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OUTLOOK FOR AIR TRANSPORT TO THE YEAR 2001

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and published under his authority*

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Foreword

Introduction

1. This circular is the first in a new series resulting from a rationalization by the Council in 1991 of the various reviews of developments in civil aviation published by the Organization. The 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, similar to those contained in the former triennial circular on *The Economic Situation of Air Transport*, for the period through to the year 2001. In addition, it includes passenger traffic forecasts for international route groups and global forecasts of aircraft movements, again through to the year 2001. The intention is that similar circulars be produced on a biennial or triennial basis and be made available to each regular Session of the Assembly.

2. In response to requests at the 26th and 27th Sessions of the Assembly, medium-term forecasts are now also produced. The first set covers world airline scheduled passenger traffic, in total and by region of registration, and, in general and global terms, world airline finances, for the period 1992-1994. This first set of forecasts is being presented to the 29th Session of the Assembly in the form of a working paper (A29-WP/15). Further sets are to be produced each year and included in a new annual publication entitled *The World of Civil Aviation, 19.. to 19..*, commencing with the base year 1992. This new publication will also contain much of the information on civil aviation developments presently appearing in Chapter I of the Annual Report of the Council.

Sources of information

3. In addition to the ICAO Digests of Statistics, use has been made of many of the Organization's economic studies, such as the former triennial review, 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 the 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 1991.

4. 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).

5. Unless indicated otherwise, all references in this circular to "cents" mean U.S. cents, and all references to "dollars" mean U.S. dollars.

Status

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

Table of Contents

	<i>Page</i>
Chapter 1. Summary	1
Chapter 2. Air transport trends and challenges	5
Economic growth and airline traffic patterns	5
Scheduled passenger, freight and mail traffic	5
Scheduled international and domestic traffic	7
Scheduled international traffic by region	7
Non-scheduled traffic	8
Aircraft movements	10
Fleet composition and productivity	11
Airport and airspace congestion	12
Environmental protection	14
Financial resources	15
Economic regulation	15
Industry structure	16
Chapter 3. World economic environment	18
Historical trends	18
Outlook	18
Chapter 4. Airline financial trends	20
Operating revenues, expenses and results	20
Distribution of revenues and operating expenses	24
Regional trends in revenues and expenses	25
Yields and unit costs	26
Outlook	26
Chapter 5. Forecasts of airline traffic to the year 2001	29
Forecasting methodology	29
Main assumptions and econometric models	29
Global passenger forecasts	30
Regional passenger forecasts	30
Passenger forecasts for intercontinental route groups	32
Global freight forecasts	34
Regional freight forecasts	36
Summary of air traffic forecasts by other organizations	36

	<i>Page</i>
Chapter 6. Forecasts of aircraft movements to the year 2001	39
Factors affecting aircraft movements	39
Measures of aircraft movements	41
Forecasting methodology	41
Forecasts of world scheduled aircraft movements	42
Appendix 1. Econometric models of demand for world scheduled air traffic	45
Appendix 2. Model for aircraft movement forecasts	46

Chapter 1

SUMMARY

1. During the period 1960-1990, the aggregate economic activities of the world measured by Gross Domestic Product (GDP) increased at an average annual rate of 3.8 per cent in real terms. The average annual growth rates for the ten-year periods 1960-1970, 1970-1980 and 1980-1990 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 9.5 per cent for the 1960-1990 period. For the ten-year periods 1960-1970, 1970-1980 and 1980-1990, traffic grew at an average annual rate of 13.4, 9.0 and 5.7 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 11.7 per cent over the 1960-1990 period. For the ten-year periods 1960-1970, 1970-1980 and 1980-1990, freight traffic grew at an average annual rate of 17.8, 10.9 and 7.2 per cent, respectively.
4. The growth in passenger and freight traffic demand over the 1960-1990 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 (3.6 per cent per annum) due primarily to a large increase in average aircraft size during this period.
5. During the period 1960-1990, average world passenger yield measured in real terms (expressed in U.S. cents per PKP) declined at a rate of 2.2 per cent per annum. Freight and mail yield measured in real terms (expressed in U.S. cents per TKP) decreased at a rate of 3.4 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 1.9 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 1990-2001, world economic growth (GDP) is expected to increase at an average annual rate of 2.6 per cent in real terms. Airline yields are expected to increase at an average annual rate of 0.5 per cent in real terms, 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 1990-2001. International traffic is expected to

increase at 6 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 per cent per annum through to year 2001, while the airlines of Africa, Europe and Latin America are expected to show growth rates below the world average, around 3.5 per cent per annum. Airlines of the Middle East and North America are expected to grow at about the world average.

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 2001.

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 1990-2001. International freight traffic is expected to increase at an average annual growth rate of 7.5 per cent compared with a domestic freight traffic growth of 3 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 1990-2001 are expected to increase at average annual growth rates of 2 and 3 per cent, respectively.

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

Table 1-1. Summary of ICAO air traffic forecasts for the year 2001 (world-wide)

	Actual 1980	Actual 1990	Estimate 1991	Forecast 2001	Average annual growth rate (per cent)	
					1980- 1990	1990- 2001*
TOTAL SCHEDULED SERVICES						
Passenger-kilometres (thousand millions)	1 089	1 893	1 826	3 232	5.7	5.0
Freight tonne-kilometres (millions)	29 133	58 869	57 160	118 440	7.3	6.5
Passengers carried (millions)	748	1 164	1 113	1 800	4.5	4.0
Freight tonnes carried (thousands)	11 090	18 288	17 310	29 016	5.1	4.5
Aircraft kilometres (millions) ¹	9 350	14 307	13 949	19 800	4.3	3.0
Aircraft departures (thousands) ¹	10 691	14 553	14 246	18 000	3.1	2.0
INTERNATIONAL SCHEDULED SERVICES						
Passenger-kilometres (thousand millions)	466	894	858	1 697	6.7	6.0
Freight tonne-kilometres (millions)	20 261	46 393	45 150	100 920	8.6	7.5
Passengers carried (millions)	163	280	261	490	5.6	5.0
Freight tonnes carried (thousands)	4 390	8 860	8 386	15 966	7.3	5.5

* Rounded to the nearest 0.5 percentage point.

1. Excludes the Russian Federation.

**Table 1-2. Summary of ICAO air traffic forecasts for the year 2001
(by region of airline registration)**

	<i>Actual</i>		<i>Estimate</i> 1991	<i>Forecast</i> 2001	<i>Average annual growth rate (per cent)</i>	
	1980	1990			1980- 1990	1990- 2001*
TOTAL SCHEDULED SERVICES						
Passenger-kilometres (thousand millions)						
Africa	29.7	42.0	41.2	62	3.5	3.5
Asia/Pacific	160.1	344.1	347.0	820	8.0	8.0
Europe	365.2	590.4	549.8	880	4.9	3.5
Middle East	28.4	47.0	43.2	80	5.2	5.0
North America	445.3	782.3	757.4	1 260	5.8	4.5
Latin America and Caribbean	60.2	87.4	87.6	130	3.8	3.5
Freight-tonne kilometres (millions)						
Africa	796	1 166	1 140	1 830	3.9	4.0
Asia/Pacific	5 596	16 337	16 453	45 800	11.3	10.0
Europe	10 749	20 008	19 210	36 300	6.4	5.5
Middle East	1 339	2 440	2 135	4 110	6.2	5.0
North America	9 060	16 173	15 571	25 600	6.0	4.5
Latin America and Caribbean	1 593	2 745	2 651	4 800	4.0	5.0
INTERNATIONAL SCHEDULED SERVICES						
Passenger-kilometres (thousand millions)						
Africa	22.4	33.1	32.1	50	4.0	4.0
Asia/Pacific	105.4	236.0	231.8	590	8.4	8.5
Europe	184.4	313.6	294.7	500	5.5	4.5
Middle East	22.0	38.1	34.5	67	5.6	5.5
North America	98.9	220.9	213.8	410	8.4	6.0
Latin America and Caribbean	33.3	51.9	50.7	80	4.5	4.0
Freight-tonne kilometres (millions)						
Africa	720	1 075	1 050	1 710	4.1	4.5
Asia/Pacific	4 991	14 830	14 851	42 500	11.5	10.0
Europe	8 232	17 413	16 860	33 000	7.8	6.0
Middle East	1 307	2 351	2 054	3 950	6.0	5.0
North America	3 792	8 532	8 204	15 800	8.4	6.0
Latin America and Caribbean	1 219	2 192	2 131	3 960	6.0	5.5

* Rounded to the nearest 0.5 percentage point.

**Table 1-3. Summary of ICAO air traffic forecasts for the year 2001
(by international route group)**

	<i>Actual</i>		<i>Forecast</i> 2001	<i>Average annual growth rate (per cent)</i>	
	1980	1990		1980- 1990	1990- 2001*
INTERNATIONAL SCHEDULED SERVICES					
Passengers carried (thousands)					
North Atlantic	16 650	30 340	51 892	6.2	5.0
Mid Atlantic	1 250	2 060	3 343	5.1	4.5
South Atlantic	1 100	1 810	2 937	5.1	4.5
Trans-Pacific	4 500	12 400	28 912	10.7	8.0
Between Europe & Asia/Pacific	4 700	10 800	23 929	8.7	7.5
Between Europe & Africa	7 520	8 400	11 347	1.1	3.0
Between Europe & Middle East	2 920	3 850	4 998	2.8	2.5
Between North America & South America	2 070	3 150	4 849	4.3	4.0
Between North America & Central America/Caribbean	9 170	15 790	27 006	5.6	5.0
Total above routes	49 880	88 600	159 213	5.9	5.5
Other routes	113 320	191 895	330 787	5.4	5.0

* Rounded to the nearest 0.5 percentage point.

Chapter 2

AIR TRANSPORT TRENDS AND CHALLENGES

ECONOMIC GROWTH AND AIRLINE TRAFFIC PATTERNS

1. 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 about 60 since 1950 (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 less than five times over the same period.
2. While growth in world air traffic has been much greater than world economic growth, economic theory and analytical studies indicate that there is a high correlation between the two and that the demand for air transport is primarily determined by economic development. Developments in personal income affect the level of consumer purchasing power and the propensity to undertake leisure travel. Commercial activity and trade have a direct impact on the demand for business travel and air freight. Figure 2-1 provides evidence of the relationship between the economy and traffic demand by illustrating the fluctuations in the rate of growth of each for the period 1960 to 1990. The economic recessions of 1974-75, 1980-82 and 1991 and their impact on air traffic are clearly visible.
3. 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

4. The growth experienced by the total demand for air transport has been shared by each of its major components — passenger, freight and mail traffic. As shown in Table 2-1, however, the average growth in 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.
5. In 1991, the world air transport industry carried 1 125 million passengers and 17 million tonnes of freight annually. The industry produced 1 215 billion passenger-kilometres (equivalent to 163 billion tonne-kilometres), 57 billion freight tonne-kilometres and 5 billion mail tonne-kilometres in 1991.

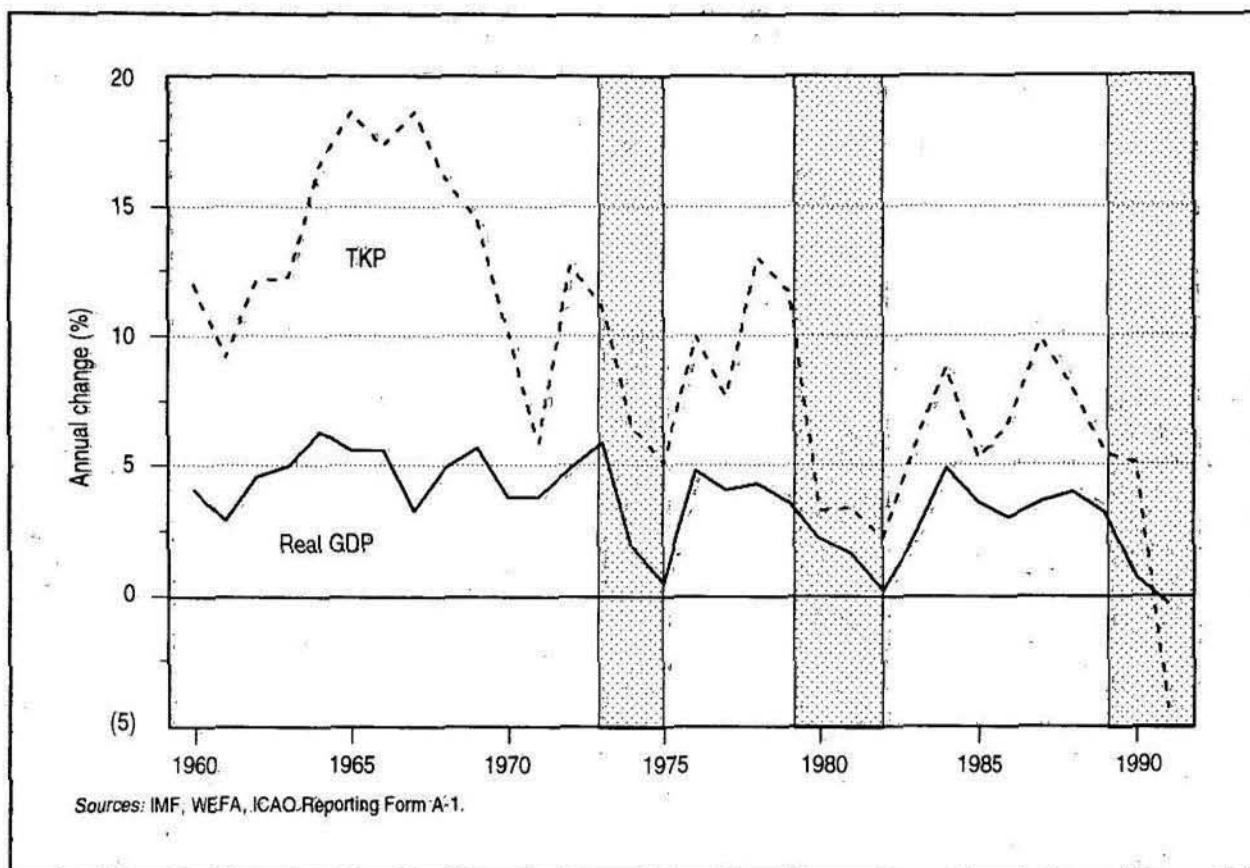


Figure 2-1. World economic and airline traffic growth
(GDP in real terms and total scheduled tonne-kilometres performed):

Table 2-1. Growth of passenger, freight and mail air traffic, 1960 to 1990

	Average annual growth (per cent)		
	1960 to 1970	1970 to 1980	1980 to 1990
Passenger-km.	13.4	9.0	5.7
Freight-tonne-km.	17.8	10.9	7.2
Mail tonne-km.	16.2	3.0	3.8
Total tonne-km.	14.5	10.6	6.0

Source: ICAO.Reporting Form A-1.

