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The Economic Catalytic Effects of Air Transport in Europe

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Abstract:
This study estimates that the catalytic effect of air transport usage over the last decade has been to increase European GDP (gross domestic product) by approximately 4% in the long run, which is €410 billion at today's prices. This growth is achieved through the impact of air transport on trade, tourism and more importantly on business investment and the underlying productivity of the European economy. By 2025, growth in air transport is forecast to lead to a further GDP growth of 1.8% in the long run, or €200 billion at today's prices.

Executive Summary

Air transport is a rapidly growing sector across Europe's economies. The growth in air transport has a wide range of associated benefits and costs for the economies concerned. These include:

- **Direct impacts** (employment and activity in the aviation sector);
- **Indirect impacts** (employment and activity supported down the supply chain to the aviation sector);
- **Induced impacts** (employment and activity supported by the spending of those directly or indirectly employed in the aviation sector);
- **Consumer welfare impacts** as individuals benefit from the increased availability of travel
- **Environmental impacts** on, for example, air quality, noise and congestion in the vicinity of airports

The aim of this study, however, is to develop a robust methodology for measuring the so-called 'economic catalytic impacts' of air transport. We define these as:

The net economic effects (eg on employment, incomes, government finances etc) resulting from the contribution of air transport to tourism and trade (demand-side effects) and the long-run contribution to productivity and GDP of growth in air transport usage (the supply-side performance of the economy).

According to our research, the economic catalytic effects of air transport in Europe are already substantial, and are set to increase in years to come. Table A summarises our findings. The key points to highlight are

(i) Demand-side economic catalytic effects

EU residents travelling by air spend more as tourists outside the EU than visitors arriving into the EU by air do – by around 0.3% of GDP (31 billion euros) in 2003 for the EU as a whole. But this gap is expected to narrow gradually over time as the emerging economies become richer and their populations increasingly travel internationally.

Moreover, the net impact of tourism by air is positive for the 10 new members of the EU (the 'Accession-10'), with spending in 2003 by foreign visitors 1.6 billion euros higher than spending by their residents abroad, equivalent to 0.4% of GDP.

It should be stressed that these quantitative estimates do not provide a comprehensive picture of the impact of air transport on tourism. There are several reasons why greater international tourism can be beneficial even if it has a negative impact on demand in the economy – for example, through improving living standards of residents by widening their choices, or through increasing understanding of different cultures and nationalities, as well as by the direct and indirect impact of airport-related activities on jobs and value added in the country / region concerned.

The value of EU exports transported by eair in 2003 was over 54 billion euros higher than the value of imports by air, equivalent to 0.6% of GDP. By 2025, exports transported by air are expected to exceed imports by 1.7% of EU GDP, primarily reflecting the strong growth expected in demand in the emerging economies.

For the Accession-10, exports by air in 2003 were 1.6 billion euros lower than imports (0.4% of GDP).

For Europe as a whole we therefore find that the overall demand-side economic catalytic impact of air transport in 2003 was to increase net demand by 0.2% of GDP. By 2025, this is expected to increase to 1.3% of GDP.

(ii) Supply-side economic catalytic effects

While the demand-side impacts of air services on tourism and trade can have important effects on employment and income in a region/country over a number of years, they will only lead to a sustained improvement in GDP if they are matched by an improvement in the supply-side performance of the economy.

Air transport has significant impacts on the supply-side performance of the Euroean economy, with long-run implications for productivity and living standards. Our econometric research – which is consistent with previous studies and survey evidence – suggests the following:

Business investment impacts

The relatively fast growth of air transport usage has boosted business investment across the EU by 5.8% over the last decade, with investment in the Accession-10 economies increased by 13.7%. This in turn is estimated to have increased GDP by 2.0% in the EU as a whole and by 6.2% in the Accession-10.

The expected growth in air transport usage in years to come means that business investment is likely to be boosted by a 3.3% by 2025 across the EU as a whole and by almost 5% in the Accession-10. This in turn is expected to increase GDP by a further 0.6% in the EU as a whole and by 1.0% in the Accession-10.

(b) Underlying productivity impacts

Underlying productivity is a measure of the efficiency with which labour and capital are combined to produce output.

The increase in air transport usage over the last decade has facilitated an increase in underlying productivity that will boost GDP across the EU by 2.0% in the long run (205 billion euros) as it has, for example, allowed firms access to bigger markets and to exploit economies of scale; it has stimulated competition and increased international networking. The impact in the Accession-10 will raise long-run GDP by 4.6% (24 billion euros).

The growth in air transport usage over the next 20 years is expected to raise underlying productivity and GDP by a further 0.6% across the EU as a whole, and by 1.0% in the Accession-10.

There are other supply-side impacts through, for example, the labour supply that we are not able to quantify. But it should be noted that, our estimates of the impact of air services on underlying productivity take account of possible adverse effects – eg increased congestion, local overheating – as well as positive effects on companies' efficiency etc.

For Europe as a whole we therefore find that the overall supply-side economic catalytic impact of air transport has been to raise both investment and underlying productivity significantly. The combined long-run effect of the growth in air transport usage over the last decade is to increase the level of GDP by 4.0% each year, or 410 billion euros. That is more than twice the value added by the machine tools sector in the EU (1.6% of GDP in 2001), or more than half of the value added by the motor vehicles and parts sector (7.1% of GDP in 2001).

The overall supply-side economic catalytic impacts of the growth in air transport usage over the next 20 years is expected to raise EU GDP by a further 1.8% (200 billion euros) in the long run, with GDP in the Accession-10 2.7% (30 billion euros) higher.

These economic catalytic effects of European air transport should be seen as part of the total contrivution that air transport makes to European economies – including the direct and indirect effects on employment and output. These are important beneficial effects for the European economy, although we do not attempt to quantify them in this paper. A range of research exists that does quantify these contributions, including:

An ACI Europe study estimates that European airports directly contribute:

- 1.2 million on-site jobs in Europe, with a further 0.2 million direct airport-related jobs.
- For every job at or directly related to airports, a further 2.1 jobs are either indirectly supported down the supply chain to the airports or induced by the spending of employees in the aviation industry. As a result, a total of 4.3 million jobs in Europe are dependent on air transport.
- That is around 2% of total employment in Europe. And the report cites research that estimates the overall contribution of air transport to GDP in the range 1.4% to 2.5%.

An ACARE study (ACARE, The Economic Impact of Air Transport on the European Economy, September 2003) estimates that air transport contributes 2.6% of EU GDP.

However, it should be emphasised that the economic catalytic contribution of air transport to GDP is bigger than its combined direct, indirect and induced impact.

Table A: catalytic effects of air transport in Europe

	EU-25		EU-15		Acc-10	
Demand-side effects *(impact of net outbound tourism and trade flows by air on GDP)*						
	2003	2025	2003	2025	2003	2025
Net Tourism Effects	-0.3%	-0.2%	-0.4%	-0.2%	+0.4%	+0.1%
Net Trade Effects	+0.6%	+1.5%	+0.6%	+1.7%	-0.4%	-0.7%
Total demand-side catalytic impacts, % GDP	+0.2%	+1.3%	+0.2%	+1.5%	0.0%	-0.6%
Total demand-side catalytic impacts, (€ bn, today's prices)	+24	+186	+24	+195	-0	-9
Supply-side effects *(contribution of growth in air transport usage)*						
	2003	2025	2003	2025	2003	2025
Location and investment decisions (impact on GDP, %)	+2.0%	+1.2%	+1.8%	+1.1%	+4.8%	+1.7%
Business operations and productivity/market structure and innovation (impact on underlying productivity, %)	+2.0%	+0.6%	+1.8%	+0.6%	+4.6%	+1.0%
Long-run supply-side impact on GDP, %	+4.0%	+1.8%	+3.6%	+1.7%	+9.4%	+2.7%
Long-run supply-side impact on GDP, (€ bn, today's prices)	+410	+200	+340	+170	+50	+30

Summary

- **Demand-side effects over the last decade** (via net air tourism and net air trade) have been small, or zero in the case of the Accession-10.
- **Demand-side effects in future** are expected to be more significant – bigger positives for the EU-25 as a whole and for the current EU-15 within that, but bigger negatives for the Accession-10.
- **Supply-side effects over the last decade** (via investment and underlying productivity) have been significant, increasing GDP by 4% in the long run.
- The growth in air transport out to 2025 is expected to contribute still more to the supply-side of the European economy, boosting EU-25 GDP by 1.8% in the long run.

The supply-side impact on the EU-25 as a whole is significant already, and is likely to become more so in future. But the impact is even more pronounced in the ten accession economies, where the current provision of air transport services is least developed, and the growth in air transport is most rapid. These economies have the most to gain from improvements in air transport services – nearly twice as much as the fifteen more-developed economies with mature air transport sectors who are already members of the European Union.

The economic catalytic effects of European air transport should be seen as part of the total contribution that air transport makes to European economies – including the direct and indirect effects on employment and output. These are important beneficial effects for the European economy, although we do not attempt to quantify them in this paper.

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2 Introduction

Air transport is a rapidly growing sector in many economies, with growth in the number of passengers and the volume of airfreight typically outstripping GDP growth by a factor of 3:1 (EU-25, 1994-2003).

That rapid growth in air transport is a consequence of growth in economic activity generally: as economies mature, and the people in them become more wealthy, foreign travel (and air travel in particular) becomes feasible and desirable for more people, both for business and pleasure.

But the growth in the provision of air transport services is also a contributor to the growth in economic activity more generally. Its contribution includes:

- Direct impacts on employment and output in the aviation industry itself.
- Indirect impacts on employment and output in the supply chain to the aviation industry.
- Induced impacts on employment and output as those employed directly and indirectly in air transport services use their earnings to buy other goods and services.
- Economic catalytic impacts or spillover effects. These capture the extent to which the growth in air transport boosts the performance of other industries (eg through tourism, trade, investment and productivity). They can also include consumer welfare impacts as individuals benefit from the increased availability of travel and environmental impacts on, for example, air quality, noise and congestion in the vicinity of airports.

Previous studies have mostly concentrated on the first three types of impact. Economic catalytic impacts have received relatively little attention in the literature, while tourism and trade impacts have been assessed though only for particular countries or airports. In general, the economic catalytic impacts through investment and underlying productivity have not been quantified.

The aim of this study is to develop a robust methodology for measuring the various catalytic impacts of air transport and to apply that methodology to European airports, quantifying both the catalytic effects that have accrued to date, and those that are to come over the next twenty years.

The rest of this report is organised as follows:

Section 3 describes what the economic catalytic effects of air transport are, and how they fit into the overall economic contribution of air transport. In Section 3 we also describe the main channels of economic catalytic effects.

Section 4 sets out our estimates of the size of economic catalytic effects of air transport in Europe to date (as a result of the growth in air transport over the last decade) and to come over the next twenty years.

Section 5 concludes the main text, while technical details of our approach and our econometric models are set out in the Appendices.

3 Defining the economic catalytic effects of air transport

In this chapter, we describe what we mean by the economic catalytic effects of air transport, and develop a precise definition which motivates the rest of the report.

Key Points

The aim of this study is to develop a robust methodology for measuring the so-called 'economic catalytic impacts' of air transport. We define these as:

The net economic effects (eg on employment, incomes, government finances etc) resulting from the contribution of air transport to tourism and trade (demand-side effects) and the long run contribution to productivity and GDP of growth in air transport usage (the supply-side performance of the economy).

Catalytic effects capture the extent to which air transport contributes to a country or economy beyond any effects that are directly or indirectly associated with the air transport industry itself. There are many studies that assess the direct and indirect impacts of air transport on economic activity. They generally agree that the impacts are large and positive. For example:

An ACI Europe study[1] estimates that European airports directly contribute:

- 1.2 million on-site jobs in Europe, with a further 0.2 million direct airport-related jobs.

[1] 'The social and economic impact of airports in Europe', York Aviation & ACI, January 2004

- For every job at or directly related to airports, a further 2.1 jobs are indirectly supported down the supply chain to the airports, for a total (direct and indirect) of 4.3 million jobs dependent on air transport in Europe.
- That is around 2% of total employment in Europe. And the report cites research that estimates the overall contribution of air transport to GDP in the range 1.4% to 2.5%.

An ACARE study[2] estimates the total contribution of air transport to be even higher, around 2.6% of GDP.

However, most existing studies, including those cited above, do not attempt to quantify the catalytic effects of air transport, but focus instead on the direct, indirect and induced effects.

One way to think about the distinction is that the economic value of the direct, indirect and induced effects of air transport together is related to the total revenues of the air transport industry – either the portion of those revenues spent on wages or taxes or distributed in profits (direct effects), or the portion devoted to other, non-labour costs (indirect effects), or the portion recycled via the spending of those employed directly or indirectly in the air transport industry or down the supply chain to the air transport industry (induced effects). Together, they capture how the money spent in the air transport industry ripples through the rest of the economy – see Figure 3-1 below.

But tracing that flow of money will not capture the catalytic, or spillover effects of air transport. That is the aim of this study.

These catalytic impacts could be defined as all other benefits and costs associated with an airport or the air transport sector. That would include impacts both on users of the airport (net of the payments they make to companies in the air transport industry) and on other households and companies in the wider economy. Potentially, they could also include environmental and social impacts as well.

