

**Cir 281  
AT/116**



# **Outlook for Air Transport to the Year 2010**

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Approved by the Secretary General  
and published under his authority

June 2001

International Civil Aviation Organization

*Published in separate English, Arabic, French, Russian and Spanish editions by the International Civil Aviation Organization. All correspondence, except orders and subscriptions, should be addressed to the Secretary General.*

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# FOREWORD

## Introduction

1. This circular is the fourth in a series to be issued biennially or triennially (the third edition “Outlook for Air Transport to the Year 2005” was published in 1997 as Circular 270, the second edition was published in 1995 as Circular 252 and the first edition was published in 1992 as Circular 237). The present 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 2010. In addition, it includes passenger traffic forecasts for international route groups and global forecasts of aircraft movements, again through to the year 2010.

## 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 1989 to 1999. Sources of information other than ICAO, referred to in the text, 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), the World Tourism Organization (WTO), the International Monetary Fund (IMF), the World Bank, and Wharton Econometrics Forecasting Associates (WEFA).

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 1960–1999, the aggregate economic activities of the world measured by Gross Domestic Product (GDP) increased at an average annual rate of 3.6 per cent in real terms. The average annual growth rates for the periods 1960–1970, 1970–1980, 1980–1990 and 1990–1999 were 4.8, 3.6, 3.0 and 2.9 per cent, respectively.
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 (PKP) increased at an average annual rate of 8.6 per cent for the 1960–1999 period. For the periods 1960–1970, 1970–1980, 1980–1990 and 1990–1999, traffic grew at an average annual rate of 13.4, 9.0, 5.7 and 4.4 per cent, respectively.
3. World airline scheduled freight traffic (domestic and international) measured in terms of tonne-kilometres performed (TKP) increased at an average annual growth rate of 10.7 per cent over the 1960–1999 period. For the periods 1960–1970, 1970–1980, 1980–1990 and 1990–1999, freight traffic grew at an average annual rate of 17.8, 9.3, 7.2 and 7.0 per cent, respectively.
4. The growth in passenger and freight traffic demand over the 1960–1999 period resulted in comparable growth in capacity offered, while aircraft movements measured in terms of aircraft departures grew at a much slower rate (2.9 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.
5. During the period 1960–1999, average world passenger yield measured in real terms (expressed in U.S. cents per PKP) declined at a rate of 2.8 per cent per annum. Freight and mail yield measured in real terms (expressed in U.S. cents per TKP) decreased at a rate of 3.6 per cent per annum. During the same period, unit costs (operating cost per available tonne-kilometres (ATKs)) measured in real terms declined at an average annual rate of 3.0 per cent.
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 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.
7. For the forecast period 1999–2010, 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 by 0.5 per cent for the first five years of the forecast period and to remain constant for the last six years of the forecast period.
8. World scheduled traffic measured in terms of passenger-kilometres performed is forecast to increase at a “most likely” average annual rate of 4.5 per cent for the period 1999–2010. International traffic is expected to increase at 5.5 per cent per annum, while domestic traffic is expected to increase at an average annual rate of 3.0 per cent.

9. The airlines of the Asia/Pacific region are expected to experience the highest growth in passenger traffic at 7.0 per cent per annum through to the year 2010, followed by the airlines of the Latin America/Caribbean region with a 5.0 per cent annual growth rate. Airline traffic in each of the Middle East, European and African regions is expected to grow at about the world average, 4.5 per cent per annum; in the North American region, airline traffic is expected to increase at 3.0 per cent per annum.

10. Forecasts of the number of passengers carried on scheduled services in nine intercontinental route groups show the North America-Central America/Caribbean and the North America-South America markets as the fastest growing, each at 7.0 per cent per annum, for the forecast period through to the year 2010.

11. World scheduled freight traffic measured in terms of tonne-kilometres performed is forecast to increase at a "most likely" average annual rate of 6.0 per cent for the period 1999–2010. International freight traffic is expected to increase at an average annual growth rate of 6.5 per cent compared with a domestic freight traffic growth of 3.0 per cent per annum. Airline traffic in the Asia/Pacific region is expected to remain the fastest growing (at 7.5 per cent per annum). Other regions are projected to experience growth rates below the world average, ranging from 5.0 per cent for the African and North American regions to 4.0 per cent for the Middle East region.

12. Aircraft movements in terms of aircraft departures and aircraft kilometres flown for the period 1999–2010 are expected to increase at average annual growth rates of 3.0 and 4.2 per cent, respectively.

13. Tables 1-1, 1-2 and 1-3 provide summaries of global, regional and route group forecasts, respectively.

**Table 1-1. Summary of ICAO air traffic forecasts for the year 2010**  
(worldwide)

	Actual 1989	Actual 1999	Forecast 2010	Average annual growth rate (per cent)	
				1989–1999	1999–2010*
<b>TOTAL SCHEDULED SERVICES</b>					
Passenger-kilometres (billions)	1 779	2 788	4 620	4.6	4.5
Freight tonne-kilometres (millions)	57 214	108 043	202 650	6.6	6.0
Passengers carried (millions)	1 109	1 558	2 300	3.5	3.5
Freight tonnes carried (thousands)	18 088	28 201	44 500	4.5	4.0
Aircraft-kilometres (millions) <sup>1</sup>	13 493	22 950	34 100	5.5	3.5
Aircraft departures (thousands) <sup>1</sup>	13 945	20 220	26 400	3.8	2.5
<b>INTERNATIONAL SCHEDULED SERVICES</b>					
Passenger-kilometres (billions)	822	1 614	2 960	7.0	5.5
Freight tonne-kilometres (millions)	44 925	92 680	181 480	7.5	6.5
Passengers carried (millions)	262	489	834	6.4	5.0
Freight tonnes carried (thousands)	8 635	17 160	31 000	7.1	5.5

\* Rounded to the nearest 0.5 percentage point.

1. Excludes the Commonwealth of Independent States (CIS).



**Table 1-2. Summary of ICAO air traffic forecasts for the year 2010**  
(by region of airline registration)

	Actual 1989	Actual 1999	Forecast 2010	Average annual growth rate (per cent)	
				1989-1999	1999-2010*
<b>TOTAL SCHEDULED SERVICES</b>					
Passenger-kilometres (billions)					
Africa	40.8	60.9	100	4.1	4.5
Asia/Pacific	318.9	665.5	1 405	7.6	7.0
Europe	546.2	743.0	1 240	3.1	4.5
Middle East	47.8	79.1	130	5.2	4.5
North America	741.8	1 104.9	1 520	4.1	3.0
Latin America and Caribbean	83.5	134.5	225	4.9	5.0
Freight tonne-kilometres (millions)					
Africa	1 176	19 693	3 440	5.3	5.0
Asia/Pacific	15 634	37 564	83 000	9.2	7.5
Europe	19 246	31 193	52 120	4.9	4.5
Middle East	2 570	4 068	6 140	4.7	4.0
North America	15 962	29 028	51 000	6.2	5.0
Latin America and Caribbean	2 626	4 221	6 950	4.9	4.5
<b>INTERNATIONAL SCHEDULED SERVICES</b>					
Passenger-kilometres (billions)					
Africa	31.8	52.5	90	5.1	5.0
Asia/Pacific	223.7	462.3	1 025	7.5	7.5
Europe	284.7	622.8	1 070	8.1	5.0
Middle East	39.5	67.7	115	5.5	5.0
North America	195.2	327.7	520	5.3	4.5
Latin America and Caribbean	47.5	81.0	140	5.5	5.0
Freight tonne-kilometres (millions)					
Africa	1 067	1 910	3 370	6.0	5.5
Asia/Pacific	14 306	34 550	77 300	9.2	7.5
Europe	16 545	30 430	51 200	6.3	5.0
Middle East	2 481	3 970	6 010	4.8	4.0
North America	8 496	18 320	37 600	8.0	6.5
Latin America and Caribbean	2 030	3 500	6 000	5.6	5.0

\* Rounded to the nearest 0.5 percentage point.

**Table 1-3. Summary of ICAO air traffic forecasts for the year 2010**  
(by international route group)

INTERNATIONAL SCHEDULED SERVICES	Passengers carried (thousands)			Average annual growth rate (per cent)	
	Actual 1989	Actual 1999	Forecast 2010	1989–1999	1999–2010*
North Atlantic	32 200	64 900	108 000	7.3	4.5
Mid-Atlantic	1 817	3 223	6 120	5.9	6.0
South Atlantic	1 785	3 227	6 000	6.1	6.0
Transpacific	14 729	27 688	54 400	6.5	6.5
Between Europe and Asia/Pacific	18 599	44 027	88 000	9.0	6.5
Between Europe and Africa	12 138	19 213	30 530	4.7	4.5
Between Europe and Middle East	8 463	11 938	18 100	3.5	4.0
Between North America and South America	3 522	9 559	19 710	10.5	7.0
Between North America and Central America/Caribbean	20 577	33 519	70 960	5.0	7.0
Total above routes	113 830	217 294	401 820	6.7	5.5
Other routes	148 112	271 596	438 180	6.3	4.5
Total world	261 942	488 890	840 000	6.4	5.0

\* Rounded to the nearest 0.5 percentage point.

## **Chapter 2**

# **AIR TRANSPORT TRENDS AND CHALLENGES**

### **ECONOMIC GROWTH AND AIRLINE TRAFFIC PATTERNS**

1. Air transport has for many years experienced greater growth than most other economic sectors. Increasing demand for passenger and freight services, rapid technological development and associated investment have combined to multiply the output of the industry by a factor of over 29 since 1960 (in terms of tonne-kilometres performed). To put this in perspective, the total world Gross Domestic Product (GDP) expressed in real terms, which is the broadest available measure of world output, has multiplied by 4 times over the same period. Total revenues generated by the world's airlines increased tenfold during the same period.

2. While growth in world air traffic has been much greater than world economic growth, economic theory and analytical studies indicate that there is a high correlation between the two and that the demand for air transport is primarily determined 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 economy and traffic demand by illustrating the fluctuations in the rate of growth of each for the period 1960 to the present. The economic recessions of 1974–75, 1980–82 and 1990–91 and some slowdown in 1998 (following an economic turndown in the Asia/Pacific region in particular) and their impact on air traffic are clearly visible.

3. Other factors that have affected traffic demand include changes in airline costs, and hence fares and rates, availability of air services, regulatory developments and tourism. Rapid growth in the 1960s coincided with the replacement of piston-engined aircraft with jet aircraft which led to reduced real fares and increased speed and comfort of travel. Sharp changes in oil prices have had important effects on traffic demand. In addition to an adverse effect on the world economy, the tenfold increase in crude oil prices in 1973–74, and further escalation in 1979–81 (since ameliorated), greatly increased aviation fuel prices and hence air fares and rates.

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

4. The growth experienced by the total demand for air transport has been shared by each of its major components — passenger, freight and mail traffic. As shown in Table 2-1, however, the average growth in each of these components has declined since the 1960s. The decline in the growth in mail traffic has been particularly severe, partly because of increasing competition from telecommunications.

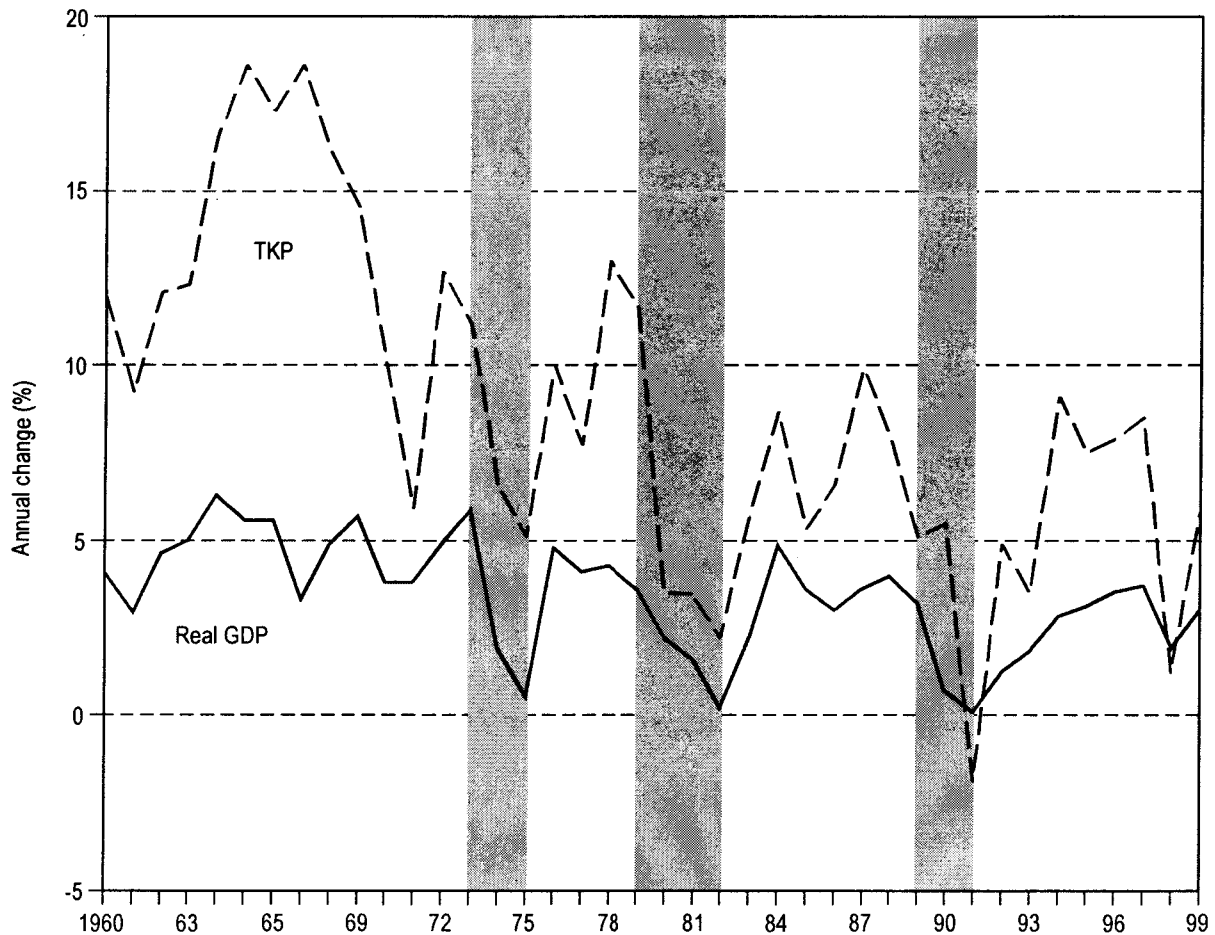
5. In 1999, the world's airlines carried over 1.5 billion passengers and over 28 million tonnes of freight on scheduled services. Airlines generated 2 788 billion scheduled passenger-kilometres (equivalent to 255 billion tonne-kilometres), 108 billion scheduled freight tonne-kilometres and 5.7 billion scheduled mail tonne-kilometres in 1999.

