a UK government initiative, Airbus and Rolls Royce were among a consortium of engineering and technology firms manufacturing thousands of ventilators for hospitals across the country, while Brazilian aerospace manufacturer Embraer participated in the global relief effort through the development of ventilator parts and filtration systems.

The industry's participation was further augmented by the production of personal protective equipment for healthcare workers with support from a range of companies, including Piper Aircraft as well as Delta Flight Products that manufactured over 1,500 units a day in addition to developing mobile hospital rooms to transport Covid-19 patients.

The relief effort largely illustrates the industry's ability to use technology to enhance critical equipment. For Boeing, this meant using 3D printing machinery to generate an initial batch of 2,300 face shields. Safran also took advantage of similar 3D printing technology to adapt 200 snorkeling masks for medical personnel.

EXECUTIVE SUMMARY

Key facts and figures
from the world of air transport

THESE STATISTICS RELATE TO THE ROLE AVIATION PLAYS IN A 'NORMAL WORLD': THE PRE-COVID 19 SITUATION. THE DATA SHOWS HOW AIR TRANSPORT CAN SUPPORT ECONOMIC ACTIVITY AND CONNECTIVITY AND WILL DO SO AGAIN, ONCE THE CURRENT CRISIS SITUATION IS REPLACED WITH A RETURN TO NORMAL OPERATING CONDITIONS. CURRENT ESTIMATES SUGGEST THAT MAY BE BY 2024.

87.7 million

Jobs supported by aviation worldwide[14].

$3.5 trillion

Aviation's global economic impact (including direct, indirect, induced and tourism catalytic)[21].

4.1%

Global GDP supported by aviation[22].

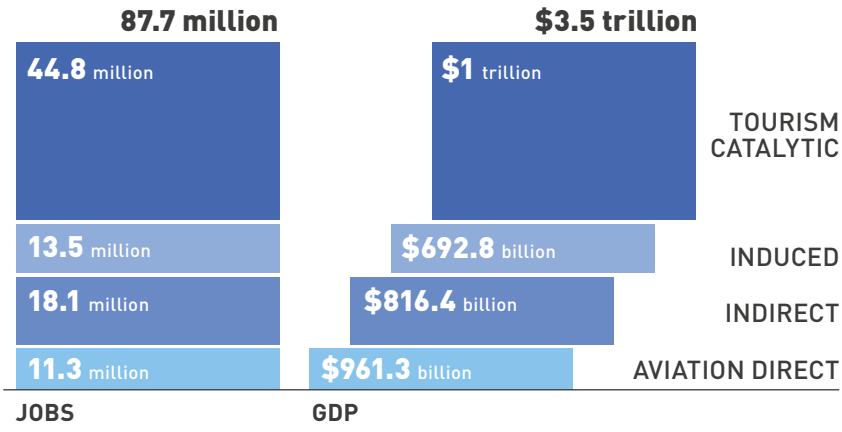
All employment and GDP figures are for 2018, unless otherwise stated, to give a single set of data for one year. Where available, traffic and financial statistics data are for 2019.

These figures represent a snapshot of the benefits that aviation activities delivered to the global economy in the pre-Covid-19 world. They do not include other economic benefits of aviation, such as the jobs or economic activity generated when companies or whole industries exist because air travel makes them possible. They also do not include the intrinsic value that the speed and connectivity of air travel provides nor domestic tourism and trade. Including these would increase the employment and global economic impact numbers several-fold[23].

The figures in *Aviation: Benefits Beyond Borders* should be viewed as a snapshot of the aviation sector in 2018-2019 and not as part of a trend. Differences in data sources mean the reports are not directly comparable.

Beyond the industry

Aviation's global employment and GDP impact[15].



Direct jobs

648,000
Airport operators[16]
(operations, planning, engineering, security)

1.3 million
Civil aerospace[19]
(engineers and designers of civil aircraft, engines and components)

5.5 million
Other on-airport[17]
(retail, car rental, government agencies such as customs and immigration, freight forwarders, some catering)

237,000
Air navigation service providers[20]
(air traffic controllers, engineers, executives)

3.6 million
Airlines[18]
(flight and cabin crews, executives, ground services, check-in, training and maintenance staff)

17th If aviation were a country, it would rank 17th in size by GDP (similar to Indonesia or the Netherlands)[24].

4.3x Globally, each aviation job generated $117,000 in gross value added (GVA). Aviation jobs are, on average, 4.3 times more productive than other jobs[25]. By opening markets and enabling knowledge transfer and other catalytic effects, aviation also makes jobs in other sectors more productive.

48,044
Routes served globally in 2019. Of these, 21,187 are unique city pairs[26].

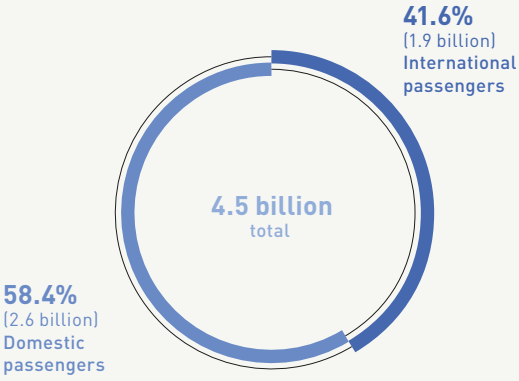
4.5 billion
Passengers carried by airlines, 2019[27].

46.8 million
Scheduled commercial flights worldwide, 2019[28].

8.68 trillion
Revenue Passenger Kilometres (RPK), 2019[29].

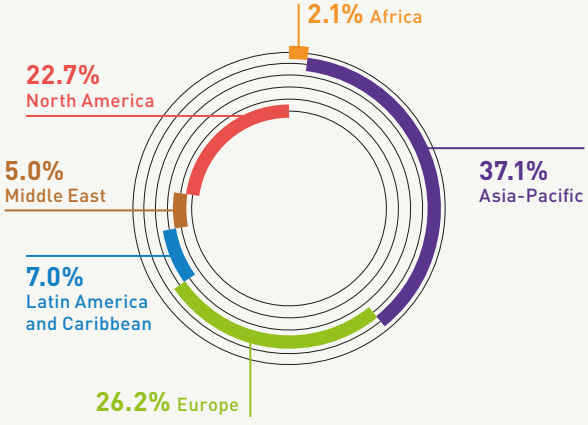
Going places

Global passenger split, international/domestic, millions[30].



Asia-Pacific in front

Regional passenger traffic split[31].



1,478 Commercial airlines[32].

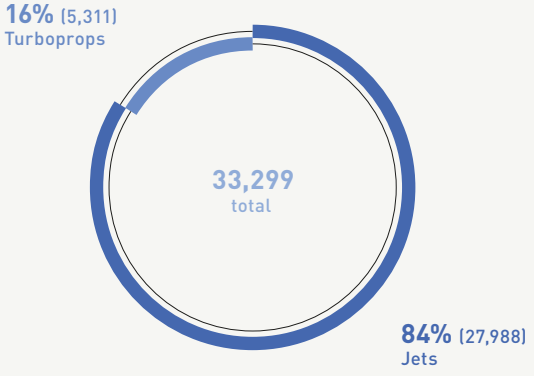
3,780 Airports with scheduled commercial flights[33] (it is estimated there are 41,764 airports and airfields in the world, including military and general aviation aerodromes[34]).

162 Air navigation service providers[35].

33,299 Commercial aircraft in service[36].

Jetting off

Aircraft in commercial service, by type 2019[37].

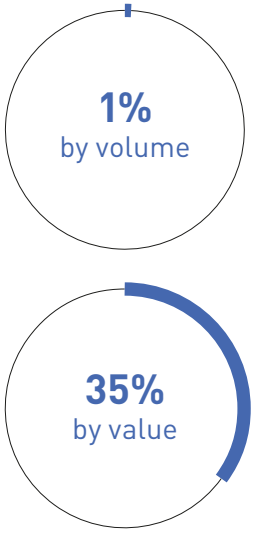


35%

Air transport carries around 35% of world trade by value and less than 1% by volume[38].

High value, time sensitive

Proportion of global trade transported by air[39].



61 million

Tonnes of freight handled by air, 2019[40].

$6.5 trillion

Value of cargo handled by air, 2019[41].

254 billion

Scheduled cargo tonne kilometres, 2019[42].

58%

Percentage of international tourists who travel by air[43].

CLIMATE TARGETS

Improve 1.5%

Aviation will improve its fleet fuel efficiency by an annual average of 1.5% between 2009 and 2020, a target the industry is tracking well above at an average of 2% improvement per annum 2009-2019.

Stabilise

From 2020, net carbon emissions from international aviation will be capped through carbon-neutral growth.

Reduce 50%

By 2050, net aviation carbon emissions will be half of what they were in 2005.

82.5% Average aircraft occupancy, 2019[55]: much higher than other forms of transport[56].

40 million

Litres of neat sustainable aviation fuel used by commercial flights in 2019 (32,000 tonnes). This was blended with traditional fuel in over 65,455 flights from five international airports (Los Angeles, San Francisco, Bergen, Oslo and Stockholm)[49]. Whilst this only represents less than 1% of the current fuel used in aviation globally, as this new source of fuel takes off, we will see this figure rise substantially.
Follow developments at www.enviro.aero/SAF

ENVIRONMENTAL PROGRESS

The air transport industry has made significant progress in reducing its environmental impact:

- » Decoupling CO_2 emissions growth (2.49% average from 1990) from air traffic growth (5.33%)[50].
- » CO_2 emissions per seat kilometre ▼ 80% since first jet aircraft in the 1950s.
- » Civil aerospace spends $15 billion per year on efficiency-related research and development.
- » A typical new generation single aisle aircraft coming off the production line today emits around 50 grams of CO_2 per seat kilometre (equivalent to 2 litres fuel burn per passenger for 100km, comparable to that of compact cars, although aircraft travel much further and faster).
- » Currently surpassing the first climate goal, with an average annual fuel efficiency improvement of over 2% between 2009 and 2019[51].
- » Over 11 billion tonnes of CO_2 avoided since 1990 through a combination of new technology, operational efficiencies and infrastructural improvements, including airlines spending over $1 trillion on 15,000 new aircraft since 2009[52].
- » The industry has invested in new technology, better operations and improved infrastructure. As an example, the average aircraft age in European fleet is around 11 years[53].
- » Perceived noise ▼ 75% since first jets.
- » Today's sustainable aviation fuels (SAF) can reduce CO_2 emissions by up to 80% over their lifecycle compared with fossil fuel. A tipping point for SAF will be reached when it powers 2% of all flights – this could be possible as soon as 2025[54].
- » Air traffic management modernisation, including the introduction of new technologies and procedures, is increasing capacity, shortening routes, improving efficiency and reducing delays, saving millions of tonnes of CO_2.
- » From 2021 onward, annual international aviation net emissions will be kept at or below the 2019 emissions level, using the world's first sector-wide market based measure, CORSIA.

363
billion

Litres of jet fuel used by commercial operators (290 million tonnes), 2019[44]. This is 8% of global liquid fuel use[45].

$188
billion

Amount the world's airlines paid for fuel, 2019. This is 23.7% of airlines' expenses[46].

914
million

Tonnes of carbon dioxide (CO_2) emitted by airlines, 2019[47]. This is 2.1% of the global human CO_2 emissions of around 43.1 billion tonnes[48]. Around 80% of aviation CO_2 is emitted from flights over 1,500 kilometres in length.

EXECUTIVE SUMMARY

This report provides a global view of a truly global industry. Oxford Economics analysed the economic and social benefits of aviation at a national level in 80 countries and used the results of that assessment to build the most comprehensive global picture of air transport's many benefits. Working with partners across the industry, the Air Transport Action Group (ATAG) has expanded the analysis to build a unique view of the air transport system, which creates and supports jobs, trade, connectivity, tourism, vital lifelines for many remote communities and rapid disaster response.

Every day in 2019...

- Nearly **12.5 million** passengers
- **128,000** scheduled flights
- **$18 billion** worth of goods carried[61]

Air transport is a major contributor to global economic prosperity

Aviation provides the only rapid worldwide transportation network, which makes it essential for global business and tourism. It plays a vital role in facilitating economic growth, particularly in developing countries.

Airlines transported over 4.5 billion passengers in 2019, with revenue passenger kilometres (the distance flown by all passengers) totalling nearly 8.7 trillion.

Air transport facilitates world trade. It helps countries contribute to the global economy by increasing access to international markets and allowing the globalisation of production. Nearly 61 million tonnes of cargo were carried by air in 2019.

The total value of goods transported by air, $6.5 trillion, represented 1% of all international trade.

Aviation is indispensable for tourism, a major engine of economic growth, particularly in developing economies. Globally, 58% of international tourists travel by air.

Connectivity contributes to improved productivity by encouraging investment and innovation, improving business operations and efficiency, and allowing companies to attract high-quality employees.

Aviation's global economic impact (direct, indirect, induced and tourism catalytic) was estimated at $3.5 trillion, equivalent to 4.1% of world gross domestic product (GDP).

These figures do not include other economic benefits of aviation, such as the jobs or economic activity that occur when companies or industries exist because air travel makes them possible, the intrinsic value that the speed and connectivity of air travel provides, or domestic tourism and trade. Including these would increase the employment and global economic impact numbers several-fold.

Around 1,478 airlines operate a total fleet of over 33,299 aircraft. They serve almost 3,800 commercial airports through a route network of several million kilometres managed by 170 air navigation service providers.

Landing zone

Top 10 airports by total passengers, millions, 2019[57].

Rank	Airport	Passengers 2019	Change
1	Atlanta Hartsfield-Jackson (ATL)	110.5 million	▲ 2.9%
2	Beijing Capital (PEK)	100.0 million	▼ 1.0%
3	Los Angeles (LAX)	88.1 million	▲ 0.6%
4	Dubai (DXB)	86.4 million	▼ 3.1%
5	Tokyo Haneda (HND)	85.5 million	▼ 1.7%
6	Chicago O'Hare (ORD)	84.6 million	▲ 1.7%
7	London Heathrow (LHR)	80.9 million	▲ 1.0%
8	Shanghai Pudong (PVG)	76.2 million	▲ 2.9%
9	Paris Charles de Gaulle (CDG)	76.2 million	▲ 5.4%
10	Dallas Fort Worth (DFW)	75.1 million	▲ 8.6%

Passport, please

Top 10 airports by international passengers, millions, 2019[58].

Rank	Airport	International passengers 2019	Change
1	Dubai (DXB)	86.3 million	▼ 2.9%
2	London Heathrow (LHR)	76.0 million	▲ 1.0%
3	Amsterdam Schiphol (AMS)	71.7 million	▲ 1.0%
4	Hong Kong (HKG)	71.3 million	▼ 4.1%
5	Incheon (ICN)	70.6 million	▲ 4.3%
6	Paris Charles de Gaulle (CDG)	69.8 million	▲ 5.2%
7	Singapore Changi (SIN)	67.6 million	▲ 4.2%
8	Frankfurt (FRA)	63.1 million	▲ 2.1%
9	Bangkok Suvarnabhumi (BKK)	52.9 million	▲ 4.1%
10	Taipei Taoyuan (TPE)	48.4 million	▲ 4.8%

Air transport is a major global employer

The air transport industry supported a total of 87.7 million jobs globally.

It provided 11.3 million direct jobs. Airlines, air navigation service providers and airports directly employed nearly 4.5 million people, and the civil aerospace sector, which manufactures aircraft systems, frames and engines, employed 1.3 million people. A further 5.5 million people worked in other on-airport positions.

There were 18.1 million indirect jobs generated through the purchases of goods and services from companies in the air transport industry supply chain.

Industry employees supported 13.5 million induced jobs through the spending of wages.

Aviation-enabled tourism generated around 44.8 million jobs globally.

Air transport invests substantially in vital infrastructure

Unlike other transport modes, the air transport industry pays for a vast majority of its infrastructure costs (runways, airport terminals, air traffic control), rather than being financed through taxation and public investment or subsidy (as is typically the case for road and railways).

In 2018, airports invested nearly $51.5 billion in construction projects, creating jobs and building new infrastructure[62].

The benefits to society of research and development spending by the aerospace industry are estimated to be much higher than in manufacturing as a whole. Every $100 million of spending on research eventually generates additional GDP benefits of $70 million, year after year.

Air transport provides significant social benefits

Air transport contributes to sustainable development. By facilitating tourism and trade, it generates economic growth, provides jobs, improves living standards, alleviates poverty and increases revenues from taxes.

The increase in cross-border travel is a reflection of the closer relationships developing between countries, both between individuals and at state level. In the same way, eased restrictions on the movement of goods and people across borders facilitate the development of social and economic networks that will have long-lasting effects. This improved flow of people and goods benefits the host and the originating countries, encouraging increased social and economic integration.

Air transport offers a vital lifeline to communities that lack adequate road or rail networks. For many remote communities and small islands, access to the rest of the world and to essential services, such as health care, is often only possible by air.

Aviation's speed and reliability are perhaps most immediately apparent in the delivery of urgently needed assistance during emergencies caused by natural disaster, famine and war. Air services are particularly important in situations where physical access is problematic.

Long haulage

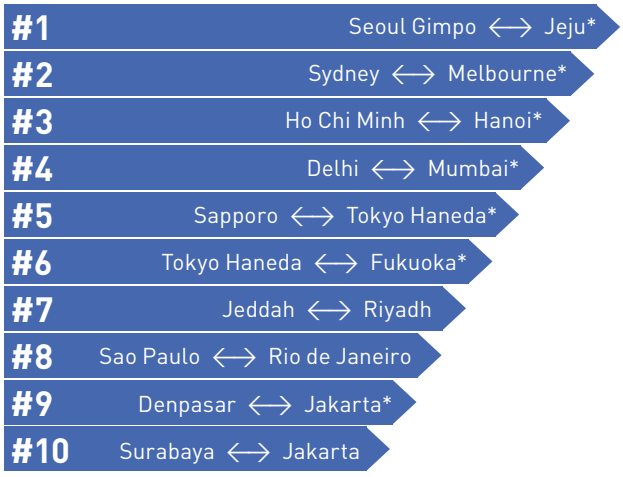
Top 10 airports by cargo tonnes, 2019[59].

Rank	Airport	Tonnes of cargo 2019	Annual change
1	Hong Kong (HKG)	4.8 million	▼ 6.1
2	Memphis (MEM)	4.3 million	▼ 3.3
3	Shanghai Pudong (PVG)	3.6 million	▼ 3.6
4	Louisville (SDF)	2.8 million	▲ 6.4
5	Incheon (ICN)	2.8 million	▼ 6.4
6	Anchorage (ANC)*	2.7 million	▼ 2.2
7	Dubai (DXB)	2.5 million	▼ 4.8
8	Doha Hamad (DOH)	2.2 million	▲ 0.8
9	Taipei Taoyuan (TPE)	2.2 million	▼ 6.1
10	Tokyo Narita (NRT)	2.1 million	▼ 6.9

**Includes transit freight*

High frequency

Top 10 busiest airport pair routes (by flights), 2019.
Those with * are also in the top 10 by seat numbers[60].



Air transport is working to mitigate its environmental impact

Airline operations produced 914 million tonnes of carbon dioxide (CO_2) in 2019, 2.1% of the total human carbon emissions of around 43.1 billion tonnes.

The aviation industry agreed in 2008 to the world's first set of sector-specific climate change targets. The industry is well on track to achieve the first target to improve fleet fuel efficiency by 1.5% per year until 2020, through achieving an average 2% improvement per annum. From 2020, aviation will cap its net carbon emissions while continuing to grow to meet the needs of passengers and economies. By 2050, the industry has committed to reduce its net aviation operational carbon footprint to half of what it was in 2005.

Waypoint 2050 demonstrates that there are potential options for the almost complete decarbonisation of air transport with the industry at a global level able to meet net zero emissions a decade or so after 2050 (and some regions and companies able to reach this point sooner). This assumes the right level of support from governments, the finance sector, the energy industry and research institutions. The industry itself will need to redouble efforts as well.

>> **Waypoint 2050: www.aviationbenefits.org/W2050**

Companies across the sector are collaborating to reduce emissions using a four-pillar strategy of new technology, efficient operations, improved infrastructure and market-based measures to fill the remaining emissions gap.

Modern jet aircraft are 75% quieter than the models that first entered service, and each new generation of aircraft continues this downward trend.

Today's sustainable aviation fuels can reduce CO_2 emissions by up to 80% over their lifecycle compared with fossil fuel. A tipping point for these fuels will be reached when they power 2% of all flights – this could be possible as soon as 2025 with the right political willingness and investment.

Aviation brings unparalleled connectivity

Aviation is an integral part of any future transport ecosystem. It provides overall global mobility and is in many cases the only practical connection in a national and international context: both for global routes between developed and emerging economies, between international business centres and also access to remote communities where building rail or road infrastructure would be too costly.

Changes in trade policies will have a dent on future global benefits of aviation

Forecasts suggest that in 2038 aviation could see over 8.2 billion passengers and support 143 million jobs and $6.3 trillion in economic activity.

However, if growth were to slow due to restrictive trade, immigration and political factors, the total number of jobs supported by the air transport sector (including air transport-supported tourism) could be more than 5.5 million lower than the base forecasts. The contribution of the air transport sector to world GDP could be $200 billion (2018 prices) lower, with an additional $94 billion lost through lower tourism activity.

A GLOBAL INDUSTRY, DRIVING SUSTAINABLE DEVELOPMENT

Aviation's **global economic, social and environmental profile** in 2018

Before Covid-19 hit, the global air transport industry supported 87.7 million jobs worldwide and contributed $3.5 trillion (4.1%) to global GDP.

Aviation plays a critical role in sustainable development. Although the core economic, social and environmental elements of sustainability have long been understood, the United Nations 2030 Agenda for Sustainable Development set 17 more specific sustainable development goals (SDGs) that the world should aim to achieve by 2030. A number of these goals are based on improving the living conditions and economic prosperity of people all over the globe. The SDGs are backed up by around 170 statistical indicators.

To realise these ambitious goals, the international community must work towards shared sustainable economic growth, creating jobs and boosting economic activity worldwide. Aviation, as a global transport sector, is playing an instrumental role in supporting this task and is committed to finding additional ways to contribute. The following assessment provides a specific zoom on how the sector contributes to the SDGs through economic and social benefits, but is not an exhaustive list of all aviation's contribution to the UN's sustainability goals.

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

ENABLING ECONOMIC GROWTH

Direct impacts

The industry itself is a source of considerable economic activity, creating jobs that directly serve passengers at airlines, airports and air navigation service providers (ANSPs). These include check-in, baggage handling, on-site retail, cargo and catering facilities. However, aviation also directly enables high-skilled jobs in the manufacturing sector with those companies that produce aircraft, engines and other vital technologies.

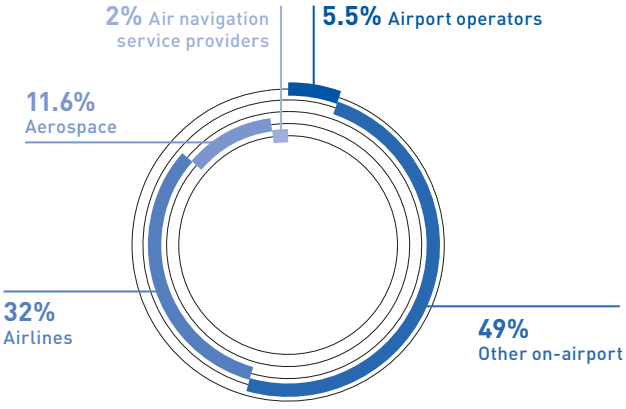
The world's 1,478 airlines collectively transported 4.5 billion passengers to 3,780 commercial airports all over the globe in 2019 and carried 61 million tonnes worth of freight. To enable this activity, the industry generated 11.3 million direct jobs and added $961.3 billion to global gross domestic product (GDP). To put that into context, that is equivalent to 1.1% of global GDP, or similar to the basic metals industry ($968 billion)[63].

The air transport industry directly provided an estimated 11.3 million jobs worldwide:

- The airport sector accounted for 6.17 million jobs (55% of the total). Of these, 648,000 positions were with airport operators (such as airport management, maintenance and operations). On-site employment (for example at retail outlets, restaurants, hotels, government agencies) created an extra 5.5 million jobs, or 49% of the total.
- 3.6 million jobs (32% of the total) were provided by airlines (for example, flight crew, check-in staff, maintenance crew, reservations and head office staff).
- In the manufacturing sector, 1.3 million jobs (11.6%) were supported, employing people in the building of civil aircraft and their associated parts, such as engines, electronic systems and components.
- Air navigation service providers employed an additional 237,000 people (2%).

What we do

Direct employment in air transport by segment[64].



Growth in traffic at airports also brings growth in the direct jobs generated. A common rule-of-thumb calculation is for every million passengers an airport handles around a thousand jobs are created on-airport[65]. This impact reduces slightly as airports grow (due to efficiencies of scale), and this only relates to direct jobs at an airport and not the wider employment and economic benefits of connectivity growth across the economy (or even in indirect and induced employment).

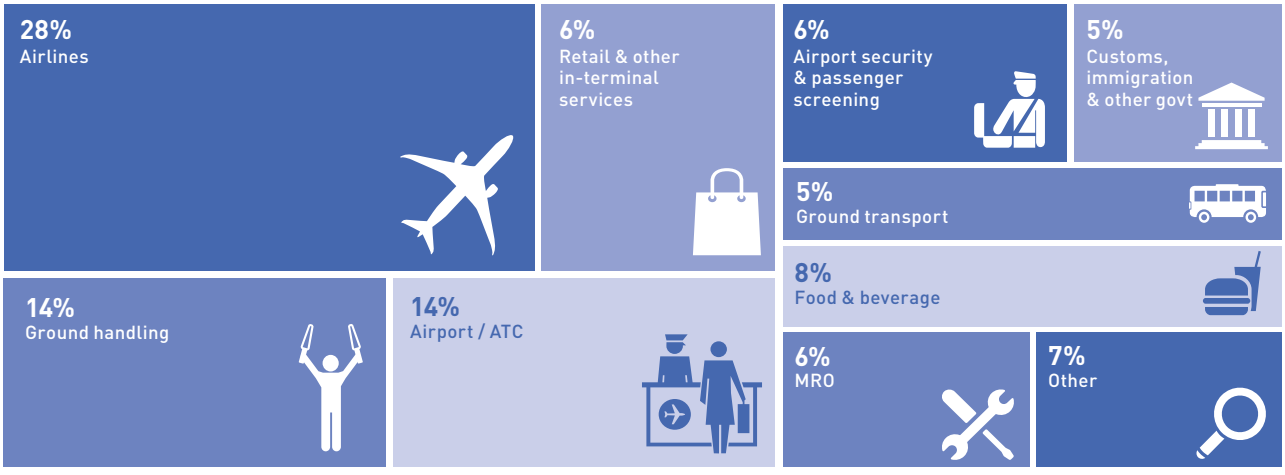
Growing in tandem

How growth in passenger numbers helps support growth in direct employment[66].

Airport size	Each 1,000 passenger movements generates
0 — 1 million passengers	+1.20 jobs
1 — 10 million passengers	+0.95 jobs
Over 10 million passengers	+0.85 jobs

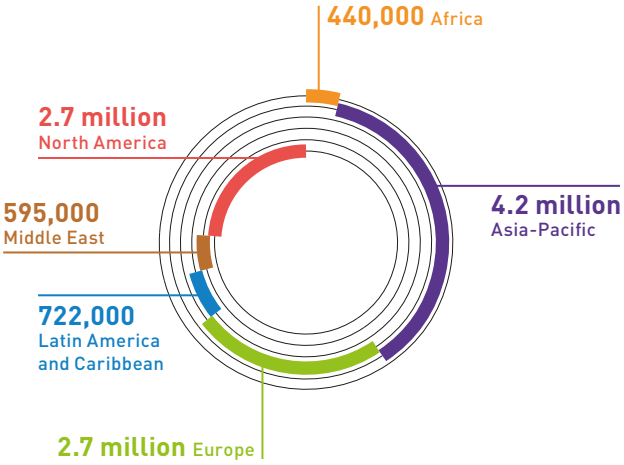
On the ground

Overview of the types of jobs at a typical European airport[67].



Where we work

Direct employment by air transport by region[68].



The role of many parts of the industry is well known, but there are a number of players who are not quite so visible. Ground handlers provide contract services for airlines, often when the airline has a limited number of flights into an airport and employing its own staff would not make sense. These can be check-in, gate agent, dispatch, fuelling and cleaning services for airlines. Four of the world's largest independent ground handling companies, Swissport, dnata, Menzies and Worldwide Flight Services, employed an estimated 170,600 staff between them[69]. Many airports and airlines also employ their own ground handling teams.

The economic impact of the aviation industry does, however, go further than just its direct impacts. The consequential economic benefits of both additional jobs and GDP should also be considered. These benefits demonstrate at least partially the breadth of air transport's economic reach.

Indirect impacts

Indirect impacts include employment and activities of suppliers to the air transport industry – for example, aviation fuel suppliers; construction companies that build airport facilities; suppliers of sub-components used in aircraft; suppliers of products such as radars and satellite-based navigation systems to the air traffic management industry; manufacturers of goods sold in airport retail outlets; and a wide variety of activities in the business services sector (such as call centres, information technology and accountancy).

Just over 18.1 million indirect jobs globally were supported through the purchase of goods and services by companies in the air transport industry. This supply chain activity contributed approximately $816.4 billion to global GDP.

Induced impacts

The spending of those directly or indirectly employed in the air transport sector supports additional jobs in industries such as retail outlets, companies producing consumer goods and a range of service industries (such as banks, telecommunication providers and restaurants). Worldwide, 13.5 million induced jobs globally were supported through employees in the air transport industry (whether direct or indirect) using their incomes to purchase goods and services for their consumption.

The induced contribution to global economic activity was estimated at $693 billion.

Supporting wider economic development

Although this report has explored the direct, indirect and induced impacts of the global aviation industry, there is far more to air transport's economic impact. Many other industries rely on effective air links to function.

- One of the industries that relies most heavily on aviation is tourism. Without the connectivity provided by flight, many countries that rely on a steady inflow of tourists (particularly developing countries in regions remote from their source tourism markets) would not be able to enjoy their present levels of economic growth.
- World trade in a vast range of commodities and services is facilitated by air travel, increasing countries' access to international markets and allowing the globalisation of production.
- Countries also need connectivity to fully participate in the worldwide economy, encouraging higher productivity, investment and innovation. Connectivity helps businesses operate efficiently and attract high-quality employees.
- Air transport plays an especially pivotal role in 'just-in-time production' where parts are only produced and delivered in the quantity and at the time actually required to fulfil customer orders, and in speeding fresh produce to global markets.
- Airports play an increasingly important role in supporting the communities they serve through direct and indirect employment, diverse economic activity and the catalytic economic benefit they bring to local, regional and national economies.
- These wider economic benefits have been acutely felt in 2020 with the global shutdown of travel and tourism. Whilst it is too early to show the total final cost of Covid-19 (beyond the human cost), a significant proportion of the economic damage has been done by a halt in connectivity.

Other than for tourism, the exact economic impact of these wider benefits is difficult to determine given the complexity of the global economy. Tourism's effects are easily assessed. Since reliable data exists, its flow-on impacts and the economic links between the two industries are explored below.

Aviation supports tourism

Tourism represents a significant contribution to the worldwide economy, providing employment and boosting global economic activity. In 2018, tourism supported 319 million jobs and made up 10.4% of world GDP, a total of $8.8 trillion[70]. For example, these employment figures include the people who work for the world's nearly 60,000 IATA-accredited travel agencies[71].

According to the World Travel & Tourism Council, the sector's growth will continue into the future, with average annual growth of 3.7% expected up until 2029. If these predictions prove correct, by 2029 tourism should account for 11.5% of global GDP ($13.1 billion) and provide 421 million jobs globally (11.7% of total employment)[72] .

Tourism's growth, which is above the average of wider economic growth, is dependent on travel, particularly air transport. In 2018, 58% of international tourists travelled to their destination by air[74]. Tourists spent approximately $902 billion in 2019, a 7.1% increase on the year before[75]. For developing countries in particular, air links provide a vital economic lifeline to communities. In Africa, including direct, indirect and induced impacts, an estimated 7.7 million people are employed in areas supported by the steady influx of overseas visitors, most of whom arrive in the region by air. In addition, these arrivals by air supported an estimated $44 billion contribution to GDP in African economies in 2018[76].

Tourism supported over 10% of the global economy and 319 million jobs.

For small island states, the economic input provided by international tourists is invaluable. These countries, many of which are in remote parts of the world, enjoy tourism-induced economic boosts which would not be available without air links.