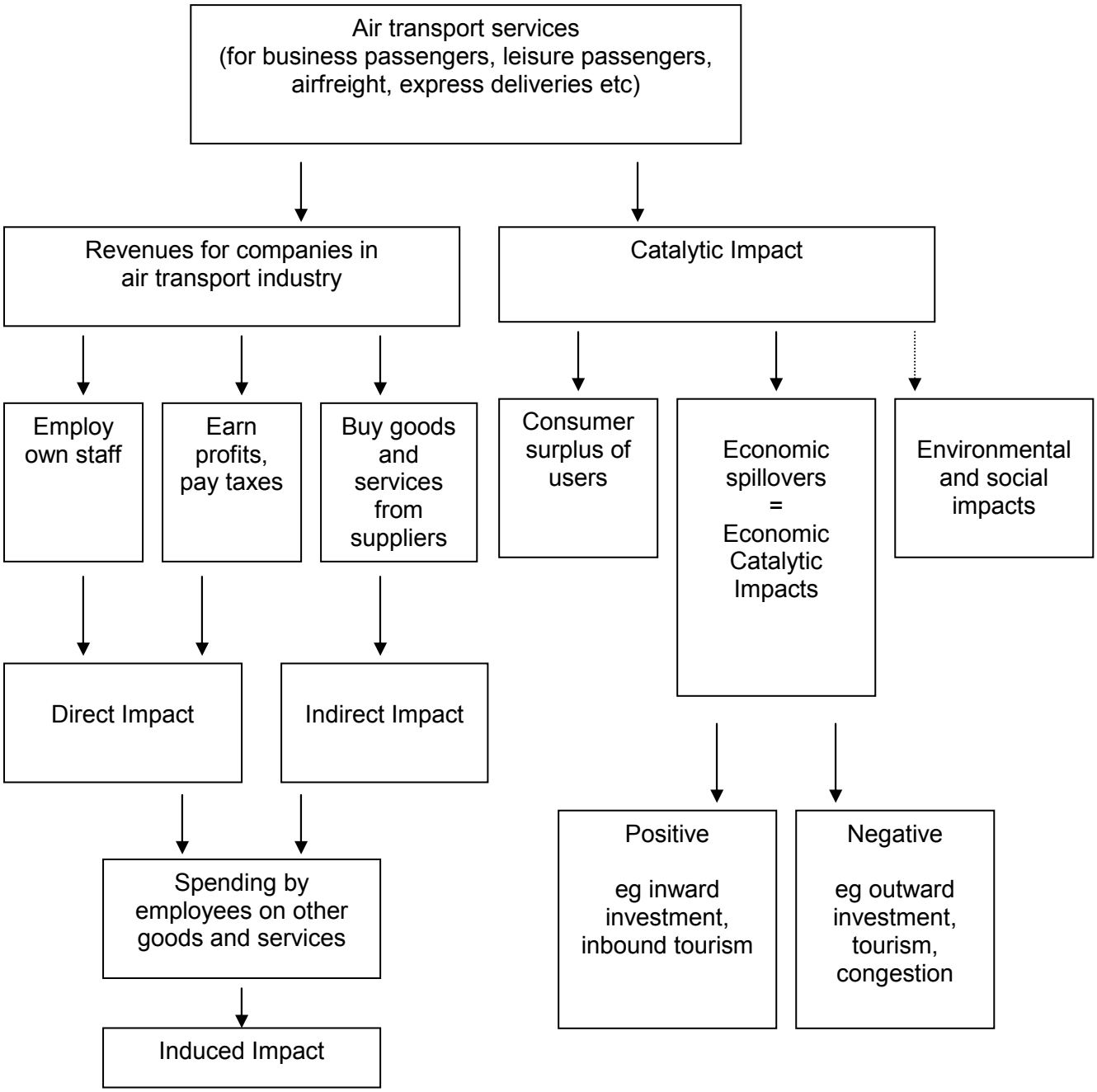
Such an approach, however, defines the catalytic impacts of an airport/air transport very broadly. It includes:

[2] ACARE, September 2003

- The so-called ‘consumer surplus’ of those users of air services whose airfares are less than the price they would be willing to pay for their flights.
- In principle, it also includes environmental and social impacts of air transport as well. While there is a case for treating most environmental impacts of air transport services as beyond the scope of economic impacts studies, air transport can have negative as well as positive effects on the wider economy that should be taken into account. Most notably, the presence of an airport attracts economic activities to the airport region. This requires careful management of economic development to face the possible risks of congestion on surrounding roads, which may increase the costs companies face in transporting staff and goods.

We focus on the economic catalytic impacts for the purposes of this study: **the economic spillover effects**. Figure 3-1 below sets out how these catalytic effects fit into the wider picture of the overall economic contribution of air transport.

Figure 3-1: Direct, Indirect, Induced and Catalytic Impacts of Air Transport



Overall catalytic impacts break down into three categories in the diagram above – consumer surplus; environmental and social impacts; and economic spillovers. Of these, in this study we consider only the last. Concerning the other two:

Nobody wants to pay more for anything, including flights. But there are some air travellers who **would pay more if they had to**. These air travellers are enjoying what is known as a '**consumer surplus'**: the difference between the value of the flight to them, and how much they paid for it. That surplus, summed across all air travellers, can be large, and is not

reflected in airport revenues. While the consumer surplus is important, we do not consider it in this study because its contribution to the performance of the economy is not clear.

Similarly, the **environmental and social impacts** of air transport - beyond those that indirectly have an impact on economic performance, such as congestion, for example - while undoubtedly important, are outside the remit of this study.

We consider only the economic catalytic impacts of air transport. These are defined as:

the net economic effects (eg on employment, incomes, government finances etc) resulting from the contribution of air transport to tourism and trade (demand-side effects) and the contribution to GDP of growth in air transport usage (the supply-side performance of the economy)

We distinguish between **'demand-side catalytic effects',** which operate through the use of air services to transport tourists and goods, and **'supply-side catalytic impacts',** which represent the net effects of air transport on the supply-side performance of the economy and so have long-run implications for productivity and living standards

3.1 Catalytic impacts: main channels

There are a number of sources of economic spillover or economic catalytic impact from air transport that this study assesses. These fall into two groups:

(i) **Demand-side impacts** – Effects of air services on the net demand for goods and services produced in a region/country. These include:

- **Tourism impacts** – A large proportion of international tourists travel by air. How much do incoming tourists spend when they visit Europe by air? How much do European tourists spend when they travel outside Europe by air? How large is the net inflow of tourism spending to Europe, and what contribution does it make to European GDP?

- **Trade impacts –** A high proportion of the value of international trade is transported by air; both exports and imports. Good air links mean that European exporters can access more distant markets, but they also mean that more distant foreign exporters can access the European market. What is the impact on European GDP of the net inflow of goods transported by air?

(ii) **Supply-side impacts**

It is worth stressing, however, that, while the demand-side impacts of air services on tourism and trade can have important effects on employment and income in a region/country over a number of years, they will only lead to a sustained improvement in GDP if they are matched by an improvement in the supply-side performance of the economy.

However, air transport also has the potential to influence the supply-side capacity of an economy, either via impacts on the quantity of resources deployed in a region/country, or via the efficiency with which those resources are employed (known as 'underlying productivity' or

'underlying productivity'). Again, it is necessary to take account of potential adverse supply-side impacts as well as any beneficial spillovers generated by air transport.

Such supply-side spillovers - or 'externalities' – include:

- **Impacts on investment,** including company location/investment decisions and technology transfer. Transport links are often cited as critical to companies' investment decisions. So the quality of air services is likely to influence investment in a given region - both by foreign firms and by companies already based in the area. This could, however, work both ways. Most existing impact studies look at the implications of air services for a region's ability to attract more inward investment. But air services may also make it easier for firms to manage overseas operations and therefore encourage greater outward investment as well.

  If air services encourage greater net investment then this will raise a region's capital stock and the potential level of GDP it can generate. But inward investment may have the added benefit of introducing new technologies or management techniques that can be emulated by other firms in the region/country, leading to a further increase in GDP by raising underlying productivity.

  Underlying productivity - formally known as 'total factor productivity' (TFP) - is a concept that we refer to frequently in this paper. It is a measure of the efficiency with which the various factors of production are combined to produce output. The factors of production include the stock of fixed capital (the cumulation of years of investment in plant and machinery, buildings and infrastructure) and the number of people employed. Further details of how we calculate underlying productivity are included in Appendix D.

- **Impacts on labour supply** – Good air links may enable a region to attract high quality employees, possibly as 'weekly commuters', who would otherwise not choose to live there. Similarly, air links allow staff from outside a region to input into companies through day visits etc. Of course, they also allow high quality employees from within a region to commute to other regions. But this is not a zero-sum game: there may be a mismatch

between the composition (industrial sector, skill level) of local labour supply and local labour demand that can be resolved by better air links, benefiting all regions.

- **Impacts on productivity** and business operations– As highlighted by SACTRA[3], transport services such as aviation increase the potential market in which companies operate. This in turn may lead to a more efficient allocation of resources to exploit economies of scale. Good air freight/express delivery services may, for example, enable companies to reduce the need to hold expensive inventories to meet customer demand or supply their production processes, or reduce the risk that production runs may be interrupted because spare parts cannot be delivered quickly. They may also allow companies to rationalise production between different sites within Europe or source raw materials and sub-components from cheaper suppliers.

- **Impacts on market structure** and innovation – By improving market access, good air links may strengthen competitive pressures on companies – both as they seek to penetrate foreign markets and as overseas competitors have better access to the home market. That will encourage greater efficiency and specialization in areas of comparative advantage, and it could reduce monopoly profits.

  Moreover, there may be dynamic effects if improved air services increase the profitability of investment in other sectors and so encourage greater innovation by companies – eg if increasing the size of the potential market allows the fixed costs of R&D to be spread over larger sales, or if air links allow collaboration between companies across regions/countries and more effective networking.

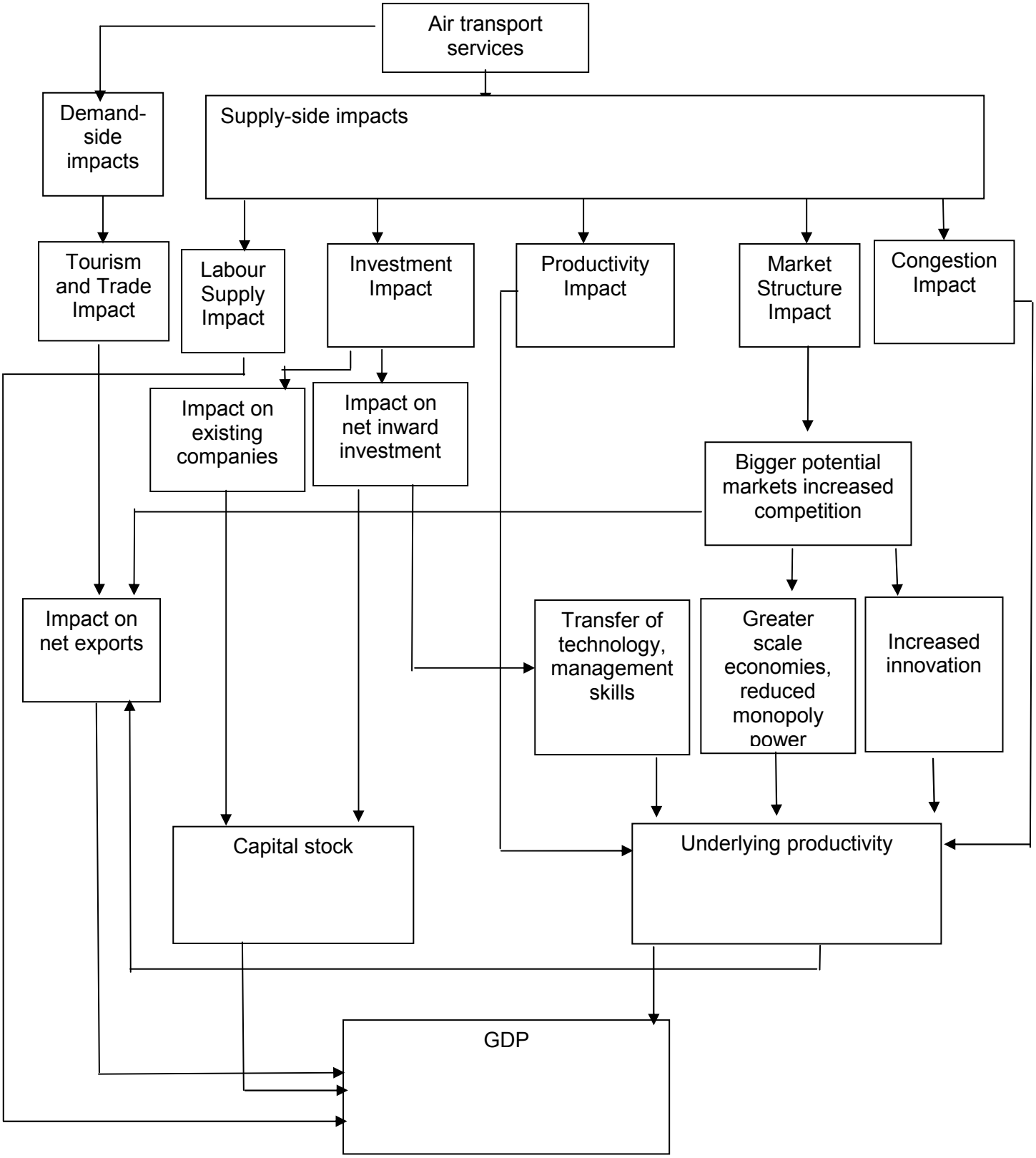
- **Impacts on congestion** and local business costs. Similarly, while there is a case for treating most environmental impacts of air transport services as beyond the scope of economic impact studies, it should be noted that airports can have negative as well as positive effects on the wider economy that should be taken into account. Most notably, the presence of an airport attracts economic activities to the airport region. This

[3] Transport and the economy, The Standing Advisory Committee on Trunk Road Assessment, August 1999.

expansion requires careful management to minimise the possible risks of congestion on surrounding roads, and the increasing costs facing local companies in terms of transport, staff and goods.

The different channels of catalytic impact are summarized in Figure 3-2 below.

Figure 3-2: Economic Catalytic Impacts of Air Transport



In Section 4, we set out our approach to estimating these effects, and summarise the results. The results are set out channel by channel, and in two stages for each channel.

First, we assess the economic catalytic effects via each channel that have accrued **over the last decade** in Europe as a result of the growth in air transport over the last decade.

Second, we assess the likely contribution of air transport **in future** over the next twenty years.

4 Quantifying the Economic Catalytic Impact of Air Transport

We provided above a working definition of the economic catalytic impacts of air transport and identified a number of channels through which these catalytic effects operate. In this Section we describe our approach to measuring the impact of air transport on European economies over the last decade via the main channels set out above, and our estimates of the effects to come over the next twenty years:

Part 4.1 discusses impacts through the tourism sector.