Note.— Includes domestic and international scheduled traffic.

SCHEDULED INTERNATIONAL AND DOMESTIC TRAFFIC

6. International traffic has tended to grow more rapidly than domestic traffic, particularly in the case of freight. Figure 2-2 Shows the increases over the period 1980 to 1990 in the international and domestic components of both scheduled passenger and scheduled freight traffic. The United States and the Russian Federation are the dominant producers of domestic air traffic, accounting for 76 per cent of total domestic passenger and freight traffic.

SCHEDULED INTERNATIONAL TRAFFIC BY REGION

7. Turning to the regional pattern of scheduled international traffic, Figure 2-3 shows the shares of international traffic by region of airline registration in 1980 and 1990. 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.

8. Scheduled passenger traffic trends between 1980 and 1990 on some intercontinental route groups are illustrated in Figure 2-4. The strength of the North Atlantic market, in terms of its size (30 million passengers in 1990) and growth (82 per cent between 1980 and 1990), is clearly illustrated. However, the fastest growing markets were the trans-Pacific and Europe-Asia/Pacific route groups.

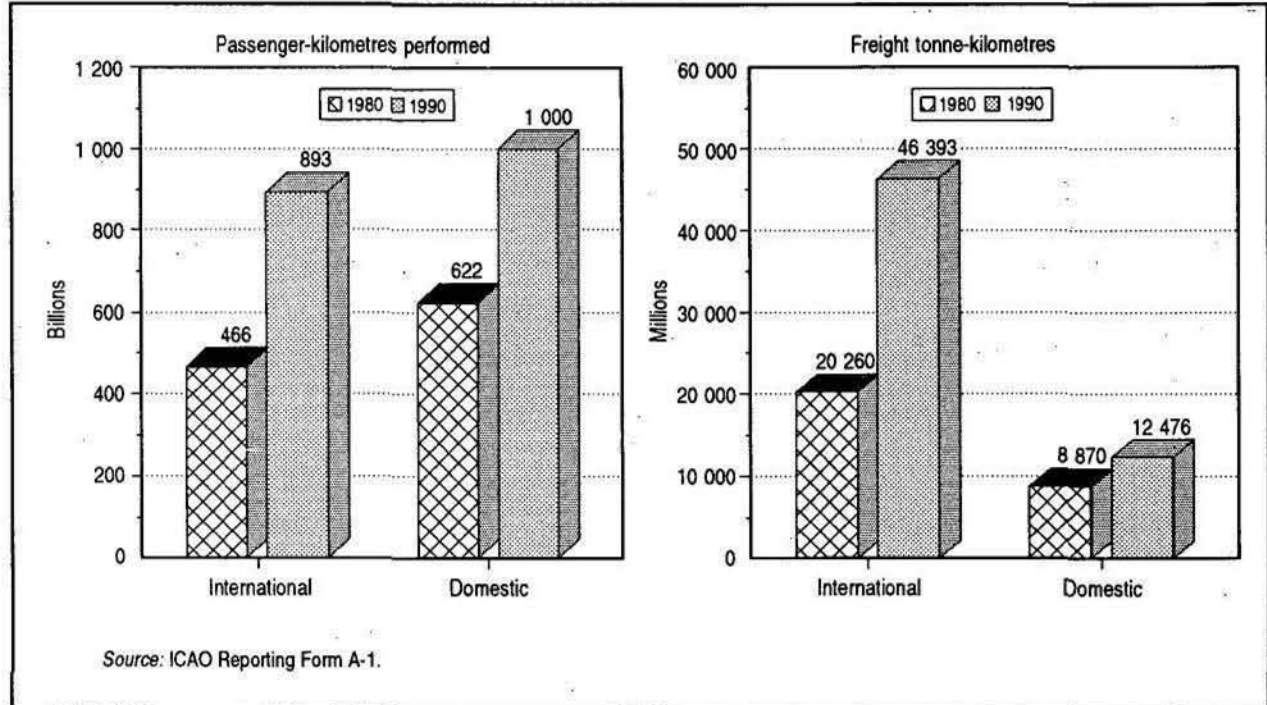


Figure 2-2. Trends in international and domestic traffic
(scheduled operations, 1980 and 1990)

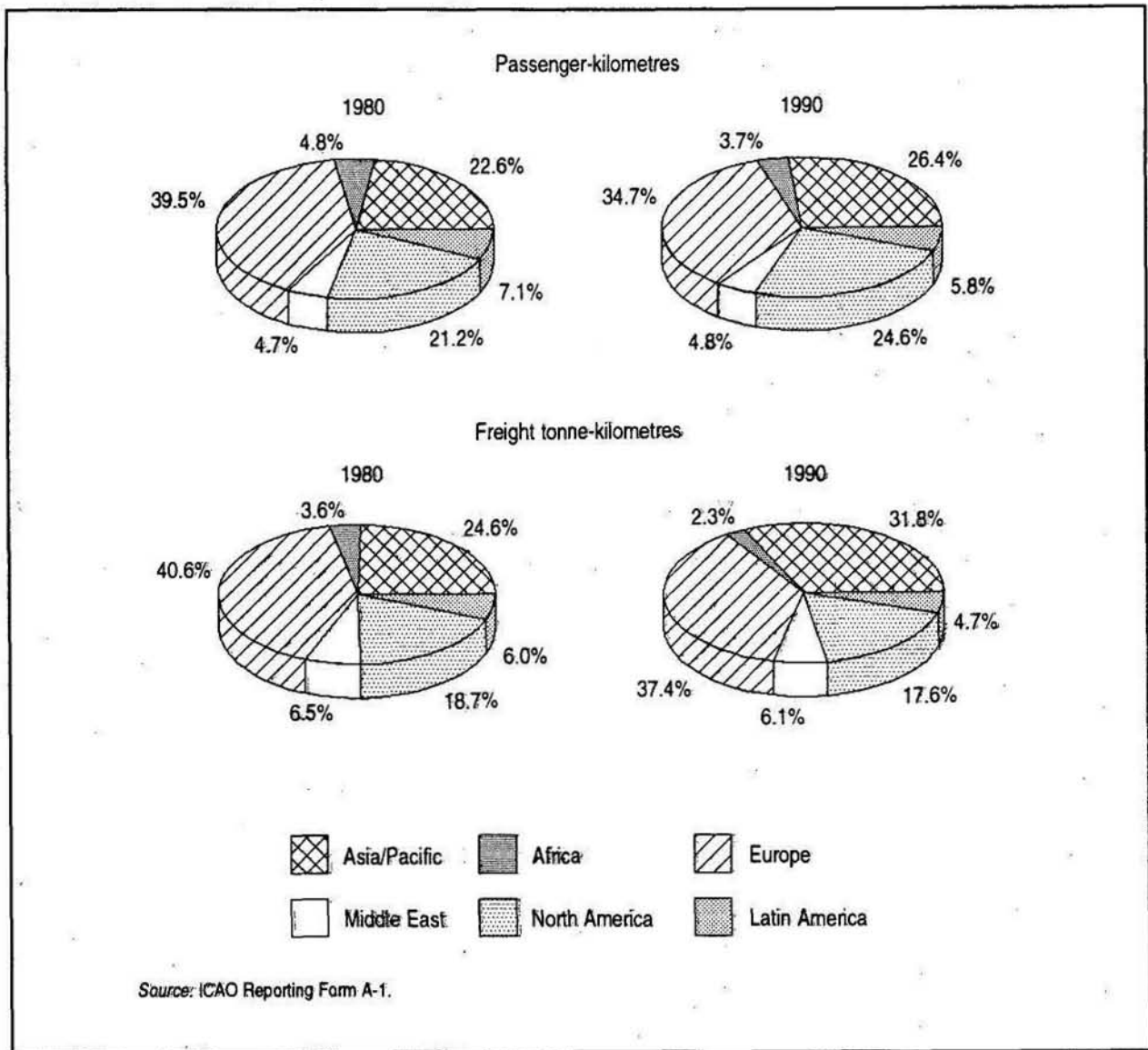


Figure 2-3. Regional shares of international traffic
(scheduled operations, 1980 and 1990)

NON-SCHEDULED TRAFFIC

9. 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.

10. Non-scheduled air transport is primarily devoted to international passenger traffic, with freight traffic and domestic traffic being relatively small by comparison. Non-scheduled passenger traffic represents about 16 per cent of the total international passenger traffic. Table 2-2 provides estimates for 1980 and 1990 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 1980s, below the 7 per cent per annum growth rate for scheduled international traffic.

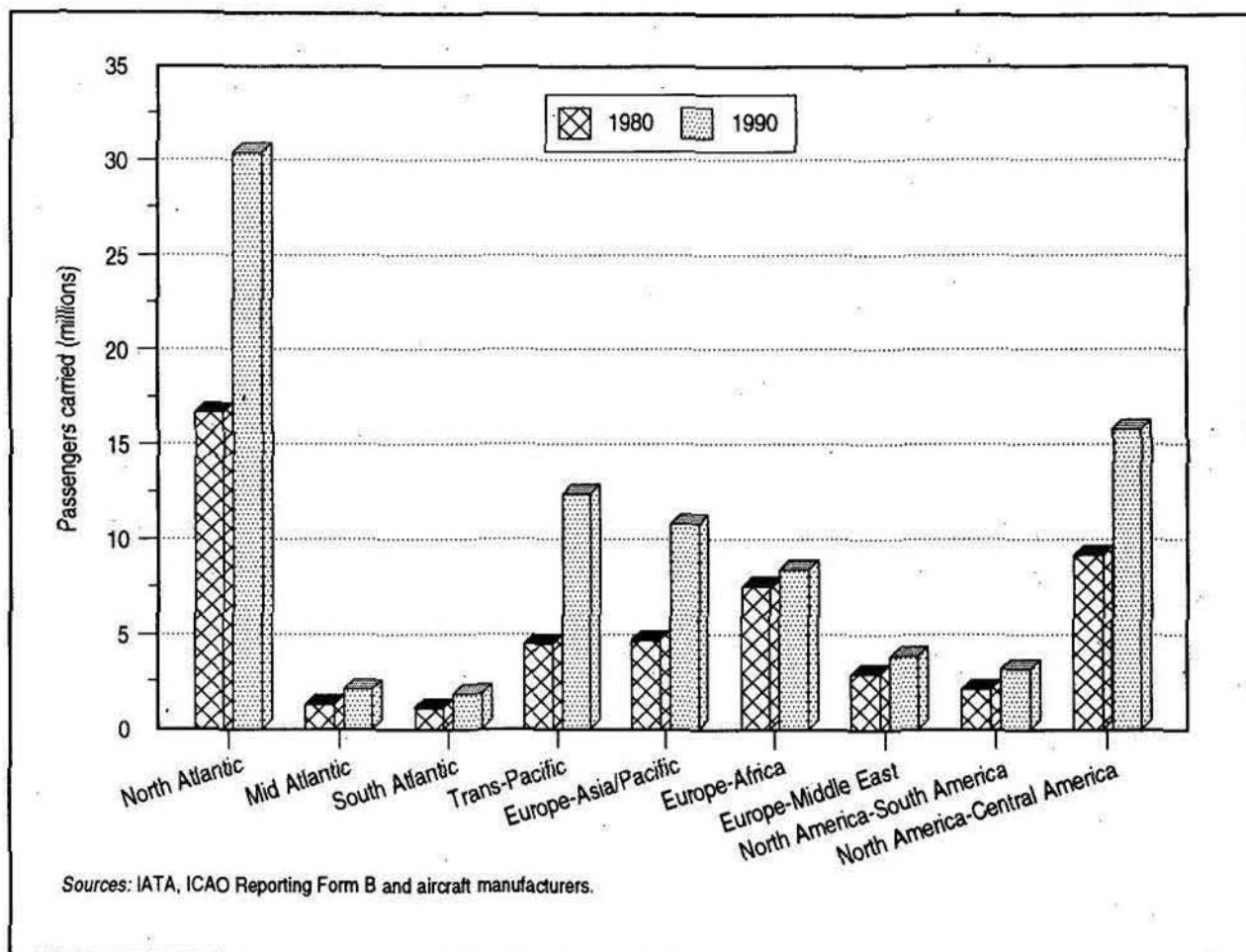


Figure 2-4. Passengers on intercontinental route groups
(scheduled operations, 1980 and 1990)

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

	1980 (billions)	1990	Average annual growth (per cent)
Non-scheduled carriers	60.6	94.3	4.5
Scheduled carriers	49.3	82.6	5.3
Total	109.9	176.9	4.9

Source: ICAO Reporting Form A-2.

11. 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.

AIRCRAFT MOVEMENTS

12. 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 2-5. A statistical smoothing technique has been used to eliminate large short-term fluctuations in order to better illustrate the trends in the relationships between the variables.

