# Airline Operations and Management

## A Management Textbook

SECOND EDITION

Gerald N. Cook and
Bruce G. Billig

ROUTLEDGE

# Airline Operations and Management

*Airline Operations and Management: A Management Textbook* presents a survey of the airline industry, with a strong managerial perspective. It integrates and applies the fundamentals of several management disciplines, particularly operations, marketing, economics and finance, to develop a comprehensive overview. It also provides readers with a solid historical background, and offers a global perspective of the industry, with examples drawn from airlines around the world.

Updates for the second edition include:

- Fresh data and examples.
- A range of international case studies exploring real-life applications.
- New or increased coverage of key topics such as the COVID-19 pandemic, state aid, and new business models.
- New chapters on fleet management and labor relations and HRM.
- Lecture slides for instructors.

This textbook is for advanced undergraduate and graduate students of airline management, but it should also be useful to entry and junior-level airline managers and professionals seeking to expand their knowledge of the industry beyond their functional area.

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# Contents

# Figures

# Tables

# Goal of Airline Management and Operations

This textbook is a survey of the airline industry from a managerial perspective. It does not include other sectors of the broader aviation industry, such as airport operations or general aviation. The primary audience is senior and graduate students of airline management, but it should also be useful for entry and junior-level airline managers needing a broad knowledge of the industry extending beyond their functional area. A background in the various management disciplines typically covered in an undergraduate degree program in business or management is helpful, but not essential. The text incorporates fundamental concepts from several management disciplines, particularly, economics, operations, marketing, and finance in developing an overview of the industry. The focus is on tactical, rather than strategic, management that is specialized or unique to the airline industry. Human Resource Management, for example, is not addressed, not because it is not crucial to an airline's success, but because the skills required are not unique to the industry. The manager with a broad understanding of the industry and its competitive environment is better equipped to work in interdisciplinary assignments and, ultimately, to succeed and progress in an airline career. This is the goal of this text.

## Revisions in the Second Edition

This second edition maintains the basic structure of the original textbook. Airline examples, operational and financial data and statistics are updated throughout. This textbook was written in the first half of 2022 as the industry was recovering from the COVID-19 pandemic. As data in several chapters of the textbook illustrate, the pandemic severely disrupted airline operations. Data from 2019 are occasionally provided rather than the latest available information to provide valid historical comparisons.

The new labor relations Chapter 6 consolidates labor issues into one chapter. Chapter 8 covering airline fleet selection and acquisition is also new; however, much of the content was relocated from the first edition chapter on finance and economics. Each chapter concludes with a case study that illustrates the

application of many concepts in a current industry setting. We appreciate the suggestions from several reviewers.

*September 2022*

## Introduction

The dynamic and rapidly expanding airline industry is essential to the function of the world economy and for continued economic growth. It's also an industry often in turmoil, sometimes as a result of myopic management focus on market share but more often due economic crises beyond the control of airline executives. The first decade of the 21st century was especially cruel to the industry as it endured two severe economic recessions, the so-called Great Recession beginning in 2008 being the most devastating since the Great Depression of the 1930s. As a direct result of falling demand, several airlines failed, including ATA, Maxjet, Aloha, Sterling, and Oasis. Others were forced to par routes and frequencies and reduce costs in restructuring that continues today. This book examines the history, structure, and functions of the airline industry from a management perspective with the goal of providing students and junior managers with a broad overview of airline operations and management. Although the tools of several management disciplines are employed, previous study of business administration is not required.

The text begins with a summary of airline history from the emergence of earliest passenger airlines immediately following the end of World War I to the present. Chapter 1 emphasizes the role of government economic regulation, ownership, and subsidies in the development of the early industry. Rapid technological progress, especially in aircraft speed, reliability, and comfort, increased demand and lower costs to the point that government policy makers, beginning in the United States, freed airlines from regulation of routes and fares leading to an increasingly free market in much of the developed world.

Chapter 2 turns to the forces that drive airline demand and supply and the rapid growth in airline passenger and cargo transportation, which is now most evident in Asia. Airline product offerings are the subject of the next two chapters beginning with an airline's choice of route structure to connect the destinations it has chosen to serve. An airline has a range of product amenities it can provide with its core transportation product from the Spartan service characteristic of low-cost-airlines to a choice of amenities from first class to economy coach provided by most the world's largest airlines. The first half of the book ends by exploring the process of developing and managing a flight schedule.

Chapter 6 begins with a discussion of airline labor relations focusing on what is often the largest category of airline expenses. Chapter 7 dives into airline economics and finance. Fleet selection, renewal, expansion, and financing are included in Chapter 8. The complex and frequently misunderstood process of airline pricing and revenue management systems is the subject of Chapter 9. Sophisticated processes employed by airlines attempt to maximize revenue by

charging different prices to different passenger segment based on willingness and ability to pay for air travel. Distribution of airline product information and ticketing is covered in Chapter 10. This chapter covers the reservation and ticketing process throughout history – from early hand-written paper ticket coupons to present day smart-device technology. Chapter 11 shifts to focus from domestic to international operations. Bilateral Air Service Agreements that began after WWII are being replaced with more liberal Open Skies agreements as airlines form the Big-3 global airline alliances. The text concludes with Chapter 12 which reviews challenges for the future. Environmental constraints and the weakening of lucrative business travel through teleconferencing are only two of the issues facing airline manages in the future. Although strong demand will exist for air travel, managers will need to continually adjust business models to maintain profitability.

# 1 Historical Perspective

Upon completion of this module, you should be able to:

- Analyze how various governments supported their early airlines to ensure the growth of the industry.
- Understand the significance of The Contract Mail Act of 1925 and how it resulted in the birth of the airline industry in the United States.
- Using the airline industry as an example, explain how technology improves the material standard of living.
- Interpret the pros and cons of economic airline regulation and the reasons for deregulation.
- Compare and contrast the economic deregulation of the airline industries in the United States, Europe, and China.

## 1.1 Introduction

Several scheduled passenger airlines emerged in Europe shortly after the end of World War I in 1918. Economic regulation of routes and prices followed shortly thereafter and prevailed for much of the 20th century. Late in the century, deregulation of the US airline industry began a trend followed by the European Union and then by most countries worldwide. This history provides a foundation for understanding today's complex, competitive, and global airline industry. This chapter traces the industry from the era of economic regulation to the increasingly free-market competition allowed in most of the world's largest markets. After outlining the growth of the early airlines in Europe, the focus shifts to the United States beginning in 1918 with airmail operated by the US Post Office. Using this early airmail endeavor as our starting point, the chapter traces the fledgling industry through the years of economic regulation under the Civil Aeronautics Board until economic deregulation in 1978, emphasizing the economic, regulatory, and technical evolution that shaped the industry. This historical perspective then continues with post-deregulation developments, including the emergence of low-cost carriers, bankruptcies, mergers, and buyouts. Airline deregulation next occurred in Europe, then spread to several other world regions. To gain a broader perspective on the deregulation process

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and outcome, the US experience is compared with that of Europe, China, and India, leading to the conclusion that competitive results are remarkably similar. A short characterization of the industry concludes the chapter.