Part 4.2 considers impacts on trade.

Part 4.3 quantifies effects on company location/investment decisions.

Part 4.4 quantifies the effects on underlying productivity.

Part 4.5 summarises the overall economic catalytic effects.

4.1 Tourism Impacts

Key Points

- EU residents travelling by air spend more as tourists outside the EU than visitors arriving into the EU by air do – by around 0.3% of GDP (31 billion euros) in 2003 for the EU as a whole. But this gap is expected to narrow gradually over time as the emerging economies become richer and their populations increasingly travel internationally.

- Moreover, the net impact of tourism by air is positive for the 10 new members of the EU (the 'Accession-10'), with spending in 2003 by foreign visitors 1.6 billion euros higher than spending by their residents abroad, equivalent to 0.4% of GDP.

- It should be stressed that these quantitative estimates do not provide a comprehensive picture of the impact of air transport on tourism. There are several reasons why greater international tourism can be beneficial even if it has a negative impact on demand in the economy – for example, through improving living standards of residents by widening their choices, or through increasing understanding of different cultures and nationalities, as well as by the direct and indirect impact of airport-related activities on jobs and value added in the country / region concerned.

The travel and tourism industry is an important source of both jobs and output in Europe. It accounts for around 3-4% of GDP in Germany, France and the United Kingdom, and over 1 million people are employed in the sector in each of those countries[4].

The potential for air transport to boost tourism is one of the few catalytic effects that have sometimes been quantified in airport economic impact studies[5]. The approach in previous studies – which we develop here - is to multiply an estimate of the average spend per visitor with an estimate of the number of in-bound visitors arriving by air.

In Appendix A, we set out in detail the thinking behind our approach to measuring the catalytic impact of air transport through tourism. The main difference from the standard approach is that we look at the net spending of all inbound foreign visitors by air minus that of outbound foreign visitors by air. In adopting this approach, we are recognising that airports support travel in both directions, not just inbound – and that estimates of the economic contribution of airports should take this into account.

In our view, an approach that took the gross spending of inbound air tourists as the basis of the economic contribution of air transport via tourism, would overstate the size of that contribution. First, the employment and fixed capital that are supported by that gross spending by inbound air tourists would be redeployed elsewhere in the economy if that inbound air tourism spending did not take place, and it is not clear what the impact on GDP would be in that event. Second, there is a clear effect on GDP from the net inbound spending of air tourists via its impact on the Balance of Payments – an effect that would be overlooked if only the gross flows were examined. And third, at least some proportion of the spending of outbound air tourists would probably be spent in the domestic economy in the event that air transport services were withdrawn, with – again – an indeterminate effect on GDP.

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[4] Source Eurostat

[5] See, for example, The Economic Impact of the Scottish Airports, Fraser of Allander Institute, Sept 1997; Impact Economique du Pole Aéroport Nice Côte d'Azur Arénas dans les Alpes-Maritimes, Sirius CCI, Sept 2002

Key data for our estimates are passenger numbers split into foreign and domestic passengers (eg from origin/destination surveys), plus average spending per visitor figures from visitor spending surveys.

Tourism impacts in 2002

Table 4-1 sets out our estimates of the impact of air transport on tourism in 2002 for the EU-25, the 'old' members of the EU (Current EU-15) and the 'new' accession members (Accession-10). This way of breaking down our results will be maintained throughout the remainder of this report. It highlights the overall impact of air transport on the European economy, and also draws attention to the difference between the impact in advanced economies with mature air transport sectors (Current EU-15) and developing economies with relatively immature and rapidly growing air transport and tourism sectors (Accession-10).

Table 4-1: Estimates of the catalytic effects on tourism from air transport (2002)

	EU-25	EU-15	Acc-10
Inbound (m)	227	218	9
Outbound (m)	134	129	5
Inbound Spending (€m)	78,614	76,116	2,498
Outbound Spending (€m)	108,708	107,838	870
Total Net Impact (€m)	-30,095	-31,722	1,628
Inbound Spending as a percentage of GDP	0.8	0.8	0.6
Outbound Spending as a percentage of GDP	1.1	1.2	0.2
Total Net Impact as a percentage of GDP	-0.3	-0.4	0.4

Sources: World Tourist Organisation, Eurostat, OEF Calculations

The spending of tourists travelling by air represents a relatively large share of GDP in the current EU-15, but a smaller share in the Accession-10. This reflects the fact that tourism is a luxury: people tend to spend a higher proportion of their income on tourism as their income increases. In countries such as the Accession-10, where average incomes tend to be relatively low, people do relatively little tourism by air: residents in the Accession-10 cannot afford it, and the facilities to attract tourists from outside the Accession-10 are still not fully developed. But in the current EU-15, where average incomes are higher, people spend a lot of money on foreign travel by air, and domestic tourism facilities are fully developed to attract inflows of foreign tourists.

Air tourism makes a small negative contribution to the overall current account position in the current EU-15, but a small positive contribution in the Accession-10. Old Europe is a net importer of tourism services by air, while New Europe is still a net exporter – again reflecting the relative wealth of Old Europe.

Some of the spending by tourists travelling by air would have occurred even if the air transport services had not been available, since some of those travellers would have found other means to get to their destinations in that event – via rail, road or sea. So it is unlikely that the entire contribution of air transport via tourism would be lost in the event that air transport were not available. However, it is extremely difficult to be sure about what proportion of travellers would find other means of transport in that event. And since they are in fact travelling by air, they are in that sense dependent on air services, even if some of them might travel by other means in the absence of those services. We believe that our approach is the simplest and clearest way of estimating these effects.

Moreover, the spending of international air travellers in the country they visit is on a variety of goods and services: hotels, restaurants, entertainment – in fact the range of services provided to support the tourism and business traveller industry. In our approach, we are counting all of this spending in the contribution of air transport, but it should be acknowledged that the contribution of air transport, defined in this way, overlaps with the contribution of other sectors, such as hotels, restaurants etc. Overlaps of this sort are a feature of many economic impact assessments, but it is important to be clear about them where they exist.

The charts below show how the impacts of total and air-related tourism on net trade in the current EU-15 and the Accession-10 have evolved in recent years.

Chart 4-1

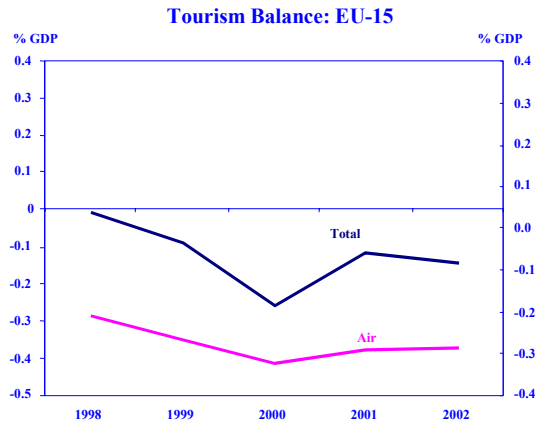
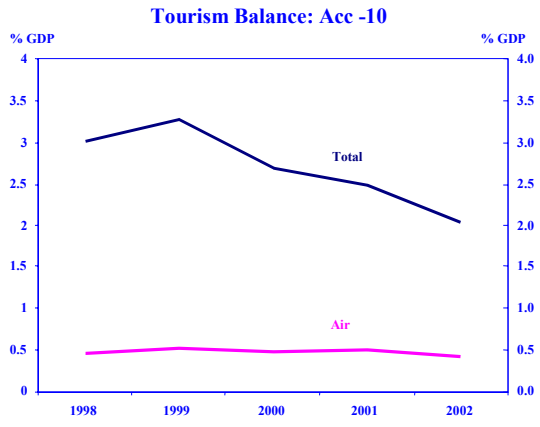


Chart 4-2



It should be emphasised that the fact that air tourism can have a negative effect on GDP does not imply that it has a negative effect on welfare. Air travel is a luxury:

- **Foreign travel enriches the lives of those who undertake it.** Indeed, for many travellers, the value of the experience that foreign travel offers – whether it be meeting up with friends and family, experiencing a foreign culture, or even just lying on a beach - can substantially exceed the cost of that travel.
- **Foreign travel broadens the understanding of foreign cultures**. This is a welfare benefit in itself, and also plays a role in facilitating closer international economic integration, with the attendant benefits that brings. It might also contribute to the

incalculable goal of improving international understanding and reducing the risk of conflict.

And air travel has other economic effects not captured in the net spending figures reported above:

- **Some international travellers are on business**. The impact that access to foreign travel has on goods trade, business investment and productivity is one of the catalytic effects of air transport explored below. But there may be benefits that are not captured in that analysis: if someone travels abroad on a marketing trip, for example, it could be that the benefits are realised in the form of increased exports of financial or business services, for example.
- **The direct and indirect employment and value added** supported in and around airports makes a significant contribution to the economy as a whole (not part of the 'catalytic effect' of air tourism).
- **Outbound tourism involves some domestic spending as well**. For example, travel agents and tour operators who arrange foreign tourism also contribute important jobs and value added to their domestic economies – in the UK accounting for some 0.4% of total employment (see Appendix B for further details).

Moreover, the tourism deficits themselves need to be interpreted with caution. It is worth highlighting the fact that not all of the money spent by air tourists travelling abroad would necessarily be spent on tourism at home if there were no air services – it is likely that some proportion would be saved or spent on other goods and services, some of which would be imported.

Tourism impacts in future

Table 4-2: Net catalytic effect of air transport on tourism

	2003	2010	2015	2020	2025
EU-25			€bn, 2003 prices		
Inbound spend	75.8	107.6	127.4	157.7	179.2
Outbound spend	107.0	133.6	152.8	183.8	207.5
Balance	-31.2	-26.0	-25.4	-26.1	-28.3
			% of GDP		
EU-25	-0.3	-0.2	-0.2	-0.2	-0.2
EU-15	-0.4	-0.3	-0.3	-0.3	-0.2
Acc-10	0.3	0.3	0.2	0.1	0.1

Table 4-2 shows our estimates of the catalytic effects of air transport on tourism in Europe over the next twenty years. Just as over the last several years, the impact of air transport on tourism is negative in the current EU-15 and positive in the Accession-10 accession economies.

4.2 Trade Impacts

Key points.

- As with tourism, it is the net impact of trade carried by air (exports minus imports) that is our metric for the economic catalytic effects of air trade.
- On this basis, **trade by air makes a small positive contribution to GDP across the EU-25**, accounting for most of the overall surplus on the current account of the balance of payments. That positive contribution is expected to increase in years to come.
- But air trade makes a small negative contribution to GDP in the ten accession economies, and that negative contribution is expected to get more negative in years to come.
- The difference between the Current EU-15 and the Accession-10 reflects the fact that air transport facilitates general trade flows, and the Current EU-15 have a surplus on the current account of the Balance of Payments (they are net savers), while the Accession-10 have a deficit (they are net borrowers).

Our general approach to measuring the catalytic impact of air transport on trade is analogous to the impact on tourism (details of our approach are set out in Appendix C):

- We focus on the value of goods carried by air.
- As with tourism, our approach requires an estimate of the net impact on trade after allowing for imports carried as well as exports.
- We look at all imports and exports carried by air, rather than only those that would not have taken place in the absence of air transport.

Trade impacts over the last decade

Only a tiny proportion of the *volume* of all international trade (by weight) is carried by air – just 0.4% of extra-EU trade for the current EU-15. But the *value* share of air cargo is far higher, because the average tonne of air cargo tends to be far more valuable than the average tonne of road or sea cargo. Eurostat estimates the value share of extra-European air cargo at 20%, while IATA puts it as high as 40%. We use the Eurostat figures in this paper, so as to err on the side of caution when estimating the impact of air transport on the European economy.

As with air tourism, and for the same reasons, it is the contribution of air trade to the overall net trade position in Europe that is our metric for the economic catalytic effects of air transport via trade. Clearly, many European exporters rely on air transport as their preferred

mode to provide access to foreign markets. But the same holds true for foreign exporters accessing European markets. So the demand-side economic catalytic impact of air trade is purely its impact on the overall net trade position – the extent to which air trade contributes to GDP.

Again, as with the tourism effects, a proportion of the international trade that is carried by air would be carried by other modes of transport in the event that air transport services were not available. But it is hard to be sure how large this proportion is and, since it is carried by air at present, it is in that sense dependent on air transport services. As with tourism, we believe that our approach, counting the whole of trade that is carried by air as the contribution of air transport via trade, is the clearest and simplest way to calculate these effects.

As Chart 4-3 shows, the net trade position of the Current EU-15 is to a large extent accounted for by net trade carried by air in that region. For the Accession-10 (Chart 4-4), the air trade deficit is small compared to the overall trade deficit.

Chart 4-3

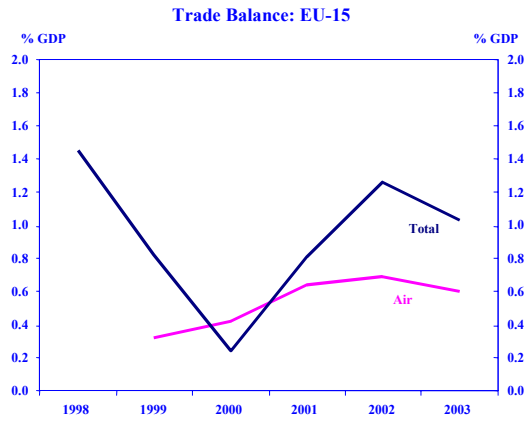
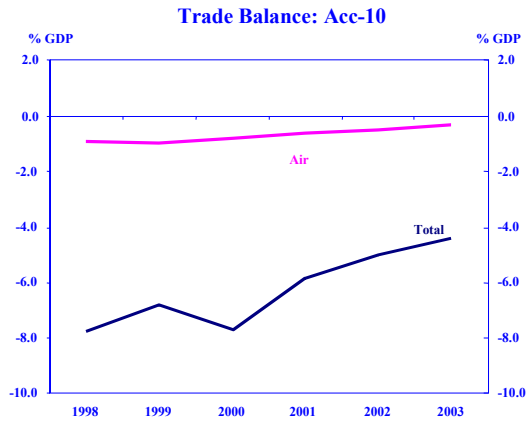


Chart 4-4



The value of extra-European air cargo (inbound and outbound) tells us the size of the direct catalytic effects of air transport on trade in goods at the country level. Table 4-3 summarises the Eurostat data on the *value* of extra-EU goods trade by mode of transport for 2003.

