Journal of Aviation/Aerospace Education & Research

Volume 1
Number 3 *JAAER Spring 1991*

Article 5

Spring 1991

Divisibility, Technology, and the Competitive Potential of Regional Airlines

Stanley A. Fawcett

Stanley E. Fawcett

DIVISIBILITY, TECHNOLOGY, AND THE COMPETITIVE POTENTIAL OF REGIONAL AIRLINES

Stanley A. Fawcett and Stanley E. Fawcett

ABSTRACT

During the 12 years following deregulation of the airline industry, tremendous change has taken place involving both industry structure and industry competition. Much of the discussion concerning these changes has not fully considered the factor supply side of the industry, especially with respect to emerging technology and factor indivisibility. However, new technology airframe and engine design (turboprop and turbofan) and the use of new materials promises to mitigate the problems associated with aircraft size. The availability of this new technology will enable regional air carriers to implement new competitive strategies such as regional hubbing and hub bypassing. This paper discusses the impact of technology on the competitive potential of regional airlines, looking at the benefits of and impediments to such competition.

INTRODUCTION

In the years following the passage of the Airline Deregulation Act of 1978, a tremendous body of literature discussing the competitive implications of airline deregulation has appeared (Levine, 1987). Much of this literature has addressed the applicability of the theory of contestable markets to the airline industry. In a macroeconomic sense, if prices, wages, and salaries are perfectly flexible, they would move instantaneously to clear the market at all times. Recognizing this, contestability or any other theory cannot fully explain a market that has restraints on the factors side. Unions, governmental policies (Federal Aviation Administration [FAA] policies), airports, and other restraints exist, blocking a free flow of actors. Switching costs (frequent flyer programs) and other constraints further complicate market operations in the airline industry. Considerable attention has also been given to the issue of airline mergers and the resulting industry concentration. Other issues widely discussed include airport congestion, airline profitability, development of hub and spoke route systems, employee relations in a deregulated environment, and the overall efficacy of airline deregulation. Despite this widespread interest in the airline industry, several important issues have been overlooked. For example, the factor input market (the factor supply side of the airline industry) has received comparatively little attention. Perhaps two of the most important issues concerning the factor market include the availability of skilled labor (in particular, pilots and mechanics) and the development and application of new technology.

The focus of this paper is on the application to the airline industry of new technology, with particular emphasis on emerging technology's potential to alter the structure and competitiveness of the industry. A brief overview of the impact of technology application on the airline industry is presented by looking at the relationships between technology and two of the industry's primary input factors--labor and capital.

The impact of technology on divisibility and industry structure is then reviewed. Finally, specific technological developments and their potential application to the industry are discussed from the perspective of industry competition. The paper concludes with a summary and a discussion of policy implications.

TECHNOLOGY AND COST OF FACTOR INPUTS

The primary production factors purchased by regional airlines are labor, fuel, management, and capital. Capital is represented mainly by aircraft, spare parts, maintenance facilities, ground handling equipment, and other leased facilities. The largest labor factor cost components are costs of operating a scheduled air transport system--the costs involved in generating capacity on the routes. These costs account for nearly three-fourths of the total labor factor costs. Conversely, passenger and freight servicing costs are about one-fifth of the total labor factor costs (Douglas & Miller, 1978). Combined, labor costs exceed 40 per cent of total costs for the airlines. Over time, changes in production technology have impacted each of the factor inputs.

Production technology's primary impact on the labor factor cost has been largely one of increasing labor productivity. With these improvements in productivity, improved profitability should result. However, because the purchase of labor takes place in a restricted market with considerable interference from governmental agencies, many of the productivity gains resulting from the application of new technology have been dissipated by high wages and salaries. This technology-labor relationship can be best illustrated by looking at the role of the Air Line Pilots Association (ALPA). Since many of the early airline founders were pilots recently released from the military, pilots have historically possessed a strong power base within the traditional incumbent carriers. The overall position of pilots has continued to be strong because of the very low short-run demand elasticity for their services. This position is perpetuated by such factors as the rivalry in oligopolistic markets for a limited supply of qualified pilots, the rigidities of technology, and federal safety regulation. From their influential position, the pilots have not only played a pervasive role in management decisions, but have also been very successful in pressing for high wage levels--increases that were not resisted by the airlines under regulation.