**Table 2-1. Growth of passenger, freight and mail air traffic, 1960 to 1999**

	Average annual growth (per cent)		
	1960–1979	1979–1989	1989–1999
Passenger-kilometres	11.8	5.3	4.6
Freight tonne-kilometres	14.3	7.4	6.6
Mail tonne-kilometres	8.5	4.0	1.2
Total tonne-kilometres	12.2	5.8	5.2

Source: ICAO Reporting Form A-1.

Note.— Includes domestic and international scheduled traffic.



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

**Figure 2-1. World economic and airline traffic growth**  
(GDP in real terms and total scheduled tonne-kilometres performed)

## SCHEDULED INTERNATIONAL AND DOMESTIC TRAFFIC

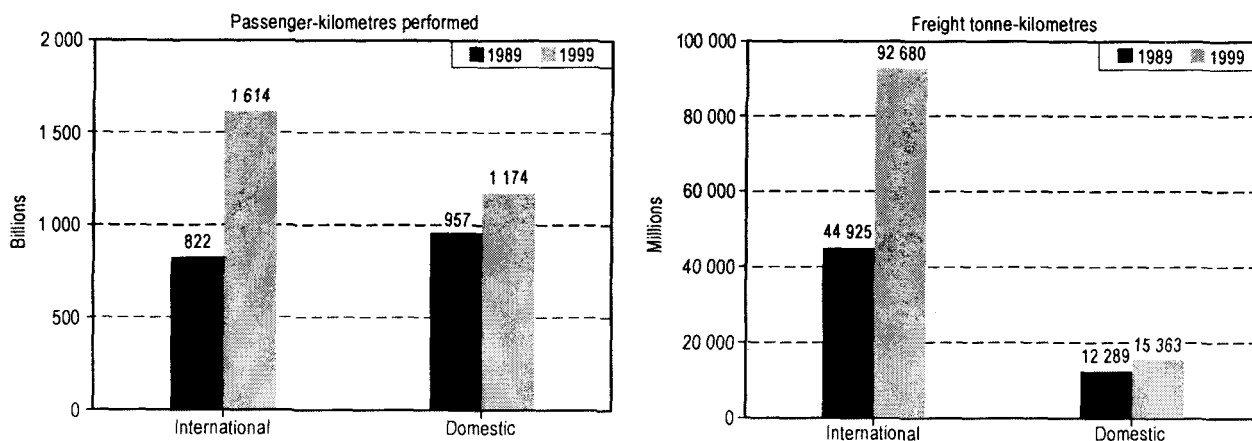
6. International traffic has tended to grow more rapidly than domestic traffic, particularly in the case of freight. Figure 2-2 shows the increases over the period 1989 to 1999 in the international and domestic components of both scheduled passenger and scheduled freight traffic. The United States is the dominant producer of domestic air traffic, accounting for nearly 65 per cent of total domestic passenger and freight traffic.

## SCHEDULED INTERNATIONAL TRAFFIC BY REGION

7. Turning to the regional pattern of scheduled international traffic, Figure 2-3 shows the shares of international traffic by region of airline registration in 1989 and 1999. European airlines retain the major share of both passenger and freight traffic, but their share in freight traffic declined over the period concerned, while the share of Asia/Pacific airlines in passenger traffic continued to increase and in freight traffic grew substantially.

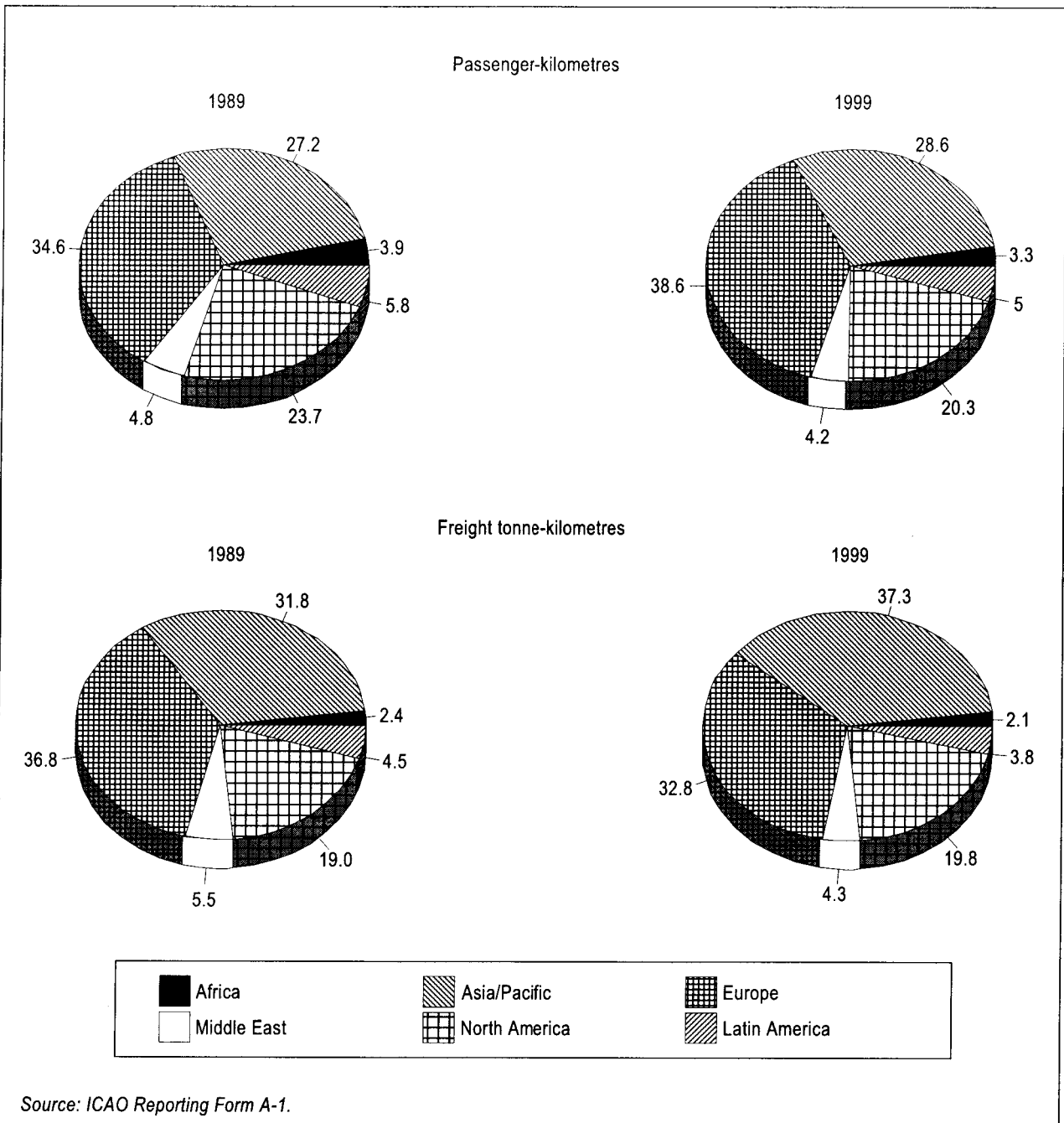
## SCHEDULED PASSENGER TRAFFIC ON MAJOR INTERCONTINENTAL ROUTE GROUPS

8. Scheduled passenger traffic trends between 1989 and 1999 on some intercontinental route groups are illustrated in Figure 2-4. The strength of the North Atlantic market, in terms of its size (close to 65 million passengers in 1999) and growth (some 100 per cent between 1989 and 1999), is clearly illustrated. However, the fastest growing markets were the North America-South America and Europe-Asia/Pacific route groups.

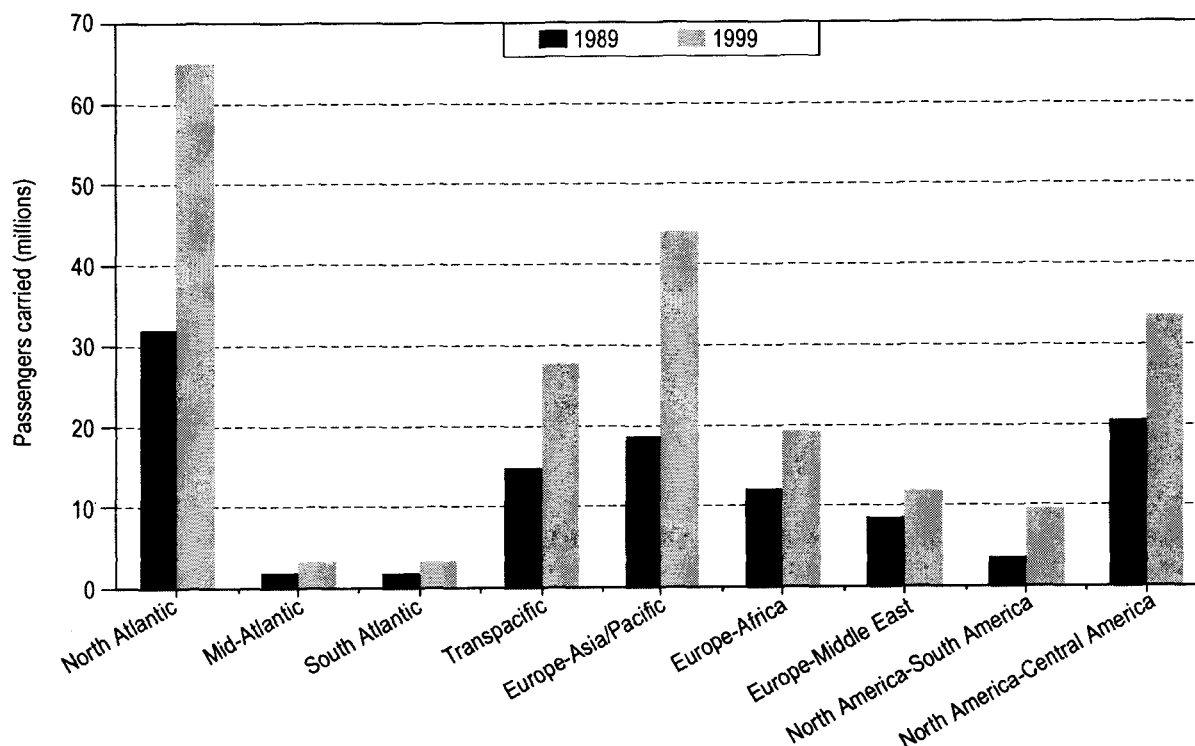


Source: ICAO Reporting Form A-1.

**Figure 2-2. Trends in international and domestic traffic**  
(Scheduled operations, 1989 and 1999)



**Figure 2-3. Regional shares of international traffic**  
(scheduled operations, 1989 and 1999)



Source: IATA, ICAO Reporting Form B and manufacturers.

**Figure 2-4. Passengers on intercontinental route groups**  
(scheduled operations, 1989 and 1999)

### NON-SCHEDULED TRAFFIC

9. 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.

10. 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 has 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 1989 and 1999 of non-scheduled passenger traffic carried by non-scheduled carriers and by scheduled carriers. Growth in their combined non-scheduled international traffic was approximately 4.1 per cent per annum on average during the 1989 to 1999 period, below the 7.0 per cent per annum growth rate for scheduled international traffic.

11. Non-scheduled traffic is very important on intra-European routes. Intra-European, non-scheduled traffic accounts for the largest part of the total world charter market in terms of passengers. Non-scheduled traffic remains quite important on North Atlantic routes, accounting for approximately 10 per cent of the total North Atlantic market.

**Table 2-2. World international non-scheduled passenger traffic**  
(passenger-kilometres)

	1989 (billions)	1999 (billions)	Average annual growth (per cent)
Non-scheduled carriers	92.8	140.0	4.1
Scheduled carriers	84.0	124.0	4.0
Total	176.8	264.0	4.1

*Source: ICAO Reporting Form A-2.*

### AIRCRAFT MOVEMENTS

12. The growth in passenger and freight traffic demand over the past 39 years has resulted in comparable growth in air carrier capacity. Growth patterns in 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.

13. 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.

14. 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 has been increasing. The rate of increase in average stage length was greatest when jet aircraft were replacing piston-engined aircraft.