Table 4-3: The value of EU trade, 2003

Millions of euros	Total Exports	Total Imports	Total Exports by Air	Total Imports by Air	Net Impact of Air Trade	Net Impact as a percentage of GDP
EU-25	2,631,978	2,555,287	307,988	253,830	54,158	0.6
EU-15	2,449,212	2,353,112	304,763	249,018	55,745	0.6
Acc-10	182,766	202,176	3,225	4,812	-1,587	-0.4

Source: Eurostat, Comext, OEF calculations

As with the tourism effects above, the fact that the catalytic impact of air trade on GDP is negative in the Accession-10 and small (relative to the absolute size of trade) for the current EU-15 and for the EU-25 as a whole does not imply that air trade is negative or negligible for welfare. For one thing, in many countries the ability to export and import by air is deeply embedded in the industrial structure of the economy, so that potentially costly structural changes would be necessary if that ability were restricted. Moreover:

More trade implies more choice, and choice enriches people. Improved transport, including air transport, means that goods and services that were difficult or impossible for our grandparents to buy (particularly perishable or for other reasons time-critical goods and services) are now readily available at a reasonable price. We are better off because we can order a new computer from another country (to mention just one example) and have it delivered to our door within a few days – even though that import will contribute negatively to our GDP.

- **The jobs and value added accounted for by those who make air trade possible** also make an important contribution to their domestic economies – a contribution not picked up in the net trade figures.
- **Growth in trade overall makes a significant contribution to economic productivity growth**. To the extent that this is true, it will be captured in the investment and productivity effects described below.

There are other very important impacts of air transport via trade over-and-above the impacts on goods exports and imports considered here. In particular, economists place a high value on the benefits of international trade in facilitating world growth regardless of whether there is a net addition to demand in any particular economy. (By definition, there cannot be a net addition to demand in aggregate across the whole world.) These benefits stem from the scope for increased specialisation and economies of scale, competition, technology transfer, and so on, resulting in an increase in the overall efficiency of economic activity. In terms of our categorisation of the channels through which the impact of air transport is felt, therefore, this means that facilitating trade should increase underlying productivity in the European economy, and we consider the methodology for estimating such effects among the supply-side catalytic effects below.

One other effect of air transport on trade that we might consider is the impact of international business travel in facilitating international trade through making it easier for companies to deal with counterparties in other countries. This is the main way in which air transport impacts on trade in services (apart from the special case of tourism) since air services are not needed to transport the services themselves. But it can also provide a channel through which air transport facilitates trade in goods over-and-above those goods that are transported by air (which will already be picked up by the analysis proposed above), since there is no reason why goods should not be transported by road, sea, etc after being sold as a result of an air trip. These are not easy effects to estimate, however, and we believe the practical approach is to accept that we may be understating the impact of air services on trade as a result of excluding these effects, just as we may be overstating them by assuming that all international freight carried by air is an addition to the trade that would take place in the absence of air transport.

Trade impacts to come

Table 4-4: Catalytic effects of air transport on trade in the EU-25

	2003	2010	2015	2020	2025
EU-25			**€bn, 2003 prices**		
Exports by air	308.0	424.3	495.4	603.0	673.3
Imports by air	253.8	301.7	333.5	387.6	422.6
Air trade balance	54.2	122.5	161.9	215.4	250.6
			Air trade balance % of GDP		
EU-25	0.6	1.1	1.2	1.5	1.5
EU-15	0.6	1.1	1.3	1.6	1.7
Acc-10	-0.4	-0.5	-0.6	-0.7	-0.7

Table 4-4 shows our estimates of the economic catalytic effects of air transport on trade in Europe to come over the next twenty years. Just as over the last several years, the impact of air transport on trade is positive in the current EU-15 and negative in the Accession-10 economies.

4.3 Impacts on company location / investment decisions

Key points

- Business investment is boosted by improved provision of air transport services – better air transport services encourage more businesses to locate in a region, and encourage existing businesses to expand in that region.
- The overall effect of the growth in air transport usage over the last decade has been positive, boosting business investment by 5.6% across the EU-25, and by 13.7% in the Accession-10.
- The expected growth in air transport usage in years to come means that positive effect is likely to increase – with EU-25 business investment boosted by 3.3% by 2025 (boosting GDP by 1.1% in the long run) and by 4.9% for the Accession-10 (boosting GDP by 1.7% in the long run).

The economic catalytic impacts on business investment can be split into two effects.

- The extent to which the amount of investment that takes place is higher both by foreign firms and by companies already based in the area (investment decisions).
- The extent to which companies locate near airports to take advantage of the benefits which accessibility to airports provides (location decisions).

Ideally, in looking to quantify both of these impacts, we would undertake a detailed survey of businesses around airports, analysing how their location and investment decisions have been affected. Indeed, the Economic Impact Study Kit by York Consulting[6] suggests that catalytic impacts are best described in qualitative terms, citing surveys on the attitudes to business locations, surveys of business location factors and surveys on the impact of airports on location decisions.

Such survey work is, however, expensive and beyond the scope of this project. In its absence, our approach is based on quantitative econometric analysis of the impact that air services have on business investment decisions. A recent ACI report[7] offers some supporting evidence here, setting out the foreign-owned firms in the vicinity of Brussels International Airport, together accounting for 34% of the total value added of the Flemish Brabant province. Many of these companies (Table 4-5 below) are active in sectors identified in the report as 'air intensive'.

[6] Creating employment and prospects in Europe: an economic impact study kit, ACI Europe / York Consulting, February 2000

[7] The social and economic impacts of airports', 2004, ACI and York Consulting

Table 4-5: Foreign-owned firms in the vicinity of Brussels International Airport

Firm	Sector	Ownership
3M	Office equipment	USA
Air Liquids	Industrial gases	France
Air Products	Industrial gases	USA
Alco Nobel Coatings	Plastics	Netherlands
Asea Brown Bovery	Heat exchangers	Switzerland
Bandag	Plastics	USA
BASF Coatings	Plastics	Germany
Bostitch	Office equipment	USA
Caterpillar	Building equipment	USA
Exel Logistics	Logistics	Great Britain
Exxon Chemical	Plastics	USA
Galbani	Food	Italy
Gervais Danone	Food	France
Grohe	Building equipment	Germany
Komatsu	Building equipment	Japan
Minolta	Office equipment	Japan
Nestle	Food	Switzerland
Panasonic Battery	Batteries	Japan
Procter & Gamble	Chemicals	USA
Pfizer R&D	Pharmaceuticals	USA
Unilever	Kitchen equipment	Netherlands

Source: York Consulting

Impact on investment over the last decade

We have used econometric techniques to examine whether **air transport usage** (scaled by GDP) – both passengers and freight - has an effect **on the level of business investment**. This research is based on data across 24 European countries (cross-section) and over 10 years up to 2003 (details in Appendix E). This research essentially involves looking for correlations between air transport usage and business investment, once we have controlled for the effects on business investment from its other key drivers. Ideally, we would be able to identify separate effects (on investment and on underlying productivity – see below) coming from improvements in the air transport infrastructure and from the transport infrastructure overall. However, these two concepts are closely correlated, so it is difficult to separate the effects. Moreover, in our view, it is increasingly the case, as the world becomes more 'globalised', that the provision of good international transport links – to a large extent focused on air transport – that provides the channel for the substantial impacts on investment and underlying productivity that we identify below. But we should acknowledge that our focus on air transport rather than transport overall is a possible source of bias in our estimates.

'Air transport usage' is a concept that we refer to frequently in the text below. Because it is difficult to identify separate effects in the econometrics for variables that are closely related to each other, we combined the number of air passengers and the volume of air freight into a single index. In line with the recommendations at the start of the project, we have taken ten air passengers to be 'equivalent' to one metric tonne of air freight. The combined index,

called ‘air transport usage’, is in (notional) units of ‘metric tonne equivalents’, or Work Load Units. Our measure of air transport usage includes all air passengers, whether business or leisure. Ideally, we would separate out business passengers from leisure passengers, since most of the effects on investment are likely to come from the provision of air services for business passengers. However, data constraints meant that this was not feasible for this project. And we do not believe that this is a major issue that affects our conclusions below – our conclusions are sound as long as the relationship between business passengers and air freight on the one hand and leisure passengers on the other is broadly consistent over time.
To estimate the impact of air transport usage on investment (and underlying productivity – see below), we have divided our measure of air transport usage in each country by GDP in that country. The purpose of doing this is to try and exclude from our estimation any effects that might be working in the opposite direction: it is likely that air transport usage will be higher in countries where GDP (and therefore investment and possibly underlying productivity too) is higher, just because those economies have more people and/or more wealth per person. By dividing air transport usage through by GDP, we aim to strip out these effects, so our model gets hold of the true impact of increased air transport usage on investment and on underlying productivity.

As in most models of business investment, in our model, business investment is driven in large part by the relationship between the cost of capital and the return on capital. But the innovation in our model is to include ‘air transport usage’ among the long-run drivers of business investment. **The model implies that if air transport usage increases by 10% (relative to GDP) then business investment will tend to increase by 1.6% in the long run.**

What does this imply for the contribution of air transport to the European economy via business investment?

For Europe as a whole, **air transport usage** increased by 5.1% a year over the last decade, compared with an increase of around 2% a year in GDP over the same period. Translating the relatively fast growth of air transport usage via our model, we find that air transport usage contributed just under one-third of the growth in European business investment over the last decade. Average annual growth in business investment was 0.6% points higher over the last decade than it would have been had air transport usage grown no faster than GDP.

Chart 4-5

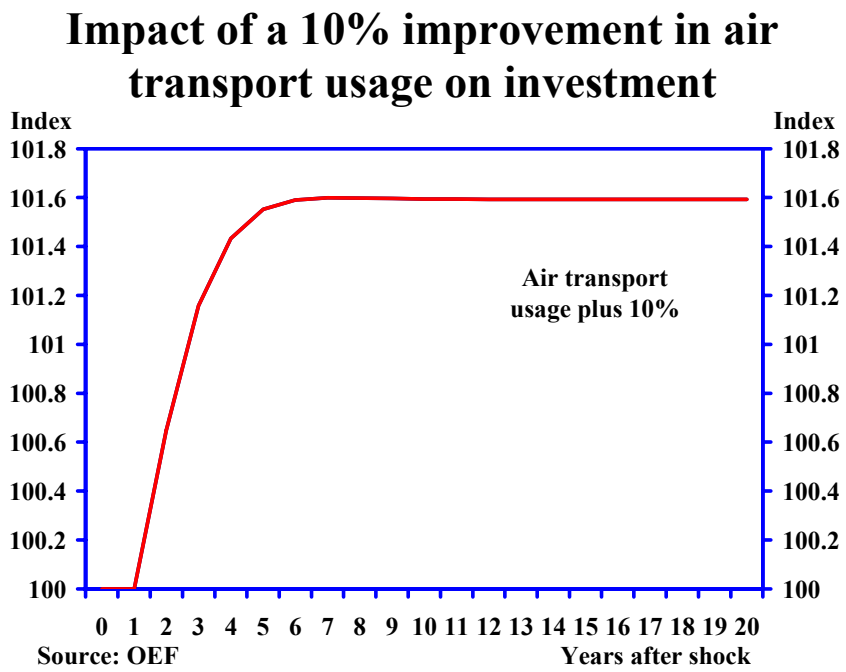


Table 4-6 summarises the impact of air transport (usage and connectivity) on business investment over the last decade.

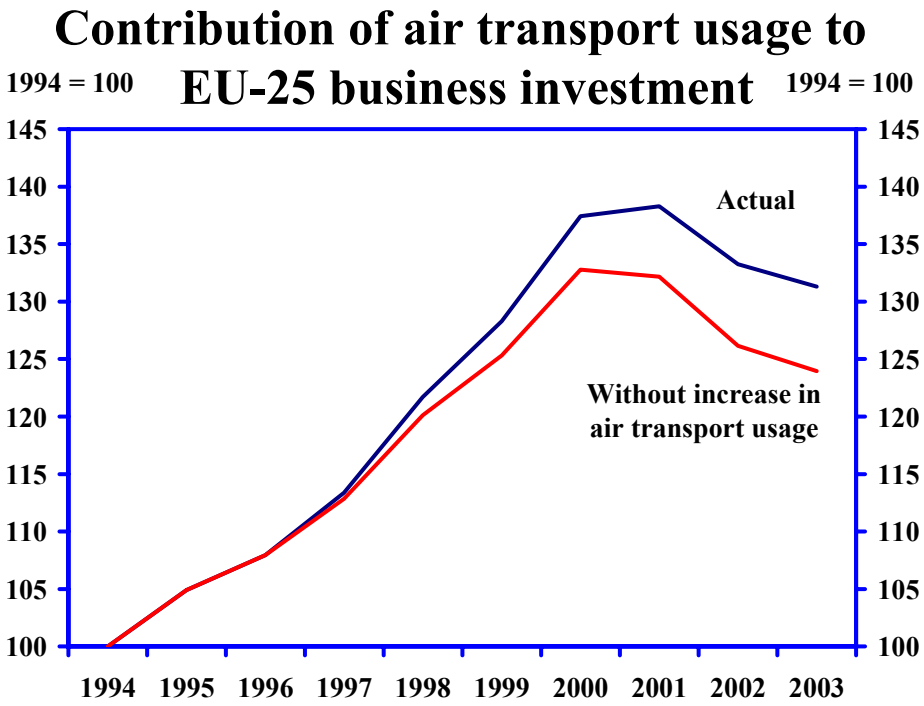
Table 4-6: Effect of air transport on investment and GDP in Europe

	EU-25	EU-15	Acc-10
Annual growth rates			
Air transport usage* 1994 - 2003	5.1%	5.0%	7.3%
Contributions			
Long-run contribution of air transport usage to the level of investment (%)	+5.8%	+5.2%	+13.7%
Long-run contribution of air transport usage to the level of investment today (€ bn)	+ €66 bn	+ €56 bn	€10 bn

* Weighted sum: air passengers * 0.1 + air cargo (metric tonnes)

Chart 4-6 shows the actual path of business investment in the EU-25 since 1994, and our estimate of how it would have evolved if air transport usage had remained flat at its 1994 level throughout that period.