Indeed, wage settlements have historically allocated large proportions of productivity gains to pilots. For example, in the 1951-52 period, the pilots association successfully sought modification of the speed component of the pay schedule so that the cost per mile of a pilot's services increased with the number of miles flown in a month. The aim was to protect the number of jobs in the face of rapid increases in aircraft speed. Other adjustments in pilots' wages have effectively absorbed improvements in productivity brought on by such key technology gains as the development and adoption of jet and wide-body aircraft, as well as the more recent automation of many pilot and flight engineering functions. From its prominent position, ALPA has developed a negotiating strategy that resists industry-wide bargaining in favor of single-carrier bargaining to establish general precedents for contract settlement. The very success of this "whipsawing" technique caused considerable distortion in airline labor markets when deregulation occurred (Caves, 1962). (The International Association of Machinists [IAM] use very similar tactics.) The modification of mutual assistance pacts by the Airline Deregulation Act of 1978 has further served to perpetuate the position of influence held by airline pilots in today's dynamic marketplace.

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

During the early part of the deregulation era, a number of carriers successfully resisted the demands of pilots and mechanics. This success was a result of the intensified competition brought on by new entry airlines such as PeopleExpress and America West as non-union carriers. Eastern Airlines is a very good case study of entrenched labor unions and public policy actions which constrain market forces on the factor supply side. Eastern's human resources policies were a contributing factor, but management direction was correct though not successful (Borman, 1988; and "Unions...," 1988).

This new competition forced ALPA to accept the establishment of two-scale pay systems for pilots. Even so, the recently negotiated contract at Delta Air Lines together with increased industry concentration and the potential return to oligopoly competition suggest that substantive technology-related productivity gains continue to be susceptible to labor demands ("Proposed Delta...," 1990). While Delta did retain the B scale for its pilots, this scale has been considerably modified in favor of the pilots. Delta did gain an increased work month from 75 hours to 80 hours, but had to guarantee a fall back to 75 hours before any pilot could be furloughed if the company's operations are scaled back in the future. American Airlines has negotiated a similar contact with their pilots' union, the Allied Pilots Association.

Production technology's impact on the capital input cost has been quite different from that on labor and has indirectly led to the current structure of most major airline operation. The service nature of airline competition makes the economics of scheduled air transportation complex. Because scheduled service cannot be stored, current consumption must come entirely from current production. Further, the necessary capacity for the production of scheduled air service is provided by an airline's capital stock (equipment). Unfortunately, capacity is produced only in discrete units equivalent to the number of seats available on the plane being flown to provide city-pair service. Thus, a definite challenge exists in matching capacity supplied to capacity demanded--once a plane takes off, each empty seat represents capacity that is lost forever. This challenge of economically supplying adequate capacity is exacerbated both by a pricing structure that encourages schedule augmentation as a means of non-price competition and by an existing bias toward the use of large, jet aircraft. The bias toward larger aircraft occurs because the production function for airline service is characterized by variable proportions--plane choice therefore represents a principal means of factor substitution. For each unit of production (seat-mile or ton-mile) which can be produced with a Metro IV or a DC-9, the DC-9 is the more capital-intensive and labor-conserving choice. Also, airlines have sought to minimize the number of different airplane types in their fleets for efficient maintenance purposes. Similarly, airframe manufacturers, operating under conditions of considerable uncertainty, have biased their research and development efforts to the largest single airline market--typically toward long-haul, luxury aircraft. The result of these practices is that scheduled air transportation tends toward "excess" capacity.

In an industry that requires a capacity utilization (load factor) of approximately 60% to be profitable, the utilization of larger, faster planes that has come about through technological innovation (and persists because of customer preference) has created a service/capacity dilemma. That is, the preferred use of large, jet aircraft by the major airlines to serve various routes cannot always be economically justified on a capacity demanded basis. The core of this dilemma is created by the indivisibility of the major capital input--the airplane. (Indivisibilities: The inability to divide some factor unit of production such as capital equipment into smaller units without either complete loss of usefulness in production or partial loss of efficiency. It is not always possible to adjust all factor inputs in the same proportions). One widely adopted approach to overcoming the service/capacity dilemma has been the development of hub-and-spoke route networks. The major airlines have been able to circumvent the service/capacity dilemma while further partitioning competition within the overall industry. The relationship between technology and industry structure is discussed in greater depth in the following section.

