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# **Outlook for Air Transport to the Year 2015**

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International Civil Aviation Organization

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Telephone: +234 (1) 4979780; Facsimile: +234 (1) 4979788; Sitatex: LOSLORK; E-mail: [aviation@landovercompany.com](mailto:aviation@landovercompany.com)

*Peru.* Director Regional de la OACI, Oficina Sudamérica, Apartado 4127, Lima 100  
Teléfono: +51 (1) 575 1646; Facsimile: +51 (1) 575 0974; Sitatex: LIMCAYA; Correo-e: [mail@lima.icao.int](mailto:mail@lima.icao.int)

*Russian Federation.* Aviaizdat, 48, Ivan Franko Street, Moscow 121351 / Telephone: +7 (095) 417-0405; Facsimile: +7 (095) 417-0254

*Senegal.* Directeur régional de l'OACI, Bureau Afrique occidentale et centrale, Boîte postale 2356, Dakar  
Téléphone: +221 839 9393; Fax: +221 823 6926; Sitatex: DKRCAYA; Courriel: [icaodkr@icao.sn](mailto:icaodkr@icao.sn)

*Slovakia.* Air Traffic Services of the Slovak Republic, Letové prevádzkové služby Slovenskej Republiky, State Enterprise, Letisko M.R. Štefánika, 823 07 Bratislava 21 / Telephone: +421 (7) 4857 1111; Facsimile: +421 (7) 4857 2105

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*Thailand.* ICAO Regional Director, Asia and Pacific Office, P.O. Box 11, Samyaeak Ladprao, Bangkok 10901  
Telephone: +66 (2) 537 8189; Facsimile: +66 (2) 537 8199; Sitatex: BKKCAYA; E-mail: [icao\\_apac@bangkok.icao.int](mailto:icao_apac@bangkok.icao.int)

*United Kingdom.* Airplan Flight Equipment Ltd. (AFE), 1a Ringway Trading Estate, Shadowmoss Road, Manchester M22 5LH  
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# **FOREWORD**

## **Introduction**

1. This circular contains information on air transport trends and challenges and long-term airline passenger and freight traffic forecasts, in total and by region of registration, for the period through to the year 2015. In addition, it includes passenger traffic forecasts for international route groups and global forecasts of aircraft movements, again through to the year 2015. The present circular is the fifth in a series to be issued biennially or triennially (the previous edition “Outlook for Air Transport to the Year 2010” was published in 2001 as Circular 281).

## **Sources of information**

2. In addition to the ICAO Digests of Statistics, use has been made of many of the Organization’s economic studies and of the Annual Reports of the Council to the Assembly for the years 1992 to 2002. Sources of information other than ICAO, referred to in the circular, include the appropriate and most recently available statistical publications of the United Nations, the United Nations Conference on Trade and Development (UNCTAD), the European Civil Aviation Conference (ECAC), the Organization for Economic Co-operation and Development (OECD), the International Air Transport Association (IATA), the Association of European Airlines (AEA), the United States Department of Transportation (DOT) and Department of Energy (DOE), the World Tourism Organization (WTO-OMT), the International Monetary Fund (IMF), the World Bank, BACK Aviation Associates, the WEFA Group (formerly known as Wharton Econometrics Forecasting Associates) and aerospace manufacturers.

3. Unless indicated otherwise, all references in this circular to “cents” mean U.S. cents, and all references to “dollars” mean U.S. dollars; references to “billion” mean one thousand million.

## **Status**

4. This circular has been approved by the Secretary General and is published under his authority.

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# Chapter 1

## SUMMARY

1. During the period 1960–2002, the aggregate economic activities of the world measured by Gross Domestic Product (GDP) increased at an average annual rate of 3.4 per cent in real terms. For the period 1992–2002, GDP and GDP per capita grew at an average annual rate of 3.0 per cent and 1.6 per cent, respectively (see Chapter 3).
2. Growth in air transport has been much greater than economic growth but is closely linked with it. World airline scheduled passenger traffic (domestic and international) measured in terms of passenger-kilometres performed (PKPs) increased at an average annual rate of 8.1 per cent for the 1960–2002 period. For the periods 1960–1972, 1972–1982, 1982–1992 and 1992–2002, passenger traffic grew at an average annual rate of 12.8, 7.6, 5.4 and 4.3 per cent, respectively (see Table 2-1). While economic conditions continued to be the major driver of air travel demand, security and safety concerns and so-called fear and hassle factors, triggered by the unprecedented events of 11 September 2001, had adverse effects on air traffic in 2001 and 2002. These effects, further amplified by the war in Iraq and the outbreak of Severe Acute Respiratory Syndrome (SARS), continued in 2003 and were taken into account for the projection of future air traffic trends.
3. World airline scheduled freight traffic (domestic and international) measured in terms of tonne-kilometres performed (TKPs) increased at an average annual rate of 8.5 per cent over the 1960–2002 period. For the periods 1960–1972, 1972–1982, 1982–1992 and 1992–2002, freight traffic grew at an average annual rate of 16.9, 8.2, 7.1 and 6.4 per cent, respectively (see Table 2-1).
4. The growth in passenger and freight traffic demand over the 1960–2002 period resulted in comparable growth in capacity offered, while aircraft movements measured in terms of aircraft departures grew at a much slower rate (2.7 per cent per annum) due primarily to a large increase in average aircraft size and in average distance flown per aircraft departure during this period. Historical traffic trends are described in Chapter 2.
5. During the period 1960–2002, average world passenger yield measured in real terms (expressed in U.S. cents per PKP) declined at a rate of 2.5 per cent per annum. Freight and mail yield measured in real terms (expressed in U.S. cents per TKP) decreased at a rate of 3.5 per cent per annum. During the same period, unit costs (operating cost per available tonne-kilometre (ATK)) measured in real terms declined at an average annual rate of 2.5 per cent (see Chapter 4).
6. Future growth of air transport will continue to depend primarily on world economic and trade growth and airline cost developments (which are in turn heavily dependent on fuel prices). This growth will also be influenced, however, by the extent to which the industry faces up to major challenges such as fear and hassle factors influencing consumer confidence, airport and airspace congestion, environmental protection and increasing capital investment needs. The shape and size of the air transport system will also be affected by governmental decisions, notably those determining the type and extent of economic regulation of airlines. Airline traffic forecasts are presented in Chapter 5.
7. For the forecast period 2002–2015, world economic growth (GDP) is expected to increase at an average annual rate of 2.5 per cent in real terms. Airline yields are expected to decline at an annual rate of 0.5 per cent for the first four years for passenger traffic and six years for freight traffic and to stabilize for the remaining years of the forecast horizon.



8. World scheduled traffic measured in terms of passenger-kilometres performed is forecast to increase at a “most likely” average annual rate of 4.4 per cent for the period 2002–2015. International traffic is expected to increase at 5.1 per cent per annum, while domestic traffic is expected to increase at an average annual rate of 3.1 per cent.

9. The airlines of the Middle East region are expected to experience the highest growth in passenger traffic at 6.4 per cent per annum through to the year 2015, followed by the airlines of the Asia/Pacific region with a 6.1 per cent annual growth rate. Airline traffic in each of the European, Latin America/Caribbean and African regions is expected to grow at around 4 per cent, slightly below the world average. In the North American region, airline traffic is expected to increase at 2.8 per cent per annum.

10. Forecasts of the number of passengers carried on scheduled services in nine intercontinental route groups show the Transpacific and the Europe-Africa markets as the fastest growing, at 6.6 per cent and 5.5 per cent per annum, respectively, for the forecast period through to 2015.

11. World scheduled freight traffic measured in terms of tonne-kilometres performed is forecast to increase at a “most likely” average annual rate of 5.5 per cent for the period 2002–2015. International freight traffic is expected to increase at an average annual growth rate of 5.8 per cent compared with a domestic freight traffic growth of 3.2 per cent per annum. Air freight traffic in the Middle East region is expected to remain the fastest growing at 6.6 per cent per annum, followed by the Asia/Pacific region (6.4 per cent). Other regions are projected to experience growth rates below the world average, ranging from around 5 per cent for the North American and European regions to 2.5 per cent for the Latin America/Caribbean region.

12. Aircraft movements in terms of aircraft departures and aircraft kilometres flown for the period 2002–2015 are expected to increase at average annual rates of 3.2 and 4.2 per cent, respectively (see Chapter 6).

13. Tables 1-1, 1-2 and 1-3 provide summaries of traffic forecasts at the global, regional and intercontinental route group level.

**Table 1-1. ICAO air traffic forecasts — World (1992–2015)**  
(ICAO Contracting States)

Scheduled services	Actual 1992	Actual 2002	Forecast 2015	Average annual growth rate (per cent)	
				1992–2002	2002–2015
<b>TOTAL</b>					
Passenger-kilometres (billions)	1 928	2 942	5 120	4.3	4.4
Freight tonne-kilometres (millions)	62 675	116 628	233 850	6.4	5.5
Passengers carried (millions)	1 146	1 615	2 520	3.5	3.5
Freight tonnes carried (thousands)	17 647	29 538	51 700	5.3	4.4
Aircraft-kilometres (millions) <sup>1</sup>	15 420	23 878	40 750	4.5	4.2
Aircraft departures (thousands) <sup>1</sup>	14 728	20 013	30 010	3.1	3.2
<b>INTERNATIONAL</b>					
Passenger-kilometres (billions)	982	1 732	3 310	5.8	5.1
Freight tonne-kilometres (millions)	50 753	100 588	209 600	7.1	5.8
Passengers carried (millions)	299	544	1 030	6.2	5.0
Freight tonnes carried (thousands)	9 313	19 013	37 200	7.4	5.3

1. Excluding operations of airlines registered in the Commonwealth of Independent States (CIS).

Source: ICAO

**Table 1-2. ICAO air traffic forecasts — Regions of airline registration (1992–2015)**  
(ICAO Contracting States)

Scheduled services by region of airline registration	Actual 1992	Actual 2002	Forecast 2015	Average annual growth rate (per cent)	
				1992–2002	2002–2015
<b>TOTAL</b>					
Passenger-kilometres (billions)					
Africa	42.9	66.2	110	4.4	4.0
Asia/Pacific	409.2	785.1	1 700	6.7	6.1
Europe	525.7	769.7	1 300	3.9	4.1
Middle East	53.4	106.7	240	7.2	6.4
North America	806.4	1 082.3	1 550	3.0	2.8
Latin America and Caribbean	90.9	132.3	220	3.8	4.0
Freight tonne-kilometres (millions)					
Africa	1 238	1 856	3 100	4.1	4.0
Asia/Pacific	19 410	42 062	94 600	8.0	6.4
Europe	19 460	32 828	61 000	5.4	4.9
Middle East	2 625	5 355	12 250	7.4	6.6
North America	16 867	30 586	57 500	6.1	5.0
Latin America and Caribbean	3 075	3 940	5 400	2.5	2.5
<b>INTERNATIONAL</b>					
Passenger-kilometres (billions)					
Africa	34.9	57.5	100	5.1	4.3
Asia/Pacific	276.8	537.6	1 220	6.9	6.5
Europe	330.8	643.8	1 150	6.9	4.6
Middle East	44.5	93.5	220	7.7	6.8
North America	238.8	322.4	490	3.0	3.3
Latin America and Caribbean	56.4	77.4	130	3.2	3.9
Freight tonne-kilometres (millions)					
Africa	1 135	1 777	3 000	4.6	4.1
Asia/Pacific	17 752	38 196	86 500	8.0	6.5
Europe	17 680	32 019	60 000	6.1	4.9
Middle East	2 552	5 251	12 100	7.5	6.6
North America	9 114	20 264	44 000	8.3	6.1
Latin America and Caribbean	2 520	3 079	4 000	2.0	2.0

Source: ICAO

**Table 1-3. ICAO air traffic forecasts — Intercontinental route groups (1992–2015)**  
(ICAO Contracting States)

International scheduled services	Passengers carried (thousands)			Average annual growth rate (per cent)	
	Actual 1992	Actual 2002	Forecast 2015	1992–2002	2002–2015
North Atlantic	40 900	64 900	123 600	4.7	5.1
Mid-Atlantic	2 300	3 900	7 300	5.4	4.9
South Atlantic	2 760	4 370	7 750	4.7	4.5
Trans-Pacific	18 121	24 279	55 916	3.0	6.6
Between Europe and Asia/Pacific	15 000	30 000	57 300	7.2	5.1
Between Europe and Africa	13 200	21 645	43 410	5.1	5.5
Between Europe and Middle East	8 100	13 100	24 700	4.9	5.0
Between North America and South America	5 250	8 740	15 500	5.2	4.5
Between North America and Central America/Caribbean	22 000	35 800	65 000	5.0	4.7
Total above routes	127 631	206 734	400 476	4.9	5.2
Other routes	171 836	337 876	629 524	7.0	4.9
Total world	299 467	544 610	1 030 000	6.2	5.0

Source: ICAO

## **Chapter 2**

### **AIR TRANSPORT TRENDS AND CHALLENGES**

#### **ECONOMIC DEVELOPMENT AND AIRLINE TRAFFIC PATTERNS**

1. From a long-term historical perspective, air transport has experienced greater growth than most other industries. Since 1960, increasing demand for passenger and freight services, rapid technological development and associated investment have combined to multiply the output of the air transport industry by a factor of nearly 30 in terms of TKPs. This expansion of air transport compares favourably with the broadest available measure of world output, the global GDP, which when measured in real terms has multiplied by 4 times over the same period.

2. Economic theory and analytical studies indicate that there is a high correlation between the growth patterns of air traffic and economic trends in that the demand for air transport is primarily driven by economic development. Developments in personal income affect the level of consumer purchasing power and the propensity to undertake leisure travel. Commercial activity and trade have a direct impact on the demand for business travel and for air freight. Figure 2-1 provides evidence of the relationship between the strength of the economy and traffic demand by illustrating the fluctuations in the rate of growth of each for the period 1960 to the present. The impact of economic slowdowns and recessions on air traffic trends is clearly visible during the following years or periods: 1974–75, 1980–82, 1990–91, 1998 and 2001 (the latter coupled with the unprecedented events of 11 September).

3. Between 1992 and 2002, worldwide scheduled traffic, measured in TKPs, grew at an average annual rate of 4.9 per cent, compared to a 3.0 per cent GDP growth. While the pattern of traffic growth over that period was generally a reflection of economic conditions, the impact of recent event-related developments on air travel demand (events of 11 September 2001, war in Iraq and the SARS outbreak) indicate that the air transport industry is sensitive to safety and security concerns and so-called fear and hassle factors which influence consumer confidence.

4. Other factors that have affected traffic demand include airline costs, and hence fares and rates, regulatory developments and the access to air and tourism services. Rapid growth in the 1960s coincided with the replacement of piston-engine aircraft with jet aircraft which led to reduced real fares and increased speed and comfort of travel. In addition to an adverse effect on the world economy, sharp changes in the price of oil and aviation fuel (such as in 1973–1974 and further escalation during 1979–1981) have had important effects on airline costs.

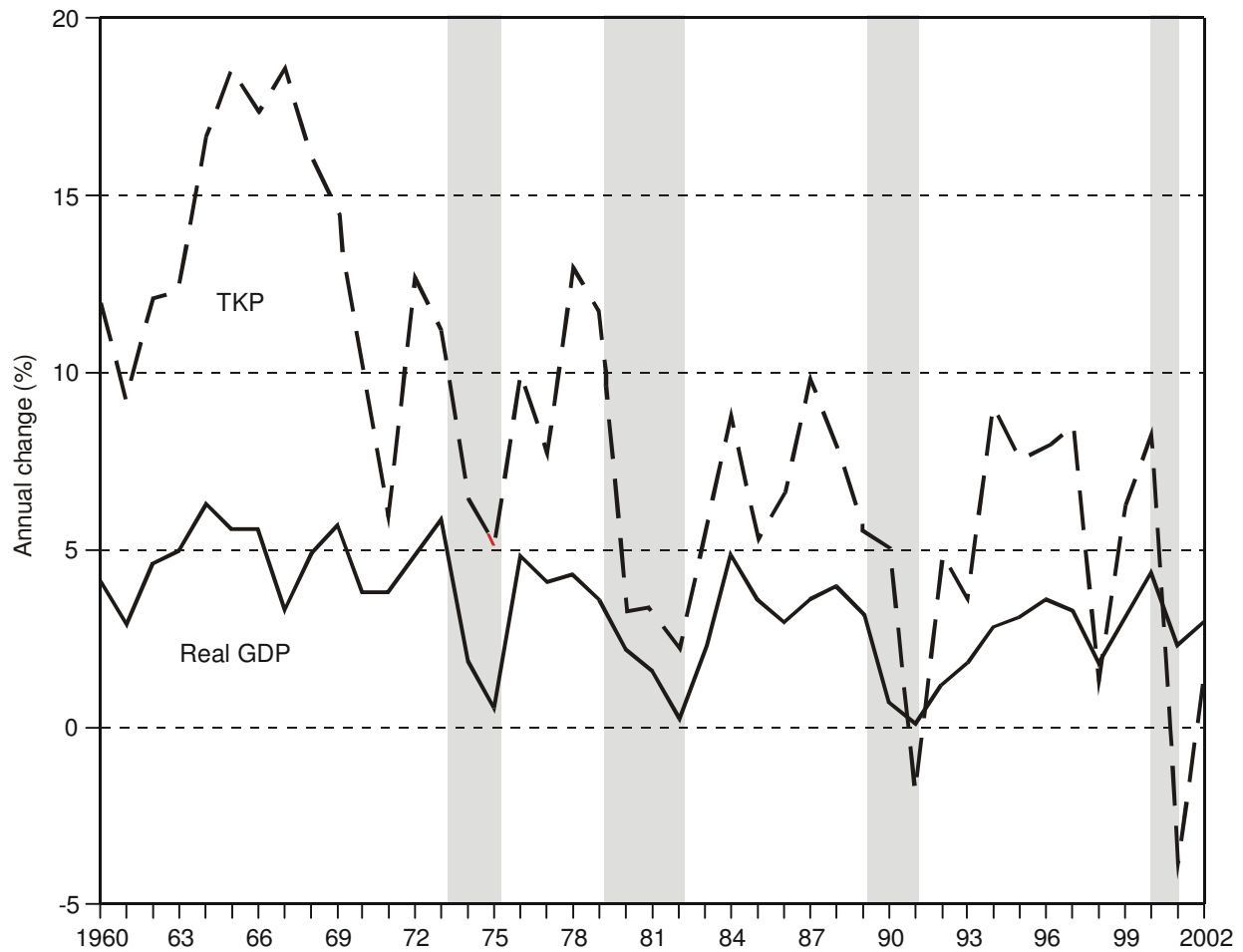
#### **TRENDS IN SCHEDULED PASSENGER, FREIGHT AND MAIL TRAFFIC**

5. Over the decades, the growth experienced by the total demand for air transport has been shared to a varying extent by each of its major components — passenger, freight and mail traffic. The average growth rate for each of these components has declined since the 1960s as shown in Table 2-1. The gradual decline in mail traffic has been particularly severe, partly because of increasing competition from telecommunications.

**Table 2-1. Trends in total scheduled traffic — World (1960–2002)**  
(ICAO Contracting States)

Scheduled services	Average annual growth (per cent)			
	1960–1972	1972–1982	1982–1992	1992–2002
Passenger-kilometres	12.8	7.6	5.4	4.3
Freight tonne-kilometres	16.9	8.2	7.1	6.4
Mail tonne-kilometres	12.2	3.2	2.8	-1.2
Total tonne-kilometres	13.7	7.6	5.7	4.9

*Note: Excluding operations of airlines registered in the CIS.  
Source: ICAO Reporting Form A-1.*



*Source: IMF, WEFA, ICAO Reporting Form A-1.*

**Figure 2-1. Economic and airline traffic trends — World (1960–2002)**  
(GDP in real terms and total scheduled TKPs)

6. In 2002, the world's airlines carried over 1.6 billion passengers and 30 million tonnes of freight and mail on scheduled services. Airlines performed on scheduled services 2 942 billion passenger-kilometres (equivalent to 271 billion tonne-kilometres), 116 billion freight tonne-kilometres (FTKs) and 4.5 billion mail tonne-kilometres in 2002. From 1992–2002 total scheduled traffic grew at an average annual rate of 4.9 per cent.

