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Economic Impact of Air Traffic Control Strikes in Europe

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Concerns of the Industry

Air traffic management (ATM) services are an essential enabler of air transport operations in Europe. Conduct of ATM depends on the skills of a relatively small number of specialists (circa 15,000 air traffic control officers across the EU).

These specialists are highly respected for their skills. However, they also enjoy *market power* through their ability to withhold those same skills. During the past six years, many controller strikes have occurred. These have imposed high costs on airlines and their customers with knock-on impacts to the wider economy.

A4E Airlines[1] for Europe has engaged PricewaterhouseCoopers LLP (PwC) to undertake a study of the economic impacts of air traffic controller (ATC) strikes in Europe. The study demonstrates that the costs of taking down the air traffic management network go far beyond the aviation industry. Consumers, non-aviation businesses and their employees bear significant costs.

Relationship between air transport and the economy

The European aviation sector is central to the European economy. With 900 million air passengers travelling each year, it makes up one third of the world market[2]. The value of air transport is widely recognised. In 2015, the Airports Council International estimated the economic impact of aviation related activities at €338 billion across the EU. The aviation sector acts as a critical factor for wider economic growth[3] and supports 5.5 million jobs.[4]

Mitigating problems, such as lack of airport capacity, through better air traffic management is central to meeting growing demand. In 2014, the EU Commission adopted guidelines on state aid to enable airports to receive public funding. Through the Connecting Europe Facility (CEF), €26.25 billion is available to reduce connectivity gaps between Member State's transport systems and provide appropriate infrastructure.[5] **Reliable connectivity is, therefore, both a social and economic good**.

Regulatory requirements of ATC services

As defined in the Chicago Convention of 1944, Member States of the International Civil Aviation Organisation (ICAO) have sovereign responsibility to organize and/or provide directly air navigation services within their airspace jurisdictions in compliance with ICAO regulations and implementing Standards (see Annex 11 of the Convention). The objectives of these services can be broadly grouped under three policy goals:

- safety;
- efficiency; and
- fairness.

[1] A4E membership comprises AirFrance-KLM, easyJet, Finnair, IAG International Airlines Group, Jet2.com, Lufthansa Group, Norwegian, Ryanair, TAP Portugal, Volotea.
[2] http://ec.europa.eu/transport/modes/air/airports/index_en.htm
[3] European Commission, (2016). Airports - Transport. p. 1
[4] European Commission, (2016). Airports - Transport. p. 1
[5] Ibid. p. 1

Whilst diverse organisational models have emerged, the legal accountability of the ICAO Member States remains undiminished. Most Air Navigation Service Providers (ANSPs) in the EU are state-owned[6] (in some cases, are government departments).

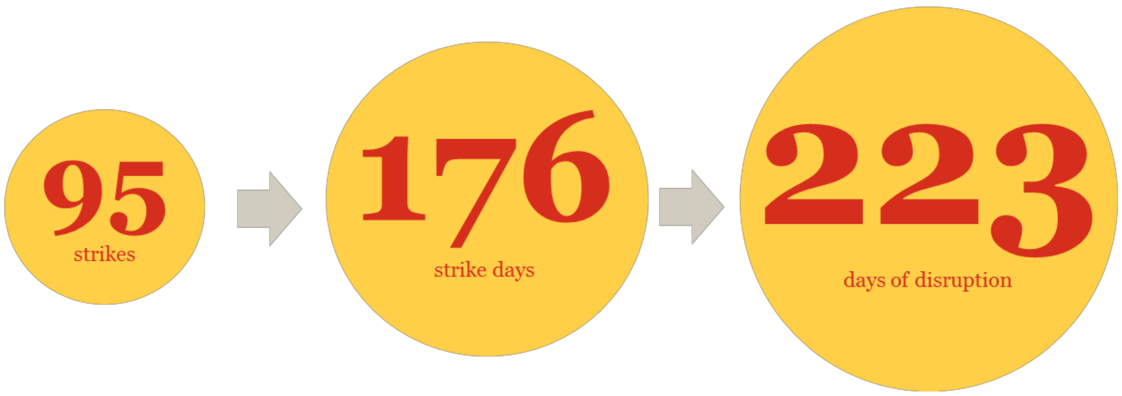
ANSPs are thus monopoly providers of services within national airspace[7]. Prices for services within the Eurocontrol[8] area are set according to the Eurocontrol charging mechanism.

Economic Position of air traffic controllers

Whilst the media has reported on the high salaries enjoyed by individual controllers, or the restricted number of days worked by individuals,[9] it is not the function of this study to examine in detail remuneration and working conditions. Fundamental, however, is understanding that ATCOs are not industrial workers but rather highly skilled individuals, whose pay and conditions reflect managerial roles – in short, controllers occupy a position of substantial economic/market power.

Where have ATC strikes occurred, and how often?

Between 2010 and 2015, there were 95 incidences of ATC strikes[10] in ten EU countries, encompassing 176 days of strike activity. Depending on the location, extent and duration of strikes, however, some instances have a disruptive impact on air traffic for longer than the strike itself continued. This is especially the case following longer strikes, during which many passengers have been unable to reach their destinations as scheduled and where schedule disruption continues into the next day[11]. As a result, the total number of days or disruption occasioned by the 176 days of ATC strikes were 223 - equivalent to one day of disruption for every 10 days for the past 6 years.



Air traffic controllers from ten European countries went on strike during the 2010-2015 period, namely in Austria, Belgium, France, Germany[12], Greece, Ireland, Italy, Portugal, Spain, and Romania. However the frequency of ATC strikes varied significantly by country. Most countries experienced only a few strike incidences, but in a handful of countries ATC strikes are much more frequent. The frequency is highest in France. French air traffic controllers went on strike on 95 days from 2010 to 2015, 72 days more than Greece,

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[6] Only in one case – NATS in the UK, which is minority owned by airline and pension fund interests – is there any private sector involvement.
[7] Certain exceptions, mainly airport tower services, may be open to competition and not subject to economic regulation.
[8] Eurocontrol is the European Organisation for Safety of Air Navigation, an intergovernmental organisation with 41 States which, inter alia, charges users flying through the controlled airspace of States and disburses those fees to the States.
[9] E.g. https://www.theguardian.com/world/2010/aug/03/spain-air-traffic-controllers-strike
http://www.independent.co.uk/news/uk/air-traffic-controllers-and-police-officers-among-the-10-best-paid-jobs-of-2014-9917957.html
[10] Source: Eurocontrol data and A4E airlines
[11] Note: the schedule disruptions indicated here are those where there is a discernible ongoing disruption to scheduled flight timings as compared with normal schedule adherence on selected comparable days (in the weeks immediately prior and after strike days). That is, the disruption *as it impact consumers*. Any internal disruption to airlines, for example, with aircraft or crew out of place or hours, that does not have an impact on consumers, is not included.
[12] Note A nine-day-strike of the Trade Union of Air Traffic Control (GdF) at Frankfurt Airport occurred in February 2012. Unlike other strikes included in this report, this strike was by airport controllers and had the effect of largely closing down Frankfurt Airport, leading to a high number of flight cancellations. Impacts into the wider air traffic system, however, are more limited.

the location with the second-highest frequency. See Annex C for a full list of individual strikes during the study period.

Across the European Union during the aforementioned six year period, ATC strikes lead to increases in both flight cancellations and flight delays. Our analysis indicates that there were 24 million minutes of extra delay across the six years and an average of approximately 1.5 million passengers a year affected by extra flight cancellations.

Our analytical approach

Our analytical approach followed four steps.

1. **Establishing the channels of transmission:** We identified the channels through which ATC strikes could affect the wider economy.

2. **Data gathering and analysis:** We describe the data that we have collected from a variety of sources and the methods that were implemented to analysis these datasets.

3. **Estimating model inputs:** We calculated the size of the effects associated with specific channels of impact that are included in the model. These enter in the model as inputs to calculate the wider economic impact.

4. **Modelling impacts using a computable general equilibrium (CGE) model:** The CGE model is used widely by institutions such as the World Bank, the IMF and OECD as well as national governments. A CGE model captures the interactions of the three main elements in an economy — households, business and government.

The model built for this project is a single-country dynamic model for the EU28, based on 2010-2015 data. The region is further broken down into 16 industries, and differentiates capital provisions between debt and equity.

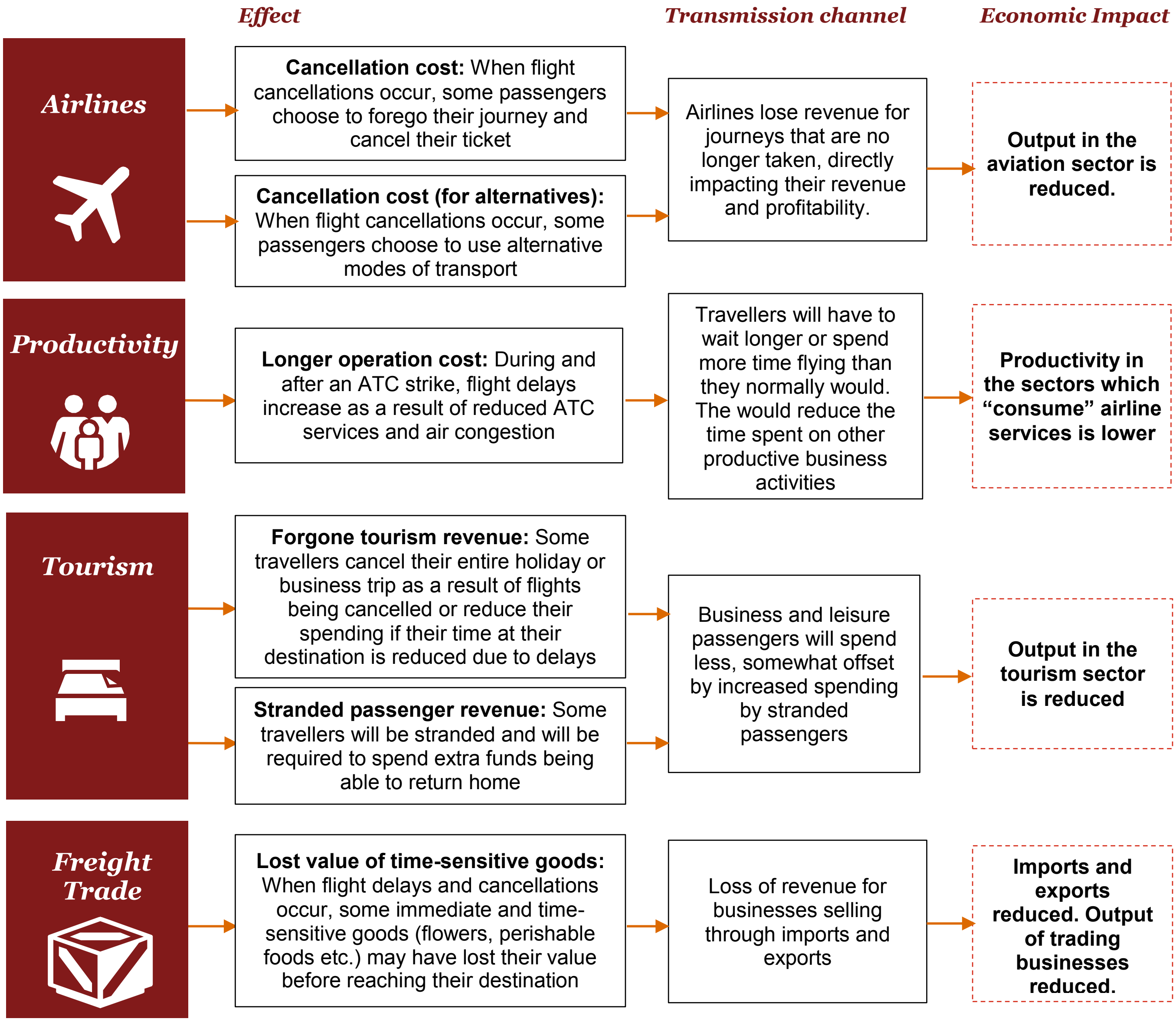
Our CGE model captures the key features of the EU28 economy. We have made several additions to a standard version of a large-scale dynamic model to reflect the underlying economic characteristics of the tourism and aviation sectors.[13]

Summary of economic impact of flight disruptions

To summarise the previous research that has been conducted on the impact of flight disruptions, there are 4 key channels through which they affect the economy. These are through:

- impact on airline revenues,
- passengers' loss of productive time,
- foregone tourism revenues, and
- impact on air cargo.

[13] In the main body or the report and its annex we explain methodology and content further.



Key Effects

Our modelling results suggest that the overall impact of ATC strikes:

- reduced EU GDP by **€ 10.4 billion** in the six years to 2015; and
- that the cumulative negative impact on EU employment for the six years to 2015 was **143,000 jobs**.

€10.4 bn.

Cumulative negative impact of ATC strikes on EU GDP for the 2010-15 period

143,000 jobs

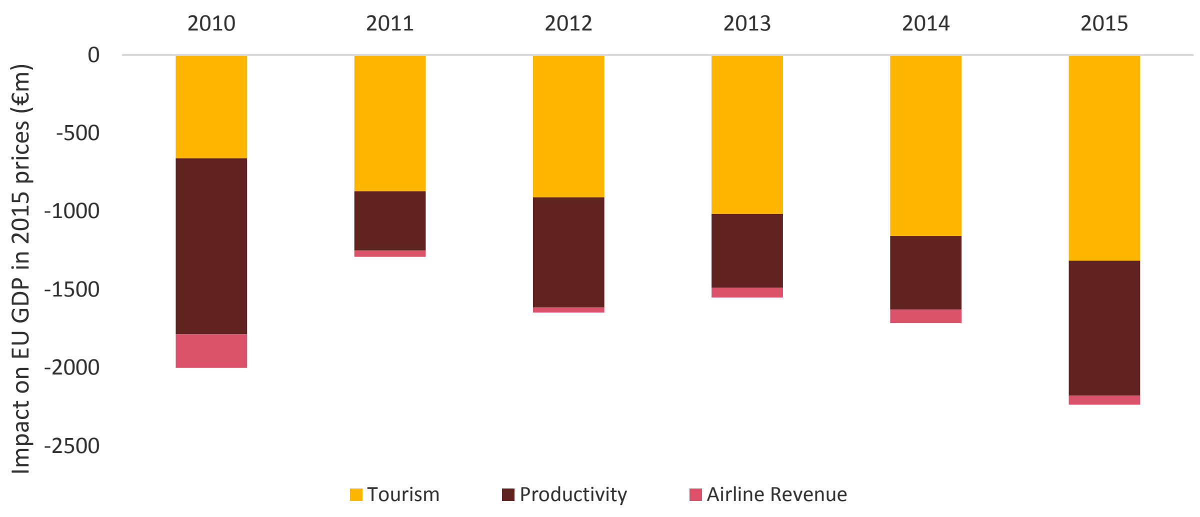
Cumulative negative impact of ATC strikes on EU employment for the 2010-15 period

The majority of the economic impact of ATC strikes impact is felt through reduced tourism spending. ATC strikes cause cancellation of flights, which could have transported travellers to their destinations. Closely related sectors that are affected include: Wholesale and Retail trade services, Entertainment and Recreation services, Accommodation and Food services and the Aviation sector. Our modelling suggests the overall impact through this channel over the past six years amounts to around €5.9 billion or €990 million a year in 2015 prices.

The second largest impact is felt through the reduction in productivity associated with longer flights and waiting times. During and after an ATC strike, flight delays increase as a result of reduced ATC services and air congestion. This means that users of airline services will have to wait longer to board flights or spend more time flying than they normally would. The impact of this is reduction in the time spent on productive business activities. In the CGE model, the economic impact input from this channel is modelled as lower productivity in the sectors which "consume" airline services. The cumulative economic impact felt through this channel amounts to € 4.0 billion or just under €670 million a year in 2015 prices.

Finally, the third largest impact is felt via lower airline sector revenues. This loss in revenue occurs when flights are cancelled so that some passengers choose to forego their journey and cancel their ticket. The airlines therefore lose revenue for journeys that are no longer taken, directly impacting revenue and profitability, equivalent to a reduction in the aviation sector. The economic impact of this, however, is limited to around €490 million or around €80 million per year in 2015 prices.