## 1.2 Transportation and Commerce

Air transportation is just one element of the world's transportation infrastructure essential for economic growth and prosperity. Sailing ships have traded between countries for at least two millennia making those cities and states that controlled trade wealthy. The past riches of Venice, still evident today in magnificent buildings, were based on trade. Today, ever larger and more efficient container ships reduce the cost of ocean shipping facilitating extensive trade between China, Europe, and the Americas.

Rivers were the first and most efficient means for inland transportation of goods and people. The construction of canals to improve and supplement natural waterways dates to at least the sixth century BC when a canal linked the Nile River with the Red Sea. Extensive waterway building in China began in the third century BC. The famous Venetian canals were extensions of the natural waterways among the islands on which Venice is built and date from the city's founding in the fifth century. Elsewhere in Europe, the Netherlands began canal construction to foster economic development in the 12th century with construction then spreading across much of Europe. The British canal system played an important role in the industrial revolution beginning in the 18th century. In contrast, economic development in Africa has been stunted by the lack of navigable rivers to facilitate commerce. Waterway construction in the United States is more recent with the building of the Erie Canal connecting the Hudson River in New York with Lake Erie and the other Great Lakes completed in 1825. The alternatives to waterway transportation at that time, usually by horse and wagon train, were comparatively much more expensive, slower, and limited. Railroads, first introduced in Great Britain in the early 19th century, gradually replaced canals by offering higher speed over a much larger geographical area.

Transportation systems have often been financed and built by private firms, but market forces are generally insufficient to provide for the vast transportation infrastructure necessary to foster widespread economic growth. Therefore, governments frequently plan, build, subsidize, and regulate transportation systems.

In the United States, for example, the federal government encouraged and subsidized the development of both water and rail transportation. Railroads were often joint ventures of federal and state governments and private firms. The great western expansion of railroads following the Civil War, most notably the completion of the transcontinental railroad in 1869, allowed for farm products from the Midwest to reach the heavily populated East Coast cities beginning in the early 1870s. Midwest farmers, in turn, were able to readily purchase goods from East Coast manufacturers which vastly improved their

standard of living. The Great Plains was transformed from a wasteland to a breadbasket. Transportation enables trade which improves the overall standard of living.

The federal government remains essential in supporting transportation systems, including highways and roads, waterways, railways, pipelines, airways, and airports. The US Army Corps of Engineers still operates the series of locks on the Mississippi and Ohio rivers over which Midwest grains are transported for export worldwide. Likewise, governments have also played a critical role in the development of commercial aviation. The Middle Eastern countries – especially the United Arab Emirates and Qatar – have recently invested heavily in airports and state-owned airlines to promote economic growth and diversity from dependence on petroleum exports.

## 1.3 The Earliest Airlines

Just over a decade after the Wright Brothers achieved powered flight, aviation entrepreneurs and military strategists around the world were finding new opportunities to use the innovative capability. For example, in 1914, people traveling from St. Petersburg to Tampa, Florida were faced with a circuitous train ride of over 11 hours around Tampa Bay. Seeing an opportunity, promoter Paul Fansler started an airboat service from St. Petersburg to Tampa across Tampa Bay. The Tampa – St. Petersburg Airboat Line (Figure 1.1, left) began the first-ever scheduled air passenger service using a Benoist XIV airboat (Figure 1.1, right). The flight took only 23 minutes and could carry one passenger seated next to the pilot. The airline flew twice daily round-trips Monday through Friday from

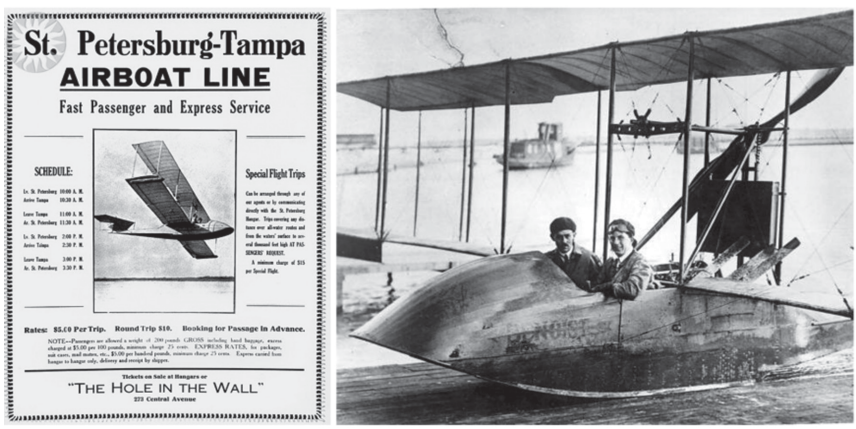


*Figure 1.1* Tampa – St. Petersburg Airboat Line – 1914.

Source: Left photo from Public.Resource.Org. (2004) CC BY 2.0. Right photo from Florida Memory: State Library and Archives of Florida (1914).

January through March 1914, ending with the tourist season. The fare was $5 and the 90% average load factor would make today's airline executives jealous.

It wasn't until after World War I, however, that passenger air transportation companies began to develop. Enabled by the rapid wartime advances in technology and a post-war surplus of aircraft, many airlines were founded in the immediate aftermath of World War I in 1918. While there were a few short-lived ventures, many current European airlines trace their origins to that immediate post-war era. The British, French, and Dutch saw aviation as a method of linking together their distant colonial empires. KLM, founded in 1919 and claiming the title of the world's oldest airline under the same name, was "born out of the need to connect Amsterdam to what was then the East Indies" (EAS Barcelona, n.d., p.2). Scheduled flights between London and Amsterdam began in 1920 and continue to this day (Air France/KLM, n.d.). KLM's claim notwithstanding, British Airways initiated the first daily international scheduled service with its forerunner airline. Air Transport and Travel Limited started London to Paris service in August 1919. Similarly, the airlines that would later become Air France trace their origins to this period. Australia's Qantas dates from 1920 when two WWI veterans envisioned an air service connecting Australia to the rest of the world (Qantas, n.d.). In the Americas, Columbia's Avianca is the oldest airline (second worldwide behind KLM), where it revolutionized transportation, replacing riverboats for cross-country travel. Although Germany had fewer distant colonies, it was also home to several early airlines. Today's Lufthansa is a post-World War II creation, however, its predecessor, Deutsche Luft Hansa, dates to 1926. Asia is now the fastest-growing airline market, but its airlines generally trace their origins to the post-World War II era.