### *International and domestic traffic*

7. International traffic has tended to grow more rapidly than domestic traffic, particularly in the case of freight. Figure 2-2 shows the expansion in the international and domestic components of scheduled passenger and freight traffic over the period 1992 to 2002. Over this 10-year period both passenger and freight traffic almost doubled on international routes namely from 982 billion PKPs in 1992 to 1 732 billion PKPs in 2002 and from 50 754 million FTKs to 100 588 million FTKs, respectively.

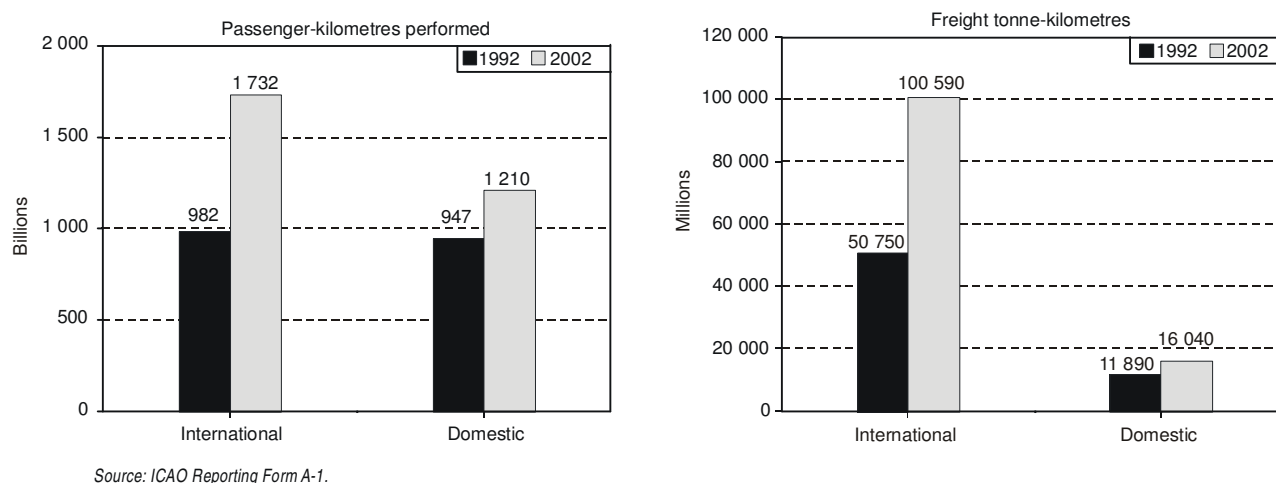
### *Regional distribution of scheduled international traffic*

8. Figure 2-3 compares the share of international passenger and freight traffic by region of airline registration in 1992 and 2002. Airlines registered in Europe retained the major share in passenger traffic, i.e. about 34.0 and 37.0 per cent in 1992 and 2002, respectively. Airlines registered in the Asia/Pacific region ranked second and increased their share of international passenger traffic to 31.0 per cent. North American airlines kept the third rank but with a decreased share of around 19 per cent. Among the airlines from the regions with smaller shares, Middle Eastern carriers increased their share while the remaining regions saw their shares decrease.

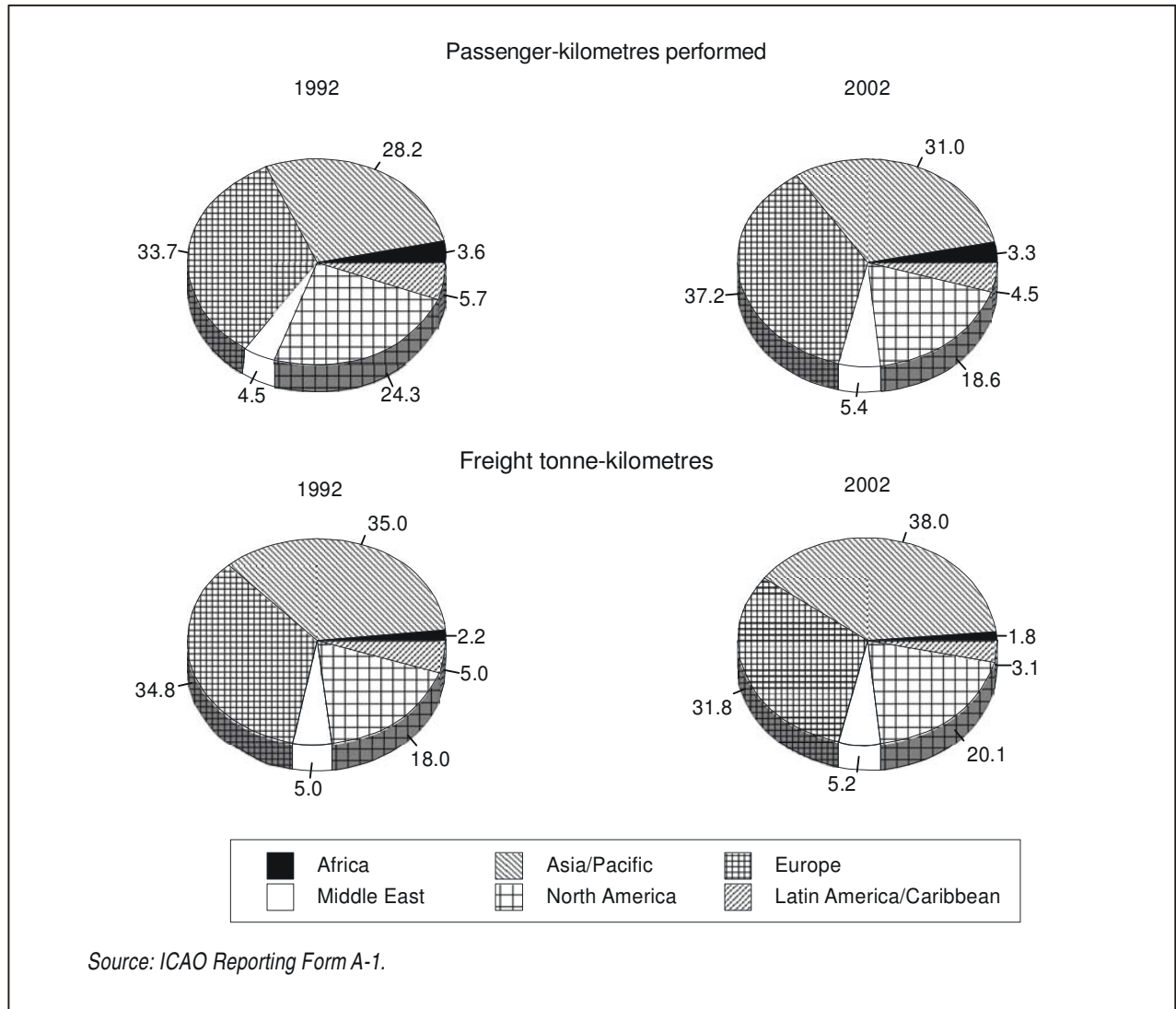
9. Airlines of the Asia/Pacific region retained their major share of freight traffic and increased it from 35.0 per cent to 38.0 per cent, while the European airlines decreased their share by 3 percentage points to 31.8 per cent in 2002. The North American region increased its share to 20.1 per cent in 2002. The other regions with significantly lower freight traffic experienced smaller changes in their respective shares.

### *Passenger traffic on major intercontinental route groups*

10. Figure 2-4 illustrates trends of scheduled passenger traffic on major intercontinental route groups between 1992 and 2002 (for data see Table 1-3). It clearly displays the strength of the North Atlantic market, in



**Figure 2-2. Trends in scheduled international and domestic traffic — World (1992 and 2002)**

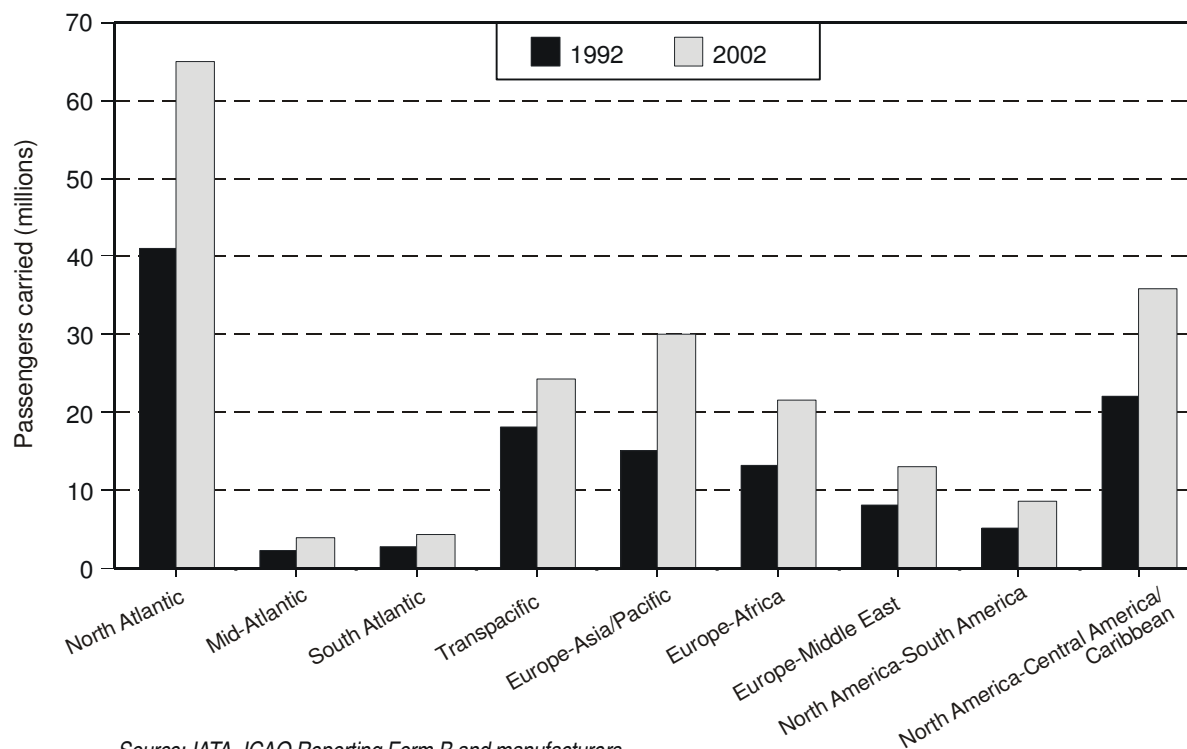


**Figure 2-3. International passenger and freight traffic — Shares by region (1992 and 2002)**

terms of its size (more than 64 million passengers in 2002) and growth (some 60 per cent increase of traffic at an average annual growth rate of 4.7 per cent). Over the same period, the faster growing route groups among the other four large markets (with a passenger volume of over 20 million in 2002) were Europe-Asia/Pacific, Europe-Africa and North America-Central America/Caribbean with average annual growth of 7.2, 5.1 and 5.0 per cent, respectively.

### TRENDS IN NON-SCHEDULED PASSENGER TRAFFIC

11. The global development of non-scheduled traffic has been partially masked by some statistical reporting deficiencies among non-scheduled air carriers. Available data, however, permit some indications of the development and importance of charter traffic.



**Figure 2-4. Passengers on scheduled services — Intercontinental route groups (1992 and 2002)**

12. Non-scheduled air transport is primarily devoted to international passenger traffic, with freight traffic and domestic traffic being relatively small by comparison. Non-scheduled passenger traffic represented about 14 to 15 per cent of the total international passenger traffic during the latter part of the 1990s. Table 2-2 provides estimates for 1992 and 2002 of non-scheduled passenger traffic carried by non-scheduled and scheduled carriers. Growth in their combined non-scheduled international traffic was approximately 3.6 per cent per annum on average in terms of PKPs during the 1992–2002 period, below the 5.8 per cent per annum growth rate for scheduled international traffic. Non-scheduled traffic is very important on intra-European routes which account for the largest part of the world charter market in terms of passengers, followed by North Atlantic routes.

### AIRCRAFT MOVEMENTS

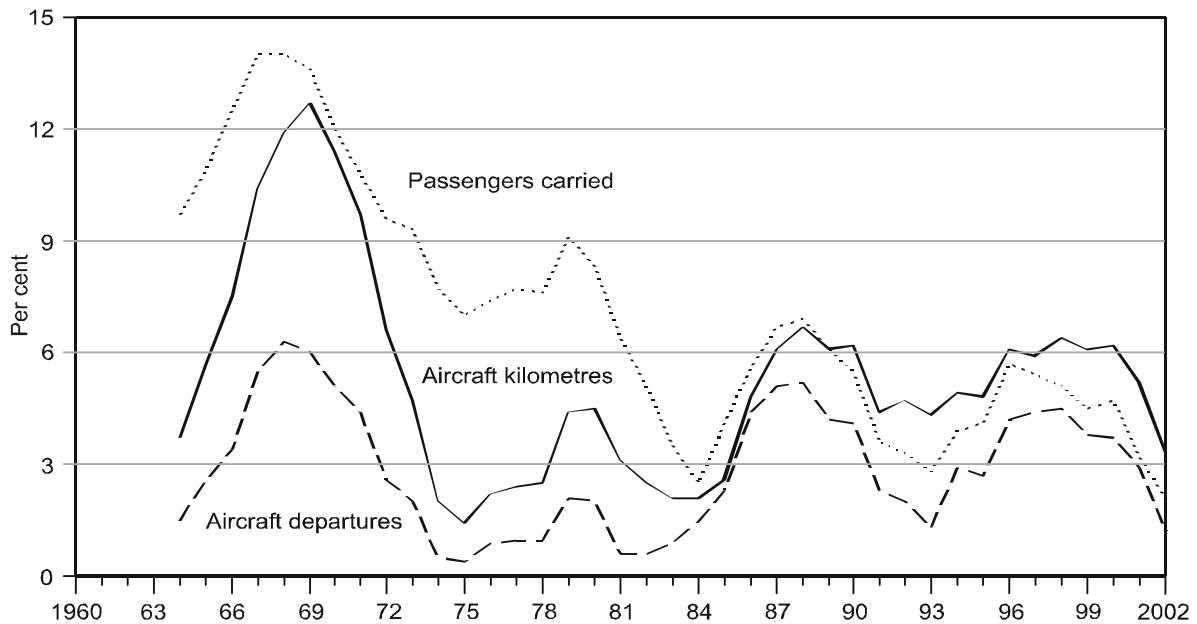
13. The growing demand for passenger and freight air services since 1960 went hand in hand with an expanded fleet capacity. Growth patterns of passenger numbers, aircraft departures and aircraft-kilometres are portrayed in Figure 2-5. A statistical smoothing technique has been used to eliminate large, short-term fluctuations in order to better illustrate the trends in the relationships between the variables.



**Table 2-2. International non-scheduled passenger traffic —  
World (1992 and 2002)**  
(ICAO Contracting States)

	Passenger-kilometres performed		Average annual growth (per cent)
	1992 (billions)	2002 (billions)	
Non-scheduled carriers	93.2	95.5	0.2
Scheduled carriers	78.5	149.1	6.6
Total	171.7	244.6	3.6

*Source: ICAO Reporting Form A-2.*



*Source: ICAO Reporting Form A-1.*

*Note: 5-year moving average of annual growth.*

*Excluding operations of airlines registered in the Commonwealth of Independent States (CIS).*

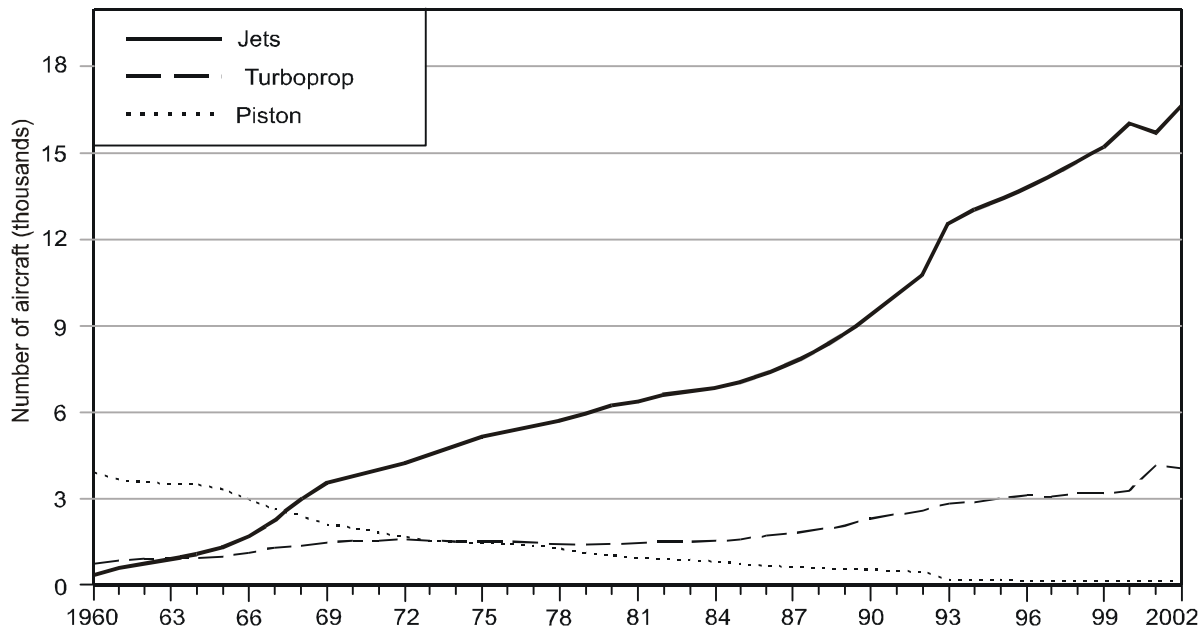
**Figure 2-5. Growth in passengers and aircraft movements — World (1960–2002)**  
(Total scheduled operations)

14. The large gap between the growth rates for passengers carried and aircraft departures that existed in the 1960s and 1970s is primarily a reflection of the increases in average aircraft size over this period. In the 1980s, as this trend in aircraft size levelled out, the growth rate for aircraft departures increased towards the passenger growth rate.

15. The growth in aircraft-kilometres has been consistently higher than the growth in aircraft departures, with a particularly large gap in the 1960s and early 1970s, since the average aircraft stage length (i.e. average length of non-stop flights) has been increasing. The rate of increase in average stage length was greatest when jet aircraft were replacing piston-engine aircraft.

### FLEET COMPOSITION AND PRODUCTIVITY

16. At the end of 2002, the scheduled and non-scheduled carriers of ICAO Contracting States had a combined fleet of about 20 877 aircraft of over 9 tonnes (t) maximum take-off mass (MTOM) for their international and domestic operations. This is an increase of about 40 per cent over the 1992 fleet. The number of jet aircraft at the end of 2002 was some 16 670, which is an increase of about 39 per cent over 1992. Jet aircraft obviously account for an even larger proportion of carriers' fleet capacity than indicated by the relative number of aircraft. Figure 2-6 contrasts the steep upward trend in the number of jet aircraft since 1960 with the slow growth in the number of turboprop aircraft and the decline in piston-engine aircraft.



Source: ICAO, *BACK Aviation Associates*.

Note: As from 2001, turboprop aircraft manufactured in China and the Russian Federation are included.

