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## OUTLOOK FOR AIR TRANSPORT TO THE YEAR 2003

*Approved by the Secretary General  
and published under his authority*

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# FOREWORD

## Introduction

1. This circular is the second in a new series to be issued biennially or triennially (the previous edition — *Outlook for Air Transport to the Year 2001* — 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 2003. In addition, it includes passenger traffic forecasts for international route groups and global forecasts of aircraft movements, again through to the year 2003. In recognition of the 50th anniversary of the signing of the Convention on International Civil Aviation in December 1944, a 50-year summary of the performance of the air transport industry is included on this occasion as an introduction to the chapter on trends and challenges.

## Sources of information

2. In addition to the ICAO Digests of Statistics, use has been made of many of the Organization's economic studies, such as earlier forecast publications, the study on the *Economic Implications of Future Noise Restrictions on Subsonic Jet Aircraft* (Circular 218), the study on *Investment Requirements for Aircraft Fleets and for Airport and Route Facility Infrastructure to the Year 2010* (Circular 236) and a former series of regional studies dealing with the development of international air freight and air passenger transport. Use has also been made of the Annual Reports of the Council to the Assembly for the years 1981 to 1992.

3. 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).

4. 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

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

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# Table of Contents

<b>Chapter 1. Summary</b> .....	<b>1</b>
<b>Chapter 2. Air Transport Trends and Challenges</b> .....	<b>5</b>
Economic growth and airline traffic patterns .....	6
Scheduled passenger, freight and mail traffic .....	8
Scheduled international and domestic traffic .....	9
Scheduled international traffic by region .....	9
Non-scheduled traffic .....	9
Aircraft movements .....	12
Fleet composition and productivity .....	13
Relationship between productivity, prices and financial performance .....	17
Safety and quality of service .....	17
Airport and airspace congestion .....	19
Environmental protection .....	19
Financial resources .....	20
Economic regulation .....	21
Industry structure .....	22
<b>Chapter 3. World Economic Environment</b> .....	<b>24</b>
Historical trends .....	24
Outlook .....	24
<b>Chapter 4. Airline Financial Trends</b> .....	<b>26</b>
Operating revenues, expenses and results .....	26
Distribution of revenues and operating expenses .....	27
Regional trends in revenues and expenses .....	32
Yields and unit costs .....	33
Outlook .....	34
<b>Chapter 5. Forecasts of Airline Traffic to the Year 2003</b> .....	<b>36</b>
Forecasting methodology .....	36
Main assumptions and econometric models .....	36
Global passenger forecasts .....	37
Regional passenger forecasts .....	39
Passenger forecasts for intercontinental route groups .....	40
Global freight forecasts .....	41
Regional freight forecasts .....	42
Summary of air traffic forecasts by other organizations .....	43

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<b>Chapter 6. Forecasts of Aircraft Movements to the Year 2003</b> .....	<b>45</b>
Factors affecting aircraft movements .....	45
Measures of aircraft movements .....	47
Forecasting methodology .....	47
Forecasts of world scheduled aircraft movements .....	48
<b>Appendix 1. Econometric Models of Demand for World Scheduled Air Traffic</b> .....	<b>51</b>
<b>Appendix 2. Model for Aircraft Movement Forecasts</b> .....	<b>53</b>

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## **Chapter 1**

### **SUMMARY**

1. During the period 1960-1992, the aggregate economic activities of the world measured by Gross Domestic Product (GDP) increased at an average annual rate of 3.7 per cent in real terms. The average annual growth rates for the periods 1960-1970, 1970-1980 and 1980-1992 were 4.8, 3.6 and 2.4 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 9.4 per cent for the 1960-1992 period. For the periods 1960-1970, 1970-1980 and 1980-1992, traffic grew at an average annual rate of 13.4, 9.0 and 5.0 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 11.3 per cent over the 1960-1992 period. For the periods 1960-1970, 1970-1980 and 1980-1992, freight traffic grew at an average annual rate of 17.8, 10.9 and 6.4 per cent, respectively.
4. The growth in passenger and freight traffic demand over the 1960-1992 period resulted in comparable growth in terms of aircraft seats and payload, while aircraft movements measured in terms of aircraft-kilometres grew at a much slower rate (2.7 per cent per annum) due primarily to a large increase in average aircraft size during this period.
5. During the period 1960-1992, average world passenger yield measured in real terms (expressed in U.S. cents per PKP) declined at a rate of 2.1 per cent per annum. Freight and mail yield measured in real terms (expressed in U.S. cents per TKP) decreased at a rate of 3.5 per cent per annum. During the same period, unit costs (operating cost per available tonne-kilometres, ATKs) measured in real terms declined at an average annual rate of 2.2 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). However, this growth will also be influenced 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 1992-2003, world economic growth (GDP) is expected to increase at an average annual rate of 2.8 per cent in real terms. Airline yields are expected to remain constant for the first five years of the forecast period and increase at an average annual rate of 0.5 per cent in real terms for the following five years, without as much ability as in the past to offset upward pressures on costs through productivity increases alone.

8. World scheduled traffic measured in terms of passenger-kilometres performed is forecast to increase at a "most likely" average annual rate of 5 per cent for the period 1992-2003. International traffic is expected to increase at 6.5 per cent per annum, while domestic traffic is expected to increase at an average annual rate of 4 per cent.
9. The airlines of the Asia/Pacific Region are expected to show the highest growth in passenger traffic at 8.5 per cent per annum through to year 2003, while the airlines of Africa, Europe and Latin America are expected to show growth rates below the world average, around 3.5 to 4 per cent per annum. Airlines of North America are expected to show growth at about the world average, while the airlines of the Middle East are expected to show a traffic increase of almost 6 per cent per annum.
10. Forecasts of the number of passengers carried on scheduled services in nine intercontinental route groups show the transpacific and the Europe-Asia markets as the fastest growing, at 8 and 7.5 per cent per annum, respectively, for the forecast period through to the year 2003.
11. World scheduled freight traffic measured in terms of tonne-kilometres performed is forecast to increase at a "most likely" average annual rate of 6.5 per cent for the period 1992-2003. International freight traffic is expected to increase at an average annual growth rate of 7.0 per cent compared with a domestic freight traffic growth of 3.5 per cent per annum. The regional pattern of growth is expected to be similar to that of passenger traffic. Traffic of airlines in the Asia/Pacific Region is expected to remain the fastest growing (at 10 per cent per annum).
12. Aircraft movements in terms of aircraft departures and aircraft kilometres flown for the period 1992-2003 are expected to increase at average annual growth rates of 2 and 3 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 2003 (world-wide)**

	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	Average annual growth rate (per cent)	
					1982-1992	1992-2003*
<b>TOTAL SCHEDULED SERVICES</b>						
Passenger-kilometres (billions)	1 137	1 953	1 971	3 425	5.6	5.0
Freight tonne-kilometres (millions)	31 235	62 050	67 650	124 860	7.1	6.5
Passengers carried (millions)	759	1 167	1 171	1 835	4.4	4.0
Freight tonnes carried (thousands)	11 568	17 318	17 544	26 700	4.1	4.0
Aircraft-kilometres (millions) <sup>†</sup>	9 140	15 421	15 990	21 200	5.4	3.0
Aircraft departures (thousands) <sup>†</sup>	10 379	14 693	15 130	18 100	3.5	2.0
<b>INTERNATIONAL SCHEDULED SERVICES</b>						
Passenger-kilometres (billions)	497	980	1 046	1 960	7.0	6.5
Freight tonne-kilometres (millions)	22 623	50 060	55 660	107 520	8.3	7.0
Passengers carried (millions)	170	300	320	524	5.8	5.0
Freight tonnes carried (thousands)	4 727	9 105	10 031	16 100	6.8	5.5

\* Rounded to the nearest 0.5 percentage point.

<sup>†</sup> Excludes the Commonwealth of Independent States (CIS).



**Table 1-2. Summary of ICAO air traffic forecasts for the year 2003**  
(by region of airline registration)

	Actual	Actual	Estimate	Forecast	Average annual growth rate (per cent)	
	1982	1992	1993	2003	1982-1992	1992-2003*
<b>TOTAL SCHEDULED SERVICES</b>						
Passenger-kilometres (billions)						
Africa	33.7	44.0	41.7	65	2.7	3.5
Asia/Pacific	186.8	406.7	452.9	980	8.1	8.5
Europe	381.3	551.7	507.6	800	3.8	3.5
Middle East	33.2	53.1	58.4	100	4.8	6.0
North America	441.5	806.4	816.2	1 340	6.2	4.5
Latin America and Caribbean	60.3	90.7	94.0	140	4.2	4.0
Freight tonne-kilometres (millions)						
Africa	977	1 199	1 242	1 810	2.1	4.0
Asia/Pacific	6 792	18 430	22 083	49 000	10.2	9.5
Europe	11 158	19 825	20 298	35 100	5.9	5.5
Middle East	1 553	2 653	2 942	4 650	5.5	5.0
North America	8 719	16 868	17 674	28 900	6.8	5.0
Latin America and Caribbean	1 856	3 075	3 411	5 400	5.2	5.5
<b>INTERNATIONAL SCHEDULED SERVICES</b>						
Passenger-kilometres (billions)						
Africa	25.8	36.6	34.6	55	3.6	4.0
Asia/Pacific	128.4	272.2	300.9	673	7.8	8.5
Europe	186.9	331.1	353.5	580	5.9	5.0
Middle East	26.2	44.8	49.0	88	5.5	6.5
North America	97.6	238.8	248.8	464	9.4	6.0
Latin America and Caribbean	31.6	55.9	58.8	100	5.9	5.5
Freight tonne-kilometres (millions)						
Africa	897	1 131	1 167	1 720	2.3	4.0
Asia/Pacific	6 225	16 782	20 318	45 200	10.4	9.5
Europe	8 671	17 941	18 793	33 200	7.5	6.0
Middle East	1 493	2 591	2 867	4 550	5.7	5.5
North America	3 973	9 114	9 749	18 200	8.7	6.5
Latin America and Caribbean	1 364	2 501	2 766	4 650	6.3	6.0

\* Rounded to the nearest 0.5 percentage point.

**Table 1-3. Summary of ICAO air traffic forecasts for the year 2003**  
(by international route group)

	Passengers carried (thousands)				Average annual growth rate (per cent)	
	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	1982-1992	1992-2003*
North Atlantic	16 345	35 425	34 260	60 589	8.0	5.0
Mid Atlantic	1 444	2 350	2 364	4 019	5.0	5.0
South Atlantic	1 065	2 130	2 674	3 643	7.2	5.0
Trans-Pacific	7 083	16 154	16 978	37 665	8.6	8.0
Between Europe and Asia/Pacific	5 018	14 738	16 290	32 654	11.4	7.5
Between Europe and Africa	8 568	9 399	10 289	13 010	0.9	3.0
Between Europe and Middle East	3 336	6 485	5 080	9 467	6.9	3.5
Between North America and South America	2 420	5 249	5 301	8 978	8.1	5.0
Between North America and Central America/Caribbean	9 970	15 219	15 436	24 698	4.3	4.5
Total above routes	55 249	107 149	108 672	194 723	6.6	5.5
Other routes	114 578	193 087	211 662	329 577	5.4	5.0
Total world	169 827	300 236	320 334	524 300	5.8	5.0

\* Rounded to the nearest 0.5 percentage point.

## Chapter 2

# AIR TRANSPORT TRENDS AND CHALLENGES

1. Fifty years ago, air transport was a very small industry. Air travel was expensive and restricted to a very small segment of the population. Air freight was in its infancy. Since then, the output of the industry has multiplied many times over as a result of increasing demand for passenger and freight services, combined with rapid technological development and associated investment. The result is an industry which today plays an important role in the world economy.
2. In 1945, nine million passengers travelled on commercial air services. This represented less than one-half of one per cent of the world's population at that time. In 1993, almost 1.2 billion passengers were carried on scheduled services, equivalent to approximately 25 per cent of the world's population. The average annual growth rates in passengers carried for the periods 1945-1955, 1955-1965, 1965-1975, 1975-1985 and 1985-1993 are 22.4, 10.0, 9.4, 6.1 and 4.4 per cent, respectively, as depicted in Figure 2-1. This is equivalent to an average annual growth rate of 10.5 per cent for the period 1945 to 1993.
3. In the last 50 years, a total of 25 billion passengers — five times the current population of the world — have been carried on scheduled services by civil aircraft.
4. The world's airlines have generated 36 000 billion passenger-kilometres on scheduled services over the last 50 years; this is equivalent to carrying one passenger to the sun and back 120 000 times.
5. Over the last 50 years, 350 million tonnes of freight have been carried by air on scheduled services. This is equivalent to the weight of one million fully loaded Boeing 747-200s.
6. In 1944, a typical airliner, the Douglas DC-3, had 28 seats, flew at 320 kilometres per hour and had a range of 3 400 kilometres. In 1994, a typical Boeing 747 has over 400 seats, flies at approximately 900 kilometres per hour and can have a range of over 11 000 kilometres.
7. Safety in scheduled air services has improved tremendously. In 1947, 590 passengers were killed in 24 fatal aircraft accidents. This translates into 3.12 passenger fatalities per 100 million passenger-kilometres. The safety level has improved steadily since then, to the extent that by 1993, the fatality rate had declined to 0.04 (801 passengers killed in 31 fatal accidents).
8. It is estimated that there are approximately 10 000 aircraft in the air at any given moment. Excluding China and the countries of the former Soviet Union, approximately 380 000 civil aircraft are registered in ICAO States. Of these, 45 000 are used by commercial operators.
9. There are approximately 1 200 scheduled air carriers in the world. The largest international airline is British Airways which in 1993 carried 26 million passengers on 250 aircraft. The largest airline over-all is American Airlines which carried 84 million passengers on 691 aircraft in 1993. One of the world's smallest airlines is Druk Air of Bhutan. In 1993, it carried 9 000 passengers on its two aircraft.

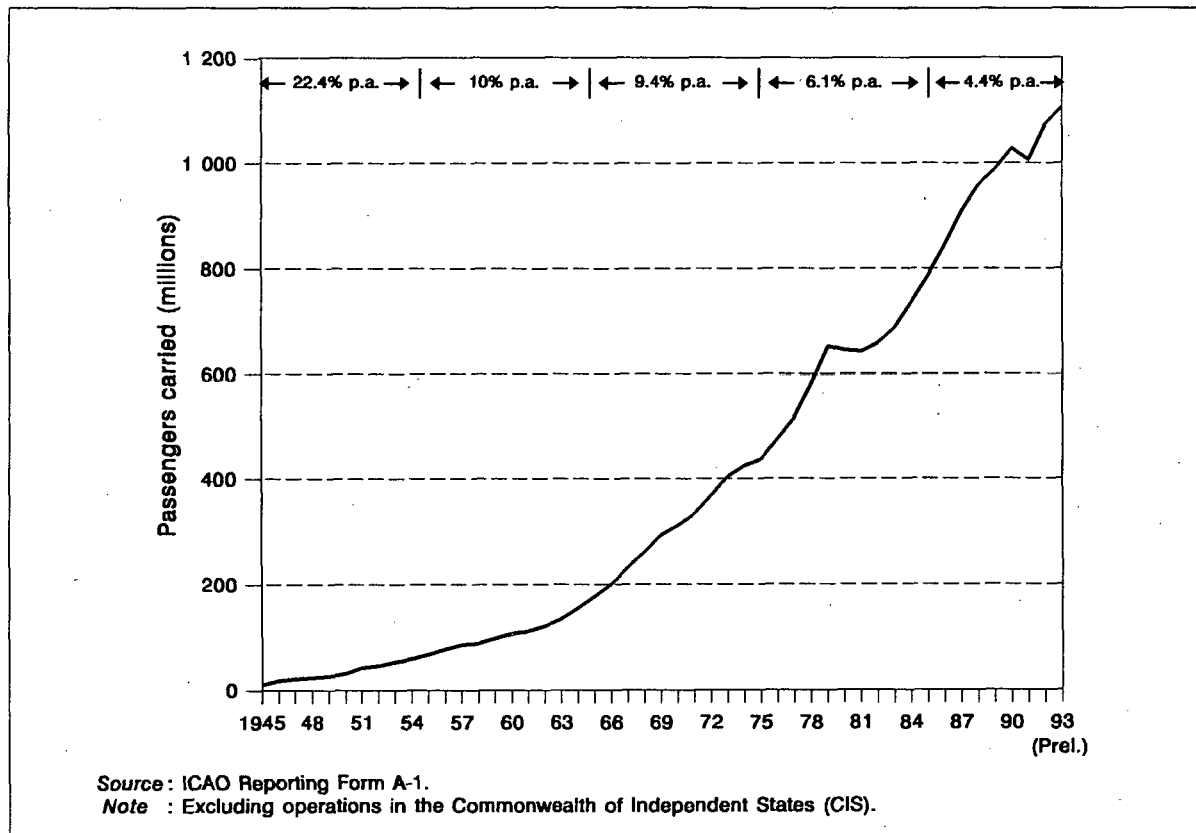


Figure 2-1. Development of world passenger traffic

## ECONOMIC GROWTH AND AIRLINE TRAFFIC PATTERNS

10. The air transport industry has for many years experienced greater growth than most other industries. 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 nearly 20 since 1960 (in terms of tonne-kilometres performed). To put this in perspective, the total world Gross Domestic Product (GDP), which is the broadest available measure of world output, has multiplied by only 3.7 times over the same period.