## 1.4 Regulation

The rapid international expansion of airline routes led to the first international aviation conference, the Paris Convention of 1919, to address the regulation of air commerce and conflicting claims of national sovereignty of airspace. The conferees concluded that each nation has absolute sovereignty over the airspace overlying its territories and waters and, therefore, the right to deny entry and regulate flights through its airspace. However, the conferees sought to encourage air transport by developing rules applying equally to all airlines and affording as much freedom of passage as possible. The convention was ultimately ratified by only 11 states. The United States declined to ratify based on the Convention's link to the League of Nations, to which the United States objected (De Gouyon Matignon, 2019). The Paris Convention built the foundation for later regulatory expansion until superseded by the Chicago Convention of 1944.

Ten years later, the Warsaw Convention established the first international airline liabilities and passenger rights. Airlines of the ratifying countries were required to issue passenger tickets and baggage claim checks for checked luggage. The Convention recognized the right to compensation for loss of

cargo or luggage and injury or death, but it limited the airlines' liability. The Warsaw Convention has been modified several times but remains the basis for airline liability worldwide.

## 1.5 Government-Supported Airlines

Early airlines, regardless of their homeland, were generally not financially viable. The cost to carry passengers in aircraft with only a few seats was very high. While early European airlines began as private companies, most could not survive independently and quickly became reliant on state subsidies. All British airlines, finding themselves unable to compete with subsidized French companies, ceased operations for a few months in 1921 until the British government implemented subsidies, first temporary, and then permanent. Thus began an era of state control and often direct ownership of airlines. The United States and Australia also subsidized their first airlines with contracts to carry mail. Two examples, British Airways and Qantas Airways, exemplify how these two national flag carriers emerged in their respective countries.

### *1.5.1 British Airways*

The evolution of British Airways is illustrative of the growth of European aviation. From 1916 to 1922, five airlines began operations in Great Britain: Air Transport and Travel (AT&T), Handley Page Transport Limited, Instone Airline, Daimler Airway, and British Marine Air Navigation. In 1920 AT&T ceased operations and its assets were bought by Daimler. In 1921, all British airlines suspended flying until government subsidies were implemented. In 1924, the government decided to combine the four subsidized airlines into one carrier. Imperial Airways was anointed as the "chosen instrument" of the British government with the mission of developing routes across the vast British Empire (British Airways, n.d.). By 1935 (with the help of Indian Trans-Continental and Qantas), Imperial Airways' routes extended from London to Cape Town, South Africa, and across Europe, the Middle East, India, and Asia terminating in Brisbane, Australia (see Figure 1.2 top).

Imperial Airlines operated a diverse fleet of aircraft, including four-engine flying boats. One of their land planes was the ungainly and aerodynamically inefficient Handley Page H.P. 42 biplane, pictured in Figure 1.2 (bottom). The H.P. 42 entered service in 1930 flying Imperial Airways eastern routes. Although cruising at only 100 mph, it had a range of 500 miles. Typical seating was for 24–26 passengers in surprisingly ornate first-class cabins split fore and aft. In 1934, Imperial Airways joined Qantas Limited to form Qantas Empire Airways (QEA). Jointly, Imperial Airways and QEA completed weekly London to Brisbane flights. Although the flight was primarily used for mail, a few hardy passengers did fly the 12,654-mile, 12-day trip (Eames, 2018).

The name British Airways (BA) first surfaced in 1936 with the consolidation of three airlines: United Airways, Hillman's Airways, and Spartan Airlines.

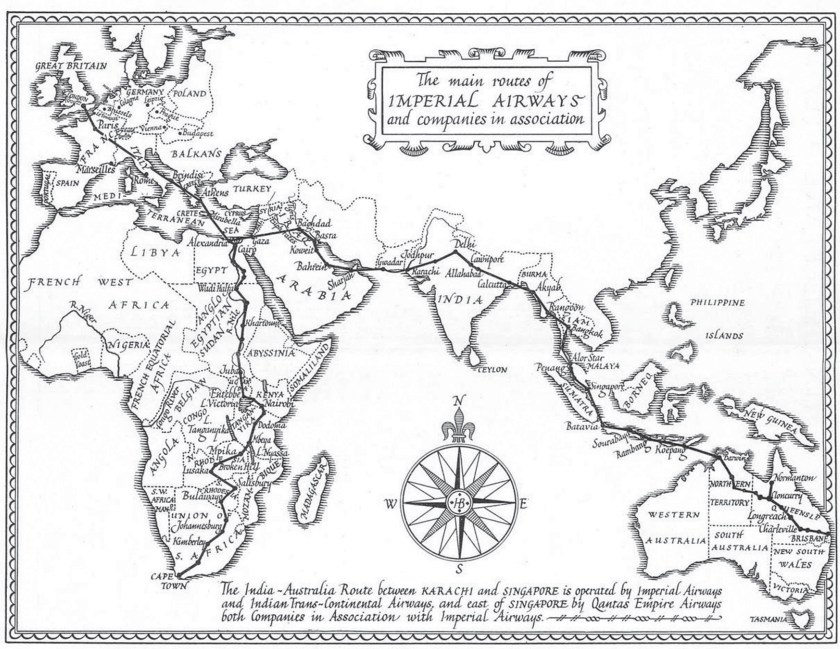


*Figure 1.2* Imperial Airways Route System and Handley Page H.P.42.

Source: From Wikimedia Commons. Top photo: Imperial Routes April 1935 (Imperial Airways, 2020). Bottom photo Matson (G. Eric and Edith) Photograph collection at the Library of Congress.

British Airways and Imperial Airways operated independently for three years until the start of World War II in 1939 when they were combined to form British Overseas Airways Corporation (BOAC). BOAC operated under the direction of the British Secretary of State for the duration of the war.

With the War's conclusion, the new Labour government decided that air services would be provided by three state corporations – BOAC would continue to operate routes to the Far East and North America; British European Airways (BEA) would serve domestic and European destinations, and British South American Airways (BSAA) would begin new services to South American and Caribbean destinations. Following the unexplained disappearance of two aircraft over the Atlantic in 1948 and 1949, BSAA was absorbed by BOAC. The British Airways brand was resurrected in 1974 when BOAC and BEA merged. The modern era began in 1979 when the Conservative government under Margaret Thatcher declared that British Airways would no longer receive state support or interference in decision-making by offering it for privatization. Soon after, however, BA was reporting major losses due to a recession, so the privatization was delayed. BA was fully privatized in 1987, concurrent with European airline deregulation (British Airways, n.d.).