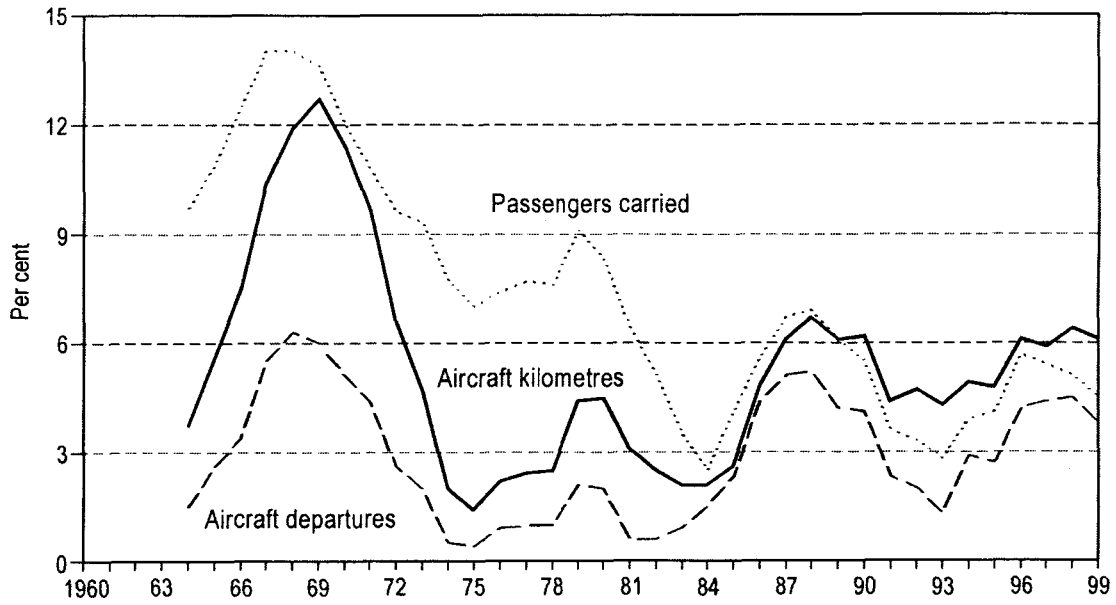
### FLEET COMPOSITION AND PRODUCTIVITY

15. At the end of 1999, the scheduled and non-scheduled carriers of ICAO Contracting States (excluding China and the Russian Federation) had a combined fleet of about 18 200 aircraft of over 9 000 kg maximum take-off weight (MTOW) for their international and domestic operations. This is an increase of about 60 per cent over the 1989 fleet. The number of jet aircraft at the end of 1999 was some 14 500, which is an increase of about 66 per cent over 1989. Jet aircraft obviously account for an even larger proportion of carrier capacity than indicated by the relative number of aircraft.

16. Figure 2-6 contrasts the strong 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-engined aircraft.

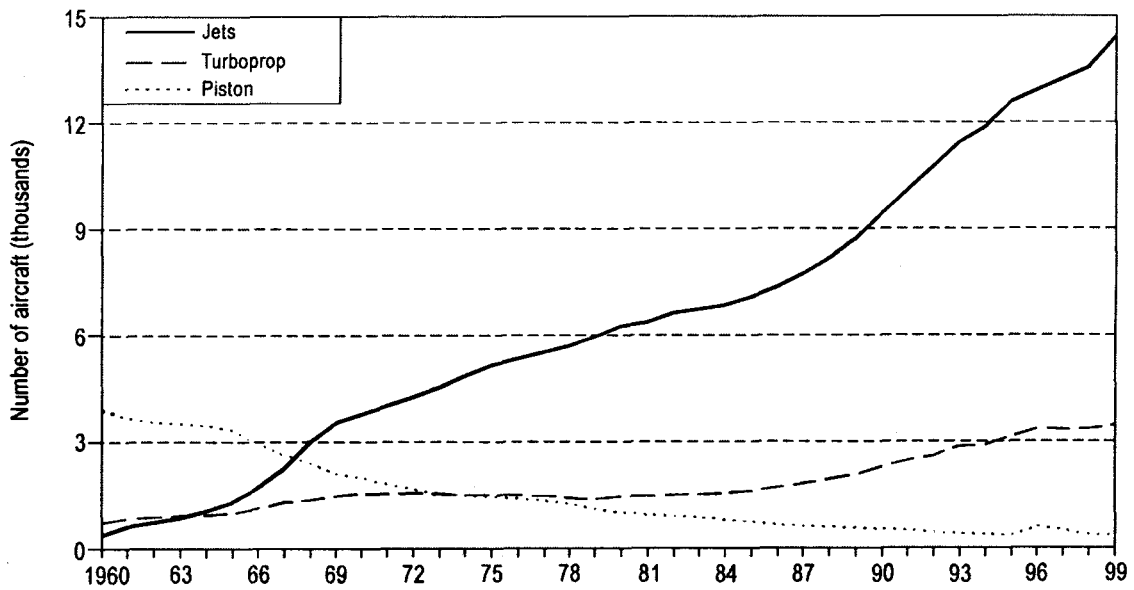
17. The progressive absorption of new technology aircraft into airline fleets has been a major source of productivity improvement for the air transport industry, as measured by the quantity of output per unit of input. A single comprehensive measure of productivity requires comprehensive measures of output and input. For the airline industry, tonne-kilometres performed (TKP), including both passenger and freight traffic, is





Source: ICAO Reporting Form A-1.  
 Note: 5-year moving average of annual growth.  
 Excluding operations in the Commonwealth of Independent States (CIS).

**Figure 2-5. Growth in passengers and aircraft movements**  
 (total scheduled operations, 1960 to 1999)



Source: ICAO Reporting Form H.

**Figure 2-6. Composition of world commercial transport fleet**  
 (aircraft of 9 000 kg MTOW and over)

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 39 years. The three components of aircraft productivity have been combined into a single measure of aircraft productivity whose trend is included amongst those illustrated in Figure 2-7. There have been some fluctuations in performance related to business cycle conditions. Over the whole 39-year period, aircraft productivity has advanced at an average annual rate of about 3.1 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 6.2 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 nearly 27 tonnes in 1999. 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 5.5 per cent per annum between 1960 and 1999.

**Table 2-3. Developments in airline productivity**  
(international scheduled airlines)

Productivity measure	Average levels				
	1965	1975	1985	1995	1999
<b>Aircraft productivity</b>					
Aircraft load factor (per cent)	52	50	59	60	61
Aircraft speed (km/h)	469	619	634	644	635
Aircraft utilization (hours per aircraft per year)	1 678	2 064	2 179	2 751	3 031
<b>Labour productivity</b>					
TKP per employee (thousands)	43	82	144	258	295
<b>Fuel productivity</b>					
TKP per litre of fuel (index)	100	123	187	213	214



Source: ICAO Reporting Form H, IMF, OECD.

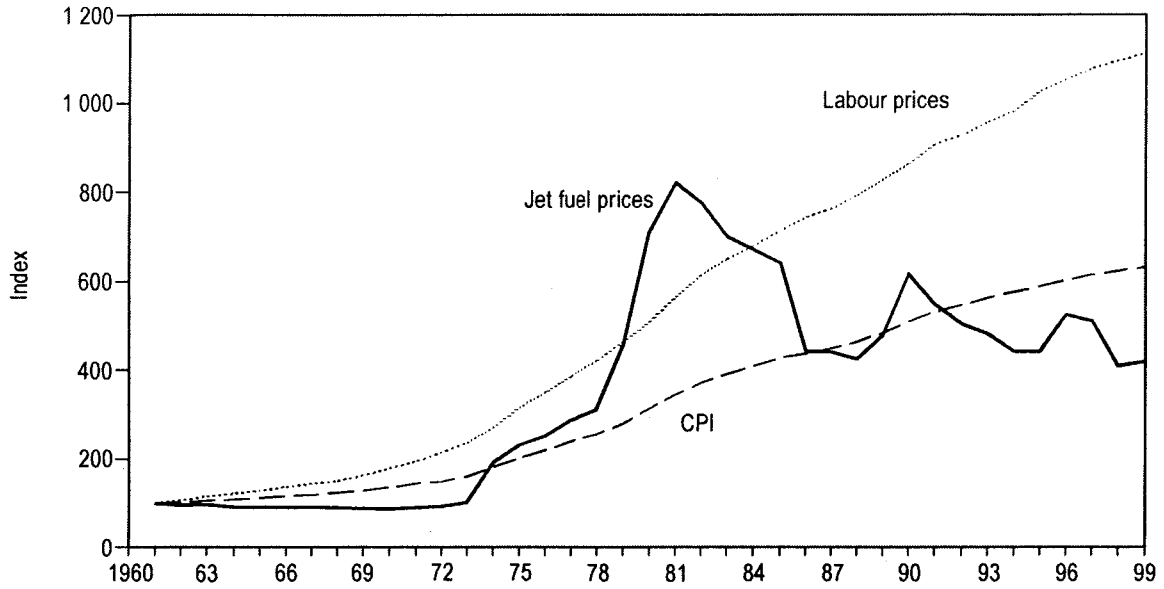
**Figure 2-7. Trends in airline productivity**

### 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.

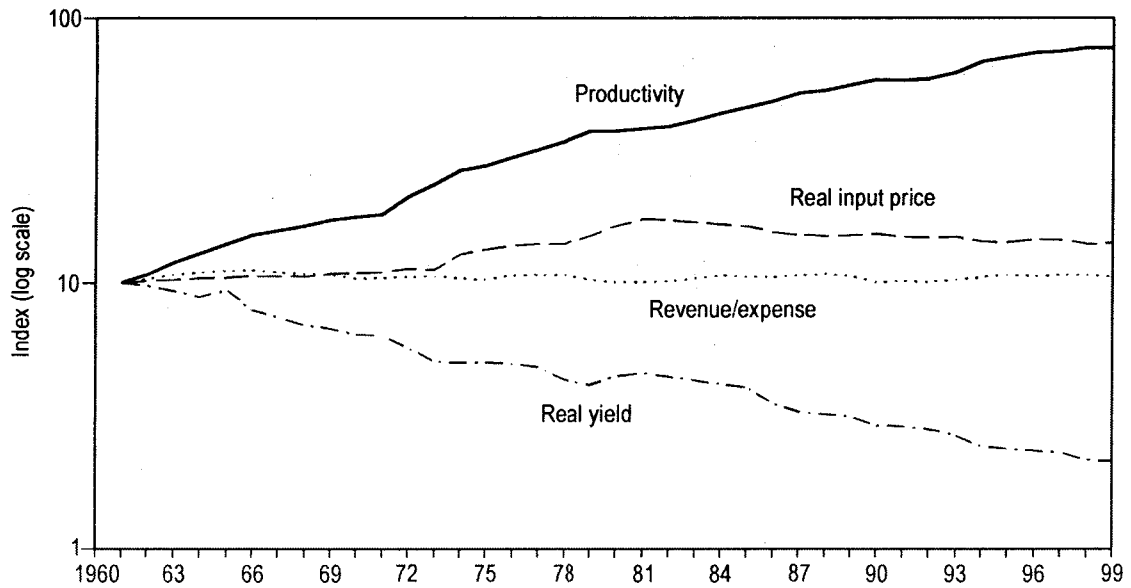
22. Changes in the real prices paid for inputs (e.g. labour and fuel) purchased by the airlines are also reflected in the cost per unit of output, and hence in real fares and rates or in financial performance. The price trends of two of the most important inputs, labour and jet fuel, are indicated in 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.

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. 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.



Source: IMF, OECD.

**Figure 2-8. Input price trends**



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

**Figure 2-9. Trends in airline industry performance**

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.

25. Although there have been substantial changes in the operating results of the airline industry in the short and medium terms, there has been neither an improving nor declining trend in financial performance over the long term. A significant 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 0.02 in 1999.

27. There have also been significant enhancements in the quality of service provided to airline customers. There are many dimensions of 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 (i.e. average length of non-stop flights) 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 in 1960 to 620 kilometres per hour in 1980 (an increase of 72 per cent). There has been little change in block speed since 1980. The average stage length has more than doubled from 470 kilometres in 1960 to 1 135 kilometres in 1999. 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 1999. 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 general 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 growth stimulation of demand. While it is not possible to isolate cause and effect, the fact that aircraft departures have increased by 206 per cent between 1960 and 1999 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, with vigorous growth in aircraft movements now occurring, further pressure on facilities is expected, with spillover effects between regions. In some congested areas, the limits of terminal and runway expansion are being reached at some major airports. 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. The new satellite-based global communications, navigation and surveillance/air traffic management (CNS/ATM) systems being implemented through ICAO are 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 between 1995 and 2002. While the phase-out of Chapter 2 aircraft has been successful in reducing noise levels near many airports, in recent years governments have been turning their attention to the situation that will exist once Chapter 2 aircraft have largely been phased out. While most aircraft will then meet the stricter "Chapter 3" standards, there are concerns that the rapid growth of air transport could increase noise levels once again, and efforts are under way to address these concerns.

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. At ICAO's request, the Intergovernmental Panel on Climate Change (IPCC) has prepared a *Special Report on Aviation and the Global Atmosphere*<sup>1</sup>. This estimates 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 December 1997 but has not yet entered into force, requires the countries listed in Annex I to the Convention (the industrialized countries) to reduce their collective emissions of greenhouse gases by approximately 5 per cent by the 2008–12 period compared with 1990 levels, with the reduction varying from country to country. These targets focus on six greenhouse gases, the one most relevant to aviation being CO<sub>2</sub>. Article 2, paragraph 2, of the Kyoto Protocol states that the responsibility for limiting or reducing emissions from aviation bunker fuels shall fall to the Annex I parties, working through ICAO.

39. Future concerns about aviation's role in both climate change and local air quality are largely due to the projected continued growth. While past technological improvements have reduced the growth rate of emissions and this progress is expected to continue into the future, total emissions will continue to increase. For example, the IPCC's report projects aviation growth of 5 per cent per year between 1990 and 2015, with fuel consumption and CO<sub>2</sub> emissions growing at 3 per cent annually over the same period.