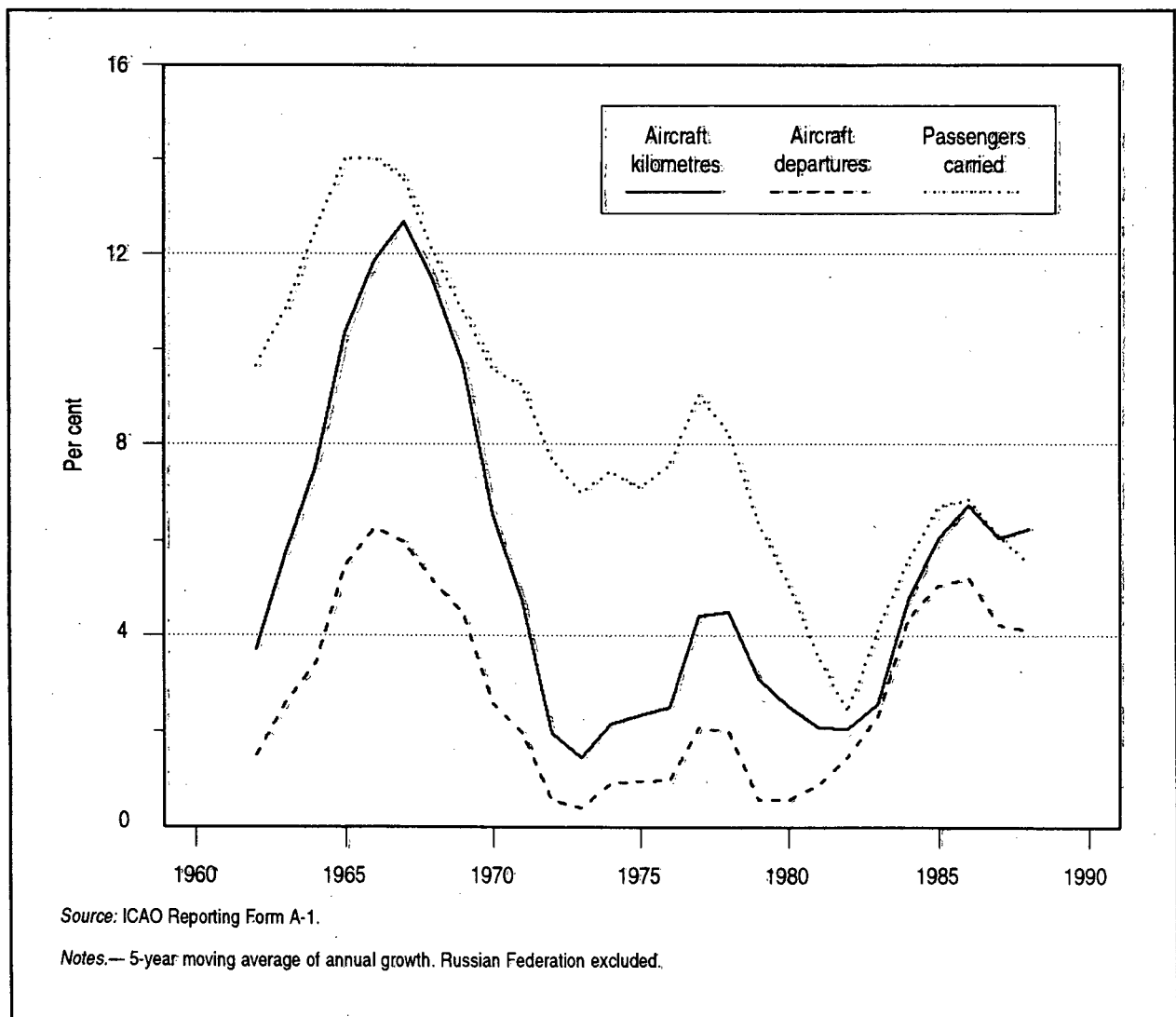


Figure 2-5. Growth in passengers and aircraft movements
(total scheduled operations, 1960 to 1990)

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

14. 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.

FLEET COMPOSITION AND PRODUCTIVITY

15. At the end of 1991, the scheduled and non-scheduled carriers of ICAO Contracting States (excluding China and the Russian Federation) had a combined fleet of about 12 970 aircraft of over 9 000 kg maximum take-off weight (MTOW) for their international and domestic operations. This is an increase of about 6 per cent over 1990 and 49 per cent over 1980. The number of jet aircraft at the end of 1991 was about 10 200, which is an increase of 6.5 per cent over 1990 and 61 per cent over 1980. Jet aircraft obviously account for an even larger proportion of carrier capacity than indicated by the relative number of aircraft.

16. Figure 2-6 contrasts the strong upward trend in the number of jet aircraft since 1960 with the slow growth in the number of turbo-prop aircraft and the decline in piston-engined aircraft. Figure 2-7 illustrates the changing composition of the jet fleet among narrow-body and wide-body and 2-, 3-, and 4-engine aircraft. The 2-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 2-engine wide-body aircraft (now increasingly providing long-haul services) grew rapidly during the 1980s.

17. 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. It is difficult to construct a single measure of input because of the diversity of inputs, which include aircraft and other equipment, fuel and various categories of labour. Several partial productivity measures, each using a different input measure, are therefore shown in Table 2-3 for the aggregated operations of international scheduled airlines.

18. The change in average output per aircraft is broken down into four components, i.e. changes in load factor, aircraft size, aircraft speed and aircraft utilization. Over-all output in terms of TKP per aircraft increased at an average annual rate of a little more than 4 per cent between 1980 and 1990. Over the same period, labour productivity (measured by TKP per employee and TKP per flight crew member) increased at an average annual rate of about 5 per cent. Fuel efficiency (TKP per litre consumed) improved at an average annual rate of about 3.5 per cent.

19. Airline requirements for lower unit costs and competitive service frequencies have been met by incorporating new technology in aircraft and engine design and by providing an increased diversity of aircraft types in terms of their size and range characteristics. An impressive number of entirely new aircraft (for example, Boeing 757 and 767, Airbus 310 and 320, MD-11, BAe 146, Fokker 100) and new engines (for example, Pratt and Whitney PW 4000, Rolls Royce 535 and Tay, General Electric CF6-80C2), as well as many upgraded derivatives of existing aircraft and engine types, have been introduced into airline fleets over the past decade. Unit costs (i.e. costs per

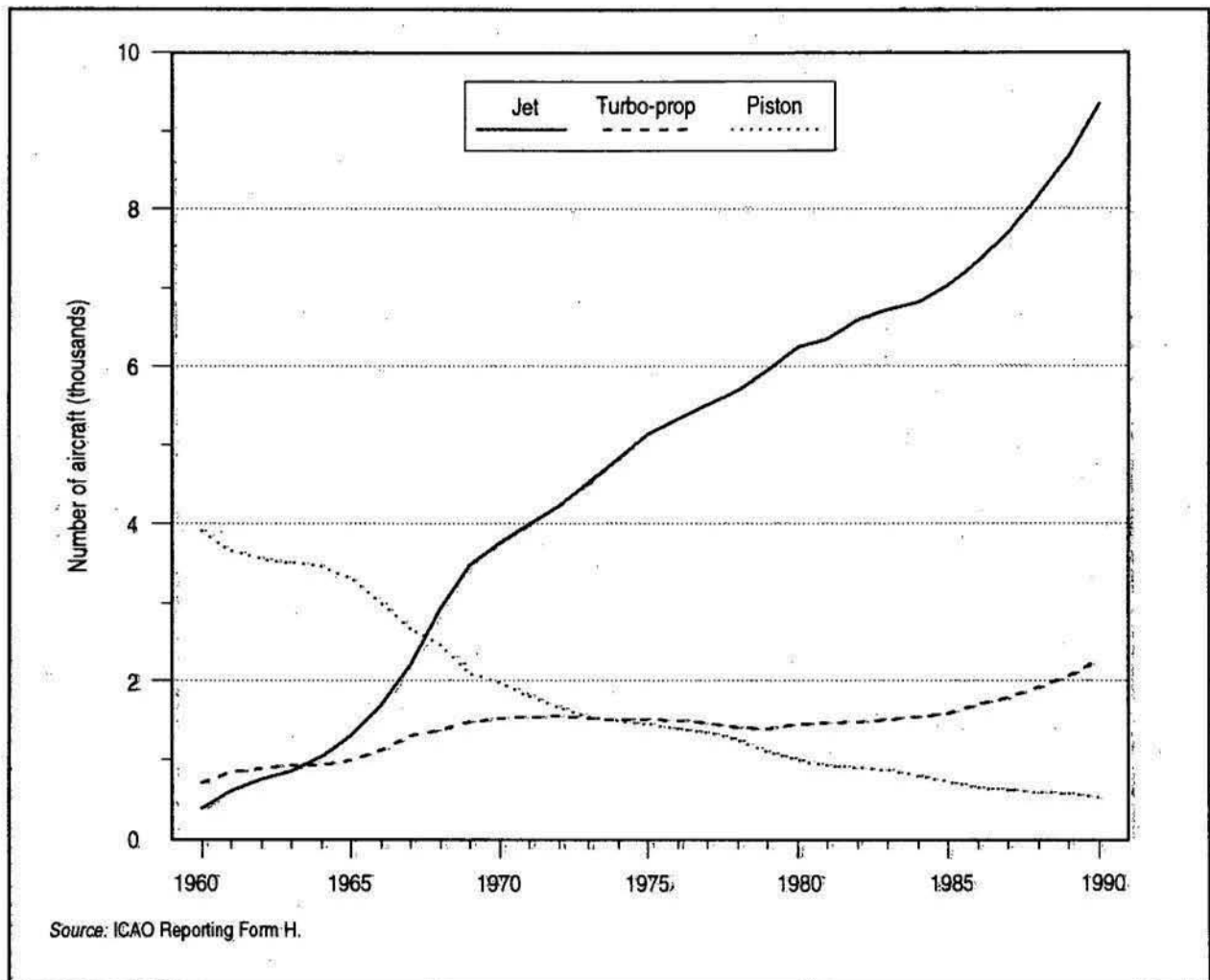


Figure 2-6. Composition of world commercial transport fleet
(aircraft of 9 000 kg MTOW and over)

available tonne-kilometre) have fallen at an average annual rate of 2 per cent in real terms, even without the benefits of economies of scale from increasing average aircraft size which were available in previous decades. Furthermore, the new aircraft have much improved noise, emission and fuel efficiency characteristics than older aircraft.

AIRPORT AND AIRSPACE CONGESTION

20. Growth in passengers of over 50 per cent and in aircraft departures of about 35 per cent over the 1980s has produced 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. Relatively few new airports have been built during the past decade or are currently under construction in the most congested areas 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.

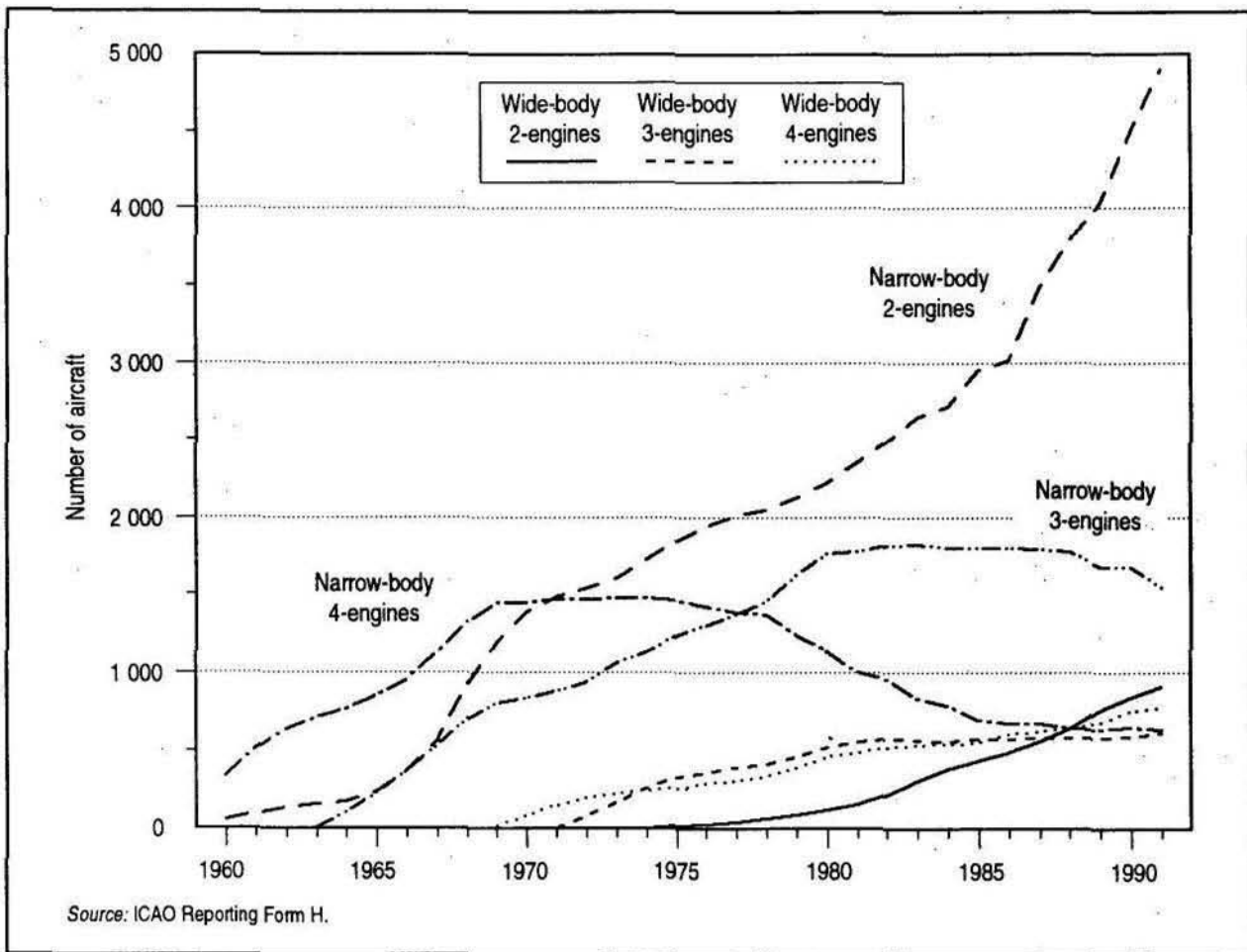


Figure 2-7. Composition of world commercial jet fleet
(aircraft of 9 000 kg MTOW and over)

21. 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) concept adopted by ICAO in 1991 is expected to lead to significant improvements. This concept 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.