### *1.5.2 Qantas*

The Queensland and Northern Territory Aerial Services (Qantas) Limited was started in 1920 when Australian Flying Corps World War I veterans Paul McGinness and Hudson Fysh envisioned an air service connecting Australia to the rest of the world (Qantas, n.d.). They started with just two biplanes offering air taxi and sightseeing services; regular airline service was initiated by 1922 (Hayward, 2019). Like British Airways, it was not long before Qantas needed government assistance to survive. Weekly subsidized domestic mail service started in 1922 followed by other contracts in 1924 and 1927. Additionally, in 1928, Qantas contracted with the government to provide on-demand medical flights, called the Australian Medical Service, flying 225 patients in its first year of operation (Qantas, n.d.). After flying domestically for 15 years, the founders' international vision was brought closer to fruition. In 1934, Qantas joined with Britain's Imperial Airways in a 50–50 venture to jointly form the subsidiary Qantas Empire Airways Ltd (QEA). Later that year, Qantas transferred all its operations to QEA. QEA started flying mail domestically, but in 1935 it began flying mail from Australia to Singapore as part of the UK's Empire Air Mail Route (Gunn, 1985; Hayward, 2019). These first overseas Empire flights from Brisbane to Singapore were in the De Havilland DH-86 (Figure 1.3), an aircraft De Havilland designed especially for Qantas (Qantas, n.d.; BAE Systems, n.d.). This airmail route was so popular for mail that often there was little room for passengers (Eames, 2018).

During World War II, Qantas continued service within Australia as well as the international flights to Singapore even though some of its aircraft were temporarily transferred to the Royal Australian Air Force. However, the Singapore service was shut down in 1942 after two Qantas Empire flying boats were shot down (Qantas, n.d.). Following the British lead with the nationalization of Imperial Airways, the Australian government began nationalizing QEA in 1947 by first purchasing BOAC's (formerly Imperial's) 50% share, then Qantas holding company's 50% share. The company continued to grow after WWII,


*Figure 1.3* Qantas De Havilland DH-86s in 1935 at Charleville Airport, Queensland, Australia.

Source: From Wikimedia Commons (The Queenslander, 2020).

rapidly expanding internationally. The first round-the-world service began in 1958. The following year, the Boeing 707, Qantas' first jet aircraft, began replacing the propeller-driven fleet. In 1967, QEA placed an order for four Boeing 747s, beginning a transition from the 707 to the 747. Also in 1967, Qantas Empire Airways dropped the "Empire," changing its name to its current version, Qantas Airways Limited (Qantas). By 1979, Qantas became the world's first all-747 airline (Gale, 2019). In 1992, needing a capital infusion that the government was unwilling to provide, Qantas was privatized, with British Airways buying a 25% share. The partnership went further in 1998 with the two airlines forming the Oneworld Alliance. Ending a 50-year era with the 747 in 2020, Qantas now headlines its fleet with Boeing 787 and Airbus 380 aircraft.

## 1.6 US Air Mail

Early US airlines did not follow the pattern of carriers overseas. The US entered World War I late, did not produce any large aircraft, and generally did not enjoy the technological advances common in Europe. An extensive railway system served all major US cities offering more speed, range, and reliability than aircraft of the early 1920s. And, unlike several European countries, the US did not have colonies scattered across continents that could be reached only by ship or tortuous overland routes. Still, the US government recognized the importance of aviation, especially after WW I conclusively demonstrated the power of aircraft as weapons of war and the potential for passenger transportation. Military aircraft production was mostly dismantled after the War, but the US understood the need to retain an aircraft production capability in the event of a future war, a prospect that unfortunately materialized within 25 years. The limited passenger air transportation available after WWI wasn't economically viable. The aircraft were too small, slow, unsafe, uncomfortable, and expensive. The train offered a superior alternative for long-distance travel. Start-up airlines, unable

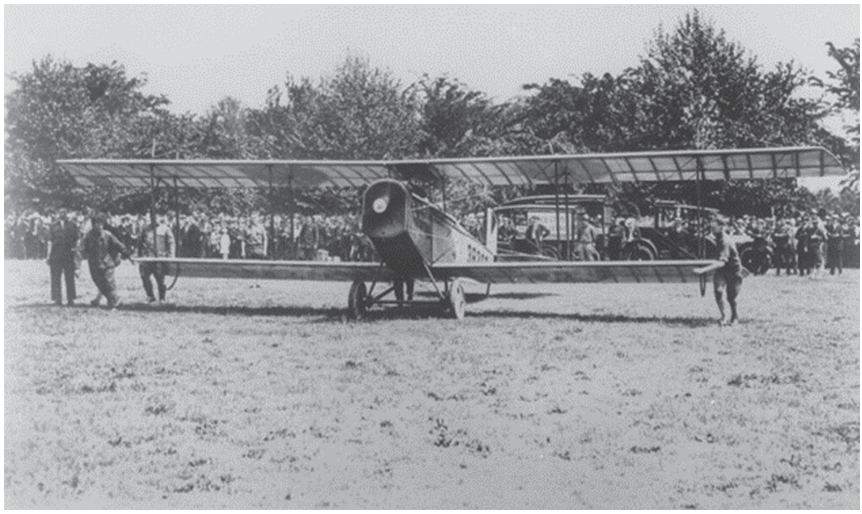

*Figure 1.4* Curtis JN-4HM Jenny at the inauguration of US Airmail service in Washington, D.C., 15 May 1918.
Source: From Smithsonian Institution (2008b).

to compete with the railroads, failed. Rather than attempt to build a system focused on passenger travel, heavily subsidized airmail service was chosen as a vehicle to begin air transportation system development.

The Post Office had been interested in airmail as early as 1912, but Congress didn't appropriate funds until 1918 when $100,000 was made available for experimental airmail service to be conducted jointly by the Army and the Post Office on a route between Washington and New York with an intermediate stop in Philadelphia. The initial aircraft fleet consisted of six new Curtiss JN-4HM Jenny biplanes originally designed as pilot trainers but slightly modified for airmail service (Figure 1.4).

After three months of flights flown by the Army Air Corps, the Post Office bought their own Standard JR-1B biplanes designed specifically for mail service, hired civilian pilots, and assumed full control of the operation.

Over the next eight years, the Post Office operated an ever-expanding air mail system developing procedures and facilities for reliable night flying, including sequential beacon lights to guide pilots along the transcontinental airways, weather reporting, and new airports. It experimented with several types of aircraft, but the converted ex-Army DeHavilland DH-4s were widely used.

In the mid-1920s, Congress decided that the growing airmail service should be transferred from the Post Office to private companies, a move that contrasts with the strategy of government-owned airlines typical of most of the world at that time. In 1926, the Post Office began auctioning its routes to the lowest bidders. Figure 1.5 shows the system of Contract Air Mail routes (CAM) awarded to private airlines.