Chart 4-6



Examining the propensity to locate near airports

Our model picks up the impact of air transport on total investment. That overall effect will reflect the impact on both investment decisions by companies already located in the region, and location decisions by companies deciding whether or not to locate in the region. The overall impact is large. That is borne out by the importance of airports in influencing business location decisions, which is well-recognised in many airport studies. Findings from surveys stress the importance of air transport links, relative to other factors that affect location decisions, such as the quality and availability of labour, property and land costs, the quality of other infrastructure such as telecommunication, the road or rail network and a whole host of other factors. Table 4-7 illustrates the findings from one such survey by Healey and Baker, which found that 56% of respondents considered international transport links (by all modes including air) to be an absolutely essential factor for locating businesses in 2003.

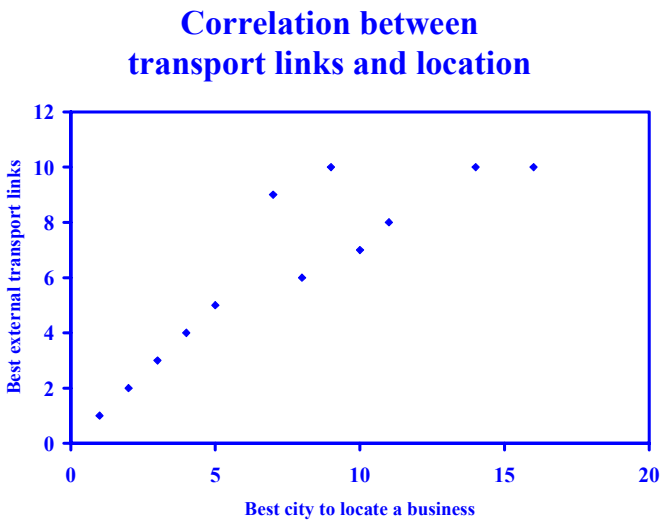
Table 4-7: Essential factors for locating a business

	% of respondents reporting factor as "absolutely essential"	
	2002	2003
Easy access to markets, customers or clients	57	58
Availability of qualified staff	59	57
Transport links with other cities and internationally	**51**	**56**
Quality of telecommunications	46	49
Climate governments create for business through tax and the availability of financial incentives	34	33
Cost of staff	32	35
Value for money of office space	30	31
Availability of office space	27	26
Ease of travelling around within the city	21	24
Languages spoken	20	24
Quality of life for employees	18	15
Freedom from pollution	12	14

Source: Healey and Baker

From the same survey, it is striking that the top 10 cities ranked best for external transport links with other cities and internationally are also rated highly in terms of where to locate a business (see Chart 4-7 below). Transport links in this case include all modes – air, road, rail and sea – but, as the question emphasises international links, air travel is likely to be most significant to respondents.

Chart 4-7



Impact on investment in future

In this section, we explore the impact of air transport usage on investment growth in Europe to come over the next twenty years, under two alternative scenarios. The first scenario makes the cautious assumption that the impact of air transport usage on business investment will diminish in years to come compared to the previous decade. Although we have found no statistical evidence of such diminishing returns in the data, we believe it is sensible to assume that they exist all the same, and will start to have an influence over a twenty-year horizon, so our benchmark scenario assumes diminishing returns in future. For reference, the alternative scenario (without diminishing returns) shows what the impact of air transport on investment would be if we did not make an assumption about diminishing returns.

Table 4-8: forecast impact of air transport usage on business investment

	Impact on business investment					
	2015			2025		
	EU-25	EU-15	Acc-10	EU-25	EU-15	Acc-10
with diminishing returns	1.9%	1.9%	2.7%	3.3%	3.2%	4.9%
without diminishing returns	2.9%	2.8%	3.4%	4.9%	4.7%	6.2%

The table makes clear that the impact is larger for the Accession-10 than for the current EU-15, because the assumed growth in air transport usage is more rapid in the Accession-10 over the forecast period, as it has been over the last decade.

The effects are substantial. For example, business investment in the EU-25 is expected in our benchmark forecast to be 3.3% higher by 2025 (boosting GDP by 1.1% in the long run) than it would be were air transport usage to grow only as fast as GDP over the forecast period. In fact, air transport usage grows faster than GDP throughout the forecast period, to end up some 32% higher by 2025 than it would be were it to grow in line with GDP. In the Accession-10, in our benchmark case, the impact is to boost investment by 4.9% by 2025 (boosting GDP by 1.7% in the long run).

The impact on the *level* of business investment gradually builds up over the whole forecast period, boosting average annual *growth* in business investment by around 0.2% per year (EU-25). And the impact on the Accession-10 is likely to be even more pronounced: air transport is set to grow more rapidly, for one thing; and, for another, it starts from a lower base in proportion to GDP than in the more mature EU-15, and hence the returns to increased air transport usage do not diminish so rapidly in the Accession-10 as in the EU-15.

4.4 Underlying Productivity Impacts

Key Points

- Underlying productivity is boosted by improvements in the provision of air transport services. Better air transport services mean firms are better able to exploit economies of scale, can access a wider pool of labour, and are exposed to foreign competition that encourages innovation and efficiency.
- The rapid growth in air transport usage over the last decade has boosted long-run underlying productivity by 2.0% across the EU 25, and by 4.6% in the Accession-10.
- And the impact is expected to become more positive in future, with EU-25 productivity a further 0.6% higher by 2025 thanks to the expected growth in air transport usage.
- The rapid expected growth in air transport usage in the Accession-10 means the impact there is expected to be even larger, boosting underlying productivity by 1.0% by 2025.

Air transport can improve business operations and productivity, by increasing the potential market in which companies operate, thereby allowing them to exploit economies of scale, and by allowing next-day international delivery of product or inputs etc.

Business surveys provide one way to estimate the importance of these effects. However, such surveys are expensive to conduct and beyond the scope of this project.

The alternative approach pioneered by OEF in its study on the economic importance of the UK aviation industry[8] is based on econometric analysis of the relationship between the use of air transport and underlying productivity - what economists call 'total factor productivity' (see Appendix D). Underlying productivity captures changes in GDP over-and-above those that simply reflect changes in the amount of labour and capital inputs – it measures the overall efficiency with which labour and capital are employed in producing GDP.

In our UK research, we analysed this relationship across 27 industrial sectors. We found that a 10% increase in the provision of transport services increases overall UK productivity by 1.3%. This is towards the lower end of the range of estimates from other studies looking at the impact of the transport infrastructure on underlying productivity, which suggest that a 10% increase in transport services might be expected to increase underlying productivity by 0.5-4%.

For this study, we have estimated the relationship between underlying productivity and air transport usage, on the basis of information for 24 different EU countries over 10 years.

Technical details of the regression are included in Appendix F. The model suggests that air transport usage plays an important role in influencing underlying productivity in the long run – along with research and development spending, educational standards and some country-specific effects.

Underlying productivity impacts over the last decade

Our model says that a 10% increase in air transport usage (scaled by GDP) will increase underlying productivity by 0.56% in the long run.

Chart 4-8 below shows how a 10% increase in air transport usage affects underlying productivity according to our model. The chart makes clear that the impact on underlying productivity takes a very long time to come through in full. The long-run impact of a 10% improvement in air transport usage would be a 0.56% increase in underlying productivity – but after twenty years, only three-quarters of that increase has come through.

[8] The contribution of the aviation industry to the UK economy, OEF, November 1999.

Chart 4-8

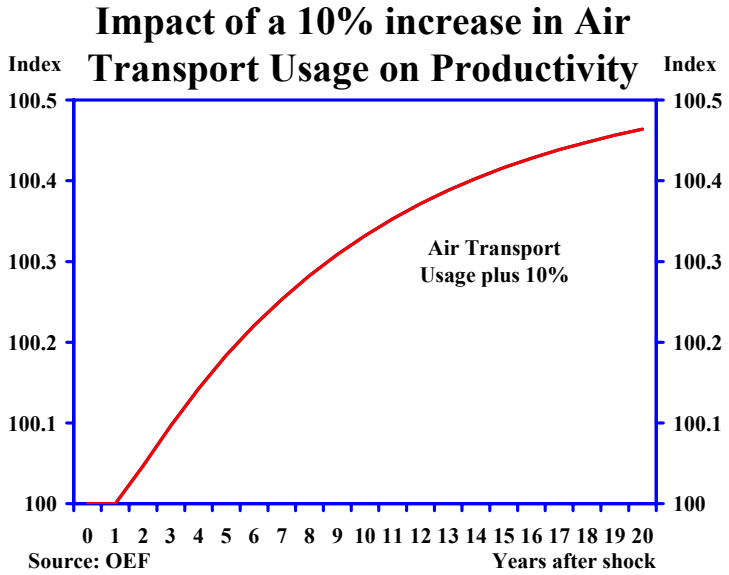


Table 4-9 summarises the implications of our model for the contribution of air transport to underlying productivity in Europe today (note that, given the long lags in the chart above, there may still be some effects in the pipeline, not reported in this table, if air transport usage and connectivity remain at their current levels).

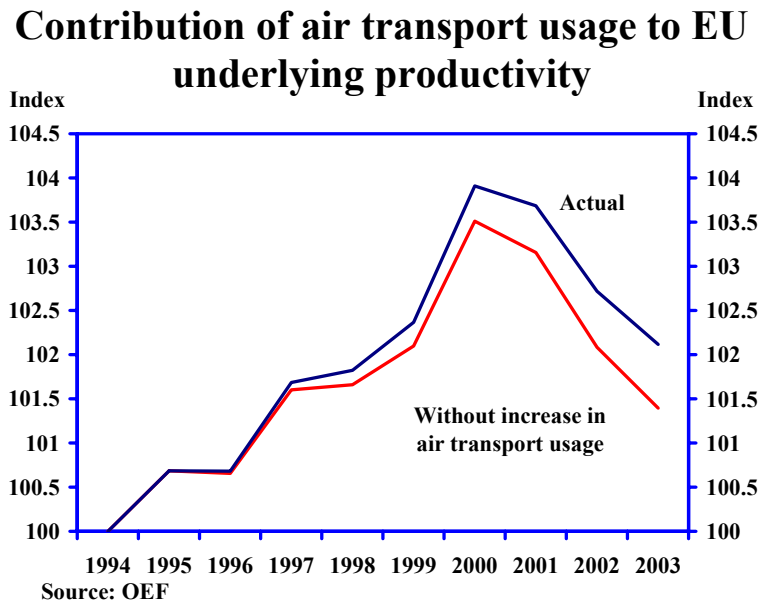
- For the **EU-25** as a whole, the impact of overall air transport usage over the last decade raises the level of underlying productivity by 2.0% in the long run.
- The contribution of air transport usage is **more pronounced for the Accession-10 than for the current EU-15**, because the growth in air transport usage has been so much more rapid there.

Table 4-9: Annual growth rates 1994 – 2003, and contributions to underlying productivity

	EU 25	EU-15	Acc-10
Air transport usage, average annual growth %	5.1%	5.0%	7.3%
Overall effect of air transport on the level of underlying productivity in the long run (%)	+2.0%	+1.8%	+4.6%

Chart 4-9 below shows how underlying productivity in the EU-25 actually evolved since 1994, and contrasts it with how it would have evolved had air transport usage remained at its 1994 levels. Without the increase in air transport usage underlying productivity would have been significantly lower.

Chart 4-9



Underlying productivity impacts in future

In this section, we explore the impact of air transport usage on underlying productivity growth in Europe to come over the next twenty years. Table 4-10 below shows the percentage contribution to the level of underlying productivity in 2015 and 2025 attributable to the growth in air transport usage between now and 2025 in each of the EU-25, the current EU-15 and the Accession-10.

As with the investment effects above, we show two cases. The first, cautious, case assumes that the impact of air transport usage on underlying productivity diminishes over the next twenty years compared to the last decade. In fact, we have found some evidence to this effect in the data, suggesting that the impact has already waned to some extent for those economies where air transport usage is already high. Our benchmark forecast assumes that it diminishes even further in years to come. For reference, the alternative case shows the impact on underlying productivity if the effect of air transport usage does not diminish any further than it already has for the current EU-15.

Table 4-10: forecast impact of air transport usage on underlying productivity

	Impact on underlying productivity					
	2015			2025		
	EU-25	EU-15	Acc-10	EU-25	EU-15	Acc-10
with diminishing returns	0.3%	0.3%	0.4%	0.6%	0.6%	1.0%
without diminishing returns	0.4%	0.4%	0.4%	0.9%	0.9%	1.1%

As with the effects on investment, the impact on underlying productivity is larger for the Accession-10 than for the current EU-15, partly (again) because the assumed growth in air transport usage is more rapid in the Accession-10 over the forecast period, as it has been over the last decade. However, the Accession-10 also benefit over the forecast period because they are not running into diminishing marginal returns to air transport usage, in terms of its effect on underlying productivity, as rapidly as are the current EU-15: the biggest gains from increased air transport usage are still there for the Accession-10, but for the current EU-15, those gains have to some extent already been made.

Once again, the effects are substantial, with growth in air transport usage boosting underlying productivity by 0.6% by 2025 (EU-25).

4.5 Summary of Economic Catalytic Effects of Air Transport in Europe

To calculate the overall impact of air transport on GDP, we have to take the following steps: Add together the **demand-side** impacts via tourism and trade.

On the **supply-side**, translate the impact on investment into an impact on GDP, as follows. A 1% increase in the flow of **investment** will contribute a much smaller proportional increase in the capital stock of the country concerned. If the flow of investment is held 1% higher permanently, then the capital stock will eventually converge on a 1% higher level too. But that process can take a very long time, and it is the impact on the capital stock that matters for GDP – a 1% increase in the capital stock translates into a 0.35% increase in GDP.