40. Technology offers some prospect of reductions in greenhouse gas emissions by aircraft, although this is by no means straightforward and will take some time. In the case of CO<sub>2</sub> (which is not controlled by the present Standards), this is an unavoidable product of fossil fuel combustion, and therefore 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 emission-related levies (charges or taxes), emissions trading or voluntary agreements, are all under consideration.

## FINANCIAL RESOURCES

41. 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.

## ECONOMIC REGULATION

42. The shape and size of the air transport system will continue to be influenced by governmental decisions at the national, bilateral and multilateral levels. Although these decisions continue to be made largely by air transport authorities, bodies outside of the traditional aviation regulatory regimes have become

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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 Website ([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.

increasingly involved in airline regulation. For example, since 1995, the World Trade Organization (WTO) has become involved in dealing with three specific air transport activities (i.e. the repair and maintenance of aircraft, the sale and marketing of air transportation, and computer reservation systems services) pursuant to the Annex on Air Transport of the General Agreement on Trade in Services (GATS). Although traffic rights and services directly related to their exercise were excluded from the application of the Agreement, the WTO launched the review process in 2000 as required by the Annex with a view to the further application of the GATS to the air transport sector.

43. There have been three significant developments over the past decade within the aviation regulatory structure: 1) actions taken by many governments towards less detailed regulation of airline commercial activities coupled with promotion of competition and greater reliance on airlines responding to market forces; 2) the widespread use by airlines of alliances and cooperative devices, such as codesharing, to obtain access to new markets and to better serve existing ones; and 3) industry concentration in both domestic and international markets. These developments have involved aviation regulatory authorities in questions such as what measures are needed to ensure fair competition in not only the operation of international air services but also their sales and marketing, and when and under what conditions should airline alliances and codesharing arrangements be approved. There is also a growing convergence of economic, safety, security and environmental issues in the regulation of air transport.

44. At the national level, a number of regulatory authorities continue to be occupied with full or partial privatization of government-owned airlines and the often-related question of foreign investment in airlines. Several governments have adjusted or introduced new policies concerning foreign investment in their national airlines. Equity participation in national airlines by foreign airlines, often a means of indirect market access and cement of partnership, has occurred with increasing frequency in all regions. While the permissible levels of such foreign investment generally range from 20 to 49 per cent, a few States have even allowed majority or full foreign ownership in their national airlines. In other cases, permission for foreign airline investment is accompanied by other requirements, such as reciprocity, which have become an issue in some bilateral negotiations.

45. Bilaterally, States continue to expand the international air transport network using air service agreements. There has been a considerable increase in the number of liberal bilateral agreements-involving unrestricted route rights and free market access provisions. From 1995 to 2000, over 70 such "open skies" agreements were concluded between some 60 countries. As airline business evolves, more bilateral air service agreements will contain provisions dealing with computer reservation systems, airline codesharing, leasing of aircraft and intermodal transport.

46. At the regional level, groups of States have created multilateral regulatory regimes based on membership in their respective groups. Most of these regional or subregional arrangements are aimed at fostering cooperation and liberalizing air transport regulation amongst member States. Before 1995, there were just two such regional arrangements, namely the European Union involving 15 States and the Andean Pact involving 5 States. Since then, 8 more arrangements have emerged with a worldwide dispersion. They include the Caribbean Community Air Service Agreement amongst 14 States in the Caribbean, the Fortaleza Agreement amongst 6 States in South America, the CLMV Agreement by 4 States in Southeast Asia (i.e. Cambodia, Lao People's Democratic Republic, Myanmar and Viet Nam), an agreement amongst 16 States of the Arab Civil Aviation Commission (ACAC) in the Middle East, and 4 others in Africa (i.e. the Banjul Accord by 6 States, agreements amongst the 6 States of the Central African Economic Union and amongst the 21 States of the Common Market for Eastern and Southern Africa, the Yamoussoukro II Ministerial decision for gradual liberalization amongst all 53 African States). Several of these agreements provide for instant or phased-in liberalization leading to full market access. The establishment of regional multilateral aviation arrangements has generally led to an expansion of air services within the regions concerned.



47. Other more general governmental 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 the Acquired Immune Deficiency Syndrome is sought) and national narcotics control efforts.

## INDUSTRY STRUCTURE

48. The most noteworthy changes in airline industry structure, arising from the need to meet increased traffic demand and competition, are the use of automation, computer reservation systems and personal communication systems to respond to the challenges of less regulated domestic and international markets, and ongoing moves towards globalization.

49. An important innovation in the United States, which is also increasingly found elsewhere, is the refinement of 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. Megacarriers and the trend to globalization 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). Both as a part of this development and as a method of quickly achieving and improving market access (albeit indirectly), there has been a continuing process of formation of intercarrier (often transnational) alliances, as well as joint marketing arrangements, often involving the sharing of airline designator codes. Several “global alliance” groupings have also been established by major carriers. These developments have caused some small- and medium-size airlines concern for their survival and have prompted efforts by some airlines either to develop a particular part of a market or to compete as low-cost, point-to-point airlines or to enter various alliances of their own. 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.

50. Two of the ways automation is changing industry structure involve the use of computers. First, product distribution is now being carried out through computer reservation systems (CRS) and more recently through the Internet. Second, the development of sophisticated yield management systems for airlines, associated with the use of computers, has enabled the airlines concerned 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 often reliant upon low fares to achieve market penetration.

51. 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 done 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 have also taken actions to adjust to the new business environment and pursued the Internet market through different strategies. Some have provided reservation services to major on-line travel sites or have become owners of such sites; others 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.

52. 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.

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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 1960–1999, the aggregate world economy measured in terms of Gross Domestic Product (GDP) increased at an average annual rate of 3.6 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 capability 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. Some major economies, including those of the United States, the United Kingdom and Canada, entered into a recession in 1991, and a slowdown was observed in Germany and Japan. As a result of the continued weakness in these economies, 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 an estimated GDP growth of 3.0 per cent, based mainly on economic recovery in the Asia/Pacific region and continued strong growth in the United States economy.
5. World population growth between 1980 and 1999 increased at an average annual rate of 1.6 per cent. Hence, the world's GDP per capita between 1980 and 1999 increased at an average annual rate of 1.3 per cent, lower than the growth of GDP itself, as indicated in Figure 3-1.

### **OUTLOOK**

6. There appears to be consensus among economic forecasters that the world economic and financial conditions remain generally encouraging and that the global economy will continue to expand over the medium term, although rising crude oil prices may have a dampening effect. Based on strong recovery in

1999, the world economic activity is expected to pick up to approximately 3.9 per cent in the year 2000 and continue to grow at over 3 per cent in 2001 and 2002. Over the long period up to 2010, the world economy is projected to grow at an average annual rate of 2.5 per cent in real terms.



Source: IMF, WEFA.

**Figure 3-1. World GDP, GDP per capita growth**  
(real terms, 1980–1999)

## **Chapter 4**

# **AIRLINE FINANCIAL TRENDS**

### **OPERATING REVENUES, EXPENSES AND RESULTS**

1. This chapter indicates general trends in airline financial data for the years 1965, 1975 and 1985 and for the period 1989–1998 (and including 1999 where preliminary estimates were available) and, in broad terms, the outlook to the year 2010. The treatment is global in nature, dealing with totals and averages for the airlines as a whole, and for this reason does not show the wide differences that exist between 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. Financial data for the period concerned, categorized by major components of operating revenues and expenses, are given in Table 4-1.
3. The trends in overall annual operating revenues and expenses for the period 1988 to 1999 are illustrated in Figure 4-1. Although there has been neither an improvement nor a decline in the long-term trend in the financial performance of scheduled airlines as a whole, there have been relatively large changes in the operating results in the last ten years. During the 1983–1989 period, however, 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 the 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. Much improved operating results were obtained in 1994, and this trend continued in the ensuing years, with 1998 operating profit reaching almost \$16 billion. Preliminary estimates for 1999 indicate that an operating profit of some \$12.6 billion was achieved.
4. As shown in Table 4-2, from 1989 to 1998 in terms of current dollars, the total operating revenues of the world's scheduled airlines from all their services, scheduled and non-scheduled, and including incidental revenues, increased at an average annual rate of 5.8 per cent, from \$177 800 million to \$295 500 million. During the same period, the corresponding total operating expenses increased at an average annual rate of 5.7 per cent, from \$170 200 million to \$279 600 million. The growth in world airline operating revenues during this period was associated with an average annual growth in traffic of 6.3 per cent in terms of tonne-kilometres performed and a decline in airline yields in current terms (average operating revenue per tonne-kilometre performed) from 84.2 cents in 1989 to 80.6 cents in 1998. The unit cost per available tonne-kilometres declined from 48.5 in 1989 to 45.3 cents in 1998.
5. As with overall revenues and costs, unit revenues and costs varied from year to year over the 1988–1999 period, as shown by Figure 4-2.

**Table 4-1. Operating revenues and expenses — 1965–1998**  
(scheduled airlines of ICAO Contracting States<sup>1</sup>, total domestic and international services)

Description	1965	1975	1985	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	(millions of dollars)												
<b>OPERATING REVENUES</b>													
Scheduled services (total)	7881	35 166	102 000	157 580	173 970	178 470	187 590	193 930	212 710	233 660	247 030	254 070	257 880
Passenger	6 748	30 174	87 000	137 050	153 330	156 760	165 140	171 440	186 530	205 000	216 710	221 820	226 100
Freight	755	4 196	13 300	18 520	18 410	19 400	20 110	20 270	23 890	25 980	27 830	29 720	29 420
Mail	378	796	1 700	2 010	2 230	2 310	2 340	2 220	2 290	2 680	2 490	2 530	2 360
Non-scheduled operations	358	1 612	3 500	6 160	7 090	8 260	7 870	8 230	9 110	10 680	11 740	11 250	9 660
Incidental	195	1 513	6 700	14 060	18 440	18 770	22 340	23 840	22 880	22 660	23 730	25 680	27 960
Total operating revenues	8 434	38 309	112 200	177 800	199 500	205 500	217 800	226 000	244 700	267 000	282 500	291 000	295 500
<b>OPERATING EXPENSES</b>													
Flight operations (total)	1 971	12 215	34 930	44 060	56 320	56 420	57 360	59 270	61 350	66 550	74 810	76 390	75 080
Flight crew salaries and expenses	705	3 292	7 250	11 340	13 780	15 220	15 790	16 520	17 860	19 450	21 020	21 550	22 330
Aircraft fuel and oil	944	7 305	23 780	23 120	30 300	27 120	26 800	26 840	26 900	28 970	34 600	34 580	29 180
Other (insurance, rental, training, etc.)	322	1 618	3 900	9 600	12 240	14 080	14 770	15 910	16 590	18 130	19 190	20 260	23 570
Maintenance and overhaul	1 331	4 688	11 070	19 540	22 900	23 120	23 830	22 530	23 770	26 810	28 540	30 310	31 190
Depreciation and amortization	845	3 065	7 770	12 490	13 850	14 310	15 380	15 580	17 990	18 400	19 100	17 990	18 280
User charges and station expenses (total)	1 199	6 351	17 340	29 210	32 460	34 460	37 880	38 740	41 640	46 140	47 920	47 690	50 010
Landing and associated airport charges	212	1 424	3 540	6 290	7 730	8 160	8 460	9 260	10 480	11 440	11 600	11 210	12 400
Other	987	4 927	13 800	22 920	24 730	26 300	29 420	29 480	31 160	34 700	36 320	36 480	37 610
Passenger services	647	3 514	10 310	17 590	20 710	21 380	23 630	23 580	25 610	28 070	29 090	29 310	29 770
Ticketing, sales and promotion	1 183	5 491	18 470	29 450	32 860	34 340	36 050	36 590	37 360	39 590	41 320	40 700	40 110
General, administrative and other operating expenses	450	2 255	8 210	17 860	21 900	21 970	25 470	27 410	29 280	27 940	29 420	32 310	35 160
Total operating expenses	7 626	37 579	108 100	170 200	201 000	206 000	219 600	223 700	237 000	253 500	270 200	274 700	279 600
Operating result [profit or loss (-)]	808	730	4 100	7 600	-1 500	-500	-1 800	2 300	7 700	13 500	12 300	16 300	15 900
Operating result as a percentage of operating revenues	9.6	1.9	3.7	4.3	-0.7	-0.2	-0.8	1.0	3.1	5.1	4.4	5.6	5.4
Net result	488	-67	2 100	3 500	-4 500	-3 500	-7 900	-4 400	-200	4 500	5 300	8 550	8 200
Net result as a percentage of operating revenues	5.8	-0.2	1.9	2.0	-2.3	-1.7	-3.6	-1.9	-0.1	1.7	1.9	2.9	2.8