Economic Impact of ATC Strikes on EU GDP (Millions EUR)



Other impacts not modelled

Our study has focussed on the impacts on the EU economy arising from ATC strikes that disrupt the EU air transport system. Additional areas of impact that have not been included due to limitations of the data we were able to collect. These include:

- **Losses borne by businesses related to late or non-arrival of cargo**
- **Impacts on the express industry**
- **Inability to reschedule cancelled flights when strikes averted at short notice**
- **Compensation to delayed passengers Regulation (EC) NO. 261/2004**
- **Impacts on airports**
- **Costs associated with cancelled trips that are passed on to the insurance industry**
- **Direct costs borne by consumers who make their own way home**

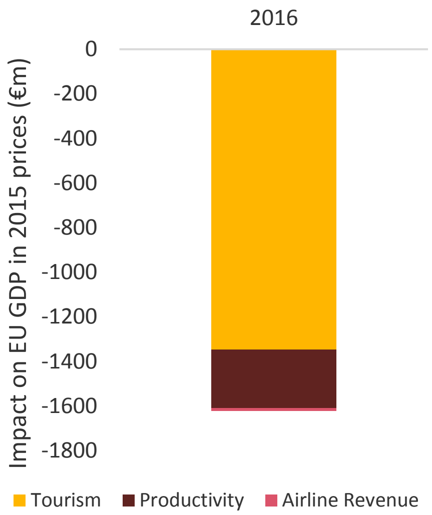
Examining these areas would have added significantly to the overall costs.

Impacts of Strikes in 2016

In the period 1 January – 30 September 2016, there have been 22 separate strikes by air traffic controllers in Europe, encompassing 41 days of strike, and 55 days of disruption.

This level of disruption over the first nine months of the year is similar to levels experienced by EU industry and consumers in 2010 – the most prolific year for strikes in the period of our study.

Utilising the economic model developed to determine the economic impacts of strikes during the 2010-2015 period, we have examined the impact of strikes to date in 2016. The results of this analysis suggest that the economic impact of ATC strikes already in 2016 have reduced EU GDP by **€ 1.6 billion in the first nine months** of the year.

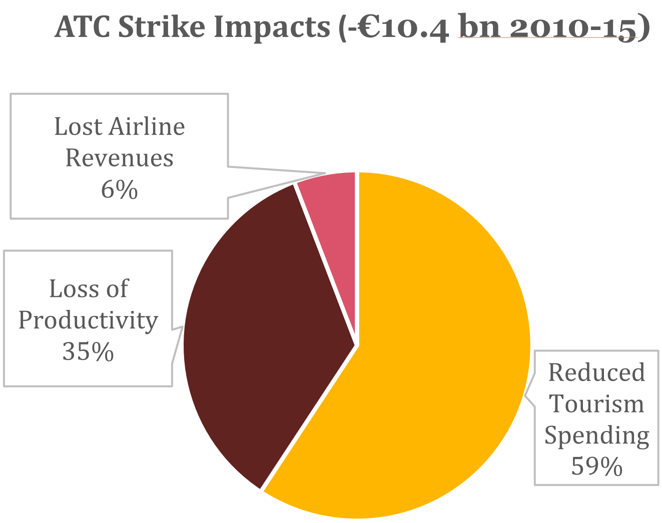


Concluding observations

Since 2010, less than seven years, the economic cost of ATC strikes in the EU has been **€ 12 billion[14].**

In its 2015 Aviation Strategy, the European Commission recognises that the "*main challenge for the growth of European aviation is to reduce the capacity and efficiency constraints, which are seriously impeding the European aviation sector's ability to grow sustainably, compete internationally, and which are causing congestion and delays and raising costs.*

Our study has highlighted that measurements of delay based on the ability of the ATM system to deliver on operational flight plans (as currently practiced) have served to mask the extent of the problem – as delay is measured by comparing actual time of operation to the last-filed flight plan. This fails to take account of the rescheduling that has already taken place by operators that in many cases means that the delay experienced by passengers is substantially larger than that measured by the ATM system. The test must be on the ability of the system to deliver the ***performance that that consumers and shippers have planned on and paid for***. We recommend that ongoing monitoring of disruptions to the air transport system be promptly established to provide commercial impact information - rather than relying on existing systems which are focussed on measuring operational and technical performance of purely tactical character.



Furthermore, the majority of the countries in which ATC strikes have occurred are those whose economies rely significantly on travel and tourism – either as a high proportion of GDP (e.g. Cyprus, Greece) or in absolute terms (e.g. France, Spain).

Thus there is also a high **social** cost when the transport system gets shut down. Efficient connectivity is a social and economic good - a vital and fundamental attribute of the production, distribution and

[14] € 10.4 bn in the 6 years 2010-2015, and € 1.6 bn in the first nine months of 2016

consumption of goods and services in today's EU and its Member States that citizens and businesses expect -- and around which they organise their lives. Largely for this reason many States condition the right to strike in areas, such as public transport systems, where vital public services are affected. Few if any States elsewhere in the world have experienced the EU's level of industrial action of the recent years against the air transport system.

Institutionally speaking, ATC strikes are (except in rare instances) not against airlines as employers.[15] When most ATM services providers, who typically enjoy an exclusive franchise in their country/operating area, confront a strike -- they do so at little serious cost to its owners (in all but a few cases the government) or its general management.[16] Typically, pricing of user fees or other forms of tax recovery reflects regulated monopolistic power and is based on fully-allocated cost recovery. Notably, these regulated charges take into account ATCO employment costs, which – as reported within our study – reflect a highly skilled workforce whose earnings are several multiples of average or median national wages.

On the other hand, the provider's direct users (airlines and other aircraft operators) and their employees as well as the consumers and shippers they serve – none of which are party to the dispute - bear the overwhelming brunt of service delays and cancellations and, under current conditions, have limited recourse to recover their losses.

[15] In only two States, Canada and the UK, do airspace users play a role in the ownership or management of the ATM System.

[16] The only current exceptions to this situation are cases of cooperative and/or user ownership such as Canada and the UK.

1 Introduction

1.1 *Concerns of the Industry – why this study*

The control of air traffic – the provision of air traffic management (ATM) services – is an essential enabler of air transport operations in the busy airspace of Europe. Although significant advances in technology have been made in recent years, realistically (for at least the medium term) the safe and efficient conduct of air transport services depends on the skills of a relatively small number of specialists (circa 15,000 air traffic control officers across the EU[17]).

These specialists are highly respected for their professional skills. However, in economic policy terms, they also enjoy *market power* through their ability to disrupt public transport. During the past six years, a large number of air traffic controller strikes have occurred. These have imposed serious and growing costs, which have far reaching effects on airline operations and even more seriously on their customers with flow-on impacts on the wider economy.

A4E Airlines for Europe (A4E) has engaged PricewaterhouseCoopers LLP (PwC) to undertake a study of the economic impacts of air traffic controller (ATC) strikes in Europe. The study demonstrates that the costs of taking down the air traffic management network go far beyond the aviation industry. Consumers, non-aviation businesses and their employees bear significant costs.

1.2 *Scope*

PwC has been commissioned by A4E to provide an evaluation of the economic impact of ATC strikes within the European Union. A secondary task was that the report should describe, in high level terms, the economic situation of the air traffic control profession. Whilst A4E commissioned and financed the work and A4E member airlines commented on draft reports, the final report represents the independent analysis of PwC.

The scope of our analysis includes an empirical model of the impact of air traffic delays and cancellations, caused by ATC strikes, on GDP, accounting for direct, indirect, induced and catalytic effects. The model assesses the economic impact on the EU economy over the six years from 2010 to 2015 inclusive. An example of a similar model is in the work recently published by the UK Airports Commission.

Preliminary findings from our work were presented in June 2016. Since then, further work has been undertaken to:

a) validate and strengthen our findings with respect to the average delays incurred during strikes;

b) include the impacts arising from 9 days of strikes by the Trade Union of Air Traffic Control (GdF) at Frankfurt Airport in February 2012[18]; and

c) assess the impact of ATC strikes that have occurred to date in 2016.

1.3 *Report outline*

Our report continues as follows:

- **Section 2: Air transport and the EU economy**

[17] Eurocontrol ACE Benchmarking Report 2014; see further Chapter 3 of this report.

[18] Note that this strike was by Vorfeldlotsen" (apron controllers, rather than air traffic controllers). They are employed by FRAPORT and not by DFS, the German ANSP. However, they are organised in the same union as the DFS air traffic controllers.

In this section we outline briefly the importance of air transport – as an industry, as an enabler of wider economic growth, and its importance both economically and socially in the provision of connectivity. *A meaningful collateral finding of this Study is that the European airline industry has lacked a basic agreed reporting methodology to measure and quantify the impact of strike actions in real time. The Eurocontrol system focusses primarily on measuring the performance of air traffic flow management – that is, its ability to deliver performance on tactical flight planning -- rather than on the strategic scheduling on which travellers and shippers depend on when making their plans.*

- **Section 3: ATC strikes in Europe**

  We provide information on the frequency and extent of disruptions to the air transport system brought about by ATC strikes.

- **Section 4: Our approach to Calculating the Economic Impact**

  We discuss the previous work that has been done to assess the impact of flight disruptions in order to build a picture of the potential areas of economic impact of ATC strikes. We outline the methodology that we use in our economic impact assessment. We set out how our methodology captures the channels of impact and how these are accounted for the in our computable general equilibrium model (CGE) analysis. We outline the four stages from data collection to results.

- **Section 5: Data Gathering and Analysis**

  We describe the data that we have collected from a variety of sources and the methods that were implemented to analysis these datasets.

- **Section 6: Establishing Economic Impact Model Inputs**

  We outline how the specific channels of impact that are included in the model and the figures that relate to them and enter in the model as inputs.

- **Section 7: Results**

  We present the impact of ATC strikes on EU GDP and employment over the period of 2010-2015. We discuss some of the modelling limitations and include a sensitivity which discusses the impact that including additional data has on the final results.

- **Section 8: 2016 Impacts**

  We present the impact of ATC strikes on EU GDP arising from strikes that have occurred to date in 2016. This additional analysis was undertaken following publication of our preliminary findings in June 2016, due to the increasing frequency of ATC strikes in this year.

- **Section 9: Concluding observations**

Annexed to the report are details of the assumptions made throughout the analysis as well as some key concepts crucial to this piece of analysis, such as the definitions of a “delay” or “cancellation” and investigating the importance of aviation on GDP and the existing literature on the effect of flight delays and cancellations on various economic agents and sectors.

2 Air Transport and the EU Economy

2.1 *Chapter overview*

The purpose of this chapter is to outline the importance of air transport to the European economy, providing context to why understanding the impact of ATC strikes on GDP is of high importance to policymakers. This chapter includes:

- an outline of the importance of air transport as an industry, and as an enabler of economic growth
- an assessment of existing literature on the effect of flight delays and cancellations on tourism, the aviation sector and other industries

2.2 *Relationship between air transport and the economy*

The European aviation sector is central to the European economy. With 900 million air passengers travelling each year through the European Union, it makes up one third of the world market.

The value of air transport is widely recognised. In 2015, the Airports Council International (ACI) estimated the total economic impact of airport and aviation related activities at €338 billion across the EU, demonstrating that the aviation sector can act as a critical factor for wider economic growth.[19] Furthermore, it is pertinent for the employment as it supports 5.5 million jobs.[20]

Such is the recognised value of air transport that mitigating problems, such as lack of airport capacity, through better air traffic management is central to adapt to the growing demand for flights. The EU is actively working on this. In 2014, the EU commission adopted new guidelines on state aid in the aviation sector, ensuring that airports with specific air transport requirements receive public funding. Moreover, through the Connecting Europe Facility (CEF), €26.25 billion is available to reduce connectivity gaps between Member State's transport systems and ensuring the availability of appropriate infrastructure.[21]

> ***A strategically important sector that makes a vital contribution to the EU's overall economy and employment, aviation supports close to 5 million jobs and contributes €300 billion, or 2.1% to European GDP.***
>
> **European Commission, DG MOVE**

In its 2015 Communication on an aviation strategy for Europe, the Commission prioritises tackling limits to growth in the air and on the ground, by reducing capacity constraints and improving efficiency and connectivity. Alongside this, it notes that action is needed to reinforce the social agenda, create high quality jobs in aviation, and protect passenger rights.

As our study will show, air transport and efficient connectivity is a vital and fundamental attribute of the production, distribution and consumption of goods and services in today's EU and its Member States that citizens and businesses expect -- and around which they organise their lives. **Reliable connectivity is, therefore, both a social and economic good**.

[19] European Commission, (2016). Airports - Transport. p. 1

[20] European Commission, (2016). Airports - Transport. p. 1

[21] Ibid. p. 1

2.2.1 The importance of connectivity

The International Civil Aviation Organization (ICAO) defines connectivity as an indicator of a network's concentration and its ability to move passengers from their origin to their destination seamlessly[22]. Air connectivity is key to economic growth, in part because it enables States to attract business investment and human capital. An increase in air connectivity also spurs tourism, which is vital to many countries' economic prosperity.

There is a range of evidence produced by airline industry authorities and academics which suggests that as aviation expands, productivity and hence GDP increases.[23] In 2013 PwC completed a deep-dive analysis into how aviation connectivity contributes to the UK's economy. The study identified five channels through which aviation plays a "positive enabling role": trade in services, trade in goods, tourism, business investment and innovation, and productivity.

A key finding emerging from academic and industry studies is the strong linkage that has been observed over the last 20 years between airline industry growth and GDP growth. In addition, studies have found that a 10 percent increase in business air usage, or air travel connectivity, leads to an increase in whole economy productivity of between 0.07 percent and 0.9 percent.[24] This includes:

- reducing air travel times, giving businesses greater efficiency of access to a wider marketplace;
- facilitating oversight of far-flung operations and thereby helping control their risks; thus
- enabling investment and human capital to flow more freely across borders and exploit comparative advantages.

In particular, a 2006 Oxford Economics study highlights the statistical linkage between business air usage and the level of GDP – in technical terms the study found that business air usage and Total Factor Productivity have a robust co-integrating relationship. Their key result implies that, *"other things equal, a 10% increase in business air usage could raise GDP by 0.6% in the long run"*. The report also notes that the growth in air transport in the 10 years prior to 2006 "boosted long-run underlying productivity by 2.0% across the EU25."[25]

Further evidence on the specific channels of impact of aviation on GDP is outlined in the literature review in Section 4.3 of this report.

> ***Air transport is an important enabler to achieving economic growth and development. Air transport facilitates integration into the global economy and provides vital connectivity on a national, regional, and international scale.***
>
> **World Bank**

In the context of this study, if an air traffic control strike causes a reduction in the ability for airlines to operate flights as scheduled, this reduces the number of passengers and shipments able to reach their desired destinations as planned. Both cancelled and delayed flights obstruct trade and connectivity. Furthermore, a pattern of disruptions will create uncertainty and discourage businesses and consumers from activities that

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[22] ICAO (2013), Worldwide Air Transport Conference (ATConf/6-WP/20)

[23] Three separate elements of how improved transport sector connectivity boosts productivity through its impact on business are set out in: "Transport infrastructure and regional economic growth: evidence from China", *Transportation vol.38, pp.737-752,* Hong, Chu and Wang (June, 2011). A similar framework can also be found in; "Transportation and Economic Development", Button and Reggiani, 2011. The impact of business travel on innovation levels is discussed in "International Business Travel: An Engine of Innovation?" Keller and Hovhannisyan (August, 2012).

[24] Studies include:

"The economic contribution of the Aviation Industry in the UK", Oxford Economics (2006)

Tam, R. and Hansman, R.J. (2002) "Impact of air transportation on regional economic and social connectivity in the United States" International Centre for Air Transportation Department of Aeronautics and Astronautics Massachusetts Institute of Technology Cambridge, Massachusetts, USA.

Smyth, A. Christodoulou, G. Dennis, N. AL-Azzawi,M. Campbell, J.(2012) "Is air transport a necessity for social inclusion and economic development?", Journal of Air Transport Management, Volume 22, July 2012, Pages 53-5

[25] "The economic contribution of the Aviation Industry in the UK", Oxford Economics (2006)

require air travel, therefore reducing trade and connectivity further. Given the importance of the link between the whole economy productivity and the airline sector output, it is therefore crucial to incorporate this linkage directly into our economic modelling of the impact of ATC strikes.