The contribution of air transport to tourism employment and GDP:

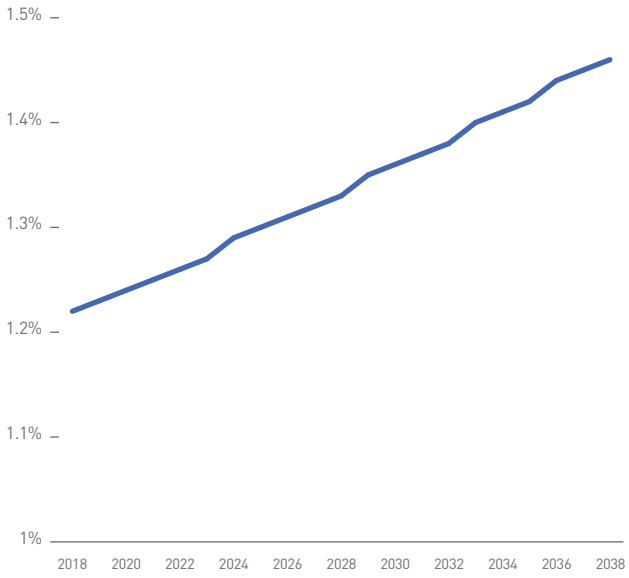
- **Direct:** An estimated 19.6 million direct jobs in tourism globally were supported by the spending of foreign visitors arriving by air. This includes jobs in industries such as hotels, restaurants, visitor attractions, local transport and car rental, but it excludes air transport industry jobs.
- **Indirect:** A further 16.4 million indirect jobs in industries supplying the tourism industry were supported by visitors arriving by air.
- **Induced:** These direct and indirect tourism jobs supported by air transport generated a further 8.7 million jobs in other parts of the economy through employees spending their earnings on other goods and services.

When these factors are viewed together, air transport supported 44.8 million jobs within the tourism sector, supporting $1 trillion a year to global GDP[78].

Travel and tourism competitiveness is increasing worldwide, especially in Europe, Asia-Pacific, the Middle East and North Africa[79]. The trends show that tourism from, and between, developing economies is growing steadily; however, as incomes rise in emerging economies and airfares fall, one of the obstacles to international travel remains restrictive visa

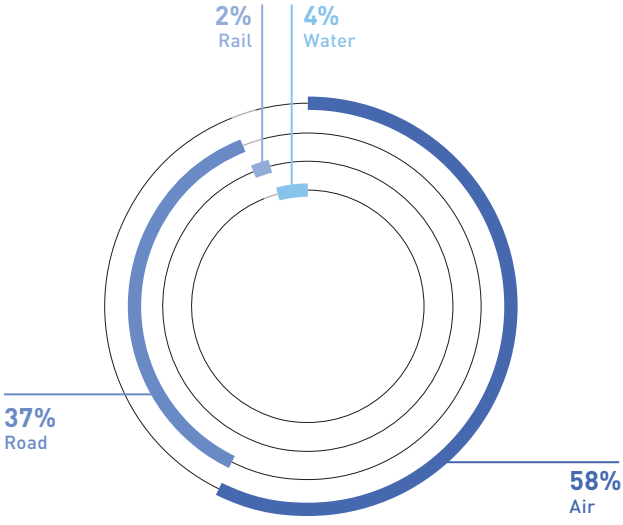
Onwards and upwards

Contribution to global GDP from international tourism facilitated by aviation, 2018-2038[73].



Getting you there

Travel modes of international tourists, 2018[77].



regimes, even for tourism purposes. The good news is that the trend shows countries are realising the unnecessary barrier that these entry procedures place on their own tourism sector, curtailing economic opportunities and job creation.

According to the UN World Tourism Organization, in 2018 destinations worldwide required 53% of the world's population to obtain a visa prior to departure, a significant improvement from 2008, when 77% of the world's population was made to apply for a traditional visa. Over the same decade, the destinations without visa requirements has only increased from 17% to 21% but the number of countries allowing visa-on-arrival or electronic visas has increased (6% to 16% for visa upon arrival and 0% to 10% for electronic visa)[80].

A driver of global trade

The international trade of goods and services is one of the key drivers of global economic growth and development. The ability of people and businesses to trade with others all over the world is one of the key features of our modern, globalised society. Alongside the internet and other transport modes, air transport is a vital enabler of the global economy.

$6.5 trillion worth of goods was transported internationally by air in 2018.

Air transport is, of course, not the only means of transporting goods over long distances, with shipping and trucking making up a larger proportion. For time-sensitive global industries, however, such as those that require components produced in multiple parts of the world, air freight is the best way to ensure that production lines run smoothly and efficiently.

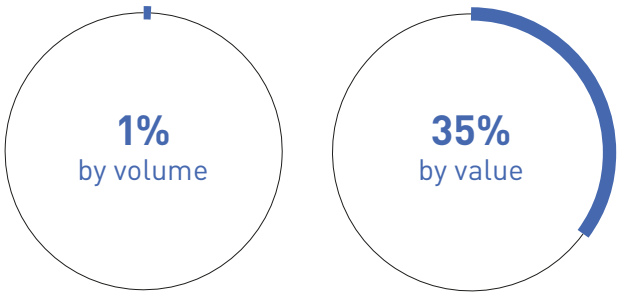
In the past years, driven by advances in internet commerce, a whole new sector of rapid delivery 'e-commerce' businesses have been established and are thriving entirely based on the ability to move goods to consumers safely and quickly. Since 2005, global internet retail sales have grown above 20% a year on average, according to Euromonitor International, much faster than traditional store-based sales[81]. Express cargo carriers, such as DHL, UPS and FedEx, have benefited from the rise of e-commerce, and the value of air transport in this sector was once again highlighted in 2016, when online retailer Amazon branched out its business and began operating 40 Boeing 767 freighters[82], adding another 20 Boeing 737 cargo aircraft in 2019 and announcing to have a portfolio of 70 aircraft by 2021[83].

The pharmaceutical industry is one sector that relies heavily on air transport to move drugs and vaccines across long distances under strictly regulated storage conditions. In some cases, it is the perishable nature of the goods that require swift transportation. In other situations, such as vaccines, it is the necessity of getting the products to the people who need them as quickly as possible. At the height of the Covid-19 response, air transport's unique airlift capabilities allowed governments to rapidly accelerate the delivery of ventilators, personal protective equipment and to repatriate citizens in an effort unlike the world has ever seen. The capabilities of air transport will also be seen once a vaccine is available and needs to be rapidly distributed worldwide.

The specialist nature of air freight is highlighted by comparison with other modes of transport. While air freight accounts for less than 1% of the tonnage, it makes up around 35% of the value of international trade.

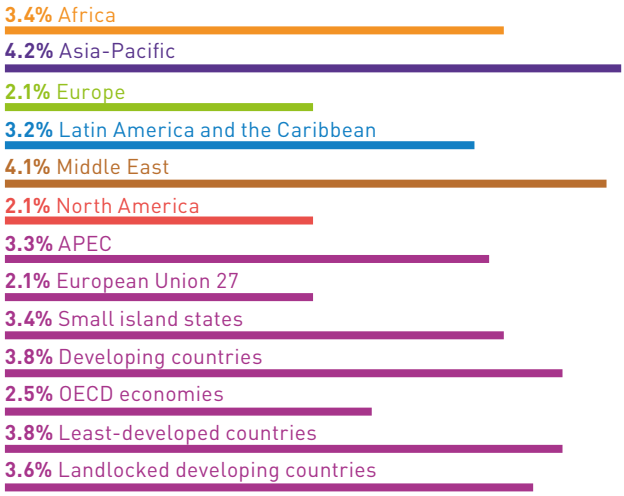
Small volumes, big values

Air freight by volume and by value, 2019[84].



Sustaining growth

Projected average annual growth rate for international traffic by region, 2018-2038[85].



Bringing business partners together

The sharp increase in the level and quality of telecommunication technology has made meetings between business partners easier to undertake without travelling long distances in person. However, while virtual meetings are useful in some situations (and has particularly shown its worth during the Covid-19 shutdown), in many cases professionals feel that in-person interactions are far more effective. This is often due to the fact that rich details can be seen from each other during a face-to-face meetings: from body language, mannerisms and subtle tone of voice to how one enters the room and the small talk shared in side-line conversations – factors that can be crucial for decision making, negotiations and team building. Some of these factors can be captured with live video of virtual meetings but they are still limited to a flat representation of a person and the quality of the connection. The personal relationships built up between representatives of companies are considered to be an important part of business. In some countries, for example China and Brazil, it is customary to interact and bond with a client or possible business partner on a personal level before carrying on with important business. To earn trust, in-person meetings are an essential investment[86].

A Harvard Business Review survey found that despite advances in technology, business travel remained essential, with 79% of respondents viewing in-person meetings as the most effective way to meet clients and sell business and 89% saying that face-to-face meetings are essential for sealing a deal[87]. Face-to-face requests have also been shown to be 34 times more likely than virtual communications alone to garner positive responses[88]. While the industry is expecting a slow return to business travel in the post-Covid environment, this segment will eventually return as businesses confirm the richness of interaction available via in-person meetings.

Fronting up the cash

When one looks at the array of air transport infrastructure around the world, such as airport terminals, runways and air traffic management, it is easy to forget that the vast majority is financed by its end users: passengers and shippers. The aviation industry on the whole pays for its infrastructure, rather than relying on government investment or subsidies. This is in stark contrast to other modes of transport, such as rail and road.

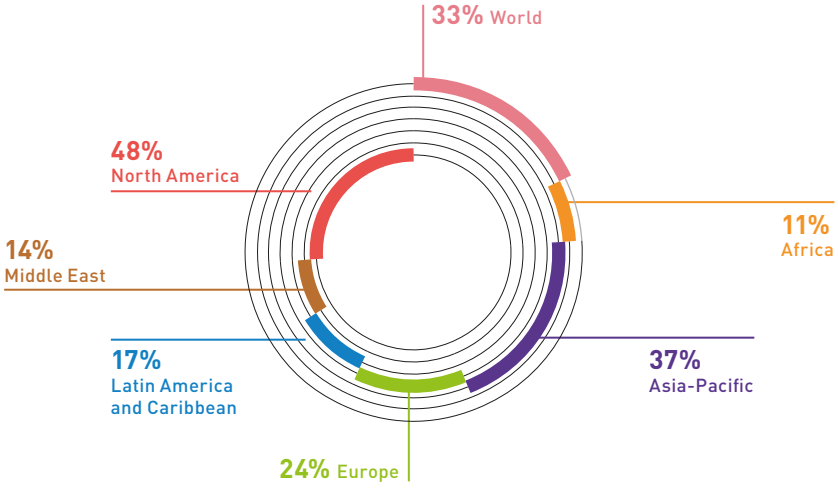
The investments made by the industry in developing its infrastructure, particularly on-airport, lead to further benefits for local communities, often providing skilled labour for construction as well as long-term regional benefits from improved surface access and employment. Airports are wealth generators as a result of increased economic activity. Their socio-economic impact and multiplier effect extend to the broader economy. Some $51.4 billion was invested in airport infrastructure in 2018, with most investment taking place in North America, followed by Asia-Pacific and Europe[89].

To give a sense of the potential magnitude of the increase in passenger numbers from airport infrastructure investment, Oxford Economics compared the per capita airport infrastructure investment in 50 countries with the increase in air arrivals relative to each country's population over the same period[91]. This analysis found that an increase in airport infrastructure investment of $100 per capita over the nine-year period is associated with nearly 50 more passenger arrivals per capita, on average[92]. These additional passengers would have spent money on goods and services, forged friendships and cultural connections, and done business, all of which would have stimulated economic activity and jobs.

Operational costs in aviation are funded through user charges (on passengers and airlines) and airport commercial revenue. Passenger-based charges are generally included in the price of the airline ticket, while aircraft-based charges are directly invoiced to airline clients. When investing in modern aircraft and airport construction to meet industry growth, it is vital that air traffic management is also upgraded and modernised to cater to increasing demand. Investment is needed to increase capacity, efficiency and avoid congestion and delays.

Building the future

Airport infrastructure investment as % of total revenue, per region 2018[90].



Paying our own way

Relative to other modes of public transport, such as rail and road which are subsidised, aviation covers most of its infrastructure costs and air transport compares favourably as a cost-effective sector.

Analysis for the European Commission shows that, relative to other modes of public transport such as rail and bus/coach which are often heavily subsidised, aviation covers most of its infrastructure costs[93]. For each mode of transport, the study assessed the cost of infrastructure and externalities, comparing them to taxes and charges levied. All modes of passenger and freight transport were considered including road, rail, inland waterway, maritime and aviation. Externality costs include accidents, air pollution, climate change, noise, congestion, well-to-tank emissions and habitat damage. Airlines and their passengers pay the cost of the infrastructure they use in the EU, both on the ground and in the air (air traffic management). By contrast, the infrastructure costs for rail are significantly higher relative to aviation. The total infrastructure costs for rail are estimated at €81 billion (versus €14 billion for airports). The revenue from taxes and charges on rail users covers only a relatively small portion of infrastructure costs for diesel, electric and high-speed trains.

According to the European Commission, rail subsidies in Europe totalled roughly $59.4 (€50) billion in 2018[95]. Meanwhile, aviation subsidies (primarily for public-service obligation routes to remote communities and small islands) were in the order of $149.3 (€135.3) million across the EU in 2017 – or around 2% of the subsidies given to rail[96]. These figures will be considerably different for the 2020 year as governments seek to support vital sectors during the Covid-19 crisis.

In developing economies, some air transport infrastructure is financed through World Bank project loans. In 2018, this amounted to $979 million in investment, a decrease of 4% from the previous year due to the completion and closing of larger airport infrastructure projects. This amounts to only 2% of the World Bank's $48.2 billion transport portfolio (which itself is less than a sixth of total invested that year). The 44 projects funded included reforming the Pacific Aviation Safety Office to deliver regional aviation safety and security oversight; airport infrastructure development in Bolivia, Vanuatu and the Democratic Republic of Congo; airport safety improvement in Bhutan; air traffic management (ATM) modernisation in Kenya; assessment of the Sint Maarten Airport following a devastating hurricane; and advisory services in Yemen[97].

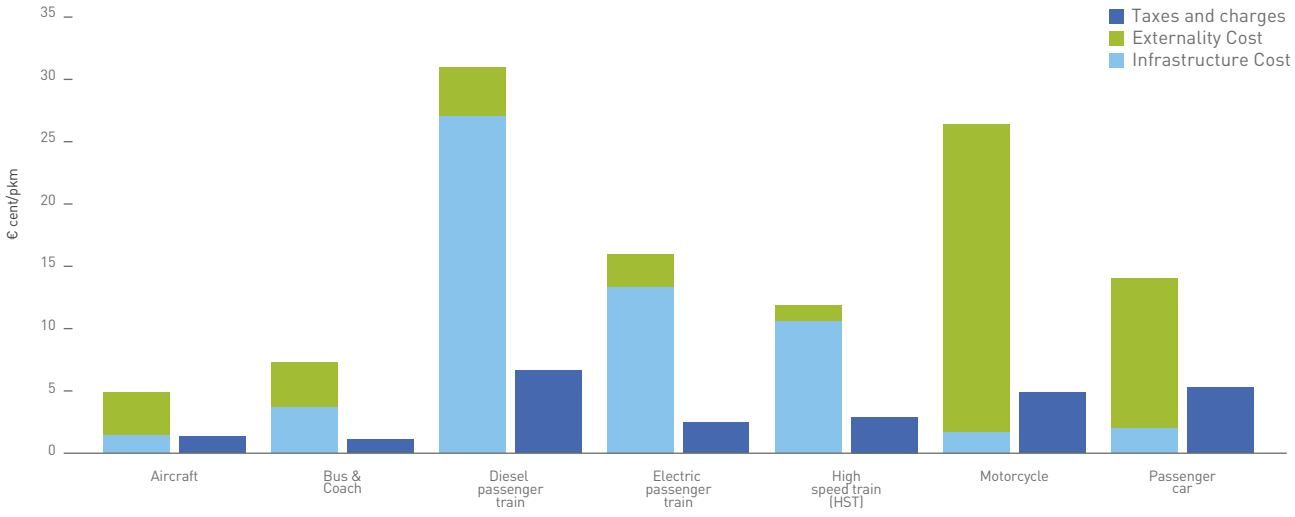
There is significant scope for international financing to help improve connectivity, particularly for remote regions. Governments could ensure that air transport is part of their mobility planning for both urban and rural access and could access funding from multilateral institutions.

The Single African Air Transport Market (SAATM) is a flagship project of the African Union Agenda 2063 to create a single unified air transport market in Africa to advance the liberalisation of civil aviation and act as an impetus to the continent's economic integration. SAATM will ensure aviation plays a major role in connecting African countries, promoting its social, economic and political integration and boosting intra-Africa trade and tourism as a result.

It is the role of States to ensure that improvements in ATM infrastructure are properly financed. As there are long lead times for procuring new equipment, such as air traffic control centres and the latest surveillance equipment, ATM investment needs long-term planning. Many air navigation service providers (ANSPs) have difficulty acquiring funding to modernise infrastructure, as most are government-owned and compete with other government departments, such as health, education and defence, in the budget process. The Civil Air Navigation Services Organisation, which represents ANSPs, is therefore calling for countries to separate responsibility for providing air navigation services from their regulatory function and allow ANSPs, where appropriate, to operate more as normal businesses and seek funds from investors.

European transport

Comparison of the costs of transport infrastructure, versus the tax and charge revenue[94].



Stimulus for greater productivity

Arguably, the largest economic benefit of increased connectivity comes through its impact on the long-term performance of the wider economy by enhancing the overall level of productivity. A rise in productivity in firms outside the aviation sector comes through two main channels: the effects on domestic firms of increased access to foreign markets and increased foreign competition in the home market and the freer movement of investment capital and workers between countries.

Improved connectivity

- » opens new markets, boosts exports and increases competition and choice in the home market from foreign-based producers, encouraging firms to specialise in areas where they possess a comparative advantage;
- » drives down costs and prices for firms that have a comparative advantage (such as innovative products and services), benefitting domestic consumers in the process;
- » opens domestic markets, which can also be an important driver for reducing unit production costs, either by forcing domestic firms to adopt best international practices in production and management methods or by encouraging innovation; and
- » benefits domestic customers through competition by reducing the mark-up over cost that firms charge their customers, especially where domestic firms have hitherto enjoyed some shelter from competition.

Improved connectivity can further enhance an economy's performance by making it easier for firms to invest outside their home country, which is known as foreign direct investment. This necessarily entails some movement of staff, whether for technical know-how, management oversight, or servicing and meeting customers. Increased connectivity also allows firms to exploit the speed and reliability of air transport to ship components between plants in distant locations, without the need to hold expensive stocks of inventory as a buffer.

Less tangibly, but just as importantly, improved connectivity increases passenger traffic and trade. This, in turn, can lead to a more favourable environment in which foreign firms can operate – greater links to the outside world often drive a more conducive global business environment.

How aviation affects productivity

Quantifying the impact that improved air links have on a country's GDP is a difficult task. There are many factors to this calculation, and the complexity makes any assertion, at best, an estimate. However, there are some broad indicators that can be used to make an informed determination.

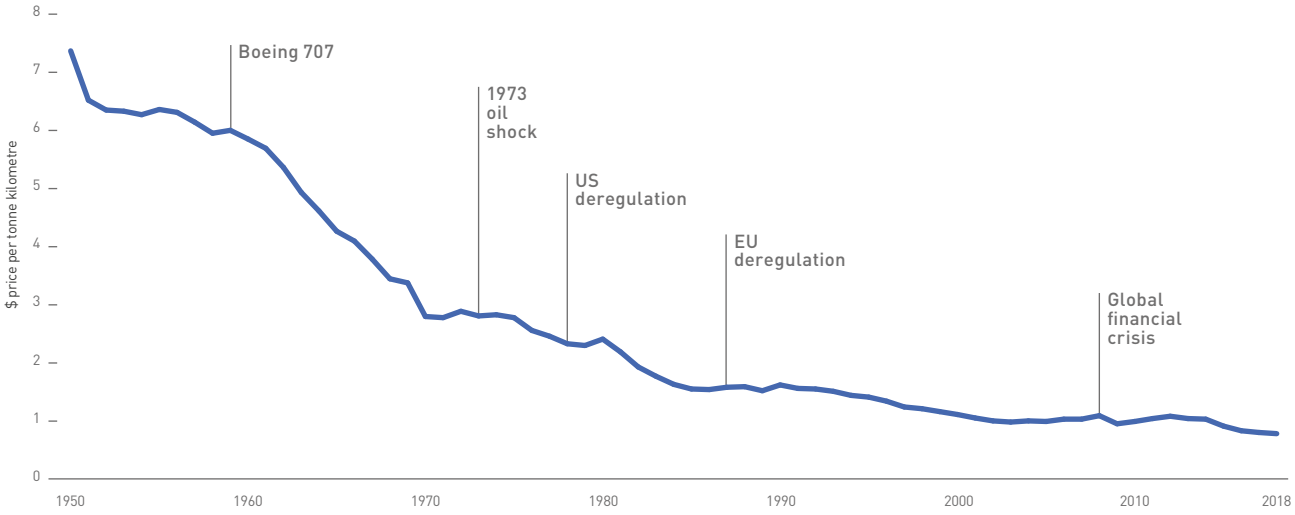
The International Air Transport Association (IATA) has developed a connectivity indicator that measures the degree of integration a nation has within the global air transport network. Using it, IATA has linked connectivity to economic performance to make a conservative estimate of the value of the sector to national economies.

Research suggests that a 10% increase in a country's global air connectivity (relative to GDP) results in a 0.5% increase in long-run GDP per capita. Oxford Economics estimates that rapidly rising global connectivity over the past two decades boosted global GDP by $200 billion in 2014, a number that continues to grow.

Analysis shows a positive relationship between connectivity to the global network as a proportion of GDP and labour productivity, and hence higher GDP and living standards among developing economies. For developed countries, there is still a positive relationship but with smaller incremental impacts once a threshold level of connectivity as a proportion of GDP is reached[98].

A good deal

Evolution of the average price of air travel ($ per revenue tonne kilometre), in real terms[105].



A driver of innovation

Since the dawn of air travel, aviation has been at the forefront of technological innovation, researching and developing disruptive, ground-breaking technology with each new generation of aircraft. There are many motivations for this drive in technological advancement. Not only do more efficient aircraft, engines and air navigation systems have a positive environmental impact through reduced fuel use and associated emissions but they also lower fuel costs for airlines in the long term, also leading to more affordable air travel.

Aviation's focus on technological innovation has other benefits for society. It encourages research at universities and results in a highly skilled section of a country's workforce. The benefits to society of research and development spending by the aerospace industry are estimated to be much higher than in manufacturing as a whole – every $100 million of investment into research eventually generates an additional $70 million in GDP year after year[99].

Aerospace also drives the development of technologies that can be used in other sectors. The aviation sector was one of the pioneers in the use of additive layer manufacturing (also known as 3D printing). Many components of next-generation aircraft will be made using this technique. Composite materials, such as carbon fibre and ceramic composites, also owe much of their development to aviation research and development – and make up significant proportions of the finished product of modern, lightweight aircraft, such as the Boeing 787 and Airbus A350 XWB.

In economic impact, the aerospace sector plays a substantial role in the regions where it is based. According to the Aerospace and Defence Industries Association of Europe, civil aeronautics in Europe created a $150.6 (€126.7) billion turnover, with $10.7 (€9) billion invested by private and public stakeholders in research and development in 2018[100]. Exports from European civil aerospace manufacturers totalled $115.3 (€97) billion in the same year. In the United States, total civil aerospace exports amounted to a $131.5 billion contribution to the national economy in 2018[101].

Affordability of air travel

A key driver in the growth of passenger traffic has been the steady decrease in the real price of air travel – by nearly 90% since jet aircraft first flew in 1950. Indeed, since 1970 the real price of air travel has been reduced more than 70% through the deregulation of the aviation market in the 1980s, the development of more fuel-efficient aerospace technologies and the introduction of low-cost carriers. Compared to twenty years ago real air transport costs have more than halved. It is now more affordable for more of the population to travel by air.

In the United States, for example, the average domestic round-trip airfare fell by 35% between 1990 and 2019[102]. This decrease in cost has led to an increase in the accessibility of air travel – the democratisation away from a pursuit just for the wealthy to a part of normal, middle-class life, especially in the developed world. According to a recent survey, 86% of American adults have flown at least once in their lives, with 45% in the past 12 months[103]. Statistics in the United Kingdom show similar results. The majority of UK adults (54%) have flown within the last 12 months, whilst only 6% have never flown before[104]. But flying is also becoming increasingly accessible in the developing world, with low-cost carriers opening up business and leisure travel to more and more citizens.

The impact of taxes

Tax revenues are vital to finance social and economic programmes administered by the state. Globally, in 2018 airlines paid governments $125 billion in tax ($129 billion in 2019)[106]. On top of this are billions of dollars in income taxes paid by industry employees and corporate taxes contributed by manufacturers and airports.

However, a tax that is levied on individual consumers or firms could represent a market distortion. There are jurisdictions where providers and users of aviation infrastructure face a significant tax burden. This, in turn, may lead to a loss in competitiveness and opportunities for air service development aimed at enhancing connectivity and trade. Inefficient and burdensome tax measures that increase the cost of air travel will have a negative effect on demand. This, in turn, will hamper economic growth.

Consistent with the International Civil Aviation Organization (ICAO) Policies on Charges and Taxation, taxes on international air transport services should only be levied in a justifiable, equitable and non-discriminatory manner.

SUPPORTING SOCIAL DEVELOPMENT

Sustainable development is not just about working towards economic progress in an environmentally sustainable way. A significant aspect of this concept is improving the lives of people in ways other than financial prosperity. These socially based ambitions are an important part of the Sustainable Development Goals and are supported in many ways by civil aviation.

For many people all over the globe, the ability to travel to any other country is an invaluable asset, relied on to visit friends and relatives, move abroad for work and study or, of course, go on holiday. Without air transport, being able to travel and experience new countries and cultures would be far more difficult – and certainly impossible in a short time span. And when the most acute crises happen, air transport can literally make the difference between life and death.

Ensuring well-being: visiting friends and relatives

The third sustainable development goal, which relates to well-being, is about more than just physical health. Families in the 21st century are a prime example of how globalisation has changed the modern world. Many families are now spread all over the world as people move for employment opportunities, education or simply for personal choice. This has resulted in far greater cross-border ties between individuals and countries.

The United Nations' International Labour Organization estimates that in 2017, 164 million people were migrant workers – a rise of 9% since 2013, when they numbered 150 million. Globally, it is estimated that migrant workers make up 4.7% of all workers. The majority of migrant workers (87%) are employed in high- or upper middle-income countries, including in North America, the Arab States and Europe. The large presence of migrant workers in high-income countries is reflected in their share of all workers in those countries, at 18.5%. In other words, one in six workers in high-income countries travelled there from another country.[107]

Many of the host countries of migrant workers, particularly in Europe, have ageing populations. This makes the international labour market essential for their long-term economic well-being, supporting those of pensionable age.

A prime example of how cross-border ties have strengthened is the geopolitics of the European Union and associated countries, where the free movement of people and goods has been enabled by the Schengen Agreement of 1985. Although recent political developments have dented confidence in this arrangement, it remains one of the cornerstones of European integration. Naturally, many European citizens are able to travel across national borders by modes of transport other than air travel, such as rail, road, or even by foot. However, in many cases, flying is the quickest, most secure and most cost-efficient means of travelling between European nations. Almost every intra-European flight can be completed in less than three hours, allowing individuals and businesses to connect seamlessly and consolidating personal ties and business relationships.

Connecting you, wherever you are

There are over 3,780 airports globally, the best known of which handle millions of passengers. However, perhaps some of the most important airports are not very well known at all, except to the small communities they help connect to the outside world. Half of these airports rely exclusively on regional-sized aircraft due to capacity constraints and 36% are limited to turboprop aircraft[108]. In the Arctic, across vast stretches of wilderness and on small island states all across the world, air services can provide connections to regional centres and the rest of the world that otherwise would not be available and without the need for expensive and challenging road infrastructure development.

Studies have shown that access to air services not only helps remote communities with vital lifeline needs but also economic development, including the ability to attract and retain businesses and professionals, particularly those with travel needs to maintain proficiency in their field. Greater aviation activity in a region is correlated with some increase in the growth in population, employment, or per capita incomes[109]. One study found that a 1 percent increase in traffic at an airport receiving subsidised Essential Air Service in the United States was related to a 0.12 percent increase in per-capita income. US government support for otherwise un-economic air routes has a considerable benefit for 173 communities, of which 65 are in Alaska and Hawaii, far beyond the cost of the subsidy to the government[110]. In Europe, support is provided to 176 'public-service obligation' routes, most of which are in France and Greece with its thousands of islands[111]. In Australia, the Remote Air Services Subsidy helps connect 372 communities (266 directly serviced locations and a further 106 neighbouring communities) across a vast continent – some of these cattle stations and indigenous communities are as small as six people, others have up to 200 residents[112]. In Malaysia, the Transport Ministry signed an agreement in 2019 to operate 40 rural air service routes in Sabah and Sarawak on the island of Borneo to help promote national connectivity and provide support for remote communities[113].

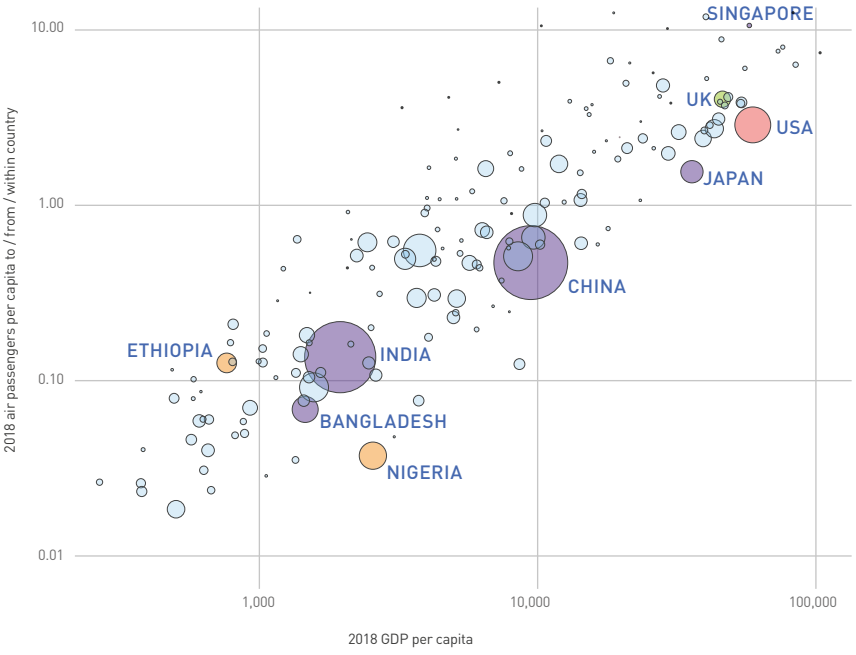
In studies of regional economies in Sweden, Indonesia and Brazil, a 10% increase in airport connectivity was shown to support an increase in foreign direct investment of 4.7%, up to a 0.5% increase in regional GDP, up to a 0.7% increase in local wages and up to a 0.9% increase in employment. In some regions, these impacts were shown to be significantly higher: an 8% increase in foreign direct investment; a 5% increase in tourism and a 6% increase in regional GDP[114].

To take advantage of efficiencies of scale and scope, some airports work in networks to connect less-busy regions with higher-traffic hubs. Globally, around 1,780 small airports (with fewer than one million passengers per annum) – over half of all small airports -are operated in these network structures and collectively serve over 345 million passengers annually[115]. Indeed, small airports and airlines act as catalysts in feeding traffic into hub airports for onward journeys to other major national and international destinations. Smaller airports within a network generate traffic that ensures the sustainability of larger airports, resulting in improved load factors and optimal aircraft utilisation by airlines.

It is not surprising that the greatest increase in propensity to travel between 2019 and 2038 will be in developing and emerging economies: India (243%), Bangladesh (240%), Viet Nam (222%), China (204%), Sri Lanka and Ethiopia (both 200%)[117]. Data also show that the rate of growth in some so-called south-south routes is increasing at a much higher rate than the global average. The last decade has seen substantially more traffic between China and Africa, for example. In addition, half of the top 20 countries for passenger traffic are now developing or emerging economies[118].

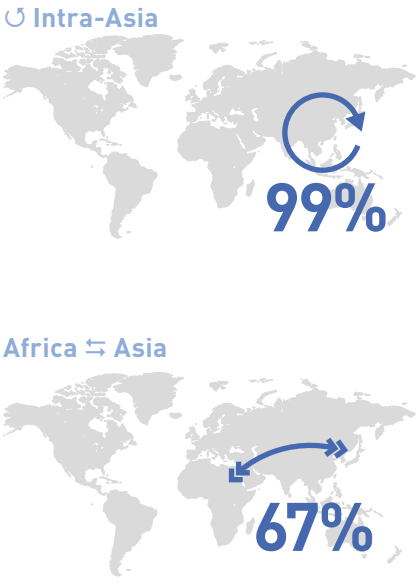
Who's travelling?