By contrast, any impact on **underlying productivity** passes straight through to GDP in full. However, underlying productivity is itself very slow to converge on its new, higher level – after 20 years it gets about three-quarters of the way there.

Table 4-11 below summarises our estimates of the contribution of air transport to GDP in Europe, via demand-side effects and supply-side effects. Taking the demand-side and the supply-side effects together, the impact of air transport over the last decade on GDP today is worth a total of €410 billion. That is 4.0% of GDP in the EU-25. The effects are even more pronounced for the Accession-10, where the impact of air transport on GDP is around 9.4%.

Table 4-11: Contribution of air transport to GDP over the last decade

	EU 25	EU-15	Acc-10
Demand-side effects in 2003			
Overall demand-side effect of air transport on the level of GDP in 2003 (%)	0.2%	0.2%	0.0%
Overall demand-side effect of air transport on the level of GDP in 2003 (billion euros)	24	24	0
Supply-side effects of air transport growth over the last decade*			
Long-run supply-side effect of air transport growth over the last decade on the level of GDP (%)	+4.0%	+3.6%	+9.4%
Long-run supply-side effect of air transport growth over the last decade* on the level of GDP today (billion euros)	+410	+340	+50

Table 4-12 below summarises our estimates of the impact of air transport usage over the next twenty years on GDP in the long run, via demand-side effects (on tourism and trade) and supply-side effects (on investment and underlying productivity, translating the investment impact into an impact on GDP as above).

Table 4-12: Summary of impacts of air transport usage on GDP to come

Demand-Side Impact on GDP

	2015			2025		
	EU-25	**Old-15**	**New-10**	**EU-25**	**Old-15**	**New-10**
Tourism effects	-0.2%	-0.3%	0.2%	-0.2%	-0.2%	0.1%
Trade effects	1.2%	1.3%	-0.6%	1.5%	1.7%	-0.7%

Supply-side impact on GDP

	2015			2025		
	EU-25	**EU-25**	**Acc-10**	**EU-25**	**EU-15**	**Acc-10**
with diminishing returns	1.0%	0.9%	1.3%	1.8%	1.7%	2.7%
without diminishing returns	1.4%	1.3%	1.6%	2.6%	2.5%	3.3%

5 Conclusions

This paper has set out a clear methodology for quantifying the economic catalytic impacts of air transport in Europe. Table 5-1 summarises our conclusions, where the future figures are the impacts in 2025 under our benchmark forecast assuming diminishing returns to air transport in terms of the supply-side catalytic effects that it generates.

- **Demand-side effects over the last decade** (via net air tourism and net air trade) have been small, or zero in the case of the Accession-10.
- **Demand-side effects in future** are expected to be more significant – bigger positives for the EU-25 as a whole and for the current EU-15 within that, but bigger negatives for the Accession-10.
- **Supply-side effects over the last decade** (via investment and underlying productivity) have been significant, increasing GDP by 4% in the long run.
- The growth in air transport out to 2025 is expected to contribute still more to the supply-side of the European economy, boosting EU-25 GDP by 1.8% in the long run.

The supply-side impact on the EU-25 as a whole is significant already. For Europe as a whole, we therefore find that the long-run effect of the growth in air transport usage over the last decade is to increase the level of GDP by 4.0% each year, or by 410 billion euros. That is more than twice the total value added by the machine tools sector in the EU (1.6% of GDP in 2001), or more than half of the value added by the motor vehicles and parts sector (7.1% of GDP in 2001).

The supply-side benefits of air transport are likely to increase further in the EU over the next 20 years. But the impact is likely to be particularly pronounced in the ten accession economies, where the current provision of air transport services is least developed, and the growth in air transport is most rapid. These economies have the most to gain from improvements in air transport services – nearly twice as much as the fifteen more-developed economies with mature air transport sectors who are already members of the European Union.

The economic catalytic effects of European air transport should be seen as part of the total contribution that air transport makes to European economies – including the direct and indirect effects on employment and output. These are important beneficial effects for the European economy, although we do not attempt to quantify them in this paper. An ACARE study that does quantify these effects, estimates them to be worth 2.6% of European GDP in 2000.

However, it should be emphasised that the economic catalytic contribution of air transport to GDP is bigger than its combined direct, indirect an induced impact.

Future research in this area could usefully address the question of whether air transport usage adequately captures the changes in the provision of air services: there is a sense in which this measure reflects demand for air transport as much as it does supply – and it may be that examining a supply-side measure, such as air 'connectivity', would yield further interesting insights into the role of air transport.

Table 5-1: Summary of economic catalytic impacts of air transport in Europe

	EU-25		EU-15		Acc-10	
Demand-side effects *(impact of net outbound tourism and trade flows by air on GDP)*						
	2003	2025	2003	2025	2003	2025
Net Tourism Effects	-0.3%	-0.2%	-0.4%	-0.2%	+0.4%	+0.1%
Net Trade Effects	+0.6%	+1.5%	+0.6%	+1.7%	-0.4%	-0.7%
Total demand-side catalytic impacts, % GDP	+0.2%	+1.3%	+0.2%	+1.5%	0.0%	-0.6%
Total demand-side catalytic impacts, (€ bn, today's prices)	+24	+186	+24	+195	-0	-9
Supply-side effects *(contribution of growth in air transport usage)*						
	2003	2025	2003	2025	2003	2025
Location and investment decisions (impact on GDP, %)	+2.0%	+1.1%	+1.8%	+1.1%	+4.8%	+1.7%
Business operations and productivity/market structure and innovation (impact on underlying productivity, %)	+2.0%	+0.6%	+1.8%	+0.6%	+4.6%	+1.0%
Long-run supply-side impact on GDP, %	+4.0%	+1.8%	+3.6%	+1.7%	+9.4%	+2.7%
Long-run supply-side impact on GDP, (€ bn, today's prices)	+410	+200	+340	+170	+50	+30

Appendices

Appendix A: Our approach to calculating tourism effects

When calculating the catalytic impact of air tourism in the main body of the text above, we drew attention to a number of clarifications that were necessary before these calculations could be completed. These are set out below.

What do we mean by tourism?
In accordance with the definition used by the World Tourism Organisation, 'tourism' covers visitors travelling outside their normal environment - in other words, it includes business travellers and people visiting friends and relations, as well as those travelling on holiday. In principle, it would be possible to incorporate different assumptions about average spending for different types of visitors, but data limitations mean that in practice it is more appropriate to apply an overall average. It is possible, however, to take account of differences in the average spend by inbound/outbound tourists to/from each of the EU25 countries.

b) Should the impact on outbound tourism be netted off, rather than just looking at the impact on inbound tourism?

All the airport studies we have looked at that have estimated tourism effects have focused on the impact of inbound tourism. However, air transport facilitates local residents visiting distant locations just as much as it facilitates people travelling from a distance to visit the local area. We therefore base our measurement of the catalytic impact of air services through tourism on the net impact on spending once both inbound and outbound visitors are taken into account. As with inbound tourism, the impact on outbound tourism is measured by combining an estimate of average spending per visitor with the number of outbound visitors travelling by air.

This does, of course, have a significant impact on the estimates. For the UK and Belgium, for example, netting off the effects of outbound tourism leads to a significantly negative estimate of the catalytic effect of air transport through tourism on demand and GDP (and, indeed, the same is true for the EU as a whole, as we detail below). This does not mean that the impact of air transport on UK tourism is a bad thing – there are several reasons why greater international tourism can be beneficial even if it has a negative impact on demand in the economy. These include, for example, the following beneficial effects of tourism:

- Improving living standards by widening choice and increasing access to foreign travel.
- Increasing understanding of different cultures and nationalities.
- Direct benefits to airports and the area surrounding airports in terms of jobs and value added.
- Indirect benefits in terms of jobs and value added supported down the supply chain to those direct airport-related jobs.

It does mean, though, that it is wrong to assume that air services necessarily boost tourism demand in the local economy.

Moreover, not all of the revenues that are directed towards outbound tourism escape the country of origin: travel agents and tour operators play a key role in facilitating international tourism, particularly by air. The employment and value added generated by travel agents and tour operators make an important contribution to the whole economy. A study of the contribution of travel agents and tour operators to the UK economy[9] found that they directly employed 104,000 people in 1999, or 0.4% of the total employed population, while the sector contributed some 0.25% of GDP. A large proportion of this contribution is likely to be attributable to foreign holidays involving air travel. The extent to which spending on foreign holidays is captured by the value added of domestic travel agents should be taken into account when calculating the effect on net trade of international air tourism.

What about visits that would have happened anyway without air transport?

Ideally, estimates of the impact of air transport on tourism should exclude the spending of air passengers who would have made the same visit by some other mode in the absence of the appropriate air service. (In traditional appraisal/evaluation terminology this is the 'displacement' effect, which is not part of the net impact of what is being appraised or evaluated.) However, this is not always easy, and existing studies generally focus on all visitors by air rather than only net new visitors.

For some islands it is probably reasonable to assume that none of the visitors would have come in the absence of air transport. But in many other cases there will be considerable uncertainty over how many visitors would still have travelled, no doubt varying according to the length of their journey. One approach would be to split up passengers by country and make an assumption about what proportion in each case would have travelled anyway, ranging from none for inter-continental long-haul flights, upwards. However, we believe a more appropriate assumption for a general study such as this is to disregard domestic visitors on the grounds that they will typically have other means of travel available but to

[9] 'The contribution of travel agents and tour operators to UK plc', OEF, October 1999

include all foreign visitors rather than try to make a potentially controversial distinction between those who would still have come without air services and those who would not.

Is it appropriate to apply a multiplier to the estimated impact on spending?
Estimates of direct spending by visitors can be converted into estimates of jobs supported through assumptions about the amount of spending that is required to support a job in the tourism industry. These are widely used in tourism impact studies, and we apply the standard methodology here. However, there are also second round ('induced') effects from jobs supported by visitor spending, as employees in those jobs themselves support other jobs through their own spending out of the wages and salaries earned. It would be possible to gross up our estimates of the direct jobs impact using an induced jobs multiplier to take account of these second-round effects. But we believe this is unnecessary in the context of catalytic effects, however standard it is in the context of direct and indirect airport and airline jobs.

Appendix B: Tourism calculations

The table below goes through the twelve steps taken to come up with the Belgian and UK country tourist impacts, to illustrate our general approach to calculating the catalytic impact of tourism. Key assumptions are highlighted in bold and discussed below.

Table 6-1

		Belgium	United Kingdom
1	Total Arrivals	Estimate	WTO Data
2	Total Overnight Arrivals	WTO Data	Estimate (Data not required)
3	Arrivals by Air	WTO Data	WTO Data
4	Total Inbound Expenditure	WTO Data	WTO Data
5	Average Expenditure per Arrival	(4)/(1)	(4)/(1)
6	Expenditure by Air Arrivals	Estimate: (5)*(3)	Estimate: (5)*(3)
7	Departures	WTO Data	WTO Data
8	Departures by Air	Estimate: (7)*(3)/(1)	Estimate: (7)*(3)/(1)
9	Total Outbound Expenditure	WTO Data	WTO Data
10	Average Expenditure per Outbound tourist	(9)/(7)	(9)/(7)
11	Expenditure by Air Departures	Estimate (10)*(8)	Estimate (10)*(8)
12	Net Tourism by Air	(6)-(10)	(6)-(10)

For some countries, including Belgium, the WTO data does not have a total arrivals figure, but just one for overnight arrivals. It is therefore necessary to scale up the overnight arrivals figure so that an average spend per visitor figure can be calculated. We do this for Belgium by taking an average ratio of overnight arrivals to total arrivals for the countries where these data are available: on average, overnighters make up 40% of total arrivals. To illustrate the sensitivity of the results to this assumption, if the real figure for Belgium were 10% lower than this, then the net tourist impact would be –0.46% of GDP rather than –0.6%. If it were 10% higher, the net impact would be –0.76%.

The other key assumption is that assume that the ratio of those departing by air to total departures by all modes of transport is the same as the ratio of those arriving by air to total arrivals by all modes of transport. So in the UK, the ratio of air to total arrivals and departures is 70.3%. We can compare this to the estimate from the ONS International Passenger Survey (IPS) data. It turns out the ratio according to this survey is 73.8% - fairly close to the estimate above. Adopting the IPS estimate would change the net UK impact from –0.99% to –0.96%.

We also attempt to verify these figures more generally by looking at international terminal passenger data and dividing by two, to get the total number of trips, both arrivals and

departures. Subtracting arrivals by air then yields another estimate of the number of departures.

Comparing arrivals and departures estimates

Data on the Eurostat website allow us to do this for major airports, including those in the table below:

Table 6-2

	Number of passengers			
Reporting Airport	1998	1999	2000	2001
(A) Brussels Airport total passengers	18,478,779	19,998,238	21,586,961	19,785,859
(B) A / 2 – number of trips	9,239,390	9,999,119	10,793,481	9,892,930
(C) Belgium Arrivals by Air (WTO)				8,153,000
(D) Belgian Departures by Air (B – C)				1,739,930
(E) OEF alternative calculation				3,711,542
BIRMINGHAM airport total passengers	5,421,016	5,768,010	6,278,875	6,540,406
MANCHESTER/INTL airport total pass.	14,555,699	14,727,022	15,459,702	16,248,500
LONDON LUTON airport total passengers	3,263,857	3,936,299	4,444,021	4,779,240
LONDON/GATWICK airport total passengers	26,302,885	27,625,617	29040267	28,119,926
LONDON/HEATHROW airport total pass	53,178,850	54,841,515	56,885,371	53,812,881
GLASGOW airport total passengers	3,036,637	3,256,930	3,362,083	3,414,765
EDINBURGH airport total passengers	1,042,180	1,327,869	1,501,815	1,778,692
LONDON/STANSTED airport total pass.	5,601,879	7,951,975	10,438,892	11,635,472
Other airports from UNITED KINGDOM	13,083,121	14,025,121	15,384,535	15,909,971
(F) UK Total passengers	125,486,124	133,460,358	142,795,561	142,239,853
(G) F / 2 UK total trips	62,743,062	66,730,179	71,397,781	71,119,927
(H) UK Arrivals (WTO)				16,040,000
(I) Estimate (UK) departures (G – H)				55,065,927
(J) IPS data on UK departures by air				43,011,000

Source: Eurostat, OEF, ONS

If we take this approach, then for the UK the estimated number of departures is around 55 million compared to the IPS estimate of 43 million – quite a big difference. For Belgium, we

don't have a source of departures data to contrast with this approach. But the estimate using this approach (looking just at Brussels International) is for departures by air of 1.7m, compared to the estimate on the basis of assuming the share of air departures is the same as that of air arrivals of 3.7m. To get the figure implied by using the Eurostat data as above, we would have to assume that the share of overnight visits in total visits for Belgium was around 20%. That then would increase the estimate of total arrivals and feed through to a lower estimate of departures by air.