3 Situation of Air Traffic Control and Extent of Strikes in Europe

3.1 Regulatory setting of ATC services

As defined in the Chicago Convention of 1944, Member States of the International Civil Aviation Organisation (ICAO) have sovereign responsibility to organize and/or provide directly air navigation services within their airspace jurisdictions in compliance with ICAO regulations and implementing Standards (see Annex 11 of the Convention). The objectives of these services can be broadly grouped under three policy goals:

- safety;
- efficiency; and
- fairness.

Whilst a diversity of service provision organisational models have emerged -- especially during the past 25 years -- the legal accountability of the ICAO Member States remains undiminished. Meanwhile the economic system has gone global and depends on the efficiency of cross-border ATC network efficiency as well as purely national systems' operations.

Whilst air navigation services continue to be organised broadly along national, single-provider lines, the efficiency needs of cross-border operations have also led to a range of institutional developments at regional as well as global level. In the EU for example, the Single European Sky initiative has been aimed at reforming air traffic management in Europe in order to cope with sustained air traffic growth and improving both cost- and flight-efficiency.

We note, however, that a clear, unambiguous line between the resolution of internal national operating problems of a particular State (for example, disputes in the labour relations area) and its obligations toward its neighbouring States as well as the global system remains yet to be drawn.

3.2 Provision and Regulation of ATC in Europe

As noted above, ATC services are the responsibility of States to provide, and – consequently and historically - Air Navigation Services Providers (ANSPs) are organised along single-provider national lines. Most ANSPs in the EU are wholly state-owned[26] (in some cases, are government departments).

ANSPs are thus monopoly providers of services within national airspace[27]. Prices for services within the Eurocontrol area are set according to the Eurocontrol charging mechanism, and pricing overall is subject to economic regulation as defined in Regulation EC 390/2013, in common with a number of other industries including, *inter alia*, water and energy utilities, telecommunications, airports and rail networks.

In a 2006 report for Eurocontrol[28] that addressed the issue of cost benchmarking, NERA noted that "*The economic theory underlying the estimation of a cost function relies on the assumption that producers minimise costs subject to the best available technology. In the context of air navigation service provision, this assumption may not be entirely accurate. Almost all ANSPs operate under a full cost recovery regime*[29] *and so are able to pass on any cost increase (though subject to some time delay) to their customers. Therefore, most ANSPs face possibly weak incentives to avoid an inefficient use of inputs and the corresponding inflated costs.*[30]"

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[26] Only in one case – NATS in the UK, which is minority owned by airline and pension fund interests – is there any private sector involvement.

[27] Certain exceptions, mainly airport tower services, may be open to competition and not subject to economic regulation.

[28] See: https://www.eurocontrol.int/sites/default/files/publication/files/cost-benchmarking-stochastic-analysis-.pdf

[29] The single exception to this rule is NATS, which operates under a price cap incentive regime.

[30] The underlying theory also assumes that firms face competitive prices for inputs. This might not be the case, for example under the cost recovery regime if certain ANSPs agreed to pay excessive wages. In such cases, ANSPs' labour costs would be higher than in a competitive environment and the share of labour costs in total costs would be higher than the efficient labour costs share. We have not adjusted our analysis to reflect this possibility. Comparisons between cost efficiency and productive efficiency could be used to highlight any evident anomalies.

Furthermore, in a 2014 report for the European Commission[31] – DG MOVE – SteerDaviesGleave noted that:

"… air navigation differs significantly from the other industries [which are subject to economic regulation under Regulation EC 390/2013] in a number of respects. These differences must be taken into account in any consideration of the efficient costs of air navigation… :

- *Air navigation is subject to little or no competition, in contrast to some (although not all) other regulated industries;*

- *Air navigation is* ***characterised by a higher proportion of staff costs in its overall cost base*** *as compared with the other industries included in the comparison, which tend to be relatively capital intensive and subject to high fixed costs;*

- *The demand for air navigation is more affected by variations in the economic climate than some other regulated industries, although the impact of demand variations on ANSPs is mitigated through regulation as it is in other sectors, in this case through specific risk sharing arrangements; and*

- *Air navigation is subject to a specific, international regulatory framework that* ***requires Member States to provide for the continuity of navigation services****, although other sectors are subject to security of supply provisions in national legislation."*

The salient points arising for the purposes of this study are that, under the existing monopoly provision and national regulatory structures:

(a) ANSPs may have weak incentives to control costs;

(b) ANSP's costs are highly associated with staff costs, more so than other regulated industries; and

(c) Any losses ANSPs may incur due to industrial action by ATCOs are able to be passed on to customers (airlines, and hence consumers) through regulated charges.

3.2.1 Economic position of air traffic controllers

Air traffic control is a highly valued profession, and services provided by a small number of specialists – less than 15,000 throughout the EU. The following table shows the number of Air Traffic Control Officers (ATCOs – or air traffic controllers) employed by each national ANSP in the EU.

Number of ATCOs in Member States[32]					
Country	ATCOs	Country	ATCOs	Country	ATCOs
Austria	291	Germany	1,777	Portugal	220
Belgium	232	Greece	496	Romania	448
Bulgaria	248	Hungary	173	Slovakia	82
Croatia	234	Ireland	204	Slovenia	91
Cyprus	86	Italy	1,414	Spain	1,779
Czech Rep	192	Latvia	93	Sweden	470
Denmark	208	Lithuania	87	UK	1,415
Estonia	52	Malta	54	MUAC	278
Finland	183	Netherlands	178		
France	2,782	Poland	479	**TOTAL EU**	**14,246**
Source: Eurocontrol ACE Benchmarking Report 2014					

[31] See: http://ec.europa.eu/transport/modes/air/single_european_sky/doc/2014_03_25_final-report-cost-of_capital-and-pensions-v2-25march2014.pdf

[32] Reflects the number of ATCOs in ops: those working in operational duties.

Whilst there have been many reports in the media[33] relating to the very high salaries enjoyed by individuals, or the highly restricted number of days worked by individuals, it is not the function of this study to examine in detail controller remuneration and working conditions. However, there is relevance for policy makers in understanding that ATCOs are not low paid workers but rather are highly skilled individuals whose pay and conditions are more reflective of managerial roles.

In its 2015 report on ATCO Remuneration and HR Metrics, the Civil Air Navigation Services Organisation (CANSO) reports the following on ATCO pay scales, based on a *global sample* of 21 ANSPs.

A Measure of Relative Wealth - ATCO Pay to Average Country Wage
In the 2011 CANSO Report, the average industrial wage was sought in order to compare relative wealth between an ATCO and an average citizen. This trend has been continued in the 2015 Report but rather than collecting data from the ILO Bureau of Statistics, we asked each ANSP to provide a figure for their respective country's average industrial wage. This exercise was undertaken as an experiment to provide ANSPs with an alternative means of comparing ATCO remuneration levels.

The comparison provided an understanding of how comparatively valued or prestigious the ATCO occupation is within a country and/or how the wealth of an ATCO compares to the average citizen. Labour negotiations are undertaken within a national context and it was felt that a comparison mechanism which took account of the 'relative wealth' would be informative.

Figures 14 and 15 show the national average salary comparison for ATCO and Shift Supervisor levels. While the data set used is different, these figures continue to mirror the 2011 pattern with a significant number of ANSPs grouped closely together in the mid-200th to high 400th percentile with a smaller group of outlying ANSPs possessing a much higher/lower ratio.
Findings

In all ANSPs, ATCOs (especially at a more senior level) are paid highly compared to the average national salary. For ATCOs, gross pay vs national average varies between 2 and 14 times the country average wage (220% and 1493%) with an average of 398% but a median of 299%.

- CANSO ATCO Remuneration and HR Metrics Report, 2015

3.3 *Where have ATC strikes occurred, and how often?*

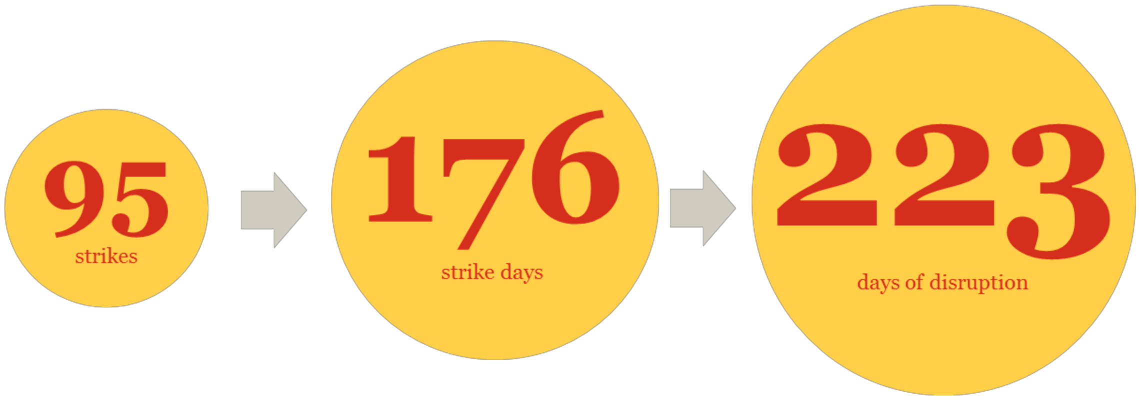
Between 2010 and 2015, there were 95 incidences of ATC strikes[34] in ten EU countries, encompassing 176 days of strike activity. Depending on the location, extent and duration of strikes, however, some instances have a disruptive impact on air traffic for longer than the strike itself continues. This is especially the case following longer strikes, during which many passengers have been unable to reach their destinations as scheduled and where schedule disruption continues into the next day[35]. As a result, the total number of days or disruption occasioned by the 176 days of ATC strikes was 223 - equivalent to one day of disruption every 10 days for the past 6 years.

[33] E.g. https://www.theguardian.com/world/2010/aug/03/spain-air-traffic-controllers-strike

http://www.independent.co.uk/news/uk/air-traffic-controllers-and-police-officers-among-the-10-best-paid-jobs-of-2014-9917957.html

[34] Source: Eurocontrol data and A4E airlines

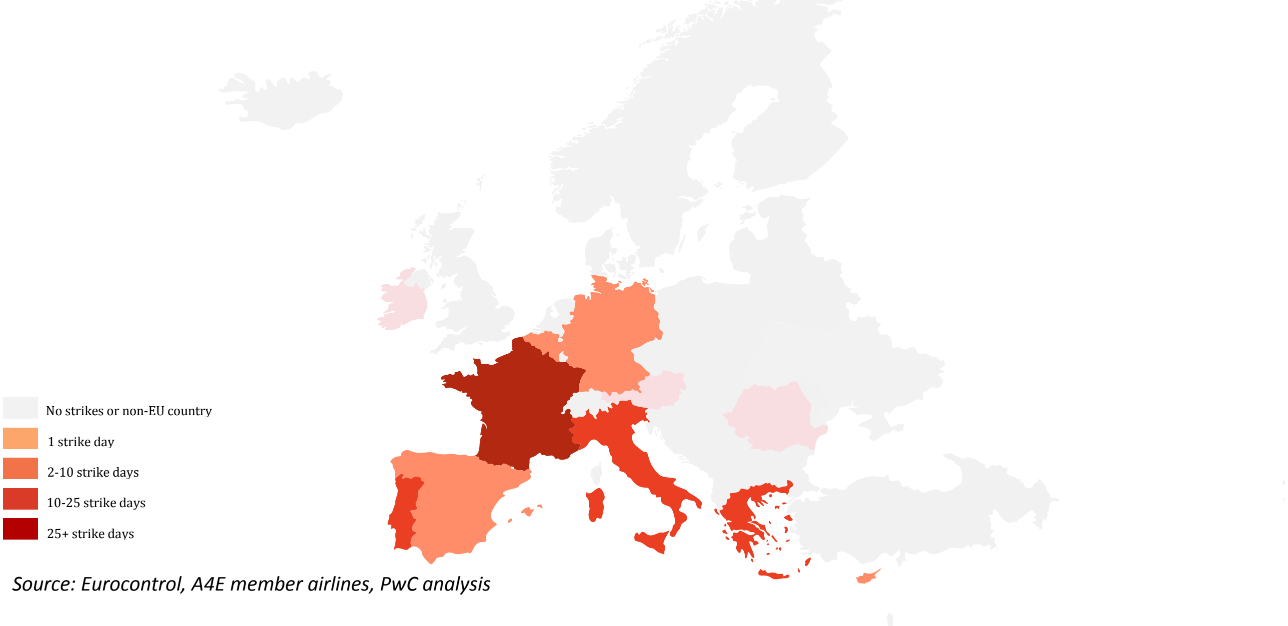
[35] Note: the schedule disruptions indicated here are those where there is a discernible ongoing disruption to scheduled flight timings as compared with normal schedule adherence on selected comparable days (in the weeks immediately prior and after strike days). That is, the disruption *as it impact consumers*. Any internal disruption to airlines, for example, with aircraft or crew out of place or hours, that does not have an impact on consumers, is not included.



Air traffic controllers from ten European countries went on strike during the period, namely in Austria, Belgium, France, Germany[36], Greece, Ireland, Italy, Portugal, Spain, and Romania. However, as illustrated in Figure 3.1, the frequency of ATC strikes varied significantly by country. Most countries experienced only a few strike incidences, but in a handful of countries ATC strikes are much more frequent. The frequency is highest in France. French air traffic controls went on strike on 95 days from 2010 to 2015, 72 days more than Greece, the location with the second-highest frequency. See Annex C for a full list of individual strikes during the study period.

Across the European Union during the aforementioned six year period, ATC strikes lead to increases in both flight cancellations and flight delays. Our analysis indicates that there were 24 million minutes of extra delay across the six years and an average of approximately 1.5 million passengers a year affected by extra flight cancellations.

Figure 3.1: Number of strike days from 2010 to 2015, by country



Source: Eurocontrol, A4E member airlines, PwC analysis

[36] Note a nine-day-strike of the Trade Union of Air Traffic Control (GdF) at Frankfurt Airport occurred in February 2012. Unlike other strikes included in this report, this strike was by airport controllers and had the effect of largely closing down Frankfurt Airport, leading to a high number of flight cancellations. Impacts into the wider air traffic system, however, are more limited.

4 Analytical approach

4.1 *Section overview*

For the purposes of estimating the economic impact of ATC strikes we follow a four step analytical approach. In summary this approach involves mapping out the different channels through which ATC strikes affect key stakeholders: airlines, tourists, the freight industry etc.; gathering data on the scale of these effects and then using a large-scale dynamic economic model of the EU-27 economy we estimate the impact of ATC strikes affect key economic metrics such as GDP and job creation.

In this section we outline this analytical approach and also present our analysis of step 1, where we provide a summary review of the evidence regarding the channels through which ATC strikes affect the economy.

4.2 *Our analytical approach*

Our analytical approach followed four steps to estimate the economic impact of ATC strikes in Europe as outlined in the list below. The following for chapters of this report align with each of these four steps.

Step 1: Establish the channels of transmission: We identified the channels through which ATC strikes could affect the wider economy, based on a literature review as well as consultation with experts and our in-house aviation team.

Step 2: Data gathering and analysis: To carry out our analysis we gathered and analysed data from a variety of sources including Eurocontrol, the A4E member airlines, and other publicly available datasets (e.g. Eurostat). Our analysis included making assumptions (particularly in cases where some of the data were incomplete) which we have clearly laid out.

Step 3: Estimate model inputs: We quantified the direct effects attributable to the key channels of transmission as identified in step 1. However, our estimates of model inputs were limited to the channels of impact we had sufficient data on. As a result, some of the channels of transmission of impact e.g. the freight industry have not been taken into account into our impact analysis.

Step 4: Model impacts using a computable general equilibrium (CGE) model: We modelled the wider economic impact of ATC strikes by changing the various sector-specific assumptions available in the model according to the effects attributable to the key channels of transmission. We did this using a computable general equilibrium model (CGE) model which is used widely by international institutions such as the World Bank, the IMF and OECD as well as national governments. A CGE model combines economic data and a complex system of equations in order to capture the interactions of the three main elements in an economy — households, business and the government. The outputs of the CGE modelling exercise show the impact of ATC strikes on indicators such as GDP and job creation.

In the remainder of this section we conduct step 1 of this process and review the relevant literature to identify the channels through which ATC strikes could affect the wider economy, summarising the possible channels of impact at the end of this chapter.