Global propensity to travel, 2018[116].



The growth is out there

Passenger growth between select developing and emerging regions, 2011-2019[119].



Leapfrogging development issues

There are other ways that air transport can bring about rapid change in development for remote communities and emerging markets. Airfields can provide access to areas where road construction proves too challenging or expensive, and the latest air traffic management technology is enabling developing countries to leapfrog to the latest cost-effective technologies. These countries can avoid installing country-wide ground based infrastructure, such as radar systems and networks, which are cost and resource intensive, and install more sophisticated Automatic Dependent Surveillance – Broadcast (ADS-B) coverage systems or even to simply buy surveillance as a service from a satellite-based supplier. They can also take advantage of remote tower technology and digitalisation, that are now operating across the globe and allow controlled conditions at remote or seasonal airports without having to build or upgrade air traffic control towers. This is labour cost-effective as air traffic controllers have the capability to control traffic for multiple airports from one centre[120].

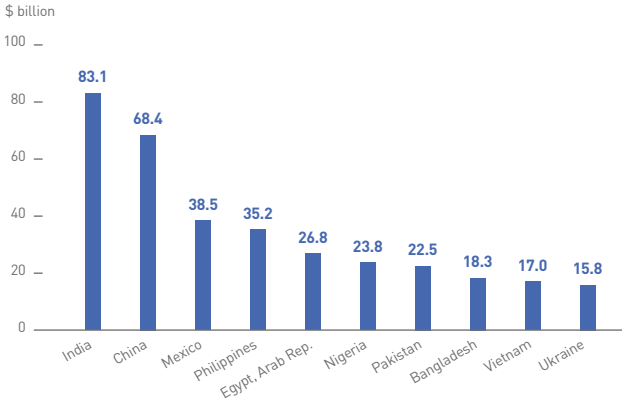
Supporting families back home

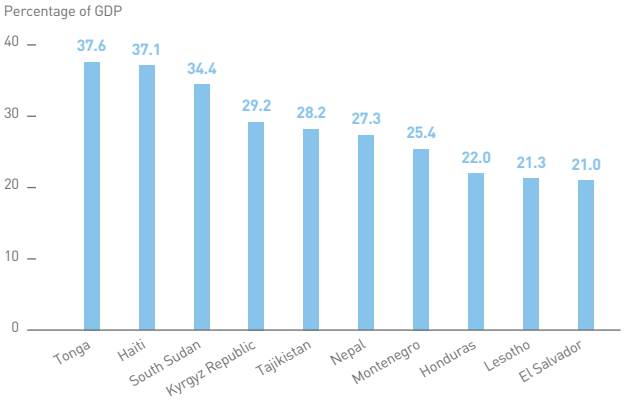
According to the United Nations, the number of international migrants worldwide reached nearly 272 million in 2019, of which about six of ten were migrant workers who move abroad for employment purposes[121]. Migrants collectively contributed a record $714 billion in remittances worldwide in 2019 (of which $554 billion were sent to low- and middle-income countries)[122].

Remittances, where someone working abroad sends part of their earnings to family back home, have exceeded official development assistance – by a factor of three – since the mid-1990s and were on track to overtake foreign direct investment (FDI) flows to low- and middle-income countries in 2019[123]. The continuity of remittances is supported by the maintenance of family and cultural ties – aided by air transport links. This source of overseas income plays a significant role in some nations and does not only help alleviate poverty in less-developed countries but also helps achieve the SDGs more widely. For example, remittances accounted for nearly 30% of the GDP in Tajikistan, Nepal and the Kyrgyz Republic and even 37% in Tonga and Haiti in 2019[124].

Supporting those at home

Top remittance-receiving low- and middle-income countries, 2019[125].





Quality education

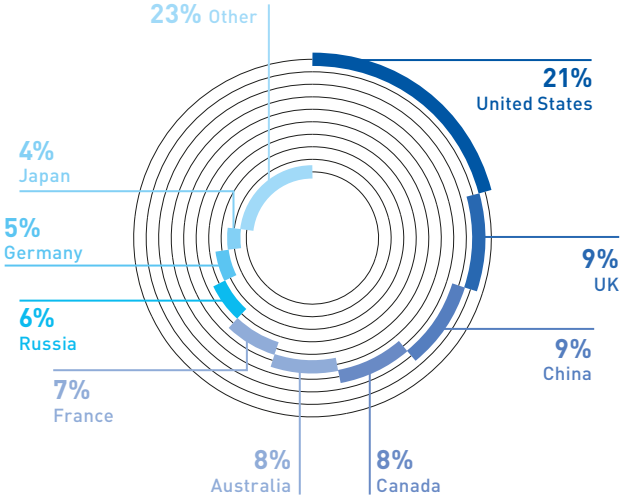
Ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all is a stand-alone sustainable development goal. To access higher-quality education for many means travelling to another country, sometimes in another region of the globe. Without air transport, these opportunities simply would not be feasible, particularly for shorter-term university exchange programmes, such as the European Erasmus system.

Sub-goals of the SDG include the aim of expanding global scholarships and, by 2030, substantially increasing the number of youth and adults who have relevant skills, including technical and vocational skills, for employment and entrepreneurship. Air transport connectivity can make these ambitions far more likely to be realised.

For students from developing countries, the opportunity to travel to established universities for higher education is invaluable, as well as benefitting the university and surrounding communities. This helps the individual's personal improvement and also creates benefits for their home country, as students return armed with knowledge to contribute to their home economy and with strengthened links to the global economy[126].

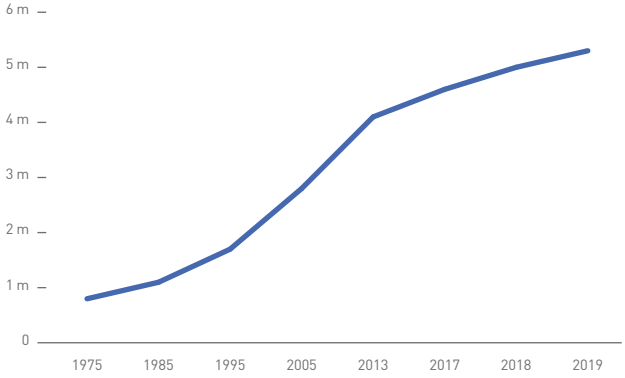
Soft power, hard learning

Global top ten destinations for higher education students studying abroad, 2019[128].



Learning overseas

Growth in higher education students studying abroad, 1975–2019[127].



Flying in to study

Global top ten countries of origin for international, tertiary students, 2017[129].

	Origin	Students
1	China	928,100
2	India	332,000
3	Germany	122, 200
4	South Korea	105,400
5	Viet Nam	94,700
6	France	89,400
7	United States	86,600
8	Nigeria	85,300
9	Kazakhstan	84,700
10	Saudi Arabia	84,300

Aviation helps foster educational connectivity for students and it has also been shown to increase scientific collaboration, particularly when more affordable airfares enter a market. Analysis of data from 1991-2012 shows that the entry of a low-cost carrier into a route increased scientific collaboration by 30%[130]. Moreover, the quality of the scientific output increased, as researchers were able to collaborate more effectively face-to-face: "Cheaper air travel, by counterbalancing how geographic distance constrains collaboration choices at stages when face-to-face interactions cannot be substituted for remote interactions, may have a significant effect on the generation and recombination of scientific knowledge."

Highly skilled workforce

Jobs in air transport cover a wide range of activities that require diverse skill sets. These include:

- technicians and engineering jobs, from aircraft and engine design and building to component production and aircraft maintenance and repair;
- air traffic control and airspace design planning and occupations as air traffic controllers;
- satellite systems providing communications, surveillance and tracking of aircraft and air navigation services;
- logistics for airlines and airports;
- complex information and communication technology systems that link aircraft, airports and air traffic management to ensure efficiency of operations;
- systems on board aircraft and in areas such as baggage handling systems design;
- airport operators and airport on-site service industry jobs, such as chefs in catering companies and customer service professionals in airline ticketing, check-in and retail;
- creative positions in design and marketing;
- manual labour on airfields, such as baggage loaders;
- flight and cabin crew;
- emergency response personnel at airports; and
- leadership, management and executive roles.

As this list indicates, many roles in the air transport sector require highly qualified workers and a significant amount of training. Value-added per employee in the air transport sector (direct employees, excluding non-airside activity at airports) generates 4.3 times as much value-added per employee as jobs in the economy overall – indicating a more productive workforce.

In addition, growth in the aerospace sector is helping to drive innovation and skills development in countries that have not normally been associated with aircraft manufacturing. This is just one of many examples of air transport-related companies investing in developing countries.

According to analysis for Airports Council International (ACI) Europe, the total direct employment at European airports received an estimated $76.8 billion (€68.5 billion) in income (wages, salaries, bonuses and other remuneration), or an average of $45,310 (€40,400) per job. This figure is considerably higher than the average income in the overall economy. In all countries, the average income of direct airport employment was higher than the national average. This reflects the large number of highly skilled positions that are supported by airport activity.[131]

In the United States, the average wage for a passenger airline employee in 2018 was $91,574, which is significantly higher than the average national private-sector wage of $63,305[132]. Globally, in 2018 airlines paid their employees $174 billion in wages ($187 in 2019)[133].

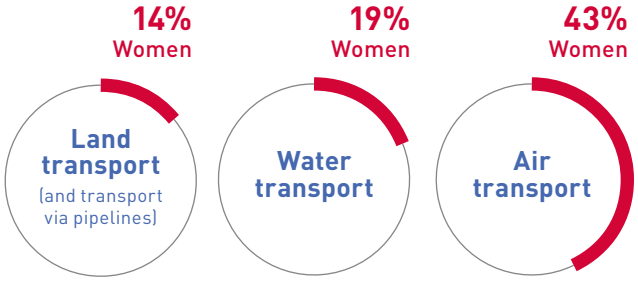
Gender imbalance

Global statistics on gender equality within the air transport sector are scarce; however, anecdotal evidence suggests that aviation still tends to be a male-dominated industry. Statistics for Europe show that women make up 43% of employees, although technical positions will likely skew towards men[134]. A global survey of gender equality in flight crews shows that, despite the first commercial pilot's licence being granted to a woman in 1934[135], women still only make up around 5% of pilots worldwide[136].

Some countries show signs of a move in the right direction: India, Iceland[137], Finland, Thailand, Sri Lanka and Slovenia all have greater than 10% female pilots[138]. But perhaps the most promising sign is in the next generation. In a 2014 survey of student pilots, more than 10% were women in 16 countries, with over 23% of student pilots being women in Singapore. Unfortunately, this analysis has not been repeated and as a general note there is a severe lack of gender balance information at a global level[139].

Gender, balanced?

Air transport has more work to do getting women into the business, EU28, 2019[140].



On the manufacturing side of the industry, women tend to have a slightly higher representation, making up 24% of the workforce in the United States (this includes defence manufacturing, whereas most of the statistics in this report are limited to civil aviation). Within this group, women make up 15% of engineering jobs, 15% of engineering executive roles and 23% of executive positions[141]. In airport operational roles and ground handling in Europe, women make up 26% of employees, although in the lower age bracket (those under 30) over 32% of staff are women[142]. Similarly, there are large gender gaps in other important line jobs in the aviation and aerospace industry. For example, women comprise only about 26% of air traffic controllers and 18% of flight dispatchers in the US[143].

In airline executive roles, the gender gap is as great as in technical positions, with women making up just 3% of the top 100 airline CEOs (v. 12% of CEOs in the wider economy); 8% of chief financial officers (v. 19%); and 3% of chief operating officers (v. 9%). In human resources, airlines outperform the wider economy, with women constituting 32% of human resources directors (v. 23%)[144]. The 'Soaring Through the Glass Ceiling' report, compiled in 2019 by six leading stakeholders in the aviation and aerospace industry, found that there are pockets of success, with female CEOs representing 19% of the total number of aerospace and defence CEOs in the US, well ahead of the 5% of female CEOs across all industries in the country[145].

In 2019, IATA launched an industry-wide initiative to increase the number of women in senior and under-represented roles by 25% by 2025. The 25by2025 campaign is a voluntary commitment by IATA member airlines.

Aviation passengers seem to be balanced in gender, with the United Kingdom and the United States reporting around a 50% split (although Heathrow Airport in particular had a higher male passenger count in 2018, at 55%, presumably due to business traffic still skewing male)[146]. Unfortunately, there are few other statistics available on passenger gender split globally.

Good health and well-being

The United Nations' third SDG, 'good health and wellbeing', is a crucial element of sustainable development. Although not directly linked to improving physical heath, air transport, with its ability to provide speedy and safe transport of people and cargo to places that are often in remote areas of the world, has a part to play.

A prime example of how aviation plays a role in public health is the ability to transport vaccinations. Not only are these vital medical supplies time sensitive, making other modes of transport unviable over long distances, but their temperatures must also be carefully regulated, something in which cargo airlines are very experienced. Today, vaccines are some of our most critical and precious shipments. And demand is growing: IAG cargo that delivered 3.5 billion vaccine doses in 2017 across 90 different countries has seen volumes rise by 40% in just the last few years[147].

Aviation also has a crucial role to play in pandemic response. When a viral outbreak occurs, it is vital that the air transport sector acts quickly to work with governments and international institutions to ensure that the virus does not travel further. Recent examples of this collaborative effort are the global Coronavirus epidemic and the Ebola and Zika outbreaks in West Africa and South America, respectively. Whereas halting all travel from affected regions was deemed necessary by many governments during the Covid-19 epidemic, often this is not the best response. The World Health Organization recommends that connectivity remain in place, although with appropriate health controls on passengers[148].

ACI, IATA, the Civil Air Navigation Services Organisation (CANSO) and International Coordinating Council for Aerospace Industries Associations (ICCAIA) work in close cooperation with their partners in the World Health Organization, the UN aviation agency ICAO and World Food Programme (WFP) and The International Air Cargo Association (TIACA) to provide aviation-specific guidelines and global coordination on the coronavirus epidemic to the travel and tourism sector with the objective of ensuring appropriate planning and action at all levels in order to mitigate the effects of the outbreak. The IATA Medical Advisor also cooperates with national public health authorities to help them make recommendations compatible with aviation industry operations.

Providing vital aid

One of the more ambitious of the UN's SDGs is the campaign to achieve 'zero hunger'. To achieve this goal requires the creation of the conditions for food security across the world. This is a long-term challenge, and, in the meantime, some parts of the world will continue to need support from the international community. Aviation's unique ability to combine speed with flexibility makes it a vital conduit for immediate response to natural and man-made emergencies.

The UN Humanitarian Air Service (UNHAS), managed by the UN World Food Programme (WFP), transports food and urgent relief items to those in need in the world's most remote and challenging locations, in the midst of conflict and disasters, including to survivors of cyclones Idai and Kenneth in Mozambique, drought in Somalia and the ongoing crises in Yemen. Because many of these areas are inaccessible by road – either because of the absence of reliable road infrastructure, precarious security situations or extreme weather conditions – air transport is often the only option. In 2019, UNHAS airlifted 35,100 tonnes of food and urgent relief material and 412,000 humanitarian workers from the UN and other agencies to 310 destinations in 20 countries, allowing life-saving projects to be implemented and monitored. UNHAS is often the only way in or out of an area of operation.[149]

The aviation industry too has a vital role to play in responding to disaster. In 2009, the non-profit organisation Airlink was established to help coordinate responses to emergencies by the air transport industry. Today, Airlink provides a vital link between more than 40 commercial and charter airlines and over 100 international non-profit aid organisations which have been pre-qualified and vetted to ensure the right aid gets to the right people. When disaster strikes, there is no need to form relationships to coordinate a response – they exist already. Since 2010, Airlink and its airline partners have transported over 6,000 humanitarian responders and 1,500 tonnes of cargo in support of a broad range of humanitarian initiatives[150].

Helping to end trafficking

The trafficking of persons remains an issue the world must tackle. Abuse can include forced labour, sexual exploitation and organ removal, and it takes place internationally and domestically. One victim out of every ten detected in 2016 was trafficked trans-regionally and over a quarter of all victims were trafficked within the sub-region, many times using air transport services[151]. The United Nations Office on Drugs and Crime (UNODC) reported 24,000 detected victims of human trafficking in 2016, of which three quarters were women and girls[152].

The aviation industry is taking action to help relevant staff identify the signs of trafficking on board aircraft and at airports and to report suspicions to law enforcement. IATA and ACI have issued resolutions to ensure airlines and airports are made aware of the issue and have prescribed actions they can take to reduce its possibility[153]. ICAO has worked with the Office of the United Nations High Commissioner for Human Rights to develop guidance material on the training of cabin crew[154]. However, for any training of cabin crew, ground staff, operations centre teams and flight crew to be effective, clear channels of communication with law enforcement are essential. The industry stands ready to help but needs government authorities to also provide effective solutions.

Halting the illegal trade in wildlife has also been an area of joint action between industry, governments, and non-governmental organisations. IATA and ACI are working alongside other aviation stakeholders through the USAID Reducing Opportunities for Unlawful Transport of Endangered Species (ROUTES) Partnership and with the United for Wildlife (UfW) Transport Taskforce of the Royal Foundation. Airlines and airports around the globe are supporting this fight, with over 60 airlines joining IATA in working with the United for Wildlife Transport Taskforce alongside other aviation stakeholders[155]. Data collected on seizures between 2009 and 2019 backs the importance of the aviation industry for breaking the illegal wildlife trade supply chain from the source to the consumer: over 2,000 seizures were registered with wildlife products and 5.5 million animals seized in 102 countries[156]. The USAID ROUTES Partnership has played an important role in providing resources and tools to the aviation sector to help combat the illegal wildlife trade, including training materials on how to spot signs of wildlife trafficking[157]. As with the trafficking of persons, the responsibility lies with the appropriate law enforcement agency. The industry can support their work by raising awareness and ensuring appropriate reporting mechanisms are available for staff to report suspicions to law enforcement.

ENVIRONMENTAL RESPONSIBILITY

The economic and social benefits of aviation are clear, with the growth of the sector being important for all countries, developed and developing. However, these benefits also come with an environmental cost. For aviation to grow sustainably, it is vital that the industry balances the advantages of growth in air travel with the responsibility to pursue climate action and to take steps to reduce other environmental impacts such as noise, emissions which affect local air quality, and effects on water courses. This responsibility is something that the global aviation sector takes seriously, and it ties in with a number of the SDGs.

Aviation accounts for 2% of all human-induced CO_2 emissions through the burning of 363 billion litres of jet fuel, which in 2019 produced 914 million tonnes of CO_2. This is less than the international shipping sector and around the same as the power needed to run the servers and transmission cables of the internet (not including the computers accessing the internet)[158].

Aviation is an efficient means of long-distance (intercity, interregional, and international) transport, operating in many places more efficiently than alternatives, such as road and even rail. For some travel, there is simply no practical alternative to flying – around 80% of aviation emissions are produced from flights greater than 1,500 kilometres. The challenge for aviation is to further reduce emissions while retaining the benefits of a growing air transport sector.

To meet this challenge, the aviation industry agreed a global, sector-wide climate action framework to tackle emissions in 2008 – a world first. The framework is based on a set of three global goals: short, medium and long-term.

SHORT-TERM GOAL

Achieve a 1.5% average annual fuel efficiency improvement from 2009 to 2020 (a goal which is already being surpassed, with an average improvement of 2% per year).

MEDIUM-TERM GOAL

Stabilise net CO_2 emissions levels through carbon-neutral growth.

LONG-TERM GOAL

Reduce net CO_2 emissions to 50% of what they were in 2005 by 2050.

To meet these goals, the industry has put in place a collective strategy that takes account of all means of reducing aviation emissions, in the air and on the ground. The industry has been implementing many of these measures for years and has made significant progress in fuel and CO_2 efficiency. In fact, per passenger a flight taken today will produce around half of the CO_2 produced by the same flight in 1990. This has been achieved through technological advancement and improvements in operations and infrastructure.

Technological innovations

Aviation has always had a focus on efficiency. Fuel makes up one of the main operating costs for airlines – just under 25% in 2019 – so in this sense economic and environmental motivations are intertwined. Since the first jets in the 1950s, technology-driven efficiency has improved 80% with the introduction of new models of aircraft and engines. On average, each new generation of aircraft is roughly 15% to 20% more fuel efficient than the previous generation, and aircraft and engine manufacturers spend around $15 billion each year in on efficiency research and development, representing a major investment in the sustainable future of air travel[159].

Airlines have continued to improve their fuel efficiency performance, securing an average annual improvement of 2% between 2009 and 2019, surpassing the industry goal of 1.5%. Since the year 2000, industry fuel efficiency has cumulatively improved 38% and CO_2 tonnes per thousand kilometres performed has decreased from 1.84 to 0.84. This improved fuel efficiency has been driven by airlines investing over $1 trillion in 15,000 more efficient new-technology aircraft since 2009 and by improving performance through higher load factors and other operational measures. Weight-based load factors improved by 4.5% from 64.9% in 2008 to 69.4% in 2019, as airlines continued to make better use of space available on aircraft. Passenger load factors under normal (pre-Covid-19) conditions now average 82.5% globally[160].

Thanks to new aircraft and the introduction of cutting-edge technologies and new flight procedures, US airlines emitted just 3% more total CO_2 in 2018 than they did in 2000, while carrying 42% more passengers and cargo on a revenue-ton-mile basis, according to data from the US Bureau of Transportation Statistics[161]. In Europe, the average fuel burn per passenger kilometre flown for passenger aircraft, excluding business aviation, decreased by 24% between 2005 and 2017 while passenger kilometres flown by commercial flights rose by 60% over the same period[162]. This is thanks to several factors, including new technology and air traffic management efficiency.

The last decade has seen the development or introduction of entirely new aircraft types, such as the Airbus A350 XWB and A220 family and the Boeing 787 Dreamliner. These were joined by new versions of existing aircraft, such as the Embraer E2, 737MAX, A320neo, A330neo and Boeing 747-8. These are powered by next-generation jet engines made by manufacturers such as CFM International, Pratt & Whitney, GE Aviation and Rolls-Royce, and all have produced impressive fuel savings. In addition, in-service aircraft models are subject to continuous performance improvements. These

include highly efficient turbo-prop aircraft, such as the ATR72-600 and Bombardier's Q400 series. Early 2020, another fuel-efficient aircraft, the Boeing 777X with a wingspan of 72 metres to further reduce drag, completed its first test flight and is expected to enter service in 2021.

In addition to the latest propulsion technology, additional technological features have been included to maximise fuel efficiency. Improved aerodynamics, new manufacturing techniques and composite materials play a prominent role in determining how much fuel is burned on any given flight.

Manufacturers are increasingly using light-weight materials such as carbon fibre composites to build aircraft components, particularly the wings, which improves fuel efficiency through decreasing weight and enabling advanced aerodynamics. The Boeing 787 and 777X, Airbus A220 and A350XWB aircraft all use these cutting-edge materials and technologies to deliver exceptional gains in environmental performance. Engine manufacturers are also using highly advanced processes such as additive layer manufacturing and new materials such as ceramic-matrix composites to develop new engines. Ceramic-matrix composites used in jet engines allow the engines to operate at a higher temperature than conventional engines, resulting in better fuel efficiency. Like the composites used to make wings, this material is lighter than traditional metal alloys, and that further cuts fuel use.

Technology on new aircraft can either improve fuel burn through aerodynamic efficiency (mainly airframe) or reduce actual combustion use (mainly engine-related). Combined, these elements create a new aircraft with a reduced environmental impact.

From 2020, the world's first CO_2 efficiency standard for aircraft applies to new aircraft designs. Adopted by ICAO, the CO_2 standard formalises the industry improvements that have so far been purely market-driven.

Although in the early stages of research and development, established aerospace manufacturers and start-ups alike are investigating the introduction of fully electric and hybrid-electric aircraft. As battery technology develops, increased energy storage may make electrically powered commercial flight a reality in the coming decades. Already, several small-scale demonstrators are showing how it can be used for operations with a limited number of seats. In the short-term, electric propulsion is likely to be restricted to so-called 'air taxi' operations which could start service in some cities from around 2023-2025. These will provide two-to-four-person commuter flights to avoid ground traffic congestion.

Longer-term, several companies are developing more familiar commercial aircraft concepts. These would be regional jet-sized, short-haul aircraft powered by electricity or hydrogen systems and could potentially be in service by around 2035, although more research is needed before they are ready to begin test flights. The quest to maximise range and payload (passengers or freight) while reducing the weight of the batteries and increasing the energy density of stored electricity is a challenge. There is also a lot of research into hybrid options – combining the performance of liquid sustainable aviation fuel with the efficiency of electric propulsion. This may be an option for mid to long-range flights in future.

WAYPOINT 2050

AN **AIR TRANSPORT ACTION GROUP** PROJECT

In a two-year project called Waypoint 2050, the aviation sector has outlined several potential pathways to reach its 2050 goal and how, with the right support from governments, net-zero emissions could potentially be achievable a decade or so later. The analysis shows that the implementation of radical new technologies such as commercial-scale electric, hybrid or hydrogen flight could be possible in the 2035-2040 timescale. This would be accompanied by improvements in operational and infrastructure performance. Importantly, a significant scaling up of sustainable aviation fuel will be needed, in the region of 450-500 million tonnes of SAF by 2050.

Waypoint 2050 explores three consolidated scenarios for how air transport can meet its goal. Which of these scenarios plays out over time will be determined by a number of decisions in the course of the coming decades:

- Will the industry choose to prioritise investment in sustainable fuel deployment or radical new technologies?
- Can energy providers massively scale up SAF and hydrogen production at the same time?
- Will governments, finance institutions and consumers play the role they need to accelerate the energy transitions?

Whilst the solution will likely be some combination of all the above, the important lesson learnt from the work in this report is that it can be done. Aviation can meet its ambitious -50% climate goal in 2050 and pursue net-zero emissions by 2060/65 at a global level, with some parts of the world hitting that point earlier. There is enough feedstock to produce the necessary SAF and hydrogen is a realistic possibility. Efficiency will continue to improve and modern air transport will remain a key driver of connectivity, business and social connections across the world well after 2050.

www.aviationbenefits.org/W2050

Sustainable aviation fuel

Sustainable aviation fuels (SAF) could be the key to sustainable long-haul air travel, contributing hugely to the industry's emissions-reduction strategy. But what is SAF and what sustainability criteria does it need to meet?

WHAT IS SAF?

Sometimes referred to as 'biofuels', SAF is almost chemically identical to traditional jet fuel and must meet the rigid jet fuel specification. But rather than being made from fossil fuels, they are synthesised from other, sustainable feedstocks. These feedstocks can take the form of plant matter, municipal waste, even used cooking oil or even drawing CO_2 from the atmosphere and using low-carbon electricity to make sustainable aviation fuel.

WHAT MAKES THESE FUELS SUSTAINABLE?

The aviation industry has a clear vision for the sources of its alternative fuels: they should be produced from feedstocks that can be grown or produced without negatively impacting food supplies, water or land use negatively and without the risk of other environmental and social consequences. To qualify as SAF, a fuel must be demonstrably less carbon intensive over its life cycle than a fossil-based fuel and must fulfil certain internationally recognised sustainability criteria. The aviation industry is working together through groups such as the Sustainable Aviation Fuel Users Group (SAFUG) and sustainability certification schemes such as the Roundtable on Sustainable Biomaterials (RSB) to make sure that any fuels used by the industry are, in fact, sustainable. By investigating only fuels that can be manufactured from sustainable feedstocks, the aviation industry is determined not to repeat the mistakes made with the first generations of alternative fuels in transportation. Many recent innovative alternative fuels have been produced using sources such as a range of waste sources, microalgae, saltwater tolerant plants that grow where food crops cannot, rotation crops that enhance soil nutrients off season, and nicotine-free tobacco.

WHAT ARE THE ADVANTAGES OF SAF?

First and most importantly, SAF can be around 80% less carbon intensive over its life cycle compared with fossil-based fuels. "Life cycle" refers to all emissions produced during the entire process, from extracting or collecting the feedstock to refining, transporting and using the fuel. Research is also underway into fuels that could even have a negative emissions lifecycle, meaning that they absorb more CO_2 than they emit. A major advantage of SAF is the diversity of available feedstocks. The fuels must all meet rigorous jet fuel specifications following the production process, but producers are able to utilise whatever feedstock is abundant in a particular region of the world, be that forestry waste in Norway, agricultural residues in the US or municipal waste around the world.

WHAT ARE THE MAJOR CHALLENGES TO RAMP UP SAF PRODUCTION?

The challenge for this new energy industry is to produce these fuels to a sufficient quantity to make them commercially viable. This requires significant investment from industry and governments alike. Research institutions and traditional energy producers also have a significant role to play to make aviation's energy transition a reality. However, impressive progress has already been made in this fledgling sector thanks to the leadership of airlines and airports in different parts of the word, particularly in the last few years. Since the use of SAF was approved in 2011, over 270,000 flights have taken place with an alternative / traditional fuel blend[163]. As of publication, SAF is routinely being deployed by several stakeholders, including airlines and their partners at six international airports, and there are plans for deployment from additional airports in the near future.

For updates about the deployment of SAF, see **www.enviro.aero/SAF.**

<1%

Sustainable aviation fuels currently account for less than 1% of global jet fuel use.

2%

(around 5.6 million tonnes or 7 bn litres) of the total aviation fuel supply could be SAF by 2025 with the right policy support, reaching a tipping point for SAF supply.

4.8m tonnes

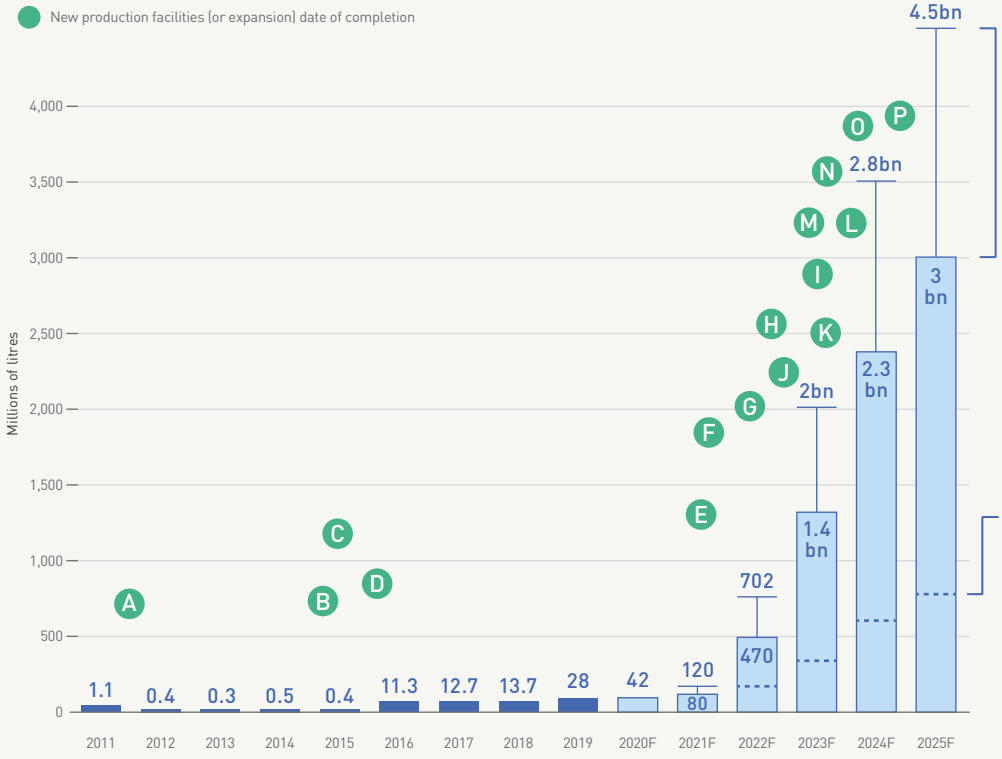
(6 bn litres) in airline SAF forward purchase agreements so far.

7

technical pathways to SAF development have been certified.

Onwards and upwards

Estimate of annual global production potential of SAF, as new production facilities come on stream[164].



Difference between a low take-up of SAF from production facilities (lower number) and a high take-up, driven by policy and airline decision-making. The top number represents the full possible output of SAF production already in operation, under construction or advanced planning and financing.

Without the correct policy measures, the fuel output could be optimised to go to other forms of transport - the lowest dotted line represents the least uptake of SAF (output goes to road transport).

This analysis does not include SAF capacity that has not yet been announced, is in concept stage, nor the impact of aggressive policy support which could double the potential by 2025.