**Figure 2-6. Composition of commercial aircraft fleet — World (1960–2002)**  
(aircraft of 9 t MTOM and over)

17. The progressive absorption of advanced aerospace technology into airline fleets has been a major source of productivity improvement for the airline industry, as measured by the quantity of output per unit of input. A single comprehensive measure of productivity requires comprehensive measures of output and input. For the airline industry, TKP, including both passenger and freight traffic, is a good measure of output. However, the measurement of productivity is complicated by the diversity of inputs, which include aircraft, labour and fuel, among other resources, and also by the complexity of the production process. Several partial productivity measures for the aggregated operations of international scheduled airlines are shown in Table 2-3. Aircraft productivity refers to the quantity of TKPs that are obtained from the total payload of the scheduled airline fleet. Improvements in the average load factor (the percentage of the capacity provided by aircraft flights that is occupied with revenue-earning passengers and freight), aircraft speed, and aircraft utilization (the extent to which aircraft are kept flying on revenue-earning missions) have all contributed to growth in aircraft productivity, although increased aircraft utilization has had by far the largest impact over the past four decades. The three components of aircraft productivity have been combined into a single measure of aircraft productivity whose trend is included among those illustrated in Figure 2-7. There have been some fluctuations in performance related to business cycle conditions. Over the whole 42-year period, aircraft productivity has advanced at an average annual rate of about 2.9 per cent.

18. Estimates for labour productivity, in terms of TKP per employee, are also given in Table 2-3, and the trend in labour productivity is also illustrated in Figure 2-7. The introduction of labour-saving technology and systems has resulted in an impressive 5.9 per cent per annum growth (on average) since 1960. The impact of improvements in aircraft and engine design is also seen in the improvement in fuel productivity which has grown at an average rate of about 2.3 per cent per annum over the same period.

19. Productivity benefits have come from economies of scale as well as from the adoption of new technology. Some of the scale economies are closely related to the new technology. In the 1960s, the new jets were much larger than the propeller aircraft they were replacing. The next generation of jet aircraft, which began replacing the early jets in the 1970s, were larger again. Aircraft size increased from an average capacity of nine tonnes in 1960 to over 27 tonnes in 2002. Average aircraft size has not changed much since 1985.

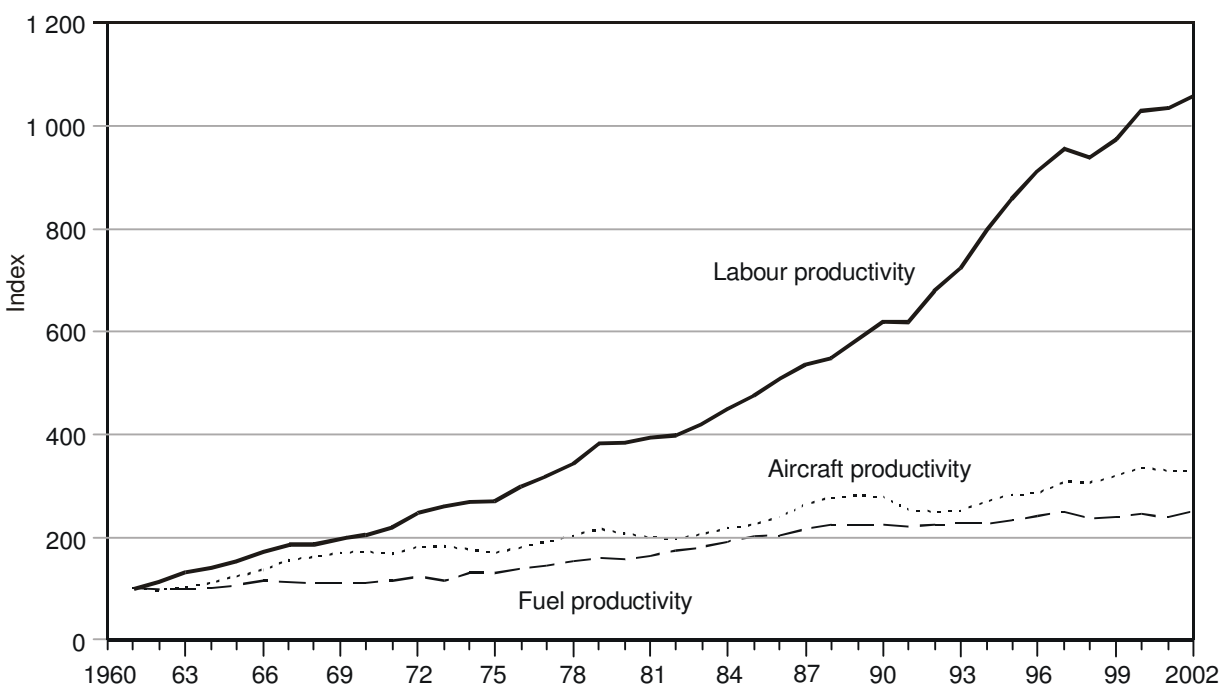
20. An overall index of airline productivity has been derived by combining the indices for aircraft, labour and fuel productivity into a single average measure (presented in para. 23). The average growth in this measure was about 5.2 per cent per annum between 1960 and 2002.

**Table 2-3. Productivity of international scheduled airlines — World (1965–2002)**  
(ICAO Contracting States)

Productivity measure	Average levels				
	1965	1975	1985	1995	2002
<b>Aircraft productivity</b>					
Aircraft load factor (per cent)	52	50	59	60	62
Aircraft speed (km/h)	469	619	634	644	648
Aircraft utilization (hours per aircraft per year)	1 678	2 064	2 179	2 751	3 001
<b>Labour productivity</b>					
TKP per employee (thousands)	43	82	144	258	320
<b>Fuel productivity</b>					
TKP per litre of fuel (index)	100	123	187	213	234

*Note: Excluding operations of airlines registered in the CIS.*

*Source: ICAO*



Source: ICAO, BACK Aviation Associates, IMF, OECD.

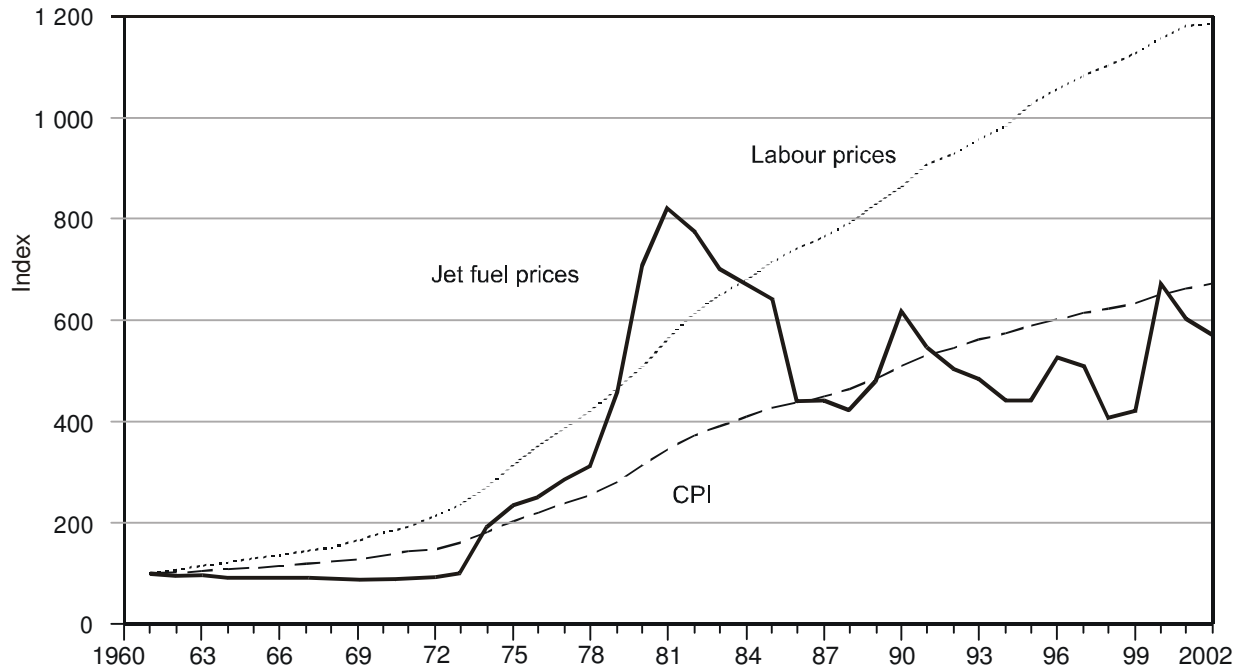
**Figure 2-7. Trends in airline productivity — World (1960–2002)**

### RELATIONSHIP BETWEEN PRODUCTIVITY, PRICES AND FINANCIAL PERFORMANCE

21. Having estimated the improvement in productivity performance achieved by the airline industry, the questions of how the improved productivity was used and who received the benefits can be addressed. By reducing the quantities of inputs required to produce a unit of output, productivity growth has the effect of reducing the cost per unit of output. These cost reductions may be used either to reduce real fares and rates paid by passengers and shippers or to provide airlines with improved financial results.

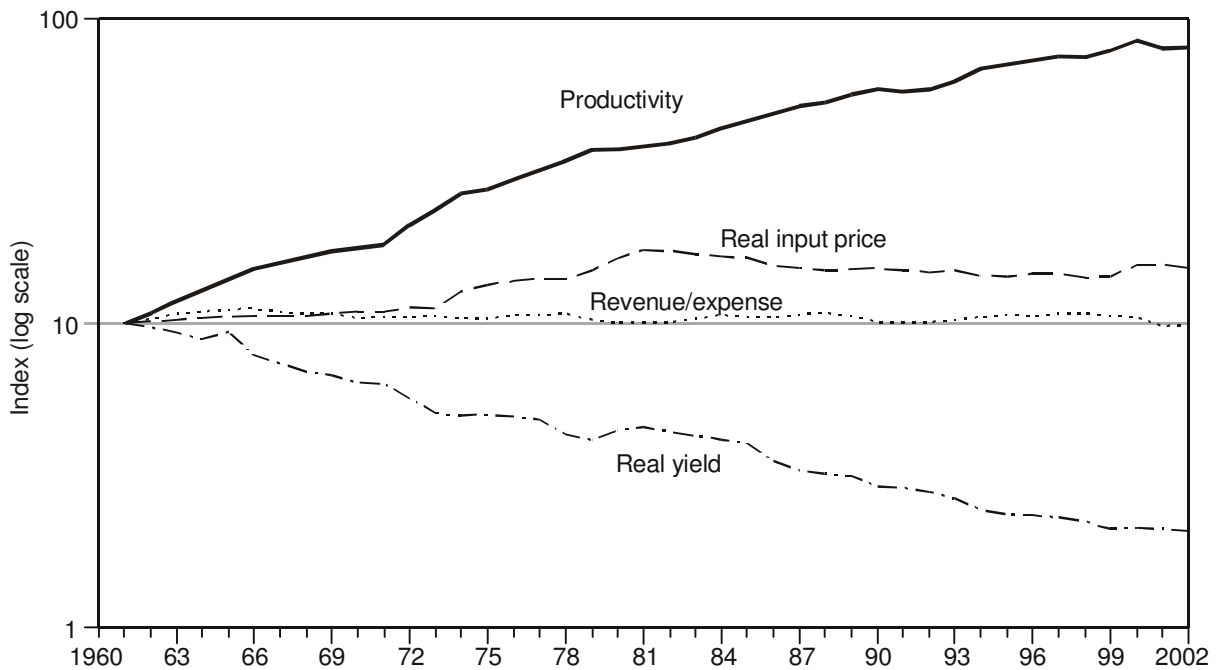
22. Changes in the real prices paid for inputs (e.g. labour and fuel) purchased by the airlines are also reflected in the cost per unit of output, and hence in real fares and rates or in financial performance. The price trends of two of the most important inputs, labour and jet fuel, are indicated in Figure 2-8, which also shows the trend in the Consumer Price Index (CPI). International Monetary Fund (IMF) indices for industrial countries are used for the labour price and the CPI. The importance of labour cost in the total cost structure of airlines and the high rate of increase in wage rates suggested in the figure have together acted as a powerful incentive for the improvement in labour productivity observed in Figure 2-7. Fuel is another key item on the expense side of the accounts. The impact on expenses of the very large fuel price increases in 1973–74 and 1979–80 was partly reversed by the price declines in 1985. Further hikes in jet fuel prices occurred in 1990, 1996 and most recently in the year 2000 when the average annual price in U.S. dollars reached 85 cents per gallon. Due to a contraction in demand, the jet fuel price softened to 69 cents on average in 2002 easing the pressure on airline operating costs. During the 1990s, fuel and oil costs ranged from around 10 to 15 per cent of total operating costs of scheduled airlines.

23. The trends in productivity, input prices, yields (i.e. fares and rates), and financial performance are summarized in Figure 2-9. A log scale is used so that the slopes of the trend lines represent percentage changes.



Source: IMF, OECD, Energy Information Administration of US Department of Energy.

**Figure 2-8. Input price trends — World (1960–2002)**



Source: IMF, ICAO Reporting Forms A-1 and EF-1.

**Figure 2-9. Trends in airline industry performance — World (1960–2002)**

The productivity measure is the overall index referred to above. An overall input price index has also been developed from individual input prices. Input prices and yields are expressed in real terms (i.e. after removing the impact of general inflation). Financial performance is represented by the ratio of revenues to expenses, where expenses are defined to exclude taxes and interest.

24. By and large, the productivity gains have not been retained by the airlines over the long term. Most of the cost savings associated with the full range of labour, fuel and aircraft productivity improvements have been passed on to the consumer in the form of lower fares and rates. The impact of productivity improvements has been offset to some extent by the increases in real input prices in the 1970s. A slight increase in these prices can also be observed in recent years which can be mainly attributed to the fuel price hike in 2000. In contrast, labour prices in the airline industry have had a reverse trend since 2001 due to traffic declines, both when compared to other operational cost items and the overall labour price index (for industrialized countries).

25. Although there have been substantial changes in the operating results of the airline industry in the short and medium terms (see Chapter 4), there has been neither an improving nor declining trend in financial performance over the long term. A significant sustained upward or downward trend would not be expected because of the magnified impact such a trend would have on the levels of industry profits or losses.

### **SAFETY AND QUALITY OF SERVICE**

26. Air transport has a strong tradition of giving top priority to safety. While the traffic growth, productivity improvement and cost and yield reductions described above have been occurring, a substantial improvement in the safety of air travel has been achieved. The number of passenger fatalities per 100 million passenger-kilometres flown has fallen from 0.8 in 1960 to 0.08 in 1980, 0.03 in 1990 and has ranged between 0.05 and 0.02 since then. The year 2002 saw 0.03 passenger fatalities per 100 million passenger-kilometres flown.

27. There have also been significant enhancements in the quality of service provided to airline customers. There are many dimensions to the quality of service, including journey time, convenience and reliability of service, comfort in the aircraft cabin and the range of on-board facilities. Some of these factors are difficult to measure in an objective fashion. However, increases in aircraft speed and average stage length have been achieved, with positive consequences for journey times and passenger convenience. The global average block-to-block aircraft speed increased from 360 kilometres per hour (km/h) in 1960 to 630 km/h in 1980 and 648 km/h in 2002 (an increase of 80 per cent over 1960). There has been little change in block speed since 1980. The average stage length has more than doubled from 470 kilometres in 1960 to 1 193 kilometres in 2002. This latter trend has been associated with more direct flights and fewer stopovers for refuelling, and hence a greater level of convenience for the passenger. The combined effect of increased aircraft speeds and fewer stopovers reduced the total journey time from Sydney to London from three and a half days in 1950 to under one day in 2002. Over the same period, the average journey time from New York to London was reduced from 17 hours to just under 7 hours.

28. With the growth in air transport demand in response to factors such as overall economic development, airlines have been able to increase service frequency and introduce non-stop flights for a greater range of city-pairs without increasing costs. This improved service has, in turn, led to stimulation of demand in the long run, although there have also been short-term demand contractions due to so-called fear and hassle factors and other non-economic factors. While it is not possible to isolate cause and effect, the fact that aircraft departures have increased by around 203 per cent between 1960 and 2002 is evidence of improvement in service frequency and convenience.

## AIRPORT AND AIRSPACE CONGESTION

29. During the 1980s, growth in passenger numbers of over 50 per cent and in aircraft departures of about 35 per cent resulted in airport and airspace congestion in some regions. A pause in traffic growth and measures to increase capacity provided some relief in the early 1990s. However, the subsequent resumption of traffic growth in the late 1990s put pressure again on facilities. This came to a halt in the early 2000s, with the combination of terrorist events and the general economic slowdown, which resulted in a delay of about five years in airport traffic growth. However, in some regions, traffic congestion still exists and at some major airports the limits of terminal and runway expansion are being reached. The land-intensive characteristics of airports and their environmental impact are serious barriers to the provision of extra runway capacity and, to a lesser extent, terminal capacity. Furthermore, many air traffic control systems are aging and in need of upgrading.

30. Technological developments and investment in aircraft, airports and air navigation equipment will create more capacity in the air transport system to help meet future demand. A number of new airports, as well as airport expansion projects, are due for completion over the next few years; much of this activity is in the Asia/Pacific, European and North American regions. Implementation of the global air navigation system under the leadership of ICAO is expected to lead to significant improvements in the management of air traffic in all phases of flight.

31. There are also various technical procedures, such as revisions to separation criteria, that can improve the flow of air traffic and reduce congestion delays. The provision of access and exit taxiways can increase runway capacity. In regard to congestion inside terminals, a number of States are reaching the goals of ICAO's facilitation programme such as clearing all arriving passengers (requiring normal inspection) through international airports within 45 minutes. The progressive introduction of machine readable travel documents and the general streamlining of procedures will be of increasing importance in the continuing search for improvements.

32. These are essentially supply-side measures which can effectively increase the capacity of the infrastructure. Other policies under consideration include pricing structures and regulatory controls, such as slot allocation, which act on the demand side.

33. The continuing development of high-speed rail services in Europe, in Japan and, to a limited extent, in the United States is expected to draw some air traffic from congested facilities.

34. The increasing use of secondary airports in major urban areas is providing relief, as well as a degree of competition, to large airports by diverting traffic from high-density flows but, at the same time, is adding aircraft movements, usually performed by smaller aircraft, to air traffic management systems.

## ENVIRONMENTAL PROTECTION

35. Future growth in civil aviation will take place against a background of increasing public concern regarding the environment, particularly with regard to aircraft noise and the impact of aircraft engine emissions.

36. Noise levels near airports are subject to two opposing trends: the replacement of noisy aircraft by quieter ones and the increasing number of aircraft movements. ICAO has developed noise certification Standards (Annex 16, Volume I) and in 1990 adopted a worldwide policy enabling States to introduce operating restrictions on the older, noisier ("Chapter 2") aircraft covered by these standards. The phase-out of Chapter 2 aircraft has now been completed at most airports where aircraft noise is a problem and governments have been turning their attention to concerns that the rapid growth of air transport could increase noise levels once again. With a view to addressing these concerns, the ICAO Assembly in 2001 endorsed the concept of a "balanced approach" to aircraft

noise management. This consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source (quieter aircraft), land-use planning and management, noise abatement operational procedures, and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner. In 2006, a new, more stringent ICAO standard will apply (“Chapter 4”).

37. As regards aircraft engine emissions, initially the main concern was the impact on air quality in the vicinity of airports, as a result of which ICAO developed Standards for the control of gaseous emissions through an engine certification scheme (Annex 16, Volume II). More recently, there have been increasing concerns that these emissions may be contributing to global atmospheric problems. The principal issue is aviation’s contribution to climate change. In 1999, the Intergovernmental Panel on Climate Change (IPCC) prepared a *Special Report on Aviation and the Global Atmosphere*<sup>1</sup> which estimated that aircraft contribute about 3.5 per cent of the total radiative forcing<sup>2</sup> by all human activities. The emissions from aircraft of relevance for climate change include carbon dioxide (CO<sub>2</sub>), water vapour, nitrogen oxides (NO<sub>x</sub>), sulphur oxides and soot.