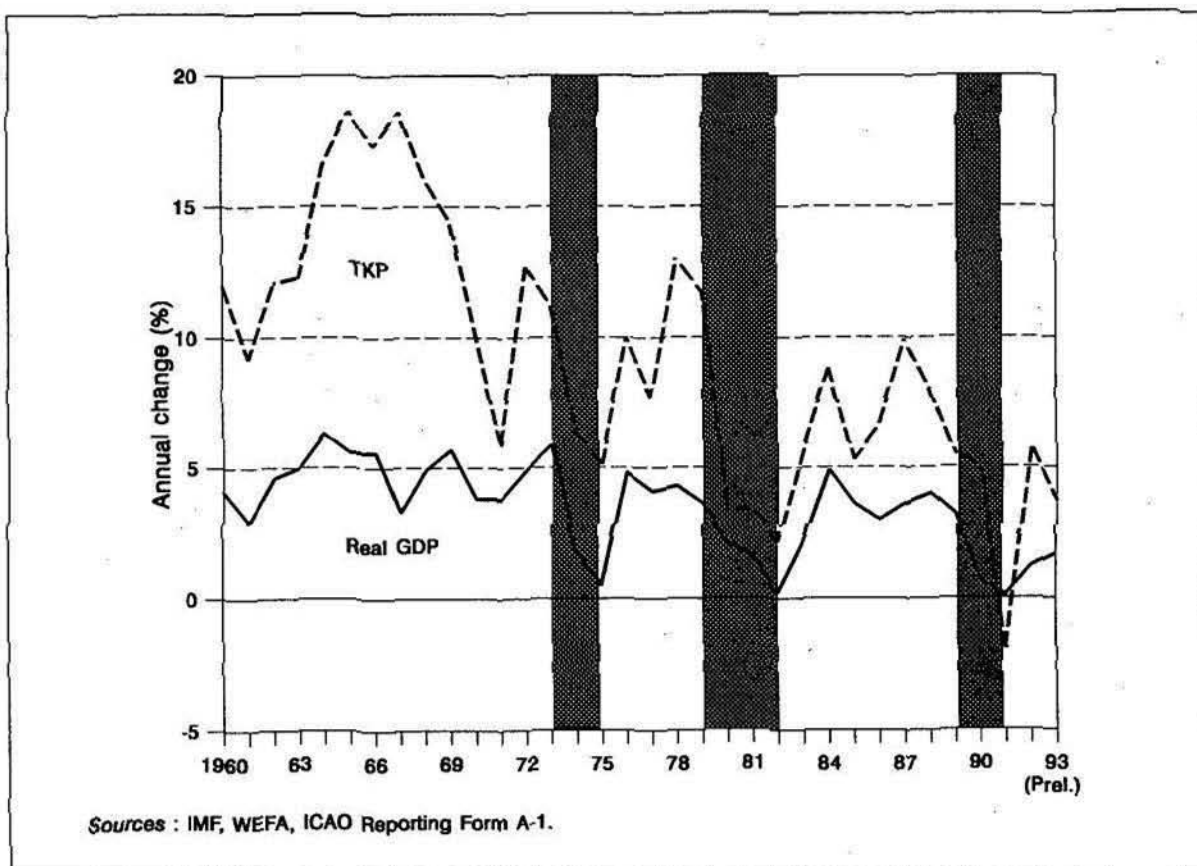
11. While growth in world air traffic has been much greater than world economic growth, economic theory and analytical studies indicate that there is a high correlation between the two and that the demand for air transport is primarily determined by economic development. Developments in personal income 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 air freight. Figure 2-2 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 1991 and their impact on air traffic are clearly visible.

**Table 2-1. Growth of passenger, freight and mail air traffic, 1960 to 1992**

	Average annual growth (per cent)		
	1960-1972	1972-1982	1982-1992
Passenger-kilometres	12.8	7.4	5.4
Freight tonne-kilometres	16.9	7.7	7.1
Mail tonne-kilometres	12.2	3.4	2.8
Total tonne-kilometres	13.7	7.3	5.8

Source: ICAO Reporting Form A-1.

Note— Includes domestic and international scheduled traffic.



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

12. Other factors which 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. Higher oil prices from 1973 have had a restraining effect on traffic demand. In addition to their adverse effect on the world economy, the ten-fold increase in crude oil prices in 1973-74, and a further escalation in 1979-81, greatly increased aviation fuel prices and hence air fares and rates.

### SCHEDULED PASSENGER, FREIGHT AND MAIL TRAFFIC

13. 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 scheduled passenger and freight traffic progressively declined from the 1960s through to the 1980s. The decline in the growth in mail traffic after 1970 was more abrupt, partly because of increasing competition from telecommunications.

14. In 1992, the world's airlines carried 1.2 billion passengers and 17.3 million tonnes of freight on scheduled services. Airlines generated 1 953 billion scheduled passenger-kilometres (equivalent to 177 billion tonne-kilometres), 62 billion scheduled freight tonne-kilometres and 5 billion scheduled mail tonne-kilometres in 1992.

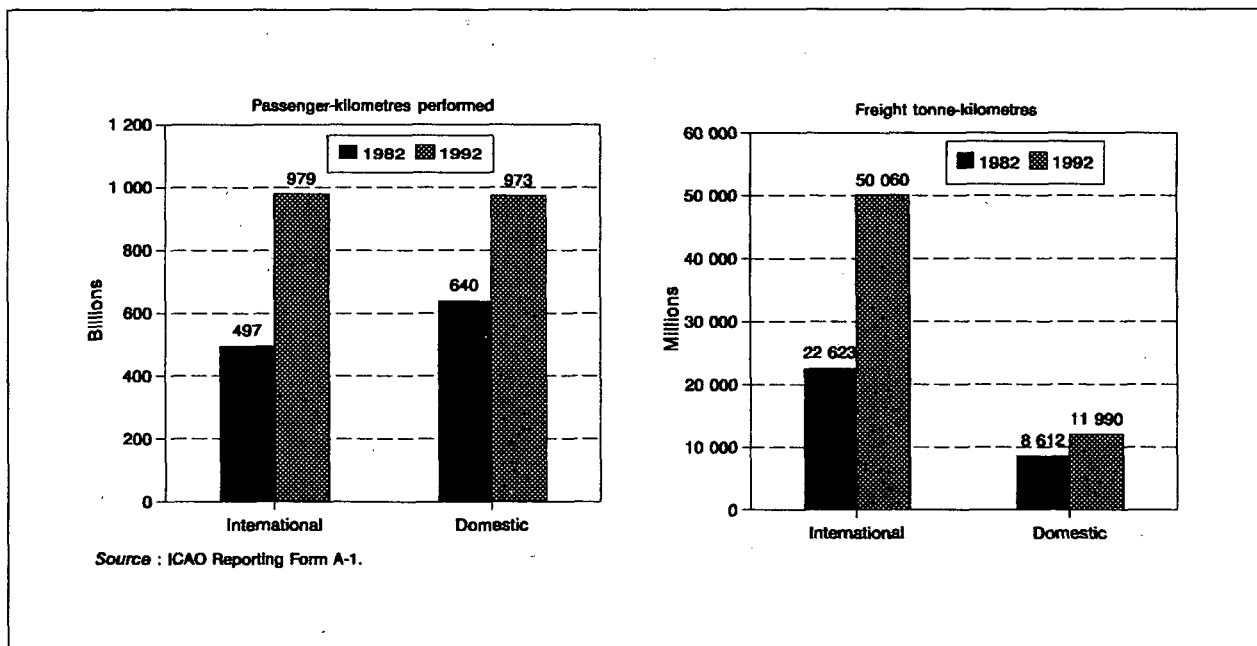


Figure 2-3. Trends in international and domestic traffic  
(scheduled operations, 1982 and 1992)

## SCHEDULED INTERNATIONAL AND DOMESTIC TRAFFIC

15. International traffic has tended to grow more rapidly than domestic traffic, particularly in the case of freight. Figure 2-3 shows the increases over the period 1982 to 1992 in the international and domestic components of both scheduled passenger and scheduled freight traffic. The United States and the Commonwealth of Independent States (CIS) are the dominant producers of domestic air traffic, accounting for 75 per cent of total domestic passenger and freight traffic.

## SCHEDULED INTERNATIONAL TRAFFIC BY REGION

16. Turning to the regional pattern of scheduled international traffic, Figure 2-4 shows the shares of international traffic by region of airline registration in 1982 and 1992. European airlines retain the largest share of both passenger and freight traffic, but their share declined over the period concerned, while the share of Asia/Pacific airlines grew substantially. The shares of Latin American and African airlines each declined.

17. Scheduled passenger traffic trends between 1982 and 1992 on some intercontinental route groups are illustrated in Figure 2-5. The strength of the North Atlantic market, in terms of its size (35 million passengers in 1992) and growth (117 per cent between 1982 and 1992), is clearly illustrated. However, the fastest growing markets were the trans-Pacific and Europe-Asia/Pacific route groups.

## NON-SCHEDULED TRAFFIC

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

19. 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 represents about 15 per cent of the total international passenger traffic. Table 2-2 provides estimates for 1982 and 1992 of non-scheduled passenger traffic carried by non-scheduled carriers and by scheduled carriers. Growth in their combined non-scheduled international traffic was around 5 per cent per annum on average during the 1982 to 1992 period, below the 7 per cent per annum growth rate for scheduled international traffic.

20. Non-scheduled traffic is very important on intra-European routes, where it accounts for 40 to 50 per cent of all passengers and some 60 per cent of all passenger-kilometres performed. Intra-European non-scheduled traffic also accounts for about 60 per cent of the total world charter market in terms of passengers. Non-scheduled traffic is also significant on North Atlantic routes, although it has declined in importance over the past 30 years from more than 30 to less than 10 per cent of the total North Atlantic passenger market.

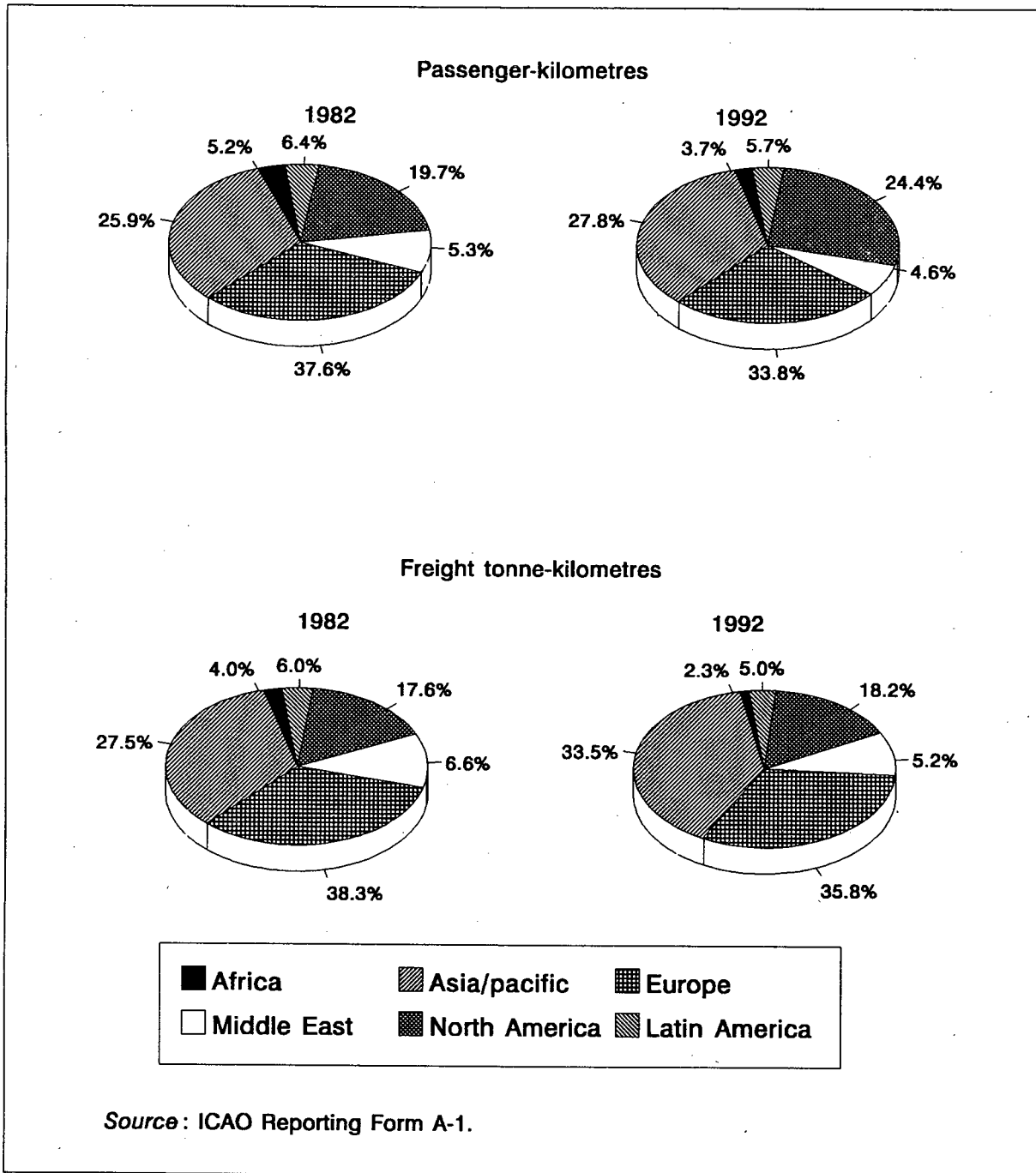
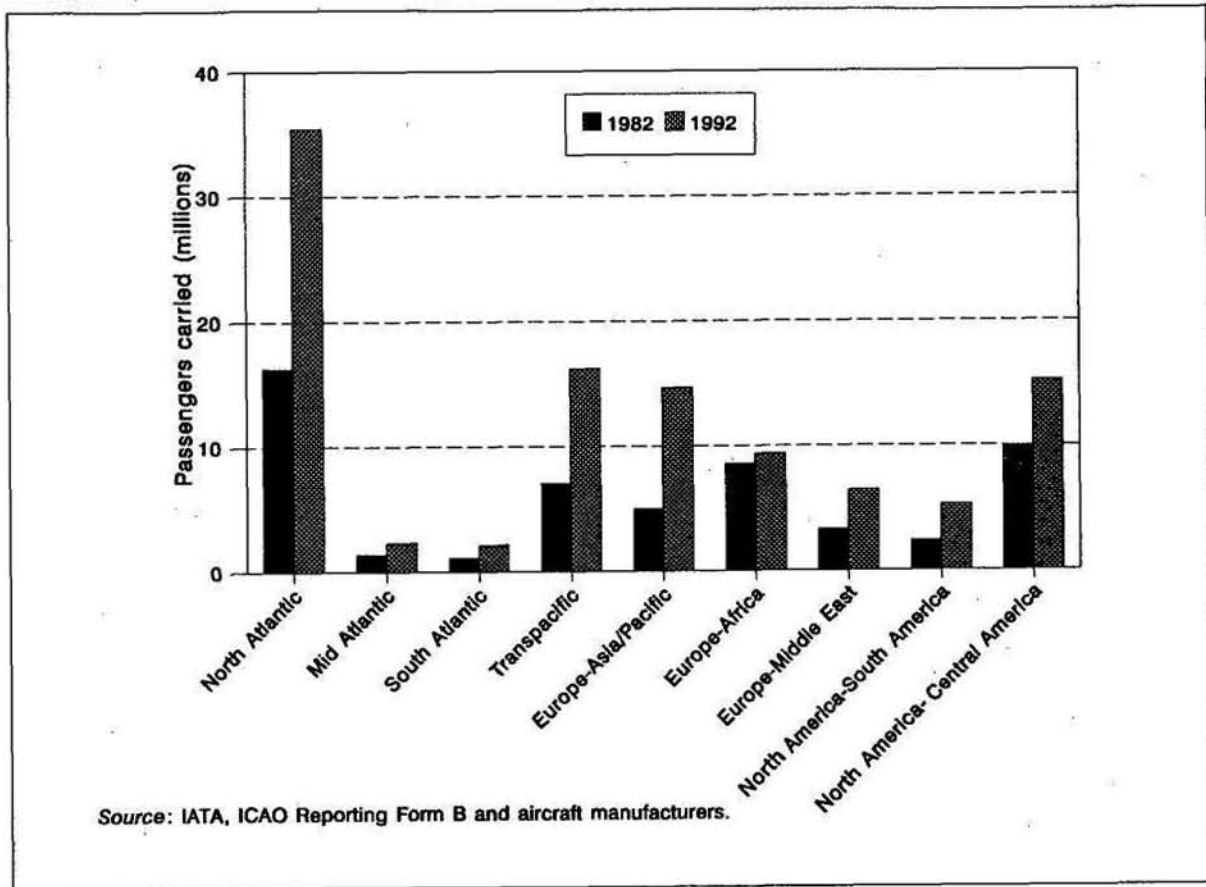


Figure 2-4. Regional shares of international traffic (scheduled operations, 1982 and 1992)





**Figure 2-5. Passengers on intercontinental route groups**  
(scheduled operations, 1980 and 1992)

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

	1982 (billions)	1992 (billions)	Average annual growth (per cent)
Non-scheduled carriers	64.9	91.4	3.5
Scheduled carriers	41.2	77.2	6.5
Total	106.1	168.6	4.7

Source: ICAO Reporting Form A-2.