Operational improvements

The operations pillar of the industry's climate strategy deals with how aircraft are run once they are in service to ensure that all flights maximise fuel efficiency. At every step of an aircraft's operation – at the gate, during taxiing, take-off, cruise and landing – there are opportunities to reduce fuel burn and consequently, emissions.

Many efficiency gains come from cutting all unnecessary, non-flight-critical weight. Numerous airlines have invested in features such as lightweight seats and cabin trolleys or Kevlar cargo containers, which have the added benefit of being stronger and lighter than conventional aluminium counterparts[165]. It has also become increasingly common for flight crews to be issued with tablet computers in place of paper-based flight manuals, which can weigh up to 20 kilograms[166]. While on their own these savings are not huge, when added together they account for significant CO_2 savings. By installing lighter but stronger seats, one airline reduced annual CO_2 emissions across its fleet by 21,000 tonnes.

Wingtip technology is another operational improvement that has led to major fuel and emissions savings for airlines. Most new aircraft have these features included at the point of production, and many airlines have invested in having their aircraft retrofitted with wingtip technology. These additions to the tips of the wings reduce drag and can reduce fuel consumption by around 4%[167].

Modifying how an aircraft climbs to cruising altitude and descends on approach can also reduce emissions. ANSPs are constantly improving operating techniques and airspace to allow more and more continuous climb and descent operations, which enables airlines all over the world to reduce fuel use and the associated emissions. Rather than following the traditional 'staggered' or 'stepped' procedure, aircraft are now able to climb out of and approach airports more smoothly, avoiding the need to use additional engine power to level off at multiple altitudes during these phases of flight. Landing using a continuous descent saves on average 150kg of CO_2 and continuous climb around 50kg per flight. A Eurocontrol study indicates that in Europe, the potential emissions savings from optimising continuous climb and descent operations are up to 1.1 million tonnes CO_2 per year (340,000 tonnes of fuel). Nearly all flights in European airspace already perform a partial continuous climb (to around 10,000 feet) and three quarters perform a full continuous climb. Further potential for improvement is available for landing procedures as fewer than half of all flights perform a partial continuous descent and only a quarter fly a full continuous descent[168], often due to complex airspace and routes.

Through a process called airport collaborative decision-making, airports, ANSPs, and airlines work together to optimise flights by sharing information on potential inefficiencies and delays on the runway and en route, which saves airlines from wasting unnecessary time in the air[169]. By working together to flag delays early, all parties involved in a flight get crucial arrival and departure information at the same time, allowing them to adjust their schedules and resources as the latest information comes to hand. A process known as air traffic flow management allows airlines and airports to work with ANSPs to ensure the available capacity is used efficiently. This works best when multiple nations cooperate regionally. For example, if one airspace sector in a region is congested, its neighbouring sector might be able to take some traffic.

Taxiing is also an opportunity for cutting emissions. Many airlines only use one engine during taxiing. Taking this concept further, new technologies have been developed that power the aircraft entirely with electric motors or external tugs while it taxis to the runway[170].

When parked at airport gates, aircraft must be powered to provide air conditioning and electricity for cabin lightning, to run pre-flight systems and also to start the engines. Aircraft are equipped with a small generator in the tail called an auxiliary power unit (APU). A large number of airports have now equipped gates with fixed electrical ground power and pre-conditioned air, allowing pilots to switch off the APU, saving fuel, reducing emissions and noise and reducing airline costs while parked at the gate.

Engines ingest contaminants during taxi, take-off and landing such as dust, soot, insects and pollution. These can cause engines to operate inefficiently and burn more fuel. Every kilogram of fuel saved eliminates 3.15 kilograms of CO_2 emissions[171]. Regular internal engine washing can recover as much as 1% fuel efficiency and improve reliability: one airline reduced its fuel consumption by 1.2m tonnes (15m litres) per year through a routine engine washing programme[172].

An airline's choice of aircraft to operate a certain route can also provide efficiency gains. Turbo-prop aircraft on some short-haul routes can produce up to 40% less CO_2 than equivalent jets[173].

Infrastructure efficiencies

The infrastructure pillar of the climate strategy for aviation emissions relates mainly to improving navigational systems and procedures, ensuring that aircraft are guided through the sky as efficiently as possible. In many regions of the world, mid-20th-century technology still determines the route structures, with aircraft needing to zigzag between ground-based navigation aids throughout their journey. However, this situation is rapidly changing.

By using an array of new satellite-based navigational technologies and procedures collectively referred to as 'performance-based navigation', aircraft are able to follow optimised, more direct routes with greater accuracy and efficiency. Cutting out unnecessary travel time can save fuel, reduce CO_2 emissions and enable ATM more efficiently to cater for increasing traffic and help reduce congestion and delays.

Another procedure that is enabling aircraft to improve efficiency and reduce emissions is called 'free route airspace'. Traditionally, aircraft have flown along fixed routes, like motorways in the sky traditionally organised around ground-based navigational aids. These route structures, whilst providing predictability and consistency through any section of airspace, can prevent a more flexible approach to maximise the use of tailwinds for aircraft.

Australia's air navigation service provider Airservices Australia, for example, calculates and publishes this so-called Flextrack information for airlines flying into, through and out of Australian airspace, offering them the most prevailing weather patterns and winds to reduce fuel usage and emissions. Flextracks are now being used widely between Australia and airports in Asia and the Middle East. New surveillance technology much like GPS systems will enable it to be used on more crowded routes as well. The move from fixed to free route airspace in Europe has reduced 2.6 million tonnes of CO_2 emissions since 2014[174] and has the potential to reduce these emissions by 10,000 tonnes per day (3,000 tonnes of fuel)[175]. However, this requires cooperation among the countries over which an aircraft flies, good examples of which are being experienced in Europe.

For the full potential of new navigational technology to be realised, the industry needs the engagement and cooperation of governments and international institutions. Airspace is governed by sovereign states, meaning that any large scale reform needs governmental buy-in. As aviation transcends national boundaries, the opportunity for operational processes and procedures in civilian airspace to be organised and air navigation services delivered more aligned with operational requirements will require multiple sovereign states to work together even better than they do today.

Such harmonisation of airspace may allow aircraft to navigate more seamlessly across national borders on the most efficient routes. In some regions, large areas of airspace are permanently reserved for the military, which means civil aircraft must fly around these areas, adding time, fuel burn and emissions. CANSO and its members are therefore working with governments in those regions to free up this airspace on a flexible basis when it is not required for military purposes and to also look at the possibility of reducing the size of such restricted areas to allow for more direct commercial routes. The so-called "flexible use of airspace" means that it can be closed when required by the military but open at all other times.

In Europe, a collaborative project is underway called Single European Sky ATM Research (SESAR), which is part of the vision to transform Europe's aviation infrastructure enabling it to handle future growth while minimising environmental impact with efficient flight routes and optimised trajectories. Once in place, the Single European Sky will be a key enabler for enhancing sustainability, contributing to an effective environmental improvement of the sector and helping to be more resilient.

The €3.7 billion investment in the SESAR programme 2008-2024 is being put forward by the European Union, Eurocontrol and the industry, each of which contribute one third to the total funding. SESAR aims to contribute to CO_2 reduction by reducing fuel burn by between 250-500 kilograms per flight between 2012 and 2035, a relative improvement of 5-10% – this corresponds to between 800-1,600 kilograms of CO_2 emissions per flight[176]. Around 26% of SESAR solutions had already been deployed as of 2018, so that a relative improvement of only 3.7 to 7.4% remains to reach the target.

A similar modernisation of airspace is underway in the United States. Once fully implemented, the Next Generation Air Transportation System (NextGen), like SESAR, will result in significant emissions reductions. The NextGen project is being undertaken by the US Federal Aviation Administration (FAA) and aims to simplify US ATM by rolling out Performance Based Navigation (PBN), an advanced satellite-enabled form of air navigation, and other satellite-based technologies known as Automatic Dependent Surveillance-Broadcast (ADS-B) that replace radar technology, as well as collaborative air traffic management technologies[177].

Market-based measures

Encouraging progress has been made on the first three pillars of the industry's environmental strategy. However, to achieve the goal of carbon-neutral growth other measures need to be taken. This is why the industry has called on the world's governments, represented at the International Civil Aviation Organization (ICAO), to put in place a global market-based measure for aviation.

At the 2016 ICAO Assembly, the world's governments agreed to implement the first global carbon emissions mechanism for any single industrial sector. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is being implemented in phases, with aircraft operators being tasked with monitoring and reporting emissions since 1 January 2019. Operators based in countries that have volunteered to take part in the early phases of CORSIA's offsetting obligations will need to offset the growth in their international aviation CO_2 emissions after 2020. From 2027, participation becomes mandatory for most countries. Based on the 88 volunteer nations confirmed at the time of printing, nearly 80% of the growth in international aviation CO_2 will be offset through CORSIA[178].

Green taxes

Environmental or "green" taxes add a cost to each flight; a charge for each passenger carried, each take-off or landing, or for each leg of a flight. They aim to internalise the external cost of air travel, which may mean pricing some passengers out of the market. But in many instances, travellers have no reasonable alternative to air transport. There is also little transparency or accountability over governments' use of the revenues collected, and no quantifiable environmental benefits. Such taxes are not a viable solution to reducing CO_2 emissions because they may drain the aviation sector of financial resources and delay investments into fleet renewal and efficiency research and development. In nearly all cases, the money raised by governments from such taxes has not been reinvested in environmental improvement measures – the United Kingdom's Air Passenger Duty is a case in point. The aviation industry agrees that it needs to pay for its environmental impact, but a proper mechanism like CORSIA, where there is a direct link to emissions reductions, is a more effective way that yields true environmental results.

It is also worth noting that aviation is already subject to about $400 million of environment-specific passenger taxes and charges around the world[179]. This does not include the European Union Emissions Trading Scheme (which cost airlines some $950 million in 2019[180]). In the coming years, additional taxes will increase this to around $4 billion per year[181], not including the ICAO CORSIA.

Carbon offsetting

The air transport industry is making major strides by cutting CO_2 emissions. But these activities are not sufficient to eliminate the carbon footprint completely, at least in the medium term. When reducing one's own emissions becomes unfeasible, many emitters turn to carbon offsets — measurable and trackable units of CO_2 emissions reductions. The name 'offset' can cover a variety of sources of CO_2 reduction. It is a way to compensate for CO_2 being produced in one sector, by helping to fund a project which reduces CO_2 emissions in another sector. Because CO_2 is a long lasting gas it doesn't matter where it is produced or reduced, the greenhouse warming effect is the same.

If a passenger's flight, for example, produces two tonnes of CO_2, the passenger can choose to help fund a project which provides renewable energy or more cheaply reduces the equivalent emissions, to replace two tonnes of fossil fuel-related CO_2 production. This is an offset, or a 'carbon credit'. Most credits or offsets are in units of one tonne of CO_2 and they can be generated by a range of different programmes around the world, in renewable energy, forestry protection or reforestation, and eventually they may be available in carbon capture, using technology to draw CO_2 out of the atmosphere. Many of these projects are in developing countries and also bring additional economic and social benefits in support of sustainable development.

With the right environmental criteria in place, offsetting can be a reliable mid-term measure which many scientists agree has a role to play in climate abatement. Offsetting helps balance the growth in air transport connectivity. Investing in CO_2 reductions in other sectors gives the aviation industry time to develop and deploy new technology and sustainable fuels that will help bring down emissions in-sector. It also supports the offset scheme which might not otherwise be viable. This is not a fast process — it takes time to design, develop and certify safe solutions — but the industry is working hard to make it happen. Offsetting is a better alternative than environmental taxes as there is a direct link to emissions reductions.

Today, offsetting projects used in the aviation industry adhere to methodologies set out by one of several voluntary standards. These require that offsets be:

- Real: there is evidence that the project actually removes or prevents emissions;
- Additional: the emissions reductions would not occur without the project activities;
- Measurable: the volume of emissions reductions can be accurately measured; and
- Verifiable: a neutral, third-party auditor has verified the emissions reductions.

Several airlines have been offsetting the emissions produced by their flights partially or even entirely. Over 40 airlines, including half of the world's 20 largest airlines, offer voluntary carbon offsetting programmes to their passengers and a large number of organisations, corporate travellers and individual passengers offset their emissions through third party providers.

On the ground

Airports, too, are playing their part in improving infrastructure. They work to reduce their environmental footprint through the sustainable management of waste, water, energy, noise, local air quality and emissions. Airport planning and design also takes into consideration environmental aspects to maximise efficiency with the minimal possible impact on the environment.

The Airport Carbon Accreditation Programme, launched by ACI Europe in 2009 and later expanded to all regions, recognises airports at ascending levels of certification: mapping, reduction, optimisation and neutrality[182].

Airport energy-efficiency gains have been made via a number of initiatives, such as LED lighting, electrical ground support equipment and renewable energy sources such as wind, hydro and solar. Athens International Airport was one of the pioneers in harnessing the abundant sun in its location, through its €20 million investment in a photovoltaic park. The park produces 20% of the airport operator's energy needs (11 million kWh per year) – that's equivalent to a reduction of 10,000 tonnes of CO_2[184]. Cochin Airport, the eighth busiest airport in India, became the world's first airport fully powered by solar energy in 2015, and Galapagos Airport on the Ecuadorian island uses only renewable energy sources – both wind and solar generated.

Airports have also been increasing their rate of waste recycling and diversion from landfill and even using waste to produce energy. In addition, airports have started to introduce the concept of circular economy into environmental programmes. For example, Schiphol entered into a partnership with Engie and Philips to replace the lighting fixtures in its terminal introducing a different business model where the airport pays for light performance while Philips remains the owner of the fittings and installations and is responsible for the system's performance and service life. The circular economy concept can also be applied to the design and development of new infrastructure projects, for instance, using materials which can last longer and be disassembled and assembled in different ways, serving different purposes to extend its life cycle.

Airports also play an important role in collaborative projects involving various stakeholders operating at their sites. These include the provision of fixed electrical ground power and preconditioned air to aircraft, which allows pilots to turn off the aircraft's own generator, thereby saving fuel and CO_2, and the installation of charging points for electric vehicles used by ground handlers or passengers. Collaboration is also key to the success of Sustainable Aviation Fuels and airports can play a role in supporting the commercial deployment of SAF on site at airports.

Airport operator CO_2 reductions

There are currently **314 airports** in **72 countries,** covering nearly **45%** of global air passenger traffic, accredited to the Airport Carbon Accreditation Programme. More than **320,000 tonnes of CO_2** were reduced between 2018 and 2019, equivalent to the emissions from **767 million** hours of video streaming in HD.

Climate adaptation

The aviation industry is prioritising fuel efficiency to reduce its impact on climate change. However, a changing climate also impacts flights and ground operations at airports and will continue to do so. Aviation is a resilient industry, used to dealing with operational challenges, from extreme weather events to closure of airspace due to volcanic ash. Some future climate impacts could be dealt with the knowledge and existing practices of normal daily network planning and operations, particularly in the short-term, while others will require more systematic planning and changes. Assessing risks at early stages, understanding knock-on effects of anticipated impacts, working in collaboration with aviation and non-aviation stakeholders and planning to increase overall resilience are general recommendations. Identifying opportunities to combine mitigation with adaptation measures are also relevant to ensure resilience of projects. For example, as airports invest in renewable energy generation onsite to reduce CO_2 emissions, considerations on resilience to more adverse weather conditions are advisable.

- Weather changes, including increased storminess (resulting in more diversions or flight cancellations); more turbulence; increased snowfall and snow or frost in places that have not traditionally experienced it; or a trend towards hotter weather, which can impact the take-off performance characteristics of aircraft.
- Infrastructure impacts, including rising sea levels, which may affect airport and other ground infrastructure, and increased rainfall, flooding and storm surges, which can also flood ground infrastructure, such as airports and air traffic control facilities. A 2018 ACI resolution encouraged airports to conduct risk assessments and take into consideration the potential impact of climate change as they develop their master plans[195].
- Market dynamics, including the less-understood consequences of possible alterations in destination choices by travellers as a result of changing weather patterns. Increasing temperatures may make some destinations less attractive during summer months if they start getting too hot, and other destinations may increase in popularity.

Dealing with consumer waste

The industry recognises the importance of reducing, reusing, and recycling waste generated by both in-flight operations and on the ground at airports. Passengers are increasingly worried about the impact of single-use plastics on the marine environment, there is increased focus on minimising food waste and the industry is concerned that the regulatory system inhibits their ability to respond to these challenges. Whilst airports are putting in place best-practice recycling and waste minimisation strategies, in line with other large ground-based facilities, aviation has the unique element of on-board cabin and catering waste.

High-level research by IATA indicates that the sector generated 5.7 million tonnes of cabin waste in 2017 and with passenger growth and a lack of smart regulation from governments, this waste volume could double in the next 10 years[185]. IATA is working to support the simplification and harmonisation of cabin waste regulations and promote technical solutions that will reduce industry costs and contribute to the circular economy.

Often the rules are different for domestic and international flights when it comes to recycling catering waste. A number of countries with economically important agriculture sectors such as Australia, Canada, the European Union, New Zealand and the USA, have imposed strict controls on catering waste from international flights based on animal health concerns. These controls often preclude the reuse and recycling of any materials removed from an international flight due to the perceived risk of transferring animal disease. This, despite the in-flight catering sector operating under very strict hygiene and ingredient source controls. Studies have shown that most of these regulations have not been adopted based on the actual risk involved[186].

For domestic and other flights not subject to such regulation, recycling is often possible and practiced, as crew collect used service items. One of the key areas of focus for many businesses and consumers is the reduction and eventual elimination of single-use plastics. These products are widely used in aviation and offer a wide variety of benefits including being safe, hygienic and light-weight. Although many single-use plastic products can be removed or replaced easily (straws, stirrers, cutlery), others are more problematic. Alternative products will need to comply with aviation security and safety restrictions and ensure there is no displaced pollution. For example, replacing plastic water bottles with glass would increase weight and therefore fuel use (and CO_2 emissions). Some plastics, if recycled properly, will have a lower lifecycle impact than other materials such as paper or aluminium.

Whilst airlines are supportive of a move to more sustainable inflight products, it is essential that the sector follows a cohesive and phased implementation plan that can meet national waste reduction targets but also recognise the characteristics of the airline industry. For international airlines, the surge in plastic bans presents an additional challenge, with over 127 countries regulating the consumption of plastic bags, and 27 more extending these bans to other plastic products, including plates, cups, straws and materials such as polystyrene. In May 2021, the 27 EU member states will also implement bans and restrictions. Airlines now face the challenge of asymmetric legislation with certain products banned on the outbound and others on the return leg. There is a lack of consistency in these bans being applied, coupled with an absence of the recognition that certain single-use plastic products are essential in aviation to meet medical, security and safety rules.

End of service

A passenger aircraft will typically remain in service for 20-25 years. During that time, it will fly on average over 40 million kilometres – over 1,000 times around the world – with some long-haul aircraft at several airlines flying over 100 million kilometres[187]. Once it reaches the end of its useful life, 85% to 90% of the aircraft by weight can be recovered. This ensures environmentally-sound management of the aircraft's end of life, but also takes advantage of the many high-quality components and materials. The industry is optimistic that current recycling rates can be maintained as technology advances.

All airframe and engine manufacturers support the responsible management of aircraft and engines after their end of service. These companies, through organisations such as the Aircraft Fleet Recycling Association (AFRA)[188], collaborate to promote responsible environmental management in the disassembly and recycling of aircraft and accredit companies to best practice standards requiring rigorous on-site auditing[189].

Approximately 700 aircraft are retired each year. It is anticipated that in the next 20 years, some 15,000 aircraft will be retired. Some 400-450 aircraft are disassembled each year. Between 40-50% of the weight of all dismantled aircraft is returned to the parts distribution pipeline. The remaining unserviceable material is mainly repurposed, recycled and returned to the supply chain as raw materials[190].

Manufacturers are ensuring that new aircraft are designed not only for a long, safe and efficient life but also for end-of-service opportunities. Newer materials, such as composites, are increasingly being recycled for commercial applications in electronics and auto parts. With innovative technology and economic solutions continuing to emerge, maintaining current recycle rates is anticipated. Interior components containing flame retardants required for passenger safety present a technology challenge to recycling. This will continue as a focus of research and development by civil aerospace manufacturers.

Noise

Modern jet aircraft are roughly 75% quieter than the first models, and each new generation continues this downward trend. It is estimated that the noise footprint of each new generation of aircraft is at least 15% lower than previous models. Meanwhile, the number of flights has grown and the sensitivity of people living under flight paths to perceived noise has also increased.

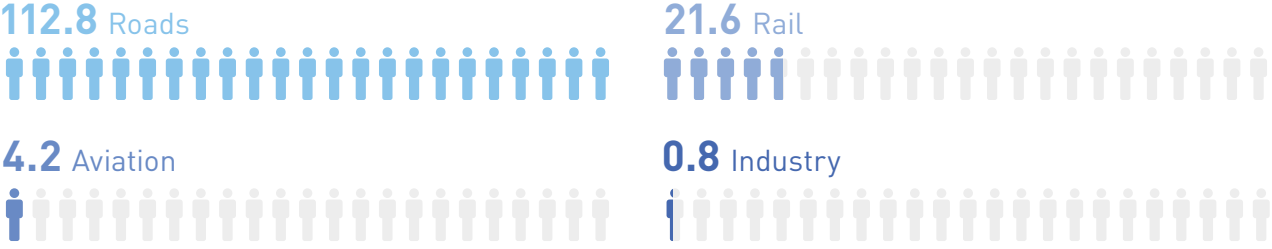
However, statistics in the US show that between 1975 and 2018 the number of residents exposed to significant aircraft noise levels fell 94%, while enplanements rose 359%. From 2000 to 2018, noise exposures were reduced by 51% while enplanements rose 31%[191]. In Europe, average noise levels around airports are still close to what they were in 2005 despite growth in traffic[192]. This trend is being replicated around the world. Aircraft are getting quieter, airports and air traffic controllers are working to provide operational noise mitigation measures, and airports continue to work with local governments to more appropriately zone areas around airports. Land-use planning is crucial for minimising the number of people exposed to aircraft noise. Effective land-use planning can discourage or prevent inappropriate new residential, health or educational developments, and encourage developments that are not sensitive to aircraft noise, such as light industry or storage areas.

Counter-intuitively, efforts to improve airspace efficiency can also lead to a higher number of noise complaints, even where the numbers of people exposed to noise have reduced. The implementation of performance-based navigation has, in some cases, led to an increased perception of noise by communities because flight paths have changed and are flown very accurately by all aircraft on those routes (compared to historically aircraft being spread more geographically across the ground). In cases like these, it is important for governments and the industry to engage with communities on issues of noise and to determine how new technologies and airspace changes, land-use planning, or other methods such as insulating houses, can be used to address concerns.

Aviation is not the only source of noise in the transport sector; in many cases, noise impacts on communities stem far more regularly from the road and rail sectors. A report by the European Environment Agency shows that road traffic is responsible for the vast majority of noise in Europe, exposing nearly 113 million people to levels above 55 decibel (dB). Rail is the second-highest cause of noise, with nearly 22 million people exposed, and aviation noise comes in third, with four million people affected[193].

Planes, trains and automobiles

Population exposed to noise above 55dB in Europe, 2017 (in millions)[194].



REGIONAL AND GROUP ANALYSIS

- Africa
- Asia-Pacific
- Europe
- Latin America and the Caribbean
- Middle East
- North America
- APEC economies
- European Union
- Small island states
- Developing countries
- OECD countries
- Least-developed countries
- Landlocked developing countries

AFRICA[196]

Air transport supported 7.7 million jobs and $63 billion in African economic activity. That is 2.2% of all employment and 2.7% of all GDP in African countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 16.5 jobs elsewhere in Africa. Similarly, $6 of economic activity was supported elsewhere in Africa for every $1 of gross value added directly created by the air transport sector.

The aviation sector in Africa directly employed 440,000 people in 2018. A sub-sectoral analysis[204] of these workers suggests that:

- **252,000 of them (57% of the total)** were employed by airlines or handling agents as, for example, flight crew, check-in staff, maintenance crew, or head office staff;
- **45,000 (10%)** had jobs with airport operators in, for example, airport management, maintenance, and security;
- **112,000 (25%)** worked on-site at airports in, for example, retail outlets, restaurants, and hotels;
- **17,000 (4%)** were employed in the manufacture of civil aircraft (including systems, components, airframes, and engines); and
- **13,000 (3%)** worked for air navigation service providers in, for example, air traffic control and engineering.

Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in Africa. In 2018, the operations of these businesses directly generated a $9 billion contribution to GDP, about the equivalent to the entire GDP of Rwanda.

The aviation sector's spending with suppliers is estimated to have supported a further 500,000 jobs and a $5.5 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 333,000 more jobs and a $4 billion gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in Africa. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to African countries supported an estimated 6.5 million jobs and a $44 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported 7.7 million jobs and a $63 billion contribution to GDP in Africa in 2018.

Air travel in Africa is expected to continue to grow at about 3.4% per year over the next two decades[205]. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in Africa will have grown to support 13.3 million jobs (72% more than in 2018) and a $144 billion contribution to GDP (a 129% increase).

2.5%
share of global passenger traffic

1,252,228
flights[198]

115
million passengers[197]

198
airlines[200]

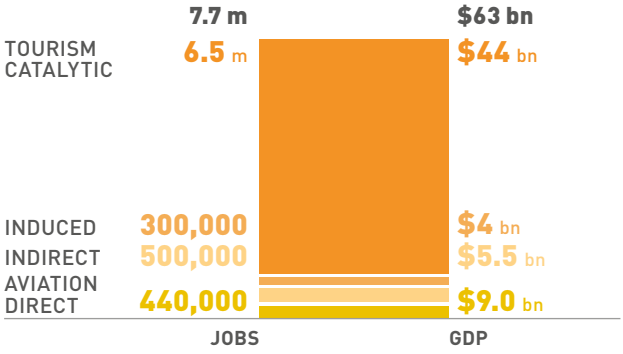
1
million tonnes of cargo[201]

352
commercial airports[199]

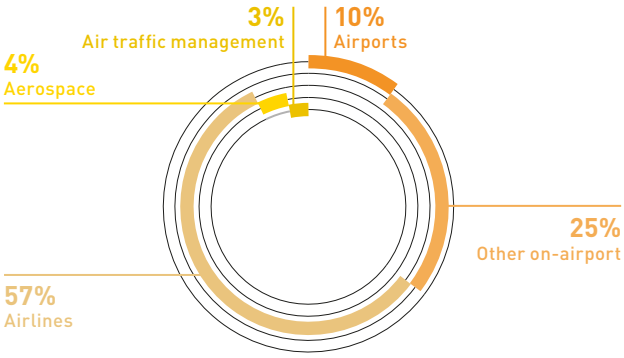
36
air navigation service providers[202]

73%
average regional load factor[203]

Total jobs and GDP generated by air transport in Africa, 2018.



Direct jobs generated by air transport in Africa.



ASIA-PACIFIC[206]

Air transport supported 46.7 million jobs and $944 billion in Asia-Pacific economic activity. That is 2.5% of all employment and 3.1% of all GDP in Asia-Pacific countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 10.1 jobs elsewhere in the Asia-Pacific region. Similarly, $3.20 of economic activity was supported elsewhere in Asia-Pacific for every $1 of gross value added directly created by the air transport sector.

The aviation sector in the Asia-Pacific region directly employed 4.2 million people in 2018. A sub-sectoral analysis of these workers suggests that:

- **1.8 million of them (42% of the total)** were employed by airlines or handling agents as, for example, flight crew, check-in staff, maintenance crew, or head office staff;
- **271,000 (6%)** had jobs with airport operators in, for example, airport management, maintenance, and security;
- **1.9 million (45%)** worked on-site at airports in, for example, retail outlets, restaurants, and hotels;
- **176,000 (4%)** were employed in the manufacture of civil aircraft (including systems, components, airframes, and engines); and
- **80,000 (2%)** worked for air navigation service providers in, for example, air traffic control and engineering.

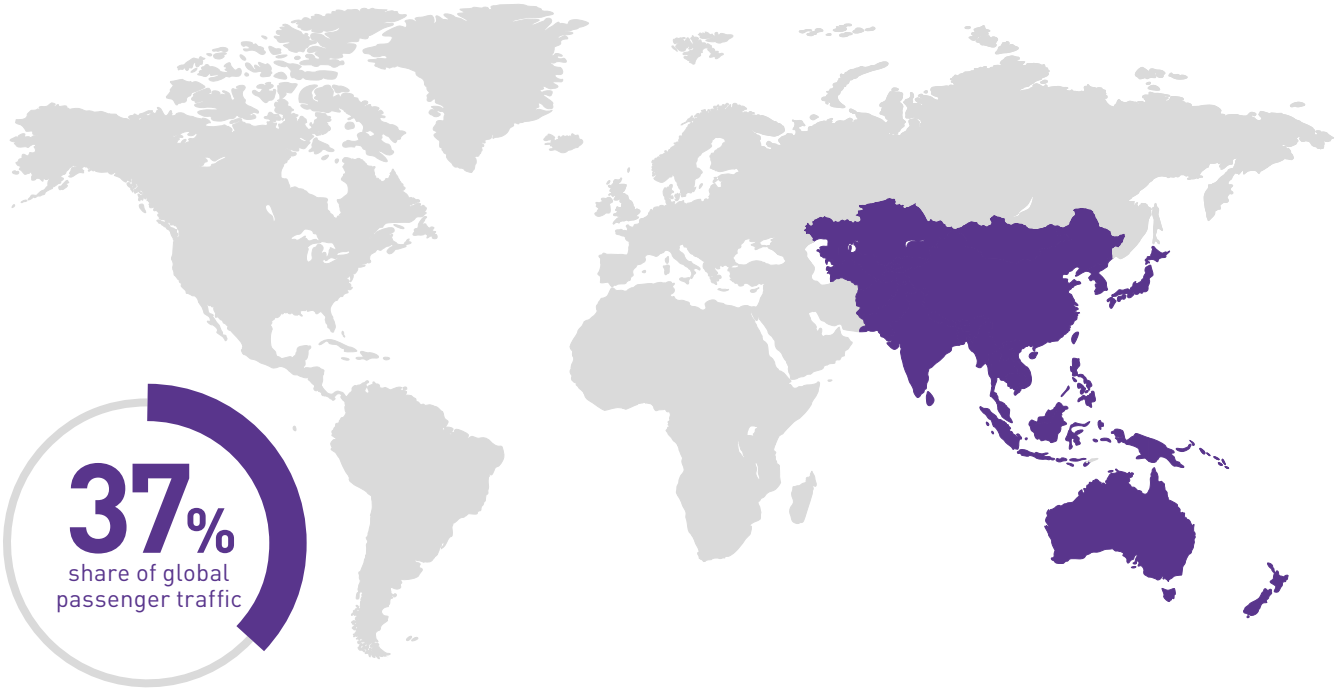
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in Asia-Pacific countries. In 2018, the operations of these businesses directly generated a $225 billion contribution to GDP, about the equivalent to the entire GDP of Bangkok.

The aviation sector's spending with suppliers is estimated to have supported a further 10.1 million jobs and a $203 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 7.0 million more jobs and a $162 billion gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in the Asia-Pacific region. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to Asia-Pacific countries supported an estimated 25 million jobs and a $354 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported 46.7 million jobs and a $944 billion contribution to GDP in the Asia-Pacific region in 2018.

Air travel in Asia-Pacific is expected to continue to grow at about 4.2% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in Asia-Pacific countries will have grown to support 80 million jobs (72% more than in 2018) and a $2.1 trillion contribution to GDP (a 120% increase).



12,817,854
flights

1.7
billion
passengers

316
airlines

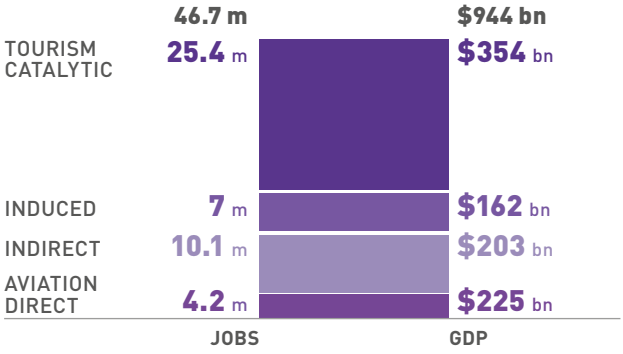
22
million tonnes
of cargo

1,214
commercial airports

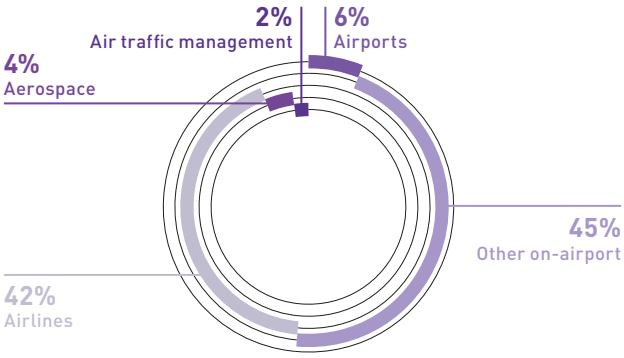
35
air navigation service providers

82%
average regional load factor

Total jobs and GDP generated by air transport in Asia-Pacific, 2018.