22. 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.

23. 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.

Table 2-3. Developments in productivity, 1980 to 1990
(international scheduled airlines)¹

Productivity measure	Average levels		Absolute increase (per cent)	Average annual increase (per cent)
	1980	1990		
TKP/aircraft (000)	17 600	26 900	53	4.3
Components of TKP/aircraft				
Aircraft load factor (per cent)	55.6	59.3	6.7	0.6
Aircraft payload (tonnes per aircraft)	22.9	25.5	11	1.1
Aircraft speed (km per hour)	636	629	-1.1	-0.1
Aircraft utilization (hours per aircraft per year)	2 180	2 830	30	2.6
TKP per employee (000)	116	188	62	5.0
TKP per flight crew member (000)	1 110	1 790	61	4.9
TKP per litre of fuel (index) ²	100	141	41	3.5

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

Note.—TKP per block-hour is another commonly used measure of productivity and is the combination of aircraft load factor, payload and speed.

1. Includes domestic and non-scheduled operations of these airlines.
2. Includes international operations only.

24. 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 eventual completion of the Channel Tunnel between France and the United Kingdom.

ENVIRONMENTAL PROTECTION

25. Future growth in civil aviation will take place against a background of increasing public concern regarding the environment. Until recently, the most important environmental problem associated with civil aviation was aircraft noise. 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 older, noisier ("Chapter 2") aircraft between 1995 and 2002. Aircraft noise is therefore likely to decline in general terms in the next decade but may eventually increase again.

26. Aircraft engine emissions are now becoming a greater concern as a result of new information indicating that they may be contributing to global warming (the so-called "greenhouse" effect) and depletion of the ozone layer. The main environmental challenge facing civil aviation in the next decade is to determine the contribution of engine emissions to these problems and to identify appropriate solutions. Such solutions could have

far-reaching consequences for civil aviation. ICAO has developed Standards for the control of gaseous emissions through an engine certification scheme (Annex 16, Volume II). The work programme of ICAO's Committee on Aviation Environmental Protection has recently been substantially revised so as to give much greater emphasis to determining the contribution of engine emissions to problems in the upper atmosphere and to identifying appropriate solutions to these problems. *In the search for solutions, much will depend upon the progress made by aircraft engine manufacturers in developing "cleaner" engines.*

FINANCIAL RESOURCES

27. The implications of aging equipment, traffic growth and technology developments for investment in civil aviation have been 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 U.S. \$800 billion of investment funds will be required over the next 20 years for air carrier fleets and about U.S. \$250-\$350 billion for airport and en-route facilities. The study also identifies 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 notes the need for further innovation in order to meet the funding requirements.

28. 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

29. The shape and size of the air transport system have been and will continue to be influenced by governmental decisions, whether they be those of individual States or those made on a bilateral or multilateral basis. Although decisions continue to be made largely by air transport authorities, there has been increased involvement in airline regulation by bodies outside the system.

30. The most significant regulatory development within the system has been the moves 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 service levels 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. Several governments have sought to change their international arrangements so as to bring about "open skies", most notably the five Andean Pact countries which, in 1991, agreed to eliminate most economic controls on their airlines.

31. In many countries liberalization has produced varying degrees of privatization of government-owned airlines. A growing number of domestic airlines have begun international service and some international airlines have started domestic operations. Minority equity participation in national airlines by foreign airlines has occurred with increasing frequency in all regions as well as moves towards more substantial ownership and even potential control.

At the same time various countries and airlines have become interested in acquiring cabotage (i.e. domestic) traffic rights in order to increase market access. In some limited cases access to international traffic is being gained outside bilateral agreements by national actions taken to increase services to certain communities and airports.

32. The liberalization and further potential liberalization of air transport has also raised important questions. What impact will liberalization have on traffic demand? What are the consequences for the airports and airspace system? Can high standards of safety regulation be maintained over the long run where the economic regulation of air carriers has been significantly lessened? Can the benefits of liberalization be sustained in circumstances where airline concentration has made it more difficult to start a new airline? Should new "plurilateral" or multilateral arrangements be found to replace bilateral air services agreements for the exchange of air traffic rights and the progressive liberalization of air services?

33. In recent years air transport authorities have become increasingly concerned about the interest shown by competition law authorities in the regulation of international air transport. The establishment of unified regional economic markets has also evoked concerns about possible adverse effects on the national airlines of non-participating States and about potential actions by the economic union to supplement or supplant existing national and bilateral air service regulation. The inclusion of international air transport in a broad multilateral accord on trade in services (e.g. telecommunications, transport, insurance), under consideration in the General Agreement on Tariffs and Trade (GATT), could significantly affect air transport regulation.

34. Other more general governmental measures also affect air transport. Such measures include the expansion of airline responsibilities associated with national entry requirements (particularly for inadmissible passengers), more stringent health standards for entry (particularly where prevention of the spread of acquired immune deficiency syndrome is sought), national narcotics control efforts and the imposition of various taxes on air transportation.

INDUSTRY STRUCTURE

35. The most noteworthy changes in airline industry structure are arising from the need to meet increased traffic demand, the need for creative responses to the liberalization of certain domestic and international markets, and ongoing moves towards globalization.

36. An important innovation in the United States, which is attracting 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. "Mega-carriers" 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). As both a part of this development and as a reaction to it, there has been a continuing process of formation of inter-carrier (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 enter various alliances of their own.

37. Computer reservation systems (CRS) have become 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. 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.

38. Developments in automation during the 1980s permitted the creation of sophisticated yield management systems for airlines, associated with usage of a CRS, enabling the airlines concerned to adjust the mix of high to low fare passengers on each flight in order to maximize revenues. In deregulated markets, yield management has enabled established higher-cost airlines to compete selectively, yet effectively, against new lower-cost airlines often reliant upon low fares to achieve market penetration.

39. 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, primarily in North America and Europe, which now 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.

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 thirty-year period 1960-1990, the aggregate world economy measured in terms of Gross Domestic Product (GDP) increased at an average annual rate of 3.8 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 slow-down 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 the previous ones in 1973 and 1980. They were smaller than in the earlier cases and the capability of the economies of the industrialized countries to cope with increases was greater because of reduced energy dependency and the effects of structural reforms in the 1980s. The increases also lasted for a shorter period, 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 slow-down 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.
5. World population growth between 1980 and 1990 increased at an average annual rate of 1.7 per cent. Hence, growth of the world's GDP per capita between 1980-1990 increased at an average annual rate of 1.1 per cent, significantly lower than the growth of GDP itself, as indicated in Figure 3-1.

OUTLOOK

6. There appears to be some consensus amongst major economic forecasting institutions that global economic activity will recover at some point in 1992 after the long slow-down experienced in 1990 and 1991. 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. Inflation is expected to moderate to about 3.5 per cent. However, a full recovery in over-all global economic activity is not anticipated until factors such as lower interest rates and inflation fully work

through the major economies. As a result, world real GDP is expected to increase by 1.7 per cent in 1992, followed by a 2.8-3.0 per cent increase in 1993.

7. For the rest of the decade, inflation is expected to remain fairly stable around 3.5 per cent, and GDP for the period 1990-2000 is expected to increase at an average annual rate of 2.6 per cent per annum in real terms.

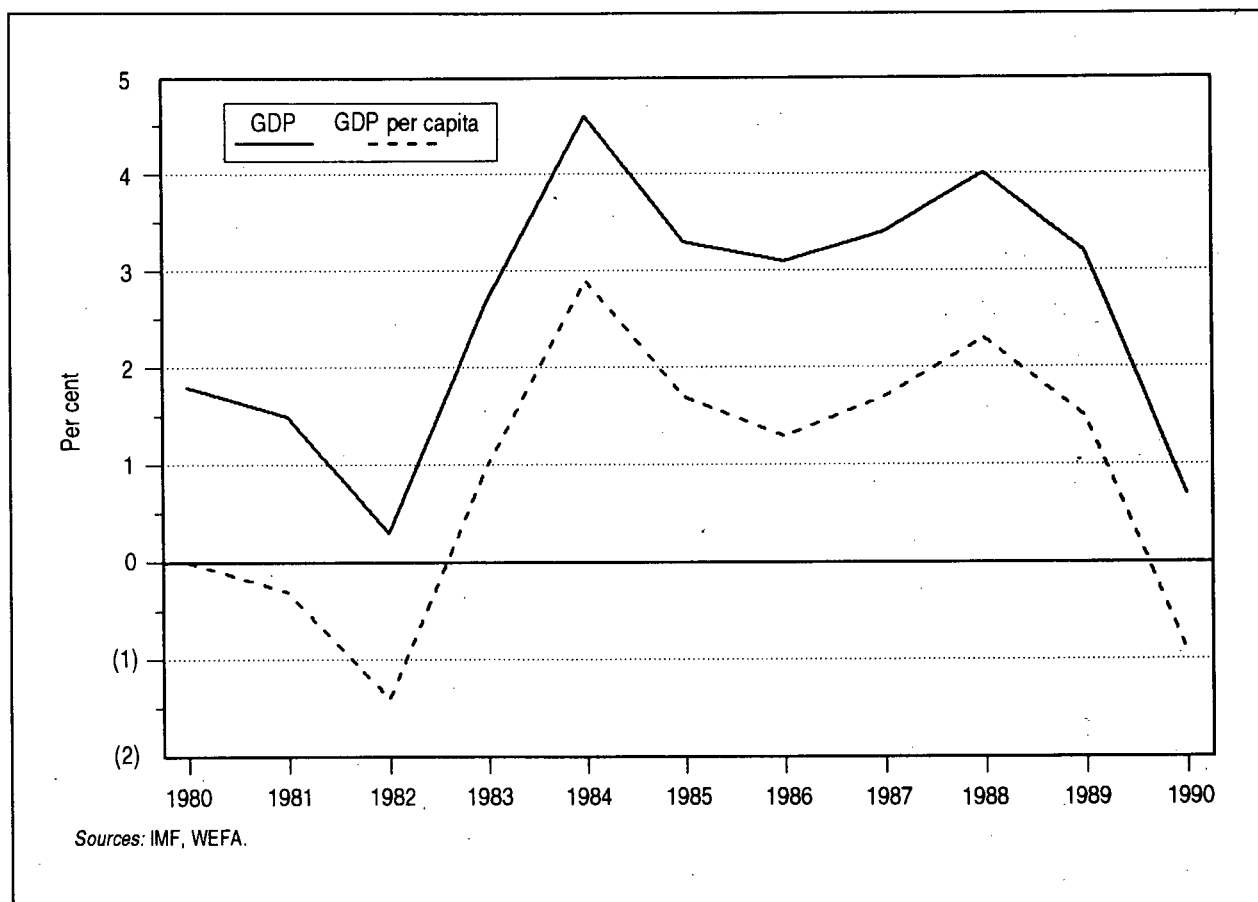


Figure 3-1. World GDP, GDP per capita growth
(real terms, 1980-1990)

Chapter 4

AIRLINE FINANCIAL TRENDS

OPERATING REVENUES, EXPENSES AND RESULTS

1. This chapter indicates general trends in airline financial data for the decade 1980 to 1990 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. Annual financial data for the period 1980-1990, 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 between 1980 and 1990 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 first part of the decade. 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 slow-down in the world economy resulted in an operating loss of \$1.5 billion, or 0.8 per cent of operating revenues. Preliminary results for 1991 indicate an operating loss of approximately \$1 billion, or 0.5 per cent of operating revenues. For the 1980-1990 period as a whole, the operating result was \$38 113 million or 2.7 per cent of the aggregate operating revenues of \$1 405 708 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 0.9 per cent of operating revenues.
4. As shown in Table 4-2, from 1980 to 1990 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 8.5 per cent, from \$87 676 million to \$199 100 million. During the same period the corresponding total operating expenses also increased at a rate of 8.5 per cent from \$88 310 million to \$200 400 million. The growth in world airline operating revenues during this period was associated with an average annual growth in traffic of 6.3 per cent in terms of tonne-kilometres performed and a rise in airline yields (average operating revenue per tonne-kilometre performed) from 72.4 cents in 1980 to 89.6 cents in 1990 (at an average annual rate of 2.2 per cent). The more rapid growth of unit costs (2.8 per cent per annum in terms of average operating expenses per tonne-kilometre of available capacity) was somewhat offset by steadily increasing load factors.
5. As with over-all revenues and costs, unit revenues and costs varied from year-to-year over the 1980-1990 period, as shown by Figure 4-2. Expenses per tonne-kilometre available jumped by 18 per cent in 1980 (mainly due

Table 4-1. Operating revenues and expenses — 1980-1990
(scheduled airlines of ICAO Contracting States¹, total domestic and international services)