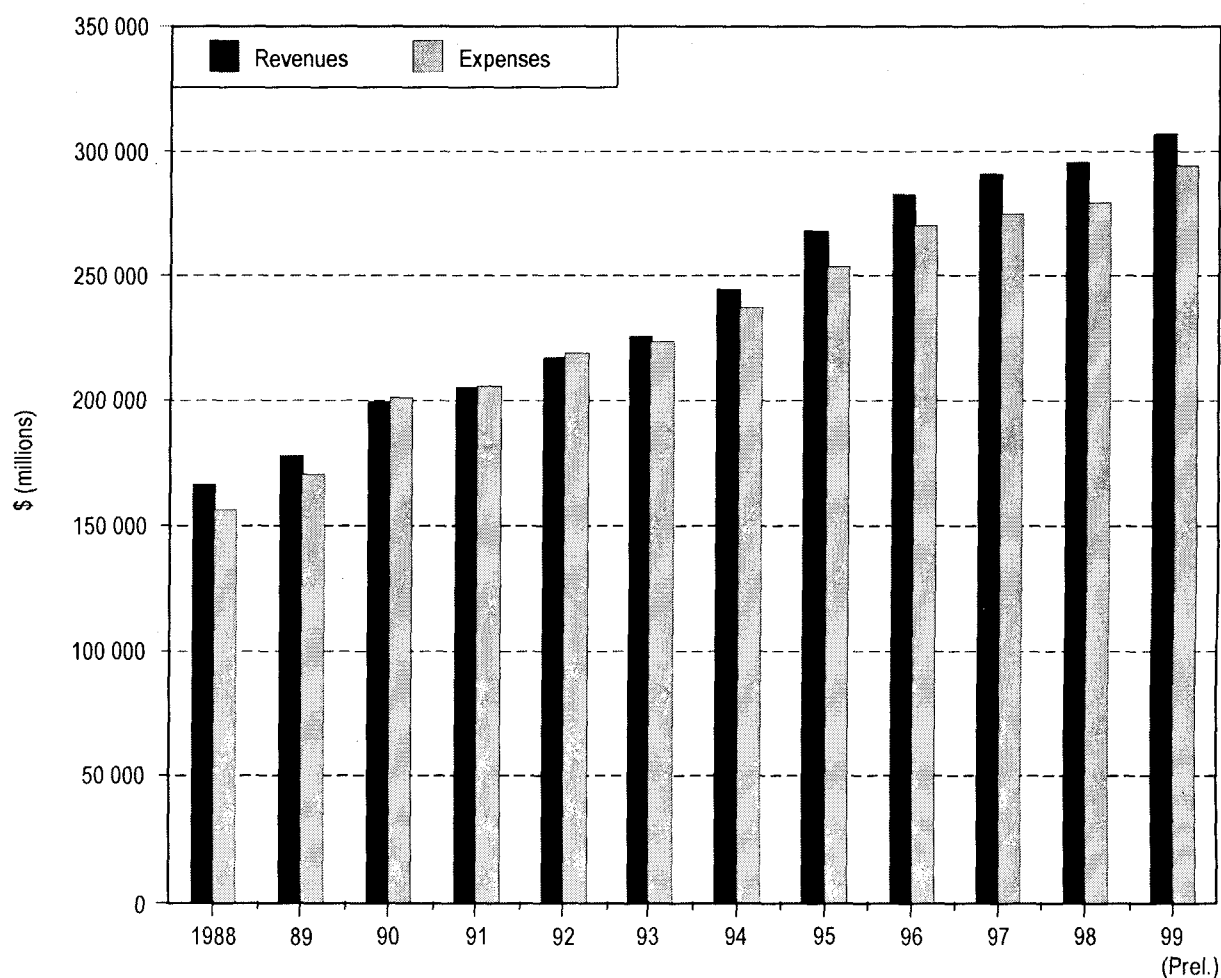
1. Excludes domestic operations in the Commonwealth of Independent States (CIS).

**Table 4-2. Total and unit operating revenues and expenses, 1989 and 1998**  
(scheduled airlines of ICAO Contracting States<sup>1</sup>, total domestic and international services)

	Operating revenues (\$ millions)	Operating expenses (\$ millions)	Total traffic (TKP millions)	Unit revenue (cents/TKP)	Total capacity (ATK millions)	Unit cost (cents/ATK)
1989	177 800	170 200	211 210	84.2	350 760	48.5
1998	295 500	279 600	366 810	80.6	616 690	45.3
Average annual growth (per cent)	5.8	5.7	6.3	-0.5	6.5	-0.8

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

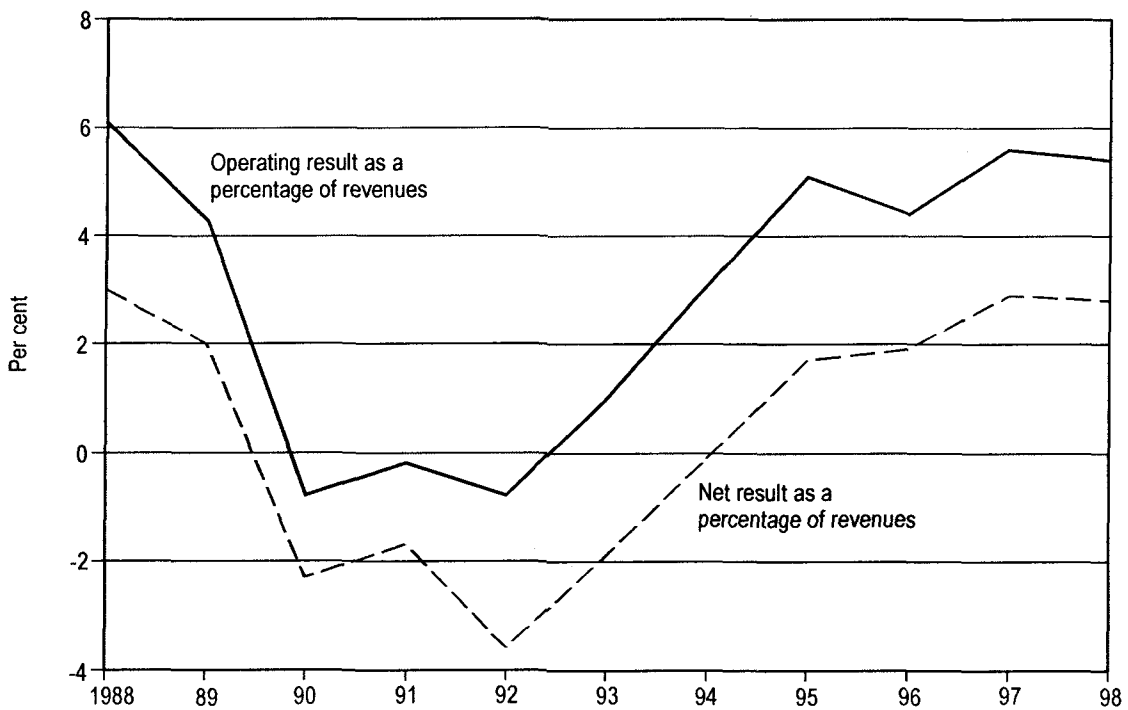
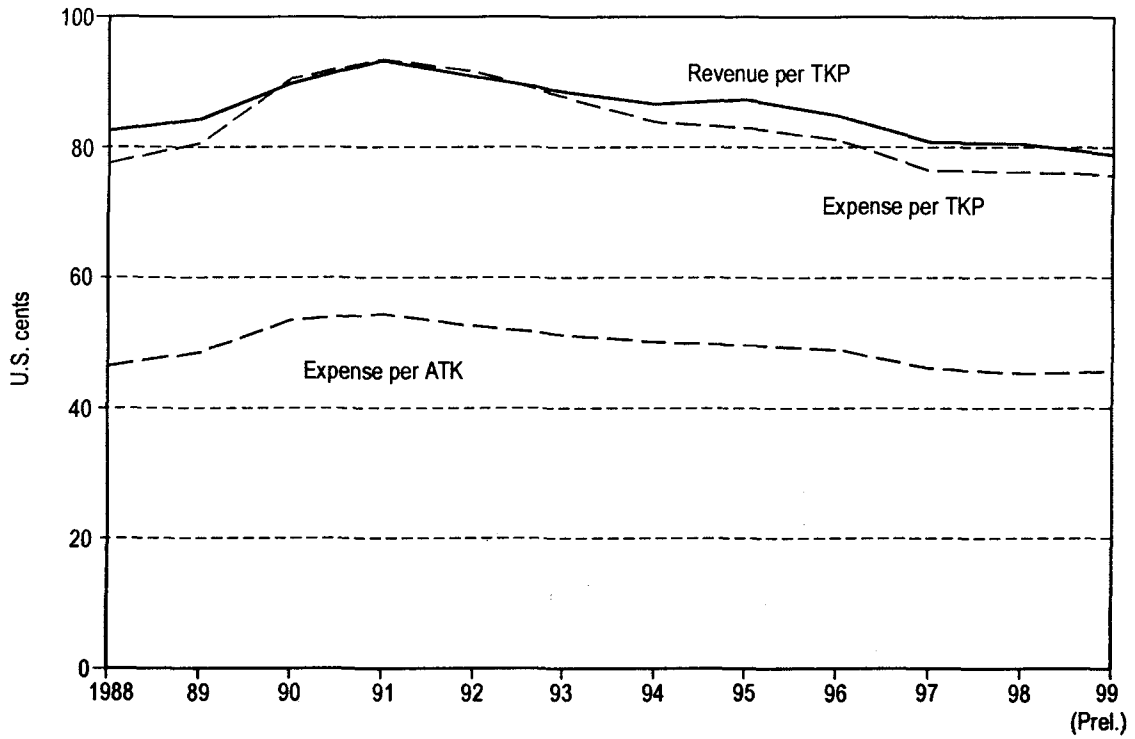
1. Excludes operations within the Commonwealth of Independent States (CIS).



Source: ICAO Reporting Form EF-1.

Note: Excluding operations in the Commonwealth of Independent States (CIS).

**Figure 4-1. World scheduled airline operating revenues and expenses, 1988-1999**



Source: ICAO Reporting Form EF-1.

Figure 4-2. Financial data for scheduled airline



## DISTRIBUTION OF OPERATING REVENUES AND EXPENSES

6. As illustrated by Table 4-3, in terms of shares of total revenues, passenger revenues of scheduled airlines declined from 77.1 per cent in 1989 to 76.5 per cent in 1998; freight and mail revenues declined from 11.5 per cent in 1989 to 10.8 per cent in 1998; non-scheduled revenues also declined from 3.5 per cent in 1989 to 3.3 per cent in 1998; while incidental revenues (which include sales of services and maintenance, and the leasing of aircraft to other airlines) increased from 7.9 per cent in 1989 to 9.4 per cent in 1998.

7. Among airline operating expenses, the most significant increase between 1989 and 1998 was attributable to “general, administrative and other operating expenses” and to “flight crew expenses”, which rose at an average annual rate of 2.0 per cent each, compared to an average annual decline of 2.8 per cent for “aircraft fuel and oil expenses”. “General, administrative and other operating expenses” and “flight crew expenses” increased from 10.5 and 6.7 per cent in 1989 to 12.6 and 8.0 per cent in 1998, respectively, while “aircraft fuel and oil expenses” and “ticketing, sales and promotion expenses” decreased from 13.6 and 17.3 per cent in 1989 to 10.5 and 14.3 per cent in 1998, respectively. “Flight operations — other”, which includes rental of aircraft from other carriers, also increased its share significantly from 5.6 per cent of total operating expenses in 1989 to 8.4 per cent in 1998, while the costs of “landing and associated airport charges” increased from 3.7 to 4.4 per cent. The proportion of direct aircraft operating expenses remained almost unchanged (44.7 per cent in 1989 and 44.6 per cent in 1998), as did the proportion of indirect operating expenses (55.3 per cent in 1989 and 55.4 per cent in 1998).

## REGIONAL TRENDS IN REVENUES AND EXPENSES

8. Estimates of the distribution of total operating revenues and expenses according to the region of airline registration are given in Table 4-4 for 1989 and 1998, together with the corresponding operating results. In 1998, about 38 per cent of operating revenues and expenses of the world’s airlines were attributable to the North American airlines, some 31 per cent to European airlines and some 20 per cent to airlines of Asia and the Pacific, with the remaining 11 per cent divided among those of Africa, the Middle East and Latin America/Caribbean. Compared to 1989, the 1998 shares of operating revenues and expenses of the airlines of Europe represented a gain of close to 3 percentage points of the world total, while those of the North American carriers declined (by 1.6 percentage points in revenues and 3.7 percentage points in expenses), as did those of African carriers (by about 1.5 percentage points in both revenues and expenses). The shares of the airlines of the remaining regions remained almost unchanged.

## YIELDS AND UNIT COSTS

9. 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 1999 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 1960–1999 period (excluding operations within the Commonwealth of Independent States), 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 2.8 per cent per annum, and freight and mail yield decreased at a rate of 3.6 per

**Table 4-3. Distribution of operating revenues and expenses in 1989 and 1998**  
(scheduled airlines of ICAO Contracting States<sup>1</sup>,  
total domestic and international services)

Description	Distribution by item (per cent)		Average annual growth (per cent) 1989 to 1998
	1989	1998	
<b>OPERATING REVENUES</b>			
Scheduled services (total)	88.6	87.3	-0.2
Passenger	77.1	76.5	-0.1
Freight	10.4	10.0	-0.4
Mail	1.1	0.8	-3.5
Non-scheduled operations	3.5	3.3	-0.7
Incidental	7.9	9.4	2.0
<b>TOTAL</b>	<b>100.0</b>	<b>100.0</b>	<b>-</b>
<b>OPERATING EXPENSES</b>			
<b>Direct aircraft</b>			
Flight operations (total)	25.9	26.9	0.4
Flight crew	6.7	8.0	2.0
Fuel and oil	13.6	10.5	-2.8
Other	5.6	8.4	4.6
Maintenance and overhaul	11.5	11.2	-0.3
Depreciation and amortization	7.3	6.5	-1.3
Sub-total	44.7	44.6	-
<b>Indirect</b>			
User charges and station expenses (total)	17.2	17.9	0.4
Landing and associated airport charges	3.7	4.4	1.9
Other	13.5	13.5	-
Passenger services	10.3	10.6	0.3
Ticketing, sales, promotion	17.3	14.3	-2.1
General, administrative and other	10.5	12.6	2.0
Sub-total	55.3	55.4	-
<b>TOTAL</b>	<b>100.0</b>	<b>100.0</b>	<b>-</b>

Source: ICAO Air Transport Reporting Form EF-1.