## AIRCRAFT MOVEMENTS

21. The growth in passenger and freight traffic demand over the past 30 years has resulted in comparable growth in air carrier capacity. Growth patterns in passenger numbers, aircraft departures and aircraft-kilometres are portrayed in Figure 2-6. 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.

22. 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, the growth rate for aircraft departures increased towards the passenger growth rate, as this trend in aircraft size levelled out.

23. The growth in aircraft-kilometres has been consistently higher than the growth in aircraft departures, with a particularly large gap in the 1960s, 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.

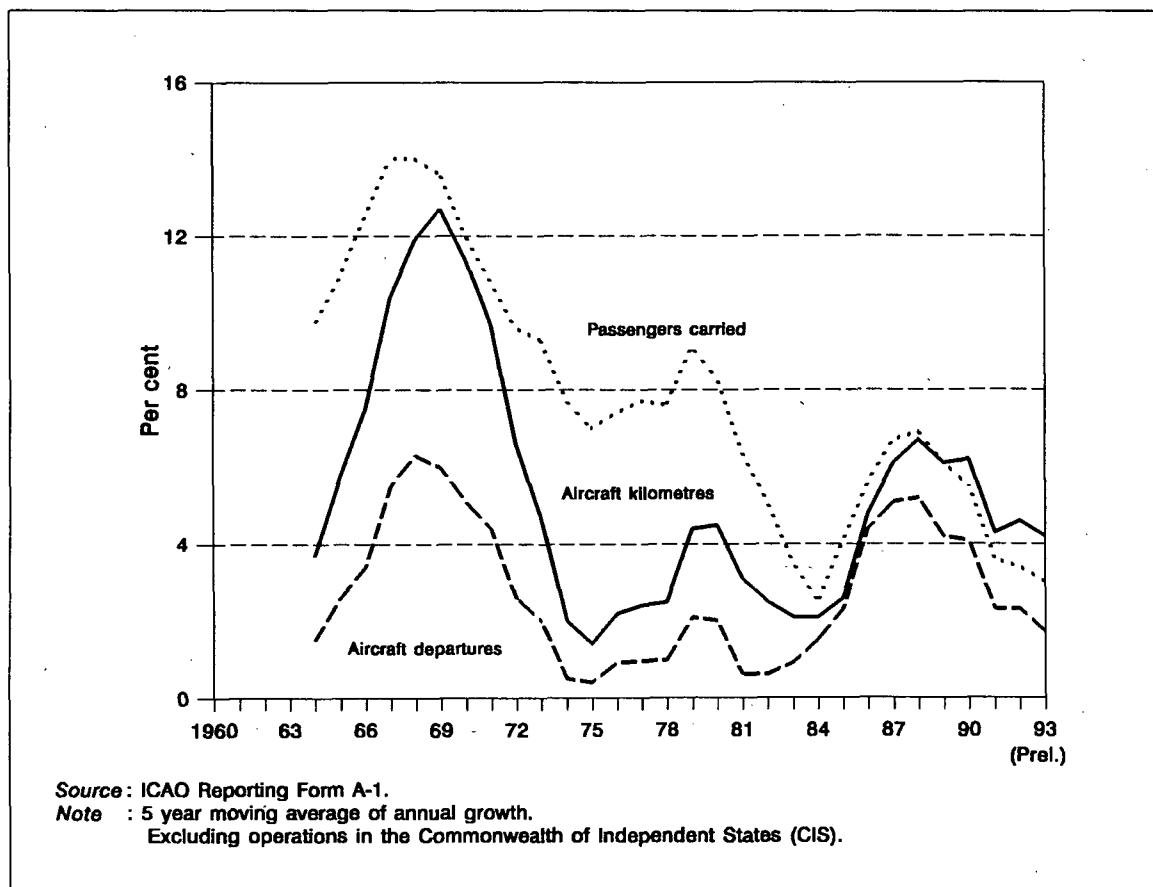


Figure 2-6. Growth in passengers and aircraft movements  
 (total scheduled operations, 1960 to 1992)

### FLEET COMPOSITION AND PRODUCTIVITY

24. At the end of 1993, the scheduled and non-scheduled carriers of ICAO Contracting States (excluding China and CIS) had a combined fleet of about 14 310 aircraft of over 9 000 kg maximum take-off weight (MTOW) for their international and domestic operations. This is an increase of about 3.5 per cent over 1992 and 64 per cent over 1980. The number of jet aircraft at the end of 1993 was about 11 200, which is an increase of about 4 per cent over 1992 and 79 per cent over 1980. Jet aircraft obviously account for an even larger proportion of carrier capacity than indicated by the relative number of aircraft.

25. Figure 2-7 contrasts the strong upward trend in the number of jet aircraft since 1960 with the slow growth in the number of turbo-prop aircraft and the decline in piston-engined aircraft. Figure 2-8 illustrates the changing composition of the jet fleet among narrow-body and wide-body and two-, three- and four-engine aircraft. The two-engine narrow-body category has shown the most sustained growth over the whole period and is now dominant in terms of numbers of aircraft (although much less so in terms of total capacity or payload). The numbers of two-engine wide-body aircraft (now increasingly providing long-haul services) grew rapidly during the 1980s.

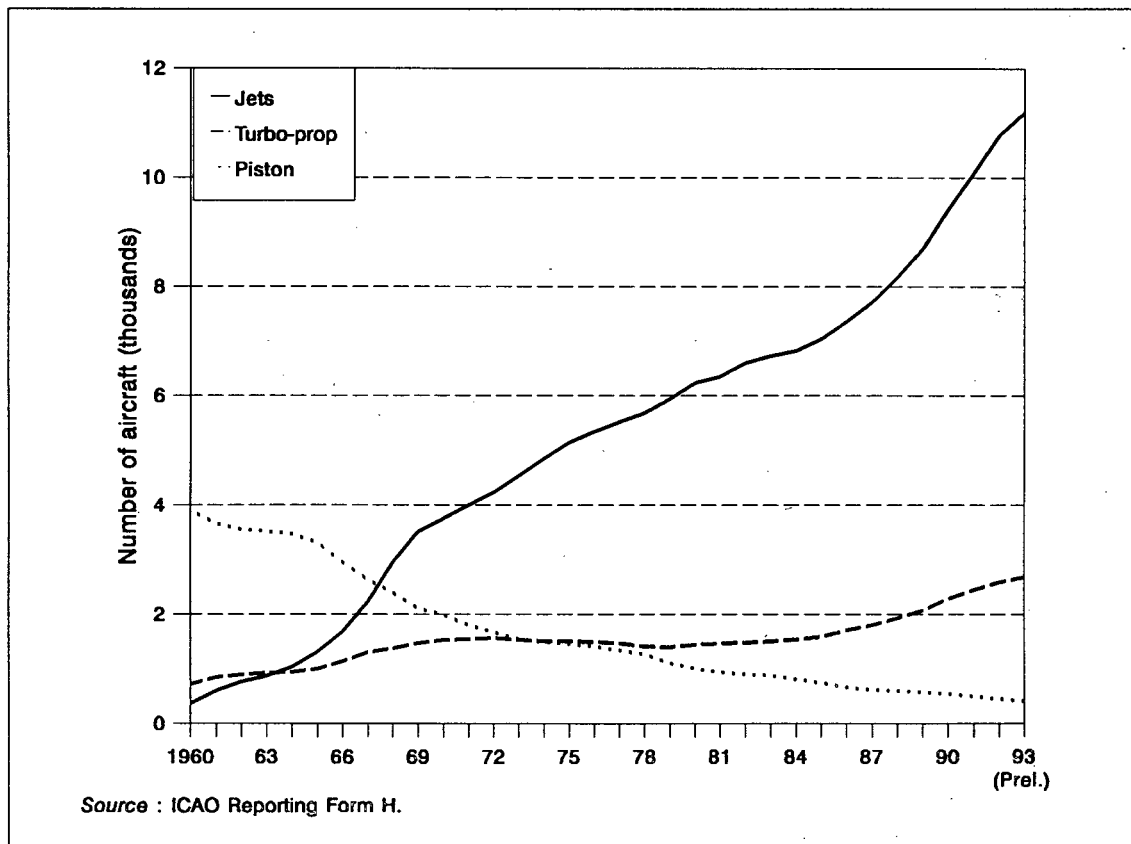


Figure 2-7. Composition of world commercial transport fleet (aircraft of 9 000 kg MTOW and over)

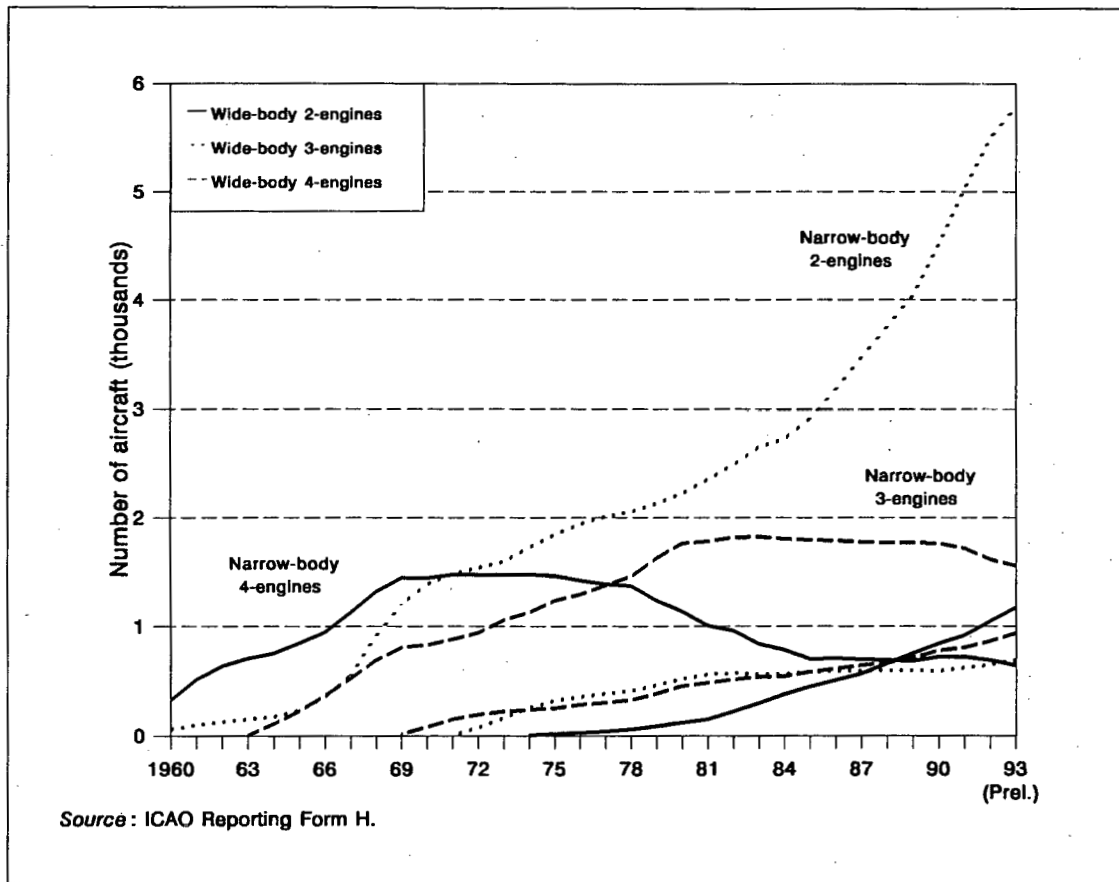
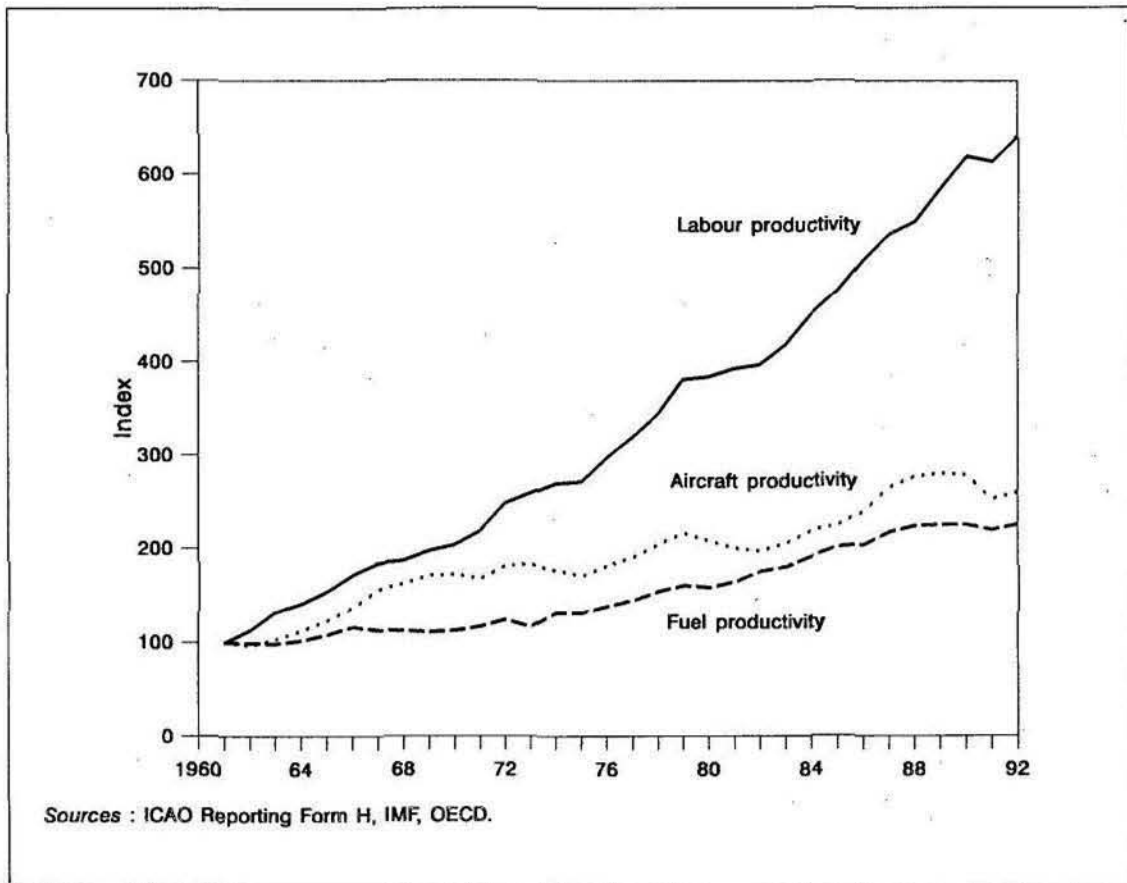


Figure 2-8. Composition of world commercial jet fleet  
(aircraft of 9 000 kg MTOW and over)

26. The progressive absorption of new technology aircraft into airline fleets has been a major source of productivity improvement, 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 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 are shown in Table 2-3 for the aggregated operations of international scheduled airlines. 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 which 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 much the largest impact over the past 30 years. The three components of aircraft productivity have been combined into a single measure of aircraft productivity whose trend is illustrated in Figure 2-9. There have been some fluctuations in performance related to business cycle conditions. Over the whole 30-year period, aircraft productivity has advanced at an average annual rate of about 3.4 per cent.