4.3 *Literature Review*

4.3.1 Overview

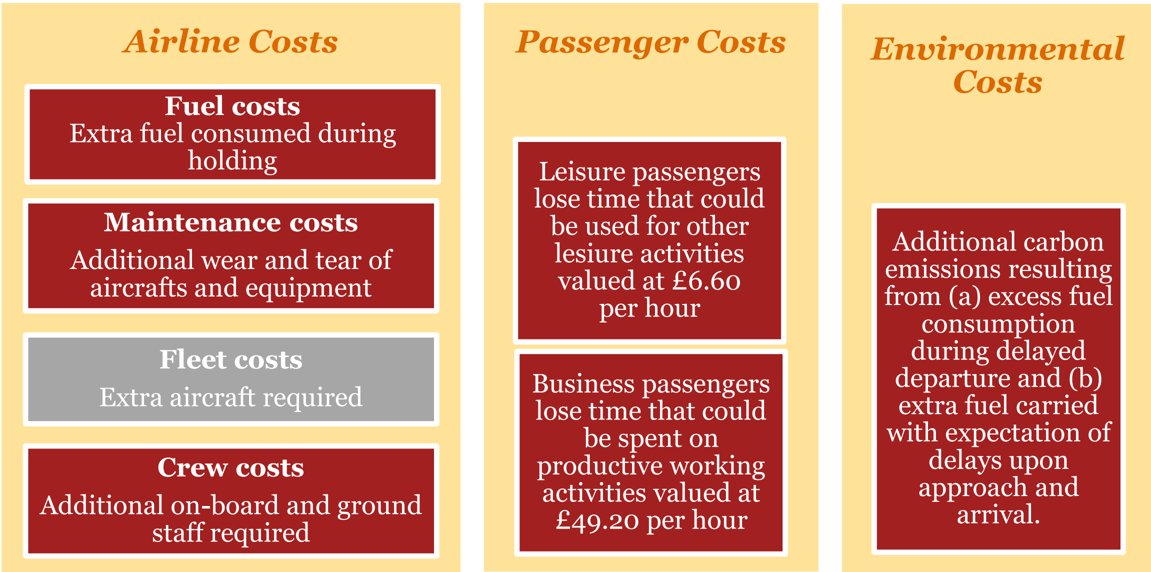
There is a significant volume of research relating to the various impacts that flight disruptions can have on the aviation sector. Hence, there is significant learning to be gained from these insights to inform the channels of impact that form the basis of modelling the economic impact of ATC strikes. However, very little of this research covers the actual economic impacts at the whole economy level. The studies that do look at this area are very detailed in their coverage and where possible we seek to replicate their methodology. In terms of the literature presented in this section we have focussed where possible on studies that seek to quantify the effects of delays on the whole economy. In turn, this restricts the number of studies that are presented. In addition to this there some channels where we are only able to make a qualitative assessment of the impacts, this is due to both lack of evidence and data.

The remainder of this Chapter summarises the key findings of this research that are most relevant to this study.

4.3.2 Initial starting point: the work of the UK Airports Commission

In 2014, PwC worked with the UK Airports Commission to assess the economic impact of delays using insights from this research. PwC calculated the costs of airline delays as airlines experience operating expense increases, passengers lose productive leisure or working time and increased fuel consumption creates additional environment costs. As part of this work, PwC researched the various costs associated with flight cancellations and delays, a summary of the finding are illustrated in Figure 4.1 below.

Figure 4.1: Cost borne by airlines, passengers, and the environment as a result of flights delays



4.3.3 The impact of flight disruptions on airlines

As seen in Figure 4.1, the economic cost of flight disruptions has a number of dimensions and are borne by a number of economic agents. The most prominent groups affected are airlines and their passengers. The impact on airlines themselves being the direct and indirect costs they incur when their flights do no operate on time. These include:

- additional payments to crew for longer working time or additional crew that are hired as a result of the additional flying time caused by more persistent delays and accounted for in airlines' strategic decisions;
- revenue reductions for passengers whose trip is cancelled; and
- the cost of additional fuel used as a result of longer flying times, longer holding times or returning planes to the correct location.

These issues are raised in a comprehensive study by Nextor (2010) [37] who sought to estimate the total costs caused by flight delays in the United States in a year. Flight delay is a widespread issue in the US aviation system; in 2007 nearly one in four airline flights landed at its destination with over 15 minutes delay. Approximately a third of these delayed flights were a direct result of the aviation system failing to operate according to the traffic demands. In completing their research, Nextor used a single-region CGE model to estimate the costs borne by airlines as a result of the flight delays as well as the productivity loss experienced by

[37] Ball et al. (2010), Total Delay Impact Study – A Comprehensive Assessment of the Costs and Impacts of Flight Delay in the United States, NEXTOR, p.1

passengers. TDI estimates that the total direct cost of all US air transportation delays in 2007 was $31.2 billion.[38] Whilst the airline cost, consisting of increased expenses for crew, fuel, and maintenance, among others, was estimated at $8.3 billion, the passenger cost, based on the passenger time lost due to schedule buffer, delayed flights, flight cancellations, and missed connections, was estimated as the largest cost at $16.7.

As well as significant research on the impact of strategic delays, which systemic and accounted for, there is evidence that tactical delays also affect the economy. One example of an extraordinary circumstance, whose economic impact has been subject to an extended amount of research, is the volcanic ash cloud caused by the Icelandic Volcano Eyjafjallajokull on 14 April, 2010. Despite the eruption being relatively minor, the resulting ash led the aviation authorities to declare most of European skies as no fly zones (NFZs) from the 15-21 April, consequently affecting passengers, imported inputs, and general productivity. One study by Oxford Economics estimates that the revenue loss for airline from schedules services were at $1.7 billion US dollars during the period of 15-21 April 2010.[39] KLM, British Airways, and Air-France reported a loss of £20 million per day.[40] The revenue loss per day varied according to the daily airspace closure and reached $400 million per day during the peak period of 17-19 April.[41]

4.3.4 The impact of flight disruptions on the tourism sector

The interdependence between the aviation and tourism industry, suggests that anything affecting one of the sectors will also affect the other, exposing them to many risks. Again, the Icelandic volcano eruption of April 2010 is a good example to demonstrate the dependency of tourism on the aviation system. According to a report by Oxford Economics, approximately 2 million potential passenger through UK airports were affected where 1.1 million were UK outbound travellers.[42] One key result of this reduction in passengers was the reduction in tourism spending in the UK as many passengers did not take their trip or had the length of their trip shortened by a delay on the flight into the UK. It is estimated that in total the UK tourism economy would have forfeited £365 million in visitor spending. However, a number of other consequences somewhat offset the scale of the impact, the largest being that stranded passengers increased their spending in hotels and restaurants.

At this point we feel it is important to raise the important role that tourism plays in the EU economy and its correlation in terms of its economic contribution and the incidence of ATC strikes at the EU country level The EC estimates that the tourism industry generated over 5% of EU GDP in 2010. While research by the World Travel and Tourism Council (WTTC) shows that the economic value of travel and tourism is more than 10% of GDP for most southern European countries, including Cyprus, Greece, Portugal and Spain.

According to Eurostat data, air travel is the preferred mode of transport for outbound trips (i.e. trips out of the country of origin) for EU citizens. As we discuss in Section 3 of this report and seen in Figure 4.2, many of the countries that have experienced ATC strikes during the 2010-2015 period are also countries whose economies rely significantly on travel and tourism – either as a high proportion of GDP (e.g. Cyprus, Greece) or in absolute terms (e.g. France, Spain).

[38] Ibid.

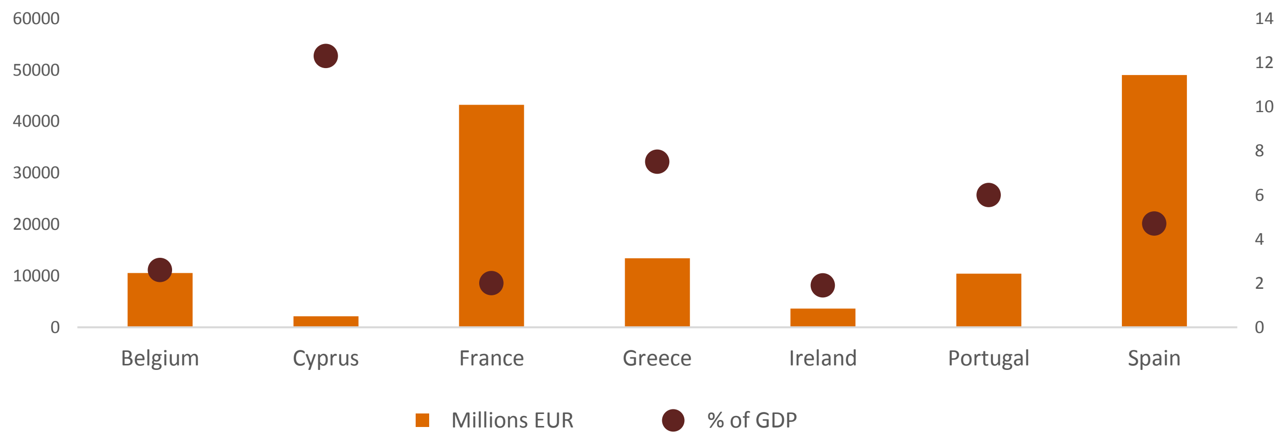
[39] Mazzocchi M.et al. (2010) The Volcanic Ash Cloud and its Financial Impact on the European Airline Industry, CESifo Forum 2/2010 pp. 92-100, p.93

[40] Ibid. p. 93

[41] Ibid. p. 93

[42] Oxford Economics. (2016) UK Economic Losses Due to Volcanic Ash Air Travel Restrictions - Prepared for VisitBritain, p. 3

Figure 4.2: Travel receipts of countries with >1 ATC strikes 2010-2015, million EUR and as a % of EU Member States' GDP



Source: Eurostat

4.3.5 The impact of flight disruptions on air cargo

Another industry very close to and dependent on the aviation system is air cargo. Air cargo, including the express industry, is economically important for a number of reasons. Firstly, it offers the opportunity to transport high value, time-sensitive, and often perishable items rapidly. In this segment of the aviation industry the scope of evidence is more limited. The only major study we could find that has attempted to quantify the impacts of delays has been undertaken by Oxford Economics who have estimated that during 2010, 269 million intra-EU cross-border express deliveries took place, demonstrating its importance in the European internal market.[43] Further, it promotes competition and productivity through the facilitation of trade across EU Member States as well as with other international partners. It is estimated that the air cargo industry supports a further 191,000 European jobs and generates a further €8.4 billion of GDP to the European economy through the purchase goods and services from other sectors.[44]

4.3.6 Other impacts of flight disruptions

Beyond aviation, cargo and tourism-related businesses, there is a wide range of evidence that air transport delays can have an impact on other industries, as well as on the environment.

According to the Oxford Economics Report on the UK Economic losses due to Volcanic Ash Air Travel Restrictions, although the aviation sector suffered extensively during the airspace shutdown, other transport services, namely rail and ferry travel, benefited from it as passengers opted for alternative modes of travel. 37% of the affected UK-Europe travellers used these alternative modes of travel.[45] Furthermore, another study partially confirmed that the car rental industry as well as the Eurotunnel benefited from the resulting increase in demand for other transport services.[46] Although the potential transport sector loss of £375, 85% (£321 million) was fully realised by the aviation sector, only 69% (£258 million) of the potential loss will be realised in the transport sector due to the availability of other transport types.[47] The net impact on UK GDP is estimated to be £466 million when including these indirect and induced impacts.

On the environmental side, using a methodology derived from the UK CAA Runway Resilience Study and European airline delay cost reference values paper and inputs from the Department for Transport's Aviation model, the Airport Commission's (AC) Interim Report demonstrates the benefits from the reduction in strategic delays in the UK airport system for carbon emissions due to airport expansion.[48] Put simply, airspace closure means that some flights are diverted on longer routings to reach their destinations (i.e. they are diverted around the closed airspace), leading to longer flights times, higher fuel burn, and increased CO2 emissions.

[43] Ibid. p. 1
[44] Oxford Economics (2011) The Economic Impact of Express Carriers in Europe, p. 1
[45] Oxford Economics. (2016) UK Economic Losses Due to Volcanic Ash Air Travel Restrictions - Prepared for VisitBritain, p. 6
[46] Mazzocchi M.et al. (2010) The Volcanic Ash Cloud and its Financial Impact on the European Airline Industry, CESifo Forum 2/2010 pp. 92-100, p.
[47] Oxford Economics. (2016) UK Economic Losses Due to Volcanic Ash Air Travel Restrictions - Prepared for VisitBritain, p. 6
[48] Economy: Delay of Impacts Assessment, Airports Commission (2014) p. 24

5 Data gathering and analysis

5.1 *Section overview*

In this section we describe step 2 of our approach: data gathering and analysis. To carry out our analysis we gathered and analysed data from a variety of sources including Eurocontrol, the A4E member airlines, and other publicly available datasets (e.g. Eurostat). In this section, we describe the data that we have sourced relating to the size of the aviation market as well as delays and cancellations as a result of ATC strikes.

5.2 *Description of data and uses*

5.2.1 Size of the European Market

The size of the European air traffic market has been estimated with the use of different sources including airline schedules, MIDT and airline-provided data. Air traffic has been estimated for travel within, to and from all EU-28 Member States for the years of 2010 to 2015. Airline schedules and passenger and revenue data have been sourced from Milanamos PlanetOptim. This data, in addition, has been supplemented with airline-provided data. The database uses the following information:

- **Airline schedule data** – data on the number of air traffic movements has been gathered from airline schedules. The capacity numbers available through the database are tied directly to the schedules that are filed by every airline with Innovata and OAG. There are some carriers that do not officially file their schedules and therefore their information is received from other sources. It should be noted that only scheduled flights are captured by the database (e.g. non-scheduled charter flights would not be captured).
- **Passenger and revenue data** - the database currently uses 80 different data sources worldwide and cross-references them in order to build a more accurate picture of the market demand and revenue. Major data sources include and are not limited to historical market data based on MIDT data from all major GDSs, BSP data, web scraping, Civil Aviation Authorities, airports and airlines-provided data.

This data on the size of the European airline market was used to develop the "base case" for the CGE model. In the case of our model, the base case must be the situation in which ATC strikes do not occur, we therefore include the foregone flights and revenues in the model's counterfactual and then compare this with a scenario which factors in the annual number of ATC strikes between 2010 and 2015.

5.2.2 Delay data

A high number of individual strikes have occurred across the period of this study - of varying location, duration and extent. We are conscious that each of these factors has a unique effect on the impact that a strike will have on air traffic. Clearly, strikes that occur in central locations and that impact all air traffic expecting to utilise the airspace have a greater impact than strikes of similar size, but taking place in less central or busy airspace or that exempts overflights, for example. However, it has not been practicable to gather detailed data on every instance of ATC strikes (which would also have required equivalent data for 'comparable days' (see further below)) to measure the precise impact of every strike instance. Furthermore, our aim has been to develop a methodology that can be readily employed to evaluate impacts arising from future strikes.

Therefore, the approach taken in this study has been to assess the impact of (1) a relatively short strike occurring in moderately utilised airspace, and (2) the average per-day impact of a multi-day strike occurring in more highly utilised airspace. Strike occurrences across the 6 year period reviewed have then been assigned to either the long or short category, depending on duration (1 full day or longer to the long category, and strikes of less than 24 hours to the short category).

It is acknowledged that there are many instances of short strikes that are likely to have a greater impact than that of the sample day selected, due to having taken place in more central/busier airspace or for longer periods than 4 hours. Our estimates of the impacts of short strikes are, therefore, conservative.

The following strikes form the basis for our calculations:

- **Short strike** (1 day or less). The industrial action of 17 February 2015 that was organised between 1pm and 5pm by the Italian Union of Flight Assistance and Control (Unica) and the League of Italian Air Traffic Controllers (Lica) was selected as the sample day.

- **Long strike** (per-day impact of strike duration greater than 24 hours). The industrial action of 08 and 09 April 2015 that was called by the main French air-traffic union SNCTA (Syndicat National des Contrôleurs du Trafic Aérien) was selected as the sample days.

Eurocontrol, through CODA (Central Office Delay Analysis) provided us with 'All-Causes Average Arrival Delay' data for the selected industrial action days for A4E[49] and non-A4E airlines. In order to isolate the impact of the industrial action from delays generated by other operational issues, CODA also supplied average arrival delay data for the equivalent day the prior and following week which was compared against days on which strikes occurred. Any delays or disruption in the system due to non-strike causes was thus removed from the delay observed on the selected strike days – the remainder of delay being isolated as due to strike action.