Description	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	(millions of dollars)										
OPERATING REVENUES											
Scheduled services (total)	80 899	85 381	85 900	89 900	95 780	102 000	111 900	131 240	148 680	158 350	174 050
Passenger	69 930	74 433	74 860	77 600	81 720	87 000	94 900	111 820	127 250	137 200	153 290
Freight	9 468	9 523	9 560	10 830	12 560	13 300	15 200	17 450	19 380	19 110	18 510
Mail	1 501	1 425	1 480	1 470	1 500	1 700	1 800	1 970	2 050	2 040	2 250
Non-scheduled operations	3 149	3 682	3 100	2 800	3 010	3 500	4 500	5 410	6 360	6 650	7 020
Incidental	3 628	3 929	4 240	5 600	6 610	6 700	8 200	10 350	11 160	14 000	17 630
Total operating revenues	87 676	92 992	93 240	98 300	105 400	112 200	124 600	147 000	166 200	179 000	198 700
OPERATING EXPENSES											
Flight operations (total)	34 345	36 677	34 600	33 050	33 350	34 930	32 710	36 790	39 270	44 520	56 060
Flight crew salaries and expenses	6 856	6 792	6 800	6 870	6 900	7 250	8 300	9 480	10 530	11 350	13 650
Aircraft fuel and oil	24 881	27 318	25 420	23 610	23 370	23 780	19 110	20 740	20 690	23 520	30 510
Other (insurance, rental, training, etc.)	2 608	2 567	2 380	2 570	3 080	3 900	5 300	6 570	8 050	9 650	11 900
Maintenance and overhaul	9 283	9 640	9 150	9 620	10 120	11 070	13 850	15 900	18 320	19 590	22 790
Depreciation and amortization	5 449	5 968	6 330	6 920	7 240	7 770	9 070	11 050	12 150	12 520	14 030
User charges and station expenses (total)	13 713	13 827	14 540	15 260	16 080	17 340	21 340	24 770	28 440	29 080	32 200
Landing and associated airport charges	3 099	3 241	3 100	3 160	3 040	3 540	4 270	5 100	5 920	6 170	7 580
Route facility charges	992	1 096	1 410	1 430	1 400	1 620	1 890	2 170	2 490	2 280	3 060
Station expenses	9 622	9 490	10 030	10 670	11 640	12 180	15 180	17 500	20 030	20 630	21 560
Passenger services	7 967	8 085	8 540	8 810	9 190	10 310	12 140	14 540	15 900	17 880	20 880
Ticketing, sales and promotion	12 484	13 800	14 510	15 810	16 560	18 470	21 480	24 440	27 080	30 070	32 960
General, administrative and other operating expenses	5 069	5 687	5 730	6 730	7 760	8 210	9 410	12 310	14 840	17 540	21 280
Total operating expenses	88 310	93 684	93 400	96 200	100 300	108 100	120 000	139 800	156 000	171 200	200 200
Operating result [profit or loss (-)]	-635	-692	-160	2 100	5 100	4 100	4 600	7 200	10 200	7 800	-1 500
Operating result as a percentage of operating expenses	-0.7	-0.7	-0.2	2.1	4.8	3.7	3.7	4.9	6.1	4.4	-0.7
Net result	-919	-1 150	-1 300	-700	2 000	2 100	1 500	2 500	5 000	3 700	-4 300
Net result as a percentage of operating revenue	-1.0	-1.2	-1.4	-0.7	1.9	1.9	1.2	1.7	3.0	2.1	-2.2

1. Excludes domestic operations in the Russian Federation.

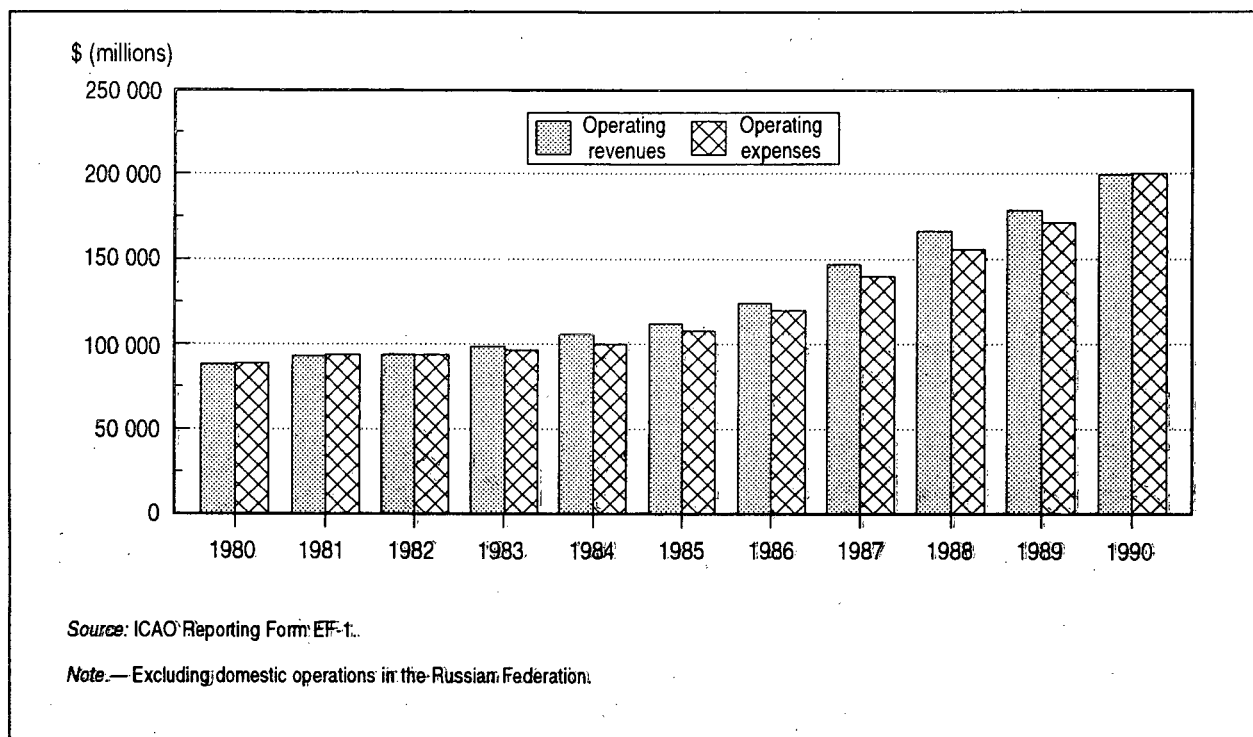


Figure 4-1. World scheduled airline operating revenues and expenses, 1980-1990

Table 4-2. Total and unit operating revenues and expenses, 1980 and 1990
(scheduled airlines of ICAO Contracting States¹, total domestic and international services)

	Operating revenues (\$ millions)	Operating expenses (\$ millions)	Total traffic (TKP millions)	Unit revenue (cents/TKP)	Total capacity (TKA millions)	Unit cost (cents/TKA)
1980	87 676	88 310	121 140	72.4	217 210	40.7
1990	199 100	200 400	222 269	89.6	375 569	53.4
Average annual growth, per cent	8.5	8.5	6.3	2.2	5.6	2.8

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

1. Excludes domestic operations in the Russian Federation.

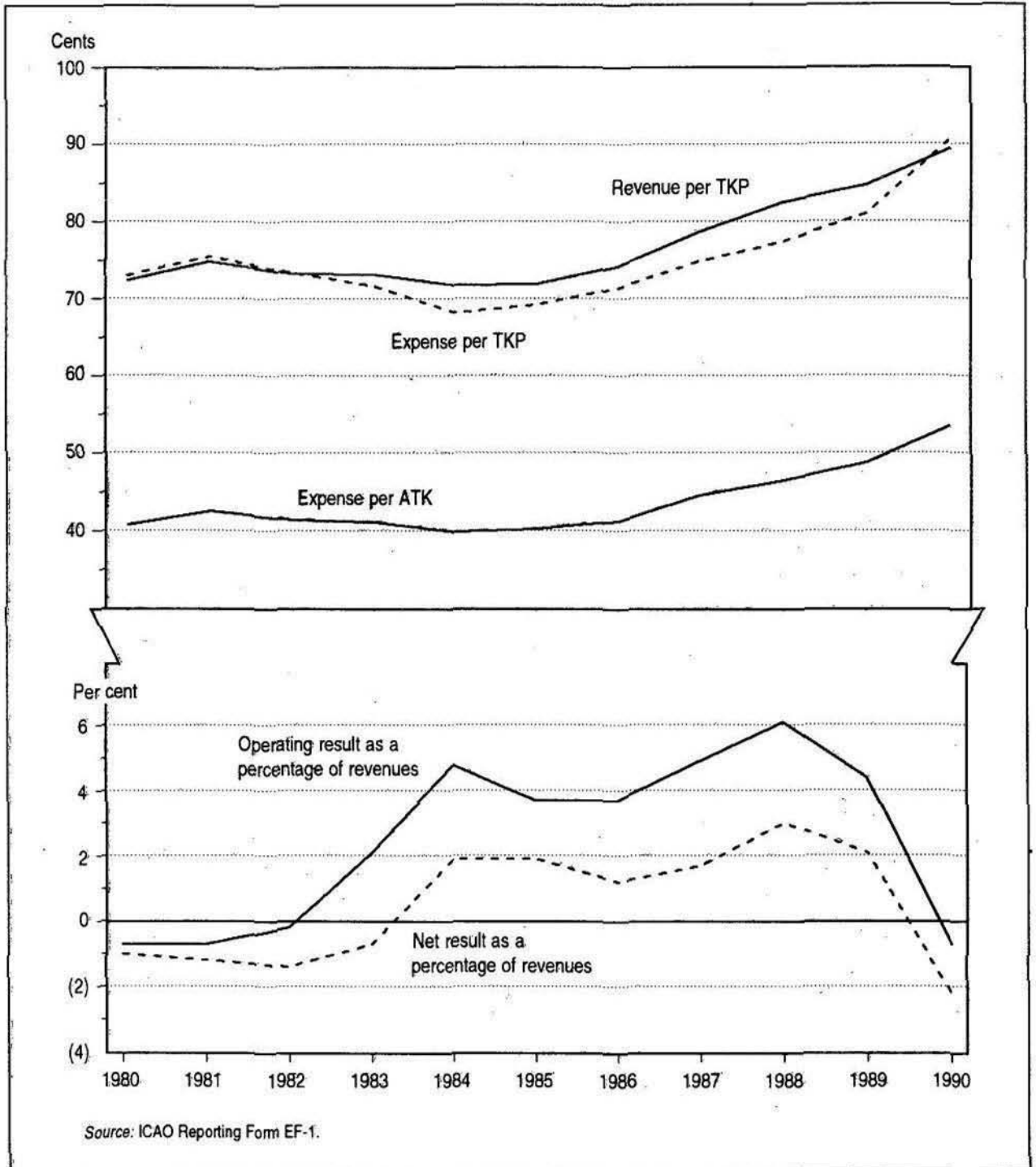


Figure 4-2. Financial data for scheduled airlines, 1980-1990

to fuel price increases), experienced a slight decrease in 1982 through 1984, a moderate increase from 1985 to 1989, and a significant increase in 1990 (9%).

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 79.8 per cent in 1980 to 77.2 per cent in 1990, freight and mail revenues declined from 12.5 per cent in 1980 to 10.4 per cent in 1990, non-scheduled revenues remained at about 3.5 per cent, while incidental revenues (which include sales of services and maintenance, and the leasing of aircraft to other airlines) increased from 4.1 per cent in 1980 to 8.9 per cent in 1990.

Table 4-3. Distribution of operating revenues and expenses in 1980 and 1990
(scheduled airlines of ICAO Contracting States¹,
total domestic and international services)

Description	Distribution by item (per cent)		Average annual growth 1980 to 1990 (per cent)
	1980	1990	
OPERATING REVENUES			
Scheduled services (total)	92.3	87.6	-0.5
Passenger	79.8	77.2	-0.3
Freight	10.8	9.3	-1.5
Mail	1.7	1.1	-4.3
Non-scheduled operations	3.6	3.5	-0.3
Incidental	4.1	8.9	8.1
TOTAL	100.0	100.0	
OPERATING EXPENSES			
Direct aircraft			
Flight operations (total)	38.9	28.0	-3.2
Flight crew	7.8	6.9	-1.2
Fuel and oil	28.2	15.3	-5.9
Other	2.9	5.8	7.2
Maintenance and overhaul	10.5	11.5	0.9
Depreciation and amortization	6.2	6.9	1.1
Sub-total	55.6	46.4	-1.8
Indirect			
User charges and station expenses (total)	15.5	15.8	0.2
Landing and associated airport charges	3.5	3.7	0.6
En-route facility charges	1.1	1.5	3.2
Station expenses	10.9	10.6	-0.3
Passenger services	9.0	10.5	1.6
Ticketing, sales, promotion	14.1	16.7	1.7
General, administrative and other operating expenses	5.7	10.6	6.4
Sub-total	44.3	53.6	1.9
TOTAL	100.0	100.0	

1. Excludes domestic operations in the Russian Federation.

7. Among airline operating expenses, the most significant increase between 1980 and 1990 was attributable to "general, administrative and other operating expenses" which rose at an average annual rate of 15.5 per cent, compared to only 2.1 per cent for "aircraft fuel and oil". As a result, this item increased from 5.7 per cent of total operating expenses in 1980 to 10.7 per cent in 1990 while "aircraft fuel and oil" decreased from 28.2 per cent in 1980 to 15.3 per cent in 1990. "Flight operations - other", which includes rental of aircraft from other carriers, also increased its share significantly from 2.9 per cent in 1980 to 5.8 per cent in 1990, while the costs of "user charges and station expenses" and "passenger services" increased only marginally from 15.5 to 15.9 per cent and from 9.0 to 10.5 per cent, respectively. The proportion of direct aircraft operating expenses dropped and that of indirect operating expenses increased from 1980 to 1990.

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 1980 and 1990, together with the corresponding operating results. In 1990 about 40 per cent of operating revenues and expenses of the world's airlines were attributable to the North American airlines, 30 per cent to European airlines and 19 per cent to airlines of Asia and the Pacific, with the remaining 11 per cent divided about equally among those of Africa, the Middle East and Latin America/Caribbean. Compared to

Table 4-4. Regional distribution of total operating revenues and expenses in 1980 and 1990

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	1980	3 390	3.8	3 473	3.9	-83	-2.4
	1990	6 800	3.4	6 850	3.4	-50	-0.7
Asia and Pacific	1980	12 876	14.7	12 703	14.4	173	1.3
	1990	39 000	19.6	37 400	18.7	1 600	4.1
Europe ¹	1980	26 730	30.5	27 292	30.9	-562	-2.1
	1990	59 800	30.1	60 200	30.1	-400	-0.7
Middle East	1980	3 603	4.1	3 771	4.3	-168	-4.7
	1990	6 000	3.0	6 050	3.0	-50	-0.8
North America	1980	35 588	40.6	35 698	40.4	-110	-0.3
	1990	78 600	39.6	80 700	40.3	-2 100	-2.7
Latin America and Caribbean	1980	5 489	6.3	5 373	6.1	116	2.1
	1990	8 500	4.3	9 000	4.5	-500	-5.9
World ¹	1980	87 676	100.0	88 310	100.0	-634	-0.7
	1990	198 700	100.0	200 200	100.0	-1 500	-0.7

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

1. Excludes domestic operations in the Russian Federation.

1980, the 1990 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.