38. The Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC), which was adopted in 1997 but has not yet entered into force, requires industrialized countries to reduce their collective emissions of certain greenhouse gases, the one most relevant to aviation being CO<sub>2</sub>. The Kyoto Protocol also calls for industrialized countries, working through ICAO, to limit or reduce emissions from international aviation.

39. Future concerns about aviation’s role in both climate change and local air quality are largely due to the projected continued growth. Because of improvements in fuel productivity, growth rates for emissions are less than those for traffic growth. While fuel productivity improvement is expected to continue, there are no easy technical “fixes” for aviation and total emissions will continue to increase. In the case of CO<sub>2</sub> (which is not controlled by the present Standards), improvements can only be achieved by reducing the rate of fuel consumption. Operational measures, as well as the use of market-based options such as voluntary agreements, emissions trading or emission-related levies (charges or taxes), are all under consideration.

## FINANCIAL RESOURCES

40. Investment in new aircraft generally follows a cyclical pattern. The latter part of the 1980s was a period of high investment. Investment levels fell away during the recession of the early 1990s but began to build up again in the latter part of the 1990s. The expected future funding requirement over the long term is substantially larger, in real terms, than was required over comparable periods in the past. This is consistent with the ongoing growth in traffic that is forecast over the long term.

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1. This Report has a *Summary for Policymakers* which is available in six UN languages (Arabic, Chinese, English, French, Russian and Spanish) and is accessible at IPCC’s Web site ([www.ipcc.ch](http://www.ipcc.ch)). The report itself (over 300 pages) is published in English only and can be purchased from Cambridge University Press ([www.cup.cam.ac.UK](http://www.cup.cam.ac.UK)).

2. Radiative forcing is a measure of the importance of a potential climate change mechanism.



41. The world passenger fleet is forecast to reach almost 22 000 aircraft by the year 2015<sup>3</sup> to meet the projected demand for new aircraft and replacement of retired aircraft. It is estimated that some 13 000 new aircraft will be added to the world fleet and just over 3 300 aircraft in the current fleet will be removed from passenger services during the same period. The freighter fleet is expected to reach almost 2 500 aircraft by 2015, of which almost 300 aircraft will be new freighters, while the remainder are expected to be converted from passenger operations.

## ECONOMIC REGULATION

42. For the past decade, there have been significant developments in the air transport regulatory scene at the national, bilateral, regional and multilateral levels. Much progress has been made in the liberalization of international air transport regulation with an increasing number of States being parties to arrangements towards full market access.

43. At the national level, several States have launched a review process of their air transport policies in light of the global trend toward increased liberalization. Some of these policies seek to liberalize air transport services, in whole or in part, on a unilateral basis without requiring comparable rights from bilateral partners in return. Others aim at liberalizing domestic air transport markets and also at permitting more carriers to fly international routes. In addition, about 130 States have announced privatization plans or expressed their intentions of privatization for approximately 190 State-owned airlines as part of the broader trends associated with globalization and liberalization across all economic sectors, although achievement of privatization has not been easy. Some States have also adopted a new policy or amended existing rules on foreign investment or control in national airlines and relaxed air carrier ownership and control conditions.

44. At the bilateral level, over 70 per cent of bilateral air services agreements which were recently concluded or amended contained some form of liberalized arrangements such as unrestricted traffic rights (covering Third, Fourth and in some cases Fifth Freedom rights), multiple designation with or without route limitations, free determination of capacity, a liberal double disapproval or country-of-origin tariff regime, and broadened criteria for air carrier ownership and control. One notable development is the considerable increase in the number of “open skies” agreements, which provide for full market access without restrictions on designations, route rights, capacity, frequencies, codesharing and tariffs. Over the past decade, over 85 such open skies agreements were concluded between some 70 States. These agreements involved not only developed countries but also an increasing number of developing countries (involved in about 60 per cent of the agreements).

45. At the regional level, 11 groups of States have created liberalization regimes on a regional basis or among a group of like-minded States; a few examples being the European Union (EU), the Andean Pact, the Yamoussoukro II Ministerial decision, and the Multilateral Agreement on the Liberalization of International Air Transportation (MALIAT) known as the “Kona” open skies agreement. There are also several other potential arrangements under development throughout the world. These regional and/or plurilateral liberalization arrangements have the basic objective of providing greater market access and improving services among the Member States concerned. Small groups of States of comparable size and development may find it easier to agree on market access than larger, diverse groups of States. The small groups would also provide a more manageable environment to test liberalized air transport policies.

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3. Source: ICAO Committee on Aviation Environmental Protection (CAEP), Sixth Meeting, Montreal 2–12/2/04, Information Paper CAEP/6-IP/13 dated 15/1/04 presented by the Forecasting and Economic Analysis Support Group (FESG) which includes traffic and fleet forecasts.

46. Within the EU, there was a significant development creating a new negotiating dynamic involving air services agreements by third parties with the EU member States, following the judgements of the European Court of Justice in November 2002, which ruled against certain provisions in some EU members' open skies agreements with the United States. In June 2003, the Council of the European Union conferred on the European Commission a mandate to negotiate air services agreements on behalf of all member States with the United States for creation of an Open Aviation Area (OAA) between the two territories, as well as to negotiate with certain third countries on the replacement of certain specific provisions in the existing agreements.

47. At the multilateral level, the World Trade Organization (WTO-OMC) came into being in January 1995 and the General Agreement on Trade in Services (GATS) entered into force. The GATS Annex on Air Transport Services applies trade rules and principles such as most-favoured nation (MFN) treatment and national treatment to three specific so-called "soft" rights, namely, aircraft repair and maintenance, selling and marketing of air transport, and computer reservation system (CRS) services. It excludes from the application of the GATS "services directly related to the exercise of traffic rights". Pursuant to an earlier ministerial decision, the WTO-OMC launched in 2000 the first review of the operation of this Annex with a view to considering possible extension of its coverage in this sector. In 2003, however, the first review was concluded with the result that the Annex remains unchanged, and the next review would commence towards the end of 2005.

48. Other more general regulatory measures also affect air transport. Such measures include competition law, the imposition of various taxes, the expansion of airline responsibilities associated with national entry requirements (particularly for inadmissible passengers), more stringent health standards for entry particularly where prevention of the spread of Acquired Immune Deficiency Syndrome (AIDS) and Severe Acute Respiratory Syndrome (SARS) is sought, and national narcotics control efforts.

## INDUSTRY STRUCTURE

49. Traditionally, changes in airline industry structure arise from the need to meet growing demand for air transport services in increasingly competitive but less regulated markets and a more globalized economic environment.

50. Mega-carriers in the United States and elsewhere operate out of their home base airports applying the "hub and spoke" system which employs large banks or complexes of interconnecting flights to maximize the number of city-pair markets that can be served by each flight. This operational approach arose from a perceived need to operate several hubs and to achieve critical mass (i.e. a size sufficient to exploit economies of scope and density, and the ability to influence market conditions). However, the hub-and-spoke concept has recently come under scrutiny as one of the measures taken by airlines to reduce airport services costs by utilizing staff, gates and aircraft more productively; for instance, American Airlines began to de-peak at its two hubs Dallas/Fort Worth (Texas) and Chicago O'Hare (Illinois).

51. Airlines are making increased use of computer-based measures to improve productivity and optimize revenues, including the use of automated systems for yield management and for marketing, sales and communication. First, the development of sophisticated yield management systems, associated with the use of computers, has enabled airlines to adjust the mix of high- and low-fare passengers on each flight in order to maximize revenues as well as to allocate seats efficiently. Yield management has enabled established higher-cost airlines in certain instances to compete selectively with new lower-cost airlines that are often reliant upon low fares to achieve market penetration. Second, product distribution is now being carried out through CRS.

### ***Product distribution***

52. An important development in the airline distribution and sales area which combines computers and personal communication systems is direct sales to consumers, including via the Internet. Although the majority of airline ticket sales are still being achieved through traditional travel agents, the share of on-line sales through the Internet is growing fast, especially in countries where Internet and credit card use is high. This development has created new opportunities as well as challenges for airlines and CRS vendors. Many airlines have started or expanded on-line sales as a way of cutting distribution costs. Some have joined forces to create travel Web sites in order to maximize the benefits of electronic commerce. The four global CRS vendors, *Amadeus*, *Galileo*, *Sabre* and *Worldspan*, have also taken actions to adjust to the new business environment and pursued the Internet market through different strategies, evolving into global distribution systems (GDSs). GDS providers offer comprehensive information and reservation services and e-commerce solutions for travel and tourism (air travel, car rentals, rail-links, hotels, leisure facilities, etc.). Some have provided reservation services to major on-line travel sites or have become owners of such sites; others have forged partnerships with retail giants for joint Web sites. Another important development in this area is electronic ticketing, initially offered for domestic flights in the United States but now becoming available for international flights in all regions. In an era of increased competition, these developments offer considerable cost savings for airlines, as well as diversification of their distribution outlets.

### ***Alliances and airline cooperation***

53. The formation of alliances as well as joint marketing arrangements among airlines is a relatively recent but rapidly evolving phenomenon implemented to achieve and improve market access (albeit indirectly) and synergies (for example, circumventing bilateral restrictions on market access, ownership and control). Currently, over 600 such voluntary interline alliance agreements exist worldwide, containing a variety of elements such as codesharing, blocked space, cooperation in marketing, pricing, inventory control and frequent flyer programmes (FFPs), coordination in scheduling, sharing of offices and airport facilities, joint ventures and franchising. Among the transnational groupings, there are four competing “global alliances”, namely *Star Alliance*, *oneworld*, *SkyTeam* and *Wings*. Each group is composed of some major airline members having different geographical coverage with fairly extensive networks. Through the alliances, these carriers have combined their route networks, which extend to most parts of the world, and carry together over 50 per cent of worldwide scheduled passenger traffic. Strategic alliances are airlines’ response to, inter alia, perceived regulatory constraints, a need to reduce their costs through economies of scope and scale, and more globalized and competitive air transport markets. In Europe and North America, intermodal alliances with railways have also grown.

54. These developments have caused concerns to small- and medium-size airlines for their survival and have prompted efforts by these airlines to develop a particular segment of a market, to compete as low-cost, point-to-point airlines or to enter various alliances of their own.

### ***Airline business models***

55. In recent years, successful low-cost carriers have been challenging the full service network models of major airlines. The common features of the business model of low-cost carriers are, with some variations: point-to-point network focusing on short-haul routes, high frequencies, simple low-fare structures, high-density single class with no seat assignment, simple in-flight services, staffing flexibility and minimal overheads, and intensive use of electronic commerce for marketing and distribution (including on-line booking via the Internet and electronic ticketing). To sustain low-cost structures, these carriers usually operate a single aircraft type with high daily aircraft utilization. They also use less-congested secondary airports to ensure quick turnarounds and punctuality and to reduce airport-related costs. Low operating costs enable low-cost carriers to allocate all their seats to low fares. The success of low-cost, point-to-point air carriers has prompted some larger carriers to create subsidiaries or separate units to compete with them.

56. In the area of air cargo, the highly sophisticated airline/parcel express delivery companies, which grew substantially in the past decade, continue to expand this specialized service. These companies operate large jet cargo fleets combined with surface delivery systems to provide continental overnight deliveries and second day intercontinental services via strategically placed sorting hubs. This concept has also been adopted by a number of postal administrations.

### ***Privatization, national consolidation and transnational ownership***

57. Privatization of State-owned airlines has been one of the preeminent transformations in international air transport, where airlines in all but a handful of States had been State-owned until recent times. It is a process of divestment, by various methods, of State-owned or -controlled equity and may be carried out in a phased manner over time. Some States may consider a minor sale of shares as privatization. The motives for privatization have been highly diverse, ranging from purely economic considerations or improving operating efficiency and competitiveness to a more pragmatic desire to reduce the heavy financial burden for States for financing capital investment in new equipment. Whatever the reasons, the privatization of airlines has accompanied a more commercially-oriented outlook within an increasingly competitive environment. Since 1985, about 130 States have announced privatization plans or expressed their intentions of privatization for approximately 190 State-owned airlines. During this period, about 90 of these targeted carriers have achieved privatization goals.

58. Airlines in many parts of the world have continued the pursuit of enhanced market strength through mergers, acquisitions or operational integration under a single holding company. The common thread of this trend is the continuing development of growth strategies designed to hold and expand existing market share, gain access to new markets, achieve unit cost reduction, shield themselves against competition, and increase the scale of operations in order to attain a critical market position. Mergers or acquisitions are easier to achieve within the same country, although some Governments have expressed concerns regarding industry consolidation and have scrutinized it.

59. The opportunity for equity investment in foreign carriers has increased as many States adopted a new policy or amended existing rules on foreign investment or control in national airlines and relaxed air carrier ownership and control conditions in air services agreements. However, most attempts to initiate transactions involving a foreign majority ownership, including cross-border mergers or acquisitions, were abandoned owing to aeropolitical, economic and regulatory complexities. Even in the implemented cases, the control and management of foreign carriers was not financially risk-free. Because of these difficulties in successful implementation, most foreign investments in the airline industry have been on a limited scale, instead of taking a majority stake or pursuing a full-scale merger, and often as part of a strategy to forge or strengthen alliances and expand market access. Nevertheless, foreign investments have sometimes been short-lived.

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## Chapter 3

### WORLD ECONOMIC ENVIRONMENT

#### HISTORICAL TRENDS

1. As indicated in Chapter 2, the world economy is subject to economic cycles but has steadily grown over the long term. During the period 1960–2002, the aggregate world economy measured in terms of GDP increased at an average annual rate of 3.4 per cent in real terms.
2. Following the recession of 1980–1982, the world economy experienced its longest period of sustained progress (1983–1989) since the Second World War, achieving an average annual growth rate of 3.6 per cent before a slowdown in 1990, due primarily to fuel price increases in the wake of the Gulf crisis in the second half of the year.
3. However, the 1990 oil price increases did less damage to the world economy than did previous increases in 1973 and 1980. The 1990 increases were smaller, and the ability of the economies of the industrialized countries to cope with them was greater because of reduced energy dependency and the effects of structural reforms in the 1980s. They also lasted for a shorter period, with both crude oil and jet fuel prices returning to pre-crisis levels by March 1991.
4. World economic growth, measured in terms of real GDP, declined from almost 3.5 per cent in 1989 to 0.7 per cent in 1990. In 1991, some major economies entered into a recession or experienced a slowdown; as a result, the world economy increased only by 0.1 per cent in 1991, the most difficult year globally since 1982. The world economy improved in 1992 and 1993, and over the period 1990–1995 it grew at an average annual rate of 2.8 per cent. Having experienced high growth rates in 1996 and 1997 (3.5 and 3.7 per cent, respectively), the world economy slowed down in 1998, led by a turndown in the Asia/Pacific region, and increased only by 1.9 per cent. It regained strength, however, in 1999 with GDP growth of 3.1 per cent, based mainly on economic recovery in the Asia/Pacific region and continued strong growth in the United States economy, and continued to grow in 2000 at 4.6 per cent. Another slowdown occurred during 2001 across almost all major regions resulting from a marked decline in trade growth, significantly lower commodity prices, and deteriorating financing conditions in emerging markets. The events of 11 September 2001 amplified the impact of an already weakening global economy, particularly on consumer and business confidence in the United States; as a result, GDP growth dropped to 2.3 per cent. With trade and industrial production improving across all regions, the world economy began to recover and grew at a rate of 3.0 per cent in 2002.
5. World population growth between 1980 and 2002 increased at an average annual rate of 1.5 per cent. Hence, the world's GDP per capita increased during the same period at an average annual rate of 1.2 per cent, lower than the growth of GDP itself. For the period 1992–2002, GDP and GDP per capita grew at an average annual rate of 3.0 per cent and 1.6 per cent, respectively.

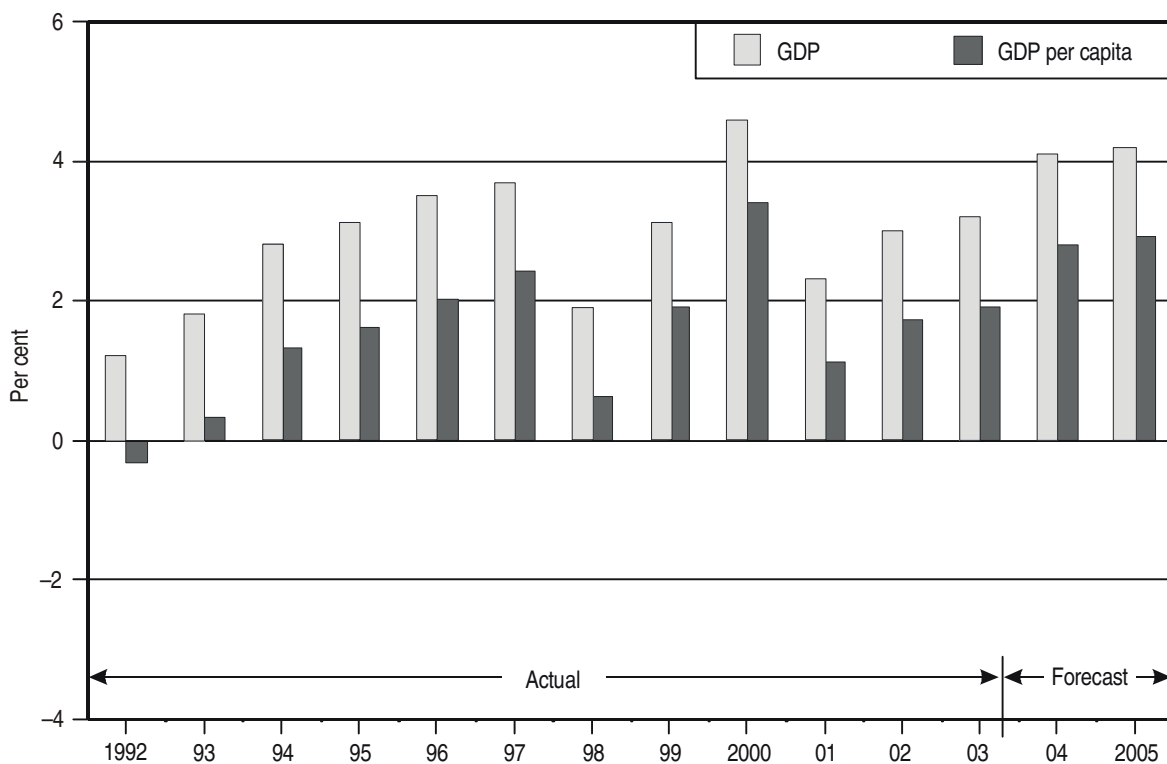
#### OUTLOOK

6. There appears to be consensus among economic forecasters that the world economic and financial conditions are on a sustainable recovery path and that the global economy will continue to expand over the

medium term. Apart from the negative impacts of the war in Iraq and the SARS outbreak in parts of Asia during the first half of 2003, the world economy began to show signs of a renewed recovery. It is estimated that the world GDP grew approximately 3.2 per cent in real terms in 2003, slightly higher than in 2002. For the years 2004 and 2005, the world economy is anticipated to further expand at 4.1 and 4.2 per cent, respectively.

7. Figure 3-1 portrays the historical growth trends of GDP and GDP per capita in real terms from 1992–2002 and the prospects through to 2005. The outlook for 2003–05 is taken from the most recent three-year forecasts on economic development and scheduled passenger traffic at the global and regional level that ICAO produces and publishes in an annual series entitled *The World of Civil Aviation*.

8. Over the long-term horizon to 2015, the world economy is projected to grow at an average annual rate of 2.5 per cent in real terms (see Chapter 5).



Source: ICAO estimates based on data from the IMF, OECD, WEFA Group, World Bank and other sources.