Note: we do not use ATFM delay as recorded by the Eurocontrol Network Manager in our analysis. This is because ATFM delay is Calculated Take Off Time (CTOT) minus Estimated Take Off Time (ETOT). It *does not include* reactionary delays and, critically, is measuring only differences in take-off time – rather than arrival times. Yet it is the difference between the planned-on-and-paid-for versus actual arrival time that is of consequence to consumers, and a truer representation of the impact felt (and also allows us to take account of any en route airborne delays occurring after take-off, longer or shorter routings, or time made up in the air that may reduce the overall delay).

5.2.3 Re-scheduling delay

Eurocontrol data, however, is only able to tell us about the difference between the last-filed flight plan and actual flight time. It does not and cannot take account of the fact that the flight may have had to be rescheduled from its originally-planned time (i.e. the time planned-on-and-paid-for by the consumer) because of strikes. Illustratively, if a passenger buys a ticket on a flight from Berlin to Rome arriving at 13:00, but because of strike action the flight has to be rescheduled to a new arrival time of 14:00 – and actually arrives at 14:15 - the delay reported by Eurocontrol systems would be 15 minutes (that is, the difference between the 14:15 arrival time compared to the last-filed flight planned time of 14:00). The delay in this example as *experienced by the passenger* however, is one hour and 15 minutes. We refer to this unreported portion of delay as *re-scheduling* delay.

Re-scheduling delay is a chronic under-reporting issue which affects Eurocontrol analysis but also shows how the problem is looked at generally. In order to overcome this problem and enable us to reflect the true extent of delays in our analysis, A4E airlines were asked to provide information on their original flight schedules (i.e. scheduled time of departure and arrival) and the time the flight was actually operated. As per Eurocontrol provided data, data was supplied for the 17 February 2015, 08 & 09 April 2015 as well as for the equivalent days the prior and following weeks (to enable us to isolate and remove any rescheduling occurring for other operational reasons).

A4E airlines were able to provide detailed data which allowed us to estimate the actual delay experienced on strike days. This data covered the above strike days and equivalent days in the prior and following weeks, enabling us to ascertain differences in arrival times on strike days versus non-strike days.

Because confidentiality restrictions meant that no data could be provided for individual non-A4E airlines (i.e. data provision was at aggregate level only), and because we believe that some of these carriers are likely to be affected to a lesser degree than A4E airlines due to operating only a small number of services in the airspace of countries that are significantly affected by ATC strikes, *no re-schedule delay has been calculated for non-A4E carriers*. The additional delay, and consequently the additional economic impact we have determined of re-scheduling delay is based on the very conservative assumption that it affects *only* A4E airlines (and is zero for all others). This additional delay, therefore, has been applied to *only 30% of flights operated* on strike days (being the approximate % of ATMs operated by A4E airlines).

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[49] Eurocontrol for this analysis has defined A4E airlines as: Air France -KLM, KLM Cityhopper, easyJet, Finnair, Lufthansa, Norwegian Air Shuttle, Ryanair, Volotea, British Airways, Iberia

5.2.4 Cancellation Data

As highlighted previously, Eurocontrol data is only able to capture the difference between the last-filed flight plan and what actually took place. This therefore does not provide an accurate picture of flight cancellations in situations such as ATC strikes since many airlines update their flight plans upon receiving notification of the upcoming industrial action (when they may be asked to cancel a proportion of flights).

Instead, to estimate the number of flights cancelled as a result of ATC strikes, we used detailed airline-provided reporting of the number of flights that they had to cancel during the incidences of ATC strikes throughout the 2010-2015 period. Though this data was detailed and provided a significant amount of the full information, it did not provide a complete figure representing the entire EU aviation network. Where data was missing, we used benchmarking and market share analysis to get to a fully representative figure. We were able to assure the robustness of our data with later information provided by Eurocontrol on delays, by comparison of the number of flights taking place on strike days compared with the equivalent days in the prior and following weeks – which indicated a similar number of missing (cancelled) flights.

5.3 Findings – and inputs to modelling

Our calculations have produced the following delay figures attributable to ATC strikes (i.e. additional to any delay caused by other factors), which have been used in the analysis:

- A weighted-average delay of 3.21 minutes per flight on short strike days
- A weighted-average delay of 15.10 minutes per flight on long strike days
- In addition, by looking at the average arrival delays registered the day after strikes (excluding any non-industrial action related delay) it was evident that in the case of long strikes, disruptions continued across the next day (a 'recovery day') due to factors such as passenger backlog, aircraft/crews out of position, etc. Hence, a recovery day with weighted-average delay of 1 minute was assumed following long strike incidences.

With respect to flight cancellations, we found that approximately 1.5 million passengers are affected by flight cancellations during each of the years from 2010 to 2015. The largest proportion of these cancellations were experienced in 2010 and 2015, years that account for half of the strike incidences across the six year period.

6 Establishing Economic Impact Model Inputs

6.1 Section overview

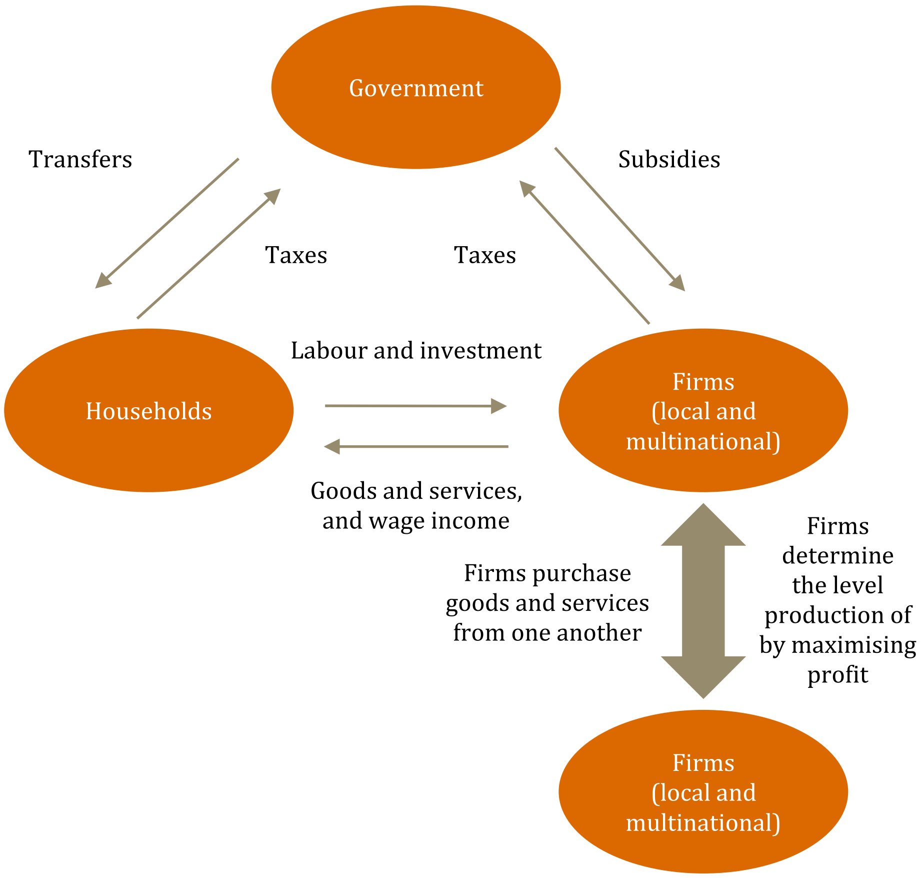
In this section we describe the economic model that is used in this study and then take the outputs from step 2 in the preceding Chapter and then undertake a further set of adjustments to align this data with our Computable General Equilibrium (CGE) model (step 3).

6.2 What are CGE models?

CGE models have become a standard tool for certain types of empirical economic analysis. Their primary domestic use is to assess the "impacts" of different government or institutional policies (e.g. changes in tax policy, government spending and the economic effects of CO2 emissions) or to investigate the effects of different economic scenarios (e.g. a change in real exchange rates, or the level of consumer demand).

A CGE model combines economic data and a complex system of equations in order to capture the interactions of the three main institutions in an economy – households, businesses and the government. Each institution is defined and interlinked through labour market or capital market flows, household consumption, intermediate product demand, taxes or government transfers. Figure 6.1 provides a basic representation of these interactions.

Figure 6.1: Relationships captured in a CGE model



Source: PwC

The economic systems that CGE models proxy are complex. The multiple households and businesses that are defined in each model engage in repeated local microeconomic interactions that in turn give rise to macroeconomic relationships affecting variables such as employment, investment and GDP growth. These macro relationships also feed back into the determination of local micro interactions. Because of this relationship, CGE models are often referred to as micro-macro models (Sue-Wing and Balistreri, 2012).[50]

The equations in our CGE model have been calibrated to economic data and a baseline view of the economy has been created. A particular new scenario is then imposed on this baseline scenario and the CGE model measures the difference between the new scenario and the baseline scenario to produce key changes in economic metrics such as GDP, employment, household consumption, exports, imports, investment, tax receipts etc. More detailed results at the industry and household level can also be generated.

6.3 *Our CGE modelling approach – key features*

The model built for this project is a single-country dynamic model for the EU27, based on 2010 data.[51] The EU economy is further broken down into the following 16 industries and different product types. There is also a single representative household.

- Agriculture and mining
- Manufacturing
- Construction
- Utilities
- Wholesale and retail trade
- Transport services (excluding aviation)
- Air transport services
- Postal and courier services
- Computer programming and consultancy services
- Financial services
- Real estate services
- Professional services
- Rental and leasing services
- Public sector
- Entertainment and culture
- Other services

[50] Sue-Wing, I., & Balistreri, E.J. (2012). Computable General Equilibrium Models for Economic Policy Evaluation and Impact Analysis. *Working Paper, Department of Earth and Environment, University of Boston.*

[51] We acknowledge that more recent data is available, but the initial year for this modelling exercise is 2010.

The CGE model uses a mixture of regional accounts data published by the Eurostat to capture the complex transactions in the European economy. These data provide a snapshot of the European economy in a single year, which is used as a starting point for comparing policy simulations against a baseline scenario. The number of industries are constrained by the availability and consistency of data across the EU28 countries. The model is programmed using GAMS software (General Algebraic Model Software)[52] with the MPSGE (Mathematical Programming Software for General Equilibrium) interface[53]. The number of equations and amount of data used are also constrained by the ability of this software to solve such a model. GAMS/MPSGE is a standard programming tool for CGE models.

Since the model is dynamic, it tracks the evolution of the economy over time as it reacts to changes. There are also a number of assumptions, grounded in economic theory, about various other interactions in the economy, such as how the government behaves when it receives additional, or reduced, income. This dynamic approach has the distinct advantage that that it captures the inter-temporal aspect of agents' decision making. For example, if an airline knows it will have to pay higher taxes on profits in three years, this will influence its decisions about investment today. Given the inherent uncertainties with such long-term projections we place more emphasis on the model's results projected to the year 2020.

A key feature of our modelling approach is that it measures the 'net' effect on key economic and fiscal variables. This differs from the approaches that measure the gross effects described in the earlier sections. Our approach also takes account of feedback mechanisms and dynamic linkages in the economy that may work to counteract or augment the gross effects from ATC strikes

The CGE model is based on a group of industrial sectors. The primary data source for these sectors is the 2010 Supply and Use Tables (SUTs) for the EU-27[54]. The EU SUTs split EU GDP down to 65 sectors ranging from different agricultural, manufacturing, utilities, construction, retailing, transport, financials, government and services sectors. This broad sector grouping gives the CGE model flexibility in the sectors it can model and allows detailed analysis of market interactions, demand, tax issues and competitiveness. The 65 sectors are aggregated to a choice of 16 sectors (depending on model specification).

The SUTs are further supplemented with tourism information from EU member state tourism satellite accounts (TSA's). Amongst other things, TSA tables give detail on the monetary values of tourists expenditure across different products in the economy. The most recent version of the TSA tables published by Eurostat provide data on tourists expenditure across 17 Member States accounting for close to 90% of tourism activity in Europe (in terms of trips made by residents or overnight stays in tourist accommodation) and "*are thus likely to be representative of the EU as a whole*" (Eurostat 2013).[55] The 2013 publication from Eurostat contains data for the year up to and including the year 2011 which aligns to the EU-27 SUT. Not all TSA's are published in line with Eurostat TSA guidance – not all contain 2011 data (for instance French data are for 2005). In order to create an EU-27 average figure we applied a weighted average based on sector expenditure patterns and the growth rate of average spend per head data to update missing data.

Once tourists expenditure by EU inbound and EU outbound are calculated for the 16 different sectors in the SUT table, the data are then separated out of corresponding export (foreign inbound tourists) and import data (EU outbound tourists) so that that tourism can be treated as an explicit expenditure category in the models aggregate demand function. Figure 6.2 below summaries our approach to analysing these features.

[52] More information on the GAMS software package can be found at: http://www.gams.com
[53] More information on the MPSGE software interface can be found at http://www.MPSGE.org
[54] http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/data/workbooks
[55] http://ec.europa.eu/eurostat/documents/3888793/5856233/KS-TC-13-006-EN.PDF/fb18f5f6-5a0d-431e-9b78-b06b2b984607

Figure 6.2: Summary of our CGE modelling approach

Source: PwC

The remainder of this chapter describes how we fit the data from Stage 2 into the CGE model.

6.4 *Channels of Impact*

Our approach analyses three separate 'channels' of impact on the economy. Figure 6.3 sets out of these three effects and details how they work within a single model. The framework involves inputting different events, analysing the implications and allocating them to different sectors in the economy. These implications, or shocks, are then inputted into the CGE model on a sector by sector basis. In the case of ATC strikes, the model captures the economic impact through output reductions in aviation and tourism as well as a productivity loss to aviation consumers, as follows:

- **Airline revenue reduction** – The revenue that airlines lose as a result of flights that are cancelled when ATC strikes occur. In the CGE model, aviation sector output is reduced by an average of 0.035% a year. This is the amount of revenue that is lost, which accounts for the amount of cancelled passengers and the average price of their tickets.

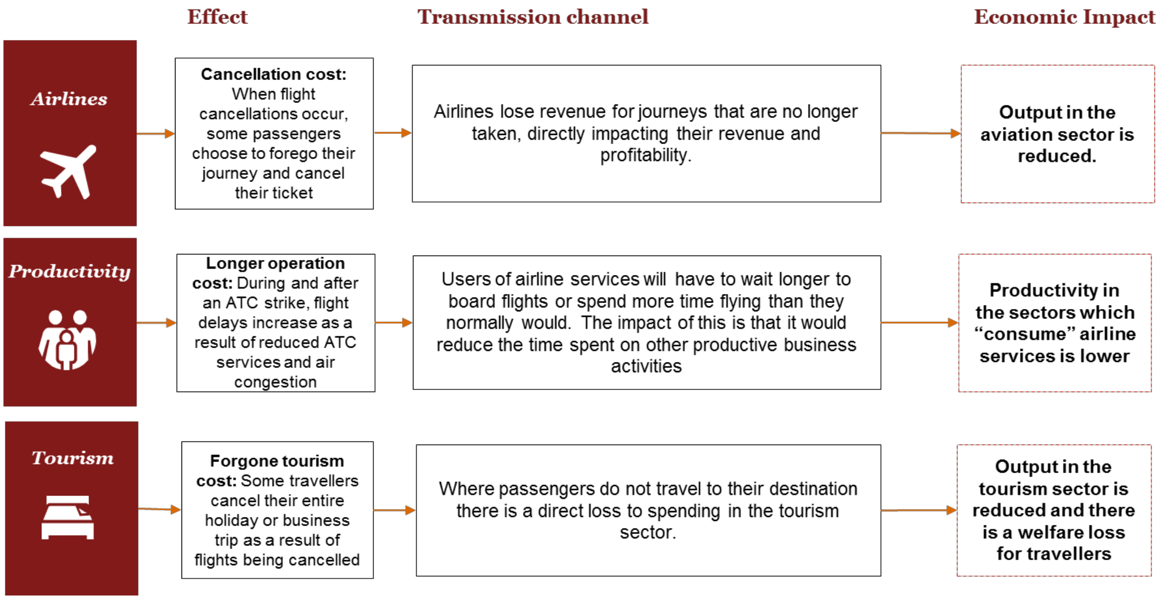
- **Loss of business and leisure tourism** – The reduction in spending as a result of leisure and business tourists cancelling their trips as a result of ATC strike-related flight cancellations. Output in the model's tourism sector is reduced by the amount of the spending reduction, an average of 0.089% a year. The tourism sector includes travel agencies, food and accommodation services, creative and entertainment industries wholesale and retail trade as well as general manufacturing and service industries.