1. Excludes domestic operations within the Commonwealth of Independent States (CIS).

**Table 4-4. Regional distribution of total operating revenues and expenses in 1989 and 1998**

Region of airline registration	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	1989	6 700	3.8	6 500	3.8	200	3.0
	1998	6 800	2.3	6 800	2.4	—	—
Asia and Pacific	1989	35 700	20.1	32 400	19.0	3 300	9.2
	1998	60 180	20.3	58 300	20.9	1 880	3.1
Europe <sup>1</sup>	1989	50 800	28.6	48 200	28.3	2 600	5.1
	1998	91 500	31.0	86 990	31.1	4 510	4.9
Middle East	1989	5 750	3.2	5 600	3.3	150	2.6
	1998	8 770	3.0	8 540	3.1	230	2.6
North America	1989	71 400	40.1	69 700	41.0	1 700	2.4
	1998	113 700	38.5	104 450	37.3	9 250	8.1
Latin America and Caribbean	1989	7 450	4.2	7 800	4.6	-350	-4.7
	1998	14 550	4.9	14 520	5.2	30	0.2
World <sup>1</sup>	1989	177 800	100.0	170 200	100.0	7 600	4.3
	1998	295 500	100.0	279 600	100.0	15 900	5.4

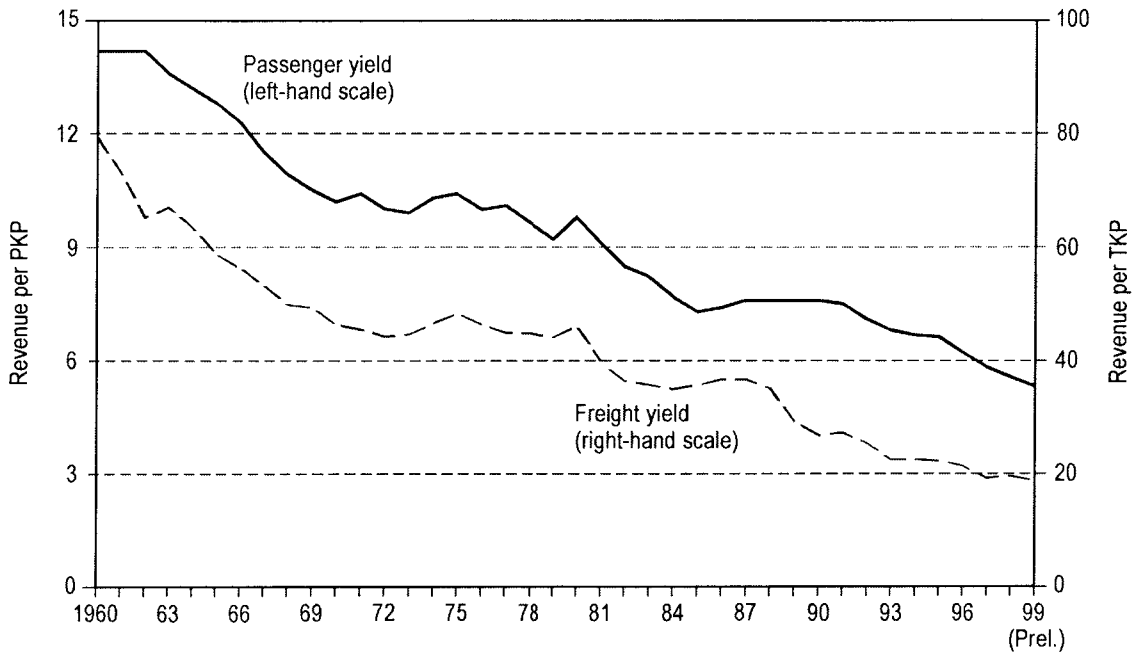
Sources: ICAO Digests of Statistics, Series F — Financial Data.

1. Excludes operations within the Commonwealth of Independent States (CIS).

cent per annum. These declines in yield were the result of technological advances, longer average trip lengths, greater competition and certain economies of scale.

10. Measured in real terms, the operating costs per available tonne-kilometre (ATK) of world scheduled airlines declined, on average, by 3.0 per cent per annum over the 1988–1999 period, with the year-to-year fluctuations illustrated in Figure 4-4.

11. 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 total costs of scheduled airlines. Unit costs declined during the period 1982–1985 partly as a result of declining fuel prices. In 1998, fuel costs accounted for only 10.4 per cent of total operating costs, as illustrated in Figure 4-5. Preliminary estimates for 1999 indicate, however, that the declining trend has reversed following sharp increases in fuel prices, and this trend is expected to continue into 2000. Although 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, aircraft utilization, seating capacity and density have an important impact on unit costs.



Source: ICAO Reporting Form EF-1.

Note: Excluding operations within the Commonwealth of Independent States (CIS).

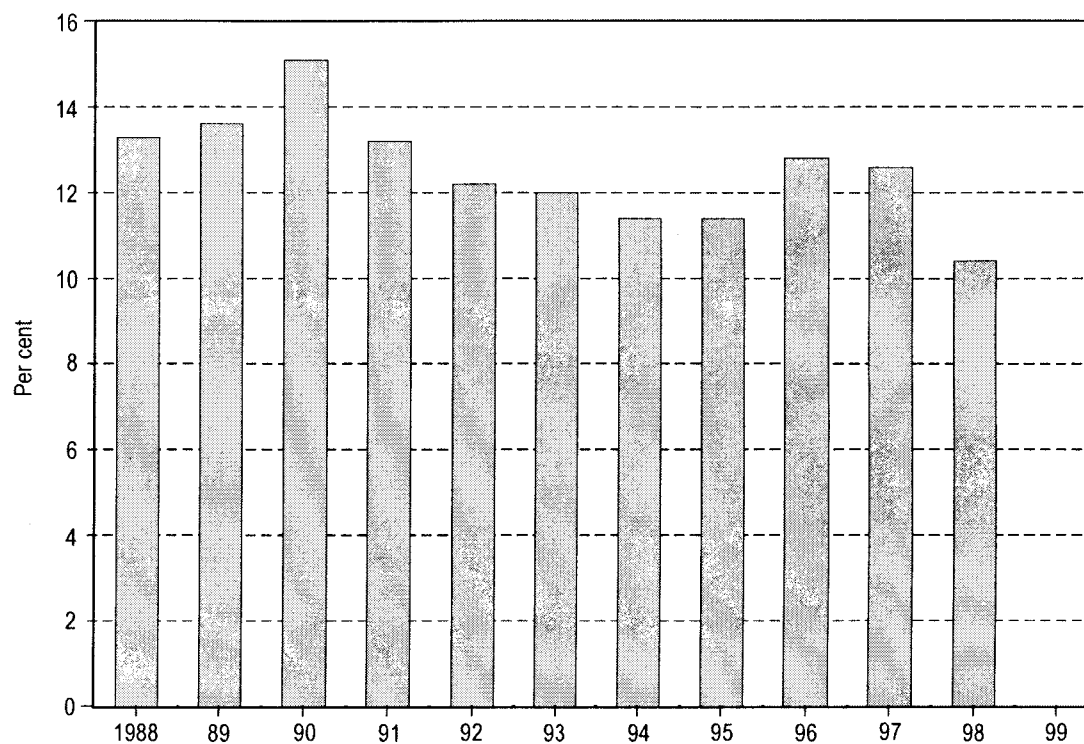
**Figure 4-3. World scheduled passenger and freight yields**  
(U.S. cents in real terms)



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

Note: Excluding operations within the Commonwealth of Independent States (CIS).

**Figure 4-4. World scheduled airlines' unit operating costs, 1988-1999**  
(U.S. cents per ATK in real terms)



Source: ICAO Reporting Form EF-1.

**Figure 4-5. World scheduled airlines' share of fuel and oil in operating expenses, 1988-1998**

## OUTLOOK

12. For the forecast period, the airline industry faces 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; 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 high capital cost of new aircraft and the increase in the cost of financing.

13. For the forecast period, airline yields are expected to decline at an average annual rate of 0.5 per cent in real terms for the 1999–2004 period and to remain stable for the following six years in real terms.

## **Chapter 5**

# **FORECASTS OF AIRLINE TRAFFIC TO THE YEAR 2010**

### **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. The projected traffic growth rates were then reviewed in the light of prospective changes in other factors which could not be accommodated in the econometric analysis.
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.
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 1999 to 2010, 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 4.0 per cent per annum;

- c) a 0.5 per cent per annum decline in average passenger and freight yields (fares and rates) in real terms for the five-year period 1999–2004, and no change in average yield (in real terms) for the six-year period 2004–2010 for the world as a whole; and
- d) availability of adequate capital resources for the development of aviation and tourist infrastructure.

6. On the basis of historic 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 next decade for world scheduled traffic of 5.5 per cent per annum for passenger-kilometres. However, due to other factors described in Chapter 2, whose impact could not be individually quantified, this growth rate has been reduced by 1 percentage point, to 4.5 per cent per annum.

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 unit costs, a “low” passenger traffic forecast of 3.0 per cent per annum results from assumptions of 2 per cent per annum for real economic average growth and an increase in real fares (yield) of 1.0 per cent per annum. A “high” forecast of 6.0 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 5.5 per cent per annum compared with 3.0 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 65 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 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 passengers carried is expected to be lower than growth in passenger-kilometres because the latter includes the effect of a gradual increase in the average passenger journey distance at an annual rate of approximately 1 per cent. During the 1989–1999 period, the increase in average journey length was more pronounced for international trips than for domestic trips. Total passengers carried on scheduled service are expected to reach 2.3 billion by the year 2010.

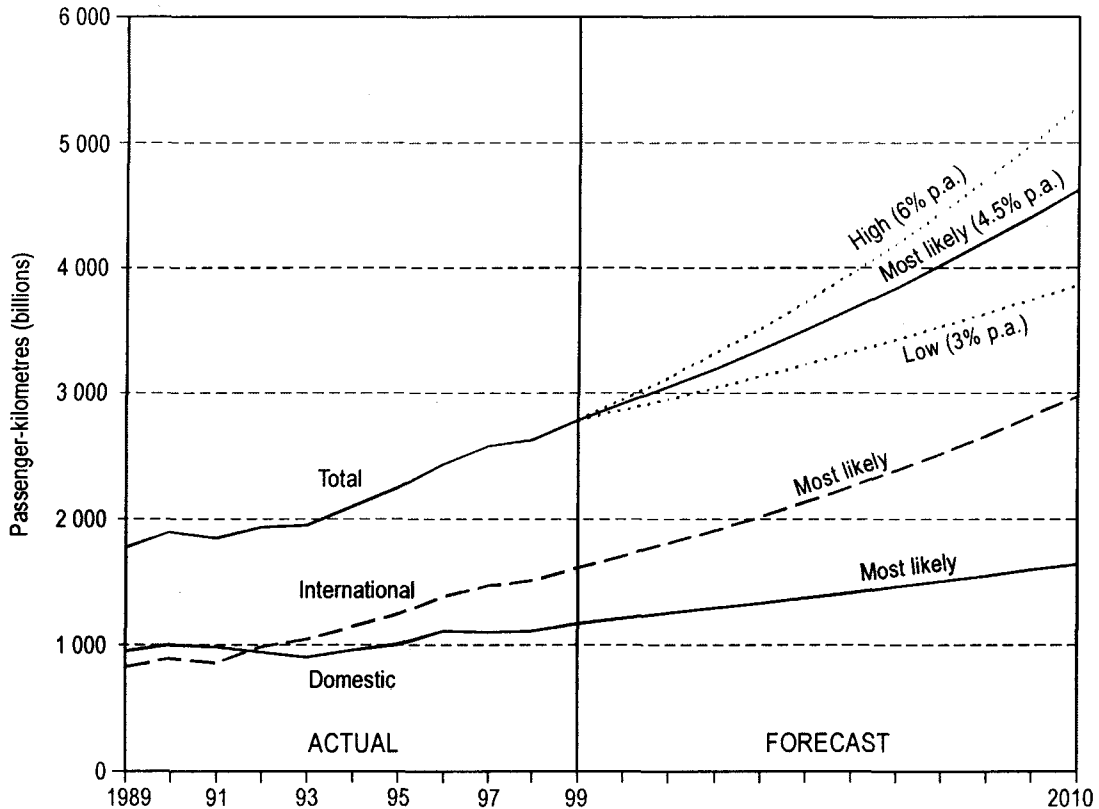
### REGIONAL PASSENGER FORECASTS

12. The “most likely” forecasts of scheduled airline passenger traffic by region of airline registration are given in Table 5-2, together with historic figures for 1989 and 1999. The airlines of the Asia/Pacific

**Table 5-1. Summary of ICAO scheduled passenger traffic forecast to the year 2010**  
(ICAO Contracting States)

	Actual 1989	Actual 1999	Forecast 2010	Average annual growth rate (per cent)	
				1989-1999	1999-2010*
Passenger-kilometres (billions)					
Scheduled services	1 779	2 788	4 620	4.6	4.5
International	822	1 614	2 960	7.0	5.5
Domestic	957	1 174	1 660	2.1	3.0
Passengers carried (millions)					
Scheduled services	1 109	1 558	2 300	3.5	3.5
International	262	489	840	6.4	5.0
Domestic	847	1 069	1 460	2.4	3.0

\* Rounded to the nearest 0.5 percentage point.