**Figure 3-1. Growth of real GDP and GDP per capita — World (1992–2005)**

## Chapter 4

### AIRLINE FINANCIAL TRENDS

#### OPERATING REVENUES, EXPENSES AND RESULTS

##### *Global trends*

1. This chapter outlines general trends in airline financial data (in current terms unless indicated otherwise) from the historical perspective and, in broad terms, the outlook to the year 2015. Financial data for the years 1970, 1980 and 1990 as well as for the period 1992–2002, categorized by major components of operating revenues and expenses, are given in Table 4-1. The trends in annual operating revenues and expenses for the period 1992 to 2002 are illustrated in Figure 4-1. The treatment is global in nature, dealing with totals and averages for the airlines at the global level, and for this reason does not show the wide differences that exist between regions or individual carriers. Since the available information on non-scheduled operators is incomplete, the analysis is confined to the scheduled airlines of ICAO Contracting States (although the non-scheduled operations of these airlines are included).

2. The long-term historical trend of the financial performance of scheduled airlines indicates neither an improvement nor a decline, although fluctuations in the operating results occurred over the past ten years. During the 1983–1989 period, a decrease in fuel costs, along with other cost reduction and yield control measures, brought about an improvement in the financial results of the industry which generated a positive net result of 4.4 per cent of operating revenues over this period. This trend was reversed in 1990 as a result of a steep increase in fuel prices caused by the Gulf crisis, along with a slowdown in the world economy. The market conditions changed as the demand weakened and the utilization of airline resources tended to decline. The emergence of excess capacity and consequent competitive pressures put downward pressure on yields. These factors combined to produce negative operating results in three consecutive years (1990–1992). In 1993, the airline industry started to move towards a more appropriate balance of supply and demand and achieved a small operating surplus. Between 1994 and 2000, the airline industry continued to show positive operating results with profit margins ranging between 3.1 and 5.6 per cent of operating revenues. In 2001, shrinking operating revenues, due to declining traffic combined with increasing fuel, security and insurance costs, led to an unprecedented operational loss of \$11.8 billion and a net loss of \$13 billion. In 2002, the operating loss is estimated at \$4.9 billion and the net loss at \$11.3 billion (see Table 4-1).

3. As shown in Table 4-2, from 1992 to 2002 the total operating revenues of the world's scheduled airlines from scheduled and non-scheduled services (including incidental revenues) increased at an average annual rate of 3.5 per cent, from \$217 800 million to \$306 000 million. During the same period, the corresponding total operating expenses increased at an average annual rate of 3.5 per cent, from \$219 600 million to \$310 900 million. During this period, the growth in world airline operating revenues was associated with an average annual growth in total traffic of 5.7 per cent in terms of TKPs (excluding domestic operations in the Russian Federation in 1992) and a decline in airline yields (average operating revenue per tonne-kilometre performed) of 2.2 per cent per annum from 90.7 cents in 1992 to 72.9 cents in 2002. The unit cost per available tonne-kilometre (ATK) declined by 1.2 per cent from 52.6 cents in 1992 to 45.2 cents in 2002. Figure 4-2 presents the trends in the financial performance indicators of the global airline industry in terms of unit revenues and costs as well as operating and net results over the 1992–2002 period.

**Table 4-1. Operating revenues and expenses — World (1970–2002)**  
(Total services of scheduled airlines of ICAO Contracting States<sup>1</sup>)

	1970	1980	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(millions of dollars)													
<b>OPERATING REVENUES</b>														
Scheduled services (total)	16 466	80 003	173 970	187 590	193 930	212 710	233 660	247 030	254 070	257 880	264 050	284 920	267 550	265 910
Passenger	14 097	69 290	153 330	165 140	171 440	186 530	205 000	216 710	221 820	226 100	231 410	248 940	232 410	231 030
Freight	1 745	9 293	18 410	20 110	20 270	23 890	25 980	27 830	29 720	29 420	30 400	33 840	32 990	32 740
Mail	624	1 420	2 230	2 340	2 220	2 290	2 680	2 490	2 530	2 360	2 240	2 140	2 150	2 140
Non-scheduled operations	805	3 260	7 090	7 870	8 230	9 110	10 680	11 740	11 250	9 660	11 440	11 710	10 470	9 790
Incidental	546	4 413	18 440	22 340	23 840	22 880	22 660	23 730	25 680	27 960	30 010	31 870	29 480	30 300
Total operating revenues	17 817	87 676	199 500	217 800	226 000	244 700	267 000	282 500	291 000	295 500	305 500	328 500	307 500	306 000
<b>OPERATING EXPENSES</b>														
Flight operations (total)	4 651	33 768	56 320	57 360	59 270	61 350	66 550	74 810	76 390	75 080	82 240	98 790	97 020	95 700
Flight crew salaries and expenses	1 796	6 424	13 780	15 790	16 520	17 860	19 450	21 020	21 550	22 330	24 280	26 380	27 840	27 960
Aircraft fuel and oil	1 944	24 524	30 300	26 800	26 840	26 900	28 970	34 600	34 580	29 180	32 190	45 900	42 950	40 400
Other (insurance, rental, training, etc.)	911	2 820	12 240	14 770	15 910	16 590	18 130	19 190	20 260	23 570	25 770	26 510	26 230	27 340
Maintenance and overhaul	2 476	9 079	22 900	23 830	22 530	23 770	26 810	28 540	30 310	31 190	31 670	33 710	36 120	35 130
Depreciation and amortization	1 899	5 457	13 850	15 380	15 580	17 990	18 400	19 100	17 990	18 280	19 280	20 780	22 670	22 190
User charges and station expenses (total)	2 908	13 364	32 460	37 880	38 740	41 640	46 140	47 920	47 690	50 010	51 760	54 720	54 000	52 860
Landing and associated airport charges	530	3 069	7 730	8 460	9 260	10 480	11 440	11 600	11 210	12 400	12 780	13 490	12 660	12 440
Other	2 378	10 295	24 730	29 420	29 480	31 160	34 700	36 320	36 480	37 610	38 980	41 230	41 340	40 420
Passenger services	1 714	7 963	20 710	23 630	23 580	25 610	28 070	29 090	29 310	29 770	31 520	31 780	32 670	31 710
Ticketing, sales and promotion	2 643	12 634	32 860	36 050	36 590	37 360	39 590	41 320	40 700	40 110	40 130	40 450	35 650	33 260
General, administrative and other operating expenses	1 076	6 055	21 900	25 470	27 410	29 280	27 940	29 420	32 310	35 160	36 600	37 570	41 170	40 050
Total operating expenses	17 367	88 310	201 000	219 600	223 700	237 000	253 500	270 200	274 700	279 600	293 200	317 800	319 300	310 900
Operating result [profit or loss (-)]	450	-634	-1 500	-1 800	2 300	7 700	13 500	12 300	16 300	15 900	12 300	10 700	-11 800	-4 900
Operating result as a percentage of operating revenues	2.5	-0.7	-0.7	-0.8	1.0	3.1	5.1	4.4	5.6	5.4	4.0	3.3	-3.8	-1.6
Net result	-27	-919	-4 500	-7 900	-4 400	-200	4 500	5 300	8 550	8 200	8 500	3 700	-13 000	-11 300
Net result as a percentage of operating revenues	-0.2	-1.0	-2.3	-3.6	-1.9	-0.1	1.7	1.9	2.9	2.8	2.8	1.1	-4.2	-3.7

1. Excluding domestic operations of airlines registered in the USSR prior to 1992 and the Russian Federation from 1992–1996.

Source: ICAO

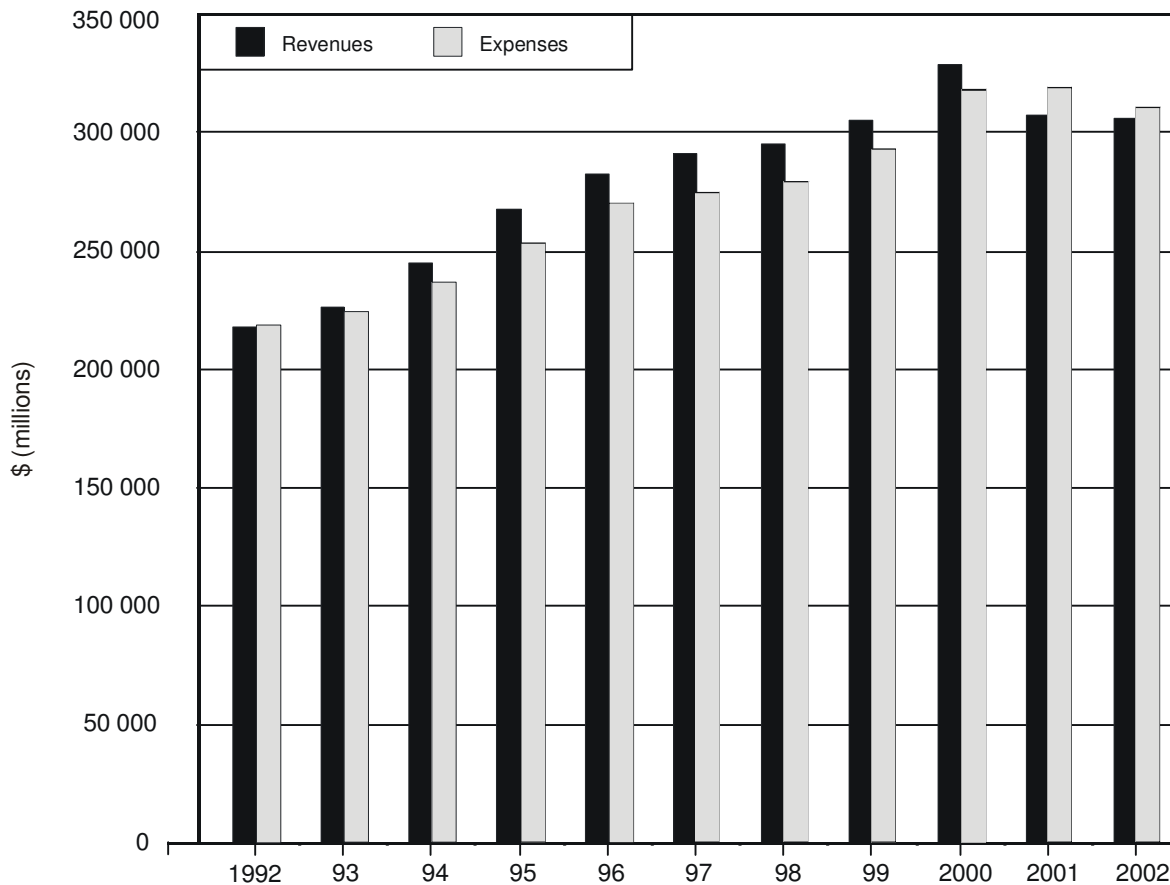


**Table 4-2. Total and unit operating revenues and expenses— World (1992 and 2002)**  
(Total services of scheduled airlines of ICAO Contracting States)

	Operating revenues (\$ millions)	Operating expenses (\$ millions)	Total traffic (TKP millions)	Unit revenue (cents/TKP)	Total capacity (ATK millions)	Unit cost (cents/ATK)
1992 <sup>1</sup>	217 800	219 600	240 100	90.7	417 840	52.6
2002	306 000	310 900	419 600	72.9	687 100	45.2
Average annual growth 2002/1992 (per cent)	3.5	3.5	5.7	-2.2	5.1	-1.5

1. Excluding domestic operations of airlines registered in the Russian Federation.

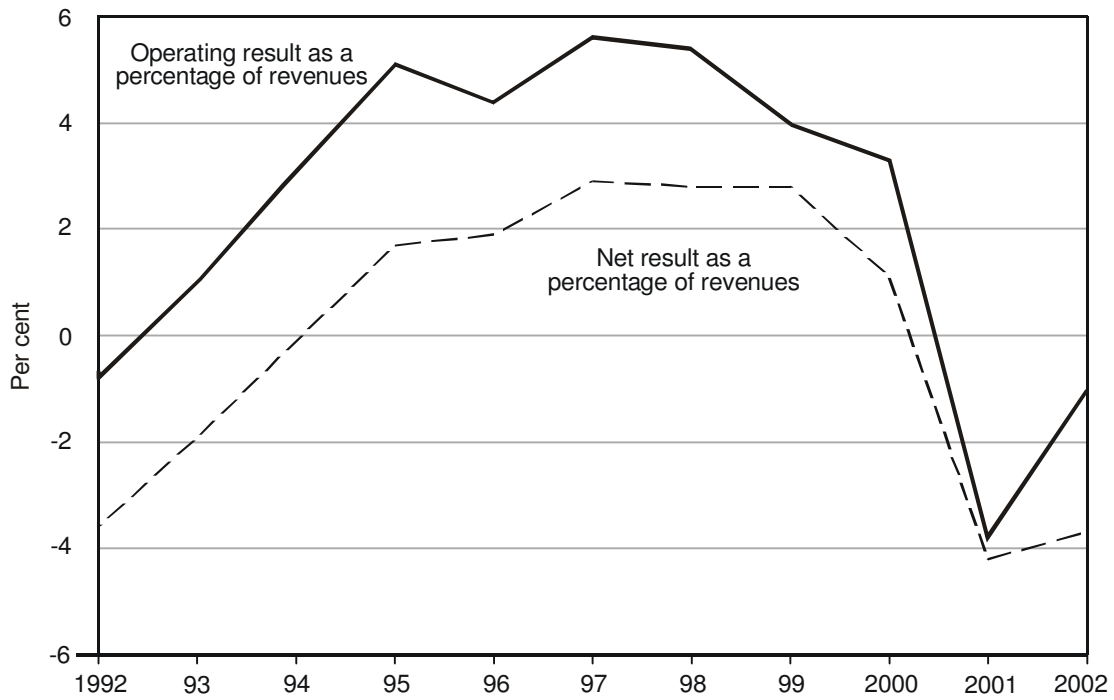
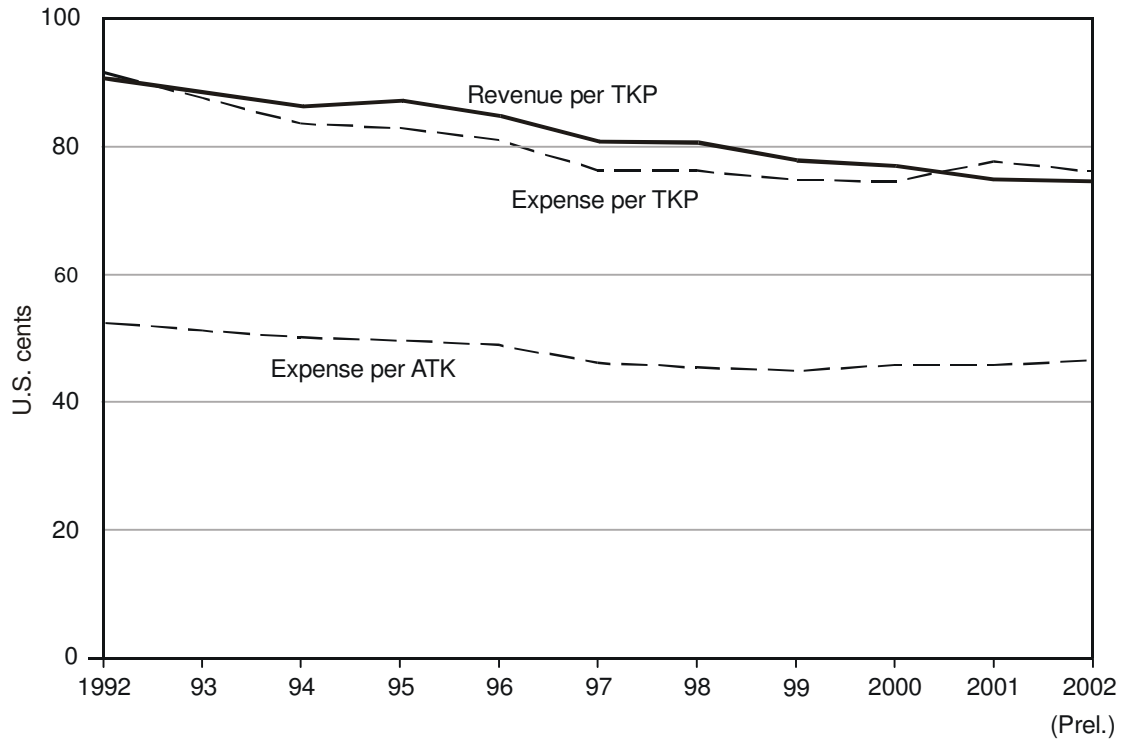
Source: ICAO Reporting Forms A-1 and EF-1.



Source: ICAO Reporting Form EF-1.

Note: Excluding domestic operations of airlines registered in the Russian Federation prior to 1996.

**Figure 4-1. Scheduled airline operating revenues and expenses — World (1992–2002)**



Source: ICAO Reporting Form EF-1.

Note: Excluding domestic operations of airlines registered in the Russian Federation prior to 1996.

**Figure 4-2. Financial performance indicators of scheduled airlines — World (1992–2002)**

### *Yields and unit costs*

4. Historically, airline fares have reflected the trends in operating costs and changing competitive conditions. Airline yields have declined in real terms almost every year since the advent of jet aircraft. The reductions in fares and freight rates, expressed in real terms, that occurred between 1960 and 2002 are reflected in real declines in passenger revenue yield per passenger-kilometre and freight yield per freight tonne-kilometre. These declines in yield contributed substantially to traffic growth. Marketing of air transport was aided by the fact that air fares (average airline yields) represented a steadily improving bargain in comparison with many other services. Figure 4-3 illustrates the annual change in average passenger yield over the 1960–2002 period as well as the annual change in freight yield per tonne-kilometre. Average world passenger yield measured in real terms decreased at a rate of 2.5 per cent per annum, while freight and mail yield decreased at a rate of 3.5 per cent per annum over that period. These declines in yield were the result of technological advances, longer average trip lengths, greater competition and certain economies of scale.

5. Measured in real terms, the operating costs per available tonne-kilometre (ATK) of world scheduled airlines declined on average by 3.6 per cent per annum over the 1992–2002 period, with year-to-year fluctuations illustrated in Figure 4-4.

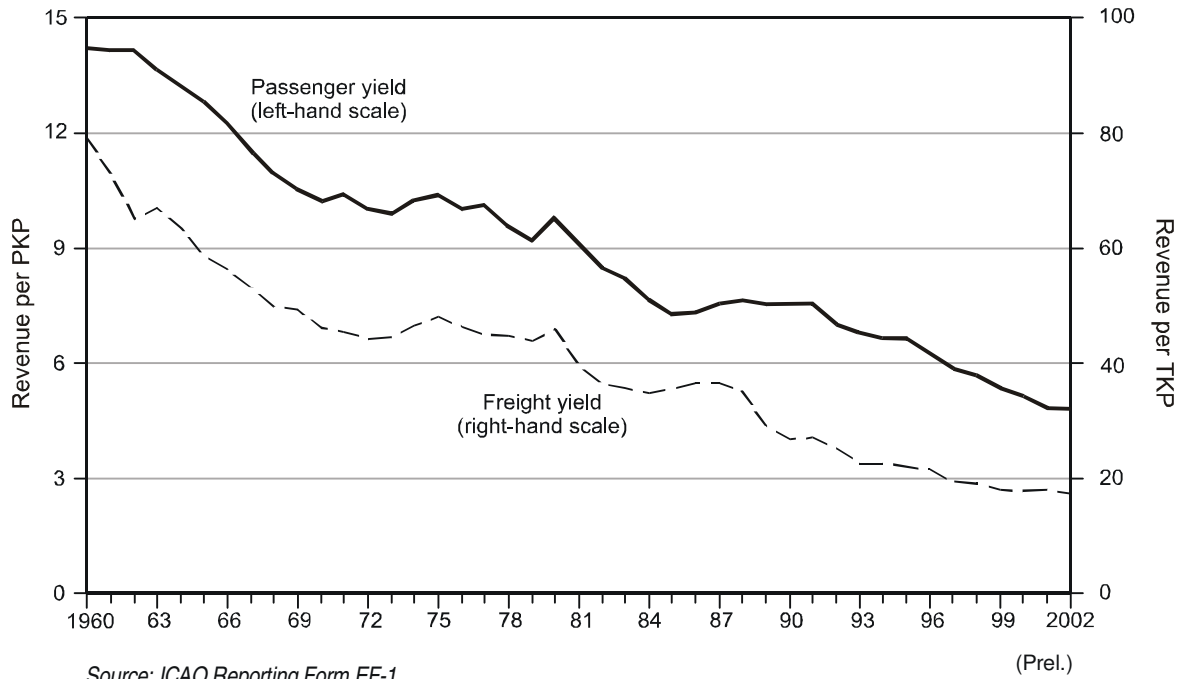
6. Airline operating costs are heavily influenced by jet fuel prices. Due to large increases in oil prices in 1979, unit costs rose sharply in 1980 with fuel costs accounting for almost 29 per cent of the total costs of scheduled airlines. Unit costs declined during the period 1982–1985 partly as a result of declining fuel prices. Due to the hike in jet fuel prices, fuel costs accounted for over 14 per cent of total operating costs in 2000. Subsequently, the share declined as fuel prices decreased in 2001 and 2002 as illustrated in Figure 4-5. In 2003, however, that declining trend reversed due to sharp increases in fuel prices, and this trend is expected to continue into 2004. The long-term outlook for fuel prices is not clear; prevailing industry expectations are for significant increases in the short term and moderate increases at the rate of inflation in the long term. While this could have a significant impact in the short term, in the long term it would have a relatively small impact on operating costs. In addition to aircraft fuel costs, other factors that have an important impact on unit costs include aircraft utilization and capacity as well as density of seating configuration.