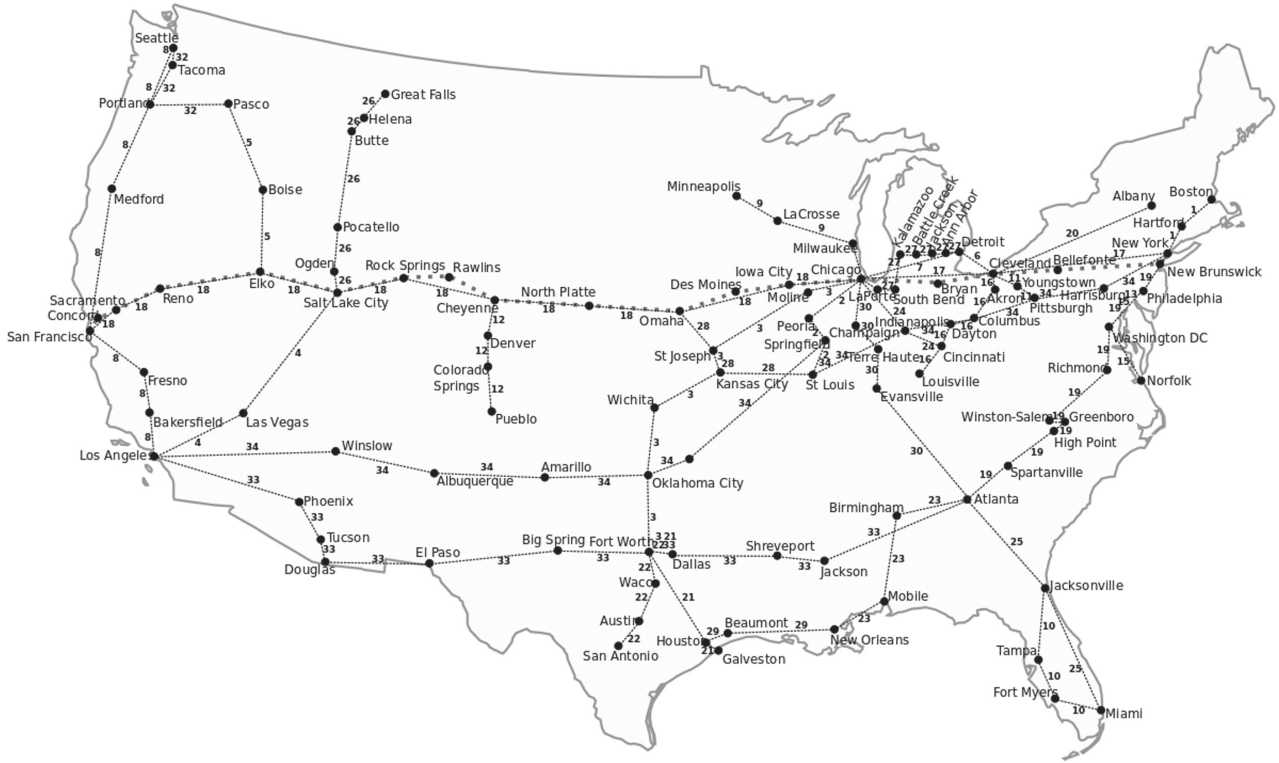


*Figure 1.5* CAM Routes, Circa 1930.
Source: From Wikimedia Commons. Photo by Rlandmann (2020), CC BY-SA 3.0.

By 1928, 44 small, financially weak, airlines were transporting mail under government contracts but often operating recklessly using obsolete, but cheap, aircraft. These airlines were either unable or unwilling to invest in facilities and equipment, so the vision of a viable air transportation industry remained unfulfilled. Intending to make airlines profitable and end subsidies, the Hoover administration engineered the consolidation of several carriers, eliminated competitive route bidding, and designated new airmail routes in a series of closed-door, semi-secret, meetings that became known as the "Spoils Conference." The "Big Four" airlines – American, Eastern, United, and TWA – trace their origins to this conference and emerged with the spoils – the new routes. Gone were smaller carriers, such as Robertson in St. Louis for whom Charles Lindberg had flown, and Ludington in Philadelphia.

Under the airmail system, aircraft technology slowly improved. In 1925, Boeing produced the Model 40 specifically for transcontinental mail routes (Figure 1.6). Although primarily designed to fly the mail, the Model 40s also had an interior cabin for two passengers marking an early attempt to combine passenger carriage on scheduled mail routes.

A leap in technology came two years later with Ford Tri-Motor. Although slow and loud, it was designed for passenger service (Figure 1.7). The Tri-Motor, affectionately called the "tin goose" was flown by many European airlines as well as carriers in Africa, Asia, Australia, South America, and the United States.


*Figure 1.6* Boeing Model 40. Note. Wikipedia Commons (Libby Photography Studio, 2022), CC BY 2.5.

Note the passengers' window in the fuselage between the two wings.


*Figure 1.7* The Ford Tri-Motor.
Source: Photo from Wikimedia Commons (Royal Air Truck Ford Tri-Motor, 2021).

It was an important milestone in the growth of air transportation because it "helped convince the traveling public that safe, reliable-albeit loud-air travel was now a possibility" (Van der Linden, 2012, p. 207). The Tri-Motor carried 13–15 passengers, depending on the model, but at only 90 miles per hour, it still couldn't match the convenience and comfort of long-distance train travel.

## 1.7 Economic Regulation

In 1929, the US stock market crashed leading to a worldwide depression that further compounded the financial struggles of nascent airline industry. As a minor part of the new Roosevelt administration's sweeping New Deal legislation, the Air Mail Act of 1934 split the responsibility for airline regulation among the Post Office, Bureau of Commerce, and the Interstate Commerce Commission, a plan that soon proved cumbersome and unproductive. Within a few years, regulatory reform was again before Congress.

## 1.8 CAB Economic Regulation 1938 to 1978

In a series of acts beginning with the Civil Aeronautics Act of 1938 and culminating in 1940, airline regulation was transferred to two separate entities. The Civil Aeronautics Board (CAB) was given responsibility for economic regulation. The Civil Aviation Administration, the forerunner of today's Federal Aviation Administration, assumed responsibility for non-economic regulation,

specifically for air traffic control, certification of aircraft and airmen, safety enforcement, and airway development.

The CAB was given a mandate to "promote the development and safety and to provide for the regulation of civil aeronautics" ("Civil Aeronautics Act," 1938, title). It was to develop adequate, economical, and efficient service "without unjust discrimination, undue preferences and advantages, and unfair or destructive competitive practices," but to preserve "competition to the extent necessary to assure the sound development of an air-transportation system" ("Civil Aeronautics Act," 1938, Section 2; Meyer & Oster, 1981). These conflicting objectives proved difficult to reconcile in practice. For most of its history, the CAB severely limited both route and price competition.

The CAB's mandate reflected the experiences of the Great Depression from which the nation had not fully recovered. The unregulated free market was judged destructive. The CAB regulation of the fledgling airline industry was informed by and patterned after railroad regulation. Evidence of the railroad legacy remains today as airline employee labor relations are still governed by the Railway Labor Act.

CAB regulation addressed three broad categories of airline operation: (a) initial approval to operate; (b) routes flown; and (c) fares charged.