- **Passenger productivity loss –** The opportunity cost of time that is "lost" as a result of flight delays caused by ATC strikes that reduce the time that passengers spend on productive business activities. In the model, productivity is reduced in the sectors that use aviation as an input, by an average of 0.53% a year.

The CGE model then helps us understand the "Investment & Employment" and "Subsequent Round Effects", impacting on variables such as GDP, welfare, prices and wages.

It should be noted that, conceptually at least, it might be appropriate to allow for a "feedback loop" between the CGE model and the airline effects. For example, to the extent that the CGE framework identifies dynamic clustering effects which are likely to change airline patterns, it may be appropriate to model these changes by means of a formal modelling framework. The results of this exercise could then be re-incorporated into the CGE framework. In principle, this process could be repeated until the results of the airline and economic models "converge".

***Figure 6.3*: Modelling framework**



6.5 *Capturing the effects in the CGE model*

6.5.1 *Airline revenue reduction*

The reduction of airline sector revenues is derived from the loss of passengers as a result of strike action. ATC strikes lead to the cancellation of flights. The airlines lose revenue equal to the number of passengers on each flight, the fare each of them paid and the number of flights cancelled.

The effect of ATC strikes on airline revenues can be modelled with the following formula:

$$Percentage\ airline\ impact = \frac{xy}{T} \times 100$$

Variable	Description	Value
x	Number of passengers whose flights are cancelled as a result of ATC strikes	Given the significant differences in the frequency of strikes in different years, the number of affected passengers varied widely across the period. Using airline-provided data on the number of flights they have cancelled and the method outline in Section 5.2 of this report, we determined that approximately 800,000 passengers had their flights cancelled in 2010 and between 100,000 and 350,000 in the subsequent years.
y	Average fare	Eurocontrol data indicates that the average fare for flights in the European market is approximately € 200.
T	Total size of EU airline market (in absence of ATC strikes)	Eurocontrol data indicates that the total value of the EU airline market varies between € 140 – 185 billion during the period from 2010-2015.

6.5.2 *Loss of business and leisure tourism*

The tourism impact is derived from the loss of spending as a result of cancelled flights. The tourism industry suffers from lost days abroad as a result of flight cancellations. We consider the loss to the tourism to be equal to the amount that would have been spent by travellers who had their flights cancelled as a result of ATC strikes, and who do not take another form of transport to their destination.

The effect of ATC strikes on the tourism industry can be modelled with the following formula:

$$Percentage\ tourism\ impact = \frac{b(ac + (1 - a)d)}{W} \times 100$$

Variable	Description	Value
a	Percentage of tourism that is business	According to the World Travel and Tourism Council, 22% of tourism GDP is generated by business travellers
$1 - a$	Percentage of tourism that is leisure	According to World Travel and Tourism Council, 78% tourism GDP is generated by leisure tourists
b	Number of passengers affected by airline strikes flight cancellations, who do not take another form of transport to their destination.	Given the significant differences in the frequency of strikes in different years, the amount of affected passengers varied widely across the period. Using airline-provided data on the number of flights they have cancelled and the method outline in Section 5.2 of this report, we determined that approximately 800,000 passengers had their flights cancelled in 2010 and between 100,000 and 350,000 in the subsequent years. Oxford Economics estimate that during flight disruptions caused by extraordinary circumstances, about one third of passengers take an alternative form of transport to their destination.
c	Average spend of a business tourist	According to Eurostat, business travellers typically spend an average of € 494 per trip
d	Average spend of a leisure tourist	According to Eurostat, business travellers typically spend an average of € 325 per trip
W	Total size of EU tourism market	Eurostat data indicates that the value of tourism within the EU economy is approximately € 400 billion a year

6.5.3 *Passenger productivity loss*

The productivity impact is calculated as the amount of extra time that passengers spend travelling when their flight is delayed as a result of ATC strikes.

The effect of ATC strikes on productivity can be modelled with the following formula:

$$Percentage\ productivity\ impact = \frac{f(ut + vs)}{M} \times 100$$

Variable	Description	Value
u	Number of "short" strike days	Airlines-provided data indicates that there were 45 days of industrial action as part of "long" strike incidences
v	Number of "long" strike days	Airlines-provided data indicates that there were 122 days of industrial action as part of "long" strike incidences
t	Average delay caused by ATC strikes on "short strike days"	As outlined in detail in Section 5.2 of this report, the delay caused by ATC strikes during short strike incidence is 3.21 minutes, averaged across all flights that day.
s	Average delayed caused by ATC strikes on "long" strike days	As outlined in detail in Section 5.2 of this report, the delay caused by ATC strikes during short strike incidence is 15.10 minutes, averaged across all flights that day.
f	Average number of flights per day	Eurocontrol data indicates that there are approximately 16,000 flights per day across the EU aviation market
M	Total number of flight minutes in network	Eurocontrol and airline-provided data indicates that there are approximately 800 million minutes of flights per year in the EU aviation market

7 Impacts

7.1 Interpreting results

Results are based on ex-post data. This means the analysis occurs after an event has happened, such as in this case where we are looking at the effects of ATC strikes from 2010-2015. The approach used examines the counterfactual scenario of "what would have happened without ATC strikes" and compares this to the actual scenario (the baseline) which is constructed using data received from A4E airlines and Eurocontrol.

7.2 Modelling Uncertainty

In analysing results, it is important to understand the possible sources of uncertainty associated with the model findings. There are two categories of uncertainty in the outputs of the CGE model:

1. Model input uncertainty. This is uncertainty associated with the inputs to the model, for example in relation to passenger flows and number of flights delayed or cancelled attributed to a strike; and

2. Within-model uncertainty. This is uncertainty from assumptions made in the construction of the model itself and associated with the parameters which determine the model's behaviour[56].

We typically assess the uncertainty in our CGE model results with a sensitivity analysis that involves repeating the calculation several times using a range of elasticity parameters. This analysis shows that our CGE model results broadly fall within -11% and +9% of the true economic impacts.

7.3 Key Effects

Our modelling results suggest that the overall impact of ATC strikes:

- reduced EU GDP by **€ 10.4 billion** in the six years to 2015; and
- that the cumulative negative impact on EU employment for the six years to 2015 was **143,000 jobs**. These are jobs that would have otherwise been created if no ATC strikes has occurred.

€10.4 bn.	**143,000 jobs**
Cumulative negative impact of ATC strikes on EU GDP for the 2010-15 period	**Cumulative negative impact of ATC strikes on EU employment for the 2010-15 period**

These are the cumulative impacts of ATC strikes felt through the three channels (airline revenues, productivity and tourism) described in Section 6.4. However, the cumulative impact on EU employment should not be taken at face value as ATC strikes are unexpected events which suggests that employers would react differently compared to a state of the world where ATC strikes were business as usual. The breakdown of the total impact is described in further detail in the next section.

[56] For example, there are different estimates in the academic literature for the "intertemporal elasticity of substitution" (which describes how willing consumers are to forego current consumption in exchange for increased consumption in the future) and adopting different assumptions could lead to different results from the CGE framework.

7.4 *Model Outputs*

The majority of the economic impact of ATC strikes impact is felt through reduced foreign inbound tourism spending in the EU. ATC strikes cause cancellation of flights, which could have transported travellers to their destinations. This means that some travellers cancel their entire holiday or business trip resulting in a reduction in tourism spending. Where passengers do not travel to their destination there is a direct loss to this sector and other closely related sectors. Closely related sectors that are affected by this reduction in spending include Wholesale and Retail trade services, Entertainment and Recreation services, Accommodation and Food services and the Aviation sector. These are all typical product categories that foreign tourists spend their money on while in the EU. The model also captures indirect and induced effects from lower tourism spending which feed through into other sectors e.g. manufacturing, which supply products to the tourism sector. This reduction in foreign tourism feeds through into lower investment and employment across the whole economy.

Lower levels of demand also feed through into lower levels of prices, this does lead to a small "rebound effect" whereby a small increase in domestic tourism is observed as EU nationals take advantage of reduced prices in their local area. However, this effect is small and offsets less than 5% of the reduction in foreign tourism expenditure.

A further effect similar to the rebound effect described above is that when flight cancellations occur, some travellers will be unable to leave their home area. This means they will spend some of the money that they would have otherwise have spent in their tourism destination region is spent in their local economy (for convenience we term this the destination effect). This effect, combined with the rebound effect are key features of the CGE models capturing of the overall "net effect" of the impact of ATC strikes. While the destination effect is positive for local GDP, it is welfare reducing i.e. people would rather have spent their money on taking a holiday rather than in their home area.

Our modelling suggests the overall impact through cancelled flights on the foreign tourism expenditure channel over the past six years amounts to around €5.9 billion or €990 million a year in 2015 prices. Where cancellation does not occur and tourists experience a delay we assume that this spending occurs anyway (e.g. tourists have a fixed budget for their holidays and would spend it regardless of whether their flight was delayed or not). Because we do not

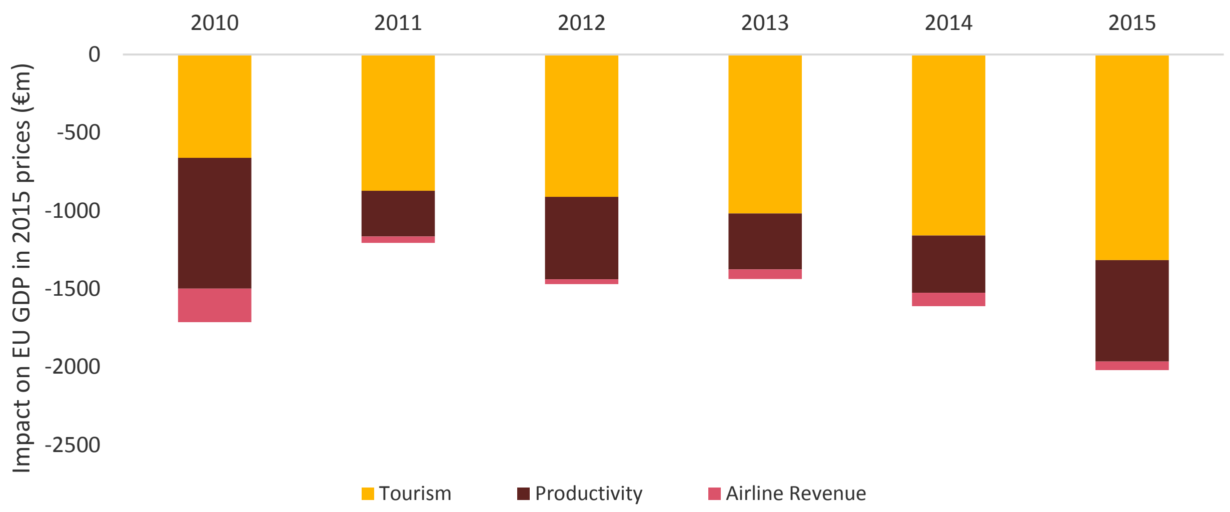
The second largest impact is felt through the reduction in productivity associated with longer flights and waiting times. During and after an ATC strike, flight delays increase as a result of reduced ATC services and air congestion. This means that users of airline services will have to wait longer to board flights or spend more time flying than they normally would. The impact of this is that it would reduce the time spent on other productive business activities. We capture this effect for business users of aviation services only.

In the CGE model, the economic impact input from this channel is modelled as lower productivity in the sectors which "consume" airline services. The EU SUT sets out the amount of purchases of air transport services made by different businesses across the 16 sectors of the economy in the CGE model. The CGE model apportions this lost productivity according to the degree to which business services use aviation to enable business transactions. A typical example of this would be a business person who needs to make a trip to visit a client or supplier. If they are unable to make this trip then the benefits of that trip would be "lost" for the company they work for and hence productivity would be lower.

The cumulative economic impact felt through this channel amounts to € 4.0 billion or just under €670 million a year in 2015 prices.

Finally, the third largest impact is felt via lower airline sector revenues. This loss in revenue occurs when flights are cancelled so that some passengers choose to forego their journey and cancel their ticket. The airlines therefore lose revenue for journeys that are no longer taken, directly impacting revenue and profitability, equivalent to a reduction in the aviation sector. This leads directly to lower investment and employment in this sector and also to lower levels of induced spending by aviation sector workers. The economic impact of this, however, is limited to around €590 million or around €80 million per year in 2015 prices.

Figure 7.1 Economic Impact of ATC Strikes on EU GDP (Millions EUR)



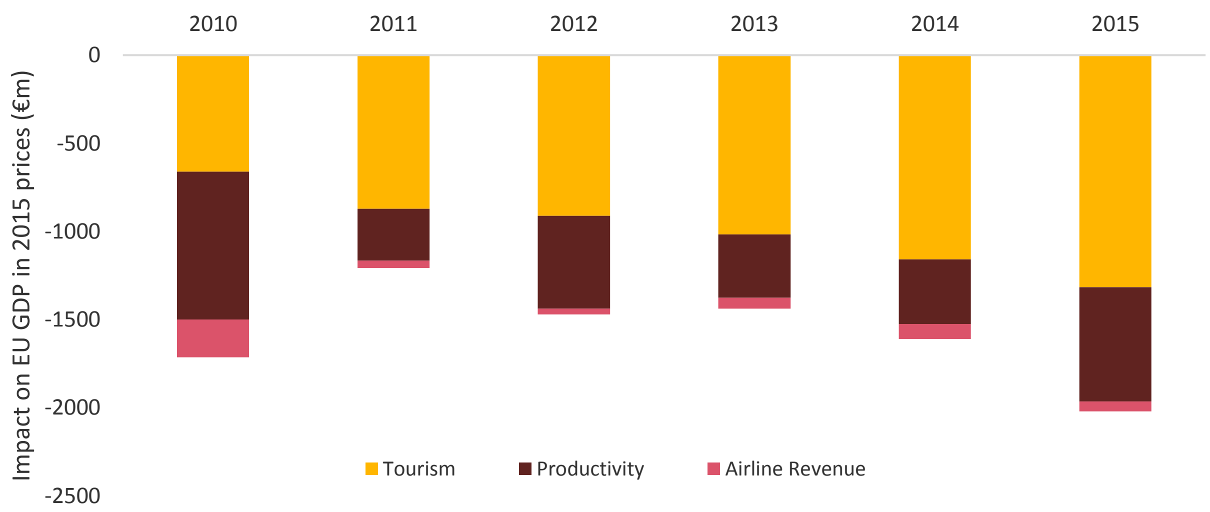
7.4.1 Sensitivity test: Impacts including only ATFM delays

In Section 5.2 of this report we highlighted that whilst Eurocontrol's data can provide accurate insight into flight operations and on flight times relative to the last-filed flight plan, it does not provide any information on how much the last-filed flight plan has changed from the original plan that determined the flight time for passengers.

As well as modelling the economic impact using enriched information on this additional rescheduling data, which yields the results above, we assessed the value of the economic impact omitting the rescheduling delays and using only Eurocontrol ATFM delay data. This augments the value for the impact of ATC strikes on productivity. Tourism and revenue impacts remained unchanged in the model since these are driven by flight cancellations only. The economic impact of ATC strikes taking into account only ATFM delays and cancelations was **€ 9.5 billion** in the six years to 2015 - see Figure 7.2.

Using delay data that only captures ATFM delays leads to an underestimate of the economic impact of ATC strikes by approximately **€ 0.9 billion** over the six year period.

Figure 7.2 Economic Impact of ATC Strikes on EU GDP (Millions EUR), not including re-scheduling delay



7.5 *Other impacts not modelled*

Our study has focussed on the impacts on the EU economy arising from ATC strikes that disrupt the EU air transport system. As described in the sections above, this analysis focusses on the impacts on the wider economy – tourism, productivity and airline revenues as the three channels of greatest impact. There are, however, additional areas of impact that have not been included in our analysis of economic impacts due to limitations of the data we were able to collect for the study. We outline some of these briefly below:

Losses borne by businesses related to late or non-arrival of cargo

The air transport industry is not only a transporter of people, but also of goods. In particular, passenger air transport services especially to/from non-EU destinations also carry bellyhold cargo, which by its nature is time-sensitive and/or high value (e.g. electronics). The losses suffered by the economy in the event that ATC strikes preclude the on-time arrival – or, in the case of certain time-sensitive goods such as fruit, vegetables and flowers which may lose value if not shipped on time - of bellyhold cargo has not been included in our analysis.