### *Operating revenues and expenses by category and region*

7. When comparing 1992 and 2002 as presented in Table 4-3, the share of revenues from scheduled services remained almost unchanged and accounted for nearly 87 per cent of total operating revenues in 2002. In terms of revenue components, passenger revenues of scheduled services declined slightly from 75.8 per cent in 1992 to 75.5 per cent in 2002; in the same period, freight revenues increased from 9.2 per cent to 10.7 per cent, while mail revenues declined from 1.1 per cent to 0.7 per cent. Non-scheduled revenues declined marginally from 3.6 per cent in 1992 to 3.2 per cent in 2002 and incidental revenues (which cover sales of services and maintenance, leasing of aircraft to other airlines and other non-core transport-related activities) decreased slightly.

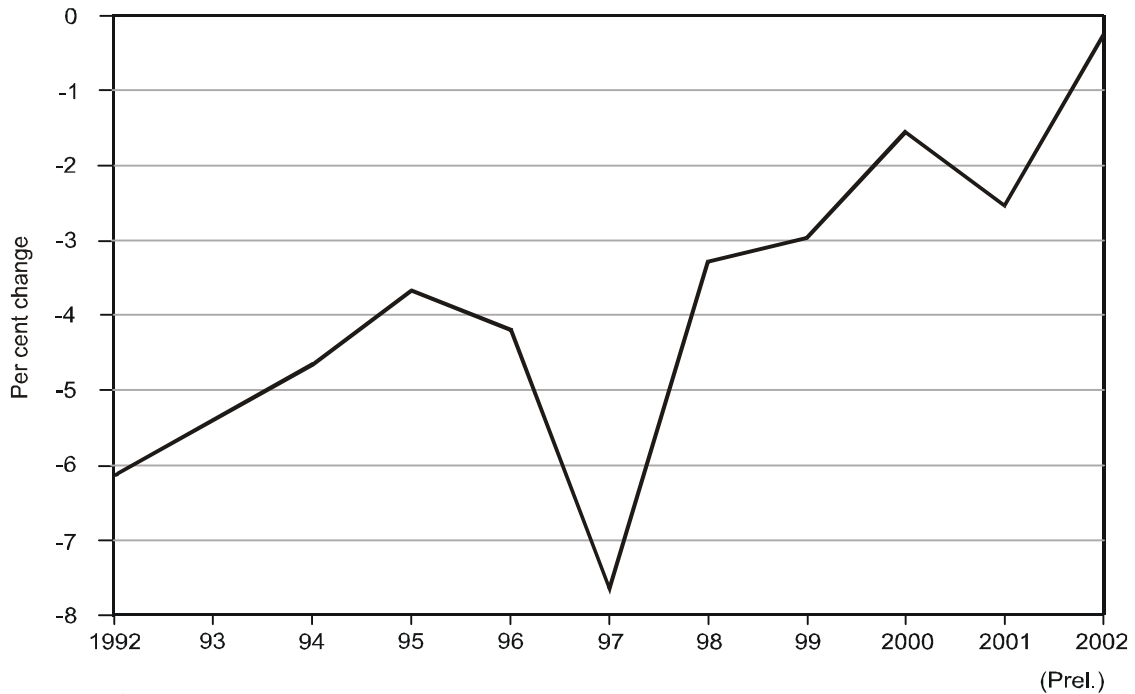
8. Considering the two major categories of airline operating expenses, direct expenses accounted for about half of the total in 2002 while indirect expenses made up the other half, compared to 44.0 and 56.0 per cent, respectively, in 1992. The major part of the direct expenses, i.e. total flight operations expenses, increased by almost 5 percentage points between 1992 and 2002, mainly because of significant increases in “flight crew” and “other” expenses. Among the indirect expenses, “general, administrative and other operating expenses” rose by 1.3 percentage points, while “ticketing, sales and promotion” fell by 5.7 percentage points during the same period (see Chapter 2, para. 52 regarding cost savings on this item).

9. Estimates of the distribution of total operating revenues and expenses according to the region of airline registration are given together with the corresponding operating results in Table 4-4 for 1992 and 2002. In 2002, about 36 per cent of operating revenues and 38 per cent of operating expenses of the world’s airlines were attributable to North American airlines, some 31 per cent of revenues and 30 per cent of expenses to European



Source: ICAO Reporting Form EF-1.  
 Note: Excluding domestic operations of airlines registered in the USSR prior to 1992 and the Russian Federation from 1992-1996.

**Figure 4-3. Passenger and freight yields of scheduled airlines — World (1960–2002)**  
 (U.S. cents in real terms)



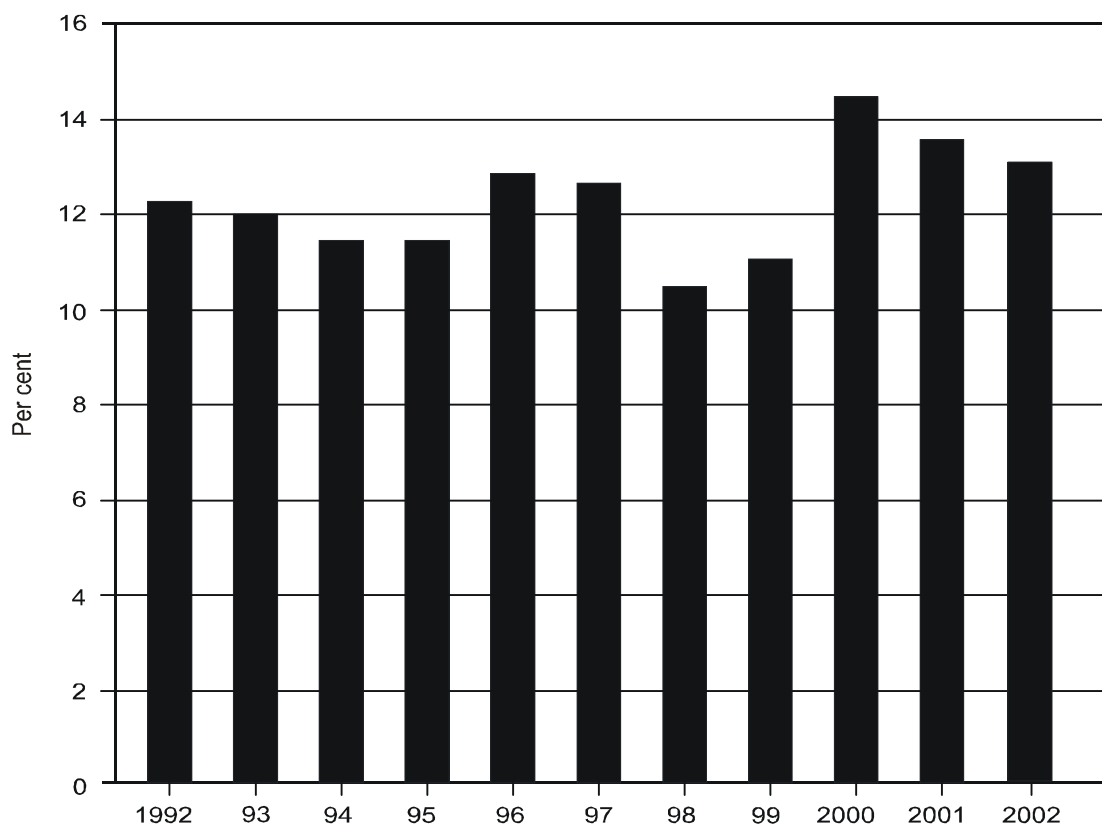
Source: ICAO Reporting Forms A-1 and EF-1.  
 Note: Excluding domestic operations of airlines registered in the Russian Federation prior to 1996.

**Figure 4-4. Unit operating costs of scheduled airlines — World (1992–2002)**  
 (U.S. cents per ATK in real terms)

airlines and some 24 per cent of revenues and 22 per cent of expenses to airlines of Asia/Pacific, with the remaining 9 per cent and 10 per cent of revenues and expenses, respectively, divided among those of Africa, the Middle East and Latin America/Caribbean. Compared to 1992, the 2002 shares of operating revenues and expenses of the airlines of Asia/Pacific represented a gain of some 2 percentage points of the world total, while those of the North American carriers declined by about 1 percentage point in revenues and remained almost unchanged in expenses. The shares of the airlines of the remaining regions declined marginally.

## OUTLOOK

10. Over the forecast period 2002–2015, the airline industry is likely to face substantial inflationary pressure on operating costs, particularly in the areas of labour and capital. The prospects for airline yields are closely related to cost developments and market conditions in the airline industry. Cost items under particular scrutiny at present are fuel and oil; labour; ticketing, sales and promotion (notably in connection with product distribution); and general/administrative expenses. Productivity improvements in the airline industry should continue to produce some cost savings. However, the magnitude of improvements in cost efficiency resulting from fleet developments is likely to be significantly less than in the past due to the high capital cost of new aircraft and the increase in the cost of financing.



Source: ICAO Reporting Forms A-1 and EF-1.

Note: Excluding domestic operations of airlines registered in the Russian Federation prior to 1996.

**Figure 4-5. Share of fuel and oil in operating expenses of scheduled airlines — World (1992–2002)**

11. Over this forecast period average passenger yields (fares) in real terms are expected to decline at an annual rate of 0.5 per cent for the period 2002 to 2006 and to stabilize for the remaining nine years. Average freight yields (rates) in real terms are expected to decline at a 0.5 per cent rate from 2002 to 2008 and to stabilize for the remaining period through to 2015.

**Table 4-3. Distribution of operating revenues and expenses — World (1992 and 2002)**  
(Total services of scheduled airlines of ICAO Contracting States)

	Distribution by category (per cent)		Change in per cent share of item 1992 to 2002
	1992 <sup>1</sup>	2002	
<b>OPERATING REVENUES</b>			
Scheduled services (total)	86.1	86.9	0.8
Passenger	75.8	75.5	-0.3
Freight	9.2	10.7	1.5
Mail	1.1	0.7	-0.4
Non-scheduled operations	3.6	3.2	-0.4
Incidental	10.3	9.9	-0.4
TOTAL	100.0	100.0	—
<b>OPERATING EXPENSES</b>			
Direct aircraft			
Flight operations (total)	26.1	30.7	4.6
Flight crew	7.2	9.0	1.8
Fuel and oil	12.2	13.0	0.8
Other	6.7	8.7	2.0
Maintenance and overhaul	10.9	11.3	0.4
Depreciation and amortization	7.0	7.1	0.1
Sub-total	44.0	49.1	5.1
Indirect			
User charges and station expenses (total)	17.2	17.0	-0.2
Landing and associated airport charges	3.9	4.0	0.1
Other	13.3	13.0	-0.3
Passenger services	10.8	10.3	-0.5
Ticketing, sales, promotion	16.4	10.7	-5.7
General, administrative and other	11.6	12.9	1.3
Sub-total	56.0	50.9	-5.1
TOTAL	100.0	100.0	—

1. Excluding domestic operations of airlines registered in the Russian Federation.

Source: ICAO Air Transport Reporting Forms A-1 and EF.

**Table 4-4. Distribution of operating revenues and expenses —  
Regions of airline registration (1992<sup>1</sup> and 2002)**  
(Total services of scheduled airlines of ICAO Contracting States)

	Year	Operating revenues		Operating expenses		Operating result	
		Dollars (millions)	Per cent of world	Dollars (millions)	Per cent of world	Dollars (millions)	Per cent of operating revenues
Africa	1992	5 700	2.6	5 350	2.4	350	6.1
	2002	6 900	2.3	6 700	2.2	200	2.9
Asia and Pacific	1992	47 200	21.7	45 650	20.8	1 550	3.3
	2002	72 600	23.7	69 700	22.4	2 900	4.0
Europe	1992	67 750	31.1	68 000	31.0	-250	-0.4
	2002	94 600	30.9	92 800	29.8	1 800	1.9
Middle East	1992	6 850	3.2	6 650	3.0	200	2.9
	2002	9 400	3.1	9 500	3.1	-200	-2.1
North America	1992	80 200	36.8	83 150	37.9	-2 950	-3.7
	2002	109 700	35.8	118 600	38.1	-8 900	-8.1
Latin America and Caribbean	1992	10 100	4.6	10 800	4.9	-700	-6.9
	2002	12 800	4.2	13 500	4.3	-700	-5.4
World	1992	217 800	100.0	219 600	100.0	-1 800	-0.8
	2002	306 000	100.0	310 900	100.0	-4 900	-1.6

1. Excluding domestic operations of airlines registered in the Russian Federation.

Source: ICAO Digests of Statistics, Series F — Financial Data.

## **Chapter 5**

# **FORECASTS OF AIRLINE TRAFFIC TO THE YEAR 2015**

### **FORECASTING METHODOLOGY**

1. As a basis for the preparation of the traffic forecasts for this study, econometric analyses were carried out of the effects of underlying factors on the historic aggregate demands for scheduled passenger and freight traffic. These analyses were used to translate expectations of future world economic development and future trends in international trade and average fares into projections of future traffic demand.
2. More detailed projections for international and domestic scheduled traffic for the airlines of each geographical region were initially developed from the forecasts of total scheduled traffic by analysing historic traffic trends and market shares for the airlines, based on the individual geographical regions. These projections were reviewed in light of economic trends and other factors relevant to particular regions. As mentioned in Chapter 2, the events of 11 September 2001 adversely affected the growth of traffic during the subsequent years. These effects were amplified by the war in Iraq and the outbreak of SARS. These traffic trends were taken into consideration while postulating future traffic projections.
3. The procedures described above relate to traffic forecasts in terms of passenger-kilometres performed and freight tonne-kilometres performed. In addition, forecasts of the number of passengers carried and freight tonnes carried were prepared for total scheduled international and domestic services. These were derived from the forecasts of passenger-kilometres and tonne-kilometres on the basis of expectations of future trends in the average length of haul for the various types of services.
4. Forecasts of passengers carried by scheduled airline services on selected intercontinental route groups were also developed. For a particular group of routes, the traffic forecasts took into account economic developments in the regions at either end of the route and average airline yield on the route concerned, as well as other factors pertinent to the particular route group. Econometric analyses were used in the forecasting process wherever possible.

### **MAIN ASSUMPTIONS AND ECONOMETRIC MODELS**

5. The following are the main assumptions concerning trends, over the period 2002 to 2015, in the factors that underlie traffic growth:
  - a) a “most likely” average rate of world economic growth of 2.5 per cent per annum (in real terms);
  - b) moderate growth in world trade at a “most likely” average rate of about 3 per cent per annum;
  - c) a 0.5 per cent per annum decline in average passenger yields (fares) in real terms for the period 2002 to 2006, and no change in average yield (in real terms) for the remaining years for the world



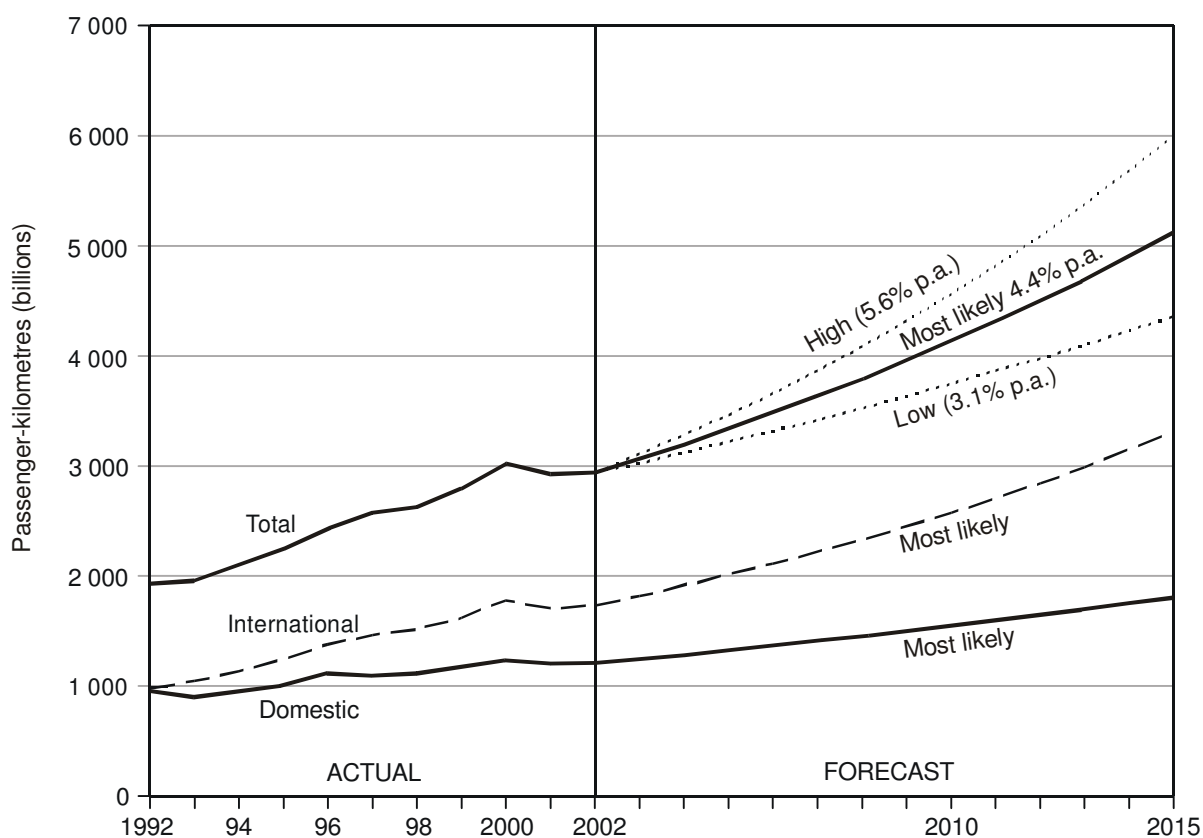
- as a whole, whereas for the freight yields (rates) in real terms, a 0.5 per cent decline for the period 2002 to 2008, and thereafter no change for the remaining period; and
- d) availability of adequate capital resources for the development of aviation and tourist infrastructure.
6. On the basis of historical data, several econometric models were developed for scheduled passenger travel demand, for freight traffic demand and for geographical regions, as well as for various route groups wherever possible.
7. The econometric models developed for predicting demand in terms of total world scheduled passenger-kilometres performed (PKPs) and total world freight tonne-kilometres (FTKs) are described in Appendix 1. The first model provided estimates of the effect on scheduled passenger travel of changes in world GDP and average passenger fare levels (both in real terms), and the second provided estimates of the effect on scheduled freight transport of changes in world exports and average freight rate levels (in real terms).