**Figure 5-1. Trends in world scheduled passenger traffic**  
(ICAO Contracting States)



**Table 5-2. Forecasts of scheduled passenger traffic by region**  
(region of airline registration, ICAO Contracting States)

	Passenger-kilometres (billions)			Average annual growth rate (per cent)		Regional share of world traffic (per cent)		
	Actual 1989	Actual 1999	Forecast 2010	1989–1999	1999–2010*	1989	1999	2010
Africa	40.8	60.9	100	4.1	4.5	2.3	2.2	2.2
International	31.8	52.5	90	5.1	5.0	3.9	3.3	3.0
Domestic	9.0	8.4	10	-0.7	1.5	0.9	0.7	0.6
Asia/Pacific	318.9	665.5	1 405	7.6	7.0	17.9	23.9	30.4
International	223.7	462.3	1 025	7.5	7.5	27.2	28.6	34.6
Domestic	95.2	203.2	380	7.9	6.0	10.0	17.3	22.9
Europe	546.2	743.0	1 240	3.1	4.5	30.7	26.7	26.8
International	284.7	622.8	1 070	8.1	5.0	34.6	38.6	36.2
Domestic	261.5	120.2	170	-7.5	3.0	27.3	10.2	10.2
Middle East	47.8	79.1	130	5.2	4.5	2.7	2.8	2.8
International	39.5	67.7	115	5.5	5.0	4.8	4.2	3.9
Domestic	8.3	11.4	15	3.2	2.5	0.9	1.0	0.9
North America	741.8	1 104.9	1 520	4.1	3.0	41.7	39.6	32.9
International	195.2	327.7	520	5.3	4.5	23.7	20.3	17.6
Domestic	546.6	777.2	1 000	3.6	2.5	57.1	66.2	60.3
Latin America and Caribbean	83.5	134.5	225	4.9	5.0	4.7	4.8	4.9
International	47.5	81.0	140	5.5	5.0	5.8	5.0	4.7
Domestic	36.0	53.5	85	4.0	4.5	3.8	4.6	5.1
World	1 779.0	2 787.9	4 620	4.6	4.5	100.0	100.0	100.0
International	822.4	1 614.0	2 960	7.0	5.5	100.0	100.0	100.0
Domestic	956.6	1 173.9	1 660	2.1	3.0	100.0	100.0	100.0

\* Rounded to the nearest 0.5 percentage point.

region are expected to continue to show the highest growth in passenger traffic, at 7.0 per cent per annum through to the year 2010, while the airlines of North America show the lowest growth, around 3.0 per cent per annum. Traffic of airlines of the Latin America/Caribbean region is expected to grow just above the world average, at 5.0 per cent per annum, whereas traffic of the African, European and Middle East airlines is expected to increase at about the world average, at 4.5 per cent per annum.

13. 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 scheduled passenger traffic by about 6.5 percentage points to 30.4 per cent of total world traffic by the year 2010, with their share of total international scheduled passenger traffic increasing to over 34 per cent.

14. The other significant change in regional shares is expected to occur in North America, whose airlines' share is anticipated to decline by about 6.7 percentage points to 32.9 per cent by the year 2010. The shares of airlines of other regions are anticipated to remain almost unchanged.

### PASSENGER FORECASTS FOR INTERCONTINENTAL ROUTE GROUPS

15. The forecasts of the number of passengers carried on scheduled services in nine intercontinental route groups, accounting for almost 44 per cent of international passengers in 1999, are presented in Table 5-3. Forecast growth rates for the 1999–2010 period are somewhat lower than during the 1989–1999 period. Traffic across the North Atlantic benefited from a stimulating competitive environment during the 1990s, growing strongly despite the relative maturity of the market. The first decade of the new millennium should see a more moderate growth in this market. The North America-South America and North America-Central America/Caribbean route groups are expected to grow at the highest rates of all those identified in Table 5-3, with average annual growth rates of 7.0 per cent each. The growth in air travel demand in these markets is supported by competitive services and by growth in leisure travel.

16. Having experienced a decrease in traffic in 1998, the transpacific market recovered in 1999 and is expected to grow at an average rate of 6.5 per cent per annum over the period up to the year 2010. The same growth rate is projected for the Europe-Asia/Pacific route group.

17. The remaining route groups shown in Table 5-3 are smaller in terms of passenger numbers. Their growth rates up to the year 2010 are projected to range from a high of 6.0 per cent for the Mid-Atlantic and South Atlantic to a low of 4.0 per cent for the Europe-Middle East route group. The performance of the latter is particularly affected by political factors and economic conditions linked to trends in the world price of crude oil.

**Table 5-3. Forecasts of international scheduled passenger traffic  
by international route group**

INTERNATIONAL SCHEDULED SERVICES	Passengers carried (thousands)			Average annual growth rate (per cent)	
	Actual 1989	Actual 1999	Forecast 2010	1989–1999	1999–2010*
North Atlantic	32 200	64 900	108 000	7.3	4.5
Mid-Atlantic	1 817	3 223	6 120	5.9	6.0
South Atlantic	1 785	3 227	6 000	6.1	6.0
Transpacific	14 729	27 688	54 400	6.5	6.5
Between Europe and Asia/Pacific	18 599	44 027	88 000	9.0	6.5
Between Europe and Africa	12 138	19 213	30 530	4.7	4.5
Between Europe and Middle East	8 463	11 938	18 100	3.5	4.0
Between North America and South America	3 522	9 559	19 710	10.5	7.0
Between North America and Central America/Caribbean	20 577	33 519	70 960	5.0	7.0
Total above routes	113 830	217 294	401 820	6.7	5.5
Other routes	148 112	271 596	438 180	6.3	4.5
Total world	261 942	488 890	840 000	6.4	5.0

\* Rounded to the nearest 0.5 percentage point.

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

### GLOBAL FREIGHT FORECASTS

18. The econometric analysis, together with the assumptions mentioned earlier, resulted in a “most likely” projected growth rate of 6.0 per cent per annum for world scheduled freight tonne-kilometres for the period 1999-2010. This is slightly lower than the 6.6 per cent per annum for the 1989–1999 period. Alternative assumptions concerning the underlying factors affecting air freight suggest a band of forecast growth rates ranging from a “low” of 4.0 per cent per annum to a “high” of 8.0 per cent per annum as illustrated in Figure 5-2.

19. 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

20. 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 is expected to remain the fastest-growing region, although its forecast rate is somewhat slower than the growth rate for the 1989–1999 period.

21. By the year 2010, airlines of the Asia/Pacific region are expected to increase their share of air freight traffic by 6.3 percentage points to over 41 per cent of total world freight, a share well above that of any other region.

### SUMMARY OF AIR TRAFFIC FORECASTS BY OTHER ORGANIZATIONS

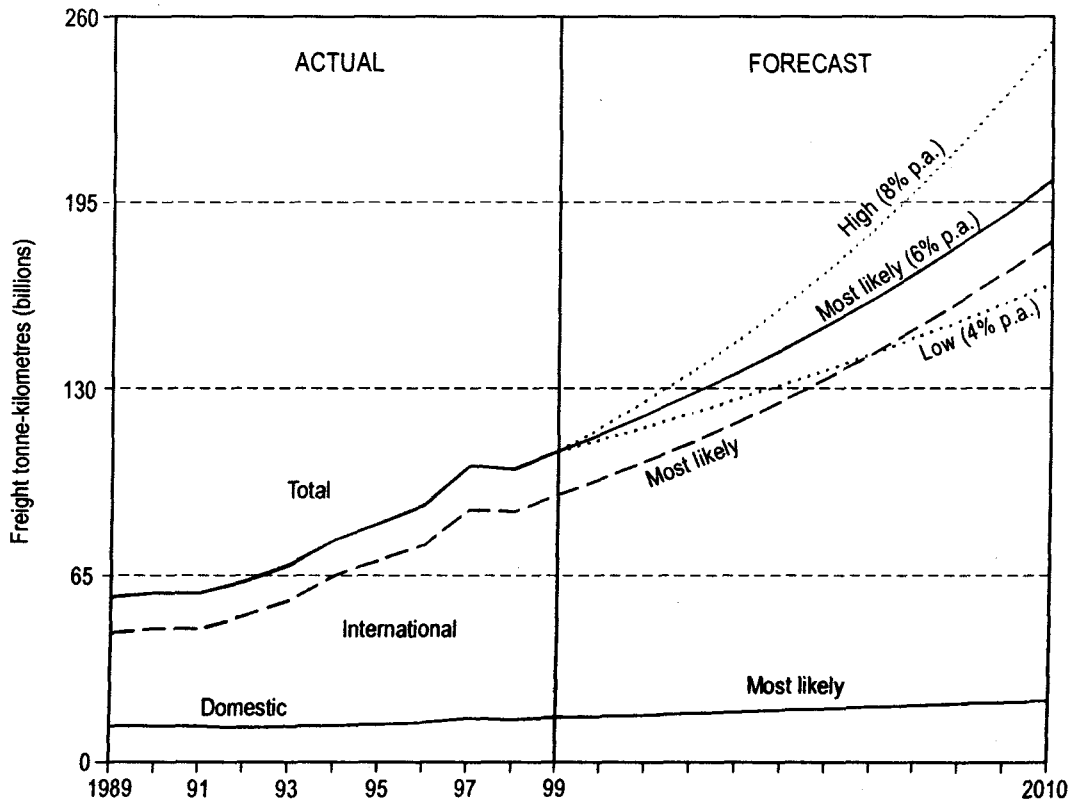
22. Some recent long-term forecasts by major airframe and engine manufacturers of growth in world scheduled traffic are given in Table 5-6. These forecast growth rates are in the range of 4.4 to 5.6 per cent per annum for passenger-kilometres, with freight tonne-kilometres generally forecast to grow at a slightly higher rate.

23. Separate forecasts (medium-term only) for the number of passenger and freight tonnes carried on international routes by member airlines are regularly prepared by the International Air Transport Association (IATA). The most recent forecast, covering the 1999–2003 period, indicates an average growth of 5.0 per cent per annum for international passengers.

**Table 5-4. Summary of ICAO scheduled freight traffic forecast to the year 2010**  
(ICAO Contracting States)

	Actual 1989	Actual 1999	Forecast 2010	Average annual growth rate (per cent)	
				1989-1999	1999-2010*
<b>Freight tonne-kilometres (millions)</b>					
Scheduled services	57 214	108 043	202 650	6.6	6.0
International	44 925	92 680	181 480	7.5	6.5
Domestic	12 289	15 363	21 170	2.3	3.0
<b>Freight tonnes carried (thousands)</b>					
Scheduled services	18 088	28 201	44 500	4.5	4.0
International	8 635	17 160	31 000	7.1	5.5
Domestic	9 453	11 041	13 500	1.6	2.0

\* Rounded to the nearest 0.5 percentage point.



**Figure 5-2. Trends in world scheduled freight traffic**  
(ICAO Contracting States)

**Table 5-5. Forecasts of scheduled freight traffic by region**  
(region of airline registration, ICAO Contracting States)

	Freight tonne-kilometres (millions)			Average annual growth rate (per cent)		Regional share of world traffic (per cent)		
	Actual 1989	Actual 1999	Forecast 2010	1989- 1999	1999- 2010*	1989	1999	2010
Africa	1 176	1 969	3 440	5.3	5.0	2.1	1.8	1.7
International	1 067	1 910	3 370	6.0	5.5	2.4	2.0	1.9
Domestic	109	59	70	-6.0	1.5	0.9	0.4	0.3
Asia/Pacific	15 634	37 564	83 000	9.2	7.5	27.3	34.7	41.0
International	14 306	34 550	77 300	9.2	7.5	31.9	37.3	42.6
Domestic	1 328	3 014	5 700	8.5	6.0	10.8	19.6	26.9
Europe	19 246	31 193	52 120	4.9	4.5	33.6	28.9	25.7
International	16 545	30 430	51 200	6.3	5.0	36.8	32.8	28.2
Domestic	2 701	763	920	-11.9	1.5	22.0	5.0	4.4
Middle East	2 570	4 068	6 140	4.7	4.0	4.5	3.8	3.0
International	2 481	3 970	6 010	4.8	4.0	5.5	4.3	3.3
Domestic	89	98	130	1.1	2.5	0.7	0.6	0.6
North America	15 962	29 028	51 000	6.2	5.0	27.9	26.9	25.2
International	8 496	18 320	37 600	8.0	6.5	18.9	19.8	20.7
Domestic	7 466	10 708	13 400	3.7	2.0	60.8	69.7	63.3
Latin America and Caribbean	2 626	4 221	6 950	4.9	4.5	4.6	3.9	3.4
International	2 030	3 500	6 000	5.6	5.0	4.5	3.8	3.3
Domestic	596	721	950	1.9	2.5	4.8	4.7	4.5
World	57 214	108 043	202 650	6.6	6.0	100.0	100.0	100.0
International	44 925	92 680	181 480	7.5	6.5	100.0	100.0	100.0
Domestic	12 289	15 363	21 170	2.3	3.0	100.0	100.0	100.0

\* Rounded to the nearest 0.5 percentage point.