Direct jobs generated by air transport in Asia-Pacific.



EUROPE[207]

Air transport supported 13.5 million jobs and $991 billion in European economic activity. That is 3.6% of all employment and 4.4% of all GDP in European countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 4.1 jobs elsewhere in Europe. Similarly, $3.00 of economic activity was supported elsewhere in Europe for every $1 of gross value added directly created by the air transport sector.

The aviation sector in Europe directly employed an estimated 2.7 million people in 2018. A sub-sectoral analysis of these workers suggests that:

- **553,000 of them (21% of the total)** were employed by airlines or handling agents as, for example, flight crew, check-in staff, maintenance crew, or head office staff;
- **230,000 (9%)** had jobs with airport operators in, for example, airport management, maintenance, and security;
- **1.4 million (53%)** worked on-site at airports in, for example, retail outlets, restaurants, and hotels;
- **395,000 (15%)** were employed in the manufacture of civil aircraft (including systems, components, airframes, and engines); and
- **69,000 (3%)** worked for air navigation service providers in, for example, air traffic control and engineering.

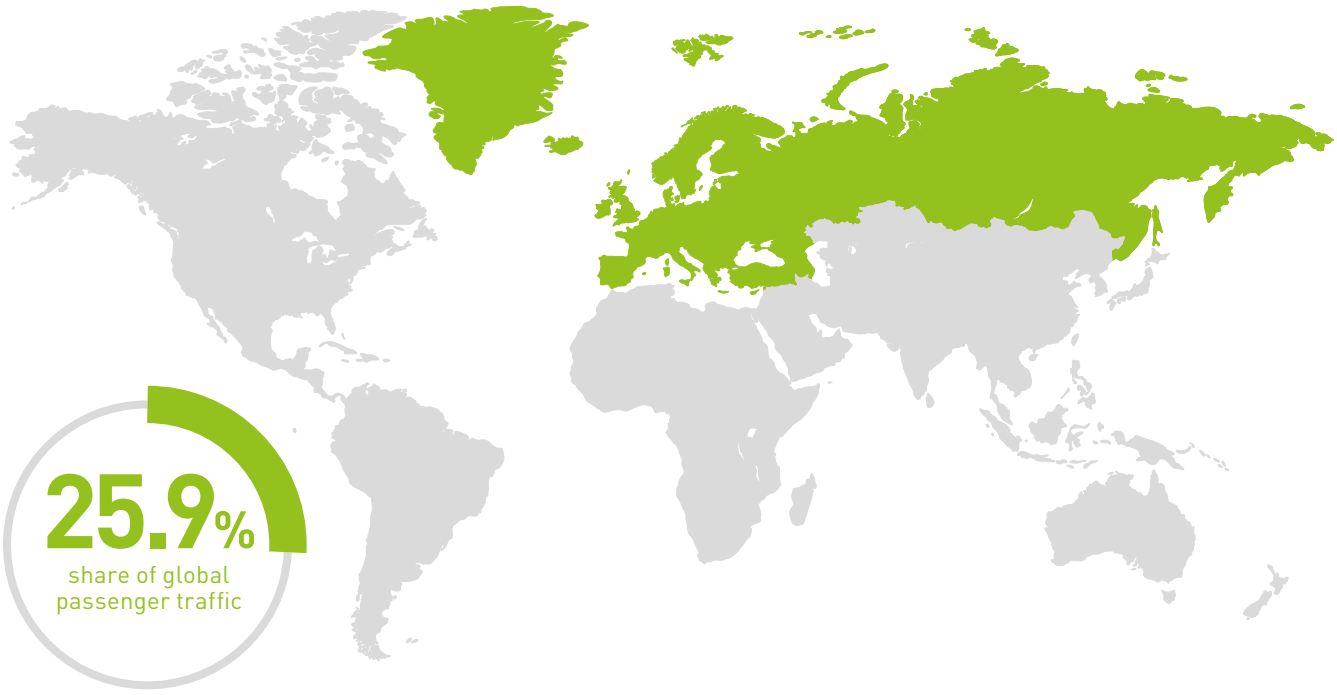
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in Europe. In 2018, the operations of these businesses directly generated a $245 billion contribution to GDP equivalent to the entire GDP of Czechia.

The aviation sector's spending with suppliers is estimated to have supported a further 3.0 million jobs and a $242 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported another 2.2 million jobs and a $180 billion gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in Europe. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to European countries supported an estimated 5.6 million jobs and a $324 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 13.5 million jobs and a $991 billion contribution to GDP in Europe in 2018.

Air travel in Europe is expected to continue to grow at about 2.1% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038, the impact of air transport and the tourism it facilitates in Europe will have grown to support 18.6 million jobs (37% more than in 2018) and a $1.5 trillion contribution to GDP (a 54% increase).



9,112,303
flights

1.2
billion
passengers

375
airlines

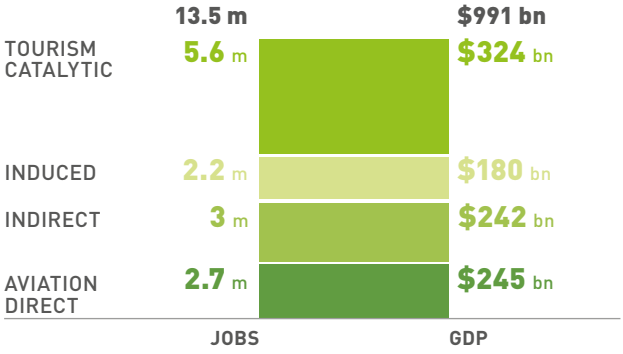
10
million tonnes
of cargo

756
commercial airports

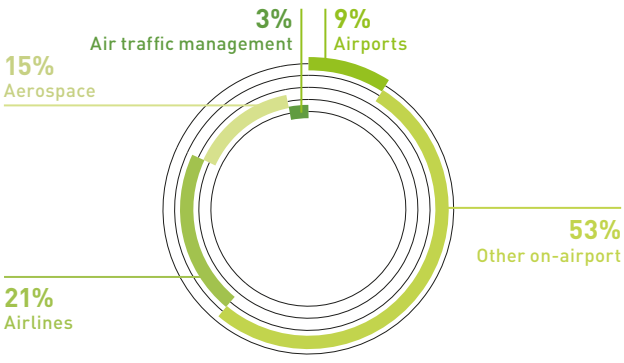
44
air navigation service providers

84%
average regional load factor

Total jobs and GDP generated by air transport in Europe, 2018.



Direct jobs generated by air transport in Europe.



LATIN AMERICA AND THE CARIBBEAN[208]

Air transport supported 7.7 million jobs and $187 billion in Latin America and the Caribbean economic activity. That is 2.7% of all employment and 3.5% of all GDP in Latin American and Caribbean countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 9.6 jobs elsewhere in Latin America and the Caribbean. Similarly, $2.80 of economic activity was supported elsewhere in Latin America and the Caribbean for every $1 of gross value-added directly created by the air transport sector.

The aviation sector in Latin America and the Caribbean directly employed an estimated 722,000 people in 2018. A sub-sectoral analysis of these workers suggests that:

- **190,000 of them (26% of the total)** were employed by airlines or handling agents as, for example, flight crew, check-in staff, maintenance crew, or head office staff;
- **27,000 (4%)** had jobs with airport operators in, for example, airport management, maintenance, and security;
- **394,000 (55%)** worked on-site at airports in, for example, retail outlets, restaurants, and hotels;
- **82,000 (11%)** were employed in the manufacture of civil aircraft (including systems, components, airframes, and engines); and
- **29,000 (4%)** worked for air navigation service providers in, for example, air traffic control and engineering.

Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in Latin America and the Caribbean. In 2018, the operations of these businesses directly generated a $49 billion contribution to GDP, equivalent to the entire GDP of Santo Domingo.

The aviation sector's spending with suppliers is estimated to have supported a further 1.7 million jobs and a $37 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 1.3 million more jobs and a $28 billion gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in Latin America and the Caribbean. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to Latin America and the Caribbean countries supported an estimated 4.0 million jobs and a $73 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 7.7 million jobs and a $187 billion contribution to GDP in Latin America and the Caribbean countries in 2018.

Air travel in Latin America and the Caribbean is expected to continue to grow at about 3.2% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in Latin America and the Caribbean will have grown to support 12.5 million jobs (64% more than in 2018) and a $367 billion contribution to GDP (a 96% increase).

3,195,191
flights

356
million passengers

178
airlines

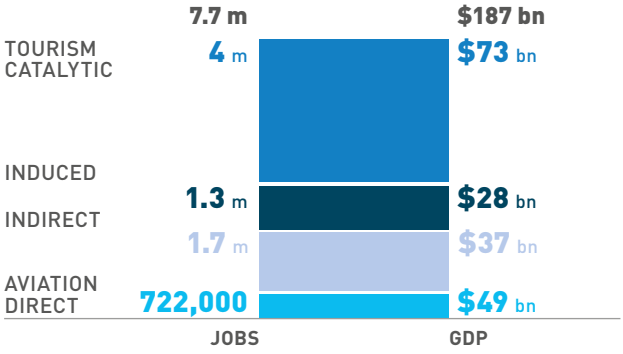
2.2
million tonnes of cargo

493
commercial airports

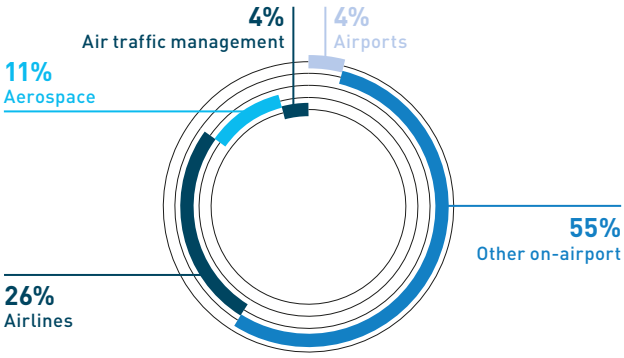
31
air navigation service providers

81%
average regional load factor

Total jobs and GDP generated by air transport in Latin America and the Caribbean, 2018.



Direct jobs generated by air transport in Latin America and the Caribbean.



MIDDLE EAST[209]

Air transport supported 3.4 million jobs and $213 billion in Middle East economic activity. That is 4.5% of all employment and 7.6% of all GDP in Middle Eastern countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 4.6 jobs elsewhere in the Middle East. Similarly, $2.10 of economic activity was supported elsewhere in the Middle East for every $1 of gross value added directly created by the air transport sector.

The aviation sector in the Middle East directly employed an estimated 595,000 people in 2018. A sub-sectoral analysis of these workers suggests that:

- **262,000 of them (44% of the total)** were employed by airlines or handling agents as, for example, flight crew, check-in staff, maintenance crew, or head office staff;
- **26,000 (4%)** had jobs with airport operators in, for example, airport management, maintenance, and security;
- **297,000 (50%)** worked on-site at airports in, for example, retail outlets, restaurants, and hotels;
- **4,600 (1%)** were employed in the manufacture of civil aircraft (including systems, components, airframes, and engines); and
- **5,300 (1%)** worked for air navigation service providers in, for example, air traffic control and engineering.

Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in the Middle East. In 2018, the operations of these businesses directly generated a $68 billion contribution to GDP, about equivalent to the entire GDP of Tehran.

The aviation sector's spending with suppliers is estimated to have supported a further 700,000 jobs and a $40 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 302,000 more jobs and a $18 billion gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in the Middle East. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to Middle Eastern countries supported an estimated 1.8 million jobs and a $87 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 3.4 million jobs and a $213 billion contribution to GDP in the Middle East in 2018.

Air travel in the Middle East is expected to continue to grow at about 4.1% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in Middle Eastern countries will have grown to support 6.7 million jobs (101% more than in 2018) and a $517 billion contribution to GDP (a 143% increase).

4.2%
share of global passenger traffic

1,257,259
flights

192
million passengers

68
airlines

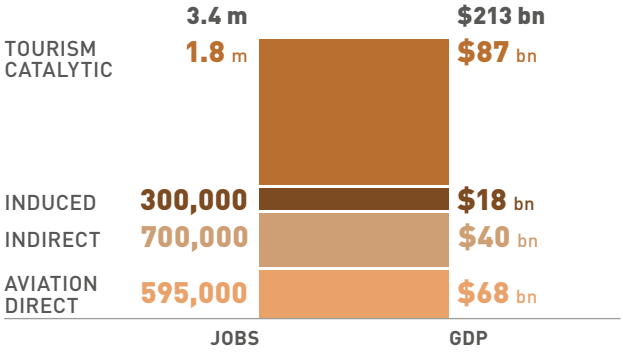
6.7
million tonnes of cargo

114
commercial airports

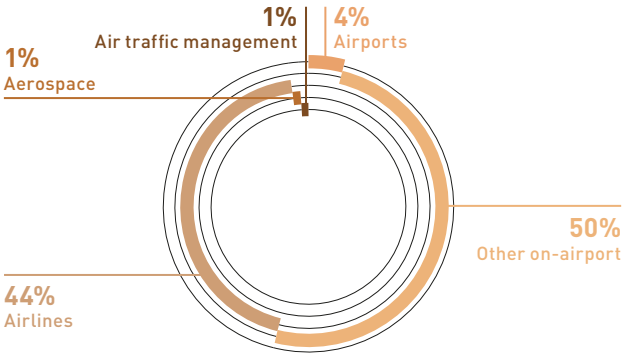
14
air navigation service providers

74%
average regional load factor

Total jobs and GDP generated by air transport in the Middle East, 2018.



Direct jobs generated by air transport in the Middle East.



NORTH AMERICA[210]

Air transport supported 8.7 million jobs and $1.1 trillion in North American economic activity. That is 5% of all employment and 5% of all GDP in the United States and Canada in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 2.3 jobs elsewhere in North America. Similarly, $2.00 of economic activity was supported elsewhere in North America for every $1 of gross value added directly created by the air transport sector.

The aviation sector in North America directly employed an estimated 2.7 million people in 2018. A sub-sectoral analysis of these workers suggests that:

- **572,000 of them (21% of the total)** were employed by airlines or handling agents as, for example, flight crew, check-in staff, maintenance crew, or head office staff;
- **48,000 (2%)** had jobs with airport operators in, for example, airport management, maintenance, and security;
- **1.4 million (52%)** worked on-site at airports in, for example, retail outlets, restaurants, and hotels;
- **636,000 (24%)** were employed in the manufacture of civil aircraft (including systems, components, airframes, and engines); and
- **40,000 (1%)** worked for air navigation service providers in, for example, air traffic control and engineering.

Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in North America. In 2018, the operations of these businesses directly generated a $364 billion contribution to GDP, significantly more than the entire GDP of Toronto.

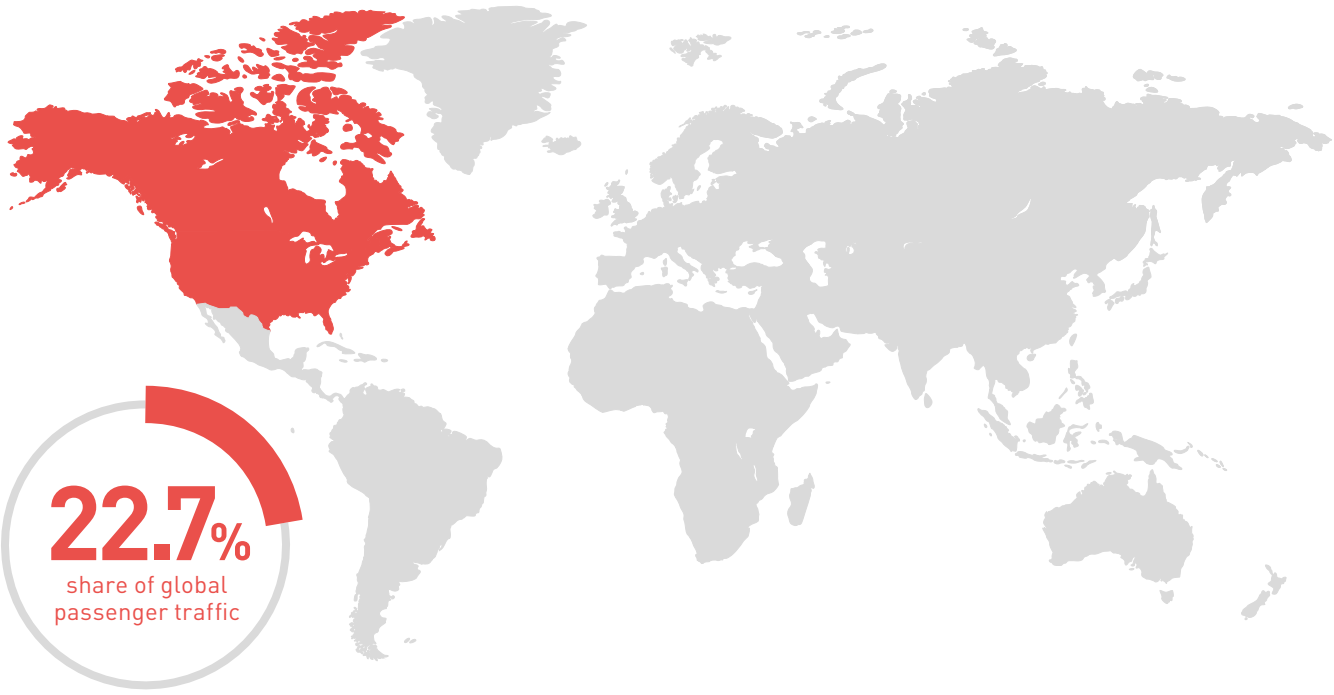
The aviation sector's spending with suppliers is estimated to have supported a further 2.2 million jobs and a $289 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 2.3 million more jobs and a $300 billion gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in North America. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to North American countries supported an estimated 1.5 million jobs and a $152 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 8.7 million jobs and an $1.1 trillion contribution to GDP in North America in 2018.

Air travel in North America is expected to continue to grow at about 2.1% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in North America will have grown to support 11.9 million jobs (35% more than in 2018) and a $1.7 trillion contribution to GDP (an 53% increase).

Note: In the United States, the FAA collects economic impact data with which these numbers are aligned. The FAA assessment further evaluates the much wider economic activity that is supported by air transport, including general aviation and the domestic tourism markets, which this report does not include. Accordingly, with these wider catalytic impacts included, the total number of jobs supported by civil aviation in the US alone is around 10.9 million, with a contribution to GDP of $1.1 trillion in 2016[211].



10,599,508
flights

1
billion
passengers

180
airlines

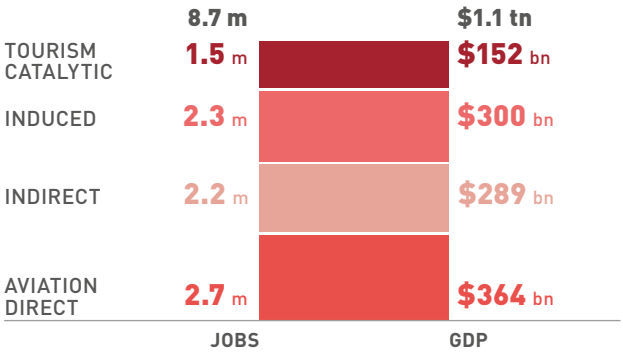
19
million tonnes
of cargo

850
commercial airports

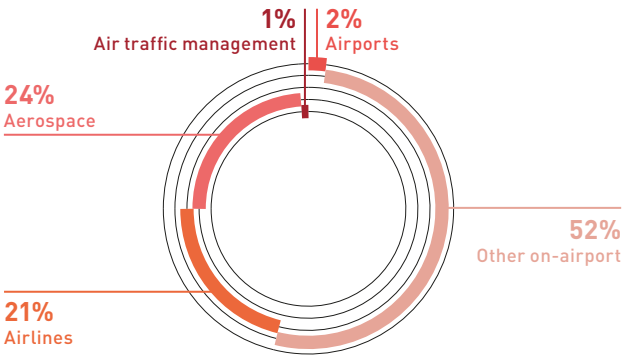
2
air navigation service providers

84%
average regional load factor

Total jobs and GDP generated by air transport in North America, 2018.



Direct jobs generated by air transport in North America.



APEC ECONOMIES[212]

Air transport supported 40.1 million jobs and $2.2 trillion across Asia-Pacific Economic Cooperation (APEC) economies. That is 2.7% of all employment and 4.3% of all GDP in the APEC countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 5 jobs elsewhere in the APEC economies. Similarly, $2.60 of economic activity was supported elsewhere in the APEC economies for every $1 of gross value added directly created by the air transport sector.

The aviation sector in APEC economies directly employed 6.7 million people in 2018 in the following sub-sectors:

- **Airlines: 2.1 million** (31% of the total)
- **Airport operators: 316,000** (5%)
- **Other on-airport: 3.3 million** (49%)
- **Civil aerospace: 886,000** (13%)
- **Air navigation service providers: 115,000** (2%)

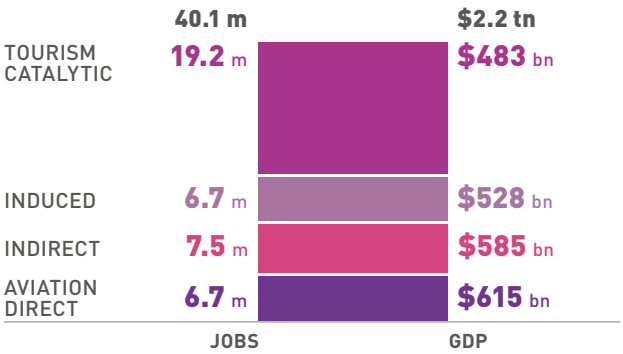
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in APEC economies. In 2018, the operations of these businesses directly generated a $615 billion contribution to GDP, more than the entire GDP of Chinese Taipei.

The aviation sector's spending with suppliers is estimated to have supported a further 7.5 million jobs and a $585 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 6.7 million more jobs and a $528 billion gross value-added contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 40.1 million jobs and a $2.2 trillion contribution to GDP in APEC economies in 2018.

Air travel in the APEC economies is expected to continue to grow at about 3.3% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in APEC economies will have grown to support 59.6 million jobs (49% more than in 2018) and a $4 trillion contribution to GDP (an 80% increase).

Total jobs and GDP generated by air transport in the APEC economies, 2018.



2.7 billion passengers[213]

59% share of global passenger traffic

473 airlines

1,924 airports

19,085 aircraft in service

EUROPEAN UNION[214]

Air transport supported 9.8 million jobs and $794 (€672) billion in European Union economic activity. That is 4.2% of all employment and 4.2% of all GDP in European Union countries (EU28 — including the UK) in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 3.8 jobs elsewhere in the European Union. Similarly, $3 (€2.54) of economic activity was supported elsewhere in the European Union for every $1 (€0.85) of gross value added directly created by the air transport sector.

The aviation sector in the European Union directly employed around two million people in 2018 in the following sub-sectors:

- **Airlines: 397,000** (19% of the total)
- **Airport operators: 135,000** (7%)
- **Other on-airport: 1.1 million** (56%)
- **Civil aerospace: 320,000** (16%)
- **Air navigation service providers: 43,000** (2%)

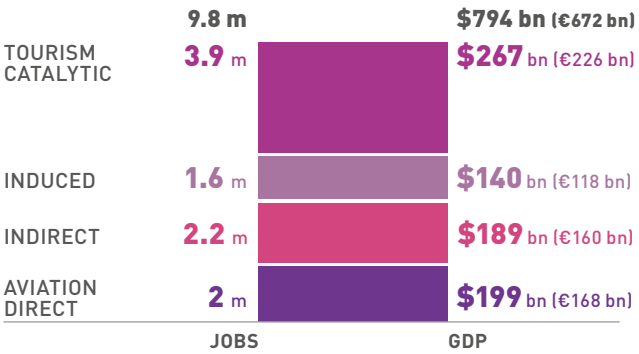
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in the European Union. In 2018, the operations of these businesses directly generated a $199 billion (€168 billion) contribution to GDP, equivalent to the entire GDP of Barcelona.

The aviation sector's spending with suppliers is estimated to have supported a further 2.2 million jobs and a $189 billion (€160 billion) gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 1.6 million more jobs and a $140 billion (€118 billion) gross value-added contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 9.8 million jobs and a $794 billion (€672 billion) contribution to GDP in the European Union in 2018.

Air travel in the 27 European Union countries is expected to continue to grow at about 2.1% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038, the impact of air transport and the tourism it facilitates in the European Union will have grown to support 12 million jobs (23% more than in 2018) and a $1.1 trillion (€889 billion) contribution to GDP (32% increase). Note that this growth figure compares EU 27 countries in 2018 with EU 27 in 2038 – the United Kingdom is removed from both figures.

Total jobs and GDP generated by air transport in the EU28 economies, 2018.



903 million passengers

19.6% share of global passenger traffic

234 airlines

417 airports

5,087 aircraft in service

SMALL ISLAND STATES[215]

Air transport supported 2 million jobs and $34.7 billion in small island states economic activity. That is 8.7% of all employment and 10.6% of all GDP in these countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 24.9 jobs elsewhere in the small island states. Similarly, $11.60 of economic activity was supported elsewhere in the small island states for every $1 of gross value added directly created by the air transport sector.

The aviation sector in small island states directly employed an estimated 75,000 people in 2018 in the following sub-sectors:

- **Airlines: 20,000** (26% of the total)
- **Airport operators: 15,000** (20%)
- **Other on-airport: 36,000** (48%)
- **Air navigation service providers: 4,000** (5%)

Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in small island states. In 2018, the operations of these businesses directly generated a $2.8 billion contribution to GDP, more than half the GDP of Fiji.

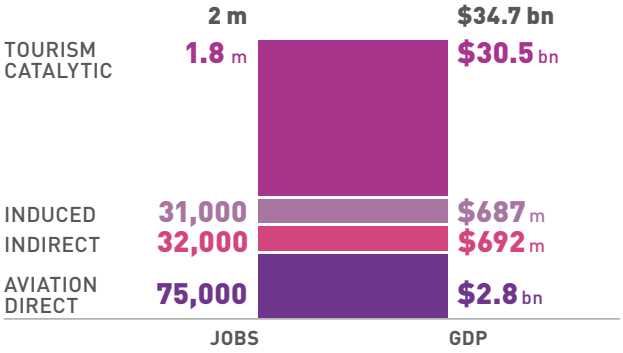
The aviation sector's spending with suppliers is estimated to have supported a further 32,000 jobs and a $692 million gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 31,000 more jobs and another $687 million gross value-added contribution to GDP.

The aviation sector also facilitates a substantial amount of tourism in small island states. This stimulates still more economic activity, as tourists spend their money with restaurants, hotels, retailers, tour operators, and other providers of consumer goods and services. In 2018, spending by foreign visitors who flew to small island states supported an estimated 1.8 million jobs and a $31 billion contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 2.0 million jobs and a $35 billion contribution to GDP in small island states in 2018.

Air travel in small island states is expected to continue to grow at about 3.4% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in small island states will have grown to support 2.6 million jobs (31% more than in 2018) and a $69 billion contribution to GDP (a 100% increase).

Total jobs and GDP generated by air transport in small island state economies, 2018.



40 million passengers

0.9% share of global passenger traffic

53 airlines

205 airports

427 aircraft in service

DEVELOPING COUNTRIES[216]

Air transport supported nearly 56 million jobs and $760 billion in economic activity in developing countries. That is 2.2% of all employment and 2.6% of all GDP in developing countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 11.2 jobs elsewhere in developing countries. Similarly, $3.60 of economic activity was supported elsewhere in developing countries for every $1 of gross value added directly created by the air transport sector.

The aviation sector in developing countries directly employed an estimated 4.6 million people in 2018 in the following sub-sectors:

- **Airlines: 2 million** (44% of the total)
- **Airport operators: 342,000** (7%)
- **Other on-airport: 1.95 million** (43%)
- **Civil aerospace: 166,000** (4%)
- **Air navigation service providers: 116,000** (3%)

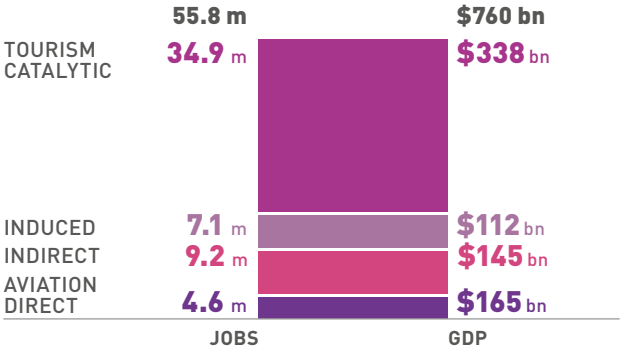
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in developing countries. In 2018, the operations of these businesses directly generated a $165 billion contribution to GDP, equivalent to the entire GDP of Kazakhstan.

The aviation sector's spending with suppliers is estimated to have supported a further 9.2 million jobs and a nearly $145 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported another 7.1 million jobs and a further $112 billion gross value-added contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 56 million jobs and a $760 billion contribution to GDP in developing countries in 2018.

Air travel in developing countries is expected to continue to grow at about 3.8% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in developing countries will have grown to support 93 million jobs (67% more than in 2018) and a $1.7 trillion contribution to GDP (a 123% increase).

Total jobs and GDP generated by air transport in developing economies.



2 billion passengers

43.4% share of global passenger traffic

763 airlines

1,969 airports

12,741 aircraft in service

OECD COUNTRIES[217]

Air transport supported 26 million jobs and $2.5 trillion in economic activity in OECD countries. That is 4.3% of all employment and 4.7% of all GDP in OECD countries in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 3.4 jobs elsewhere in OECD countries. Similarly, $2.50 of economic activity was supported elsewhere in OECD countries for every $1 of gross value added directly created by the air transport sector.

The aviation sector in OECD countries directly employed 5.9 million people in 2018 in the following sub-sectors:

- **Airlines: 1.2 million** (21% of the total)
- **Airport operators: 212,000** (4%)
- **Other on-airport: 3.3 million** (56%)
- **Civil aerospace: 1 million** (18%)
- **Air navigation service providers: 105,000** (2%)

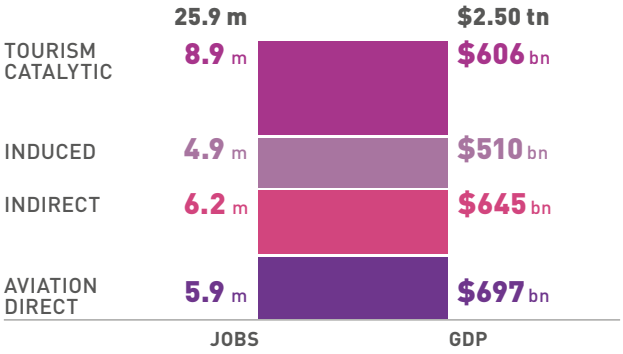
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in OECD countries. In 2018, the operations of these businesses directly generated a $697 billion contribution to GDP, equivalent to the entire GDP of Switzerland, the country with the 20th highest GDP in the world.

The aviation sector's spending with suppliers is estimated to have supported a further 6.2 million jobs and a $645 billion gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 4.9 million more jobs and a $510 billion gross value-added contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 26 million jobs and a $2.5 trillion contribution to GDP in OECD countries in 2018.

Air travel in OECD countries is expected to continue to grow at about 2.5% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in OECD countries will have grown to support 38 million jobs (45% more than in 2018) and a $4 trillion contribution to GDP (a 63% increase).

Total jobs and GDP generated by air transport in OECD.



2.5 billion passengers

54.7% share of global passenger traffic

511 airlines

1,712 airports

17,345 aircraft in service

LEAST-DEVELOPED COUNTRIES[218]

Air transport supported nearly 5.2 million jobs and $19.5 billion in economic activity across LDCs. That is 1.8% of all employment and 1.8% of all GDP in LDCs in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 24.1 jobs elsewhere in LDCs. Similarly, $5.90 of economic activity was supported elsewhere in LDCs for every $1 of gross value added directly created by the air transport sector.