### GLOBAL PASSENGER FORECASTS

8. Inserting the above economic and yield assumptions into these models resulted in growth rates for the period 2002–2015 for world scheduled traffic of 4.4 per cent per annum for passenger-kilometres. In view of the recent traffic trends and expectations of future developments of the underlying factors, this growth rate has been deemed as a fair representation of future traffic growth up to 2015, barring any unforeseen events of significance.
9. As in the past, year-to-year growth is likely to fluctuate considerably. As an indication of the sensitivity of traffic growth to alternative assumptions about economic growth and trends in passenger yields, a “low” passenger traffic forecast of 3.1 per cent per annum results from assumptions of 2.0 per cent per annum average growth of GDP in real terms and an increase in real fares (yield) of 1.0 per cent per annum during the forecast horizon. A “high” forecast of 5.6 per cent per annum results from assumptions of 3.0 per cent per annum for economic growth and an average annual decline in real fares of –1.0 per cent. The “most likely”, “low” and “high” trends are illustrated in Figure 5-1.
10. International scheduled passenger traffic (in PKPs) is forecast to grow at an average rate of 5.1 per cent per annum compared with 3.1 per cent per annum for domestic scheduled passenger traffic, as shown in Table 5-1 and also illustrated in Figure 5-1. The slower growth of domestic traffic results from the fact that nearly 63 per cent of all domestic scheduled traffic is accounted for by the already highly developed domestic system in the United States where growth rates are expected to be moderate.
11. Forecasts of scheduled passenger traffic in terms of the number of passengers carried are also given in Table 5-1. Growth in terms of world scheduled passengers carried is expected to be somewhat lower than growth in passenger-kilometres because the latter includes the effect of an anticipated increase in the average passenger journey distance at an annual rate of about 1 per cent. The number of passengers carried is projected to reach some 2.5 billion worldwide by 2015.
12. The increase in the average passenger journey distance for international traffic had been pronounced in the past, but it has declined somewhat during the 1992–2002 period. Due to this decline, the growth of passengers carried on international services slightly exceeded the growth of passenger-kilometres during the same period. It is expected that the growth in average passenger journey would remain almost unchanged during the forecast period, and the number of passengers carried on scheduled international services will reach over 1 billion by the year 2015.
13. Putting the expected growth in passenger traffic in perspective, the passenger-kilometres performed and passengers carried are expected to increase by about 74 per cent and 56 per cent, respectively, between 2002

**Table 5-1. ICAO scheduled passenger traffic forecasts — World (1992–2015)**  
(ICAO Contracting States)

	Actual 1992	Actual 2002	Forecast 2015	Average annual growth rate (per cent)	
				1992–2002	2002–2015
<b>Passenger-kilometres (billions)</b>					
Scheduled services	1 929	2 942	5 120	4.3	4.4
International	982	1 732	3 310	5.8	5.1
Domestic	947	1 210	1 810	2.5	3.1
<b>Passengers carried (millions)</b>					
Scheduled services	1 146	1 615	2 520	3.5	3.5
International	299	544	1 030	6.2	5.0
Domestic	847	1 071	1 490	2.4	2.6



**Figure 5-1. Trends in scheduled passenger traffic — World (1992–2015)**  
(ICAO Contracting States)

and 2015. In absolute terms, the increase in passenger-kilometres during the forecast period is expected to be some 2 180 billion, which is more than twice the 1 013 billion increase during the period 1992–2002. The absolute increase in passengers carried is projected to be slightly above 900 million by 2015, compared with 469 million between 1992 and 2002.

### REGIONAL PASSENGER FORECASTS

14. The “most likely” forecasts of scheduled airline passenger traffic by region of airline registration are given in Table 5-2, together with historical figures for 1992 and 2002. The airlines of the Middle East and Asia/Pacific regions are expected to show the highest growth in passenger traffic, at 6.4 per cent and 6.1 per cent per annum respectively, through to the year 2015, while the airlines of North America are anticipated to show the lowest growth, around 2.8 per cent per annum. Traffic of the airlines of the African and the Latin America/Caribbean regions are expected to grow at about 4 per cent per annum, whereas traffic of European airlines is forecast to grow at 4.1 per cent, slightly below the world average.

15. As a result of the projected growth in passenger traffic, the airlines of the Asia/Pacific region are expected to increase their share of world passenger traffic (in terms of passenger-kilometres) by about 6.5 percentage points to 33.2 per cent, with their share of total international scheduled passenger traffic increasing to about 37 per cent, both traffic shares being the highest among all the regions.

16. A significant change in regional share is expected to occur in North America, whose airlines’ share is anticipated to decline by about 6.5 percentage points to 30.3 per cent by the year 2015. The shares of international and domestic scheduled traffic of North America are expected to decrease, but the region will still hold the highest share of world domestic traffic at 58.6 per cent. The shares of airlines of other regions are anticipated to remain almost unchanged.

### PASSENGER FORECASTS FOR INTERCONTINENTAL ROUTE GROUPS

17. The forecasts of the number of passengers carried on scheduled services in nine intercontinental route groups, accounting for almost 38 per cent of international passengers in 2002, are presented in Table 5-3. For the majority of these route groups, growth rates for the 2002–2015 period are forecast to be slightly lower than during the 1992–2002 period. Traffic across the North Atlantic suffered a major setback due to the events of 11 September 2001 and has since been declining; however, it is expected to recover and grow at the world average. The Transpacific route group is expected to grow fastest among the nine route groups at an average annual rate of 6.6 per cent.

18. Since 2001, the route groups to/from Europe have experienced a slowdown in their growth rates but are anticipated to increase at about the same rate as in the past decade, except for the Europe-Asia/Pacific market which is expected to grow at about 2 percentage points lower than in the past decade, thus achieving the same average as the world during the forecast period.

19. The remaining route groups shown in Table 5-3 are smaller in terms of passenger numbers. Their growth rates up to the year 2015 are projected to range from a high of 4.9 per cent for the Mid-Atlantic to a low of 4.5 per cent for the South Atlantic and the North America-South America route groups. The growth in air travel demand in most of these markets is supported by competitive services and by growth in leisure travel.

**Table 5-2. ICAO scheduled passenger traffic — Regions of airline registration (1992–2015)**  
(ICAO Contracting States)

	Passenger-kilometres (billions)			Average annual growth rate (per cent)		Regional share of world traffic (per cent)		
	Actual 1992	Actual 2002	Forecast 2015	1992–2002	2002–2015	1992	2002	2015
<b>Africa</b>								
Total	42.9	66.2	110	4.4	4.0	2.2	2.2	2.1
International	34.9	57.5	100	5.1	4.3	3.6	3.3	3.0
Domestic	8.0	8.7	10	0.8	1.1	0.8	0.7	0.6
<b>Asia/Pacific</b>								
Total	409.2	785.1	1 700	6.7	6.1	21.2	26.7	33.2
International	276.9	537.6	1 220	6.9	6.5	28.2	31.0	36.9
Domestic	132.3	247.5	480	6.5	5.2	14.0	20.5	26.5
<b>Europe</b>								
Total	525.7	769.7	1 300	3.9	4.1	27.3	26.2	25.4
International	330.8	643.8	1 150	6.9	4.6	33.7	37.2	34.7
Domestic	194.9	125.9	150	-4.3	1.4	20.6	10.4	8.3
<b>Middle East</b>								
Total	53.4	106.7	240	7.2	6.4	2.8	3.6	4.7
International	44.5	93.5	220	7.7	6.8	4.5	5.4	6.6
Domestic	8.9	13.2	20	4.0	3.2	0.9	1.1	1.1
<b>North America</b>								
Total	806.4	1 082.3	1 550	3.0	2.8	41.8	36.8	30.3
International	238.8	322.4	490	3.0	3.3	24.3	18.6	14.8
Domestic	567.6	759.9	1 060	3.0	2.6	60.0	62.8	58.6
<b>Latin America/Caribbean</b>								
Total	90.9	132.3	220	3.8	4.0	4.7	4.5	4.3
International	56.4	77.4	130	3.2	4.1	5.7	4.5	3.9
Domestic	34.5	54.9	90	4.8	3.9	3.6	4.5	5.0
<b>World</b>								
Total	1 928.5	2 942.3	5 120	4.3	4.4	100.0	100.0	100.0
International	982.3	1 732.2	3 310	5.8	5.1	100.0	100.0	100.0
Domestic	946.2	1 210.1	1 810	2.5	3.1	100.0	100.0	100.0

## GLOBAL FREIGHT FORECASTS

20. The econometric analysis, together with the assumptions mentioned earlier, resulted in a “most likely” projected growth rate of 5.5 per cent per annum for world scheduled freight tonne-kilometres for the period 2002–2015. This is about one percentage point lower than the 6.4 per cent per annum for the 1992–2002 period. Alternative assumptions concerning the underlying factors affecting air freight suggest a band of forecast growth rates ranging from a “low” of 3.5 per cent per annum to a “high” of 7.3 per cent per annum as illustrated in Figure 5-2.

**Table 5-3. ICAO scheduled passenger traffic — Intercontinental route groups (1992–2015)**

	Passengers carried (thousands)			Average annual growth rate (per cent)	
	Actual 1992	Actual 2002	Forecast 2015	1992–2002	2002–2015
North Atlantic	40 900	64 900	123 600	4.7	5.1
Mid-Atlantic	2 300	3 900	7 300	5.4	4.9
South Atlantic	2 760	4 370	7 750	4.7	4.5
Transpacific	18 121	24 279	55 916	3.0	6.6
Between Europe and Asia/Pacific	15 000	30 000	57 300	7.2	5.1
Between Europe and Africa	13 200	21 645	43 410	5.1	5.5
Between Europe and Middle East	8 100	13 100	24 700	4.9	5.0
Between North America and South America	5 250	8 740	15 500	5.2	4.5
Between North America and Central America/Caribbean	22 000	35 800	65 000	5.0	4.7
Total above routes	127 631	206 734	400 476	4.9	5.2
Other routes	171 836	337 876	629 524	7.0	4.9
Total world	299 467	544 610	1 030 000	6.2	5.0

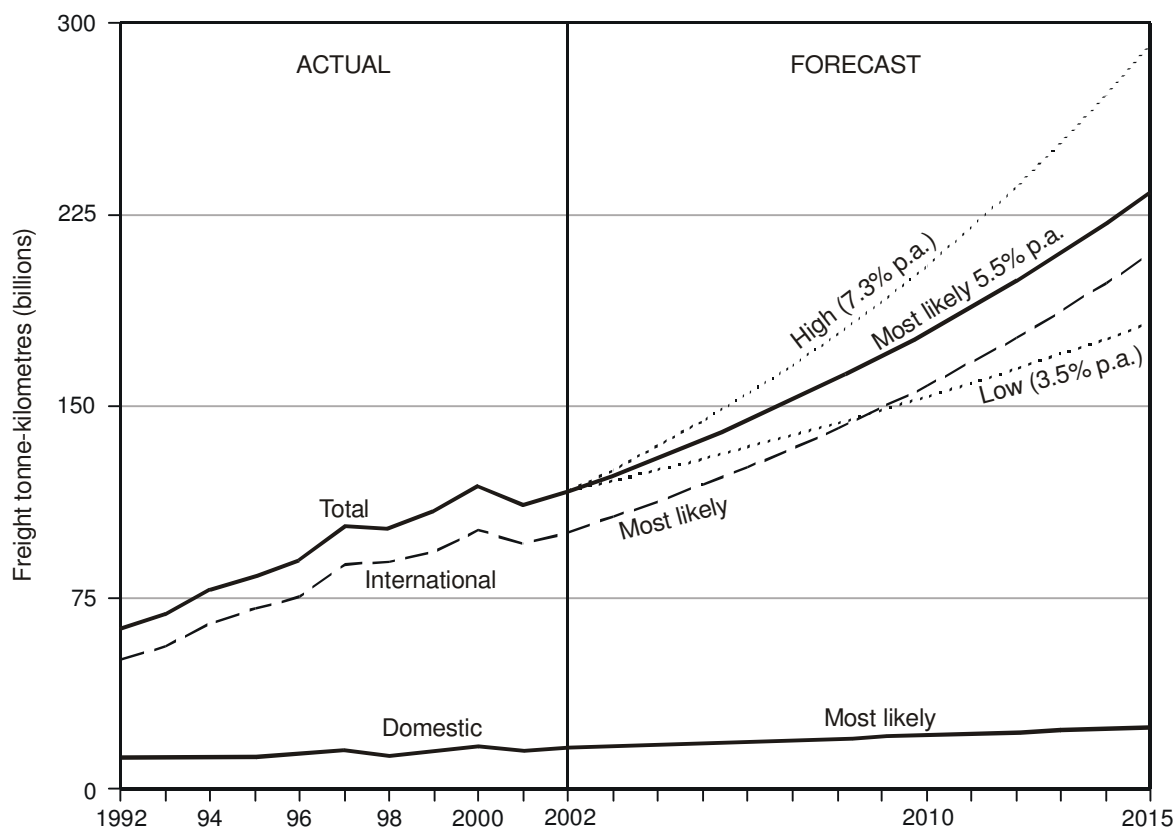
*Note: The historical database has been developed from several sources, including ICAO, ICAO traffic forecasting groups, IATA and aircraft manufacturers.*

21. Table 5-4 presents the ICAO forecasts of scheduled freight traffic (including international and domestic components) in terms of both tonne-kilometres performed and tonnes carried. International freight traffic is expected to grow more rapidly than domestic freight traffic, due partly to the relatively fast growth of international commerce. Domestic freight is dominated by the more mature market of the United States, and this is another reason for the moderate growth of total domestic traffic. Freight tonnes carried are expected to grow more slowly than freight tonne-kilometres because of a continuing increase in the average length of haul.

### REGIONAL FREIGHT FORECASTS

22. The “most likely” forecasts of scheduled freight traffic by region of airline registration are presented in Table 5-5. The regional pattern of growth is rather similar to that for passenger traffic. Asia/Pacific and the Middle East are expected to remain the fastest growing regions, although their forecast growth rates are somewhat lower than the growth rates achieved during the 1992–2002 period.

23. By the year 2015, airlines of the Asia/Pacific region are expected to increase their share of air freight traffic by 4.4 percentage points to slightly over 40 per cent of total world freight, a share well above that of any other region.



**Figure 5-2. Trends in scheduled freight traffic — World (1992–2015)**  
(ICAO Contracting States)

**Table 5-4. ICAO scheduled freight traffic forecasts — World (1992–2015)**  
(ICAO Contracting States)

	Actual 1992	Actual 2002	Forecast 2015	Average annual growth rate (per cent)	
				1992–2002	2002–2015
<b>Freight tonne-kilometres (millions)</b>					
Total	62 675	116 628	233 850	6.4	5.5
International	50 753	100 588	209 600	7.1	5.8
Domestic	11 922	16 040	24 250	3.5	3.2
<b>Freight tonnes carried (thousands)</b>					
Total	17 647	29 538	51 700	5.3	4.4
International	9 313	19 013	37 200	7.4	5.3
Domestic	8 334	10 525	14 500	2.4	2.5

**Table 5-5. ICAO scheduled freight traffic – Regions of airline registration (1992–2015)**  
(ICAO Contracting States)

	Freight tonne-kilometres (millions)			Average annual growth rate (per cent)		Regional share of world traffic (per cent)		
	Actual 1992	Actual 2002	Forecast 2015	1992– 2002	2002– 2015	1992	2002	2015
<b>Africa</b>								
Total	1 238	1 856	3 100	4.1	4.0	2.0	1.6	1.3
International	1 135	1 777	3 000	4.6	4.1	2.2	1.8	1.4
Domestic	103	79	100	-2.6	1.8	0.9	0.5	0.4
<b>Asia/Pacific</b>								
Total	19 410	42 063	94 600	8.0	6.4	31.0	36.1	40.5
International	17 752	38 196	86 500	8.0	6.5	35.0	38.0	41.3
Domestic	1 658	3 867	8 100	8.8	5.9	13.9	24.1	33.4
<b>Europe</b>								
Total	19 460	32 828	61 000	5.4	4.9	31.0	28.1	26.1
International	17 680	32 019	60 000	6.1	4.9	34.8	31.8	28.6
Domestic	1 780	809	1 000	-7.6	1.6	14.9	5.0	4.1
<b>Middle East</b>								
Total	2 625	5 355	12 250	7.4	6.6	4.2	4.6	5.2
International	2 552	5 251	12 100	7.5	6.6	5.0	5.2	5.8
Domestic	73	104	150	3.6	2.9	0.6	0.6	0.6
<b>North America</b>								
Total	16 867	30 586	57 500	6.1	5.0	26.9	26.2	24.6
International	9 114	20 264	44 000	8.3	6.1	18.0	20.1	21.0
Domestic	7 753	10 322	13 500	2.9	2.1	65.0	64.3	55.7
<b>Latin America/Caribbean</b>								
Total	3 075	3 940	5 400	2.5	2.5	4.9	3.4	2.3
International	2 520	3 079	4 000	2.0	2.0	5.0	3.1	1.9
Domestic	555	861	1 400	4.5	3.8	4.7	5.4	5.8
<b>World</b>								
Total	62 675	116 628	233 850	6.4	5.5	100.0	100.0	100.0
International	50 753	100 586	209 600	7.1	5.8	100.0	100.0	100.0
Domestic	11 922	16 042	24 250	3.0	3.2	100.0	100.0	100.0

**SUMMARY OF AIR TRAFFIC FORECASTS  
BY OTHER ORGANIZATIONS**

24. Some recent long-term forecasts by major airframe and engine manufacturers of growth in world scheduled traffic are given in Table 5-6. These forecast growth rates are in the range of 4.7 to 5.1 per cent per annum for passenger-kilometres, with freight tonne-kilometres generally forecast to grow at a slightly higher rate for the period ranging from 2001 to 2022.

25. Separate forecasts (medium-term only) for the number of passengers carried and passenger-kilometres performed on world international services by member airlines, are regularly prepared by the International Air Transport Association (IATA). The most recent forecasts, covering the 2003–2007 period, indicate an average growth of 4.7 per cent per annum for both passengers and passenger-kilometres performed.