The CAB approved airlines seeking to operate in interstate commerce. Airlines already operating in 1938 received grandfather rights to fly their existing markets. For new applicants, however, the CAB judged not only whether the prospective carrier was "fit, willing, and able," but also whether the new service was necessary for "public convenience and necessity." A prospective airline had to demonstrate that it had the financial, managerial, and technical capability to safely operate an airline and that its proposed service was needed to fill a void in the market that would benefit the public. This proved a high standard. In the years after World War II, the CAB approved many smaller airlines, but no new, large airlines, called trunk carriers, were approved during CAB's 40-year reign (Borenstein & Rose, 2007).

The CAB approved airlines to operate specific interstate routes with separate CAB approval needed to add a new route or to drop an existing route. New route requests originated for a variety of reasons such as a request from a city for new or expanded service or from the CAB's determination that more service was needed. Once a new route case was opened, all airlines could apply for the new service and, in a quasi-legal proceeding lasting a year or more, all arguments were heard. The CAB would eventually render its decision, but by the time the winning airline was announced, the market may have changed, and the winner often found the new route did not fit well into its existing structure. On all but the largest routes, only a single carrier was permitted. Trunk carriers wishing to expand on routes already served by another airline had to show that the competition would not harm the incumbent carrier. As late as 1958, there was no competition on 23 of the 100 largest domestic routes.

Most routes were operated in point-to-point or linear service often along the former airmail routes which themselves paralleled railroad lines. Enough

flights operated from the largest airports to allow some passenger connections, but the CAB generally prevented airlines from optimizing their routes to improve service or reduce costs.

Finally, the CAB set the prices charged by all airlines in scheduled service. Before World War II, fares were set to prevailing first-class railroad fares but were later computed on a mileage basis and set to allow a reasonable return (12%) on investment (Bailey, 2002). Airlines were effectively required to cross-subsidize shorter routes with profitable, often longer segments. When fares were changed, increases applied to all flights; route-specific changes were not adopted. Charter flight fares were not subject to the same regulation that later became an avenue for price competition, but the CAB discouraged price competition and rarely approved discounting from the formula rate. Consequently, airlines attempted to compete and differentiate their products with inflight service. Even here, however, the CAB attempted to limit non-price competition by restricting first-class and sleeper-seat configurations.

Even under the protective shield of economic regulation, some carriers struggled financially. The CAB responded by awarding lucrative new routes to the weakest airlines. If this was insufficient to curb losses, the CAB orchestrated mergers. For example, Delta absorbed Northeastern with CAB encouragement in 1972.

## 1.9 Advances in Aircraft Technology

While the CAB was mandated to promote the airline industry, rapid advances in aircraft technology spurred the growth of passenger air travel. As a result of incentives provided by the Post Office, Boeing developed the Model 247, often called the "world's first modern airliner," in 1933 (Van der Linden, 2012, p.208). It was the first airliner to utilize efficient engine streamlining to reduce drag and improve the speed necessary to compete with the train (Redding & Yenne, 1983; Van der Linden, 2012). Although it needed several refueling stops, the 247 could fly from New York to Los Angeles in under 20 hours – seven hours less than any other airliner (Lombardi, 2008; Boeing, n.d.-a). Boeing took an order from its affiliate United Airlines for the first 60 247s; consequently, other airlines had to wait until United's order was filled. This would prove to be a strategic error as Transcontinental and Western Air (later TWA) persuaded Donald Douglas to design and build a competing airliner. The resulting DC-1 turned out to be superior to the 247. Douglas quickly improved on the DC-1 with the DC-2. Then, American Airlines president C.R. Smith convinced Douglas to design a sleeper version of the DC-2. The result was the fabulously successful DC-3, often proclaimed as the first airliner capable of making a profit from passenger service. The DC-3 in Figure 1.8 is pictured in American Airlines livery. American introduced the DC-3 in transcontinental sleeper service in 1935. With the popular DC-3 in production, the Model 247 sales fizzled, and only 75 were sold.


*Figure 1.8* Douglas DC-3.
Source: From Wikimedia Commons (Jon Proctor collection).

The DC-3 incorporated the advanced technology introduced on Boeing's 247 – stress-carrying skin, two engines (with the capability for high altitude single-engine flight), controllable pitch propellers, retractable landing gear, and deicing for wings and propellers. Additionally, the DC-3 was slightly faster and much larger than the 247, capable of carrying 21–28 passengers in daytime and 14 in night sleeper configuration versus the 247's 10 (Boeing, n.d.-b). Within a year of its introduction into service, United began replacing its Model 247s with the more economical DC-3. The DC-3 soon dominated the airline fleets in the years immediately preceding World War II. By 1939, 90% of all US airline flights were operated with the DC-2s and -3s (Boeing, n.d.-b).

The DC-3 was larger, faster, and more reliable than the aircraft it replaced. These technological and economic improvements can be quantified with a *productivity index*. The productivity index is a measure of available seat miles per year, the product of three factors: (a) seat capacity; (b) speed; and (c) utilization measured in flight hours per year. A fourth component, load factor or the percentage of seats occupied, is sometimes included for economic comparisons. But load factor is a measure of market demand, competition, and management decisions rather than aircraft design productivity, so it is not included in the index. To compute the productivity index, multiply seat capacity, speed, and yearly utilization. For the DC-3, the index equates to 30 seats X 180 mph X 1,500 hours/year or 8.1 million available seat miles per year (ASM/year) per aircraft.

World War II, which the United States entered in late 1941 following the attack on Pearl Harbor, interrupted the growth and development of the civilian air transportation system. Airline capacity was dedicated to providing military and government transport in support of the war. Intensive wartime production allowed many firms to return to profitability following many years of losses in the Great Depression. Airlines benefited throughout the war years.

Advances in aircraft technology required to produce large bombers were quickly incorporated in the post-war period to field a new generation of airliners. The Douglas DC-6, originally a military transport (the C-118 Liftmaster), was reworked after the war for long-range commercial routes. The DC-6 entered commercial service with United Airlines in 1947. By 1949, it was in service with United, American, and Delta, among others. The DC-6 cruised at 300 miles per hour and carried about 60 passengers depending on the model and airline configuration. By the mid–1950s, piston-engine technology reached its zenith with turbocharged, compound radial engines capable of 3,500 hp. The Douglas DC-7C, tagged the Seven Seas, and Lockheed Super Constellation represent the pinnacle of piston aircraft technology. Both were capable of trans-continental and trans-Atlantic non-stop service. The Super Constellation with its distinctive three-tail configuration is pictured in Figure 1.9.


*Figure 1.9* Lockheed Super Constellation.
Source: From Wikimedia Commons by RuthAS (2020) CC BY 3.0.