In summary, technology's impact on the airline industry's controllable factor inputs--labor and capital--has played two very important roles in the development of today's airline industry. First, technological development, especially in the areas of jet propulsion, aircraft size, and flight management systems, has enhanced productivity and provided air carriers with a viable competitive advantage over other for-hire passenger transportation modes. This is true despite the fact that many of the productivity gains have been leveraged away by various labor groups.

Second, the economies created by this same technological development, principally jet propulsion and larger aircraft, has created a service/capacity dilemma stemming from an indivisible capital input. This service/capacity problem has promoted recent and widespread changes in industry route structure, leading to the dominance of hub-and-spoke routing. Thus, technological advancement has served both to promote and to limit airline competition.

TECHNOLOGY, DIVISIBILITY, AND INDUSTRY STRUCTURE

As previously suggested, the hub-and-spoke networks that operate at most major airports have developed largely as a response by the major airlines to the challenge of matching capacity supplied to capacity demanded. That is, hub-and-spoke route networks represent the airlines' operational response to the economic problem of indivisible capital inputs. The basic objective of hub-and-spoke systems is to gather passengers from a variety of outlying, low-density points and bring them together at a central location (the hub airport) and then redistribute them to the outlying points or to another hub. By developing hub-and-spoke operations, the airlines are better able to utilize today's large jet aircraft to serve lower-density, city-pair markets with satisfactory load factors (Phillips, 1985).

Hubbing potentially enables the major airlines to overcome the service/capacity complication. This practice allows economical service to many more cities by increasing both the efficiency and effectiveness of the larger, "indivisible" jet aircraft. The economics of hubbing have proven so pervasive that U.S. carriers operated forty-nine hubs at thirty-one airports at the beginning of 1987 (Fawcett and Fawcett, 1988). Further, new hubs continue to be developed each year, and the widespread use of hub-and-spoke routing has been called the most significant development in airline operations since the era of deregulation began.

While the utilization of hub-and-spoke networks has allowed the major airlines to take advantage of technological advances in aircraft development, many of the benefits and problems that have resulted promise to influence the future development of the industry. As stated, the greatest advantage of hubbing comes from the more efficient use of aircraft and personnel which increases the number of city-pairs that can be served economically by an airline.

Other benefits of hub-and-spoke systems include a reduction in dependency on other

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

airlines for interlining and improvement in schedule frequency during peak hours, a higher retention rate of passengers on-line, and the development of traffic feed through the hub. In addition, when hubs become highly concentrated, the hubbing or dominant carrier can use its market position to impose costs on potential new entrants.

The problems associated with hubbing have come about largely because hub-and-spoke operations typically require the bunching of flights around peak times--planes arrive in short time blocks, change passengers, and then depart in a very short time span. The result is often a greater frequency of congestion, confusion, and delays. In reality, the use of hubs transfers much of the daily traffic at key airports to small time intervals, causing severe capacity constraints during these peak periods. In addition, because flights are inter-dependent in a hub system, if a problem occurs in one area, it has a ripple effect throughout the system. Hubbing also presents public policy makers with some very difficult questions concerning antitrust violations and overall industry competitiveness.

The ideal operational system would provide the benefits of hubbing without creating the attendant problems. To this end, a number of new developments in aircraft and engine technology that considerably enhance factor input divisibility will provide opportunities to modify industry operating structure. These advances in technology are making it possible to substantially reduce the size of the discrete unit of production capacity while offering many of the benefits of the larger jet aircraft--speed (flight duration), comfort, and perceived safety. Such technology changes are improving the economic viability of hubbing many medium sized airports for regional air service. These changes also have the potential to make smaller regional and commuter air carriers more attractive for providing direct service to many city-pair markets (by-passing hubs). These two changes would not only potentially increase the level of competition in the airline industry, but also mitigate many of the problems associated with the current operation of large "fortress" hub airports.

TECHNOLOGY AND COMPETITION

The competitive environment in the airline industry has evolved continually throughout the deregulatory era. The initial increase in new entry and competition that occurred during the first six years of deregulation has been followed by six years of increasing industry concentration.

This increase in concentration has been particularly acute in major hub markets, which have been established by the airlines to overcome the problem of divisibility and take advantage of economies of density, information, and scope. Today, many hub markets are so highly concentrated (**Table 1** next page) that the level of industry competitiveness is now questioned--many feel the industry is close to reaching a point where the major airlines will be able to effectively partition the market to avoid aggressive fare competition (Nomani, 1990). Further, the ability of new airlines to enter the industry has become somewhat doubtful (Brenner, 1988; Fawcett and Farris, 1989).