**Table 5-6. Available forecasts by manufacturers of world scheduled traffic growth  
(average annual growth rates)**

Source of forecast	Forecast period	Passenger-kilometres (per cent)	Freight tonne-kilometres (per cent)
Airbus Industrie	1999–2009	5.2	6.1
	2009–2019	4.6	5.3
Boeing	1999–2009	4.7	–
	2009–2019	4.8	–
Rolls-Royce	1999–2009	5.6	7.2
	2009–2019	4.4	5.7

*Sources:*

- Airbus Industrie, "Global Market Forecast", 2000
- Boeing Commercial Airplanes, "Current Market Outlook into the New Century", 2000
- Rolls-Royce, "The Outlook", 2000

## **Chapter 6**

# **FORECASTS OF AIRCRAFT MOVEMENTS TO THE YEAR 2010**

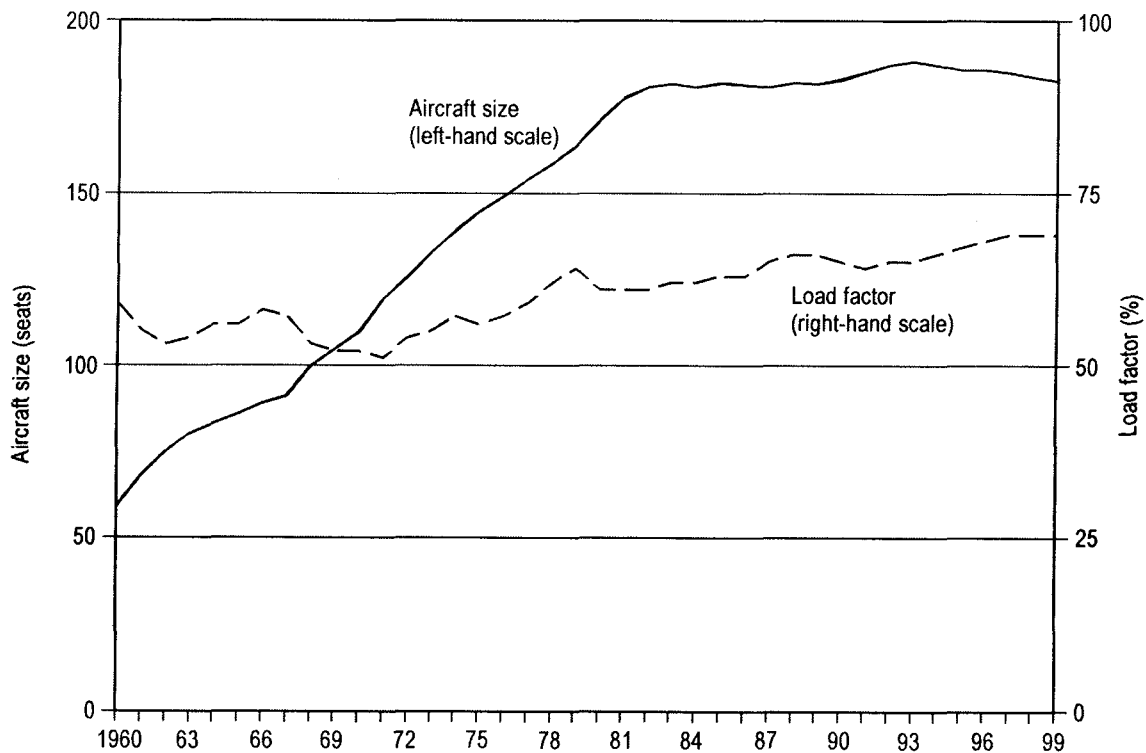
### **FACTORS AFFECTING AIRCRAFT MOVEMENTS**

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 quite rapidly for most of the past decade, increasing the pressure on airport and air traffic control facilities.
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. From the early 1980s, the trend in average aircraft size has levelled out and the growth rate in aircraft movements has approached the growth rate for passenger traffic. 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. Nevertheless, it is expected that the world average scheduled passenger load factor, which increased from 66 per cent in 1989 to 69 per cent in 1999, will rise to about 71 per cent by 2010.
5. The services provided by carriers to meet demand result from a large number of decisions concerning network structure, aircraft type 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 air services within the European Union, and 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, became important competitive tools. A more liberal regulatory environment 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 contrast, the new aircraft of the 1980s, such as the B-757, B-767, MD-80 and A-310, were in the mid-size bracket. The economics of fleet replacement and expansion, therefore, encouraged a much smaller change in the average aircraft size during the 1980s than during the 1970s.

8. The North Atlantic is an example of a route group where in recent years regulatory developments and the characteristics of new aircraft types have encouraged the deployment of smaller aircraft. For example, extended range B-767 aircraft were able to service some secondary markets with direct transatlantic service after 1984. This resulted in a proliferation of direct transatlantic services between North America and Europe. The transpacific market also experienced an increase in the number of city-pairs with direct services, but the penetration of B-767 services was more limited than on the North Atlantic, with a correspondingly reduced impact on the trend.



Source: ICAO Reporting Form A-1.

Note: Excluding all-freight operations.

Excluding the Commonwealth of Independent States (CIS).

**Figure 6-1. Average aircraft size and load factor**  
(passenger aircraft on scheduled services)

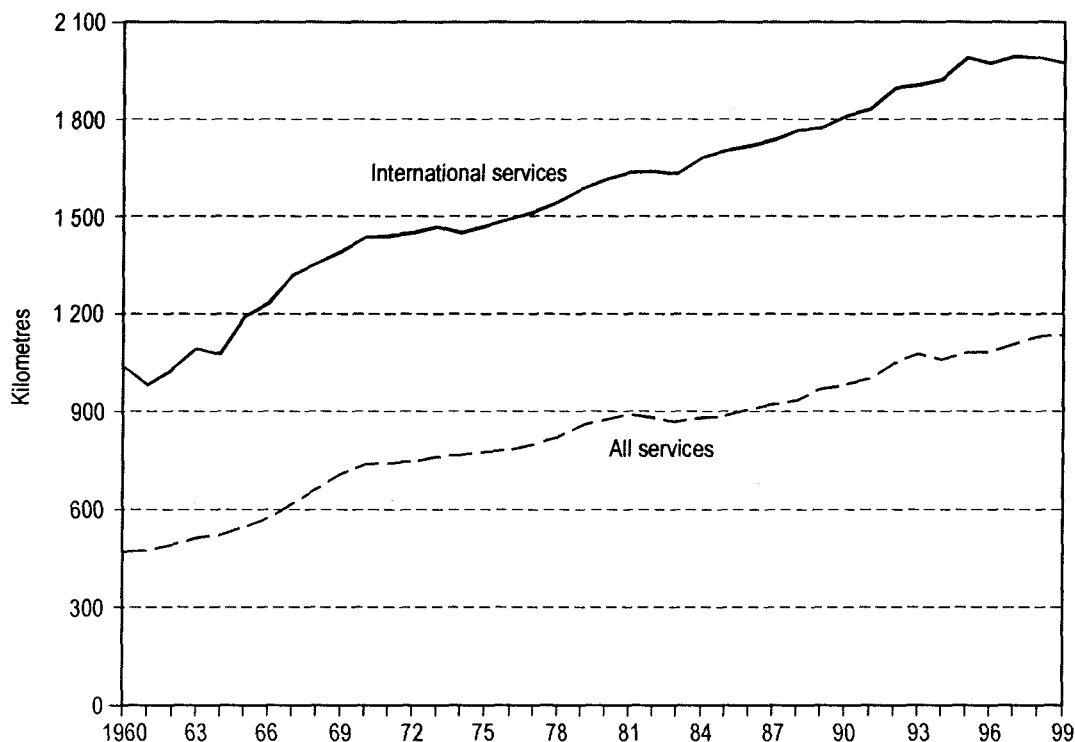


9. The regulatory and technological factors described above are likely to continue. However, the more liberal regulatory environment and competitive forces are encouraging consolidation and alliances among airlines which might eventually reduce the pressure to increase flight frequency at the expense of aircraft size. The buildup of airport and airspace congestion over the next decade is another factor that would favour larger aircraft, evident from the possible introduction of aircraft such as the 747 stretch and the A3XX. It is assumed that the world average aircraft size will increase to about 200 seats by 2010 compared with 182 seats in 1999.

### 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 4 to 5 per cent per annum faster than aircraft departures. In the past 20 years, the growth in average stage length has been around 1 or 2 per cent



Source: ICAO Reporting Form A-1.

Note: Excluding the Commonwealth of Independent States (CIS).

**Figure 6-2. Average aircraft stage length  
(scheduled services)**

per annum. 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. This was especially important in the 1960s with the introduction of jet aircraft. Over the forecast period (1999 to 2010), the average stage length is assumed to grow at about 1.2 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 4 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 1999-2010 are given below:

- a) a growth in passenger-kilometres of 4.8 per cent per annum;
- b) an increase in average load factor from 69 to 71 per cent;
- c) a growth in average passenger aircraft size (in terms of seats) of 0.8 per cent per annum;
- d) a growth in average aircraft stage length of 1.2 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 led to forecast average world annual growth rates of 3.7 per cent for aircraft-kilometres and 2.5 per cent for aircraft departures over the period 1999 to 2010.

15. The growth rate for aircraft kilometres is below the growth rate for passenger-kilometres by 1.1 percentage point per annum because of the increases in load factor and aircraft size. Growth in aircraft departures is below the growth in aircraft-kilometres by 1.2 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 1989 and 1999 was relatively buoyant when compared with the growth between 1979 and 1989. This was a consequence of higher traffic growth and slower growth in average aircraft size.

17. In Chapter 2 it was noted that traffic growth in the 1980s placed increasing demands on the aviation infrastructure. Although there was an easing of demand pressures in the early 1990s, the forecasts imply an increase of about 49 per cent in aircraft-kilometres and 31 per cent in aircraft departures between 1999 and 2010. In absolute terms, the increase in aircraft kilometres between 1999 and 2010 is expected to be some 11.2 billion compared with 9.5 billion that occurred between 1989 and 1999. The absolute increase in aircraft departures is forecast to be about 6.2 million between 1999 and 2010 compared with 6.3 million between 1989 and 1999. 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 scheduled aircraft movements<sup>1</sup>  
forecast to the year 2010**

	Actual 1979	Actual 1989	Actual 1999	Forecast 2010	Average annual growth rate (per cent)		
					1979-1989	1989-1999	1999-2010
Aircraft-kilometres (millions)	9 147	13 493	22 950	34 100	4.0	5.5	3.7
Aircraft departures (thousands)	10 666	13 945	20 220	26 400	2.7	3.8	2.5

1. Includes all-freight movements; excludes operations of aircraft registered in Member States of the Commonwealth of Independent States (CIS).

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# Appendix 1

## ECONOMETRIC MODELS OF DEMAND FOR WORLD SCHEDULED AIR TRAFFIC

The basic models form assumed was:

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

For the model of passenger traffic:

$y$  = passenger-kilometres performed (PKP)

$x_1$  = 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 (FTK)

$x_1$  = 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 39 years, but excluding the Commonwealth of Independent States (CIS). ICAO and the International Monetary Fund (IMF) were the sources of the airline and general economic data, respectively, used in the models.

Estimated passenger model:

$$\ln \text{PKP} = 0.017 + 2.19 \ln \text{GDP} - 0.50 \ln \text{PYIELD} \quad R^2 = 0.999$$

(31.8)                      (6.5)

Estimated freight model:

$$\ln \text{FTK} = -0.27 + 1.57 \ln \text{EXP} - 0.39 \ln \text{FYIELD} \quad R^2 = 0.996$$

(21.4)                      (5.9)

The figures in brackets are the "t" statistics of the corresponding coefficient estimates.

## 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:

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

The forecast for aircraft-kilometres for scheduled passenger aircraft in the year 2010 was generated by substituting into this expression the assumptions for passenger-kilometres, average load factor and average aircraft size in the year 2010 (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 1999 to 2010 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:

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

The forecast for aircraft departures in the year 2010 was generated by substituting into this expression the forecast for aircraft-kilometres and the assumption for average stage length in the year 2010.

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. 1999 to 2010).

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 historic 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. Contributions to the growth in world aircraft movements**

	Actual 1979	Actual 1989	Actual 1999	Forecast 2010	Average annual growth rate (per cent)		
					1979–1989	1989–1999	1999–2010
Passenger-kilometres (billions)	910	1 547	2 733	4 560	5.4	5.9	4.8
Passenger load factor (%)	64	66	69	71	0.3	0.4	0.3
Passenger aircraft size (seats)	163	181	182	187	1.1	0.1	0.2
Aircraft stage length (km)	858	968	1 135	1 292	1.2	1.6	1.2
Aircraft-kilometres (millions)	9 147	13 493	22 950	34 100	4.0	5.5	3.7
Aircraft departures (thousands)	10 666	13 945	20 220	26 400	2.7	3.8	2.5

— END —

## **ICAO PUBLICATIONS IN THE AIR TRANSPORT FIELD**

The following summary gives the status and also describes in general terms the contents of the various series of publications in the air transport field issued by the International Civil Aviation Organization:

**International Standards and Recommended Practices on Facilitation** (*designated as Annex 9 to the Convention*) which are adopted by the Council in accordance with Articles 37, 54 and 90 of the Convention on International Civil Aviation. The uniform observance of the specifications contained in the International Standards on Facilitation is recognized as practicable and as necessary to facilitate and improve some aspect of international air navigation, while the observance of any specification contained in the Recommended Practices is recognized as generally practicable and as highly desirable to facilitate and improve some aspect of international air navigation. Any differences between the national regulations and practices of a State and those established by an International Standard must be notified to the Council in accordance with Article 38 of the Convention. The Council has also invited Contracting States to notify differences from the provisions of the Recommended Practices;

**Council Statements** on policy relating to air transport questions, such as charges for airports and air navigation services, taxation and aims in the field of facilitation;

**Digests of Statistics** which are issued on a regular basis, presenting the statistical information received from Contracting States on their civil aviation activities;

**Circulars** providing specialized information of interest to Contracting States. They include studies on trends in the air transport industry at a global and regional level and specialized studies of a worldwide nature;

**Manuals** providing information or guidance to Contracting States on such questions as airport and air navigation facility tariffs, air traffic forecasting techniques and air transport statistics.

Also of interest to Contracting States are reports of meetings in the air transport field, such as sessions of the Facilitation Division and the Statistics Division and conferences on the economics of airports and air navigation facilities. Supplements to these reports are issued, indicating the action taken by the Council on the meeting recommendations, many of which are addressed to Contracting States.

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6/01, E/P1/1600

Order No. CIR 281  
Printed in ICAO