As an example of the post-war increase in aircraft productivity, the productivity index for the Super Constellation is 85 passengers X 335 mph X 2,000 hours/year = 57 million ASM/year per aircraft. During the 20 years from the introduction of the DC-3 to the largest piston-powered airliners, aircraft productivity increased seven-fold.

## 1.10 Post-War Airline Growth

In the later years of WWII, the airlines and the CAB turned their attention to expanding the domestic route system. With the increased range and capability of post-war airliners, the CAB awarded new routes between major cities to the 15 established trunk airlines. But competition was still restrained with even the highest demand markets limited to two carriers.

Under public and political pressure, the CAB approved another type of airline in addition to the trunk carrier – the local service airline (LSA). LSAs were awarded routes connecting smaller cities previously without air service to larger cities served by trunk carriers thereby allowing for air travel between many more cities across the US. Such travel, however, was often inconvenient because the schedules of the LSAs and trunk airlines were poorly coordinated. Passengers would often have to change airlines two or three times on an itinerary connecting two small, geographically dispersed cities. This inconvenience was an important factor in the post-deregulation development of hub-and-spoke route systems. Large numbers of war-surplus DC-3s became the backbone of the LSA fleets. LSAs were mostly unprofitable leading to various CAB subsidies (Cook, 1996).

The third type of carrier only flew internationally. Before World War II, Pan American World Airways was the sole US airline allowed to operate international routes. In return for this government monopoly, Pan Am was not permitted any domestic routes. After industry deregulation, this lack of domestic feed traffic proved an insurmountable problem for Pan Am. In 1946, Trans World Airlines broke the monopoly beginning trans-Atlantic service making it the second US-designated flag carrier. But, unlike Pan Am, TWA retained its domestic route structure.

The fourth type of airline, the supplemental carrier, operated charter services. The CAB intended for supplemental carriers to offer charters during the peak seasons to "supplement" existing scheduled service. Rather, with high-density seating and low costs, charter services gradually began to compete with trunk carriers introducing some price competition into domestic airline routes.

A new element of competition emerged in 1948 when the trunk carrier Capital Airlines inaugurated high-density coach seating on its DC-4 aircraft operating between Chicago and New York. The CAB approved coach fares of approximately two-thirds of previously existing first-class fares – and traffic soared. This event is a significant first step to greater competition and, eventually, deregulation. Capital Airlines later merged into United Airlines.

## 1.11 The Jet Age

Early jet engine designs date to the late 1930s; the Germans were the first to fly a jet-powered fighter aircraft towards the end of WWII. During the mid-1940s, Boeing engineers were designing a swept-back wing jet bomber they called the B-47, but the British were first to incorporate this new technology for commercial aircraft in the de Havilland Comet. The Comet entered service in 1952, first with BOAC, and then with other international airlines. Tragically, the aircraft experienced airframe metal fatigue, a phenomenon not then fully understood or appreciated, resulting in two in-flight breakups (Withey, 2001). Although de Havilland deserves considerable credit for starting the jet age, sales of the redesigned Comet never fully recovered.

After producing two military jet bombers, the B-47 and B-52, Boeing used similar design concepts in their first jet transport prototype – the Model 376–80. Affectionately called the "Dash Eighty," the aircraft first flew in 1954. Seeing the potential of the prototype, the US Air Force ordered an air refueling tanker version of the Dash Eighty – the KC-135. Perhaps the best example of military-civilian technology transfer, the KC-135, was introduced in 1956 and is still flying. While the KC-135 was an enormous success as a military plane, its civilian counterpart, the Boeing 707 (Figure 1.10, top) would be even more successful after its introduction as the first US-built passenger jet.

Jet engines proved far more dependable than piston-driven engines. Lower engine vibration delivered a smoother ride, placed less stress on the airframe, and reduced maintenance expenses. Jet engines burn kerosene, which, at that time, cost half as much as the high-octane gasoline used in large piston transports. While questions remained about the technical and economic feasibility of commercial jet aircraft, Pan American World Airways was the launch customer for the B-707 with a record-breaking order of 20 aircraft. With Pan Am's successful introduction of the B-707 in 1958, concerns about the feasibility of jet aircraft were resolved; other large airlines lined up to buy the new jet aircraft. The Jet Age had arrived.

Aircraft productivity took another big leap with the 707 and other manufacturers' jet transports that soon followed. The 707 was larger, much faster, and more dependable than the piston aircraft it replaced. The productivity index for the Boeing 707 quantifies another significant improvement in technology: 160 seats X 600 mph X 3,000 hours/year = 288 million available seat miles per year.

The Boeing 747, which first flew in 1969, rivals the B-707 for success and popularity as a commercial jet transport. It also ushered in another leap in productivity. Buoyed by its success with the 707, Pan American was the first airline to order and operate the world's first jumbo-jet when the Boeing 747 began transatlantic service in 1970. A Pan American World Airways 747 is pictured in Figure 1.10 (bottom). At two and half times the size of the B-707 and the rival Douglas DC-8, the 747 offered yet another leap in productivity. The


*Figure 1.10* (Top) Boeing 707 operated by Qantas and (bottom) a Pan American World Airways Boeing 747.

Source: Both photos from Wikimedia Commons. Top photo by Barry Lewis (Lewis, 2022) CC BY 2.0. Bottom photo by Paul Nelhams (Nelhams, 2020) CC BY 2.0.

productivity index for the Boeing 747: 360 seats X 550 mph X 4,000 hours/year = 792 million available seat miles per year.

From the introduction of the Douglas DC-3 in 1933 to the Boeing 747 in 1970, a period of less than 40 years, aircraft productivity measured in available seat miles per year increased by a factor of 100. This is an astonishing technological feat, a pace of innovation we now associate with computing.

Airbus, a government-sponsored consortium, including aircraft manufacturers from France, Germany, Netherlands, and Spain, produced the first wide-body, twin-engine commercial aircraft. The Airbus A300 entered service in 1974 but initially enjoyed few sales (Figure 1.11, top). Airbus scored


*Figure 1.11* Airbus A300 at Paris – Orly operated by launch customer Air France (top) and Singapore Airlines flagship A380 (bottom).

Source: Both photos are from Wikimedia Commons. Top photo by Kambui (2020) CC BY 2.0. Bottom photo from Aeroprints.com (2020) CC BY-SA 3.0.

a breakthrough in the US when Eastern Airlines ordered the A-300-B4. Other US airline orders soon followed firmly establishing Airbus in the world aircraft market.

Airbus scored another first with the introduction into service of the A-380 by Singapore Airlines in 2007 (Figure 1.11, bottom). The A-380 is the world's

largest passenger airliner typically configured for 525 passengers in three cabins but with an all-economy capacity of 853.

Since the Boeing 747, the increase in technologically-driven productivity has slowed. Neither speed nor capacity increased until the launch of the Airbus 380, but improvements in fuel efficiency and reliability have continued. The supersonic British-French Concord notwithstanding, economical cruise speed is limited by shock wave-induced drag.