Appendix C: Our approach to calculating trade effects

In principle, only analysing trade flows that would not otherwise have taken place in the absence of air transport would be desirable, but as with tourism there are problems with doing this. For express air deliveries, it is probably reasonable to assume that all trade is a result of the availability of air services, rather than being transferred from other modes of transport. For general freight it is less clear. However, given the high cost of air freight compared with other modes and the consequent high value-added to weight nature of the freight carried, we believe it is appropriate to look at all imports and exports carried by air, as has been done in existing airport studies where trade impacts have been considered.

Appendix D: Underlying productivity (total factor productivity)

To understand the concept of underlying productivity, or total factor productivity (TFP), consider an illustrative European firm that employs 1,000 people, has fixed capital worth 150 million euros and produces value added (the sum of wages and profits) each year worth 60 million euros. What is the total factor productivity of this firm? The answer depends on how we believe the factors capital and labour are combined. One common way to think about the combination of capital and labour – which we adopt in this paper – is in the context of what is known as a Cobb-Douglas production function. This has the following form:

$Y = AK^{\alpha} L^{\beta}$

In this equation, Y is value added, K is the value of the stock of fixed capital, L is the quantity of labour, α and β are parameters that capture the marginal products of capital and labour respectively (the extent to which output would increase given a marginal increase in either factor), and A is total factor productivity – the efficiency with which the different factors are combined. A special form of this production function is where β equals (1 – α). This is known as a 'constant-returns-to-scale' production function, such that a 10% increase in both capital and labour will result in a 10% increase in output. Often, the best way of calibrating the parameter α is to look at the share of value added that accrues to capital – the share of profits in total value added. For our illustrative firm, this equals 35%. So the TFP of our illustrative firm is:

$A = Y/(K^{\alpha} L^{(1-\alpha)}) = 60/(150^{0.35} * 1^{0.65}) = 10.4$

How should we interpret that 10.4? TFP for our illustrative firm is *10.4 euros of output per unit of the combined inputs*, capital and labour, where the production function dictates how

those inputs are combined. Perhaps a more intuitive way of explaining this is to think about the relationship between TFP and output, which is one-for-one: ie a 1% increase in total factor productivity means that a 1% increase in output can be achieved using the same quantities of capital and labour.

What goes for our illustrative firm also goes for whole economies. In this paper, we have assumed throughout a constant-returns-to-scale Cobb Douglas production function with a profit share of 35%.

Appendix E: Detailed estimation results for investment model

The equations that we have estimated to identify the contribution of air transport to business investment and TFP take the form of 'Equilibrium Correction Mechanisms' (ECMs). ECMs are equations structured so as to yield information about both the long-run relationships and trends in the data and the short-run dynamic fluctuations around that long-run equilibrium.

An illustrative ECM equation might look like this (all variables in logs):

$$\Delta y_t = \alpha^0 + \alpha^1 \Delta y_{(t-1)} + \Sigma_{ij} \alpha^2_i \Delta x_{i(t-j)} - \beta \left[y_{(t-1)} - \Sigma_{ij} \gamma_i x_{i(t-j)} \right]$$

In this equation, the left hand side is the growth rate of the dependent variable y – the variable we are trying to model. On the right hand side, the explanatory variables include the constant, α^0, the growth rate of the dependent variable lagged one period, $\Delta y_{(t-1)}$, multiplied by a coefficient α^1, contemporaneous and lagged growth rates of a vector of explanatory variables $\Delta x_{i(t-j)}$, multiplied by a vector of coefficients α^2_i, and the term in the square brackets $y_{(t-1)} - \Sigma_{ij} \gamma_i x_{i(t-j)}$, multiplied by the adjustment coefficient β. The term in the square brackets is a measure of the 'disequilibrium' in the dependent variable: how far away it is from its long-run equilibrium, determined by the relationship between the lagged level of the dependent variable and lagged level terms of a vector of explanatory variables. The coefficient β measures how quickly any disequilibrium is corrected: how long it takes for the long-run equilibrium to be restored.

In English, an ECM equation says at any point in time how far away is the variable of interest from the level at which it will finally end up, and how quickly it is likely to get there.

We have estimated two ECM equations, one for business investment and one for TFP. We report details of each below. The general idea of these equations is to look at the correlations between air transport and either business investment or TFP, once we have controlled for the effect of the other key drivers of those concepts.

One point worth noting that while the adjustment to the long-run equilibrium is relatively fast (β is large) in the case of investment – with more than half of any gap being closed within two years – it is much slower in the case of TFP, where it takes about 6 years for the level of TFP to get half way towards its long-run equilibrium. The effects on TFP of factors like air transport usage can take a very long time to be felt in full.

In both the investment and the TFP equations, **we have used air transport usage divided by GDP** (at purchasing power parities) as the explanatory variable. There are two reasons for this:

First, the number of passengers and the volume of airfreight are likely to be larger in big countries with big economies, as is the level of investment. But the relationship is not causal: more air travel and more investment are both the result of their being larger economies. So, to identify the true, causal relationship between air travel and investment we need to control for the size of the economy. Dividing by total GDP in the relevant country is one way of doing this.

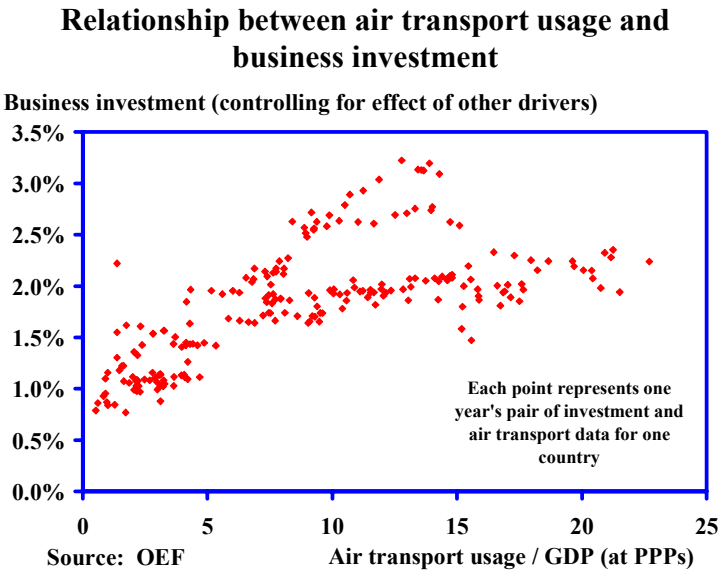
Second, air travel and business investment both reflect the state of the business cycle – both increase in good times and both fall in bad times. Once again, this relationship is not causal. To get hold of the causal relationship, we need to control for the effects of the business cycle. Dividing by GDP takes care of this too, since GDP also rises when times are good and falls when times are bad.

We have, by dividing through by GDP, made the best efforts we can to identify unbiased estimates of the true, causal relationship in the long run between air transport usage and business investment or TFP.

Business investment equation

The chart below illustrates the relationships between air transport usage (scaled by GDP in each country) and business investment, once we have controlled for the effects on business investment of the other drivers (including country-specific effects).

Chart 6-1



The chart shows a strong positive relationship, reflected in the estimated model.

Table 6-3
In the long run, business investment equals:

Variable	Coefficient	t-Statistic
Real 3-month interest rate	-1.4	-6.5
Capital stock	+1	imposed
Marginal product of capital (GDP/K)	+1.4	+6.5
Inflation	-1.2	-6.8
Air transport usage divided by GDP	+0.16	+2.2
Adjusted R-squared	98%	

The ECM equation also identifies short-term effects from lagged growth in investment and the growth in air passenger numbers as well as the adjustment to the long-run equilibrium. The short-run relationships are summarised in the table below:

Table 6-4
In the short run, annual growth in business investment equals:

Variable	Coefficient	t-Statistic
Lagged growth in business investment	+0.21	+3.8
Growth in air passenger numbers	+0.22	+3.7
Adjustment to long-run equilibrium	-0.41	-8.1
Adjusted R-squared	44%	
S.E. of regression	6%	
Durbin-Watson statistic	1.96	

There is no evidence of serial correlation in this equation, and the explanatory power is very high at 98% in levels terms (though a good deal of this explanatory power comes from the intercept shift country specific dummies below). All variables are statistically significant at the 95% confidence level. Also included in the equation above were country-specific effects, summarised in the table below

Table 6-5

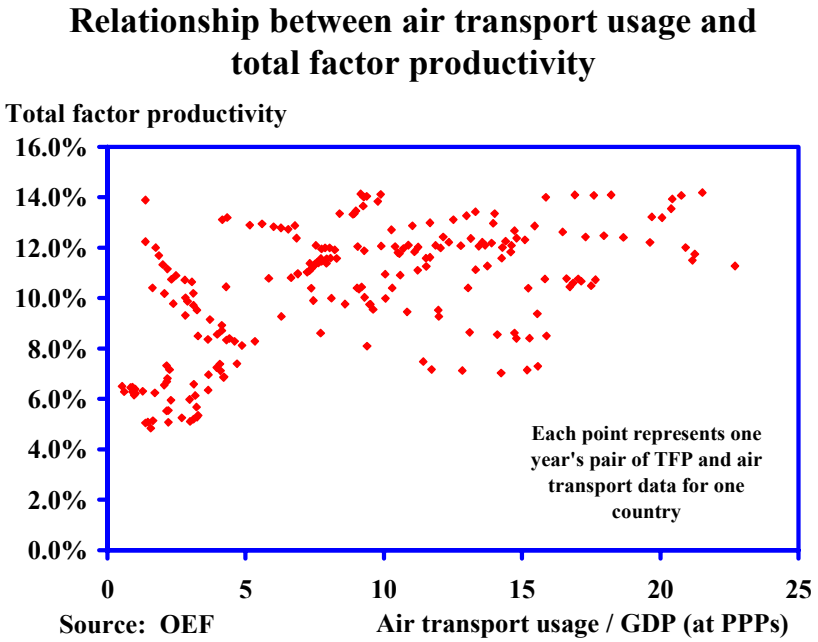
Country-specific effect	Coefficient	t-Statistic
Austria	-0.02	-0.79
Belgium	-0.07	-2.35
Denmark	-0.08	-2.41
France	-0.22	-5.29
Germany	-0.15	-4.93
Italy	-0.10	-3.29
Netherlands	-0.19	-5.18
UK	-0.29	-5.52
Sweden	-0.19	-4.67
Hungary	0.02	0.50
Finland	-0.13	-4.52
Spain	-0.15	-3.36
Ireland	-0.19	-3.78
Portugal	-0.05	-1.50
Poland	0.06	1.33
Czech Republic	0.04	0.94
Cyprus	-0.25	-3.55
Estonia	0.09	2.12
Latvia	0.14	2.84
Lithuania	0.13	2.25
Malta	-0.11	-1.89
Slovakia	0.23	2.80
Slovenia	0.08	1.74

So the econometric model suggests there is a strong positive relationship between air transport usage (scaled by GDP) and business investment. If air transport usage increases by 10% (relative to GDP), that will boost business investment by 1.6% in the long run. And higher business investment will mean faster accumulation of fixed capital, which will in turn boost the average productivity of labour and therefore GDP. A 1.6% increase in fixed investment, if it were held in place permanently, would in the end see the capital stock increase by 1.6% as well. And a 1.6% increase in the capital stock overall means a 1.6% increase in the capital stock per worker – a greater depth of capital per worker. That would mean increased labour productivity, 0.6% higher in the long run according to the model we have used. The process of capital accumulation can take many years to complete. But, in the end, a permanent 10% increase in air transport usage relative to GDP would mean a 0.6% increase in GDP per worker (and therefore GDP overall), via the impact on business investment.

Appendix F: Detailed estimation results for underlying productivity

The charts below show the relationship between TFP on the one hand and air transport usage (scaled by GDP), across all 24 EU economies that we have looked at in our econometric research.

Chart 6-3



There is a fairly strong positive relationship between air transport usage and underlying productivity. Our model picks up these positive relationships.

Table 6-6
In the long run, underlying productivity equals:

Variable	Coefficient	t-Statistic
Air transport usage / GDP (low/mid ATI countries)	+0.0556	+3.8
Air transport usage / GDP (high ATI countries)	+0.0550	+1.9
R&D intensity	+0.08	+7.9
Tertiary education share	+0.12	+3.7
Latvia/Lithuania/Estonia effect	-0.47	-11.6
Italy effect	+0.28	+5.8
Adjusted R-squared	67%	

The ECM equation also identified short-term effects coming from the lagged growth in TFP as well as from the adjustment to the long-run equilibrium. These effects are summarised in the table below

Table 6-7
In the short run, annual growth in underlying productivity equals:

Variable	Coefficient	t-Statistic
Inflation	-0.16	-6.2
Lagged TFP growth	+0.16	+3.2
Real short interest rate	-0.12	-4.1
Lagged GDP growth	-0.16	-3.6
Manufacturing share of GDP	+0.02	+1.9
Lagged ATI growth	+0.02	+3.1
Adjustment to long-run equilibrium	-0.06	-4.8
Adjusted R-squared	32%	
S.E. of regression	2.4%	
Durbin-Watson stat	1.72	

There is no evidence of serial correlation in this equation, as the DW statistic suggests. All variables are statistically significant at the 95% confidence level, except for the manufacturing share of GDP, which is significant at the 90% confidence level.