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

Productivity measure	Average levels			
	1962	1972	1982	1992
<b>Aircraft productivity</b>				
Aircraft load factor (per cent)	55	49	56	57
Aircraft speed (km/h)	362	591	618	630
Aircraft utilization (hours per aircraft per year)	1 660	2 190	2 020	2 741
<b>Labour productivity</b>				
TKP per employee (thousands)	31	75	120	194
<b>Fuel productivity</b>				
TKP per litre of fuel (index)	100	125	177	227



**Figure 2-9. Trends in airline productivity**

27. Estimates for labour productivity, in terms of TKP per employee, are given in Table 2-3, and the trend in labour productivity is illustrated in Figure 2-9. The introduction of labour-saving technology and systems has resulted in an impressive 6 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 a little under 3 per cent per annum over the period.

28. 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 23 tonnes in 1982. The increase in aircraft size has been much less marked since 1982.

29. An over-all index of airline productivity has been derived by combining the indices for aircraft, labour and fuel productivity into a single average measure. The average growth in this measure was about 4.8 per cent per annum between 1960 and 1992.

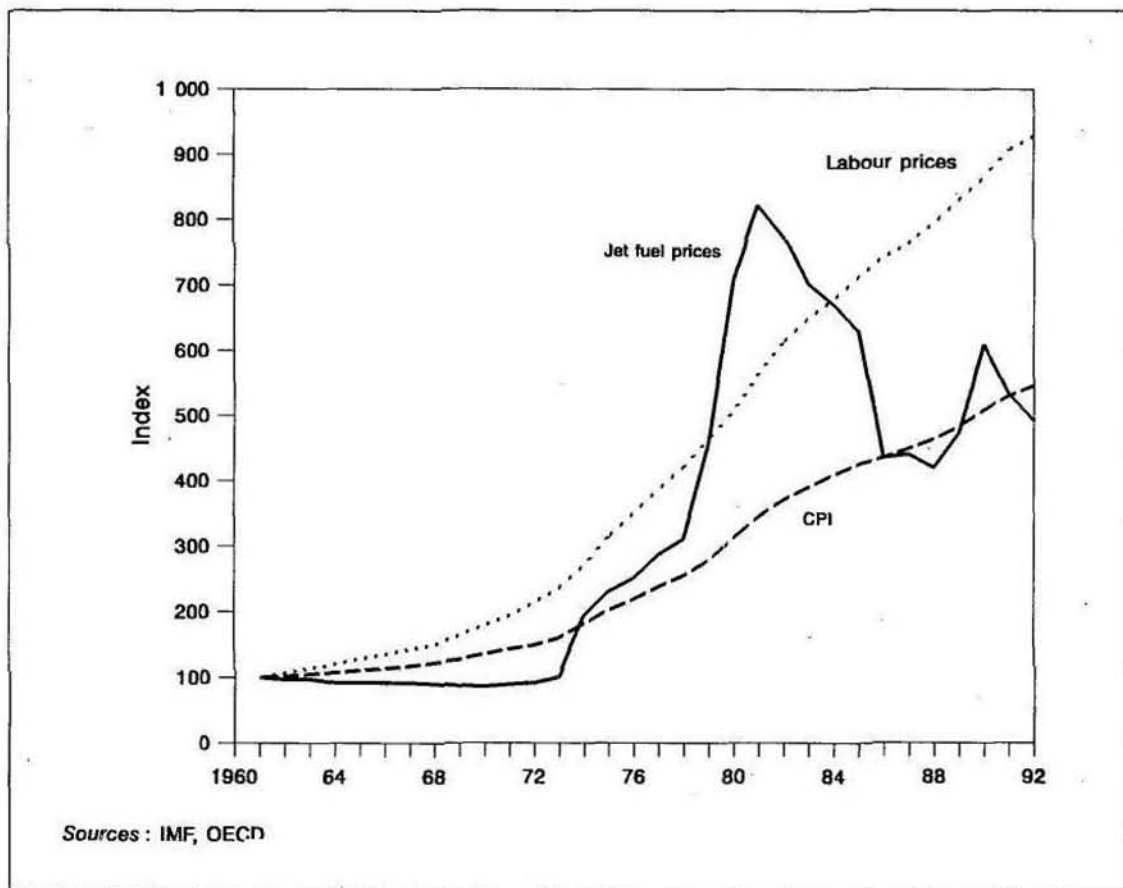


Figure 2-10. Input price trends

## RELATIONSHIP BETWEEN PRODUCTIVITY, PRICES AND FINANCIAL PERFORMANCE

30. 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.

31. Changes in the real prices paid for inputs (e.g. labour, 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 2-10, 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 2-8. 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.

32. The trends in productivity, input prices, yields (i.e. fares and rates), and financial performance are summarized in Figure 2-11. A log scale is used so that the slopes of the trend lines represent percentage changes. The productivity measure is the over-all index referred to above. An over-all 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.

33. 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.

34. 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. However, a small sustained redistribution of the productivity gains in favour of the air carriers would be sufficient to generate a more reasonable financial return than that achieved over the past 30 years.

## SAFETY AND QUALITY OF SERVICE

35. 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 large improvement in the safety of air travel has been achieved. The number of passenger fatalities per 100 million passenger-kilometres flown has fallen from nearly 2 in 1950 to 0.8 in 1960, 0.2 in 1970, 0.1 in 1980 and 0.03 in 1990.

36. 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, significant 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 1 060 kilometres in 1993. 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 1993. Over the same period, the journey time from New York to London was reduced from 17 hours to just under 7 hours for most flights and less than 4 hours for Concorde flights.

37. 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 130 per cent between 1960 and 1993 is evidence of improvement in service frequency and convenience.

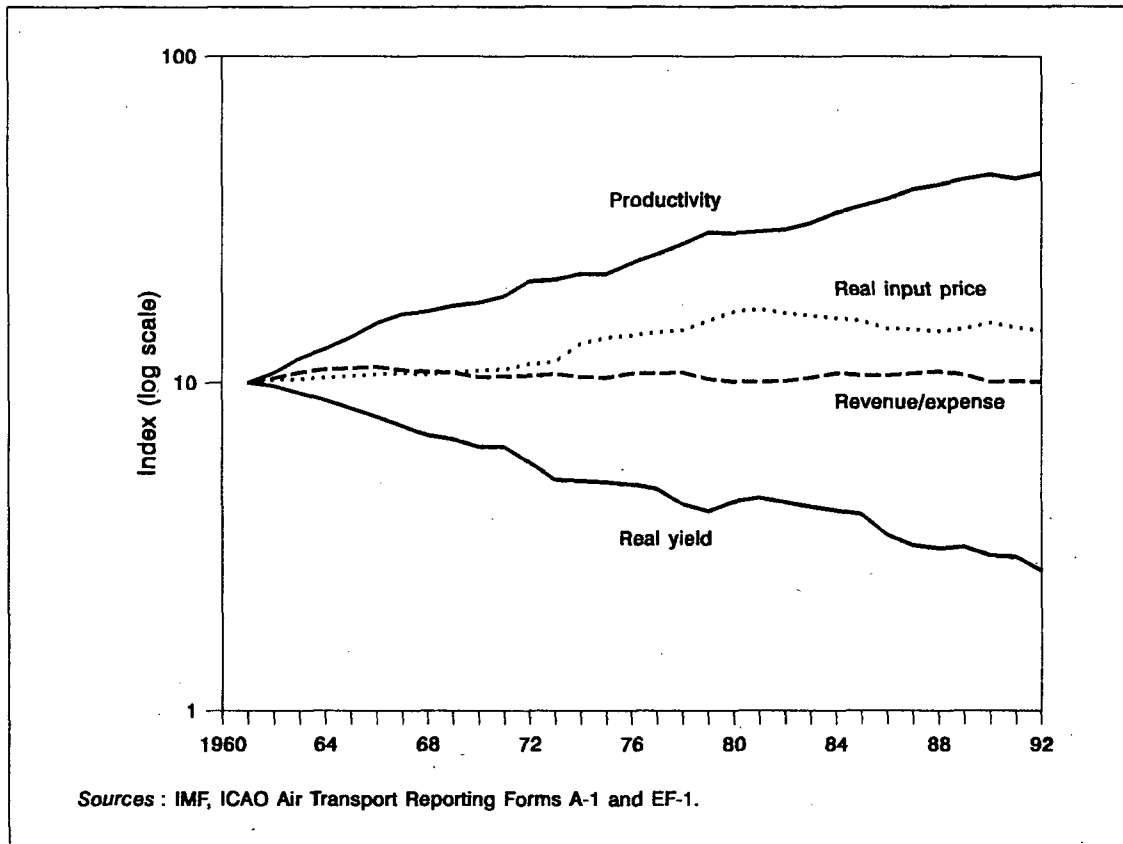


Figure 2-11. Trends in airline industry performance



## AIRPORT AND AIRSPACE CONGESTION

38. 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. Many air traffic control systems are aging and large investment expenditures are required to bring new technology into the air transport system. In the most congested areas, relatively few new airports were built during the past decade and few are currently under construction, and the limits to 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.

39. Technological developments in aircraft and in air navigation equipment will continue to provide some relief. In particular, the new global communications, navigation and surveillance/air traffic management (CNS/ATM) systems being implemented through ICAO are expected to lead to significant improvements. These systems will utilize the services of networks of navigation and communications satellites to replace existing line-of-sight systems and provide more accurate navigation, more comprehensive surveillance and greatly improved communications.

40. There are also various technical procedures, such as revisions to separation criteria, which 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.

41. 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.

42. 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. The world's busiest international air route, London-Paris, will be affected by the opening of the Channel Tunnel between France and the United Kingdom.

## ENVIRONMENTAL PROTECTION

43. 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.

44. 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 world-wide policy (Resolution A28-3) enabling States to phase in operating restrictions on the older, noisier ("Chapter 2") aircraft covered by these standards between 1995 and 2002. Aircraft noise is therefore likely to decline in general terms in the next decade but may eventually increase again.

45. Initially, the main concern regarding aircraft engine emissions 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.

46. One such problem is depletion of stratospheric ozone. The Montreal Protocol on Substances that Deplete the Ozone Layer provides for a regular scientific assessment of the causes of ozone layer depletion. Its most recent assessment, in 1991, included a chapter on aircraft which stated that addition to the atmosphere of nitrogen oxides ( $\text{NO}_x$ ) emitted by aircraft is expected to decrease ozone in the stratosphere. While much of the work in this field so far has focused on the likely impact of possible new supersonic aircraft, the assessment also noted that a proportion of the emissions from the subsonic fleet is deposited directly into the lower stratosphere. The assessment also underlined the uncertainties in this area.

47. A second global atmospheric problem to which civil aviation may be contributing is global warming. The carbon dioxide produced when aircraft burn fuel certainly contributes to this problem, although this contribution is considerably less than that of many other sources, such as power generation, manufacturing industries and road transport. However, aircraft engine emissions may also contribute in other ways. For example, whereas in the stratosphere  $\text{NO}_x$  may be causing ozone depletion, in the troposphere — where ozone acts as a greenhouse gas —  $\text{NO}_x$  may be increasing ozone levels. In its most recent assessment, in 1992, the Intergovernmental Panel on Climate Change (IPCC) identified aircraft as one of the sources of  $\text{NO}_x$  in the troposphere and suggested that aircraft emissions may be particularly significant because they are injected into the atmosphere at high altitude. However, the panel acknowledged that there is considerable uncertainty regarding the atmospheric processes involved.

48. Against this background ICAO, through its Committee on Aviation Environmental Protection (CAEP), has been intensifying its efforts to address aircraft engine emissions. ICAO has initiated contacts with other international organizations aimed at reaching a consensus regarding the extent to which aircraft engine emissions are contributing to such problems, based on as complete and accurate information as possible. This initiative has led to increased co-operation at the expert level with those responsible for the IPCC and Montreal Protocol scientific assessments. In both cases, the next assessments are scheduled for completion shortly and will specifically address the impact of aircraft engine emissions. In order to help those scientists involved in assessing the impact of aircraft engine emissions, CAEP is advising on inventories of aircraft emissions for use as inputs to atmospheric chemistry/climate models.

49. Once there is a clear understanding of aviation's contribution, CAEP will try to identify appropriate solutions as necessary. Such solutions could include further development of the existing ICAO Standards. In the case of the three pollutants that are controlled by the Standards, the focus of attention is likely to be on  $\text{NO}_x$ , which is produced when fuel is burned at high temperatures. Technology offers the prospect of improvement here, although this is by no means straightforward and will take some time. In the case of carbon dioxide (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 amount of fuel used or by using non-fossil fuels. In addition to further development of ICAO Standards, other solutions that might need to be considered are operational measures and the possible use of pricing mechanisms.

## FINANCIAL RESOURCES

50. The implications of aging equipment, traffic growth and technology developments for investment in civil aviation were explored in a recent ICAO study *Investment Requirements for Aircraft Fleets*

and for Airport and Route Facility Infrastructure to the Year 2010 (Circular 236). It was estimated that some \$800 billion of investment funds will be required over the next 20 years for air carrier fleets and about \$250-\$350 billion for airport and en-route facilities. The study also identified many different types of financing (e.g. debt, equity, leasing arrangements, cash flow from operations) and sources of funds (e.g. governments, commercial and development banks, export credit institutions) and noted the need for further innovation in order to meet the funding requirements.

51. Investment in new aircraft generally follows a cyclical pattern. The latter part of the 1980s was a period of high investment. Investment levels have fallen away during the current recession but are likely to build up substantially later in the decade. 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

52. 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 increasingly involved in airline regulation. For example, the Final Act of the Uruguay Round of trade negotiations signed on 15 April 1994 includes a General Agreement on Trade in Services (GATS) with an Annex on Air Transport Services which excludes from the application of the Agreement traffic rights and services directly related to their exercise, but with three exceptions: the repair and maintenance of aircraft, the sale and marketing of air transportation, and computer reservation systems. Another example is that several States now rely on competition law as the primary means to regulate computer reservation systems.

53. Three significant regulatory developments within the aviation regulatory structure have been the actions taken by many governments towards less economic control of airlines, the promotion of competition and greater reliance on market forces as opposed to governmental decisions to determine the type and amount of air services provided and industry concentration in both domestic and international markets. This has led both to the creation of many new airlines accompanied by the availability of lower fares in some markets, and to an increase in airline industry concentration in others, as companies have failed or merged.

54. A number of regulatory authorities continue to be occupied with complete or partial privatization of government-owned airlines and the often-related question of foreign investment in airlines, with several governments changing or clarifying their positions concerning foreign investment in their national airlines. Minority equity participation in national airlines by foreign airlines, often a means of indirect market access, has occurred with increasing frequency in all regions. The permissible levels of such foreign investment generally range from 20 to 49 per cent and are often accompanied by other requirements, such as reciprocity. In an environment of increasing industry concentration and competition, many airlines are seeking bilateral co-operative arrangements to obtain access to new markets and to better serve existing ones. One consequence of this tendency is for some authorities to become increasingly involved in, for example, code-sharing arrangements, in some cases holding different views concerning the authorization of code-shared flights, particularly in the case of such flights serving third countries.

55. At the regional level, two groups of States have created multilateral regulatory regimes based on membership in their respective groups. The States of the European Union have, over a period of ten

years and in three distinct phases, established a regulatory regime designed to create a single market for air services within Europe. The States of the Andean Pact agreed in 1991 to establish an "open skies" area in which the five freedoms of the air would be granted unrestrictedly at an intra-subregional level to the airlines of the member States. The establishment of regional multilateral aviation arrangements has evoked concerns about their effect on the national airlines of non-participating States and on the existing national and bilateral air service regulation of States which are members of the regional groups.

56. The move to a less regulated environment, increasing competition in domestic and international markets and concentration in the industry have also raised important questions. Will increased flexibility for airlines result in more air services when major airports are becoming increasingly congested? How can regulatory authorities ensure fair competition and participation by all air carriers? Will bilateral co-operative arrangements such as joint services, blocked space, code-sharing and changes in traditional ownership and control criteria for the use of market access enable smaller air carriers to continue to play a role in international air transport in an era of globalization and mega-carrier alliances?

57. In recent years air transport authorities have become concerned about the potential for computer reservation systems (CRSs) to be used in anti-competitive ways through, for example, biased displays of flights which disadvantage certain airlines. Several detailed national regulations and two regional codes involving European States have been promulgated. The avoidance of CRS abuses and the furtherance of CRS benefits to the industry were promoted by the Council of ICAO on 17 December 1991 with the adoption of a Code of Conduct for the Regulation and Operation of Computer Reservation Systems and a Resolution urging States to follow this code.

58. Other more general governmental measures also affect air transport. Such measures include competition law, environmental regulations, 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

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

60. An important innovation in the United States which has attracted increasing attention 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 on 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 ensure independent survival and the ability to influence market conditions). Both as a part of this development and as a reaction to it, 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 on some sectors in order to expand on-line markets. These developments have caused some small- and medium-size airlines concern for their survival and have prompted efforts by some airlines to either 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.