Rather than increases in size and speed, technological developments since the design of the 747 have focused on operating economics. Composite structures like those seen in the Boeing 787 and Airbus 350 lessen weight, and advanced engine technology provides greater power and better fuel economy. As a result, most new aircraft designs are now two-engine versus four-engine. Increased engine reliability permits two-engine aircraft, once limited in operations, to fly virtually any route in the world. Enhanced component reliability and advancements in cockpit automation improved flight operations efficiency and safety.

The productivity index is a measure of the rapid improvements in aircraft technology, but this index, as with any economic metric, is imperfect. Should the productivity index for the A-380 be computed using the typical passenger seating configuration or is the all-economy seating more representative even though no airline has chosen that configuration? Because we began with the computations with the DC-3 in single-class configuration, we'll use it again here: 850 seats x 600 mph x 4,750 hours per year = 2.5 billion available seat miles per year (ASM/year) or some 300 times that of the DC-3. Improved aircraft technology reduces aircraft operating costs per passenger, savings reflected in lower fares. The productivity index, however, does not measure improvements in quality, a common deficiency of economic indicators. The passenger riding current-generation commercial jet aircraft enjoys much greater safety and more comfort with a pressurized and air-conditioned cabin and other interior amenities unimaginable to the DC-3 passenger.

## 1.12 US Deregulation

With the success of the Boeing 747 in the earlier 1970s, other aircraft manufacturers rushed to build competing jumbo jets, notably the Douglas DC-10 and Lockheed L-1011. US trunk carriers dutifully ordered jumbo jets for domestic service so as not to be left behind. This resulted in an unintended consequence: too many available seats for the market demand established by CAB-set fares.

The CAB did not believe in or allow much price competition, so airlines resorted to flight frequency and inflight service to lure passengers to empty seats. Continental installed a piano bar in its DC-10 aircraft. Further, the CAB consistently refused to allow airlines operating older, slower, and less comfortable aircraft to charge lower fares; the newest aircraft became a competitive necessity (Borenstein & Rose, 2007).

Fares remained high and passenger load factors dropped from 70% in 1950 to 50% by the mid-1970s. Airlines were losing money to which the CAB

responded with a route moratorium. But financial pressures increased, so in 1974 the CAB allowed a 20% fare increase which further depressed demand. The CAB also sanctioned capacity limitation agreements among major carriers to slow continuing losses (Borenstein, 1992; Button, 1991).

As the futility of the CAB's actions became apparent, many academics, regulators, politicians, and an occasional airline executive began calling for drastic changes in CAB regulation. Several factors provided impetus: (a) capacity increased on many routes as jumbo-jets entered service; (b) the Middle-Eastern oil embargo in 1973 led to skyrocketing fuel costs and contributed to price inflation; and (c) an economic downturn put a severe strain on airlines as business travel demand fell at the same time capacity and fuel prices were rising.

In 1974, the Ford Administration began to press for government regulatory reforms in response to a growing public sentiment that government regulations were overly burdensome on US industry and contributing to inflation. Shortly thereafter, Senator Edward Kennedy chaired Senate subcommittee hearings concluding that airline prices would fall if government constraints on competition were lifted. Comparisons drawn with unregulated intrastate carriers Southwest Airlines, Pacific Southwest Airlines, and Air California exposed inefficiencies of the regulated airlines that were costly to consumers. A CAB staff report reached the same conclusion in 1975. The report said the industry was "naturally competitive, not monopolistic," (Civil Aeronautics Board, 1975, Executive Summary) and that the CAB itself could no longer justify entry controls or public utility-type pricing. On its own, the Board began to loosen its grip on the industry (Bailey et al., 1985).

The debate over airline industry economic deregulation was based, in large part, on economic studies and recommendations. Economic theory holds that under conditions of perfect competition, consumer welfare is maximized without government restriction or interference. In attempting to earn a profit under intense competition, suppliers develop and market products that consumers want while competition ensures that products are produced at the lowest possible cost and sold at prices that just cover the production expense.

However, contrary to the theory of perfect competition, airline markets are natural oligopolies in which only a few airlines compete. While economists recognized this important distinction, they generally argued that airlines were sufficiently competitive to provide the benefits of competitive competition without government regulation. Proponents offered several arguments in favor of deregulation.

- Deregulated airlines would be more efficient. Proponents argued that regulation resulted in inefficient and costly operations. With fares set by the CAB based on airline costs plus a profit margin, airlines faced few incentives to pursue lower costs. Unable to differentiate their products based on prices, airlines promoted costly and inefficient passenger amenities. Labor successfully pursued a strategy of ever-increasing common industry-wide wages

and work rules. Because all airlines incurred similar labor costs, higher labor costs were incorporated into the base fare computations.

- Subjecting airlines to competition would result in lower fares. Economists pointed to intrastate carriers Pacific Southwest Airlines (PSA), Air California (AirCal), and Southwest that were not subject to CAB economic regulation. These airlines charged only about half that of CAB-regulated airlines on routes of similar length. Deregulation would allow new, more efficient airlines to enter markets with low fares and innovative service thereby disciplining the established carriers. Incumbent carriers would either become cost-competitive or fail.
- Critics of the CAB also argued that it no longer regulated in the interest of passengers but rather in the interest of its clients, the airlines. The CAB staff were often recruited from the airlines or hoped to join the airline management following their time with the CAB. Indeed, many of the prominent post-deregulation airline executives began their careers at the CAB.
- Expansion by existing carriers and new entrants would provide more service in response to passenger demand.

Most airline executives and labor opposed deregulation. Their arguments against deregulation were also persuasive.

- The strongest carriers would engage in predatory pricing, lowering prices on routes until weaker carriers were forced out.
- Having dispatched competing airlines, strong airlines would then monopolize the most profitable routes raising fares to monopoly levels. Thus, rather than lower fares for passengers, prices would increase in the long run.
- Airlines would abandon routes with low demand that were cross-subsidized under CAB regulation. Some cities would lose air service altogether.
- Faced with intense price competition, airlines would cut maintenance and other essential safety expenditures.
- Finally, some airlines would fail with employees losing their careers and livelihoods (Cook, 1996).

### *1.12.1 The Airline Deregulation Act of 1978*

In 1977, recognizing the growing movement towards deregulation, the CAB consented to American Airlines' request for SuperSaver discounts of 45% below existing coach fares. When American's traffic swelled as much as 60% in response, the solution to overcapacity seemed at hand in an apparent vindication of the deregulation proponents. Other carriers quickly filed and received approval for similar discounts (Meyer & Oster, 1981).

Congress first freed cargo airlines from economic regulation in 1977 leading directly to the success of Federal Express (now FedEx). The same principle of free-market competition was next applied to the passenger carriers in the Airline Deregulation Act of 1978. The Act phased out domestic route and rate