Appendix G: Catalytic effects of air transport to come: four scenarios

EUROCONTROL prepares four scenarios for the long-term outlook for air traffic. The latest scenarios are based on the following storylines:

Scenario A: Globalisation and Rapid Economic Growth involves strong economic growth in an increasingly globalised world. Economic growth, free trade, and Open Skies agreements encourage flight growth at the fastest rate.

Scenario B: Business as Usual involves moderate economic growth and no significant change from the status quo and current trends. The economy grows at medium rate and EU expansion is fastest amongst the scenarios.

Scenario C: Strong Economies and Regulation involves strong economic growth, with government regulation to address growing environmental issues. As a result, noise and emission costs are higher, which encourages a move to larger aircraft and more hub-and-spoke operations.

Scenario D: Regionalisation and Weak Economies involves increased tensions between regions, with knock-on effects on economies, trade, and tourism shifting to short haul. Security costs increase further, and fuel price is highest amongst the scenarios, reaching nearly 40% of operating costs by 2025.

The resulting projections for the total IFR flights in ESRA are shown in Chart 6-5 and in Table 6-8. These build on the medium-term forecasts to 2010 produced by EUROCONTROL, with scenarios B & C starting from the base forecast up to 2010, scenario A starting from the high forecast to 2010, and scenario D starting from the low forecast to 2010.

Chart 6-5

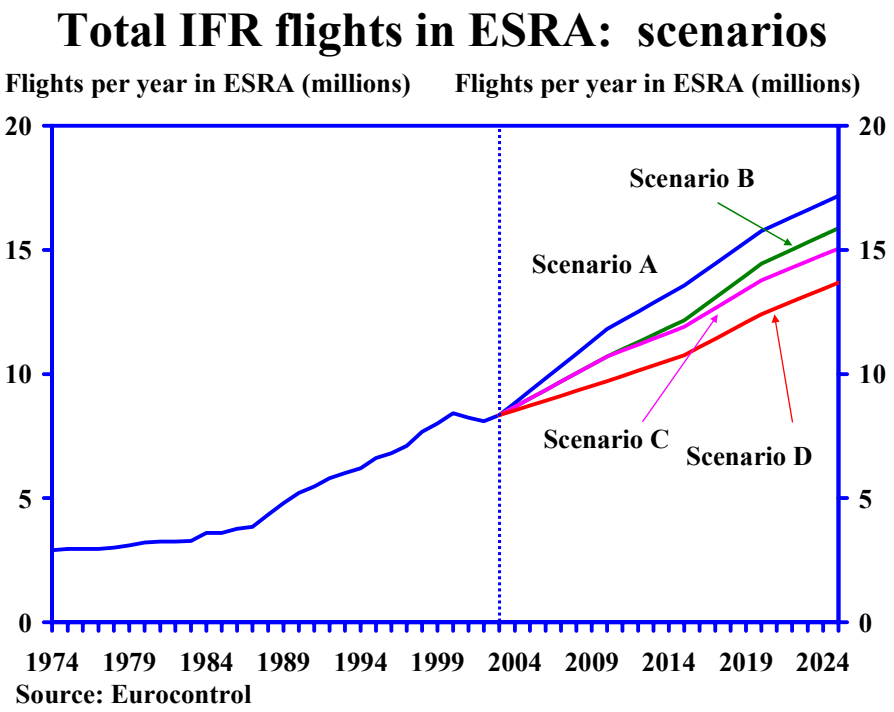


Table 6-8: Long-term forecast of IFR flights, ESRA

		2003	2010	2015	2020	2025	Average annual growth (2003-25)
Scenario A: Globalisation and rapid economic growth	Total Flights	8,332	11,802	13,564	15,755	17,173	3.3
	International	1,356	2,106	2,553	3,272	3,849	4.9
Scenario B: Business as usual	Total Flights	8,332	10,706	12,155	14,433	15,873	3.0
	International	1,356	1,915	2,270	2,834	3,218	4.0
Scenario C: Strong economies & regulation	Total Flights	8,332	10,706	11,891	13,773	15,051	2.7
	International	1,356	1,915	2,232	2,696	2,997	3.7
Scenario D: Regionalisation and weak economies	Total Flights	8,332	9,709	10,751	12,408	13,681	2.3
	International	1,356	1,767	1,950	2,208	2,371	2.6

These scenarios are underpinned by a number of assumptions. Particularly relevant for our purposes are the related projections for GDP growth and also for the average number of seats per flight. These are summarised in 6-9, where we have weighted together the figures for GDP for the regions presented by EUROCONTROL to produce aggregates for the EU25 and the non-EU world.

Table 6-9: Assumptions for GDP and seats per flight in EUROCONTROL long-term forecasts

		2004 – 2010	2011 - 2016	2017 - 2022	2023 - 2028
(i) GDP growth (annual annualised %)					
Scenario A	EU	3.0	3.0	2.9	2.8
	Non-EU	3.4	3.4	3.2	2.9
Scenario B	EU	2.5	2.5	2.4	2.3
	Non-EU	3.2	2.9	2.7	2.4
Scenario C	EU	2.5	2.8	2.7	2.6
	Non-EU	3.2	3.2	2.9	2.7
Scenario D	EU	2.0	2.0	1.9	1.8
	Non-EU	3.0	2.4	2.2	1.9
(ii) Average number of seats per flight					
			Average annual change in average number of seats per flight, 2011-2025		
Scenario A			1.3		
Scenario B			0.7		
Scenario C			1.4		
Scenario D			0.5		

In the main text, we focused on Scenario B, business as usual. Below, we show the results for each of the different scenarios.

Scenario results

The tables below set out our estimates of the economic catalytic effect of air transport in Europe channel by channel, under each of the four growth scenarios described above.

Tourism scenarios

Table 6-10

Net Catalytic Effect of Air Transport of Tourism (percentage of GDP)

	2003	2010	2015	2020	2025
Scenario A					
EU-25	-0.3	-0.4	-0.3	-0.3	-0.3
EU-15	-0.4	-0.5	-0.4	-0.4	-0.4
Acc-10	0.3	0.3	0.2	0.1	0.1
Scenario B					
EU-25	-0.3	-0.2	-0.2	-0.2	-0.2
EU-15	-0.4	-0.3	-0.3	-0.3	-0.2
Acc-10	0.3	0.3	0.2	0.1	0.1
Scenario C					
EU-25	-0.3	-0.2	-0.2	-0.2	-0.2
EU-15	-0.4	-0.3	-0.3	-0.3	-0.3
Acc-10	0.3	0.3	0.2	0.1	0.1
Scenario D					
EU-25	-0.3	-0.1	-0.1	-0.1	0.0
EU-15	-0.4	-0.2	-0.2	-0.1	-0.1
Acc-10	0.3	0.3	0.2	0.2	0.1

Table 6-11

Net Catalytic Effect of Air Transport on Trade (percentage of GDP)

	2003	2010	2015	2020	2025
Scenario A					
EU-25	0.6	0.8	1.0	1.2	1.2
EU-15	0.6	0.9	1.1	1.3	1.3
Acc-10	-0.4	-0.6	-0.7	-0.7	-0.8
Scenario B					
EU-25	0.6	1.1	1.2	1.5	1.5
Eu-15	0.6	1.1	1.3	1.6	1.7
Acc-10	-0.4	-0.5	-0.6	-0.7	-0.7
Scenario C					
EU-25	0.6	1.1	1.2	1.4	1.4
EU-15	0.6	1.1	1.3	1.5	1.5
Acc-10	-0.4	-0.5	-0.6	-0.6	-0.7
Scenario D					
EU-25	0.6	1.4	1.5	1.8	1.9
EU-15	0.6	1.5	1.7	1.9	2.0
Acc-10	-0.4	-0.4	-0.5	-0.6	-0.7

Investment scenarios

Table 6-12

2025	Impact on business investment					
	with diminishing returns			without diminishing returns		
	EU-25	EU-15	Acc-10	EU-25	EU-15	Acc-10
Scenario A	5.0%	4.8%	7.0%	7.4%	7.2%	8.9%
Scenario B	3.3%	3.2%	4.9%	4.9%	4.7%	6.2%
Scenario C	3.8%	3.7%	4.6%	5.7%	5.5%	5.8%
Scenario D	2.0%	1.9%	3.3%	3.0%	2.8%	4.2%

Underlying productivity scenarios

Table 6-13

2025	Impact on underlying productivity					
	with diminishing returns			without diminishing returns		
	EU-25	EU-15	Acc-10	EU-25	EU-15	Acc-10
Scenario A	1.0%	1.0%	1.4%	1.5%	1.4%	1.7%
Scenario B	0.6%	0.6%	1.0%	0.9%	0.9%	1.1%
Scenario C	0.7%	0.7%	1.0%	1.1%	1.0%	1.1%
Scenario D	0.4%	0.4%	0.6%	0.5%	0.5%	0.7%

GDP scenarios

The supply-side impact on GDP is the sum of the impact on underlying productivity and the indirect effect on GDP of the accumulation of investment into the capital stock, described in the main body of the text.

Table 6-14

2025	Supply-Side Impact on GDP					
	with diminishing returns			without diminishing returns		
	EU-25	EU-15	Acc-10	EU-25	EU-15	Acc-10
Scenario A	2.0%	1.9%	3.0%	3.0%	2.9%	3.7%
Scenario B	1.2%	1.2%	1.6%	1.8%	1.7%	2.0%
Scenario C	1.4%	1.4%	1.9%	2.1%	2.0%	2.3%
Scenario D	0.7%	0.6%	1.2%	1.0%	0.9%	1.5%

Table 6-15

2025	Demand-Side Impact on GDP					
	Tourism effects			Trade effects		
	EU-25	EU-15	Acc-10	EU-25	EU-15	Acc-10
Scenario A	-0.3%	-0.4%	0.1%	1.2%	1.3%	-0.8%
Scenario B	-0.2%	-0.2%	0.1%	1.5%	1.7%	-0.7%
Scenario C	-0.2%	-0.3%	0.1%	1.4%	1.5%	-0.7%
Scenario D	0.0%	-0.1%	0.1%	1.9%	2.0%	-0.7%

Appendix H: Other channels of economic catalytic effects of air transport

The economic catalytic impact of air transport on the labour supply

Air links may improve a region's labour supply by attracting high quality employees who commute to work out of choice (daily or, more likely, weekly) or maybe use air links to visit headquarters or regional offices. One example is supplied by the UK. Data collected as part of the Civil Aviation Authority's regular air passenger surveys indicates that this type of commuting to London from airports in the rest of the UK is significant, albeit a small proportion of the total. Our analysis of the 2001 data suggests that there could be around 2,000 to 3,000 commuters using air transport on a regular basis to get to a place of work in London. Around 60% of these travel from Scottish airports, with the balance shared between the North West (Manchester) and Northern Ireland.

However, the CAA study is peculiar to the UK, so equivalent weekly commuting data are not available for other EU countries. In principle, relevant statistics could be extracted from data which airlines hold on frequent flyer programmes. But, as such data is likely to be highly confidential, airlines are very unlikely to release it to a third party.

Some supporting evidence can be drawn from other studies. For example, there appears to be a stronger than average specialisation in knowledge-intensive industries in the vicinity of airports in Belgium (including Brussels International Airport)[10]. Improved access to a wider pool of appropriately skilled labour might be one reason why this is so. Moreover, it appears that foreign-owned firms are disproportionately responsible for the growth in both employment and investment in the vicinity of airports in Belgium – suggesting that the growth in airport capacity is allowing foreign firms to exploit skills that may exist in the Belgian workforce in a way that they otherwise might not be able to. The effects on flows of investment into and out of a region or country are explored in the main body of the text. But

[10]' Etude de l'impact economique de l'aeroport de Bruxelles sur l'economie Belge': Sleuwaegen, de Backer, van Pottelsberghe, Nysten, Gille, Molemaker; September 2003

there does appear to be some tentative evidence that growth in air transport contributes to an increase in the pool of available labour over and above those investment effects.

The catalytic impacts of air transport on congestion and local business costs

The presence of an airport could add significantly to congestion on surrounding roads, increasing the costs companies face in transport staff and goods, and increasing journey times for commuters and leisure travellers. There is an extensive literature on the measurement of congestion costs[11]. But while there may be data available for the congestion associated with some EU airports, collecting this information on a robust basis for a sufficiently large sample of airports in different countries would be a very large task beyond the resources available for this study. It is possible, though, to draw some illustrative examples from the literature, such as the following:

OEF's own study of the impact of building a cross-London rail link on the London and UK economies suggests that a significant proportion of the benefit would be felt through a reduction in the costs of congestion, and that a proportion of that is down to travel between the City of London and Heathrow airport, which the rail link would make much easier.

A 1998 study of congestion costs[12] in the Netherlands puts the cost of traffic congestion at 1.9% of GDP in Europe as a whole, between 0.5% and 1.9% in Belgium, and between 1% and 2.75% in the UK.

Estimates of the marginal cost of congestion (the external cost, borne by others not by the individual contributing to the extra congestion, of an extra car driving an extra mile on a given road) are many and various, ranging from 10 pence (sterling) per vehicle kilometre, to $4.34 per passenger mile, depending on which study, what model, what region, what time of day etc.

[11] See, for example, The economic costs of road traffic congestion, Paul Goodwin, May 2004; and The economic effects of transport delays on the City of London, OEF, July 2003

[12] 'Estimation of congestion costs in the Netherlands' SEO discussion paper #28, January 2004; Koopmans & Kroes

Although we do not, in this study, develop our own measure of congestion costs, our estimates of the impact of air transport do take into account effects on GDP of extra congestion, via the relationship between TFP and air transport. The historic data for TFP will be affected both by the positive influences of air transport – eg on business operations – and also the negative effects – such as congestion. The relationships we estimate therefore calculate the *net* impact of air transport on TFP – ie allowing for any negative congestion effects upon growth.