The aviation sector in LDCs directly employed an estimated 209,400 people in 2018 in the following sub-sectors:

- **Airlines: 164,000** (78% of the total)
- **Airport operators: 13,000** (6%)
- **Other on-airport: 29,000** (14%)
- **Air navigation service providers: 3,300** (2%)

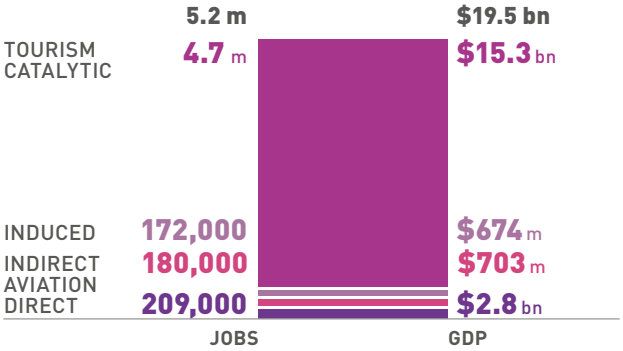
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in LDCs. In 2018, the operations of these businesses directly generated a $2.8 billion contribution to GDP.

The aviation sector's spending with suppliers is estimated to have supported a further 180,000 jobs and a $703 million gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 172,000 more jobs and a $674 million gross value-added contribution to GDP, equivalent to the entire GDP of Central African Republic.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported nearly 5.2 million jobs and a $19.5 billion contribution to GDP in LDCs in 2018.

Air travel in LDCs is expected to continue to grow at about 3.8% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in LDCs will have grown to support 8.6 million jobs (63% more than in 2018) and a $52 billion contribution to GDP (a 165% increase).

Total jobs and GDP generated by air transport in the LDCs.



56 million passengers

1.2% share of global passenger traffic

120 airlines

283 airports

658 aircraft in service

LANDLOCKED DEVELOPING COUNTRIES[219]

Air transport supported 2.6 million jobs and $13 billion in economic activity for LLDCs. That is 1.7% of all employment and 1.6% of all GDP in LLDCs in 2018.

Every person directly employed in the aviation sector and in tourism made possible by aviation supported another 12 jobs elsewhere in LLDCs. Similarly, $3.80 of economic activity was supported elsewhere in LLDCs for every $1 of gross value added directly created by the air transport sector.

The aviation sector in LLDCs directly employed an estimated 201,000 people in 2018 in the following sub-sectors:

- **Airlines: 145,000** (72% of the total)
- **Airport operators: 19,000** (10%)
- **Other on-airport: 30,000** (15%)
- **Air navigation service providers: 7,000** (3%)

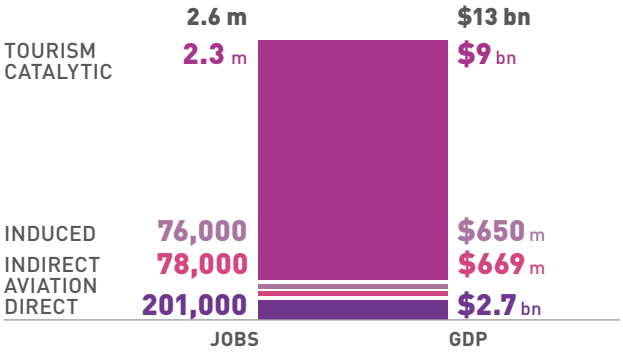
Airlines, airport operators, retailers and other on-site businesses at airports and air navigation service providers and civil aircraft manufacturers also contribute to GDP in LLDCs. In 2018, the operations of these businesses directly generated an $2.7 billion contribution to GDP, equivalent to the entire GDP of Central African Republic.

The aviation sector's spending with suppliers is estimated to have supported a further 78,000 jobs and a $669 million gross value-added contribution to GDP. In addition, wage payments to staff – by the aviation sector and businesses in the aviation sector's supply chain – supported 76,000 more jobs and a $649 million gross value-added contribution to GDP.

In total, accounting for the sector's direct impact, its supply chain impact, its wage expenditure impact, and the impact of tourism made possible by air transport, the aviation sector supported an estimated 2.6 million jobs and a $13.0 billion contribution to GDP in LLDCs in 2018.

Air travel in LLDCs is expected to continue to grow at about 3.6% per year over the next two decades. This increase will, in turn, drive growth in the economic output and jobs that are supported by the air transport industry over the next 20 years. Oxford Economics forecasts that by 2038 the impact of air transport and the tourism it facilitates in LLDCs will have grown to support 4.4 million jobs (67% more than in 2018) and a $32 billion contribution to GDP (a 146% increase).

Total jobs and GDP generated by air transport in the LLDCs.



51 million passengers

1.1% share of global passenger traffic

105 airlines

174 airports

578 aircraft in service

NATIONAL ANALYSIS

A country-by-country look at
aviation's benefits

HOW TO USE THIS SECTION

The Oxford Economics analysis has been supplemented with other analysis:

» **Airlines:** commercial airlines based in the country[220].

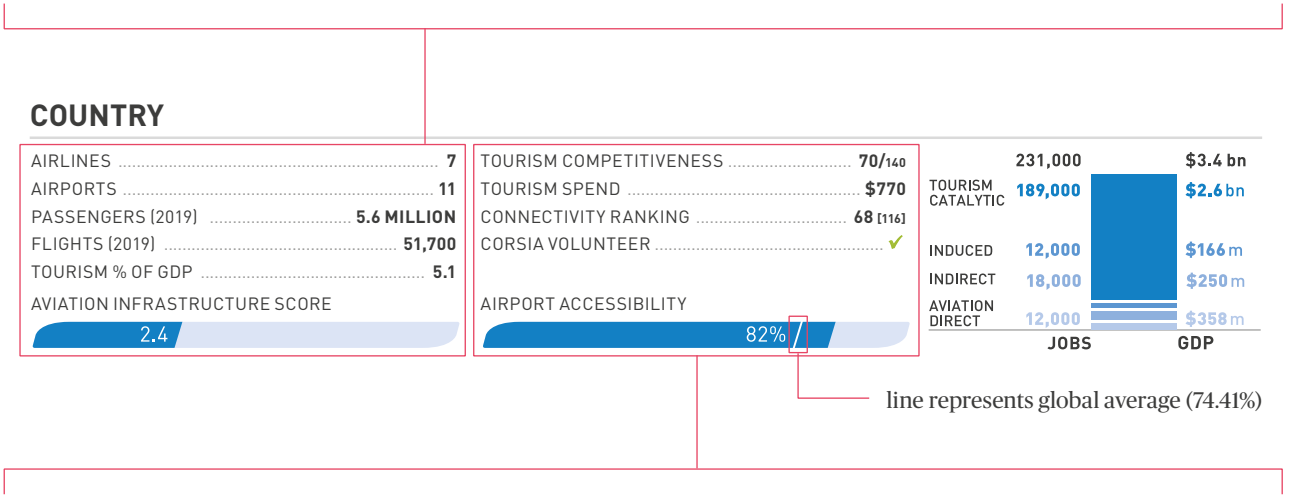
» **Airports:** commercial airports in the country[221].

» **Passengers 2019:** number of passengers departing airports in the country (does not include connecting passengers)[222].

» **Flights 2019:** number of flights operated from airports in the country[223].

» **Tourism % of GDP:** 2019 figures from the World Travel & Tourism Council[225], including direct, indirect and induced contributions of the tourism sector[226].

» **Aviation infrastructure score:** 1-7 score from the World Economic Forum *Travel and Tourism Competitiveness Report 2019*[224], based on the quality of the aviation infrastructure, using indicators such as available seat kilometres, the number of departures, airport density and the number of operating airlines, as well as the quality of air transport infrastructure for domestic and international flights. Higher is better.



» **Tourism competitiveness:** World Economic Forum *Travel and Tourism Competitiveness Report 2019*[228]. Ranking out of 140 countries - #1 is the most competitive.

» **Tourism spend:** 2018 figures from the UN World Tourism Organization *Tourism Dashboard* and the World Bank for U.S. dollars spent on average by each arriving foreign tourist[227].

» **Connectivity ranking:** ICAO Air Transport Bureau 2018 analysis ranking each country based on the number of countries and territories that can be easily reached from it by air, with the actual number of countries or territories that can be reached directly or with one stop in square brackets ([ ]).

» **CORSIA volunteer:** countries that have volunteered for the first phases of ICAO's CORSIA at the time of printing (see www.enviro.aero/CORSIA for an updated list).

» **Airport accessibility:** ICAO iStars Database percentage of a country's population within 100 kilometres of either an international airport or of a domestic airport with at least one regular to an international airport, the global average for all countries being 74.41%[229].

National figures for employment and GDP supported by aviation, with analysis provided by Oxford Economics for those countries where reliable data are available and estimations are possible at the national level. Estimates are conducted based on national statistics, industry financial statements, industry surveys and indicators such as airport employment, airport passenger traffic and airline passenger numbers.

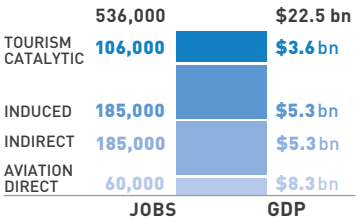
The country figures shown will not necessarily equal the regional totals expressed elsewhere in the report. In part, this is because individual country figures are computed using country-specific multipliers, whereas regional figures are computed using region-specific multipliers. The former are smaller than the latter because of the effects of 'leakage': spending that occurs outside the country or region as a result of imports. A country will have more leakage than a region, since some imports will occur only within the region to which the country belongs.

Countries not included in this section have insufficient data available for a reliable, country-specific analysis.

ARGENTINA

AIRLINES	10
AIRPORTS	40
PASSENGERS (2019)	22.6 MILLION
FLIGHTS (2019)	175,700
TOURISM % OF GDP	9.2
AVIATION INFRASTRUCTURE SCORE	3.1

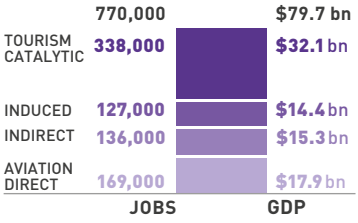
TOURISM COMPETITIVENESS	50/140
TOURISM SPEND	$800
CONNECTIVITY RANKING	43= [145]
AIRPORT ACCESSIBILITY	81%



AUSTRALIA

AIRLINES	28
AIRPORTS	157
PASSENGERS (2019)	86.2 MILLION
FLIGHTS (2019)	738,400
TOURISM % OF GDP	10.8
AVIATION INFRASTRUCTURE SCORE	6.0

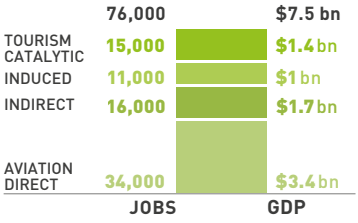
TOURISM COMPETITIVENESS	7/140
TOURISM SPEND	$4,870
CONNECTIVITY RANKING	27= [170]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	90%



AUSTRIA

AIRLINES	5
AIRPORTS	6
PASSENGERS (2019)	18.1 MILLION
FLIGHTS (2019)	151,900
TOURISM % OF GDP	11.8
AVIATION INFRASTRUCTURE SCORE	4.2

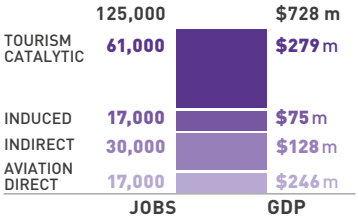
TOURISM COMPETITIVENESS	11/140
TOURISM SPEND	$750
CONNECTIVITY RANKING	12= [195]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



BANGLADESH

AIRLINES	8
AIRPORTS	8
PASSENGERS (2019)	7.3 MILLION
FLIGHTS (2019)	64,000
TOURISM % OF GDP	3.0
AVIATION INFRASTRUCTURE SCORE	2.0

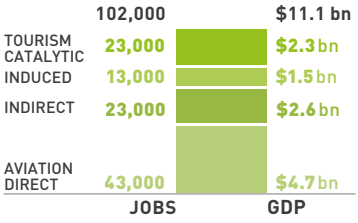
TOURISM COMPETITIVENESS	120/140
TOURISM SPEND	$340
CONNECTIVITY RANKING	54= [133]
AIRPORT ACCESSIBILITY	90%



BELGIUM

AIRLINES	6
AIRPORTS	5
PASSENGERS (2019)	17.9 MILLION
FLIGHTS (2019)	129,300
TOURISM % OF GDP	4.3
AVIATION INFRASTRUCTURE SCORE	4.1

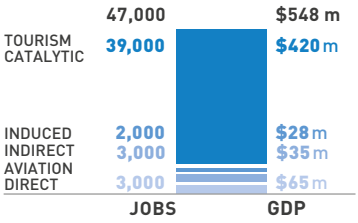
TOURISM COMPETITIVENESS	24/140
TOURISM SPEND	$980
CONNECTIVITY RANKING	15 [190]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



BELIZE

AIRLINES	2
AIRPORTS	12
PASSENGERS (2019)	2.3 MILLION
FLIGHTS (2019)	146,000
TOURISM % OF GDP	41.3
AVIATION INFRASTRUCTURE SCORE	N/A

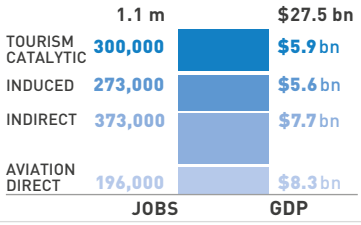
TOURISM COMPETITIVENESS	N/A
TOURISM SPEND	$1,000
CONNECTIVITY RANKING	97= [70]
AIRPORT ACCESSIBILITY	98%



BRAZIL

AIRLINES	15
AIRPORTS	121
PASSENGERS (2019)	108.9 MILLION
FLIGHTS (2019)	861,100
TOURISM % OF GDP	7.7
AVIATION INFRASTRUCTURE SCORE	3.7

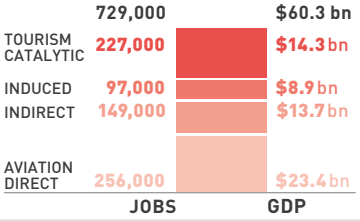
TOURISM COMPETITIVENESS	32/140
TOURISM SPEND	$890
CONNECTIVITY RANKING	20= [183]
AIRPORT ACCESSIBILITY	73%



CANADA

AIRLINES	47
AIRPORTS	218
PASSENGERS (2019)	85.3 MILLION
FLIGHTS (2019)	1,084,700
TOURISM % OF GDP	6.3
AVIATION INFRASTRUCTURE SCORE	6.6

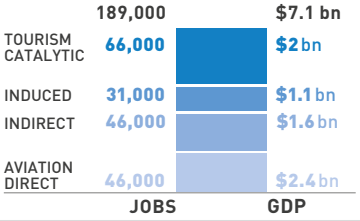
TOURISM COMPETITIVENESS	9/140
TOURISM SPEND	$1,250
CONNECTIVITY RANKING	6= [205]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	92%



CHILE

AIRLINES	8
AIRPORTS	19
PASSENGERS (2019)	20.9 MILLION
FLIGHTS (2019)	137,900
TOURISM % OF GDP	10
AVIATION INFRASTRUCTURE SCORE	3.1

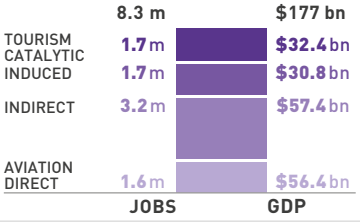
TOURISM COMPETITIVENESS	52/140
TOURISM SPEND	$520
CONNECTIVITY RANKING	49= [138]
AIRPORT ACCESSIBILITY	83%



CHINA

AIRLINES	57
AIRPORTS	238
PASSENGERS (2019)	654.6 MILLION
FLIGHTS (2019)	4,959,100
TOURISM % OF GDP	11.3
AVIATION INFRASTRUCTURE SCORE	4.3

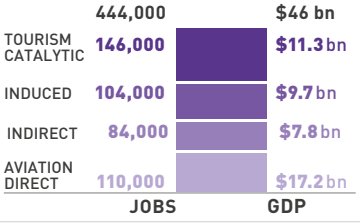
TOURISM COMPETITIVENESS	13/140
TOURISM SPEND	$640
CONNECTIVITY RANKING	5= [207]
AIRPORT ACCESSIBILITY	73%



HONG KONG SAR

AIRLINES	6
AIRPORTS	1
PASSENGERS (2019)	36.6 MILLION
FLIGHTS (2019)	178,100
TOURISM % OF GDP	12.3
AVIATION INFRASTRUCTURE SCORE	5.6

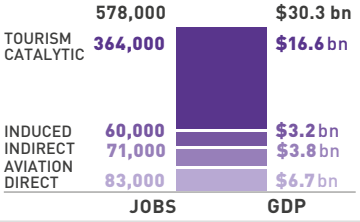
TOURISM COMPETITIVENESS	14/140
TOURISM SPEND	$1,260
CONNECTIVITY RANKING	11 [197]
AIRPORT ACCESSIBILITY	100%



CHINESE TAIPEI

AIRLINES	6
AIRPORTS	12
PASSENGERS (2019)	36.6 MILLION
FLIGHTS (2019)	248,000
TOURISM % OF GDP	6.4
AVIATION INFRASTRUCTURE SCORE	3.9

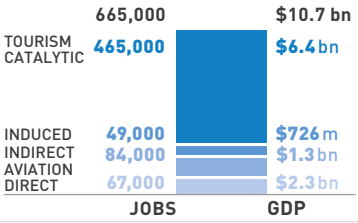
TOURISM COMPETITIVENESS	37/140
TOURISM SPEND	$1,240
CONNECTIVITY RANKING	28= [169]
AIRPORT ACCESSIBILITY	N/A



COLOMBIA

AIRLINES	17
AIRPORTS	51
PASSENGERS (2019)	37.9 MILLION
FLIGHTS (2019)	357,500
TOURISM % OF GDP	4.9
AVIATION INFRASTRUCTURE SCORE	3.0

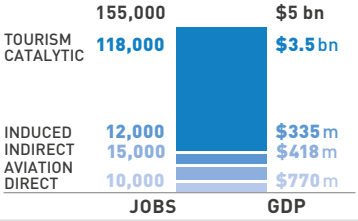
TOURISM COMPETITIVENESS	55/140
TOURISM SPEND	$1,430
CONNECTIVITY RANKING	35= [157]
AIRPORT ACCESSIBILITY	91%



COSTA RICA

AIRLINES	5
AIRPORTS	10
PASSENGERS (2019)	3.6 MILLION
FLIGHTS (2019)	33,800
TOURISM % OF GDP	12.0
AVIATION INFRASTRUCTURE SCORE	3.1

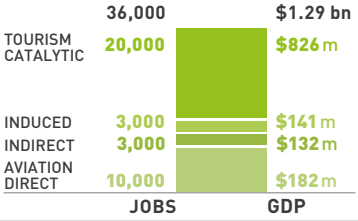
TOURISM COMPETITIVENESS	41/140
TOURISM SPEND	$1,290
CONNECTIVITY RANKING	60= [125]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



CROATIA

AIRLINES	2
AIRPORTS	9
PASSENGERS (2019)	5.5 MILLION
FLIGHTS (2019)	50,500
TOURISM % OF GDP	25.0
AVIATION INFRASTRUCTURE SCORE	3.6

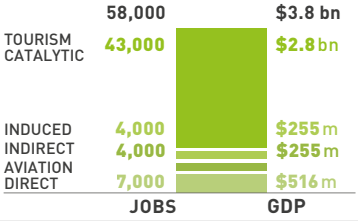
TOURISM COMPETITIVENESS	27/140
TOURISM SPEND	$710
CONNECTIVITY RANKING	30= [167]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



CYPRUS

AIRLINES	2
AIRPORTS	3
PASSENGERS (2019)	6.8 MILLION
FLIGHTS (2019)	45,700
TOURISM % OF GDP	13.8
AVIATION INFRASTRUCTURE SCORE	3.7

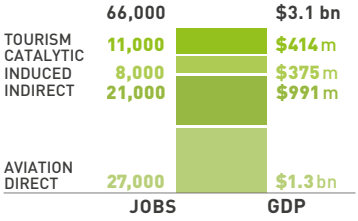
TOURISM COMPETITIVENESS	44/140
TOURISM SPEND	$880
CONNECTIVITY RANKING	44 [143]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



CZECHIA

AIRLINES	4
AIRPORTS	5
PASSENGERS (2019)	8.9 MILLION
FLIGHTS (2019)	67,000
TOURISM % OF GDP	6.5
AVIATION INFRASTRUCTURE SCORE	3.4

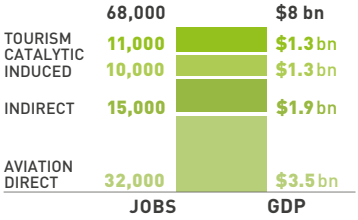
TOURISM COMPETITIVENESS	38/140
TOURISM SPEND	$780
CONNECTIVITY RANKING	23= [177]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	99%



DENMARK

AIRLINES	9
AIRPORTS	9
PASSENGERS (2019)	17.8 MILLION
FLIGHTS (2019)	158,300
TOURISM % OF GDP	6.6
AVIATION INFRASTRUCTURE SCORE	4.5

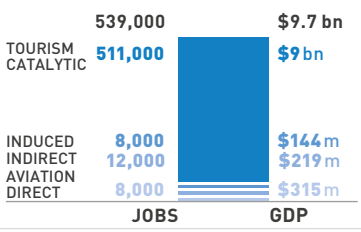
TOURISM COMPETITIVENESS	21/140
TOURISM SPEND	$710
CONNECTIVITY RANKING	17= [188]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



DOMINICAN REPUBLIC

AIRLINES	3
AIRPORTS	7
PASSENGERS (2019)	7.2 MILLION
FLIGHTS (2019)	49,600
TOURISM % OF GDP	16.3
AVIATION INFRASTRUCTURE SCORE	3.0

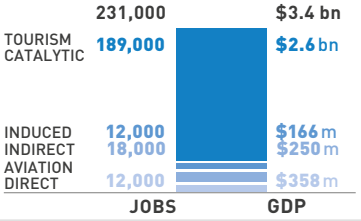
TOURISM COMPETITIVENESS	73/140
TOURISM SPEND	$1,150
CONNECTIVITY RANKING	48= [139]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



ECUADOR

AIRLINES	7
AIRPORTS	11
PASSENGERS (2019)	5.6 MILLION
FLIGHTS (2019)	51,700
TOURISM % OF GDP	5.1
AVIATION INFRASTRUCTURE SCORE	2.4

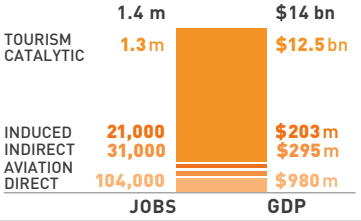
TOURISM COMPETITIVENESS	70/140
TOURISM SPEND	$770
CONNECTIVITY RANKING	68 [116]
AIRPORT ACCESSIBILITY	82%



EGYPT

AIRLINES	14
AIRPORTS	10
PASSENGERS (2019)	15.9 MILLION
FLIGHTS (2019)	118,800
TOURISM % OF GDP	9.3
AVIATION INFRASTRUCTURE SCORE	3.3

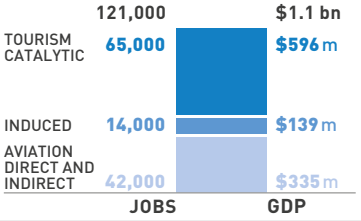
TOURISM COMPETITIVENESS	65/140
TOURISM SPEND	$1,020
CONNECTIVITY RANKING	18 [186]
AIRPORT ACCESSIBILITY	88%



EL SALVADOR

AIRLINES	1
AIRPORTS	1
PASSENGERS (2019)	2.5 MILLION
FLIGHTS (2019)	23,300
TOURISM % OF GDP	11.0
AVIATION INFRASTRUCTURE SCORE	2.1

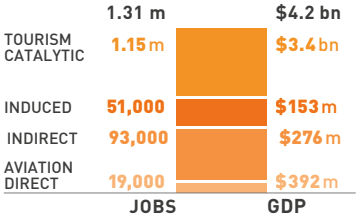
TOURISM COMPETITIVENESS	108/140
TOURISM SPEND	$600
CONNECTIVITY RANKING	84= [87]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	95%



ETHIOPIA

AIRLINES	4
AIRPORTS	20
PASSENGERS (2019)	8 MILLION
FLIGHTS (2019)	71,400
TOURISM % OF GDP	6.7
AVIATION INFRASTRUCTURE SCORE	2.2

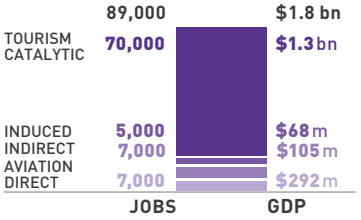
TOURISM COMPETITIVENESS	122/140
TOURISM SPEND	$1,140
CONNECTIVITY RANKING	30= [167]
AIRPORT ACCESSIBILITY	64%



FIJI

AIRLINES	2
AIRPORTS	8
PASSENGERS (2019)	1.5 MILLION
FLIGHTS (2019)	21,700
TOURISM % OF GDP	34.0
AVIATION INFRASTRUCTURE SCORE	N/A

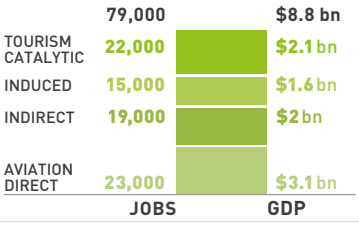
TOURISM COMPETITIVENESS	N/A
TOURISM SPEND	$1,120
CONNECTIVITY RANKING	87 [82]
AIRPORT ACCESSIBILITY	99%



FINLAND

AIRLINES	3
AIRPORTS	17
PASSENGERS (2019)	12.9 MILLION
FLIGHTS (2019)	117,000
TOURISM % OF GDP	7.5
AVIATION INFRASTRUCTURE SCORE	4.9

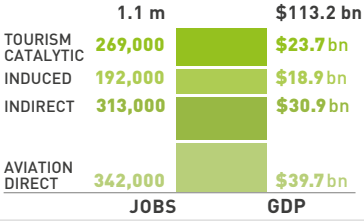
TOURISM COMPETITIVENESS	28/140
TOURISM SPEND	$1,140
CONNECTIVITY RANKING	21 [180]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	92%



FRANCE

AIRLINES	19
AIRPORTS	51
PASSENGERS (2019)	99.9 MILLION
FLIGHTS (2019)	762,000
TOURISM % OF GDP	8.5
AVIATION INFRASTRUCTURE SCORE	4.8

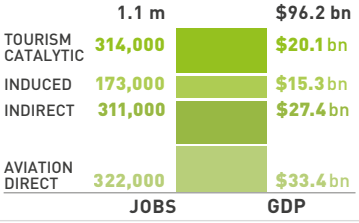
TOURISM COMPETITIVENESS	2/140
TOURISM SPEND	$730
CONNECTIVITY RANKING	2 [211]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	98%



GERMANY

AIRLINES	18
AIRPORTS	26
PASSENGERS (2019)	127.3 MILLION
FLIGHTS (2019)	966,700
TOURISM % OF GDP	9.1
AVIATION INFRASTRUCTURE SCORE	4.9

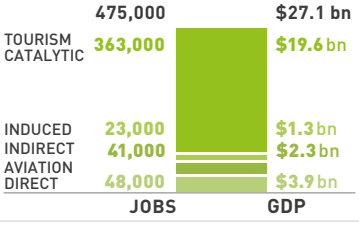
TOURISM COMPETITIVENESS	3/140
TOURISM SPEND	$1,110
CONNECTIVITY RANKING	4 [208]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



GREECE

AIRLINES	11
AIRPORTS	39
PASSENGERS (2019)	30.6 MILLION
FLIGHTS (2019)	241,000
TOURISM % OF GDP	20.8
AVIATION INFRASTRUCTURE SCORE	4.8

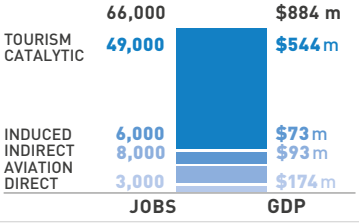
TOURISM COMPETITIVENESS	25/140
TOURISM SPEND	$570
CONNECTIVITY RANKING	19 [184]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



GUATEMALA

AIRLINES	4
AIRPORTS	4
PASSENGERS (2019)	1.7 MILLION
FLIGHTS (2019)	22,200
TOURISM % OF GDP	6.2
AVIATION INFRASTRUCTURE SCORE	1.8

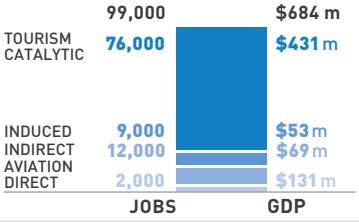
TOURISM COMPETITIVENESS	99/140
TOURISM SPEND	$870
CONNECTIVITY RANKING	90= [79]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	79%



HONDURAS

AIRLINES	6
AIRPORTS	6
PASSENGERS (2019)	1.2 MILLION
FLIGHTS (2019)	26,700
TOURISM % OF GDP	11.7
AVIATION INFRASTRUCTURE SCORE	2.1

TOURISM COMPETITIVENESS	94/140
TOURISM SPEND	$850
CONNECTIVITY RANKING	90= [79]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	87%

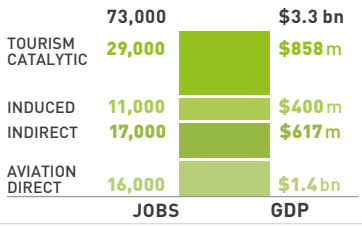


HUNGARY

AIRLINES	5
AIRPORTS	2
PASSENGERS (2019)	8.3 MILLION
FLIGHTS (2019)	55,800
TOURISM % OF GDP	8.3
TOURISM COMPETITIVENESS	48/140
TOURISM SPEND	$400
CONNECTIVITY RANKING	28= [169]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 3.4

AIRPORT ACCESSIBILITY: 89%

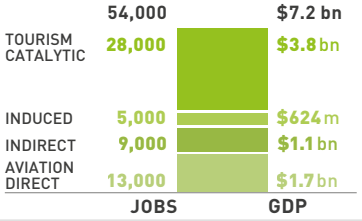


ICELAND

AIRLINES	6
AIRPORTS	8
PASSENGERS (2019)	3.9 MILLION
FLIGHTS (2019)	30,000
TOURISM % OF GDP	22.8
TOURISM COMPETITIVENESS	30/140
TOURISM SPEND	$1,330
CONNECTIVITY RANKING	54= [133]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 5.0

AIRPORT ACCESSIBILITY: 95%

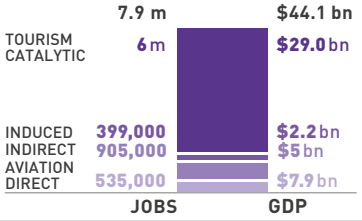


INDIA

AIRLINES	12
AIRPORTS	97
PASSENGERS (2019)	183.2 MILLION
FLIGHTS (2019)	1,267,500
TOURISM % OF GDP	6.8
TOURISM COMPETITIVENESS	34/140
TOURISM SPEND	$1,640
CONNECTIVITY RANKING	13= [194]

AVIATION INFRASTRUCTURE SCORE: 4.2

AIRPORT ACCESSIBILITY: 57%

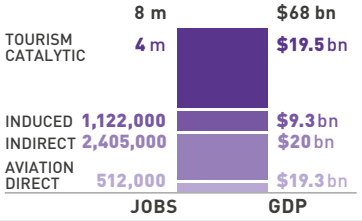


INDONESIA

AIRLINES	26
AIRPORTS	129
PASSENGERS (2019)	111.6 MILLION
FLIGHTS (2019)	1,017,000
TOURISM % OF GDP	5.7
TOURISM COMPETITIVENESS	40/140
TOURISM SPEND	$1,230
CONNECTIVITY RANKING	34= [158]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 3.9

AIRPORT ACCESSIBILITY: 79%

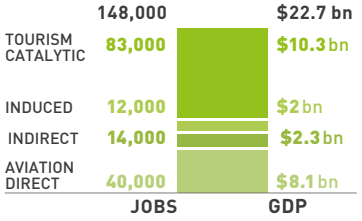


IRELAND

AIRLINES	7
AIRPORTS	6
PASSENGERS (2019)	18.7 MILLION
FLIGHTS (2019)	134,200
TOURISM % OF GDP	4.3
TOURISM COMPETITIVENESS	26/140
TOURISM SPEND	$570
CONNECTIVITY RANKING	17= [188]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 4.5

AIRPORT ACCESSIBILITY: 100%

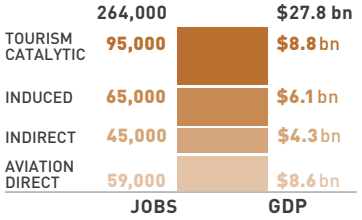


ISRAEL

AIRLINES	6
AIRPORTS	6
PASSENGERS (2019)	12.3 MILLION
FLIGHTS (2019)	80,600
TOURISM % OF GDP	5.6
TOURISM COMPETITIVENESS	57/140
TOURISM SPEND	$1,760
CONNECTIVITY RANKING	16= [189]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 3.6