61. Two of the ways automation changed industry structure in the 1980s involved the use of computers. First, computer reservation systems became the principal airline distribution tool in a number of countries, particularly in markets where there are many travel agents and frequent changes in schedules and fares (e.g. North America, Europe). With participation in a CRS now essential in many markets and widespread criticism of some systems for being biased towards certain carriers, the trend is expected to continue towards the conversion of existing systems to more neutral systems owned or controlled by groups of carriers, with participation open to all carriers world-wide. Second, the creation of sophisticated yield management systems for airlines, associated with usage of a CRS, has enabled the airlines concerned to adjust the mix of high and low fare passengers on each flight in order to maximize revenues. In less regulated markets, 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.

62. An important marketing development in the past decade, with implications for the future of air freight, has been the creation of numerous highly sophisticated airline/parcel express delivery companies. Based primarily in North America and Europe, these companies operate large jet cargo fleets, providing continental overnight deliveries and second day intercontinental services via strategically placed sorting hubs. The concept has also been adopted by a limited number of postal administrations.

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## **Chapter 3**

# **WORLD ECONOMIC ENVIRONMENT**

### **HISTORICAL TRENDS**

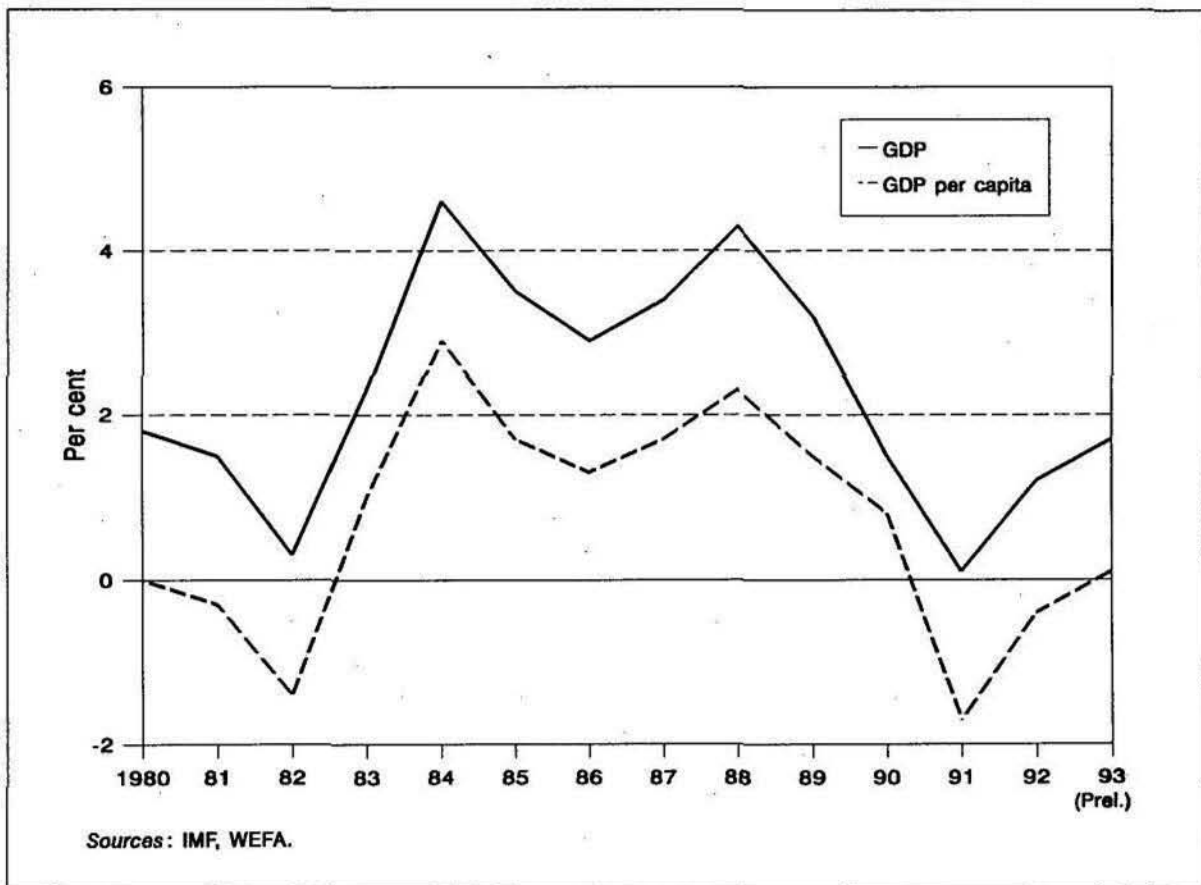
1. As indicated in Chapter 2, the world economy is subject to economic cycles but has steadily grown over the long term. During the 32-year period 1960-1992, the aggregate world economy measured in terms of Gross Domestic Product (GDP) increased at an average annual rate of 3.7 per cent in real terms.
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, 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 experienced a decline of 0.3 per cent in 1991, the most difficult year globally since 1982, and was still quite weak in 1992 despite the commencement of recovery in North America. The world economy improved in 1993, experiencing a growth rate of almost 1.4 per cent, although continental Europe and Japan remained in recession.
5. World population growth between 1980 and 1992 increased at an average annual rate of 1.7 per cent. Hence, growth of the world's GDP per capita between 1980 and 1992 increased at an average annual rate of 0.8 per cent, significantly lower than the growth of GDP itself, as indicated in Figure 3-1.

### **OUTLOOK**

6. There appears to be some consensus among major economic forecasting institutions that 1994 will mark the turning point for a full recovery of the global economy, although it could be slower than the historical experience. For example, the most recent forecasts of the International Monetary Fund (IMF), World Bank and the Organization for Economic Co-operation and Development (OECD) anticipate a

noticeable increase in world trade and GDP growth in most major economies. These forecasts indicate strong performance in North America and signs of recovery in Europe, but some weakness in Japan. Recoveries in Australia and New Zealand have also gained momentum. States in the Asia/Pacific region are expected to enter a new phase of economic growth with infrastructure and private investment replacing exports as the engine of growth. Inflation is expected to moderate to about 3.5 per cent. As a result, world real GDP is expected to increase by 2.5 per cent in 1994, followed by a 3 to 3.5 per cent increase in 1995.

7. For the rest of the forecast horizon, annual inflation is expected to remain fairly stable at around 3.5 per cent, and GDP for the period 1992-2003 is expected to increase at an average annual rate of 2.8 per cent per annum in real terms.



**Figure 3-1. World GDP, GDP per capita growth**  
(real terms, 1980-1992)

## Chapter 4

# AIRLINE FINANCIAL TRENDS

### OPERATING REVENUES, EXPENSES AND RESULTS

1. This chapter indicates general trends in airline financial data for the years 1962 and 1972 and for the decade 1982 to 1992 and, in broad terms, the outlook for the next decade. 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 over-all annual operating revenues and expenses for the period 1982 to 1992 are illustrated in Figure 4-1. The steep increase in the cost of fuel and the world-wide economic recession were the main factors adversely affecting the financial environment of the air transport industry in the early 1980s. The result was an aggregate operating loss of more than \$1.5 billion, or 0.5 per cent of operating revenues, between 1980 and 1982. 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 when a steep increase in fuel prices caused by the Gulf crisis, along with the slowdown in the world economy, resulted in an operating loss of \$1.5 billion, or 0.8 per cent of operating revenues. In 1991, the industry experienced an operating loss of approximately \$0.5 billion, or 0.2 per cent of operating revenues. This trend continued into 1992, resulting in an operating loss of \$1.5 billion or 0.7 per cent of operating revenues. Preliminary results for 1993 indicate an operating profit of \$2.5 billion or 1.1 per cent of operating revenues, the first operating profit achieved by the industry since 1989. For the 1982-1992 period as a whole, the operating result was \$39 940 million or 2.4 per cent of the aggregate operating revenues of \$1 647 640 million, and the aggregate net result (after allowing for non-operating items such as the retirement of property, subsidies, interest charges and income taxes) was -0.3 per cent of operating revenues.

4. As shown in Table 4-2, from 1982 to 1992 in terms of current money values, 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 8.8 per cent, from \$93 240 million to \$217 500 million. During the same period the corresponding total operating expenses increased at a rate of 8.9 per cent, from \$93 400 million to \$219 000 million. The growth in world airline operating revenues during this period was associated with an average annual growth in traffic of 5.8 per cent in terms of tonne-kilometres performed and a rise in airline yields (average operating revenue per tonne-kilometre performed) from 73.4 cents in 1982 to 90.5 cents in 1992 (at an average annual rate of 2.1 per cent). The higher growth of unit costs (2.4 per cent per annum in terms of average operating expenses per



tonne-kilometre of available capacity) was somewhat offset by steadily increasing load factors. In comparison, the operating revenue for the decades 1962 to 1972 and 1972 to 1982 increased at average annual rates of 13.4 per cent and 15 per cent, respectively. The operating expenses for the same periods increased at average annual rates of 13.1 per cent and 15.4 per cent, respectively.

5. As with over-all revenues and costs, unit revenues and costs varied from year-to-year over the 1982-1992 period, as shown by Table 4-2 and Figure 4-2. Expenses per tonne-kilometre available increased from 41.4 cents to 52.4 cents, whereas the revenue per tonne-kilometre performed increased from 73.5 cents to 90.5 cents.

### DISTRIBUTION OF REVENUES AND OPERATING EXPENSES

6. As illustrated by Table 4-3, in terms of shares of total revenues, passenger revenues of scheduled airlines declined from 80.3 per cent in 1982 to 76.3 per cent in 1992; freight and mail revenues declined from 11.8 per cent in 1982 to 10.4 per cent in 1992; non-scheduled revenues increased from 3.3 per cent in 1982 to 3.7 per cent in 1992; and incidental revenues (which include sales of services and maintenance, and the leasing of aircraft to other airlines) increased from 4.6 per cent in 1982 to 9.7 per cent in 1992.

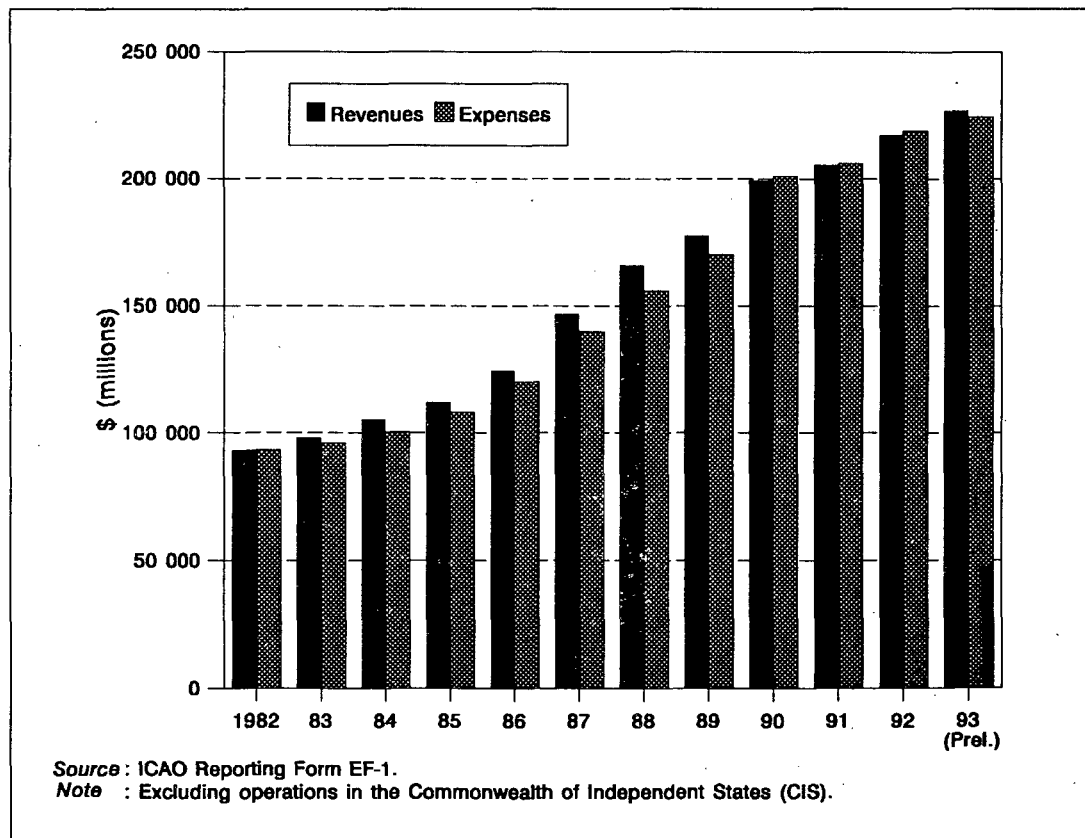


Figure 4-1. World scheduled airline operating revenues and expenses, 1982-1993

**Table 4-1. Operating revenues and expenses — 1962-1993**  
(scheduled airlines of ICAO Contracting States<sup>1</sup>, total domestic and international services)

Description	1962	1972	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993 <sup>2</sup>
	(millions of dollars)													
<b>OPERATING REVENUES</b>														
Scheduled services (total)	6 022	21 170	85 900	89 900	95 780	102 000	111 900	131 240	148 680	158 350	174 050	178 470	188 580	195 500
Passenger	5 275	18 290	74 860	77 600	81 720	87 000	94 900	111 820	127 250	137 200	153 290	156 760	165 870	171 500
Freight	530	2 280	9 560	10 830	12 560	13 300	15 200	17 450	19 380	19 110	18 510	19 400	20 320	21 500
Mail	317	600	1 480	1 470	1 500	1 700	1 800	1 970	2 050	2 040	2 250	2 310	2 390	2 500
Non-scheduled operations	341	1 000	3 100	2 800	3 010	3 500	4 500	5 410	6 360	6 650	7 020	8 260	7 940	8 500
Incidental	207	860	4 240	5 600	6 610	6 700	8 200	10 350	11 160	14 000	17 630	18 770	20 980	23 000
Total operating revenues	6 570	23 030	93 240	98 300	105 400	112 200	124 600	147 000	166 200	179 000	198 700	205 500	217 500	227 000
<b>OPERATING EXPENSES</b>														
Flight operations (total)	1 756	5 804	34 600	33 050	33 350	34 930	32 710	36 790	39 270	44 520	56 060	56 420	56 400	56 800
Flight crew salaries and expenses	594	2 240	6 800	6 870	6 900	7 250	8 300	9 480	10 530	11 350	13 650	15 220	15 910	16 300
Aircraft fuel and oil	845	2 450	25 420	23 610	23 370	23 780	19 110	20 740	20 690	23 520	30 510	27 120	26 250	26 000
Other (insurance, rental, training, etc.)	317	1 114	2 380	2 570	3 080	3 900	5 300	6 570	8 050	9 650	11 900	14 080	14 240	14 500
Maintenance and overhaul	1 205	3 070	9 150	9 620	10 120	11 070	13 850	15 900	18 320	19 590	22 790	23 120	23 910	24 500
Depreciation and amortization	794	2 370	6 330	6 920	7 240	7 770	9 070	11 050	12 150	12 520	14 030	14 310	15 630	16 200
User charges and station expenses (total)	970	3 920	14 540	15 260	16 080	17 340	21 340	24 770	28 440	29 080	32 200	34 460	37 720	39 000
Landing and associated airport charges	159	820	3 100	3 160	3 040	3 540	4 270	5 100	5 920	6 170	7 580	8 160	8 820	9 300
Route facility charges			1 410	1 430	1 400	1 620	1 890	2 170	2 490	2 280	3 060	4 050	5 090	5 500
Station expenses	811 <sup>3</sup>	3 100 <sup>3</sup>	10 030	10 670	11 640	12 180	15 180	17 500	20 030	20 630	21 560	22 250	23 810	24 200
Passenger services	473	2 250	8 540	8 810	9 190	10 310	12 140	14 540	15 900	17 880	20 880	21 380	23 690	24 500
Ticketing, sales and promotion	925	3 350	14 510	15 810	16 560	18 470	21 480	24 440	27 080	30 070	32 960	34 340	35 760	36 500
General, administrative and other operating expenses	350	1 460	5 730	6 730	7 760	8 210	9 410	12 310	14 840	17 540	21 280	21 970	25 890	27 000
Total operating expenses	6 473	22 224	93 400	96 200	100 300	108 100	120 000	139 800	156 000	171 200	200 200	206 000	219 000	224 500
Operating result [profit or loss (-)]	97	806	-160	2 100	5 100	4 100	4 600	7 200	10 200	7 800	-1 500	-500	-1 500	2 500
Operating result as a percentage of operating revenues	1.5	3.5	-0.2	2.1	4.8	3.7	3.7	4.9	6.1	4.4	-0.7	-0.2	-0.7	1.1
Net result	-27	234	-1 300	-700	2 000	2 100	1 500	2 500	5 000	3 700	-4 300	-3 500	-7 700	-3 700
Net result as a percentage of operating revenue	-0.4	1.0	-1.4	-0.7	1.9	1.9	1.2	1.7	3.0	2.1	-2.2	-1.7	-3.5	-1.6

1. Excludes domestic operations in the Commonwealth of Independent States (CIS).
2. Preliminary results.
3. Includes route facility charges.