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 1990 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 1960-1990 period (excluding domestic operations in the Russian Federation) as well as annual change in freight yield per tonne-kilometre. Average world passenger yield measured in real terms decreased at a rate of 2.2 per cent per annum, and freight and mail yield decreased at a rate of 3.4 per cent per annum. These declines in yield were achieved due to 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 1980-1990 period, as illustrated in Figure 4-4.

11. Airline operating costs are heavily influenced by jet fuel prices. Due to large increases in oil prices in 1979, unit costs rose sharply in 1980 with fuel costs accounting for almost 29 per cent of total costs of scheduled airlines. Unit costs declined during the period 1982-1985 partly as a result of declining fuel prices. 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.

13. In order to cover 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 increase at an average annual rate of 0.5 per cent per annum in real terms.

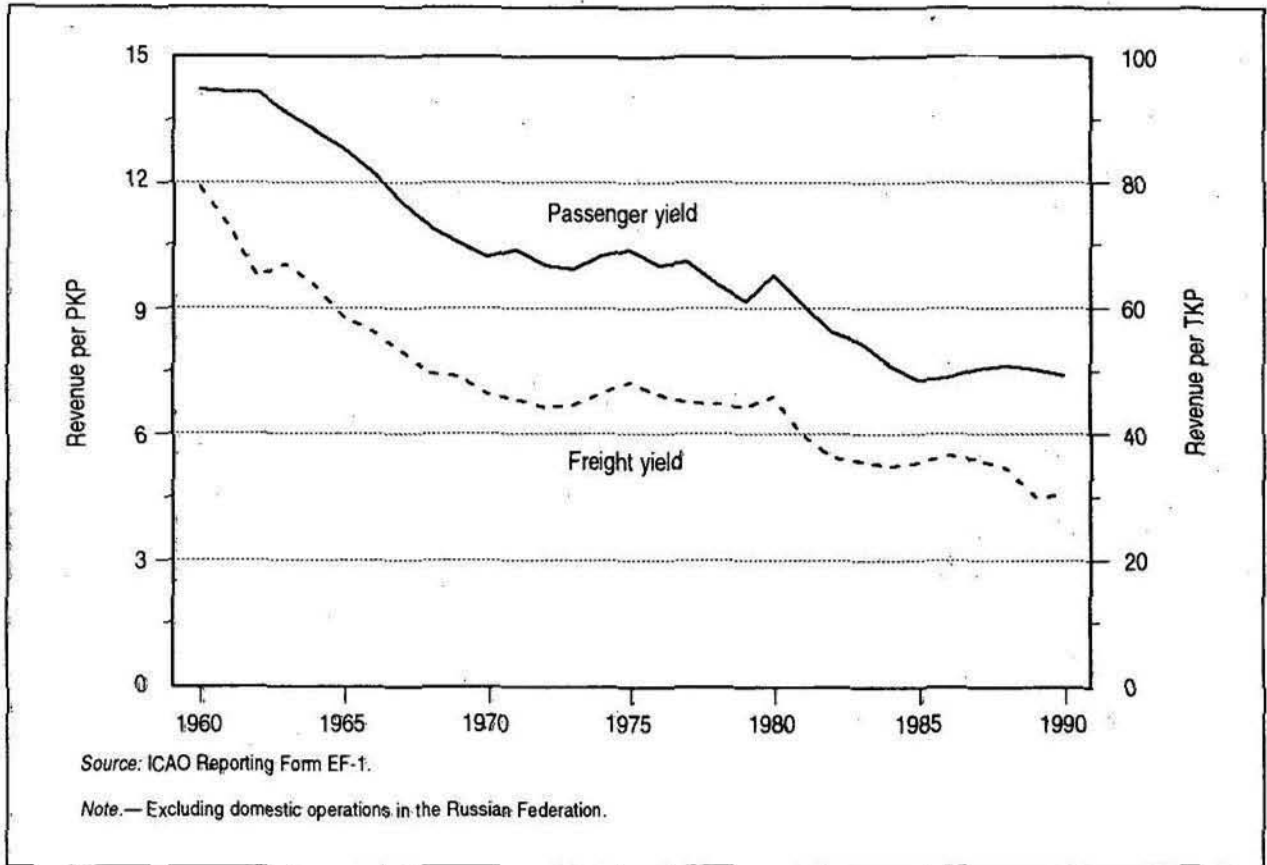


Figure 4-3. World scheduled passenger and freight yields
 (U.S. cents in real terms)

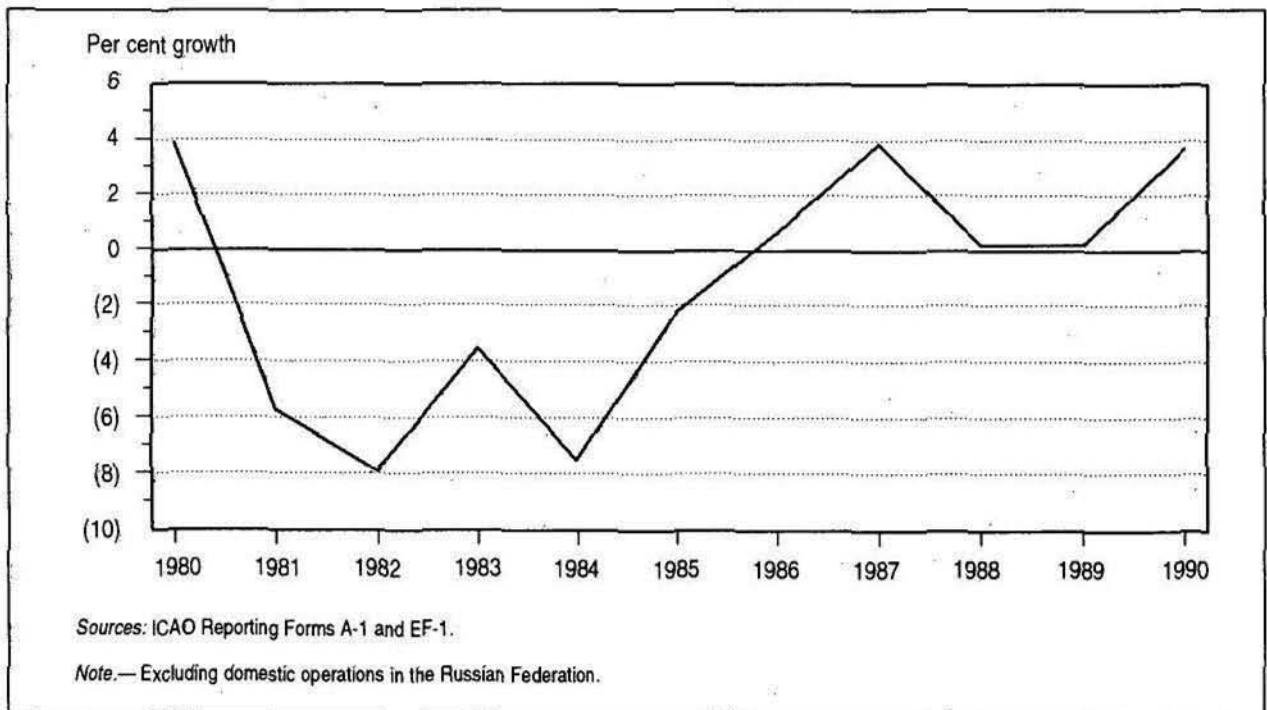


Figure 4-4. World scheduled airlines' unit operating cost, 1980-1990
 (U.S. cents per ATK in real terms)

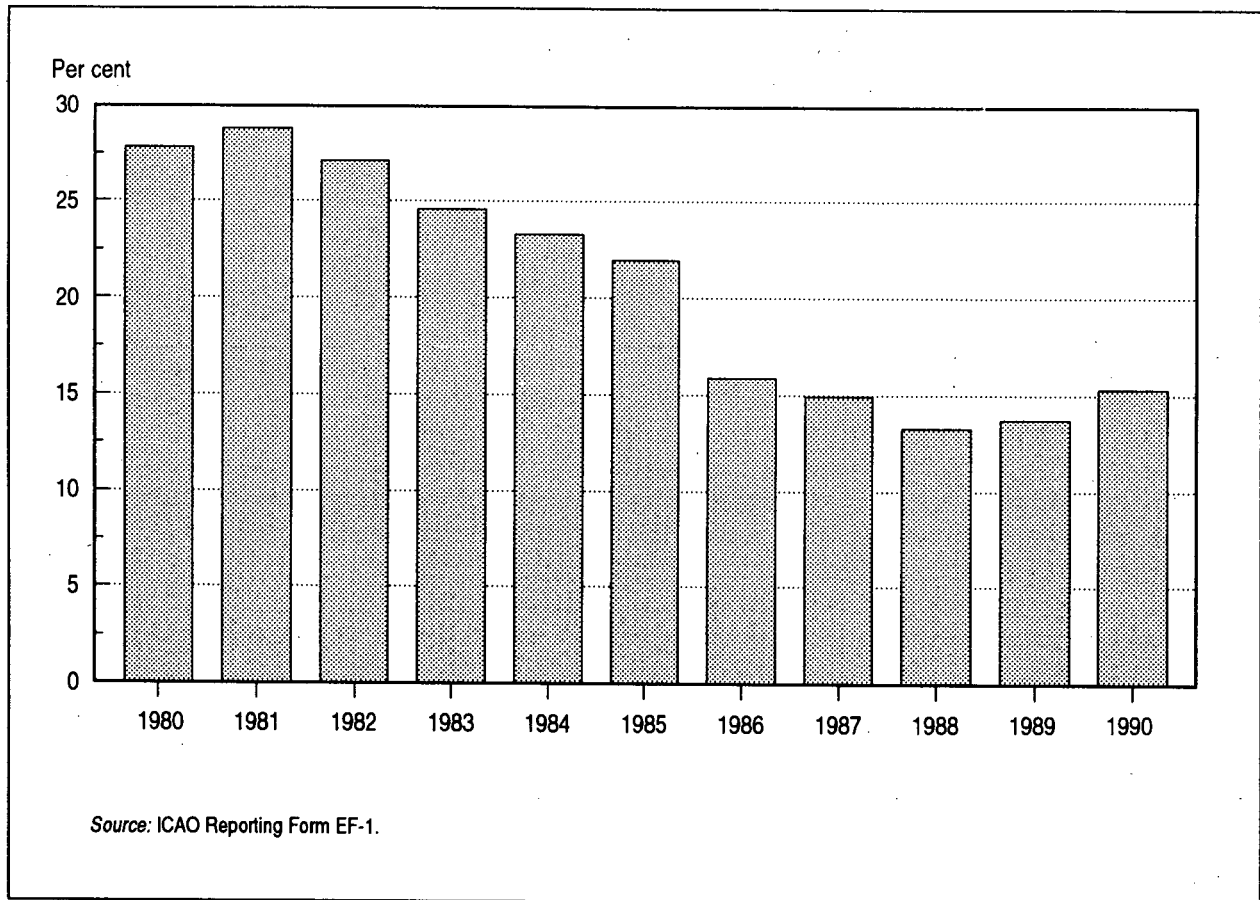


Figure 4-5. World scheduled airlines' share of fuel and oil in operating expenses, 1980-1990

Chapter 5

FORECASTS OF AIRLINE TRAFFIC TO THE YEAR 2001

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 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 of 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, 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 1990-2001 in the factors which underly traffic growth:
 - a) a "most likely" average rate of world economic growth of 2.6 per cent per annum (in real terms);
 - b) moderate growth in world trade at a "most likely" average rate of about 4 per cent per annum;

- c) a "most likely" increase of 0.5 per cent per annum (in real terms) in average yield (fares and rates) 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 3.4 per cent per annum for economic growth and an average annual decline in real fares of 1 per cent. The "most likely", "low" and "high" trends are illustrated in Figure 5-1.
10. International scheduled passenger traffic (PKP) is forecast to grow at an average rate of 6 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 76 per cent of all domestic scheduled traffic is accounted for by the already highly developed domestic systems in the United States and the Russian Federation where growth rates are expected to moderate.
11. Forecasts of scheduled passenger traffic in terms of the number of passengers carried are 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 1980-1990 period, the increase in average journey length was more pronounced for international trips than for domestic trips.