AIRPORT ACCESSIBILITY: 100%

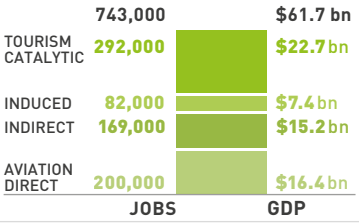


ITALY

AIRLINES	8
AIRPORTS	37
PASSENGERS (2019)	98.2 MILLION
FLIGHTS (2019)	700,300
TOURISM % OF GDP	13.0
TOURISM COMPETITIVENESS	8/140
TOURISM SPEND	$800
CONNECTIVITY RANKING	7 [202]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 4.4

AIRPORT ACCESSIBILITY: 99%

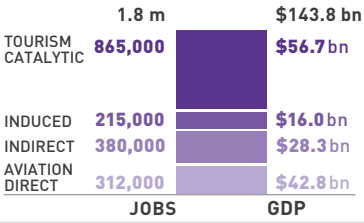


JAPAN

AIRLINES	23
AIRPORTS	79
PASSENGERS (2019)	152.2 MILLION
FLIGHTS (2019)	1,140,700
TOURISM % OF GDP	7.0
TOURISM COMPETITIVENESS	4/140
TOURISM SPEND	$1,350
CONNECTIVITY RANKING	12= [195]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 4.8

AIRPORT ACCESSIBILITY: 99%

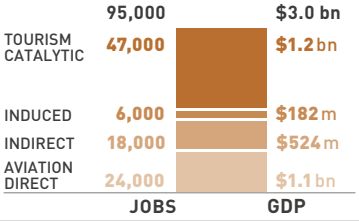


JORDAN

AIRLINES	3
AIRPORTS	2
PASSENGERS (2019)	4.3 MILLION
FLIGHTS (2019)	38,100
TOURISM % OF GDP	15.8
TOURISM COMPETITIVENESS	84/140
TOURISM SPEND	$1,260
CONNECTIVITY RANKING	34= [158]

AVIATION INFRASTRUCTURE SCORE: 2.7

AIRPORT ACCESSIBILITY: 99%

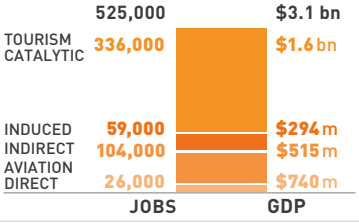


KENYA

AIRLINES	25
AIRPORTS	24
PASSENGERS (2019)	5.9 MILLION
FLIGHTS (2019)	105,700
TOURISM % OF GDP	8.2
TOURISM COMPETITIVENESS	82/140
TOURISM SPEND	$730
CONNECTIVITY RANKING	24= [174]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 2.7

AIRPORT ACCESSIBILITY: 70%

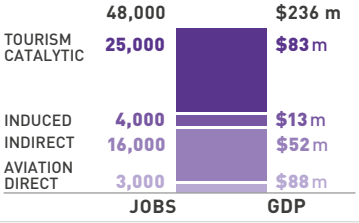


KYRGYZSTAN

AIRLINES	3
AIRPORTS	3
PASSENGERS (2019)	1.7 MILLION
FLIGHTS (2019)	13,900
TOURISM % OF GDP	8.3
TOURISM COMPETITIVENESS	110/140
TOURISM SPEND	$60
CONNECTIVITY RANKING	65= [119]

AVIATION INFRASTRUCTURE SCORE: 2.0

AIRPORT ACCESSIBILITY: 73%

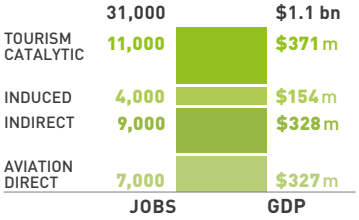


LATVIA

AIRLINES	3
AIRPORTS	2
PASSENGERS (2019)	3.9 MILLION
FLIGHTS (2019)	39,600
TOURISM % OF GDP	7.6
TOURISM COMPETITIVENESS	53/140
TOURISM SPEND	$540
CONNECTIVITY RANKING	39 [151]
CORSIA VOLUNTEER	✓

AVIATION INFRASTRUCTURE SCORE: 3.5

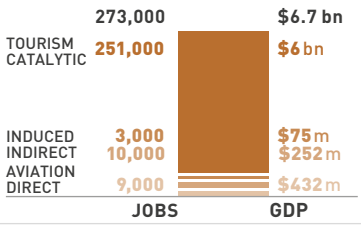
AIRPORT ACCESSIBILITY: 77%



LEBANON

AIRLINES	2
AIRPORTS	1
PASSENGERS (2019)	4.3 MILLION
FLIGHTS (2019)	32,000
TOURISM % OF GDP	18.0
AVIATION INFRASTRUCTURE SCORE	2.5

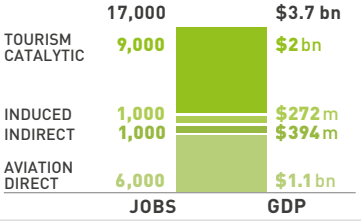
TOURISM COMPETITIVENESS	100/140
TOURISM SPEND	$4,280
CONNECTIVITY RANKING	28= [169]
AIRPORT ACCESSIBILITY	98%



LUXEMBOURG

AIRLINES	2
AIRPORTS	1
PASSENGERS (2019)	2.2 MILLION
FLIGHTS (2019)	26,900
TOURISM % OF GDP	8.9
AVIATION INFRASTRUCTURE SCORE	3.7

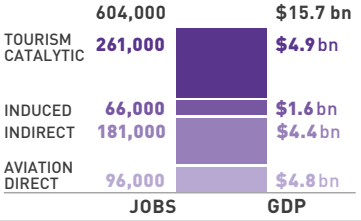
TOURISM COMPETITIVENESS	23/140
TOURISM SPEND	$4,910
CONNECTIVITY RANKING	33= [160]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



MALAYSIA

AIRLINES	10
AIRPORTS	34
PASSENGERS (2019)	55.7 MILLION
FLIGHTS (2019)	448,400
TOURISM % OF GDP	11.5
AVIATION INFRASTRUCTURE SCORE	4.6

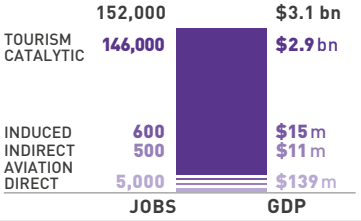
TOURISM COMPETITIVENESS	29/140
TOURISM SPEND	$760
CONNECTIVITY RANKING	28= [169]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	98%



MALDIVES

AIRLINES	4
AIRPORTS	14
PASSENGERS (2019)	3.3 MILLION
FLIGHTS (2019)	51,200
TOURISM % OF GDP	56.6
AVIATION INFRASTRUCTURE SCORE	N/A

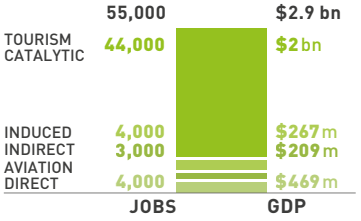
TOURISM COMPETITIVENESS	N/A
TOURISM SPEND	$2,040
CONNECTIVITY RANKING	61= [124]
AIRPORT ACCESSIBILITY	100%



MALTA

AIRLINES	5
AIRPORTS	1
PASSENGERS (2019)	3.7 MILLION
FLIGHTS (2019)	24,700
TOURISM % OF GDP	15.8
AVIATION INFRASTRUCTURE SCORE	3.9

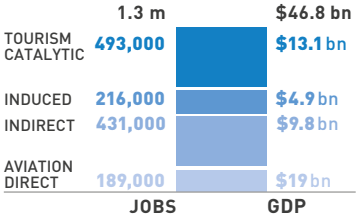
TOURISM COMPETITIVENESS	35/140
TOURISM SPEND	$710
CONNECTIVITY RANKING	38= [152]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



MEXICO

AIRLINES	21
AIRPORTS	60
PASSENGERS (2019)	77.9 MILLION
FLIGHTS (2019)	657,400
TOURISM % OF GDP	15.5
AVIATION INFRASTRUCTURE SCORE	4.0

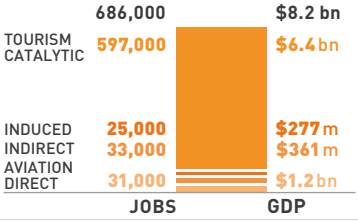
TOURISM COMPETITIVENESS	19/140
TOURISM SPEND	$550
CONNECTIVITY RANKING	35= [157]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	92%



MOROCCO

AIRLINES	4
AIRPORTS	18
PASSENGERS (2019)	12.7 MILLION
FLIGHTS (2019)	97,500
TOURISM % OF GDP	12.0
AVIATION INFRASTRUCTURE SCORE	3.2

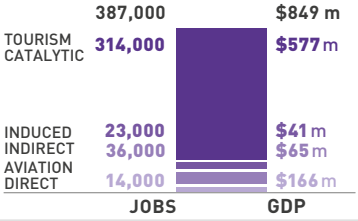
TOURISM COMPETITIVENESS	66/140
TOURISM SPEND	$630
CONNECTIVITY RANKING	26= [172]
AIRPORT ACCESSIBILITY	92%



NEPAL

AIRLINES	6
AIRPORTS	14
PASSENGERS (2019)	4.6 MILLION
FLIGHTS (2019)	79,300
TOURISM % OF GDP	6.7
AVIATION INFRASTRUCTURE SCORE	2.3

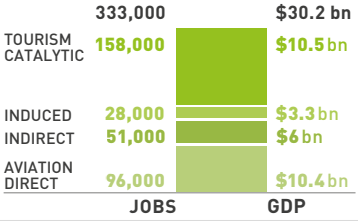
TOURISM COMPETITIVENESS	102/140
TOURISM SPEND	$550
CONNECTIVITY RANKING	52= [135]
AIRPORT ACCESSIBILITY	97%



NETHERLANDS

AIRLINES	8
AIRPORTS	5
PASSENGERS (2019)	40.2 MILLION
FLIGHTS (2019)	274,800
TOURISM % OF GDP	5.7
AVIATION INFRASTRUCTURE SCORE	5.2

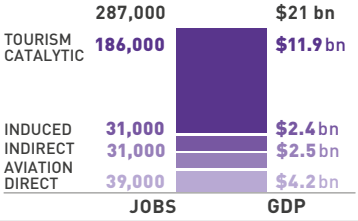
TOURISM COMPETITIVENESS	15/140
TOURISM SPEND	$960
CONNECTIVITY RANKING	6= [205]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



NEW ZEALAND

AIRLINES	7
AIRPORTS	26
PASSENGERS (2019)	21.9 MILLION
FLIGHTS (2019)	245,211
TOURISM % OF GDP	15.0
AVIATION INFRASTRUCTURE SCORE	4.9

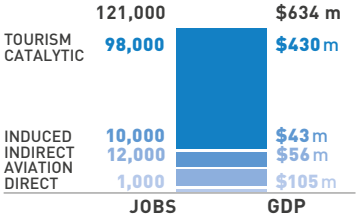
TOURISM COMPETITIVENESS	18/140
TOURISM SPEND	$2,950
CONNECTIVITY RANKING	36 [154]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



NICARAGUA

AIRLINES	1
AIRPORTS	7
PASSENGERS (2019)	0.7 MILLION
FLIGHTS (2019)	13,100
TOURISM % OF GDP	10.1
AVIATION INFRASTRUCTURE SCORE	2.1

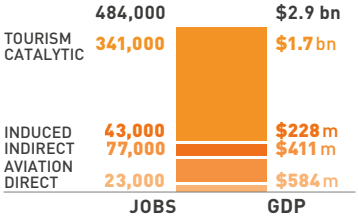
TOURISM COMPETITIVENESS	91/140
TOURISM SPEND	$430
CONNECTIVITY RANKING	97= [70]
AIRPORT ACCESSIBILITY	73%



NIGERIA

AIRLINES	14
AIRPORTS	21
PASSENGERS (2019)	7.6 MILLION
FLIGHTS (2019)	86,300
TOURISM % OF GDP	4.5
AVIATION INFRASTRUCTURE SCORE	2.0

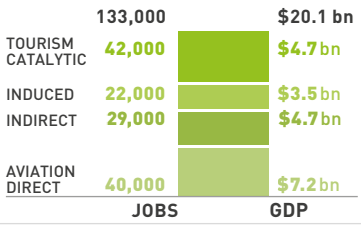
TOURISM COMPETITIVENESS	129/140
TOURISM SPEND	$322
CONNECTIVITY RANKING	26= [172]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	69%



NORWAY

AIRLINES	5
AIRPORTS	47
PASSENGERS (2019)	27.8 MILLION
FLIGHTS (2019)	322,000
TOURISM % OF GDP	8.0
AVIATION INFRASTRUCTURE SCORE	5.6

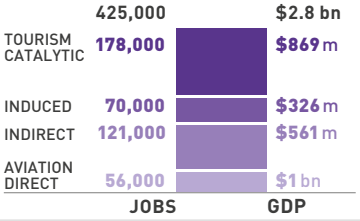
TOURISM COMPETITIVENESS	20/140
TOURISM SPEND	$1,030
CONNECTIVITY RANKING	23= [177]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	99%



PAKISTAN

AIRLINES	6
AIRPORTS	18
PASSENGERS (2019)	11.2 MILLION
FLIGHTS (2019)	68,800
TOURISM % OF GDP	5.9
AVIATION INFRASTRUCTURE SCORE	2.2

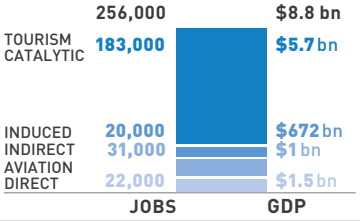
TOURISM COMPETITIVENESS	121/140
TOURISM SPEND	$250
CONNECTIVITY RANKING	52= [135]
AIRPORT ACCESSIBILITY	74%



PANAMA

AIRLINES	5
AIRPORTS	16
PASSENGERS (2019)	9 MILLION
FLIGHTS (2019)	78,900
TOURISM % OF GDP	13.6
AVIATION INFRASTRUCTURE SCORE	4.5

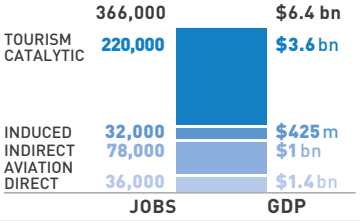
TOURISM COMPETITIVENESS	47/140
TOURISM SPEND	$1,740
CONNECTIVITY RANKING	33= [160]
AIRPORT ACCESSIBILITY	83%



PERU

AIRLINES	9
AIRPORTS	20
PASSENGERS (2019)	19.9 MILLION
FLIGHTS (2019)	151,000
TOURISM % OF GDP	9.3
AVIATION INFRASTRUCTURE SCORE	2.8

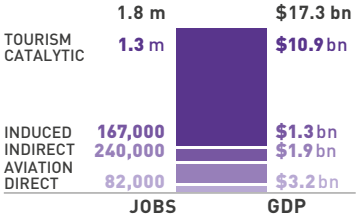
TOURISM COMPETITIVENESS	49/140
TOURISM SPEND	$890
CONNECTIVITY RANKING	51= [136]
AIRPORT ACCESSIBILITY	62%



PHILIPPINES

AIRLINES	12
AIRPORTS	46
PASSENGERS (2019)	49.1 MILLION
FLIGHTS (2019)	335,800
TOURISM % OF GDP	25.3
AVIATION INFRASTRUCTURE SCORE	3.2

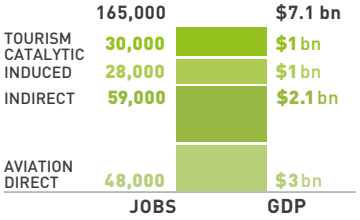
TOURISM COMPETITIVENESS	75/140
TOURISM SPEND	$1,040
CONNECTIVITY RANKING	27= [170]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	94%



POLAND

AIRLINES	6
AIRPORTS	14
PASSENGERS (2019)	23.2 MILLION
FLIGHTS (2019)	189,800
TOURISM % OF GDP	4.7
AVIATION INFRASTRUCTURE SCORE	3.2

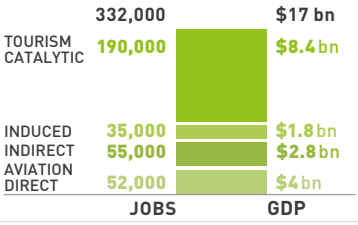
TOURISM COMPETITIVENESS	42/140
TOURISM SPEND	$720
CONNECTIVITY RANKING	22 [178]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	95%



PORTUGAL

AIRLINES	11
AIRPORTS	19
PASSENGERS (2019)	29.5 MILLION
FLIGHTS (2019)	217,200
TOURISM % OF GDP	16.5
AVIATION INFRASTRUCTURE SCORE	4.7

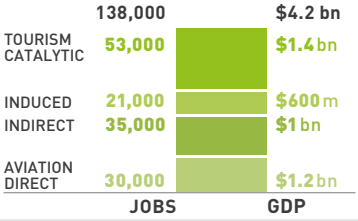
TOURISM COMPETITIVENESS	12/140
TOURISM SPEND	$870
CONNECTIVITY RANKING	20= [183]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	84%



ROMANIA

AIRLINES	7
AIRPORTS	13
PASSENGERS (2019)	11.4 MILLION
FLIGHTS (2019)	89,400
TOURISM % OF GDP	5.9
AVIATION INFRASTRUCTURE SCORE	2.7

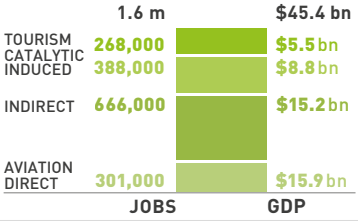
TOURISM COMPETITIVENESS	56/140
TOURISM SPEND	$990
CONNECTIVITY RANKING	25 [173]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	95%



RUSSIA

AIRLINES	46
AIRPORTS	155
PASSENGERS (2019)	99.3 MILLION
FLIGHTS (2019)	837,900
TOURISM % OF GDP	5.0
AVIATION INFRASTRUCTURE SCORE	4.6

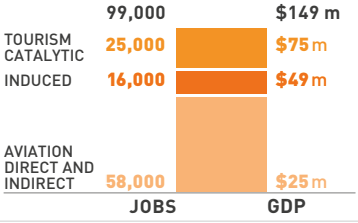
TOURISM COMPETITIVENESS	39/140
TOURISM SPEND	$470
CONNECTIVITY RANKING	14 [193]
AIRPORT ACCESSIBILITY	69%



RWANDA

AIRLINES	1
AIRPORTS	2
PASSENGERS (2019)	0.7 MILLION
FLIGHTS (2019)	8,800
TOURISM % OF GDP	10.2
AVIATION INFRASTRUCTURE SCORE	1.9

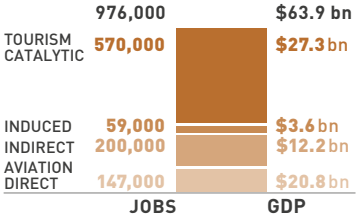
TOURISM COMPETITIVENESS	107/140
TOURISM SPEND	$320
CONNECTIVITY RANKING	49= [138]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



SAUDI ARABIA

AIRLINES	4
AIRPORTS	27
PASSENGERS (2019)	50.4 MILLION
FLIGHTS (2019)	340,400
TOURISM % OF GDP	9.5
AVIATION INFRASTRUCTURE SCORE	4.1

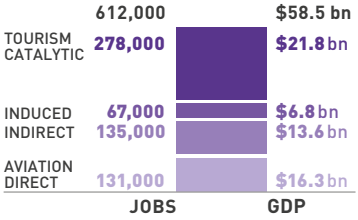
TOURISM COMPETITIVENESS	69/140
TOURISM SPEND	$780
CONNECTIVITY RANKING	24= [174]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	64%



SINGAPORE

AIRLINES	5
AIRPORTS	2
PASSENGERS (2019)	33.8 MILLION
FLIGHTS (2019)	185,100
TOURISM % OF GDP	11.1
AVIATION INFRASTRUCTURE SCORE	5.5

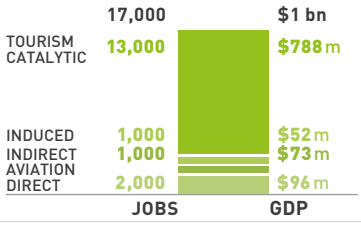
TOURISM COMPETITIVENESS	17/140
TOURISM SPEND	$1,400
CONNECTIVITY RANKING	12= [195]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



SLOVENIA

AIRLINES	3
AIRPORTS	1
PASSENGERS (2019)	0.8 MILLION
FLIGHTS (2019)	10,800
TOURISM % OF GDP	9.9
AVIATION INFRASTRUCTURE SCORE	2.6

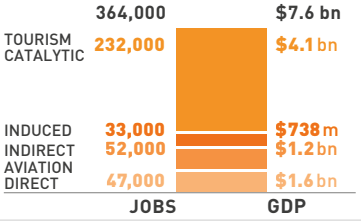
TOURISM COMPETITIVENESS	36/140
TOURISM SPEND	$720
CONNECTIVITY RANKING	45= [142]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



SOUTH AFRICA

AIRLINES	18
AIRPORTS	26
PASSENGERS (2019)	21.9 MILLION
FLIGHTS (2019)	217,600
TOURISM % OF GDP	7.0
AVIATION INFRASTRUCTURE SCORE	3.3

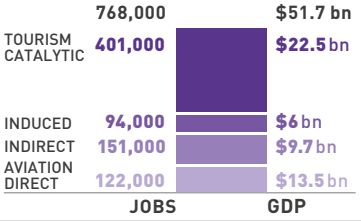
TOURISM COMPETITIVENESS	61/140
TOURISM SPEND	$850
CONNECTIVITY RANKING	12= [195]
AIRPORT ACCESSIBILITY	81%



SOUTH KOREA

AIRLINES	10
AIRPORTS	16
PASSENGERS (2019)	76.8 MILLION
FLIGHTS (2019)	396,824
TOURISM % OF GDP	4.2
AVIATION INFRASTRUCTURE SCORE	4.6

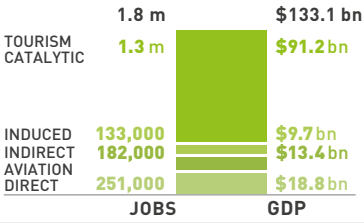
TOURISM COMPETITIVENESS	16/140
TOURISM SPEND	$1,210
CONNECTIVITY RANKING	9 [200]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



SPAIN

AIRLINES	24
AIRPORTS	42
PASSENGERS (2019)	134.6 MILLION
FLIGHTS (2019)	942,400
TOURISM % OF GDP	14.3
AVIATION INFRASTRUCTURE SCORE	5.0

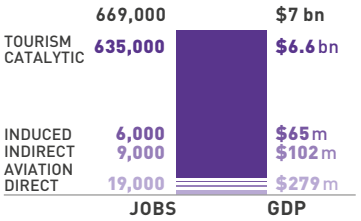
TOURISM COMPETITIVENESS	1/140
TOURISM SPEND	$980
CONNECTIVITY RANKING	10 [199]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	95%



SRI LANKA

AIRLINES	4
AIRPORTS	11
PASSENGERS (2019)	5 MILLION
FLIGHTS (2019)	38,100
TOURISM % OF GDP	10.3
AVIATION INFRASTRUCTURE SCORE	2.8

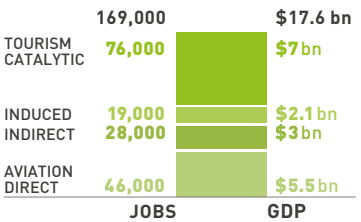
TOURISM COMPETITIVENESS	77/140
TOURISM SPEND	$1,880
CONNECTIVITY RANKING	56 [131]
AIRPORT ACCESSIBILITY	76%



SWEDEN

AIRLINES	8
AIRPORTS	31
PASSENGERS (2019)	22.5 MILLION
FLIGHTS (2019)	217,400
TOURISM % OF GDP	8.2
AVIATION INFRASTRUCTURE SCORE	5.0

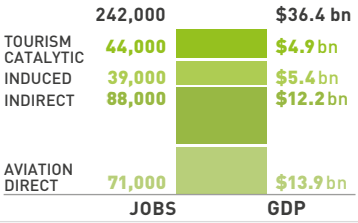
TOURISM COMPETITIVENESS	22/140
TOURISM SPEND	$2,010
CONNECTIVITY RANKING	13= [194]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	99%



SWITZERLAND

AIRLINES	7
AIRPORTS	6
PASSENGERS (2019)	29.9 MILLION
FLIGHTS (2019)	221,200
TOURISM % OF GDP	7.6
AVIATION INFRASTRUCTURE SCORE	5.0

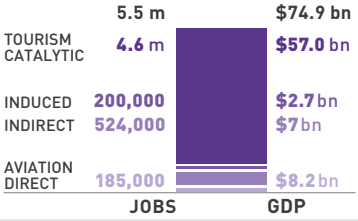
TOURISM COMPETITIVENESS	10/140
TOURISM SPEND	$1,450
CONNECTIVITY RANKING	8 [201]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



THAILAND

AIRLINES	11
AIRPORTS	32
PASSENGERS (2019)	80.9 MILLION
FLIGHTS (2019)	523,800
TOURISM % OF GDP	19.7
AVIATION INFRASTRUCTURE SCORE	4.6

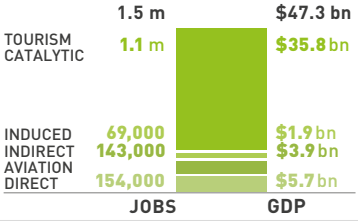
TOURISM COMPETITIVENESS	31/140
TOURISM SPEND	$1,650
CONNECTIVITY RANKING	16= [189]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	88%



TURKEY

AIRLINES	11
AIRPORTS	52
PASSENGERS (2019)	95.3 MILLION
FLIGHTS (2019)	609,400
TOURISM % OF GDP	11.3
AVIATION INFRASTRUCTURE SCORE	4.7

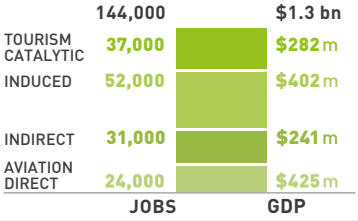
TOURISM COMPETITIVENESS	43/140
TOURISM SPEND	$550
CONNECTIVITY RANKING	12= [195]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	91%



UKRAINE

AIRLINES	25
AIRPORTS	13
PASSENGERS (2019)	11.9 MILLION
FLIGHTS (2019)	92,800
TOURISM % OF GDP	5.9
AVIATION INFRASTRUCTURE SCORE	2.7

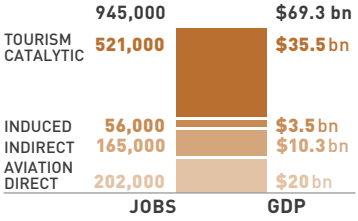
TOURISM COMPETITIVENESS	78/140
TOURISM SPEND	$100
CONNECTIVITY RANKING	29 [168]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	71%



UNITED ARAB EMIRATES

AIRLINES	10
AIRPORTS	7
PASSENGERS (2019)	60.7 MILLION
FLIGHTS (2019)	284,700
TOURISM % OF GDP	11.9
AVIATION INFRASTRUCTURE SCORE	5.7

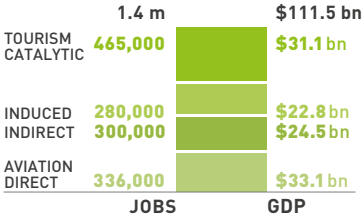
TOURISM COMPETITIVENESS	33/140
TOURISM SPEND	$1,340
CONNECTIVITY RANKING	5= [207]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	83%



UNITED KINGDOM

AIRLINES	27
AIRPORTS	61
PASSENGERS (2019)	148.8 MILLION
FLIGHTS (2019)	1,089,900
TOURISM % OF GDP	9.0
AVIATION INFRASTRUCTURE SCORE	5.2

TOURISM COMPETITIVENESS	6/140
TOURISM SPEND	$1,430
CONNECTIVITY RANKING	3 [210]
CORSIA VOLUNTEER	✓
AIRPORT ACCESSIBILITY	100%



UNITED STATES

AIRLINES	133
AIRPORTS	631
PASSENGERS (2019)	960.9 MILLION
FLIGHTS (2019)	9,514,800
TOURISM % OF GDP	8.6

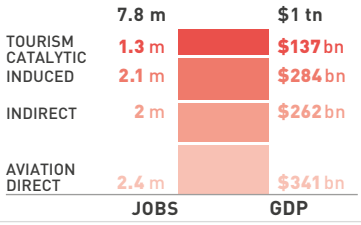
AVIATION INFRASTRUCTURE SCORE

5.9

TOURISM COMPETITIVENESS	5/140
TOURISM SPEND	$2,690
CONNECTIVITY RANKING	1 [218]
CORSIA VOLUNTEER	✓

AIRPORT ACCESSIBILITY

96%



Note: In the United States, the FAA collects economic impact data with which these numbers are aligned. The FAA assessment further evaluates the much wider economic activity that is supported by air transport, including general aviation and the domestic tourism markets, which this report does not include. Accordingly, with these wider catalytic impacts included, the total number of jobs supported by civil aviation in the US alone is around 10.9 million, with a contribution to GDP of $1.8 trillion in 2016[230].

VIET NAM

AIRLINES	5
AIRPORTS	22
PASSENGERS (2019)	55.1 MILLION
FLIGHTS (2019)	358,700
TOURISM % OF GDP	8.8

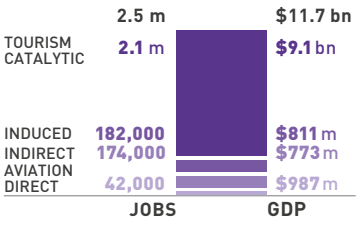
AVIATION INFRASTRUCTURE SCORE

3.4

TOURISM COMPETITIVENESS	63/140
TOURISM SPEND	$650
CONNECTIVITY RANKING	38= [152]

AIRPORT ACCESSIBILITY

86%



A GROWTH INDUSTRY

An assessment of the next
20 years of aviation

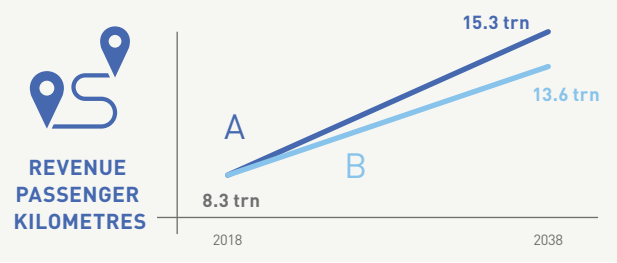
Despite near-term Covid-19 related challenges, analysis suggests that demand for air transport will increase by an annual average of 3% over the next 20 years. The 20-year outlook presented in this report is based on air transport growing at this predicted rate, which also takes into account the significant impact of Covid-19 on longer-term projections.

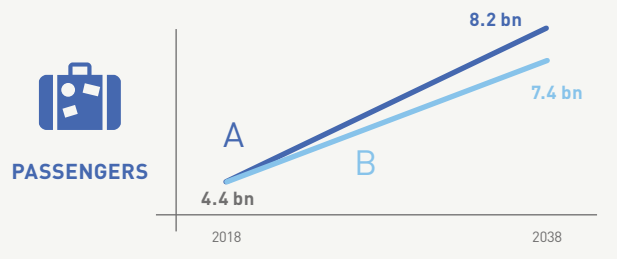
Looking ahead 20 years is, however, fraught with uncertainty. Future political turmoil, unexpected economic instability and pandemics, as witnessed with Covid-19, could throw these predictions off course. To account for unforeseen fluctuations in activity, Oxford Economics also undertook a sensitivity analysis.

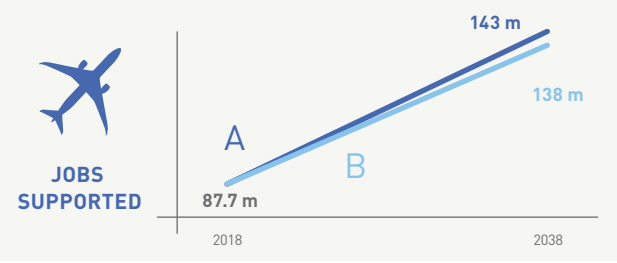
Oxford Economics has provided two scenarios for consideration on how aviation connectivity (and associated support for economic and employment trends) will evolve in the next 20 years.