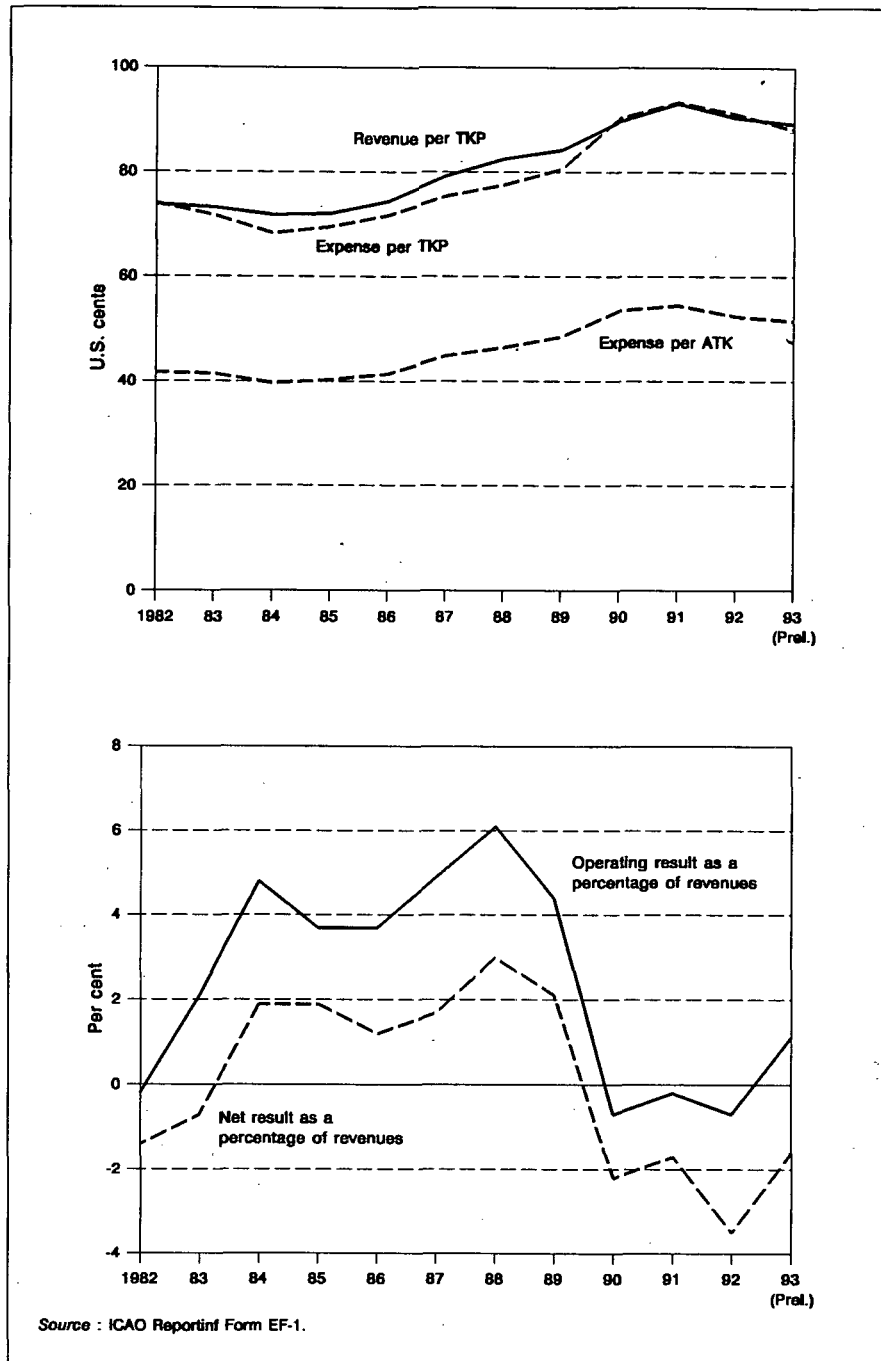


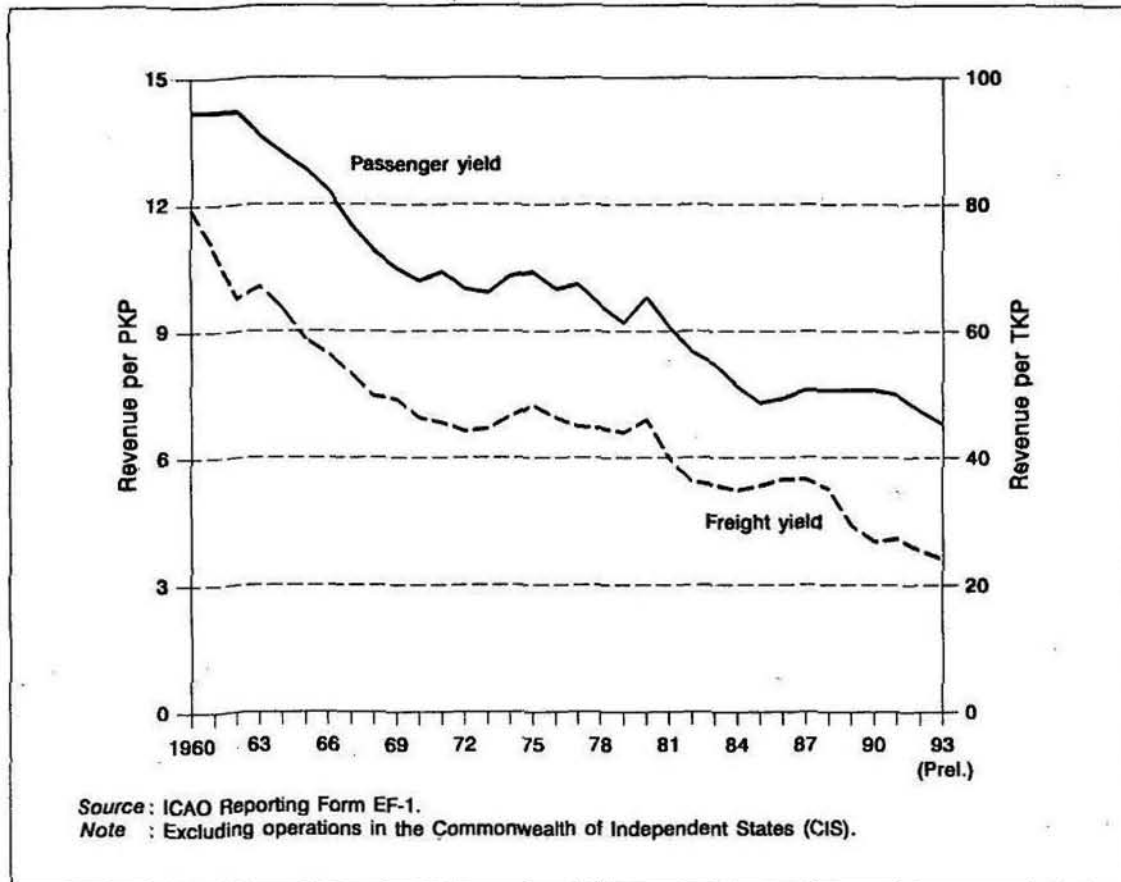
Figure 4-2. Financial data for scheduled airlines, 1982-1993

**Table 4-2. Total and unit operating revenues and expenses, 1982 and 1992**  
(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)
1982	93 240	93 400	127 040	73.5	225 720	41.4
1992	217 500	219 000	228 930	90.5	399 370	52.4
Average annual growth (per cent)	8.8	8.9	6.1	2.1	5.9	2.4

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

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



Source: ICAO Reporting Form EF-1.

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

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

**Table 4-3. Distribution of operating revenues and expenses in 1982 and 1992**  
(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) 1982 to 1992
	1982	1992	
<b>OPERATING REVENUES</b>			
Scheduled services (total)	92.1	86.7	-0.6
Passenger	80.3	76.3	-0.5
Freight	10.3	9.3	-1.0
Mail	1.6	1.1	-3.7
Non-scheduled operations	3.3	3.7	1.2
Incidental	4.5	9.6	7.9
<b>TOTAL</b>	<b>100.0</b>	<b>100.0</b>	<b>—</b>
<b>OPERATING EXPENSES</b>			
Direct aircraft			
Flight operations (total)	37.0	25.8	3.7
Flight crew	7.3	7.3	0
Fuel and oil	27.2	12.0	-7.9
Other	2.5	6.4	9.9
Maintenance and overhaul	9.8	10.9	1.1
Depreciation and amortization	6.8	7.1	0.4
Sub-total	53.6	43.8	-2.0
Indirect			
User charges and station expenses (total)	15.6	17.2	1.0
Landing and associated airport charges	3.3	4.0	1.9
En-route facility charges	1.5	2.3	4.4
Station expenses	10.8	10.9	0.1
Passenger services	9.1	10.8	1.7
Ticketing, sales, promotion	15.5	16.3	0.5
General, administrative and other	6.2	11.9	6.7
Sub-total	46.4	56.2	1.9
<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 with the Commonwealth of Independent States (CIS).

7. Among airline operating expenses, the most significant increase between 1982 and 1992 was attributable to "general, administrative and other operating expenses", which rose at an average annual rate of 16.3 per cent, compared to only 3.3 per cent for "aircraft fuel and oil". The former increased from 6.1 per cent of total operating expenses in 1982 to 11.8 per cent in 1992 while the latter decreased from 27.2 per cent in 1982 to 12.0 per cent in 1992. "Flight operations - other", which includes rental of aircraft from other carriers, also increased its share significantly from 2.6 per cent in 1982 to 6.5 per cent in 1992,

while the costs of "user charges and station expenses" and "passenger services" increased from 15.6 to 17.2 per cent and from 9.1 to 10.8 per cent, respectively. The proportion of direct aircraft operating expenses dropped and that of indirect operating expenses increased from 1982 to 1992.

### 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 1982 and 1992, together with the corresponding operating results. In 1992 about 37 per cent of operating revenues and expenses of the world's airlines were attributable to the North American airlines, 31 per cent to European airlines and 22 per cent to airlines of Asia and the Pacific, with the remaining 10 per cent divided among those of Africa, the Middle East and Latin America/Caribbean. Compared to 1982, the 1992 shares of operating revenues and expenses of the airlines of Asia/Pacific represented a gain of about 5 percentage points of the world total, while those of the Middle East and Latin America/Caribbean carriers declined significantly.

**Table 4-4. Regional distribution of total operating revenues and expenses in 1982 and 1992**

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	1982	3 760	4.0	3 900	4.2	-140	-3.7
	1992	5 700	2.6	5 400	2.5	300	5.3
Asia and Pacific	1982	16 020	17.2	15 200	16.3	820	5.1
	1992	48 000	22.1	46 200	21.1	1 800	3.8
Europe <sup>1</sup>	1982	24 730	26.5	24 380	26.1	350	1.4
	1992	66 700	30.7	67 000	30.6	-300	-0.5
Middle East	1982	4 640	5.0	4 770	5.1	-130	-2.8
	1992	6 900	3.2	6 700	3.1	200	2.9
North America	1982	38 460	41.2	39 380	42.1	-920	-2.3
	1992	80 200	36.8	83 100	37.9	-2 900	-3.6
Latin America and Caribbean	1982	5 630	6.1	5 770	6.2	-140	-2.5
	1992	10 000	4.6	10 600	4.8	-600	-6.0
World <sup>1</sup>	1982	93 240	100.0	93 400	100.0	-160	-1.7
	1992	217 500	100.0	219 000	100.0	-1 500	-0.7

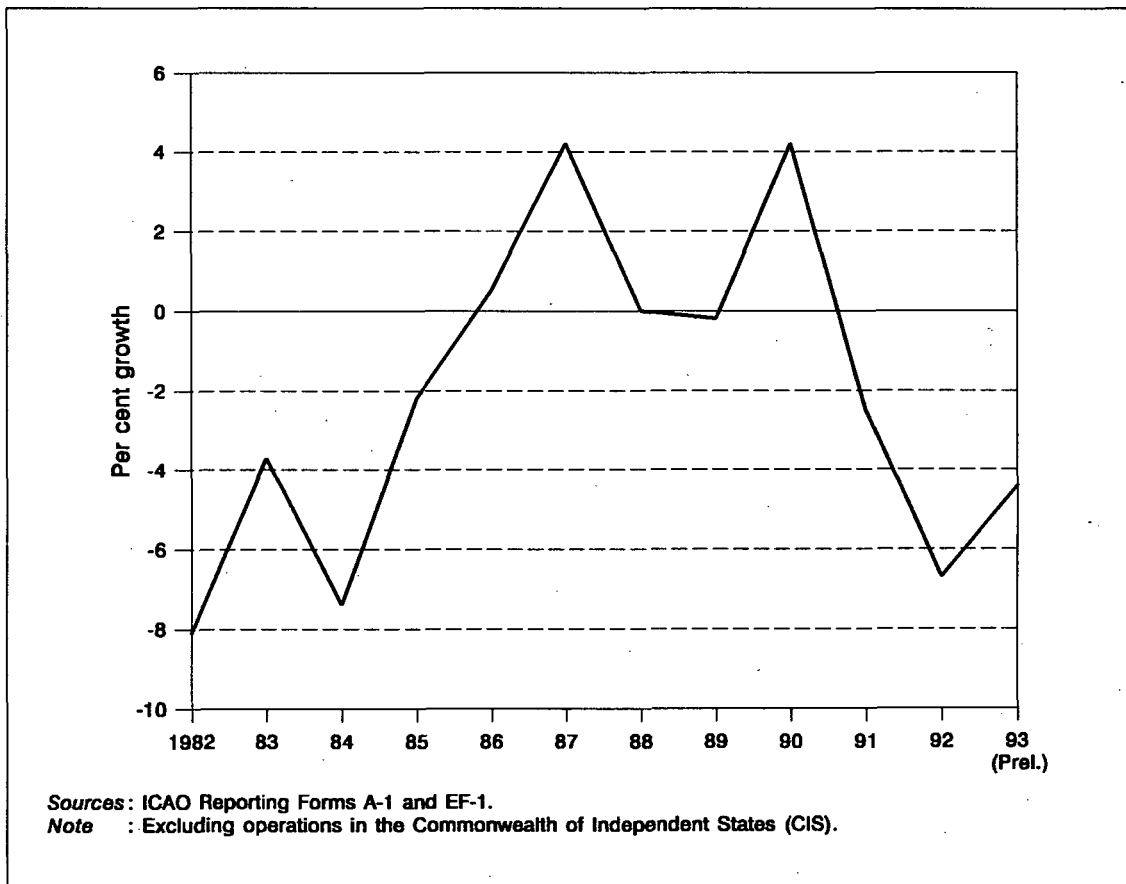
Sources: ICAO Digests of Statistics, Series F — Financial Data.

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

**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, which occurred between 1960 and 1992 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 1960-1992 period (excluding operations within the Commonwealth of Independent States) as well as annual change in freight yield per tonne-kilometre. Average world passenger yield measured in real terms decreased at a rate of 2.1 per cent per annum, and freight and mail yield decreased at a rate of 3.5 per 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 by 1.9 per cent per annum over the 1982-1992 period, as illustrated in Figure 4-4.



**Figure 4-4. World scheduled airlines' unit operating cost, 1982-1993**  
 (U.S. cents per ATK in real terms)

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. By 1988, fuel costs accounted for only 13.3 per cent of total operating costs, as illustrated in Figure 4-5. Although the long-term outlook for fuel prices is not clear, prevailing industry expectations are for moderate increases in current terms (at the rate of inflation), which should 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.

## OUTLOOK

12. For the forecast period, the airline industry faces substantial inflationary pressure on operating costs, particularly in the areas of labour and capital. As indicated in Circular 236 — *Investment Requirements for Aircraft Fleets and for Airport and Route Facility Infrastructure to the Year 2010* — world airlines have to purchase some 11 000 new aircraft between 1991-2010, valued at some 800 billion 1991 U.S. dollars, in order to meet traffic growth and replace aging aircraft. 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 cost of financing.