Impacts on the express industry

The core business of the express delivery industry is the provision of value-added, door-to-door transport and deliveries of nextday or time-definite shipments across the globe. The express delivery industry provides its customers with a comprehensive service: organising collection, usually at the end of the business day, allowing the sender access to information on the progress of shipments from pick-up to delivery, and providing proof of delivery. Where shipments cross international borders, the express delivery industry handles customs clearance as well as the payment of duties and taxes as required. DHL, TNT, UPS and FedEx, are the largest operators in the European express delivery industry, but there are many others in this highly competitive sector which utilises a mix of own-aircraft (dedicated cargo) and bellyhold cargo on passenger services (see above). An economic impacts study by Oxford Economics in 2011 put the value of the express as generating €23 billion in GDP[57] and supporting 579,000 jobs across the EU27[58]. Impacts on this sector and other parts of the economy reliant on the express sector are not included in this study, but may be substantial.

ATC strikes averted at short notice

When ATC strikes are scheduled, airlines are asked to cancel a proportion of their planned flights. The proportion they are asked to cancel depends on the location and expected impact of the planned strike (though this is itself based on estimation, as authorities may not know how many staff will strike in advance). Because of this, and the potential for strikes to be averted, airlines tend to hold off cancelling flights and notifying/re-booking passengers until close to the day of the strike.

When strikes are averted (called off) at short notice, it is not always possible for airlines to reinstate services that have been cancelled. There are, therefore, instances where flights are cancelled as a direct result of planned strike action, even if the strike does not finally go ahead. Due in part to our data not including a reliable register of averted strikes, and the timing of the notification of strike cancellation, we have not included these instances in our modelling of impacts.

Compensation and assistance to passengers in the event of denied boarding or cancellation or long delay of flights - Regulation (EC) NO. 261/2004

Regulation (EC) NO. 261/2004, aimed at protecting passengers' rights, provides that airline travellers are entitled to provision of care in the event of denied boarding or delays. It further provides for compensation of amounts between 250 – 600 Euros, in the following circumstances:

1. A flight delayed by three or more hours
2. A cancelled flight

[57] According to a 2011 study by Oxford Economics.

[58] In 2011, Oxford Economics estimated 272,000 employed by express delivery companies (direct impact). The remainder are supported outside the express delivery industry, either through the industry's supply-chain, or through the spending of the wage income that the industry and its supply-chain generates (the indirect and induced impacts)

3. An overbooked flight to which a passenger is denied boarding

However, when an airline can show that cancellations or delays are as a result of 'extraordinary circumstances' it is not liable for compensation. Extraordinary circumstances are those beyond the control of airlines, such as cases of political instability, meteorological conditions incompatible with the flight operation, security risks, unexpected safety shortcomings or strikes by air traffic control.

Whilst this means that airlines are not required to pay compensation to passengers for delays and cancellations that arise from ATC strikes, it does **not** exempt them from the requirements to provide care (mainly meals, accommodation and transport costs) to passengers affected by long delays, or to either provide refunds or alternative flights. Airlines, thus, bear additional costs in addition to those arising directly from delays or non-operation of flights. Care costs arising under the Regulation have not been included in our assessment of the economic impact of strikes.

Furthermore, we note that passengers – who would be entitled to compensation were strike action by *airline staff* the cause of delays or cancellations – have no entitlement to compensation when those disruptions are caused by ATC strikes.

Impacts on Airports

Airports are impacted by ATC strikes in two main ways: firstly, costs and reputational damage incurred when large numbers of delayed passengers occupy airport space; and secondly in lost revenue due to flight cancellations. These costs are not included in our analysis.

Insurance industry

Travel insurance *may* offer consumers recourse to costs incurred as a result of ATC strikes (for example, accommodation in the event a return flight is cancelled or delayed overnight, or food and drink whilst waiting at the airport), in the event that this is not covered by airline requirements arising from Regulation 261/2004. Travel insurance could, however, offer consumers some protection against losses – for example, hotels and other activities booked in advance – that arise in the event that flight delays or cancellations result in the traveller abandoning their travel plans.

According to www.justtravelcover.com "*in general your travel insurance policy provides cover for travel delay and abandonment due to strike action so long as you booked your holiday and bought your travel insurance before strike dates are announced…*

If your flight incurs a long delay, usually 12 or 24 hours, your travel insurance policy will generally give you the option to 'abandon' your holiday and make a claim for the cost, up to the amount specified in the cancellation section of the policy… Common conditions include that you must have checked in for your flight, this shows that you fully intended to travel, and you will need to obtain a letter from your airline confirming the length and cause of the delay."

A detailed review of travel insurance products has not been undertaken as part of this study, however we have undertaken some sampling of policies. This sampling revealed that some policies provided full coverage, others provided it only for bookings made prior to strikes being announced. Hence, not all holders of travel insurance policies would have coverage for costs arising from ATC strikes. No information is available on the uptake of travel insurance across all users of the air transport system in the EU, and we have not calculated the economic cost of ATC strikes to the insurance industry[59].

Direct costs borne by consumers who make their own way home

Our study has primarily assessed two forms of costs – those arising from delays to planned travel, and those arising from cancellations. Our data has not, however, enabled us to take into account additional costs that may accrue to consumers for whom disruptions to travel plans cannot be borne, and who may therefore incur substantial additional costs. When ATC strikes disrupt planned travel, consumers can choose to receive a refund of the ticket price (or part thereof, in the case of partially completed travel) or to travel on the next available service by the airline concerned. For those whose journeys have been partially undertaken and who are away from home, strike action has the potential to leave them stranded. Whilst airlines will become

[59] In any case, insurance premiums would already have been passed through to customers in the form of higher premiums

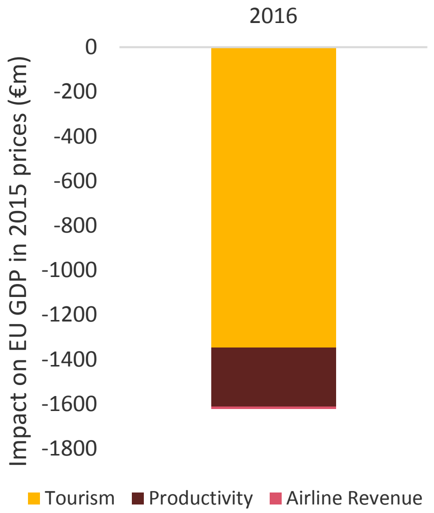
responsible for the costs of accommodating these passengers, and for arranging alternative flights home, the requirement to be away for an unplanned period has additional impacts that are not measured in this study (e.g. unplanned time away from work). In the absence of any meaningful data, it has not been possible to include any such effects – nor to ascertain the potential magnitude of additional costs on consumers. We note, however that during previous strikes there have been media reports of families who – stranded away from home by strike disruptions – have needed to return earlier than their airline was able to repatriate them and have therefore paid for alternative methods of transport at significant personal cost. We have no data to include such costs to consumers within our study, nor any assessment of whether any or part of those costs might be transferred to the insurance industry (see above).

Losses borne by airlines and environmental costs arising from longer routings

Airspace closure means that some flights are diverted on longer routings to reach their destinations (i.e. they are diverted around the closed airspace), leading to longer flights times, higher fuel burn, and increased CO_2 emissions. Neither the environmental costs of increased emissions, nor the losses borne by airlines through increased amounts of fuel burnt and potentially from increased staff flying hours has been included in this study.

8 Impacts in 2016 to date

In the period 1 January – 30 September 2016, there have been 22 separate strikes by air traffic controllers in Europe, encompassing 41 days of strike, and 55 days of disruption.



This level of disruption over the first nine months of the year is similar to levels experienced by EU industry and consumers in 2010 – the most prolific year for strikes in the period of our study. A significant difference, however, is that in 2016 a greater number of the strikes have taken place in central locations in Europe (i.e. in France), which produces a higher level of disruption to flights.

Utilising the economic model developed to determine the economic impacts of strikes during the 2010-2015 period, we have examined the impact of strikes to date in 2016. The results of this analysis suggest that the economic impact of ATC strikes already in 2016 have reduced EU GDP by **€ 1.6 billion** in the first nine months of the year.

8.1 *Additional impacts not included in analysis*

In addition to the strikes listed above, a strike planned for 23 June in Italy was averted at the last moment, but still caused over 100 flight cancellations as airlines had insufficient warning of the cancellation of the strike to reinstate flights. This impact is not included in our assessment.

As well as this, there were two ATC strikes occurring in Iceland during this period – on 28-29 April and 5-6 June 2016. Although these strikes are within the Eurocontrol area, Iceland is not an EU Member State. Therefore, the impact of these strikes has not been included.

9 Concluding observations

In its 2015 Aviation Strategy, the European Commission recognises that the "*main challenge for the growth of European aviation is to reduce the capacity and efficiency constraints, which are seriously impeding the European aviation sector's ability to grow sustainably, compete internationally, and which are causing congestion and delays and raising costs.*

Airports together with air traffic management services providers constitute the key elements of the infrastructure of civil aviation*. The quality, efficiency and cost of these services have become increasingly* ***important to the competitiveness of the industry****. In Europe, airports and air traffic management can safely handle up to 33,000 flights per day. Yet, European airspace as a whole is inefficiently managed and unnecessarily fragmented, and a slow implementation of the Single European Sky framework means higher costs for the airlines, which directly affects their competitiveness. The estimated costs of the EU's fragmented airspace represent* ***at least €5 billion a year****. Such an inefficient use of the airspace causes higher prices and delays for passengers, increasing fuel burn and CO2 emissions for operators, and impedes our efforts to improve environmental performance.*"

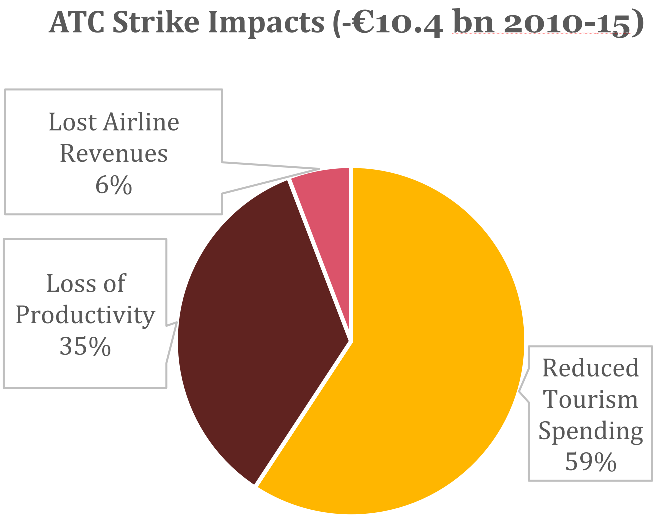
The estimated €5 billion a year costs of fragmented airspace is indeed significant and, rightly, has prompted significant effort by the EC, its Member States, ATM providers and industry toward effective solutions. As our study has shown, however, there are also very significant costs across the EU economy arising from ATC strikes – **at least €10.4 bn** over the period 2010-2015, not even taking into account collateral impacts on the freight industry, environment, consumers who make their own way home, or compensation costs borne by airlines. In the year to 30 September 2016, the impact is **€1.6 bn**. Significantly, we note that:

- Over the most recent 6 years, there have been 176 days of strikes by air traffic controllers - equivalent to almost one full month of strikes every year.
- Additionally, in the first 9 months of 2016 alone, there have been 41 days of strike.
- These disruptions are concentrated in a small number of EU countries, but may have continent-wide impacts on air traffic.
- The cost of these disruptions is borne almost entirely by the users of the air traffic system, rather than by the providers.

Furthermore, our study has highlighted that measurements of delay based on the ability of the ATM system to deliver on operational flight plans (as currently practiced) have served to mask the extent of the problem – as delay is measured by comparing actual time of operation to the last-filed flight plan. This fails to take account of the rescheduling that has already taken place by operators that in many cases means that the delay experienced by passengers is substantially larger than that measured by the ATM system. The test must be on the ability of the system to deliver the ***performance that consumers and shippers have planned on and paid for***. We recommend that ongoing monitoring of disruptions to the air transport system be promptly established to provide commercial impact information - rather than relying on existing systems which are focussed on measuring operational and technical performance of purely tactical character.

This study has demonstrated that there is a significant negative impact on the European economy arising from strikes by air traffic controllers, disrupting an essential enabling element of the air transport system upon which both consumers as well as industry depend directly. As shown in the graphic below, the majority of impact is felt in the tourism sector and in lost productivity.

Furthermore, the majority of the countries in which ATC strikes have occurred are those whose economies rely significantly on travel and tourism – either as a high proportion of GDP (e.g. Cyprus, Greece) or in absolute terms (e.g. France, Spain).



Thus there is also a high **social** cost when the transport system gets shut down. Efficient connectivity is a social and economic good - a vital and fundamental attribute of the production, distribution and consumption of goods and services in today's EU and its Member States that citizens and businesses expect -- and around which they organise their lives. Largely for this reason many States condition the right to strike in areas, such as public transport systems, where vital public services are affected. <u>Few if any States elsewhere in the world have experienced the EU's level of industrial action of the recent years against the air transport system.</u>

Here it is important to recall that, institutionally speaking, ATC strikes are (except in rare instances) not against airlines as employers.[60] When most ATM services providers, who typically enjoy an exclusive franchise in their country/operating area, confront a strike -- they do so at little serious cost to its owners (in all but a few cases the government) or its general management.[61] Typically, pricing of user fees or other forms of tax recovery reflects regulated monopolistic power and is based on fully-allocated cost recovery. Notably, these regulated charges take into account ATCO employment costs, which – as reported within our study – reflect a highly skilled workforce whose earnings are several multiples of average or median national wages.

On the other hand, the provider's direct users (airlines and other aircraft operators) and their employees as well as the consumers and shippers they serve – none of which are party to the dispute - bear the overwhelming brunt of service delays and cancellations and, under current conditions, have limited recourse to recover their losses.

Given the Commission's conclusion in its 2015 Aviation Strategy that the "*main challenge for the growth of European aviation is to reduce the capacity and efficiency constraints, which are seriously impeding the European aviation sector's ability to grow sustainably, compete internationally, and which are causing congestion and delays and raising costs*", and its consequent focus on reducing inefficiencies. However, as our study has shown, the cost of ATC strikes averages more than **€1.7 billion a year** - and surely merits a similar level of effort by policy makers and regulators to mitigate.

[60] In only two States, Canada and the UK, do airspace users play a role in the ownership or management of the ATM System.
[61] The only current exceptions to this situation are cases of cooperative and/or user ownership such as Canada and the UK.

Appendix A: Key concepts

The following are some of the key concepts used within the study:

Flight Delays

A delay is the time lapse which occurs when a planned event does not happen at the scheduled time. There are two main types of flight delay that affect airlines and their passengers: strategic delays and tactical delays. The former are accounted for by airlines in their schedules while the latter are not planned for and occur on the day of operations. ATC strikes cause tactical delays which are not anticipated and accounted for in original airline flight schedules given their temporary nature.

Airlines record and report delays as an input to improve their own processes with the aim of keeping the operational and financial impact of delays as low as possible. The cost of one minute of tactical delay varies by size of aircraft, but on average is estimated at 79 euros per minute[62]. This include crew costs, passenger compensation etc.

Airlines may decide to offset these tactical costs by applying scheduled buffers (strategic delay costs) which are estimated to cost 27 euros per minute.[63] Also, there is a level of uncertainty with tactical delay costs, compared to strategic delay costs which apply to every flight with a schedule buffer. Airlines are constantly balancing very expensive, uncertain tactical costs and relatively low, more certain strategic costs in an effort to keep operational costs as low as possible.