One possible source of competition currently exists in the form of the commuter or regional airline group. Certainly, the marketing agreements, code sharing, and equity shares by the major carriers inhibit the competitive potential of regional lines; even so, a number of regionals continue to possess operating and marketing flexibility. Further, future public policy action could be directly targeted at improving the competitive ability of the regional carriers. This future flexibility combined with continued growth, good earnings, and financial stability indicates that competitive opportunities do exist for regional carriers (Moxon, 1988;Stynes, 1989a; "U.S. Commuter...," 1989). In fact, regionals carried 31.8 million passengers in 1987 and in excess of 34 million in 1988, with market projections indicating that the regional airlines will experience growth rates as high as 7-10 percent per year through the end of this century. Much of this

Table 1

Concentration* Ratios at Large Hub Airports

Hub	Four-Firm Concentration Ratios (1988)
Chicago (O'Hare)	88
Atlanta	96
Dallas/Ft. Worth	94
Los Angeles	60
Denver	92
Newark	83
San Francisco	68
New York (LaGuardia)	61
Boston	65
New York (Kennedy)	80
Washington (National)	61
Pittsburgh	93
Minneapolis/St. Paul	89
Phoenix	75
Miami	79
Houston (Intercontinental)	91
Detroit	80
Seattle	67
Las Vegas	63
Philadelphia	79
Charlotte	97
Salt Lake City	94
St. Louis	91
Tampa	72
AVERAGE	79

(Adapted from: *Airport Activity Statistics of the Certified Route Air Carriers*: U.S. Department of Transportation, 1988.)

* *Concentration* is a major form of measuring market power in an industry. The concentration ratio is the percent of the market controlled by the largest (4,8,20) firms in the market, and it is of strategic importance in management decision making.

expected growth will result from the acquisition of the new, high technology, high speed turboprop and turbofan aircraft (Moxon, 1989; Moxon and Bailey, 1989; "Regional Airlines...,"1989).

This emerging aircraft technology will improve the operating economics, speed, comfort, and safety of the regional airlines. This new equipment will serve to provide enhanced opportunities to both hub and smaller airports; competitive regional air service; and point-to-point service to a number of key city-pair markets, thereby by-passing large hub cities.

The ability to hub smaller airports presents opportunities for passengers to avoid the congestion and accompanying delays that often exist at major hub airports. Further, some of the circuitry in current routings can be avoided, reducing the number and duration of layovers and the total passenger travel time from origin to final destination. Much of the service created by this type of regional hubbing activity would be limited to regional city-pair combinations because of the limited range of most of the smaller regional aircraft. Nevertheless, competitive regional service provided by regional and commuter airlines would not only help reduce congestion at many high-density airports, but also adequately fulfill many of the air transportation needs in the dense markets of the Midwest, Northeast, Atlantic Seaboard, and Pacific Coast region.

Additionally, many city-pair markets that currently lack the traffic necessary for the major airlines to provide point-to-point service (hub-and-spoke service is provided) could be effectively and competitively served on a point-to-point basis. That this type of "hub by-passing" approach could be successful and provide substantive competitive advantage, when the problem of divisibility can be overcome, is evidenced by the large

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

percentage of through passengers found at many hub airports (**Table 2**). Fifty percent or more of the passengers enplaned at eight hubs are connecting passengers. Many of these connecting ("through") passengers would be greatly benefitted by point-to-point service on these routes since they neither begin nor end their flights in the hub airport, but rather are routed through the hub in order to fill capacity on the "larger" jet aircraft operated by the major airlines. Point-to-point service would reduce total travel time by eliminating layovers while heightening passenger convenience. Hub bypassing will come into greater focus as industry concentration and hub congestion become more problematic from economic and policy perspectives. The discussion will now turn to the new aircraft and technological developments that will make regional hubbing and hub bypassing by regionals competitively viable options.