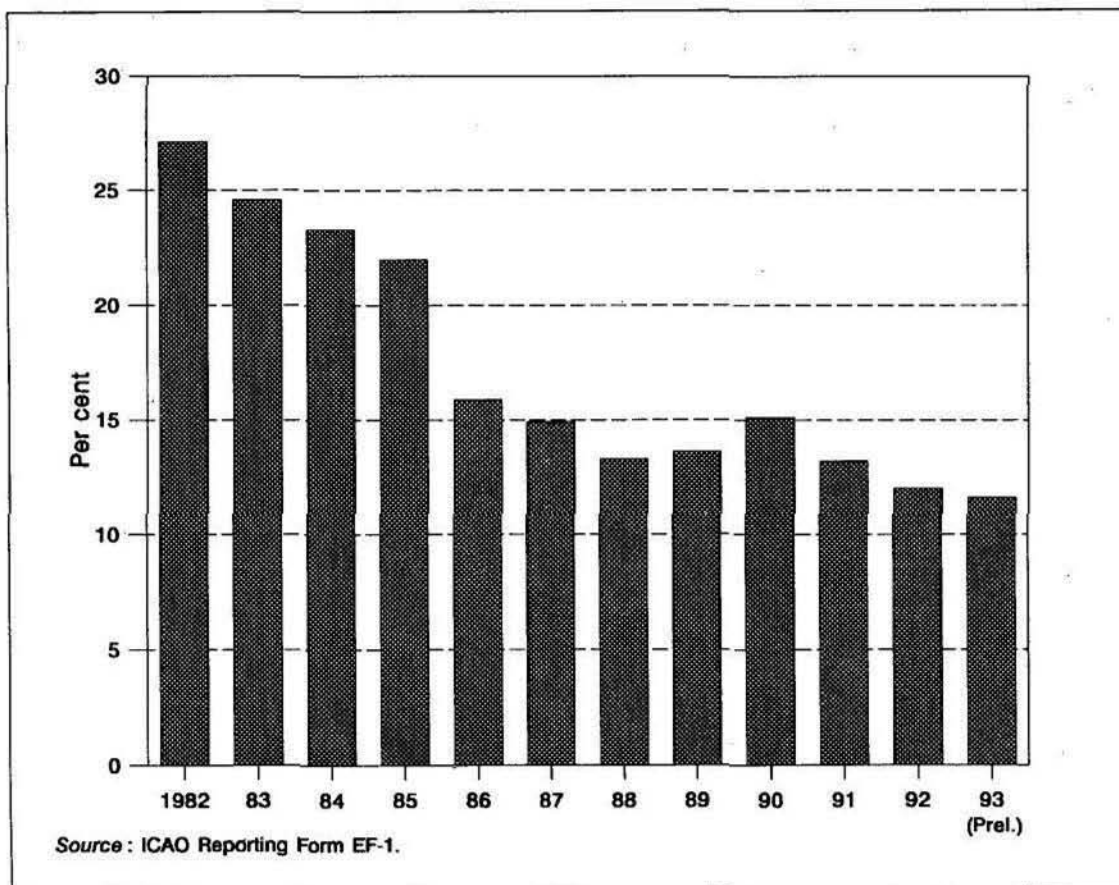


Figure 4-5. World scheduled airlines' share of fuel and oil in operating expenses, 1982-1993



13. In order to achieve and maintain a reasonable operating result of around 4 to 6 per cent, world airline yields would have to increase without as much scope as in the past to offset these upward pressures through productivity increases alone. For the forecast period, airline yields are expected to remain stable for the first five years in real terms and to increase at an average annual rate of 0.5 per cent per annum in real terms thereafter.

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## **Chapter 5**

# **FORECASTS OF AIRLINE TRAFFIC TO THE YEAR 2003**

### **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 numbers 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 1992 to 2003, in the factors which underly traffic growth:
  - a) a "most likely" average rate of world economic growth of 2.8 per cent per annum (in real terms);

- b) moderate growth in world trade at a “most likely” average rate of about 3.5 per cent per annum;
  - c) no change in average yield (fares and rates) in real terms for the five-year period 1994-1998, and an increase of 0.5 per cent per annum (in real terms) for the five-year period 1999-2003 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, 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 (again 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 per cent per annum for passenger-kilometres. Most of this growth in traffic is attributable to growth in real GDP.
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 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 1.5 per cent per annum. A “high” forecast of 7 per cent per annum results from assumptions of 3.5 per cent per annum for economic growth and an average annual decline in real fares of 0.5 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 6.5 per cent per annum compared with 4 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 some 72 per cent of all domestic scheduled traffic is accounted for by the already highly developed domestic systems in the United States and the Commonwealth of Independent 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 1982-1992 period, the increase in average journey length was more pronounced for international trips than for domestic trips.

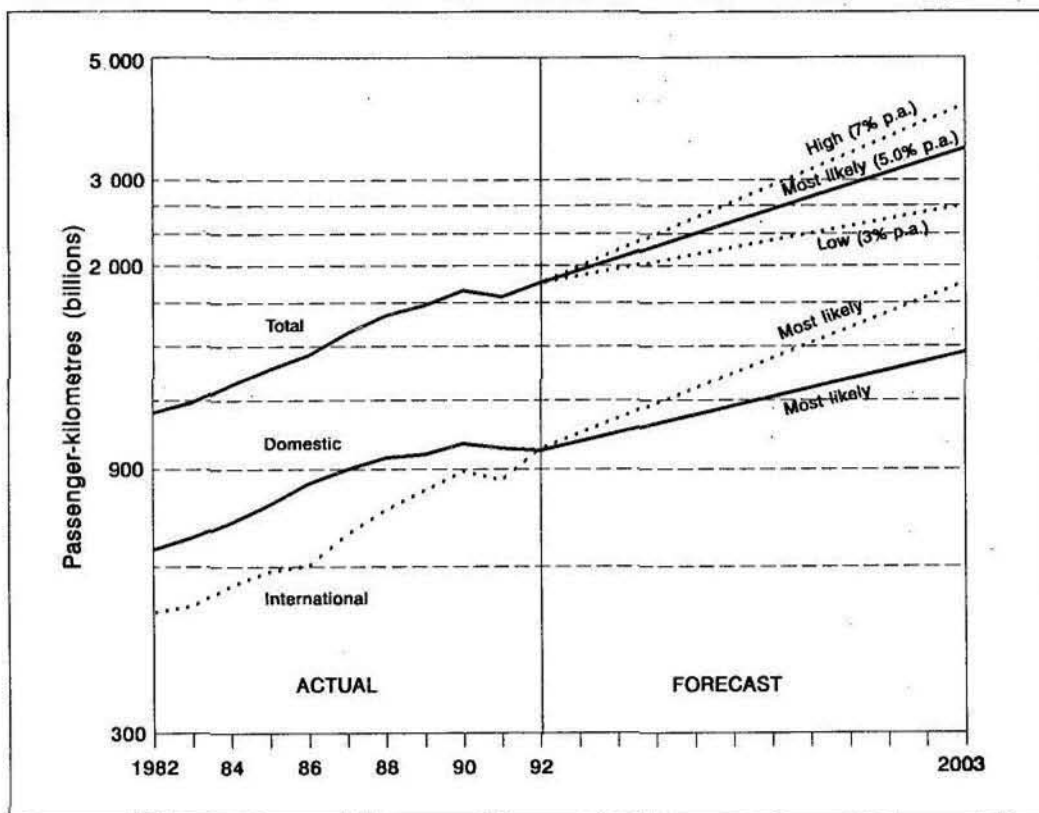


Figure 5-1. Trends in world scheduled passenger traffic  
(ICAO Contracting States)

Table 5-1. Summary of ICAO scheduled passenger traffic forecast to the year 2003  
(ICAO Contracting States)

	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	Average annual growth rate (per cent)	
					1982-1992	1992-2003*
Passenger-kilometres (billions)						
Scheduled services	1 137	1 953	1 971	3 425	5.6	5.0
International	497	980	1 046	1 960	7.0	6.5
Domestic	640	973	925	1 465	4.3	4.0
Passengers carried (millions)						
Scheduled services	759	1 167	1 171	1 835	4.4	4.0
International	170	300	320	524	5.8	5.0
Domestic	589	867	851	1 311	3.9	4.0

\* Rounded to the nearest 0.5 percentage point.

**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 1982	Actual 1992	Estimate 1993	Forecast 2003	1982- 1992	1992- 2003*	1982	1992	2003
Africa	33.7	44.0	41.7	65	2.7	3.5	3.0	2.3	1.9
International	25.8	36.6	34.6	55	3.6	4.0	5.2	3.7	2.8
Domestic	7.9	7.4	7.1	10	-0.7	3.0	1.2	0.8	0.7
Asia/Pacific	186.8	406.7	452.9	980	8.1	8.5	16.4	20.8	28.6
International	128.4	272.2	300.9	673	7.8	8.5	25.9	27.8	34.3
Domestic	58.4	134.5	152.0	307	8.7	8.0	9.1	13.8	21.0
Europe	381.3	551.7	507.6	800	3.8	3.5	33.5	28.3	23.4
International	186.9	331.1	353.5	580	5.9	5.0	37.6	33.8	29.6
Domestic	194.4	220.6	154.1	220	1.3	0.0	30.4	22.7	15.0
Middle East	33.2	53.1	58.4	100	4.8	6.0	2.9	2.7	2.9
International	26.2	44.8	49.0	88	5.5	6.5	5.3	4.6	4.5
Domestic	7.0	8.3	9.4	12	1.7	3.5	1.1	0.9	0.8
North America	441.5	806.4	816.2	1 340	6.2	4.5	38.8	41.3	39.1
International	97.6	238.8	248.8	464	9.4	6.0	19.7	24.4	23.7
Domestic	343.9	567.6	567.4	876	5.1	4.0	53.7	58.3	59.8
Latin America and Caribbean	60.3	90.7	94.0	140	4.2	4.0	5.3	4.6	4.1
International	31.6	55.9	58.8	100	5.9	5.5	6.4	5.7	5.1
Domestic	28.7	34.8	35.2	40	1.9	1.5	4.5	3.6	2.7
World	136.8	1 952.6	1 970.8	3 425	5.6	5.0	100.0	100.0	100.0
International	496.5	979.4	1 045.6	1 960	7.0	6.5	100.0	100.0	100.0
Domestic	640.3	973.2	925.2	1 465	4.3	4.0	100.0	100.0	100.0

\* Rounded to the nearest 0.5 percentage point.

## 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 1982 and 1992 and estimated traffic for 1993. The airlines of the Asia/Pacific Region are expected to continue to show the highest growth in passenger traffic, at 8.5 per cent per annum through to the year 2003, while the airlines of Africa and Europe show the lowest growth, around 3.5 per cent per annum. The slower growth in Europe can be attributed to the socioeconomic transition taking place in Eastern Europe. If Eastern Europe were to be excluded, the annual growth rate for the rest of Europe would be about 5.0 per cent. Traffic of airlines of the Middle East Region is expected to grow somewhat more than the world average at 6 per cent per annum, whereas traffic of North American airlines is expected to increase at 4.5 per cent per annum and that of Latin America at 4 per cent per annum. The growth rates for all regions represent status quo or a moderate slowdown in comparison with recent historic rates.

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

	Passengers carried (thousands)				Average annual growth rate (per cent)	
	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	1982-1992	1992-2003*
North Atlantic	16 345	35 425	34 260	60 589	8.0	5.0
Mid Atlantic	1 444	2 350	2 364	4 019	5.0	5.0
South Atlantic	1 065	2 130	2 674	3 643	7.2	5.0
Trans-Pacific	7 083	16 154	16 978	37 665	8.6	8.0
Between Europe and Asia/Pacific	5 018	14 738	16 290	32 654	11.4	7.5
Between Europe and Africa	8 568	9 399	10 289	13 010	0.9	3.0
Between Europe and Middle East	3 336	6 485	5 080	9 467	6.9	3.5
Between North America and South America	2 420	5 249	5 301	8 978	8.1	5.0
Between North America and Central-America/Caribbean	9 970	15 219	15 436	24 698	4.3	4.5
Total above routes	55 249	107 149	108 672	194 723	6.6	5.5
Other routes	114 578	193 087	211 662	329 577	5.4	5.0
Total world	169 827	300 236	320 334	524 300	5.8	5.0

\* Rounded to the nearest 0.5 percentage point.

Note.— The historic data base has been developed from several sources, including ICAO, IATA and aircraft manufacturers.

13. As a result of the expected growth in passenger traffic, the Asia/Pacific Region is expected to increase its share of world scheduled passenger traffic by about 8 percentage points to 28.6 per cent of total world traffic by the year 2003, with its share of total international scheduled passenger traffic increasing to approximately 34 per cent.

14. The other significant changes in regional shares are expected to occur in Europe and North America. The European share is anticipated to decline by almost 5 percentage points to 23.4 by the year 2003, while the North American share is expected to decline by some 2 percentage points to 39.1 per cent.

#### 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 36 per cent of international passengers in 1992, are presented in Table 5-3. With a less favourable trend in real air fares expected, forecast growth rates for the 1992-2003 period are slightly lower than during the 1982-1992 period. Traffic across the North Atlantic benefited from a stimulating competitive environment during the 1980s, growing strongly despite the maturity of the market. The second half of the 1990s should see a more moderate performance in this market. The trans-Pacific and Europe/Asia route groups are expected to remain the fastest-growing of all those identified in Table 5-3, with average annual growth rates of 8.0 and 7.5 per cent, respectively. The growth in air travel demand in these markets is supported by competitive services and by the strong economic performance of a number of Asian countries.

16. The Europe-Africa market is expected to recover in the 1992-2003 period, reflecting some improvement in the general economy. The performance of the Europe-Middle East market is particularly affected by political factors and economic conditions linked to trends in the world price of crude oil. This route group is also losing some transfer traffic because of the increasing number of direct non-stop flights between Europe and the Far East.

17. Of the remaining route groups in Table 5-3, North America-Central America and Caribbean is the largest in terms of passenger numbers. A relatively high proportion of this market is leisure travel which is responsive to the upward trend in household income levels over the long term.

### GLOBAL FREIGHT FORECASTS

18. The econometric analysis, together with the assumptions mentioned earlier, resulted in a "most likely" projected growth rate of 6.5 per cent per annum for world scheduled freight tonne-kilometres for the period 1993-2003. This is slightly lower than the 7.1 per cent per annum for the 1982-1992 period. Alternative assumptions concerning the underlying factors affecting air freight suggest a band of forecast growth rates ranging from a "low" of 4.5 per cent per annum to a "high" of 8.5 per cent per annum as illustrated in Figure 5-2.

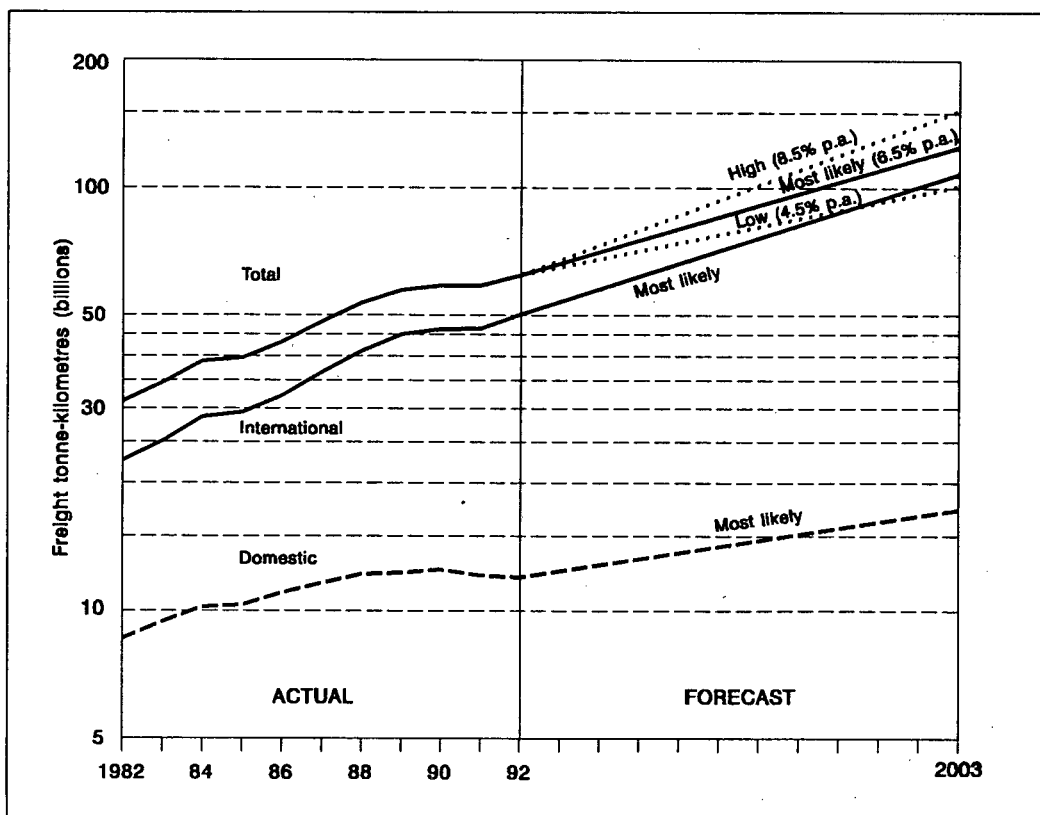


Figure 5-2. Trends in world scheduled freight traffic  
(ICAO Contracting States)

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 freight 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 1982-1992 period.