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 1980 and 1990 and estimated traffic for 1991. The airlines of the Asia/Pacific Region are expected to continue to show the highest growth in passenger traffic, at 8 per cent per annum through to the year 2001, while the airlines of Africa, Latin America and Europe show the lowest growth,

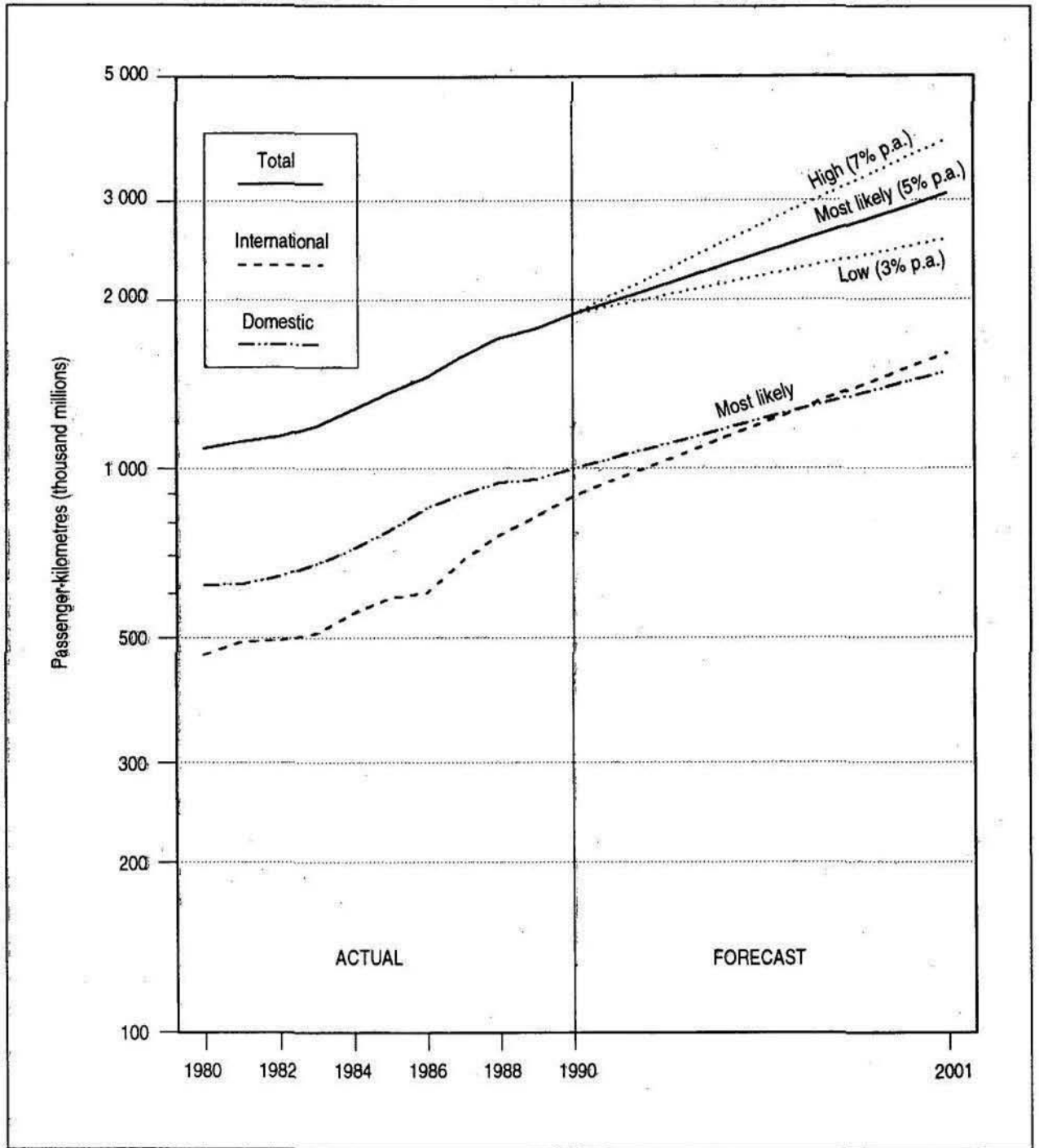


Figure 5-1. Trends in world scheduled passenger traffic
(ICAO Contracting States)

**Table 5-1. Summary of ICAO scheduled passenger traffic forecast to the year 2001
(ICAO Contracting States)**

	<i>Actual 1980</i>	<i>Actual 1990</i>	<i>Estimate 1991</i>	<i>Forecast 2001</i>	<i>Average annual growth rate</i>	
					<i>1980-1990 (per cent)</i>	<i>1990-2001* (per cent)</i>
Passenger-kilometres (thousand millions)						
Scheduled services	1 089	1 893	1 826	3 232	5.7	5.0
International	466	894	858	1 697	6.7	6.0
Domestic	623	999	968	1 535	4.9	4.0
Passengers carried (millions)						
Scheduled services	748	1 164	1 113	1 800	4.5	4.0
International	163	280	261	490	5.6	5.0
Domestic	585	884	852	1 310	4.2	3.5

* Rounded to the nearest 0.5 percentage point.

around 3.5 per cent per annum. The slower growth in Europe can be attributed to the socio-economic 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 4.3 per cent. Traffic of airlines of the Middle East Region is expected to grow at the world average of 5 per cent per annum, whereas traffic of North American airlines is expected to increase at 4.5 per cent per annum. The growth rates for all regions represent status quo or a moderate slow-down in comparison with historic rates.

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 7 percentage points to 25.4 per cent of total world traffic by the year 2001, with its share of total international scheduled passenger traffic increasing to approximately 35 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 4 percentage points to 27.2 by the year 2001, while the North American share is expected to decline by some 2 percentage points to 39 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 32 per cent of international passengers in 1990, are presented in Table 5-3. With a less favourable trend in real air fares expected, forecast growth rates for the 1990s are slightly lower than in the 1980s. Traffic across the North Atlantic benefitted from a stimulating competitive environment during the 1980s when traffic grew strongly despite the maturity of the market. The 1990s should see a more moderate but still impressive 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. The growth in air travel demand in these markets is supported by efficient and competitive services and by the strong economic performance of a number of Asian countries.

16. The Europe-Africa market is expected to recover a little in the 1990s, reflecting some improvement in the general economy. The performance of the Europe-Middle East market is 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.

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

	Passenger-kilometres (thousand millions)				Average annual growth rate (per cent)		Regional share of world traffic (per cent)		
	Actual 1980	Actual 1990	Estimate 1991	Forecast 2001	1980- 1990	1990- 2001*	1980	1990	2001
Africa:	29.7	42.0	41.2	62	3.5	3.5	2.7	2.2	1.9
International	22.4	33.1	32.1	50	4.0	4.0	4.8	3.7	2.9
Domestic	7.3	8.9	9.1	12	2.0	3.0	1.2	0.9	0.8
Asia/Pacific:	160.1	344.1	347.0	820	8.0	8.0	14.7	18.2	25.4
International	105.4	236.0	231.8	590	8.4	8.5	22.6	26.4	34.8
Domestic	54.7	108.1	115.2	230	7.0	7.0	8.8	10.8	15.0
Europe:	365.2	590.4	549.8	880	4.9	3.5	33.5	31.2	27.2
International	184.4	313.6	294.7	500	5.5	4.5	39.5	35.1	29.5
Domestic	180.8	276.8	255.1	380	4.4	3.0	29.0	27.7	24.8
Middle East:	28.4	47.0	43.2	80	5.2	5.0	2.6	2.5	2.5
International	22.0	38.1	34.5	67	5.6	5.5	4.7	4.3	3.9
Domestic	6.4	8.9	8.7	13	3.4	3.5	1.0	0.9	0.8
North America:	445.3	782.3	757.4	1 260	5.8	4.5	40.9	41.3	39.0
International	98.9	220.9	213.8	410	8.4	6.0	21.2	24.7	24.2
Domestic	346.4	561.4	543.6	850	4.9	4.0	55.6	56.2	55.4
Latin America and Caribbean:	60.2	87.4	87.6	130	3.8	3.5	5.5	4.6	4.0
International	33.3	51.9	50.7	80	4.5	4.0	7.1	5.8	4.7
Domestic	26.9	35.5	36.9	50	2.8	3.0	4.3	3.6	3.3
World:	1 088.9	1 893.2	1 826.2	3 232	5.7	5.0	100.0	100.0	100.0
International	466.4	893.6	857.6	1 697	6.7	6.0	100.0	100.0	100.0
Domestic	622.5	999.6	968.6	1 535	4.9	4.0	100.0	100.0	100.0

* Rounded to the nearest 0.5 percentage point.

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

	Passengers carried (thousands)			Average annual growth rate (per cent)	
	Actual 1980	Actual 1990	Forecast 2001	1980-1990	1990-2001*
North Atlantic	16 650	30 340	51 892	6.2	5.0
Mid Atlantic	1 250	2 060	3 343	5.1	4.5
South Atlantic	1 100	1 810	2 937	5.1	4.5
Trans-Pacific	4 500	12 400	28 912	10.7	8.0
Between Europe and Asia/Pacific	4 700	10 800	23 929	8.7	7.5
Between Europe and Africa	7 520	8 400	11 347	1.1	3.0
Between Europe and Middle East	2 920	3 850	4 998	2.8	2.5
Between North America and South America	2 070	3 150	4 849	4.3	4.0
Between North America and Central America/Caribbean	9 170	15 790	27 006	5.6	5.0
Total above routes	49 880	88 600	159 213	5.9	5.5
Other routes	113 320	191 895	330 787	5.4	5.0
Total world	163 200	280 495	490 000	5.6	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.

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 1990-2001. This is slightly lower than the 7.3 per cent per annum for the 1980-1990 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.

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 uplifted or 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 markets of the United States and the Russian Federation 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.

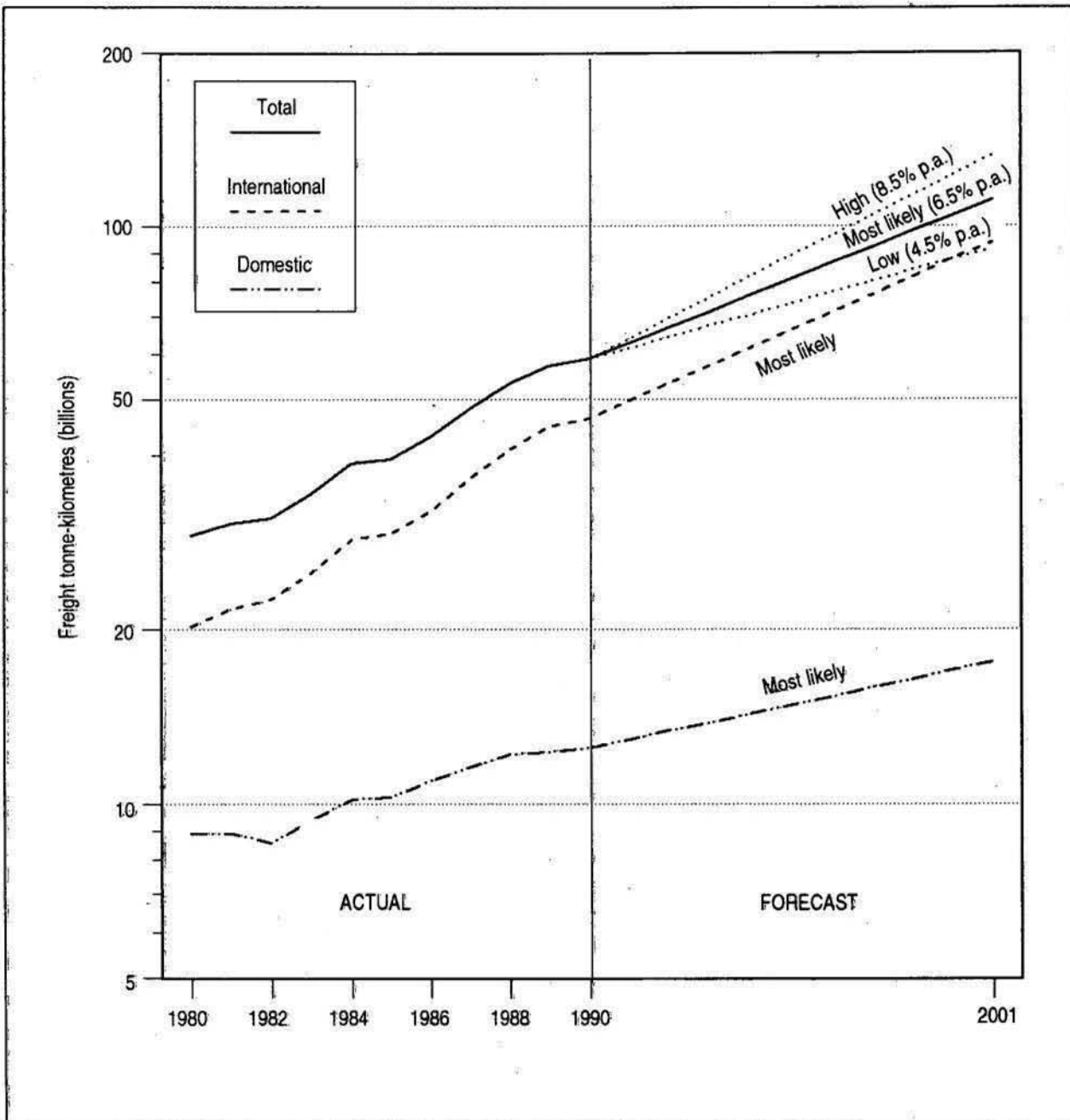


Figure 5-2. Trends in world scheduled freight traffic
(ICAO Contracting States)

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. The Asia/Pacific Region is expected to remain the fastest growing region although its forecast rate is somewhat slower than the growth rate for the 1980-1990 period.

21. By the year 2001, the Asia/Pacific Region is expected to increase its share of air freight traffic by almost 11 percentage points to approximately 39 per cent of total world freight, a share well above that of any other region.

SUMMARY OF AIR TRAFFIC FORECASTS BY OTHER ORGANIZATIONS

22. Some recent long-term forecasts by major airframe manufacturers of growth in world scheduled traffic, international and domestic combined, are given in Table 5-6. These forecast growth rates are in the range of 5 to 6.5 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 covering the 1991-1995 period. These indicate an average growth of 6.7 per cent per annum for international passengers and 7.7 per cent per annum for international freight tonnes.

Table 5-4. Summary of ICAO scheduled freight traffic forecast to the year 2001
(ICAO Contracting States)

	<i>Actual</i> 1980	<i>Actual</i> 1990	<i>Estimate</i> 1991	<i>Forecast</i> 2001	<i>Average annual growth rate</i>	
					<i>1980-1990</i> (per cent)	<i>1990-2001*</i> (per cent)
Freight tonne-kilometres (millions)						
Scheduled services	29 133	58 869	57 160	118 440	7.3	6.5
International	20 261	46 393	45 150	100 920	8.6	7.5
Domestic	8 872	12 476	12 010	17 520	3.5	3.0
Freight tonnes carried (thousands)						
Scheduled services	11 090	18 288	17 310	29 016	5.1	4.5
International	4 390	8 860	8 386	15 966	7.3	5.5
Domestic	6 700	9 428	8 924	13 050	3.5	3.0

* 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 1980	Actual 1990	Estimate 1991	Forecast 2001	1980- 1990	1990- 2001*	1980	1990	2001
Africa	796	1 166	1 140	1 830	3.9	4.0	2.7	2.0	1.5
International	720	1 075	1 050	1 710	4.1	4.5	3.6	2.3	1.7
Domestic	76	91	90	120	1.8	2.5	0.9	0.7	0.7
Asia/Pacific	5 596	16 337	16 453	45 800	11.3	10.0	19.2	27.8	38.7
International	4 991	14 830	14 851	42 500	11.5	10.0	24.6	32.0	42.1
Domestic	605	1 507	1 602	3 300	9.6	7.5	6.8	12.1	18.8
Europe	10 749	20 008	19 210	36 300	6.4	5.5	36.9	34.0	30.6
International	8 232	17 413	16 860	33 000	7.8	6.0	40.6	37.5	32.7
Domestic	2 517	2 595	2 350	3 300	0.3	2.0	28.4	20.8	18.8
Middle East	1 339	2 440	2 135	4 110	6.2	5.0	4.6	4.1	3.5
International	1 307	2 351	2 054	3 950	6.0	5.0	6.5	5.1	3.9
Domestic	32	89	81	160	10.8	5.5	0.4	0.7	0.9
North America	9 060	16 173	15 571	25 600	6.0	4.5	31.1	27.5	21.6
International	3 792	8 532	8 204	15 800	8.4	6.0	18.7	18.4	15.7
Domestic	5 268	7 641	7 367	9 800	3.8	2.5	59.4	61.2	55.9
Latin America and Caribbean	1 593	2 745	2 651	4 800	5.6	5.0	5.5	4.7	4.1
International	1 219	2 192	2 131	3 960	6.0	5.5	6.0	4.7	3.9
Domestic	374	553	520	840	4.0	4.0	4.2	4.4	4.8
World	29 133	58 869	57 160	118 440	7.3	6.5	100.0	100.0	100.0
International	20 261	46 393	45 150	100 920	8.6	7.5	100.0	100.0	100.0
Domestic	8 872	12 476	12 010	17 520	3.5	3.0	100.0	100.0	100.0

* Rounded to the nearest 0.5 percentage point.