Flight Cancellations

According to the Regulation (EC) NO. 261/2004, a "cancellation means the non-operation which was previously planned and on which at least one place was reserved".[64] Previous research on airline cancellation behaviour has demonstrated that flight cancellation are less probable on competitive routes, flights into and out of hubs, and infrequently served routes.[65] Furthermore, flights with more reservations are less likely to be cancelled.[66]

Tourism

Eurostat, the statistical office of the EU, defines tourism as 'the activity of visitors taking a trip to a main destination outside the usual environment, for less than a year, for any main purpose, including business, leisure or other personal purpose, other than to be employed by a resident entity in the place visited'.67 Tourism is the third largest socio-economic activity in the European Union (EU) and the world's number one tourist destination, contributing significantly to the EU's gross national product and employment.68 According to Oxford Economics 2014 data, 250 million passenger trips per year take place Europe, compared to 173 million passenger trips per year in North America and 117 million passenger trips per year in Asia.69 UNWTO not only predicts that the number of international arrivals worldwide will continue to grow from 2010 to 2010 by an average of 3% per year, but also that Europe will be maintaining its position as highest visited region by receiving approximately 744 million tourists.[70] Furthermore, low cost airlines are the most active in Europe, demonstrating the importance of the aviation industry for the tourism sector.

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[62] University of Westminster for EUROCONTROL PRC, 2004, for EUROCONTROL PRU, 2011
[63] Ibid.
[64] European Commission - Directorate-General for Energy and Transport, (2008). Answers to Questions on the application of Regulation 261/2004.
[65] Rupp, G. N., and G. M. Holmes. (2006) An Investigation into the Determinants of Flight Cancellations. *Economica,* Vol. 73, pp. 749–783.
[66] Tien, S., Churchill, A., & Ball, M.(2009) Quantifying the relationship between airline load factors and flight cancellation trends. *Transportation Research Record , 2106*, pp. 39-46.
[67] Methodological manual for tourism statistics, Eurostat, (2014), p. 16.
[68] Juul M. (2015), Tourism and the European Union – Recent Trend and Policy Developments, European Parliamentary Research Service, p. 1
[69] Shaping the Future of Travel. Macro trends driving industry growth over the next decade', Oxford Economics, (2014) p. 3.
[70] UNWTO 'Tourism Towards 2030. Global Overview', (2011) and 'International tourism trends in EU-28 member states. Current situation and forecasts for 2020-2025-2030', (2014)

Appendix B: Modelling assumptions

<table>
<tr><th>Economic Impact</th><th>Key Assumptions</th></tr>
<tr><td>Cancellation cost: Negative revenue shock to the airline sector due to cancelled flights</td><td>We made the following simplifying assumptions for our calculations:
• Volume of passengers: We assumed that each affected aircraft carried, on average, 162 passengers. This assumption was based on the overall average number of passengers per aircraft transferred by an A4E member airline (which has broad EU coverage) over the 2010-15 period which does not carry out trans-Atlantic flights on larger aircraft.
• Airfare: The cost of the ticket paid by passengers was equal to the annual average fare paid for each airline (excluding taxes and charges).

In practice, however, in the event of an ATC strike, airlines could prioritise cancelling flights which yield a lower profit. The implication of this would be to lower the revenue and profit loss in their airline sector, leading to a smaller GVA shock and a smaller economic impact.

Due to data limitations, our analysis was carried out at the aggregate level for each affected airline.
• Our analysis did not adjust for the number of people that could have taken an alternative air route or alternative mode of transport because of the cancelled flights due to ATC strikes because of lack of credible data. Including this type of impact could potentially lower the economic impact figure.</td></tr>
<tr><td>Longer operation cost: Negative productivity shock to users of the airline sector due to delayed flights</td><td>• We assumed that the percentage increase in flight times is equivalent to the percentage reduction in productivity for sectors that use aviation as an input to their business. In summary this means that we assume that:
  • Time is lost;
  • The loss is borne by the sector and not the individual; and
  • No leisure effect is captured and that only the impact on business is captured.
• To estimate the increase in air travel time during a short strike we calculated the percentage increase in average delays on 17th February 2015, subtracting the average delay observed on a non-strike day defined as the equivalent day in the week before and after the strike.
• To estimate the percentage increase in air travel time during a long strike we used similar methodology as above, but focused on average delays on 8th and 9th April, 2015.
• We applied the percentage increase in travel times as a result of ATC strikes, to the average scheduled duration of flights across the EU. Our analysis of data provided by an A4E member with broad European coverage showed that the average duration of flights was around 130 minutes over the 2010-15 period.</td></tr>
<tr><td>Negative shock to business and leisure tourism due to cancelled flights</td><td>• First, we estimated the size of the EU tourism market using data from Eurostat. For missing data, we calculated the five year average growth rate and used this to interpolate between years.
• Second, we assumed:
  • that the number of tourists who cancelled their business/holiday plans was around two thirds of the estimated number of total passengers whose flight was cancelled because of ATC strikes. This approximation is in line with other studies[1] which focused on the Icelandic volcanic ash and so may not be representative of patterns recorded during ATC strikes.
  • that around one third of tourists were business tourists and the remainder were leisure tourists. This was in line with other studies[2].
[1] Oxford Economics, UK Economic Losses Due to Volcanic Ash Air Travel Restrictions
[2] World Travel and Tourism Council (2015), Travel and Tourism Economic Impact 2015 Europe</td></tr>
</table>

There are other additional impacts e.g. delay costs due to connections being missed or the impact on the freight industry which, on a global level, carries around 30% of the value of global trade. This study does not take these into account.

In addition, persistent ATC strikes could force airlines to change their strategy leading to further operational costs that could have otherwise been spent elsewhere.

Appendix C: ATC strikes 2010-15 and to date in 2016

Between 2010 and 2015, there were 95 different incidences of ATC strikes across several European countries, lasting from 1 day to almost 10 days. The following table lists these incidences recorded throughout our data collection process. In addition, a table of the strike days recorded to date in 2016 follows.

Start Date	End Date	Location
13/01/2010	15/01/2010	France
20/01/2010	21/01/2010	France
20/01/2010	20/01/2010	Ireland
10/02/2010	10/02/2010	Greece
24/02/2010	24/02/2010	Greece
23/02/2010	26/02/2010	France
05/03/2010	05/03/2010	Greece
10/03/2010	10/03/2010	Greece
12/03/2010	12/03/2010	Italy
22/03/2010	23/03/2010	France
09/04/2010	09/04/2010	Italy
05/05/2010	05/05/2010	Greece
26/05/2010	28/05/2010	France
14/06/2010	15/06/2010	France
23/06/2010	24/06/2010	France
25/06/2010	25/06/2010	Italy
20/07/2010	22/07/2010	France
06/09/2010	08/09/2010	France
22/09/2010	24/09/2010	France
28/09/2010	29/09/2010	Belgium
28/09/2010	29/09/2010	France
07/10/2010	07/10/2010	Greece
11/10/2010	12/10/2010	France
18/10/2010	19/10/2010	France
28/10/2010	28/10/2010	France
23/11/2010	23/11/2010	France
24/11/2010	25/11/2010	Portugal
04/12/2010	04/12/2010	Spain
14/12/2010	15/12/2010	Greece
15/12/2010	15/12/2010	France
23/02/2011	23/02/2011	Greece
28/04/2011	28/04/2011	France
06/05/2011	06/05/2011	Italy
11/05/2011	11/05/2011	Greece
30/05/2011	01/06/2011	France
28/06/2011	29/06/2011	Greece
06/09/2011	06/09/2011	Italy
22/09/2011	22/09/2011	Greece
05/10/2011	05/10/2011	Greece
18/10/2011	19/10/2011	Greece
17/11/2011	17/11/2011	Italy
23/11/2011	24/11/2011	Portugal
15/12/2011	15/12/2011	Cyprus
17/01/2012	18/01/2012	France
18/01/2012	18/01/2012	Cyprus
16/02/2012	29/02/2012	Germany[71]
28/02/2012	29/02/2012	France
02/03/2012	03/03/2012	Cyprus

Start Date	End Date	Location
07/03/2012	08/03/2012	Cyprus
22/03/2012	22/03/2012	France
29/03/2012	29/03/2012	Spain
02/04/2012	04/04/2012	France
20/04/2012	26/04/2012	Portugal
11/05/2012	25/05/2012	Portugal
26/09/2012	26/09/2012	Greece
18/10/2012	18/10/2012	Greece
22/10/2012	24/10/2012	France
06/11/2012	06/11/2012	Greece
14/11/2012	15/11/2012	France
11/01/2013	13/01/2013	France
30/01/2013	01/02/2013	France
16/05/2013	16/05/2013	Greece
11/06/2013	13/06/2013	France
27/06/2013	27/06/2013	Portugal
09/09/2013	10/09/2013	France
10/10/2013	10/10/2013	France
15/10/2013	15/10/2013	France
18/10/2013	18/10/2013	Italy
06/11/2013	06/11/2013	Greece
26/11/2013	26/11/2013	France
29/01/2014	29/01/2014	Italy
29/01/2014	29/01/2014	Portugal
30/01/2014	30/01/2014	France
30/01/2014	30/01/2014	Austria
17/03/2014	20/03/2014	France
14/05/2014	15/05/2014	France
15/05/2014	15/05/2014	Italy
24/06/2014	25/06/2014	France
25/06/2014	25/06/2014	Belgium
06/09/2014	06/09/2014	Italy
27/11/2014	27/11/2014	Greece
12/12/2014	12/12/2014	Italy
14/12/2014	14/12/2014	Belgium
16/01/2015	16/01/2015	Italy
17/02/2015	17/02/2015	Italy
20/03/2015	20/03/2015	Italy
08/04/2015	10/04/2015	France
11/07/2015	26/07/2015	Spain
14/07/2015	14/07/2015	Italy
15/07/2015	15/07/2015	Romania
05/08/2015	05/08/2015	Greece
26/09/2015	26/09/2015	Spain
23/10/2015	27/10/2015	France
07/10/2015	08/10/2015	France
23/11/2015	01/12/2015	France

[71] 9 days of strikes within this period

2016 ATC Strikes – to end September 2016

In the period 1 January – 30 September 2016, there have been 22 separate strikes by air traffic controllers in Europe, encompassing 41 days of strike, and 55 days of disruption.

Start Date	End Date	Location
25/01/2016	25/01/2016	Italy
25/01/2016	27/01/2016	France
29/02/2016	29/02/2016	Italy
20/03/2016	22/03/2016	France
30/03/2016	01/04/2016	France
06/04/2016	07/04/2016	Greece
09/04/2016	09/04/2016	Italy
12/04/2016	13/04/2016	Belgium
20/04/2016	20/04/2016	Belgium
27/04/2016	27/04/2016	Germany
28/04/2016	29/04/2016	France

Start Date	End Date	Location
19/05/2016	20/05/2016	France
26/05/2016	27/05/2016	France
03/06/2016	06/06/2016	France
13/06/2016	15/06/2016	France
17/06/2016	17/06/2016	Italy
22/06/2016	24/06/2016	France
24/06/2016	24/06/2016	Belgium
28/06/2016	29/06/2016	France
04/07/2016	06/07/2016	France
06/09/2016	06/09/2016	Italy
14/09/2016	16/09/2016	France

Notes:

1) In addition to the strikes listed above, a strike planned for 23 June in Italy was averted at the last moment, but still caused over 100 flight cancellations as airlines had insufficient warning of the cancellation of the strike to reinstate flights. This impact is not included in our assessment.

2) In addition, there were two ATC strikes occurring in Iceland during this period – on 28-29 April and 5-6 June 2016. Although these strikes are within the Eurocontrol area, Iceland is not an EU Member State. Therefore, the impact of these strikes has not been included.

Appendix D: Examples of CGE Models in Transport

The section below summarises the relevant literature which was used to inform and justify our modelling approach and analysis. Given the scope of the analysis, and the breadth of research which has been undertaken in this area using similar methodologies, this should not be seen as an exhaustive list of literature in this field. However, the literature summarised below is the most relevant to the modelling and analysis set out in this report.

9.1.1 Examples of economic impact modelling in the context of aviation sector

9.1.1.1 Sydney Aviation Capacity Study

The largest and most comprehensive example of the use of CGE modelling as a tool for aviation infrastructure investment evaluation was based on the MMRF general equilibrium model, developed by Monash University's Centre of Policy Studies. This was in the context of the 2012 study into the economic impact of potential airport sites in Sydney, and the CGE model was used to determine the economic and employment impacts of each site. The full results and model structure can be seen in the full report (Ernst & Young, 2012)[72].

The MMRF is a dynamic model, split between 58 industries, 63 products, 8 states/ territories and 56 sub-state regions. It was run based on 5 key inputs relating to the different elements of each airport investment:

1. Airport & supporting infrastructure construction & renewal;
2. Airport and aviation operations;
3. Freight impacts;
4. Passenger flow impacts; and
5. Landside business development.

In addition to these inputs, a number of restricting assumptions on areas such as profit factors, domestic shares and passenger flow spending were also imposed upon the model. A more complete list of assumptions, and the model structure, can be found in Appendix H of Ernst & Young (2012)[73].

As outlined above, the outputs of the modelling were used to demonstrate the state-wide and national economic and employment impacts of the proposed airport developments. The table below summarises some of the key economic indicators arising from this study. This demonstrates that by 2060 the additional impact on the Australian economy could be in excess of $20bn per year, or more than 1% of GDP. The modelling also revealed important distributional effects, with approximately 80% of the additional national output being generated in New South Wales, where economic activity was estimated to increase by up to 3.2% by 2060. The analysis also demonstrated that that the majority of the national GDP increase was a result of increased private consumption, although substantial increases in investment and improvements in the trade balance also had a significant impact.

Table 1: Key economic impacts of a new airport in Sydney

Airport option	Badgery's Creek	Richmond	Wilton
Additional passengers (2060)	54 million	5 million	44.2 million

[72] Ernst & Young (2012). Aviation capacity cost benefit economic assessment.
[73] Ernst & Young (2012). Aviation capacity cost benefit economic assessment.

Airport option	Badgery's Creek	Richmond	Wilton
Additional regional FTEs (2060)	60,584	7,808	40,707
Additional real GDP (2060)	$23.9bn	$1.0bn	$20.0bn
Increase in real GDP (2060)	1.2%	0.05%	1.0%

Source: Adapted from Ernst & Young (2012)

In addition to this report, Deloitte Access Economics (2013)[74] performed similar analysis, specifically looking at one of the three options considered, using their in-house Regional General Equilibrium Model (RGEM). The findings of this analysis are presented in the table below. This similarly found that additional regional gross product could exceed $16bn per year by 2050, and were able to demonstrate that approximately two-thirds of this benefit would relate to the Western Sydney region, with the remainder in the rest of Sydney.

Table 2: Key economic impacts of a new airport in Western Sydney

Growth scenario	Scenario 1	Scenario 2	Scenario 3
Additional Passengers (2050)	27 million	33.1 million	33.1 million
Additional regional FTEs (2050)	35,216	44,766	46,285
Additional Gross Regional Product (2050)	$11.6bn	$14.7bn	$15.2bn

Source: Adapted from Deloitte Access Economics (2013)

9.1.1.2 Airport Subsidies

Although not directly investigating the impact of additional airport infrastructure investment, Forsyth (2007)[75] investigates the economic impact of regional airport subsidies. In particular, this study examines the link between additional passenger flow expenditure resulting from the subsidy, adjusted through a range of distributive and labour market assumptions, and the total product and welfare impact. This demonstrates how CGE models can be used to capture the general impact of an increase in passenger flows, which is an important element of any increase in airport capacity.

The analysis was completed using a multi-regional model of the Australian economy, developed by the Sustainable Tourism Cooperative Research Centre at the Centre for Tourism Economics and Policy Research. The model comprises two regions, New South Wales and Rest of Australia, and consists of roughly 50 industrial sectors. The model has also been amended to include a number of detailed passenger expenditure-related industries, in order to allow for more specific analysis of changes in expenditure in this area. As with the Ernst & Young (2012)[76] analysis, this model is a variant of the MMRF model, developed and implemented by the Monash University Centre of Policy Studies.

The findings from the modelling identified the potential positive welfare impact for a region of offering airport subsidies to attract passengers, through the positive GDP impact of the expenditure associated with these additional passengers. The paper also highlighted how this is largely a distributive effect, with surrounding regions likely to see a fall in overall welfare, with the net national impact uncertain.

[74] Deloitte Access Economics (2013). Connecting Australia: The economic and social contribution of Australia's airports. Prepared for Australian Airports Association.

[75] Forsyth, P. (2007). The impacts of emerging aviation trends on airport infrastructure. *Journal of Air Transport Management*, 13(1), 45-52.

[76] Ernst & Young (2012). *Economic and social analysis of potential airport sites: Sydney Aviation Capacity Study*. Report for the Australian Government Department of Infrastructure and Transport.