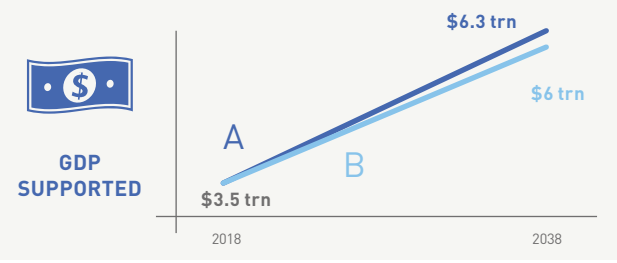
Onwards and upwards

Growing support for connectivity, employment and economic activity, 2018–2038[231].









A THE CENTRAL SCENARIO

8.2 billion
Passengers 2038

143 million
Jobs supported 2038

15.3 trillion
Revenue passenger kilometres 2038

$6.3 trillion
Economic impact 2038

Analysis based on recognised industry forecasts suggests that demand for air transport will increase an average of 3% per annum over the next 20 years[232]. That implies that demand for air travel will increase by a factor of 1.8 over the period, a continuation of longer-term historical trends, but at a lower rate to the recent growth profile of the sector.

If this growth path is achieved, then in 2038 the air transport industry will contribute

- 13.7 million direct jobs and $1.7 trillion of GDP to the world economy;
- 76 million jobs and $4.3 trillion in GDP, including indirect and induced contributions; and
- 143 million jobs and $6.3 trillion in GDP once the impacts of global tourism are taken into account[233].

Enabling factors for this scenario to take place:

- Near-term economic optimism improves.
- Increased business investment supports long-term supply growth.
- Trade between nations continues to grow.
- Flight freedoms are not restricted and are even improved.
- Technological progress continues to reinforce the downward trend in air fares.

B

THE LOW GROWTH SCENARIO

7.4 billion
Passengers 2038

138 million
Jobs supported 2038

13.6 trillion
Revenue passenger kilometres 2038

$6 trillion
Economic impact 2038

Should moves towards a more protectionist and fragmented world continue, there will likely be an impact on air traffic growth, particularly international travel and air freight. Analysis by IATA, BlueSky and Oxford Economics produced a forecast that explores the impact of this scenario. The result is a reduction in the growth of aviation activity, with an average annual growth rate in revenue passenger kilometres of 2.7% for the next 20 years. This implies that demand for air travel will increase by a factor of 1.6 over the period.

If this more pessimistic scenario materialises, then in 2038 the air transport industry will contribute

- 13.5 million direct jobs and $1.6 trillion of GDP to the world economy (227,000 fewer jobs and $78 billion less GDP than in the central scenario);
- 72 million jobs and $4.1 trillion in GDP, including indirect and induced contributions (3.6 million fewer jobs and $200 billion less GDP); and
- 138 million jobs and $6 trillion in GDP once the impacts of global tourism are taken into account (55 million fewer jobs and $293 billion less GDP)[234].

Such a scenario could materialise following some or all of these events:

- Significant reluctance to travel or a shift in propensity to travel due to health-related concerns by passengers, or travel restrictions put in place for lengthy periods of time by governments.
- A significant shift in global trade policy and multilateral, regional and bilateral agreements, with retaliatory tariffs established in response.
- The UK's withdrawal from the European Union is without a free trade deal.
- A trade slowdown that undermines the global recovery.
- No further liberalisation in air markets and even more restrictive policies.
- A slowdown in migration due to a tightening of immigration policies.
- A limiting of the ability of monetary authorities to combat the downturn in demand by relaxing monetary policy.
- Debt accumulates to weigh on consumer spending and business investment.

There is another possibility: a high-growth scenario continuing the high traffic growth trend seen in the pre-Covid years. This would result in 186 million jobs in 2038, with $8.7 trillion contribution to the global economy. However, this is not considered a likely scenario.

Rebuilding sustainably

After the shock caused by the Covid-19 pandemic that hit the global air transport sector particularly hard, the aviation industry is expected to grow again significantly in the next two decades, although at a lower level than previous projections.

The months during which air transport was limited or even completely stopped in many parts of the world during the Covid-19 crisis made us even more so aware of the importance of aviation for trade links and supply chains, the provision of goods in a globalised world and the role aviation plays on a social and personal level with the unique connectivity it provides. Rebuilding a healthy sector is more important than ever to be able to provide connectivity to all regions of the world.

The aviation industry is confident that rebuilding the sector and future growth can be achieved in accordance with an environmentally sustainable way.

Aviation has been implementing the world's first global carbon mechanism for any industrial sector: the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). As of 2021, volunteering states will offset around 80% of the post-2020 growth of international aviation in the initial phases of CORSIA, with a baseline of 2019 traffic. From 2027, the scheme becomes mandatory and will help towards achieving the industry's goal of carbon-neutral growth in the midterm.

The industry's major focus remains its long-term goal of halving net CO_2 emissions by 2050 compared to what they were in 2005. Waypoint 2050 demonstrates that there are potential options for the almost complete decarbonisation of air transport with the industry at a global level able to meet net zero emissions a decade or so after 2050 (and some regions and companies able to reach this point sooner). This assumes the right level of support from governments, the finance sector, the energy industry and research institutions. The industry itself will need to redouble efforts as well.

There are a range of measures that can help drive aviation towards the technology, energy system and operational measures that are required to meet these ambitions. Many of these are incredibly challenging, but all are achievable with the right policy environment and the necessary focus of resources.

To achieve this, the sector will need to continue to be a world leader in technological innovation. This will take the form of evolutionary developments of conventional aircraft architectures and revolutionary shifts with new types of airframe and engine and likely a move to electric, hybrid-electric and / or hydrogen powered aviation in the 2035-2040 timeframe for short-haul and small aircraft.

For long-haul operations, a complete switch to sustainable aviation fuel will be required – with up to 500 million tonnes of SAF needed by 2050. Studies have shown that this is technically feasible, using sustainable sources, but it is a significant challenge for the industry as well as energy providers. Government assistance and the right policy environment will be necessary to underpin this energy transition.

Further details on the industry's long-term climate action can be found in the Waypoint 2050 report: www.aviationbenefits.org

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[1] Flightradar24 statistics: seven-day rolling average of commercial flights being tracked on 7 March was 104,000, by 18 April that had dropped to 28,000. Commercial flights across the month of April 2020 averaged 29,439 a day compared to 111,799 a day in April 2019. www.flightradar24.com.

[2] International Air Transport Association (IATA) press release *After April Passenger Demand Trough, First Signals of Uptick*, 3 June 2020.

[3] United Nations World Tourism Organization (UNWTO) report, August 2020: https://bit.ly/3hzenIm

[4] Direct employment in 2020 for airlines, airport operators, airport on-site and air navigation service providers, and civil aircraft manufacturers is based on the 2018 estimates adjusted according to analysis provided by industry stakeholders to Oxford Economics and through public disclosures of the number of jobs expected to be lost (or furloughed) in 2020 (airlines), estimates based on regression analysis and estimated reductions in airport passengers for 2020, as of August 2020 (airport operators and airport on-site) and public announcements about redundancies in 2020 by civil aircraft manufacturers. Indirect, and induced estimates in 2020 are based on the 2018 figures adjusted by industry estimates of a decline in revenues (airlines and airport operators), passenger numbers (airport on-site), flight hours (air navigation service providers), and national statistics (civil aircraft manufacturing). Tourism estimates are based on the latest forecasts by Tourism Economics / IATA as of 31 July 2020. Sources include Oxford Economics, Tourism Economics, IATA, Airports Council International (ACI), Airbus, Boeing, Bombardier, Rolls-Royce, Aireon and national statistics agencies.

[5] Industry and Oxford Economics analysis, see above.

[6] ACI: https://bit.ly/3iinYmO.

[7] Cirium database estimates.

[8] IATA Economics analysis.

[9] IATA Economics analysis, August 2020.

[10] ATAG analysis based on a survey of airlines and aircraft operators, August 2020.

[11] ATAG analysis, August 2020.

[12] IATA Economics

[13] ATAG using data from the International Civil Aviation Organization (ICAO) and IATA Economics forecast for 2020.

[14] Oxford Economics analysis.

[15] Oxford Economics analysis.

[16] ACI figures. Most of those employed by airport operators work on-site at airports, but a small number may work off-site. To avoid double counting, the airport operator employees are subtracted from the overall on-airport employees figure. Also, on a country-by-country basis, the figures for airport operators may include activities that other countries do not. For example, airport operators in the United Kingdom are obliged to provide security services at their facilities, whereas in the United States that service is provided by the government (and, therefore, those employees appear in the 'other on-airport' category). In New Zealand, airport operators provide the rescue fire service, whereas in Australia that service is provided by the ANSP. A number of countries have one company fulfilling both airport and ANSP functions. This is a conservative approach that likely underestimates overall employment.

[17] ACI *Economics Survey* and Oxford Economics research.

[18] Oxford Economics.

[19] Oxford Economics and aerospace industry associations research.

[20] Oxford Economics figures derived from Civil Air Navigation Services Organisation (CANSO) and Aireon Data www.aireon.com. To avoid double counting, 40% of ANSP employees are subtracted from other on-site airport employment, a conservative estimate of the ratio of ANSP employment on-airport (in control towers, etc.) vs. off-airport (head office, research and training centres and en route control centres).

[21] Oxford Economics.

[22] Oxford Economics.

[23] Previous studies have indicated this additional benefit could mean aviation supports as much as 8% of global GDP.

[24] Oxford Economics.

[25] Oxford Economics.

[26] IATA Economics / SRS Analyser. A 'route' is a flight between one airport and another, bi-directionally. Therefore, LHR-GVA and GVA-LHR are both counted. **City pairs** are routes between different cities, counted only once. Therefore, all flights between all London airports and Geneva in both directions are counted as one city pair.

[27] ICAO and IATA Economics. Includes all scheduled and charter airline traffic. Does not include business aviation or non-scheduled traffic.

[28] IATA, *Safety Report 2019*.

[29] IATA Economics/IATA Direct Data Solutions (DDS).

[30] IATA Economics.

[31] IATA, *World Air Transport Statistics 2020* edition, all traffic.

[32] Commercial airlines with an IATA and/or ICAO code. From FlightGlobal.

[33] IATA Economics / SRS Analyser. Includes airports with more than one scheduled flight per week.

[34] *CIA World Fact Book*, 2019 in ACI *Annual World Airport Traffic Report*, 2019. This entry gives the total number of airports or airfields recognisable from the air. The runways may be paved (concrete or asphalt surfaces) or unpaved (grass, earth, sand, or gravel surfaces) and may include closed or abandoned installations. Airports or airfields that are no longer recognisable (overgrown or with no visible facilities) are not included. Of the 41,764 airports, 66% (27,616) have unpaved and 34% (14,148) have paved runways. Aerial or satellite photographs used by the CIA may still miss smaller landing strips such as those which may be used by small aircraft and ultralights.

[35] Civil Air Navigation Services Organisation (CANSO) analysis.

[36] IATA, *Safety Report 2019*, using Ascend, a FlightGlobal advisory service. Includes in-service and stored aircraft operated by commercial airlines.

[37] IATA, *Safety Report 2019*, using Ascend, a FlightGlobal advisory service. Includes in-service and stored aircraft operated by commercial airlines.

[38] IATA and Oxford Economics analysis.

[39] IATA, Oxford Economics and ATAG analysis.

[40] IATA Economics

[41] IATA Economics / Oxford Economics.

[42] IATA Economics

[43] UN World Tourism Organization, *International Tourism Highlights 2019*: https://bit.ly/32csXPh

[44] IATA Economics.

[45] International Energy Agency (IEA).

[46] IATA Economics.

[47] IATA Economics.

[48] Global Carbon Project, *Global Carbon Budget 2019*.

[49] IATA Environment analysis.

[50] IATA Economics.

[51] ATAG / IATA analysis.

[52] IATA Economics.

[53] European Aviation Safety Agency (EASA), Eurocontrol and European Environment Agency (EEA) *European Aviation Environmental Report 2019*. https://bit.ly/2DCp6CB

[54] IATA Environment analysis.

[55] IATA Economics.

[56] There are no reliable global figures published for other modes of transport. The European Union used to publish occupancy by other forms of public transport but discontinued this several years ago. At that time, trains tended to be on average 35–40% full (with vastly higher occupancy for commuter routes at peak hours). However, commuter trains tend to operate on a very different business model, so air travel is more comparable with high-speed and long-distance rail. In China, studies have shown that long-haul rail services can have as low as 20% occupancy (Yao et al., *Study on High-Speed Rail Pricing Strategy*, 2013). Even then, passengers on long-distance trains often embark or disembark at intermediate stations, which can skew the results. European coach trips tend to be around 60% full, and personal cars across Europe (and in many other 'developed' countries) average 1.45 passengers per vehicle (around 30% occupancy). This figure is declining. European Environment Agency and EuroStat data.

[57] ACI. Airports count passengers twice – on arrival and departure – so global passenger movement figures are twice that of passenger movement data provided by airlines (and used in the rest of this report).

[58] ACI.

[59] ACI.

[60] Official Airline Guide (OAG): www.oag.com.

[61] IATA Economics

[62] ACI analysis

[63] Oxford Economics analysis.

[64] Oxford Economics.

[65] ACI Europe and Intervistas, *Economic Impact of European Airports*, 2015: https://bit.ly/30B6Oeb. In Europe, the direct employment generated by increased traffic was studied in different bands of airport size, and it was found that, for airports with fewer than one million passengers, each increase of 1,000 passenger movements increases direct employment on-airport by 1.2 jobs. The employment generated by each additional 1,000 traffic units for small airports is greater than that for large airports. Furthermore, connecting passengers have a marginally smaller (3%) direct employment impact than origin/destination passengers. This may reflect the fact that connecting passengers do not consume certain services at airports, such as car parking, car rental and other ground transportation. Passengers flying on low-cost carriers (LCCs), have a smaller direct employment impact (20% less) than other types of traffic. This may be due to the lower staffing levels at LCCs, reduced auxiliary services (such as in-flight catering and airport lounges), and reduced LCC passenger spending on commercial offerings. It should be noted that these ratios do not attempt to find relationships between passenger numbers and the impact on total employment – in particular the impact upon catalytic impact. For example, connecting passengers may require a lower proportion of direct workers, but if connecting passengers support the operation of routes that would otherwise not be viable, this leads to an increase in traffic, which would not be factored into this ratio. Similarly, although LCC passengers also require fewer direct workers, LCC traffic has been for many airports and areas the major provider of growth in recent years. In such cases, this traffic has contributed to the catalytic impact of airports, which is again not captured in the ratios. Airports generally count each passenger twice (on arrival and departure), whereas most passenger/traffic numbers cited in this report count each passenger departure (i.e., once).

[66] ACI Europe and Intervistas, *Economic Impact of European Airports*, 2015. Airports generally count each passenger twice (on arrival and departure), whereas most passenger/traffic numbers cited in this report count each passenger departure (i.e., once).

[67] ACI Europe and Intervistas, *Economic Impact of European Airports*, 2015.

[68] Oxford Economics.

[69] Figures from early 2020 (pre-Covid-19). Swissport: 66,000; dnata: 45,000; Menzies: 32,000; Worldwide Flight Services: 27,600.

[70] World Travel & Tourism Council (WTTC) *Economic Impact 2019*: wttc.org. In 2019, tourism supported 10.3% of global GDP ($8.9 trillion) and 330 million jobs: www.wttc.org/economic-impact/

[71] IATA accredited travel agents worldwide: https://bit.ly/34kOA2P

[72] WTTC, *Economic Impact 2019*: www.wttc.org.

[73] Oxford Economics.

[74] UN World Tourism Organization (UN-WTO), *International Tourism Highlights 2019 Edition* https://bit.ly/2F1yCzV

[75] IATA Economics.

[76] Oxford Economics analysis.

[77] UN-WTO, *International Tourism Highlights 2019 Edition*.

[78] Oxford Economics.

[79] World Economic Forum (WEF),*Travel & Tourism Competitiveness Report 2019*: https://bit.ly/3iRM4VH

[80] UN-WTO, *Visa Openness Report 2018*: https://bit.ly/2DtFTrQ

[81] IATA, *Air cargo and e-commerce enabling global trade*, 2019: https://bit.ly/30yg5Dw

[82] GeekWire report: https://bit.ly/320nXx7

[83] Amazon news release, 2019: https://bit.ly/2DHwexw

[84] IATA Economics.

[85] Oxford Economics forecast.

[86] American Express Global Business Travel, 7 Reasons Why Face-to-Face Meetings Are Critical for Business: https://bit.ly/2E9BPgm

[87] Managing Across Distance in Today's Economic Climate: The Value of Face-to-Face Communication: https://bit.ly/2XCckel

[88] Harvard Business Review: https://bit.ly/2YoeK0F. A number of other studies have backed these findings. A survey of 2,000 business people worldwide found that nearly half of those surveyed felt that they had lost a contract or client due to not having enough face-to-face meetings . It also found that 81% said face-to-face meetings are better for building long-term trust and ensuring strong client relationships . This overwhelming preference was attributed to a number of factors, such as the perception that face-to-face meeting participants built longer, more meaningful relationships and had improved ability to 'read' another person (Crowne Plaza Hotels, Business meetings in the modern world: https://bit.ly/3IlC4OJ. A study by Forbes Insight (*Business Meetings: the Case for Face-to-Face*: http://onforb.es/1T7iPw0), which surveyed over 750 business executives, found that 84% preferred face-to-face meetings, rather than virtual ones.

[89] ACI analysis.

[90] ACI analysis.

[91] Sources for the airport infrastructure investment dataset (2007-2016), created for the Global Infrastructure Hub, include OECD, World Bank, individual country national statistical agencies, and Oxford Economics' econometric estimates. Air arrivals data is based on UNWTO statistics and Oxford Economics analysis. Because some countries do not report air arrivals and the basis for reporting can differ across countries, there is a degree of uncertainty in air arrival estimates.

[92] Currency values are at 2015 prices and exchange rates. There was a wide spectrum of experiences depending on the country. Singapore, Croatia, Spain, and South Korea experienced much greater increases in air arrivals between than their level of airport infrastructure investment would suggest. The United States, Canada, and the United Kingdom experienced lower increases in air arrivals than their level of airport infrastructure spending would suggest – possibly indicating the need for investment to replace outdated infrastructure. Some countries even saw declines in air arrivals relative to the size of their populations, typically because of political instability, as in Egypt's case. The variety of experiences in different countries suggests that airport infrastructure investment is not by itself sufficient to increase passenger numbers and drive an increase in tourism, trade and foreign direct investment. However, infrastructure investment can be a necessary condition to capitalise on latent demand that is being hindered by inadequate capacity.

[93] European Commission / CE Delft study *Sustainable Transport Infrastructure Charging and Internalisation of Transport Externalities*, June 2019: https://bit.ly/2E6oSEr

[94] IATA analysis of European Commission / CE Delft study *Sustainable Transport Infrastructure Charging and Internalisation of Transport Externalities*, June 2019

[95] Railway subsidies across the EU are split into two separate buckets of activity: pensions and public-service obligation (PSO) and infrastructure and other aid. The €50bn figure includes both, as PSO is generally what aviation is subsidised for. 'Infrastructure and other aid' alone counted for €26.7bn in 2016. Individual countries have varying degrees of subsidy applied, with the top three total subsidies to rail given in Germany (€14.28bn) France (€9,9bn) and Italy (€8.5bn). Looking at the distribution of rail sector spending as a share of GDP, the EU 28 average is 0.31%. European Commission, DG Competition, *State Aid Scoreboard 2019*: https://bit.ly/2FJWecK

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[97] World Bank Group, *Air Transport Annual Report 2018*: https://bit.ly/2DtEFgb

[98] IATA Economics analysis for WEF, *Economic Benefits of Aviation and Performance in the Travel and Tourism Competitiveness Index*: https://bit.ly/3j5HqDp

[99] Airbus analysis in CEO speech to the SAE Aerotech congress in Toulouse, 2011.

[100] Aerospace and Defence Industries Association (ASD), *Facts and Figures 2019*: https://bit.ly/3aIJ4DI

[101] Aerospace Industries Association (AIA), *US exports of aerospace products*: https://bit.ly/31HGP47

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[197] Throughout the regional section, this figure is provided by IATA Economics / DDS and relates to all departing O&D passengers (does not include connecting passengers).

[198] Throughout the regional section, this figure is provided by IATA Economics / SRS Analyser.

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[200] Throughout the regional section, this figure is provided by Flight Fleets Analyzer from FlightGlobal and includes operating commercial airlines with an IATA and/or ICAO code.

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[205] Throughout the regional section, this figure is provided by Oxford Economics using data from IATA DDS and IATA/Tourism Economics Long-term Air Passenger Forecasts, it is a forecast of revenue passenger kilometres for the period 2018-2038.

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[207] Europe includes the following countries: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Greenland, Hungary, Iceland, Ireland, Italy, Kosovo, Latvia, Lithuania, Luxembourg, North Macedonia, Malta, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and United Kingdom.

[208] Latin America and the Caribbean includes the following countries: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay and Venezuela. Please note that for the *Aviation: Benefits Beyond Borders* study released in 2012, Mexico was included in North America, whereas for this analysis it is included in Latin America and the Caribbean.

[209] The Middle East includes the following countries: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Republic of Yemen.

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[215] Small island states in this analysis are the members of the Alliance of Small Island States (AOSIS), excluding Singapore but including the following: Antigua and Barbuda, Bahamas, Barbados, Belize, Cape Verde, Comoros, Cook Islands, Cuba, Dominica, Dominican Republic, Fiji, Federated States of Micronesia, Grenada, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Marshall Islands, Mauritius, Nauru, Niue, Palau, Papua New Guinea, Samoa, Seychelles, São Tomé and Príncipe, Solomon Islands, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Timor-Leste, Tonga, Trinidad and Tobago, Tuvalu and Vanuatu. For more information, see www.aosis.info.

[216] Developing countries are all countries defined as low, lower-middle or upper-middle income by the World Bank and include the following: Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Costa Rica, Côte d'Ivoire, Democratic Republic of Congo, Democratic Republic of Timor-Leste, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Eswatini, Ethiopia, Fiji, Gabon, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kosovo, Kuwait, Kyrgyz Republic, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Libya, Lithuania, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, North Korea, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Republic of Congo, Republic of Yemen, Romania, Russia, Rwanda, Samoa, São Tomé and Príncipe, Senegal, Serbia, Seychelles, Sierra Leone, Solomon Islands, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, The Gambia, Togo, Tonga, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Zambia and Zimbabwe.

[217] Members of the Organisation for Economic Co-operation and Development (OECD) include the following: Australia, Austria, Belgium, Canada, Chile, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. www.oecd.org. Colombia has joined OECD in 2020, but is not included in this analysis for 2018.

[218] Least-developed countries (LDCs) as accepted by the UN include the following: Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen and Zambia. www.unctad.org.

[219] Landlocked developing countries (LLDCs) as informally accepted by the UN on geographical grounds include the following: Afghanistan, Armenia, Azerbaijan, Bhutan, Bolivia (Plurinational State of), Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Eswatini, Ethiopia, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Macedonia, Malawi, Mali, Mongolia, Nepal, Niger, Paraguay, Republic of Moldova, Rwanda, South Sudan, Tajikistan, Turkmenistan, Uganda, Uzbekistan, Zambia and Zimbabwe. Of these countries, 17 are landlocked least-developed countries. www.unctad.org.

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[232] The forecasts used in this report are based on some detailed modelling work undertaken for ATAG's Waypoint 2050 project by BlueSky Consulting and combine IATA, ACI, Airbus, Boeing and ICAO forecasts of passenger growth into consolidated forecasts. It represents a conservative estimate and is consistent with the regional analyses in this report. Furthermore, the jobs and GDP forecasts in this report also take into account similar forecasting for the tourism sector and the aerospace manufacturing sector – they are not based on RPK traffic growth alone.

[233] All in 2018 prices.

[234] All in 2018 prices.

[235] Gross value added (GVA) is the difference between the revenue a firm or industry generates less the bought-in costs needed to produce that revenue. GVA summed across all firms and industries in an economy is equal to GDP, after minor adjustments for taxes and subsidies. GDP is the most commonly used metric for an economy's size and is often used to measure economic growth or to indicate when an economy has entered or exited a recession.

[236] Where a given country-specific input-output table was unavailable, a proxy input-output table was chosen based on geographical proximity and economy size.

[237] OECD, *Inter-Country Input-Output (ICIO) Tables, 2018 edition*.

[238] Previous studies have indicated this additional benefit could mean aviation supports as much as 8% of global GDP.

METHODOLOGY

Oxford Economics analysed six key aviation sectors

ATAG commissioned Oxford Economics to estimate the aviation sector's global economic impact in the 2018 calendar year and how it might evolve over the next two decades. This follows Oxford Economics' analyses of the aviation sector's economic footprint for previous editions of *Aviation: Benefits Beyond Borders,* including those published in 2008, 2012, 2014, 2016 and 2018, and for previous similar publications reaching back to 1991.

The number of jobs and gross value added (GVA) created or supported by aviation are assessed for five key sub-sectors: airlines, airport operators, providers of goods and services on-site at airports (such as retailers and hoteliers), civil aircraft manufacturers, air navigation service providers. In addition, this report estimates the tourism activity that air travel makes possible.

The analysis was for 80 countries and 13 major regions or groups

Oxford Economics analysed aviation's economic impact in each of 80 countries that together account for 96% of global GDP and in these 13 regions or groups: Africa, Asia-Pacific, Europe, Latin America and the Caribbean, Middle East, North America, European Union, APEC economies, small island states, developing countries, OECD countries, least-developed countries (LDCs), and landlocked developing countries (LLDCs).

Regional and group estimates are created by scaling up individual country results. The scaling is based on the passenger revenue, revenue passenger kilometres, or airport passenger numbers represented by the individual countries in the dataset relative to the countries represented in an entire region or group.

Three core economic impact channels were estimated

The analysis considers three channels of spending that are in all standard economic impact studies.

- The **first** is the direct channel, which is the operational spending that airlines, airports, civil aircraft manufacturers, airport operators and air navigation service providers undertake to generate profits and employ people at their operational sites.
- The **second** is the indirect channel – the aviation sector's procurement of inputs of goods and services from other businesses in the economy. This spending supports additional jobs and gross value added contributions along the sector's supply chains[235].
- The **third** is the induced channel, comprising wage payments to staff in the aviation sector and the supply chain. Some or all of those wages are subsequently spent in the consumer economy, which supports further economic activity and jobs in retail and leisure outlets and their supply chains.

Indirect and induced impacts are estimated at the country level using multipliers that Oxford Economics calculated from 56 input-output tables sourced from the OECD and official national statistical websites[236]. At the regional or group level, these impacts are estimated using regional or group multipliers that account for the substantial cross-border economic activity spurred by the aviation sector. For this edition of *Aviation: Benefits Beyond Borders,* Oxford Economics updated the regional multipliers using the latest OECD Inter-Country Input-Output Tables[237].

In addition to these standard impact channels, Oxford Economics explores the economic impact arising from **tourists** who arrive by air and spend money on goods and services.

The estimates are based on comprehensive data sources

Building on the extensive data collection efforts undertaken for the previous edition of *Aviation: Benefits Beyond Borders,* Oxford Economics collected over 230 new data points from national statistics agencies and Eurostat to improve estimates of employment and gross value added in the airline and civil aircraft manufacturing sectors. The newly collected data accounts for 82% of the country-level gross value added in the airline sector in 2018 and for 99.6% of gross value added at the country level for the civil aircraft manufacturing sector.

Airports Council International (ACI) generously provided detailed data on jobs, revenues, and costs from its 2020 Airport Economics Survey. This survey asked 936 airports around the world about their 2018 financial year. The respondents accounted for 79% of all airport traffic in 2018.

Oxford Economics made use of detailed employment and financial data published by the Civil Air Navigation Services Organisation (CANSO), a trade body whose members help manage 85% of the world's air traffic. Where otherwise unavailable, estimates of direct ANSP employment were created using an econometric analysis based on flight hour data provided by Aireon.

Finally, the Oxford Economics / World Travel and Tourism Council database of tourism impacts which is based on national statistics and International Monetary Fund (IMF) balance of payments data on tourist expenditures, was adapted for this project to assess the number of jobs and gross value added supported by tourists who travel to their destinations by air.

Where new data were unavailable, Oxford Economics leveraged data collected on the aviation sector by the International Air Transport Association (IATA) and ACI in 2009-2010.

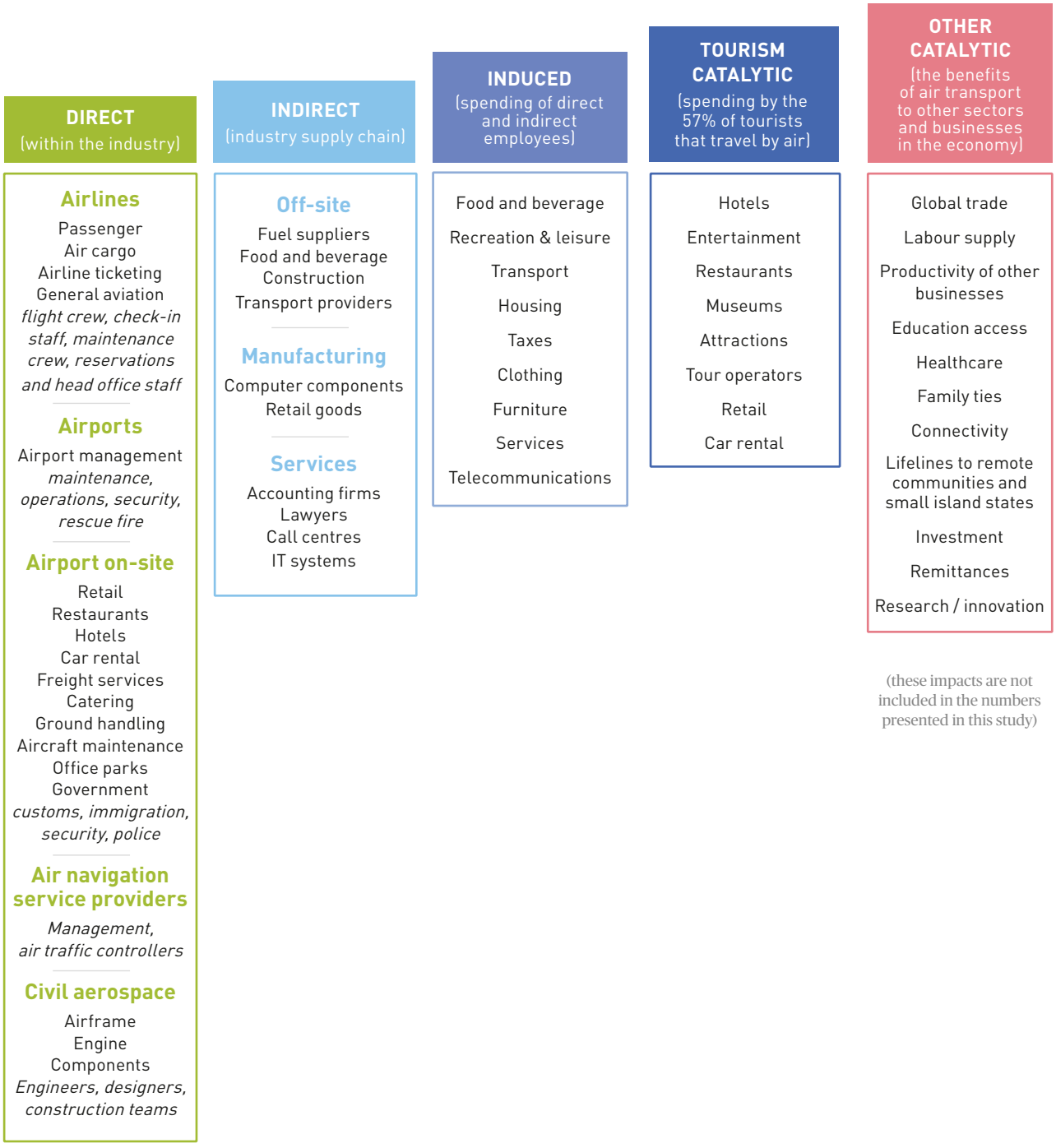
Forecasts to 2038

At the regional or group level, Oxford Economics forecast gross value added for airlines, airport operators, airport on-site businesses, and air navigation service providers using an analysis of future growth developed for the Waypoint 2050 project being run by the Air Transport Action Group. Employment in these aviation sub-sectors is forecast the same way, with an allowance for productivity increases.

The forecasts for tourism come from Oxford Economics Tourism Economics database, while the forecasts for civil aircraft manufacturing come from Oxford Economics industry model.

CALCULATING THE BENEFITS OF AVIATION

This report looks at how the air transport industry contributes to social and economic development at different levels. The first four pillars below are included in this analysis. They do not include other economic benefits of aviation, such as the jobs or economic activity generated when companies or whole industries exist because air travel makes them possible (noted under 'other catalytic'). They also do not include the intrinsic value that the speed and connectivity of air travel provides or domestic tourism and trade. Including these would increase the employment and global economic impact numbers several-fold[238].



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