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

<i>Source of forecast</i>	<i>Forecast period</i>	<i>Passenger-kilometres (per cent)</i>	<i>Freight tonne-kilometres (per cent)</i>
Airbus Industrie	1990-1999	5.5	7.5
	2000-2009	5.1	—
Boeing	1990-2000	5.4	6.0
	2000-2005	4.6	—
McDonnell Douglas	1990-2000	6.5	8.5

Note.— These forecasts exclude traffic of the Russian Federation. The Airbus and Boeing passenger forecasts include all scheduled services and the McDonnell Douglas passenger forecast includes both scheduled and non-scheduled traffic.

Sources: — Airbus Industrie, "Global Market Forecast", June 1991;
 — Boeing Commercial Airplane Company, "Current Market Outlook", February 1991; "World Air Cargo Forecast", June 1988;
 — McDonnell Douglas Corporation, "Outlook for Commercial Aircraft 1991-2010", January 1992.

Chapter 6

FORECASTS OF AIRCRAFT MOVEMENTS TO THE YEAR 2001

FACTORS AFFECTING AIRCRAFT MOVEMENTS

1. The planning of aviation facilities and the development of aviation policies require assessment of the future trends in aircraft movements as well as 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 which has increased 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 Russian Federation) are illustrated in Figure 6-1.
4. Gradual improvements in average load factors have resulted from marketing initiatives and yield management programmes. However, 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 (excluding the Russian Federation), which increased from 61 per cent in 1980 to 66 per cent in 1990, will rise to about 68 per cent in 2001.
5. The services which are 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.

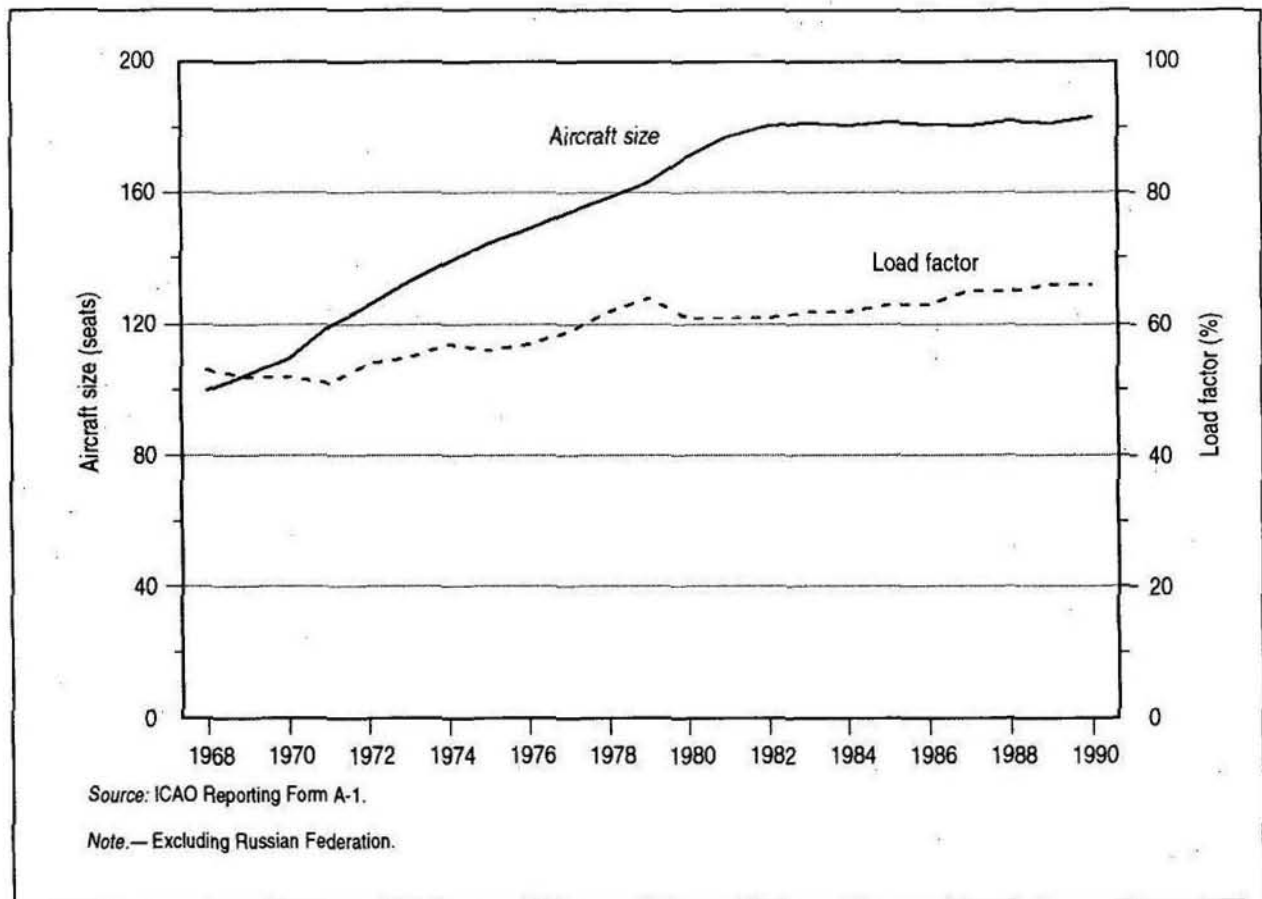


Figure 6-1. Average aircraft size and load factor
(passenger aircraft on scheduled services)

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 occurred throughout the 1980s. 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 over the latter decade than over the former decade.

8. The North Atlantic is an example of a route group where regulatory developments and the characteristics of new aircraft types encouraged the deployment of smaller aircraft during the 1980s. 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 148 (approximately) between 1982 and 1989. 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.

9. These regulatory and technological factors described above are likely to continue into the 1990s. 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 2001 compared with 183 seats in 1990 (for world-wide passenger services, excluding the Russian Federation).

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 at more than 4 per cent per annum, and thus aircraft kilometres grew at 4-5 per cent per annum faster than aircraft departures. In the past 20 years, the growth in average stage length has been 1-2 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 1990 and 2001.

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 the 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 1990-2001 are given below:

- a) a growth in passenger-kilometres of 5 per cent per annum;
- b) an increase in average load factor from 66 to 68 per cent;

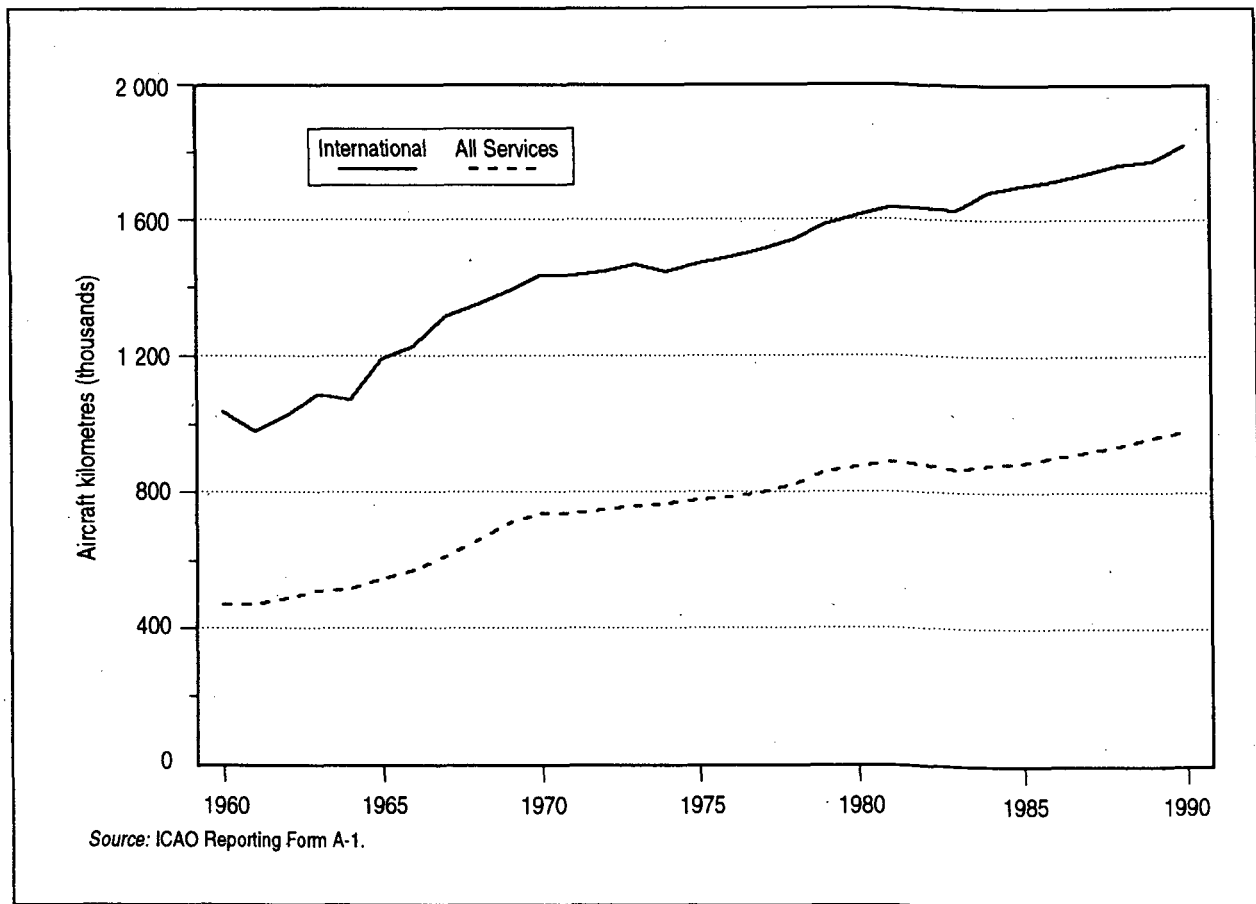
- c) a growth in average passenger aircraft size (in terms of seats) of 1.7 per cent per annum;
- d) a growth in average aircraft stage length of 1 per cent per annum.

(All assumptions and forecasts exclude the Russian Federation because of data constraints.)

FORECASTS OF WORLD SCHEDULED AIRCRAFT MOVEMENTS

14. The above analyses led to forecast average world annual growth rates of 3 per cent for aircraft-kilometres and 2 per cent for aircraft departures over the period 1990 to 2001.

15. The growth rate for aircraft kilometres is below the growth rate for passenger-kilometres by about 2 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 is relatively buoyant when compared with the 1970s. This is 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 current recession has temporarily eased the pressure, the forecasts imply an increase of over 35 per cent in aircraft-kilometres and nearly 22 per cent in aircraft departures over the 1990s. In absolute terms, the increase in aircraft kilometres forecast between 1990 and 2000 is about the same as the increase that occurred between 1980 and 1990. The absolute increase in aircraft departures is forecast to be about 3.25 million over the 1990s compared with 3.86 million over the 1980s. 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 ATC 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 2001**

	<i>Actual</i> 1970	<i>Actual</i> 1980	<i>Actual</i> 1990	<i>Forecast</i> 2001	<i>Average annual growth rate</i>		
					1970-1980 (per cent)	1980-1990 (per cent)	1990-2001 (per cent)
Aircraft-kilometres (millions)	7 004	9 350	14 307	19 800	2.9	4.3	3.0
Aircraft departures (thousands)	9 486	10 691	14 553	18 000	1.2	3.1	2.0

1. Includes all-freight movements; excludes operations of aircraft registered in the Russian Federation.

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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 31 years, but excluding the Russian Federation 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.

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 2001 was generated by substituting into this expression the assumptions for passenger-kilometres, average load factor and average aircraft size in the year 2001 (excluding the Russian Federation 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 1990 to 2001 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 Russian Federation).

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 2001 was generated by substituting into this expression the forecast for aircraft-kilometres and the assumption for average stage length in the year 2001.

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. 1990 to 2001).

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

	Actual 1970	Actual 1980	Actual 1990	Forecast 2001	Average annual growth rate (per cent)		
					1970-1980	1980-1990	1990-2001
Passenger-kilometres (billions)	382	929	1 654	2 830	9.3	5.9	5.0
Passenger load factor (%)	52	61	66	68	1.6	0.8	0.3
Passenger aircraft size (seats)	109	171	183	220	4.6	0.7	1.7
Aircraft stage length (km)	738	875	983	1 100	1.7	1.2	1.0
Aircraft-kilometres (millions)	7 004	9 350	14 307	19 800	2.9	4.3	3.0
Aircraft departures (thousands)	9 486	10 691	14 553	18 000	1.2	3.1	2.0

— 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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