21. By the year 2003, the Asia/Pacific region is expected to increase its share of air freight traffic by 9.5 percentage points to just over 39 per cent of total world freight, a share well above that of any other region.

**Table 5-4. Summary of ICAO scheduled freight traffic forecast to the year 2003**  
(ICAO Contracting States)

	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	Average annual growth rate (per cent)	
					1982-1992	1992-2003*
Freight tonne-kilometres (millions)						
Scheduled services	31 235	62 050	67 650	124 860	7.1	6.5
International	22 623	50 060	55 660	107 520	8.3	7.0
Domestic	8 612	11 990	11 990	17 340	3.4	3.5
Freight tonnes carried (thousands)						
Scheduled services	11 568	17 318	17 544	26 700	4.1	4.0
International	4 727	9 105	10 031	16 100	6.8	5.5
Domestic	6 841	8 213	7 513	10 600	1.8	2.5

\* Rounded to the nearest 0.5 percentage point.



**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 1982	Actual 1992	Estimate 1993	Forecast 2003	1982- 1992	1992- 2003*	1982	1992	2003
Africa	977	1 199	1 242	1 810	2.1	4.0	3.1	1.9	1.4
International	897	1 131	1 167	1 720	2.3	4.0	4.0	2.3	1.6
Domestic	80	68	75	90	-1.6	2.5	0.9	0.6	0.5
Asia/Pacific	6 972	18 430	22 083	49 000	10.2	9.5	22.3	29.7	39.2
International	6 225	16 782	20 318	45 200	10.4	9.5	27.5	33.5	42.0
Domestic	747	1 648	1 765	3 800	8.2	8.0	8.7	13.7	21.9
Europe	11 158	19 825	20 298	35 100	5.9	5.5	35.7	32.0	28.1
International	8 671	17 941	18 793	33 200	7.5	6.0	38.3	35.8	30.9
Domestic	2 487	1 884	1 505	1 900	-2.7	0.1	28.9	15.7	11.0
Middle East	1 553	2 653	2 942	4 650	5.5	5.0	5.0	4.3	3.7
International	1 493	2 591	2 867	4 550	5.7	5.5	6.6	5.2	4.2
Domestic	60	62	75	100	0.3	4.5	0.7	0.5	0.6
North America	8 719	16 868	17 674	28 900	6.8	5.0	27.9	27.2	23.1
International	3 973	9 114	9 749	18 200	8.7	6.5	17.6	18.2	16.9
Domestic	4 746	7 754	7 925	10 700	5.0	3.0	55.1	64.7	61.7
Latin America and Caribbean	1 856	3 075	3 411	5 400	5.2	5.5	5.9	5.0	4.3
International	1 364	2 501	2 766	4 650	6.3	6.0	6.0	5.0	4.3
Domestic	492	574	645	750	1.6	2.5	5.7	4.8	4.3
World	31 235	62 050	67 650	124 860	7.1	6.5	100.0	100.0	100.0
International	22 623	50 060	55 660	107 520	8.3	7.0	100.0	100.0	100.0
Domestic	8 612	11 990	11 990	17 340	3.4	3.5	100.0	100.0	100.0

\* Rounded to the nearest 0.5 percentage point.

### 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 3.5 to 6.0 per cent per annum for passenger-kilometres with freight tonne-kilometres generally forecast to grow at a slightly higher rate.

23. Separate forecasts 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 1992-1997 period, indicates an average growth of 6.6 per cent per annum for international passengers.

**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	1991-2000	—	7.8
	1992-2001	5.8	—
	2002-2011	5.1	—
Boeing			
Domestic	1993-2013	4.7	—
International	"	5.6	—
Total	"	5.2	—
Rolls-Royce	1993-2012	5.2	—
McDonnell Douglas	1990-2000	6.5	8.5
Fokker	1994-2013	3.5*	—

*Sources:*

- Airbus Industrie, "Global Market Forecast", February 1993;
- Boeing Commercial Airplane Company, "Current Market Outlook", May 1994;
- Rolls-Royce, "Market Outlook 1993-2012", April 1994;
- McDonnell Douglas Corporation, "Outlook for Commercial Aircraft 1991-2010", January 1992.
- Fokker, "Market Outlook", July 1994.

\* Intra-regional scheduled growth in available seat-kilometres.

## **Chapter 6**

# **FORECASTS OF AIRCRAFT MOVEMENTS TO THE YEAR 2003**

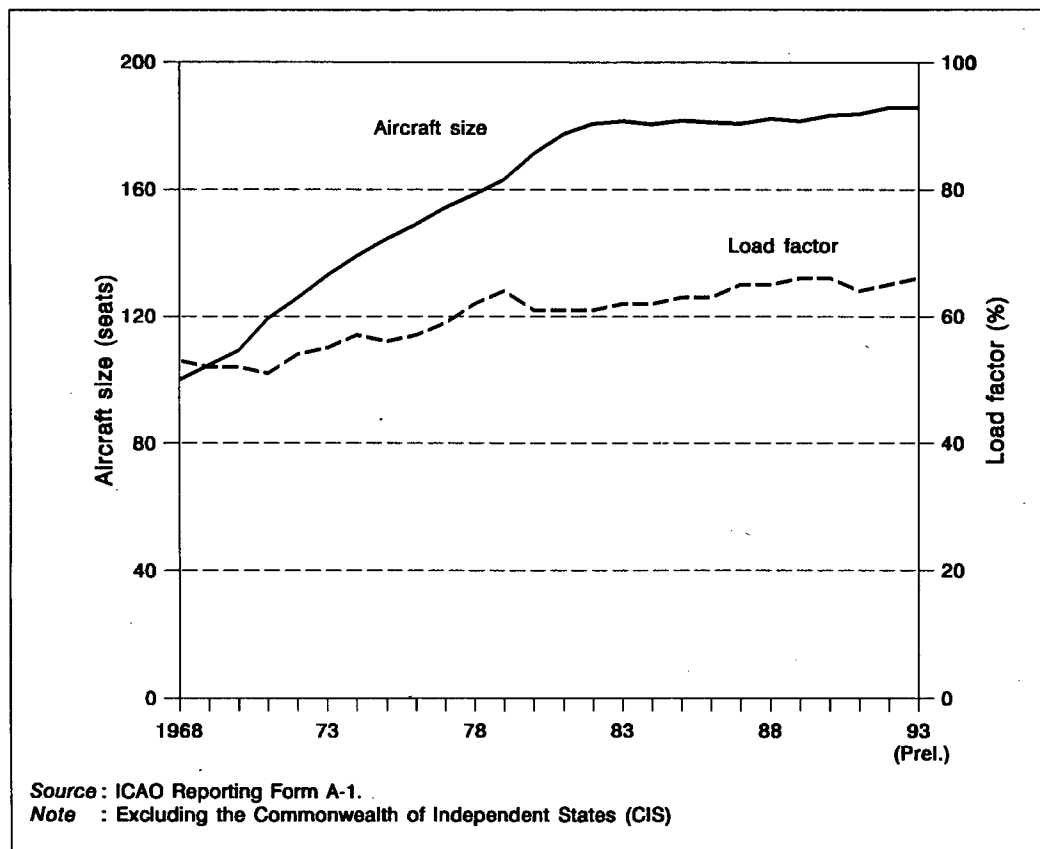
### **FACTORS AFFECTING AIRCRAFT MOVEMENTS**

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 grew more rapidly over the 1980s than over the previous 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. The trends over the past two decades 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. It is expected that the world scheduled passenger load factor, which increased from 64 per cent in 1982 to 66 per cent in 1992, will rise to about 68 per cent by 2003.
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, 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 began to emerge 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-sized, 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 trans-Atlantic service after 1984. The proliferation of direct trans-Atlantic services between North America and Europe is demonstrated by the fact that the number of city-pairs connected by at least weekly non-stop flights increased from 90 to around 230 between 1982 and 1992. The trans-Pacific market also experienced an increase in the number of city-pairs with direct services, but the penetration of B-767 services was very limited, and the decline in average aircraft size (due to a modest increase in the share of DC-10/L-1011 flights at the expense of B-747 flights) was less significant than for the North Atlantic.



**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 financial pressures from the current economic climate and the more liberal regulatory environment are forcing consolidation and alliances among airlines which might eventually reduce the pressures to increase flight frequency at the expense of aircraft size. The buildup of airport and airspace congestion over the decade is another factor which would favour larger aircraft. Furthermore, the new technology aircraft becoming available in the 1990s, such as the B-777, A-330, A-340 and MD-11, are larger than the new aircraft of the 1980s. For these reasons, it is assumed that the average aircraft size will begin to increase again and could reach almost 220 seats by 2003 compared with 185 seats in 1992.

### MEASURES OF AIRCRAFT MOVEMENTS

10. Aircraft movements can be measured in terms of the number of aircraft-kilometres (or aircraft hours) flown or the number of aircraft departures. 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 between 1 and 2 per cent 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. These gradually moderating trends can be extrapolated into the forecast period. The average stage length is expected to grow at about 1 per cent per annum between 1992 and 2003.

### 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 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 over-all trend is very small. The forecast in terms of 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 1992-2003 are given below:

- a) a growth in passenger-kilometres of 5 per cent per annum;
- b) an increase in average load factor from 65 to 68 per cent;

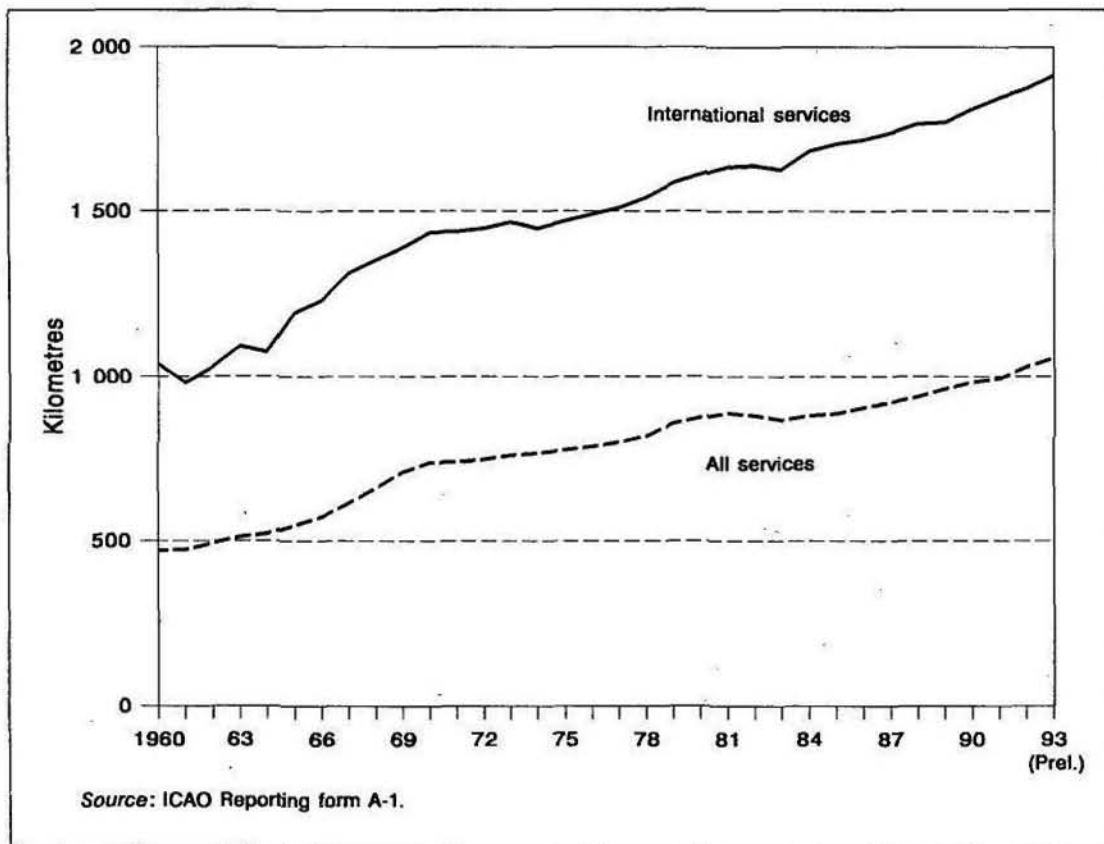
- c) a growth in average passenger aircraft size (in terms of seats) of 1.6 per cent per annum;
- d) a growth in average aircraft stage length of 1 per cent per annum.

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

### FORECASTS OF WORLD SCHEDULED AIRCRAFT MOVEMENTS

14. The above analyses led to forecast average world annual growth rates of nearly 3 per cent for aircraft-kilometres and nearly 2 per cent for aircraft departures over the period 1992 to 2003.

15. The growth rate for aircraft kilometres is below the growth rate for passenger-kilometres by about two percentage points 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 per cent per annum, which is equal to the growth in stage length.



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

16. In Table 6-1, the forecasts for 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. Despite lower traffic growth, the growth in aircraft movements for most of the 1980s and 1990s was relatively buoyant when compared with those of the 1970s. This was a consequence of slower growth in average aircraft size and load factor.

17. In Chapter 2 it was noted that traffic growth throughout most of the 1980s placed increasing demands on the aviation infrastructure. Although the recent recession has temporarily eased the pressure, the forecasts imply an increase of about 37 per cent in aircraft-kilometres and 23 per cent in aircraft departures between 1992 and 2003. In absolute terms, the increase in aircraft kilometres between 1992 and 2003 is expected to be only a little smaller than the increase that occurred between 1982 and 1992. The absolute increase in aircraft departures is forecast to be about 3.4 million between 1992 and 2003 compared with 4.3 million between 1982 and 1992. Over-all increases of this magnitude could mean serious congestion of certain already hard-pressed airport and airspace facilities by the end of the decade. It is important to recognize that in arriving at these forecasts, no allowance has been made for increased supply constraints. That is, it has been assumed that the supply of air traffic control and airport services keeps pace with demand in the same way that it has in the past.

**Table 6-1. ICAO scheduled aircraft movements  
forecast to the year 2003<sup>1</sup>**

	Actual 1972	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	Average annual growth rate (per cent)		
						1972- 1982	1982- 1992	1992- 2003
Aircraft-kilometres (millions)	7 209	9 140	15 421	15 990	21 200	2.4	5.4	2.9
Aircraft departures (thousands)	9 646	10 379	14 693	15 130	18 100	0.7	3.5	1.9

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 32 years, but excluding the Commonwealth of Independent States and China. 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:

$$\ln \text{PKP} = 1.60 + 2.08 \ln \text{GDP} - 0.66 \ln \text{PYIELD} \quad R^2 = 0.999$$

(24.7)                      (6.3)

Estimated freight model:

$$\ln \text{FTK} = 0.79 + 1.49 \ln \text{EXP} - 0.51 \ln \text{FYIELD} \quad R^2 = 0.996$$

(19.2)                      (6.5)

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

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## Appendix 2

### MODEL FOR AIRCRAFT MOVEMENT FORECASTS

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

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

The forecast for aircraft-kilometres for scheduled passenger aircraft in the year 2003 was generated by substituting into this expression the assumptions for passenger-kilometres, average load factor and average aircraft size in the year 2003 (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 1992 to 2003 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:

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

The forecast for aircraft departures in the year 2003 was generated by substituting into this expression the forecast for aircraft-kilometres and the assumption for average stage length in the year 2003.

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. 1992 to 2003).

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 below.

**Table A2-1. Contributions to the growth in world aircraft movements**

						Average annual growth rate (per cent)		
	Actual 1972	Actual 1982	Actual 1992	Estimate 1993	Forecast 2003	1972- 1982	1982- 1992	1992- 2003
Passenger-kilometres (billions)	465	970	1 786	1 866	3 050	7.6	6.3	5.0
Passenger load factor (%)	54	61	65	65	68	1.2	0.6	0.4
Passenger aircraft size (seats)	126	181	185	185	220	3.7	0.2	1.6
Aircraft stage length (km)	747	881	1 050	1 060	1 170	1.7	1.6	1.0
Aircraft-kilometres (millions)	7 209	9 140	15 421	15 990	21 200	2.4	5.4	2.9
Aircraft departures (thousands)	9 646	10 379	14 693	15 130	18 100	0.7	3.5	1.9

— 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 the economics of airports and en-route air navigation facilities, 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 regional studies on the development of international air passenger, freight and mail traffic and specialized studies of a world-wide 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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