**Table 5-6. Global scheduled traffic forecasts by aerospace manufacturers**

	Forecast period	Average annual growth rate (per cent)	
		Passenger-kilometres	Freight tonne-kilometres
Airbus Industrie	2001–2020	4.7	5.5
Boeing	2003–2022	5.1	—
Rolls-Royce	2002–2022	4.9	—

*Source: Airbus Industrie, "Global Market Forecast", 2002;  
Boeing Commercial Airplanes, "Current Market Outlook", 2003;  
Rolls-Royce, "The Outlook", 2003.*

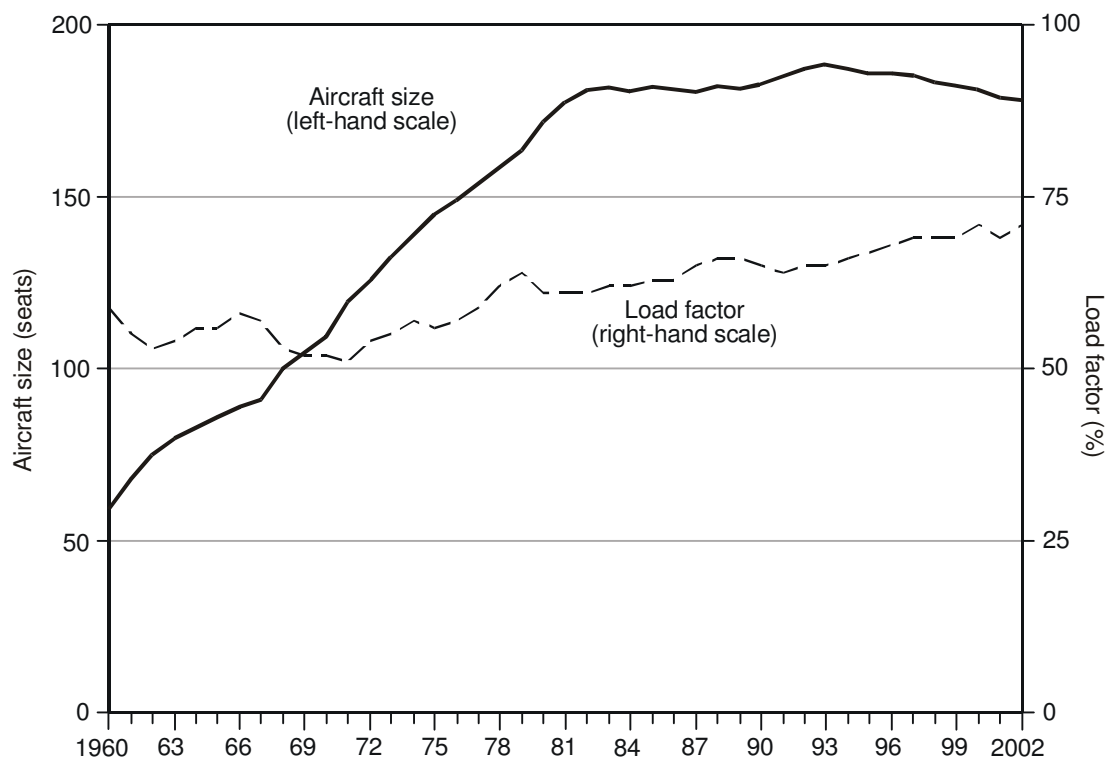


## Chapter 6

# FORECASTS OF AIRCRAFT MOVEMENTS TO THE YEAR 2015

### FACTORS AFFECTING AIRCRAFT MOVEMENTS

1. The planning of aviation facilities and the development of aviation policies require assessment of future trends in aircraft movements as well as of passenger and freight traffic flows. This is becoming increasingly important because of concerns over airport and airspace congestion in some regions. Aircraft movements have grown steadily during most of the past decade, increasing the pressure on airport and air navigation services. Traffic declines since 2001 have somewhat eased this pressure in the regions concerned, but as traffic recovers, airport and airspace congestion are expected to build up again.
2. The primary factor affecting the number of aircraft movements is the demand for passenger travel. The passenger traffic forecasts presented in the previous chapter are, therefore, key inputs to the aircraft movement forecasts.
3. When passenger demand increases, air carriers can respond by scheduling extra flights, by using larger aircraft, or by managing higher load factors. During the 1970s, air carriers accommodated most of the growth in demand by introducing larger aircraft. As a result of both increasing aircraft size and improving load factors, the growth in aircraft movements was quite small in the 1970s despite rapid growth in passenger traffic. However, in the 1980s, the trend in average aircraft size remained almost unchanged as airlines began to introduce more mid-size and smaller aircraft into their fleets. From the early 1990s, the average aircraft size began to decrease and in recent years, especially in 2001 and 2002, the decline has been more pronounced. Past trends in average aircraft size and average load factor for total world scheduled services (excluding the Commonwealth of Independent States) are illustrated in Figure 6-1.
4. Gradual improvements in average load factors have resulted from marketing initiatives and yield management programmes, but there is evidence that the rate of improvement in load factors is slowing down. This is expected as the industry gradually approaches upper limits for load factors, which are partially determined by periodic and random variations in demand. In recent years, due to traffic declines, some markets experienced exceptionally low load factors. In order to remedy this situation, capacities were reduced on affected routes. As the load factors have begun to show signs of progressive improvement, it is expected that the world average scheduled passenger load factor, which increased from 66 per cent in 1992 to 71 per cent in 2002, will rise to about 73 per cent by 2015.
5. The services provided by carriers to meet demand result from a large number of decisions concerning network structure, aircraft types and service frequency. These decisions depend on factors such as the availability of traffic rights, the characteristics of alternative aircraft, and consumer preferences and trade-offs between price and service quality. Despite the complexity of this process, it is possible to discern several key factors which are in part responsible for the observed change in the trend in average aircraft size and hence the relationship between traffic demand and aircraft movements.
6. The first of these factors is the trend towards liberalization or deregulation in some important markets. Deregulation in the United States domestic airline markets began in 1978, followed by gradual liberalization of



Source: ICAO Reporting Form A-1.  
 Note: Excluding all-freight operations.  
 Excluding the CIS.

**Figure 6-1. Average aircraft size and load factor — World (1960–2002)**  
 (Passenger aircraft on scheduled services)

air services within the European Union. The evolution of competitive strategies and market structures has continued since then. Adequate frequency and convenient interline and on-line connections, as well as low price, have become important competitive tools. A more liberal regulatory environment has also emerged gradually in other domestic markets and in international markets. The consequent increased priority given to frequency and direct service has tended to increase the number of aircraft movements required to satisfy a given level of demand.

7. The second factor is the arrival of new, mid-size, high-technology aircraft. The 1970s saw B-747, DC-10 and L-1011 aircraft absorbed into airline fleets. These aircraft had favourable range and unit cost characteristics and were at the top end of the size spectrum. In the 1980s, the airlines started to introduce mid-size aircraft such as the B-757, B-767, MD-80 and A-310. This trend continued well into the 1990s, and the airlines witnessed the introduction of additional mid-size aircraft such as the B-777, A-330 and A-340 into their fleets. Consequently, fleet replacement and expansion led to a modest decline in the average aircraft size during the late 1990s.

8. Recent trends have shown that there has been a gradual deployment of mid-size to smaller aircraft on almost all route groups as the need for more direct services has become a priority for travellers. Regulatory developments and the characteristics of these new aircraft types may have also been prevailing factors for their introduction. This change has resulted in a proliferation of services aimed at cost-cutting measures by reducing flight time and the distance flown, especially on longer routes linking two regions. Route groups such as North Atlantic and Transpacific are the prime examples where such aircraft types have increasingly been introduced.

9. The regulatory and technological factors described above are likely to continue and will motivate airlines to opt for mid-size to smaller aircraft in the coming years. The number of such aircraft placed on order during the past decade or so also supports the continuation of this trend into the future. During the past decade the average aircraft size has been declining steadily and, in the year 2002, it reached its lowest level. However, progressive liberalization and competitive forces are encouraging consolidation and alliances among airlines which might eventually reduce the pressure to increase flight frequency at the expense of aircraft size. The build-up of airport and airspace congestion during the forecast horizon is another factor which may favour larger aircraft. Based on these factors, it is assumed that over the forecast period, the world average aircraft size will remain unchanged, at about 178 seats. Moreover, the average seat size may increase on some of the major route groups, such as Europe-Asia/Pacific, with the anticipated introduction of larger aircraft during the forecast horizon.

### MEASURES OF AIRCRAFT MOVEMENTS

10. Aircraft movements can be measured in terms of the number of aircraft-kilometres (or aircraft hours) flown in the airspace or the number of aircraft departures from airports. While each measure is relevant for determining the demand for air traffic control facilities, aircraft departures is the key parameter for airport planning.

11. The link between the two measures is the average aircraft stage length. The trend in the average stage length is illustrated in Figure 6-2. In the 1960s, average stage length for scheduled services increased by more than 4 per cent per annum, and thus aircraft-kilometres grew about 4 per cent per annum faster than aircraft departures. During the 1970s, these growth rates were much lower. Over the last 20-year period, the aircraft-kilometres have grown over 4 per cent per annum, about 1.5 percentage points higher than departures. The growth in average stage length has been about 1.5 per cent per annum during the same period. The increase in stage length reflects the changing pattern of demand, with growth in passenger and freight traffic being greater for long-haul routes than for short-haul routes. Another factor has been increases in the length-of-haul capabilities of new aircraft types progressively introduced into fleets. Over the forecast period (2002 to 2015), the average stage length is assumed to grow at about 1 per cent per annum.

### FORECASTING METHODOLOGY

12. The forecasting process began with the forecasts of passenger traffic and incorporated assumptions for future load factors and aircraft size, which were together translated into forecasts of aircraft movements. The specification of the model used in this process is given in Appendix 2.

13. The forecast in terms of global aircraft-kilometres was based on passenger-kilometre forecasts and assumptions from average passenger load factors and aircraft size (measured by number of seats). Since all-freight aircraft services account for less than 5 per cent of total services, their impact on the overall trend is very small. The forecast of global aircraft departures is derived from the forecast of aircraft-kilometres and expectations for the future trend in average aircraft stage length. The main assumptions for growth in world scheduled passenger traffic and trends in load factors, aircraft size and aircraft stage length over the period 2002–2015 are given below:

- a) a growth in passenger-kilometres of 4.4 per cent per annum;
- b) an increase in average load factor from 71 to 73 per cent;
- c) no change in average passenger aircraft size (in terms of seats); and

- d) a growth in average aircraft stage length of 1 per cent per annum.

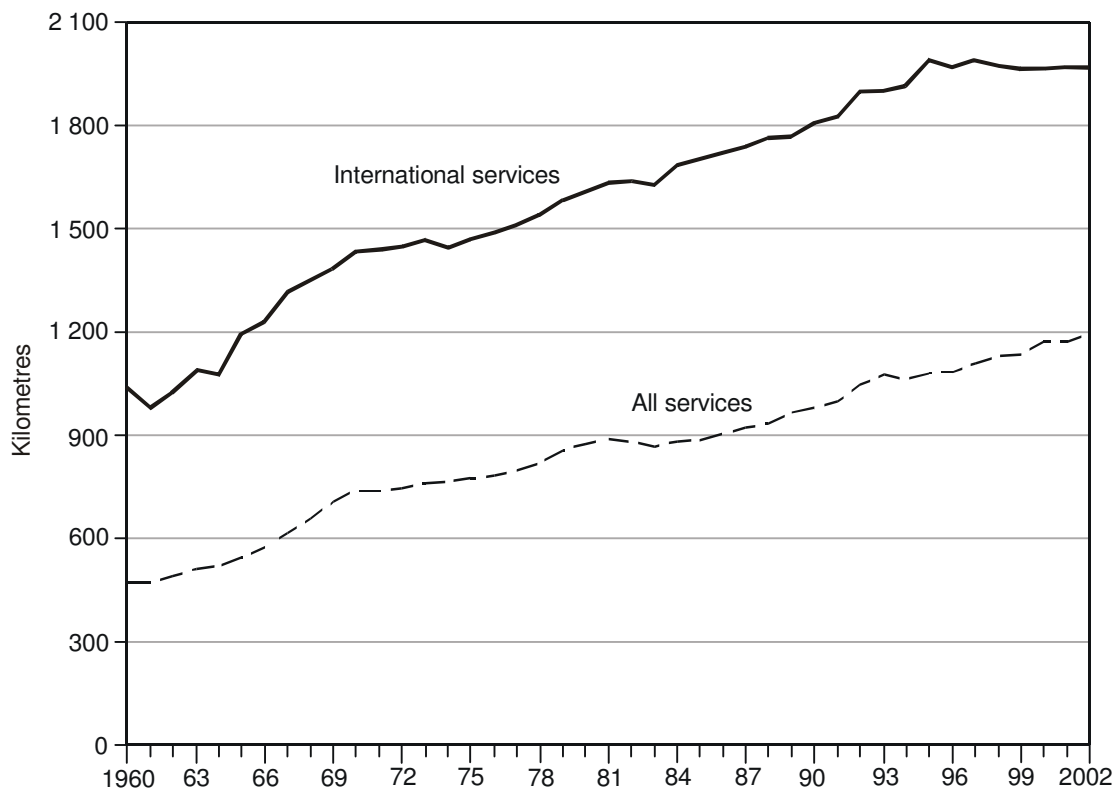
(Because of data constraints, all assumptions and forecasts exclude the Commonwealth of Independent States.)

### FORECASTS OF WORLD SCHEDULED AIRCRAFT MOVEMENTS

14. The above analyses resulted in forecast average world annual growth rates of 4.2 per cent for aircraft-kilometres and 3.2 per cent for aircraft departures over the period 2002 to 2015.

15. Over the forecast horizon, the growth rate for aircraft-kilometres is below the growth rate for passenger-kilometres by only 0.2 percentage points per annum because of the small increase in load factor and no change in aircraft size. Growth in aircraft departures is below the growth in aircraft-kilometres by one percentage point per annum, which is equal to the growth in stage length.

16. In Table 6-1, the forecasts of aircraft movements are compared with actual past movements. The rates of growth reported in the table are *average* measures over the relevant 10-year periods; the rates over shorter periods may vary. The growth in aircraft movements between 1992 and 2002 was almost the same when compared with the growth between 1982 and 1992. This was a consequence of the combined effect of a lower traffic growth, slightly higher load factors and a decline in average aircraft size.



Source: ICAO Reporting Form A-1.  
Note: Excluding the CIS.

**Figure 6-2. Average aircraft stage length — World (1960–2002)**  
(Scheduled services of airlines of ICAO Contracting States)

17. The forecasts imply an increase of about 71 per cent in aircraft-kilometres and 50 per cent in aircraft departures between 2002 and 2015. In absolute terms, the increase in aircraft-kilometres between 2002 and 2015 is expected to be some 16.9 billion compared with the 10.4 billion that occurred between 1989 and 2002. The absolute increase in aircraft departures is forecast to be about 10 million between 2002 and 2015 compared with 6.1 million between 1989 and 2002. While the interruption of traffic growth in the early 2000s eased the demand pressure on aviation infrastructure to some extent (see Chapter 2, para. 29), overall increases of this magnitude could result in serious congestion of certain already hard-pressed airport and airspace facilities. It is important to recognize that in arriving at these forecasts, no allowance has been made for the effect that potential supply constraints might have on traffic volumes. In other words, if the supply of air traffic control and airport services does not keep pace with demand in the same way that it has in the past, then actual traffic flows may be suppressed below the levels of demand forecast here.

**Table 6-1. ICAO aircraft movements forecast — World (1982–2015)**  
(Scheduled services of airlines of ICAO Contracting States)

	Actual 1982	Actual 1992	Actual 2002	Forecast 2015	Average annual growth rate (per cent)		
					1982–1992	1992–2002	2002–2015
Aircraft-kilometres (millions)	9 140	15 420	23 878	40 750	5.4	4.5	4.2
Aircraft departures (thousands)	10 379	14 728	20 013	30 010	3.6	3.1	3.2

*Note: Including all-freight movements.  
Excluding operations of aircraft registered in the CIS.*

## Appendix 1

### ECONOMETRIC MODELS OF DEMAND FOR WORLD SCHEDULED AIR TRAFFIC

The basic model form assumed was:

$$y = a x_1^{b_1} \cdot x_2^{b_2}$$

For the model of passenger traffic:

$y$  = passenger-kilometres performed (PKPs)

$x_1$  = gross domestic product in real terms (GDP)

$x_2$  = passenger revenue per passenger-kilometre in real terms (PYIELD)

For the model of freight traffic:

$y$  = freight tonne-kilometres (FTKs)

$x_1$  = world exports in real terms (EXP)

$x_2$  = freight revenue per freight tonne-kilometre in real terms (FYIELD)

The  $a$ ,  $b_1$  and  $b_2$  are constant coefficients whose values were obtained by statistical estimation, using econometric analysis. The  $b_1$  and  $b_2$  are equal to the elasticities of demand with respect to the corresponding  $x_1$  and  $x_2$ .

Annual data were used in the estimations, covering a period of 22 years for the passenger model and 42 years for the freight model. The data for the CIS are excluded from the freight model. ICAO and the IMF were the sources for the airline and general economic data, respectively, used in the models.

Estimated passenger model:

$$\ln \text{PKP} = 4.63 + 1.34 \ln \text{GDP} - 0.58 \ln \text{PYIELD} \quad R^2 = 0.975$$

(2.9)                      (1.7)

Estimated freight model:

$$\ln \text{FTK} = -0.37 + 1.58 \ln \text{EXP} - 0.37 \ln \text{FYIELD} \quad R^2 = 0.997$$

(21.4)                      (5.7)

The figures in brackets are the “t” values of the corresponding coefficient estimates. The “t” value corresponding to a particular coefficient estimate is a statistical measure of the confidence that can be normally placed in the estimate.

It should be noted that the “t” value corresponding to the yield in the estimated passenger model is less than 2. In general, the larger the magnitude of the “t” value, the greater the statistical significance that can be placed upon that value. However, a low “t” value does not necessarily imply that the model is not suitable for forecasting purposes, as in the case here. The values of the coefficients derived from the econometric analysis are relative and not absolute as bias and variance among coefficients always exist because explanatory variables are not always mutually independent. The  $R^2$  value of 0.975 for the estimated passenger model indicates that the major part of the variation of the dependent variable, in this case PKP, has been accounted for and explained by the model. In addition, in order to measure the effectiveness of the forecasting application, the actual historical results were compared with those that were predicted from the model and found to be satisfactory.

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## Appendix 2

### MODEL FOR AIRCRAFT MOVEMENT FORECASTS

1. The relationship between aircraft-kilometres, load factors and aircraft size (seats per aircraft) was developed for passenger aircraft as follows:

$$\begin{aligned}\text{Aircraft kilometres} &= \frac{\text{passenger-km}}{(\text{passenger-km/seat-km}) \cdot (\text{seat-km/aircraft-km})} \\ &= \frac{\text{passenger-km}}{\text{load factor} \cdot \text{aircraft size}}\end{aligned}\tag{1}$$

The forecast for aircraft-kilometres for scheduled passenger aircraft in the year 2015 was generated by substituting into this expression the assumptions for passenger-kilometres, average load factor and average aircraft size in the year 2015 (excluding the Commonwealth of Independent States for which some of the base data were not available). The first of these assumptions follows directly from the traffic forecast presented in Chapter 5.

2. The average rate of increase in aircraft-kilometres from 2002 to 2015 implied by this forecast was then used to calculate the forecast number of aircraft-kilometres for all scheduled services, including all-freight as well as combined passenger and freight services (but excluding the Commonwealth of Independent States).

3. The relationship between aircraft departures, aircraft-kilometres and aircraft stage length for passenger and all-freight aircraft combined is derived as follows:

$$\begin{aligned}\text{Aircraft departures} &= \frac{\text{aircraft-km}}{\text{aircraft-km/aircraft departure}} \\ &= \frac{\text{aircraft-km}}{\text{stage length}}\end{aligned}\tag{2}$$

The forecast for aircraft departures in the year 2015 was generated by substituting into this expression the forecast for aircraft-kilometres and the assumption for average stage length in the year 2015.

4. Equations (1) and (2) can be expressed, approximately, in terms of the average annual rates of change of the variables over a specified period (e.g. 2002 to 2015).

Equation (1) becomes:

$$\% (\text{ac-km}) \approx \% (\text{passenger-km}) - \% (\text{load factor}) - \% (\text{ac size})$$

Equation (2) becomes:

$$\% (\text{ac departures}) \approx \% (\text{ac-km}) - \% (\text{stage length})$$

where “ac” stands for “aircraft” and “%” stands for “average annual percentage increase”.



5. The actual historical values and forecast values, as well as the corresponding average annual rates of change for all of the variables in equations (1) and (2), are given in Table A2-1.

**Table A2-1. Growth in aircraft movements and contributing factors — World (1982–2015)**

	Actual 1982	Actual 1992	Actual 2002	Forecast 2015	Average annual growth rate (per cent)		
					1982-1992	1992-2002	2002-2015
Passenger-kilometres (billions)	970	1 782	2 881	5 038	6.3	4.9	4.4
Passenger load factor (%)	61	65	71	73	0.6	0.9	0.2
Passenger aircraft size (seats)	181	187	178	178	0.3	-0.2	0.2
Aircraft stage length (km)	881	1 047	1 193	1 358	1.7	1.3	1.0
Aircraft-kilometres (millions)	9 140	15 420	23 878	40 750	5.4	4.5	4.2
Aircraft departures (thousands)	10 379	14 728	20 013	30 010	3.6	3.1	3.2

*Note.— Excluding operations of airlines registered in the CIS.*

— END —

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