Table 2
Percentage of Through Passengers at Selected Hub Airports

Hub	Percentage of Through Passengers (1988)
Chicago (O'Hare)	49
Atlanta	64
Dallas/Ft. Worth	59
Los Angeles	14
Denver	58
Newark	15
San Francisco	17
New York (LaGuardia)	03
Boston	08
New York (Kennedy)	07
Washington (National)	07
Pittsburgh	61
Minneapolis/St. Paul	44
Phoenix	27
Miami	06
Houston (Intercontinental)	41
Detroit	32
Seattle	15
Las Vegas	15
Philadelphia	22
Charlotte	76
Salt Lake City	54
St. Louis	58
Kansas City	27
Memphis	69
Tampa	05
AVERAGE	33

(Adapted from: *Airport Activity Statistics of the Certified Route Air Carriers*: U.S. Department of Transportation, 1988.)

Many of today's technological improvements are manifested primarily in newly developed fuel efficient aircraft, which will help overcome the problem of factor indivisibility. These new aircraft will be powered by new technology turboprop and high-bypass-ratio turbofan engines, and will be equipped with the same flight control automation as larger commercial airplanes, and will help the regionals open new markets. Automation includes full-authority digital engine control (FADEC), automated flight management systems, inertial reference systems (IRS), electronic flight instrument systems (EFIS), and electronic engine and systems display (all glass cockpits).

Materials research is producing lighter weight, stronger, materials such as metal-matrix composite materials, new light weight metal alloys, carbon fibre reinforced plastics, glass-fibre reinforced materials which are being coupled with an increasing use of ceramics. Douglas aircraft projects that the new generation aircraft will contain 60 to 80 percent of these new materials in their structure, resulting in lighter weight, reduced drag, and increased fuel efficiency while simultaneously strengthening the airframe. Fuel burn will be decreased by allowing higher temperatures in the combustion chamber.

Table 3
Comparison of Turboprop Aircraft ##

AIRCRAFT TYPE	ENGINE∞	MAX CRUISE SPEED(Kts)	MAX SEATING PITCH(Ins.)	PERFORMANCE MAX PAYLOAD (Lbs.) RANGE(n.m.)	LOAD/RANGE WITH FULL FUEL TANKS
+BAe Super J31	2 GA TPE331-12UAR	295	19/32	4,200/430	1,078/2,223
+Beech 1900D	2 PWC PT6A-67D	290	19/31	4,482/672	2,153/1,612
DO 228	2 GA TPE331-5	231	19/30	4,482/672	4,156/1,638
F SA-227AC	2 GA TPE331-11U	278	20/30	4,720/290	1,078/2,223
++CBA 123	2 GA TPE351-20	355	19/31	4,751/320	1,991/1,650
+BAe J41	2 GA TPE331-14HR	295	29/30	N/A	N/A
+EMB 120	2 PWC 118A	316	30/31	6,691/300	3,040/1,575
+Saab 340B	2 GE CT-7-9B	282	37/30	8,285/643	5,117/1,848
++DO 338	2 PWC 119	350+	30/32	N/A	N/A
B/DHC 8-100	2 PWC 120	271	40/31	8,440/840	6,262/1,520
ATR 42	2 PWC 120	265	50/30	10,835/520	4,239/2,500
+Fokker 50	2 PWC 125B	282	50/32	13,404/796	9,270/1,876
B/DHC 8-300	2 PWC 123	286	56/29	11,600/830	9,822/1,350
++Saab 2000	2 GMA 2100	360+	50/32	13,000/1,110	9,993/1,993
+BAe ATP	2 PWC 126A	266	64/31	12,800/1,860	8,330/1,860
++B/DHC 8-400	2 GLC 38 or GMA 2100	370	60-70/33-30	N/A	N/A

Compiled from various issues of *Flight International* and *Aviation Week & Space Technology*.
\+ These aircraft contain a high level of new technology.
++ These aircraft contain the highest level of new technology.
∞ The engine manufacturers are: GE=General Electric; GLC=General Electric/Lycoming partnership; GMA=General Motors/Allison; GA=Garrett; PWC=Pratt & Whitney Canada.

Turboprop Technology

Most regional airlines operate 19-50 seat aircraft with "turboprop" power plants (see **Table 3** for a comparison of turboprop aircraft). These aircraft are presently much slower than "turbofan" (jet) aircraft on routes in excess of 250 miles, and most have a very limited range. Relatively high levels of noise and vibration have reduced the passenger appeal of these smaller turboprop airplane. An example of the new, and potentially very competitive, technology is the CA-123 by Embracer of Brazil and FAA of Argentina. (CA stands for "cooperation Brazil and Argentina.)

The first flight of the CA-123 occurred on July 19, 1990. Important features of this aircraft include supercritical wings, Garrett TPF351-20 pusher turboprop engines with greatly improved aerodynamic six blade propellers, a 37,000 foot ceiling, and a cruise speed in excess of 350 knots with very low cabin noise and vibration levels. The CA-123 should not only prove a popular choice for the regionals, but also overcome many of the competitive problems--speed, comfort, and perceived safety--associated with 19-seat aircraft.

The CA-123 has been ordered by a number of regional carriers because of its high speed and what Jerry Atkin, president of Skywest, calls the CA-123's ability to develop "hub-raiding or hub-bypass markets" ("Embraer Signs Up . . .," 1989; Fotos, 1989b). A stretched very high-bypass-ratio turbofan or an ultra high bypass (UHB) unducted fan (UDF)

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

engine powered CA-123 will be a natural evolution.

Several new technology aircraft in the 30-seat class became available to the regional airlines in the early 1980s. The 30 seat Embracer EMB-120 Brasilia and 30+ seat Saab/Fairchild SF-340 appear to be the most popular. The EMB-120 is the fastest of the 30-seat turboprops with a cruise speed of 300-315 knots, and the airplane has very high reliability. This aircraft is operated by the Delta Connection carriers such as Atlantic Southeast, Comair, Skywest, and a number of others ("Comair Orders...," 1989). The SF-340 is a state-of-the-art technology airplane jointly designed and build by Fairchild Aircraft and Saab Aircraft International (Saab/Scania) of Sweden. (Fairchild is no longer a partner in the 340.) The SF-340 has an all-glass cockpit and maintainability features not found on other aircraft in its class. Both airplanes have experienced a very high passenger acceptance level.

A third 33-seat airplane soon to be available is the Dornier 328 manufactured by the Dornier division of Deutsche Aerospace (DASA) (Mecham, 1990). The Dornier 328 will have a state-of-the-art airframe, with the use of considerable composite material and improved aerodynamics. Newly designed six blade propellers formed from carbonfibre laminates with a light weight foam core feeding into a split aluminum hub will improve the cruise speed to better than 350 knots while reducing the vibration and noise levels inside the cabin. Midway Airlines has ordered 33 of this type with options for 40 more (News Briefs, 1989). Several other quality planes in this class are available and operated by the regional airlines.

Saab Aircraft International has committed to the development of a new technology stretch derivative of its popular SF-340 designated the Saab 2000. This airplane will seat 50 passengers at a 32 inch seat pitch with the same comfort level and better interior noise level (76 dBA [decibals measured on the A-weighted scale to factor out anomalies]) as the MD 80, which is the present standard for comfort in narrow body jet airplanes. Jeff Marsh, president of Saab Aircraft International believes that a high-speed 50-seat airplane is needed to capitalize on a distinct new market opportunity--the growing demand from business travelers bypass hubs flying longer (300-700 n.m. [n.m. is nautical mile and is approximately 15% longer than a statute mile]) direct inter-regional routes between secondary city-pair markets. The Saab 2000 will deliver near-jet speed (Mach 0.62/360kt) to make them competitive on many 500 n.m. sectors with a block speed of only minutes longer than the turbofan Canadair Regional Jet (RJ). However, the Saab 2000 will burn 30 percent less fuel for a minimum 15 percent direct operating cost advantage per seat (Shifrin, 1989; Middleton, 1989).

To summarize, a trend toward the use of faster and larger aircraft began during the 1980s. As this trend continues in the 1990s, many regional airlines will replace their 19-seat airplanes with 30-seat airplanes, especially on routes that maintain load factors of 70 percent or more. For example, Express Airline 1 is replacing its 19-seat BAe-J31s with the Saab-340B and the new Saab-2000. The end result of this trend will be an increase in the competitive position of the regional airlines--larger, faster aircraft provide a better level of service, less noise, and greater passenger appeal.

The acceptance of the EMB-120, SF-340B, and the BAe-146 by business travelers suggests that regional airlines can compete effectively when they operate quality airplanes.

Turbofan Technology

Since jet aircraft are viewed more favorably than turboprop aircraft in terms of safety, speed, and comfort, especially by business travelers and other passengers on longer routes, the advent of the regional jet represents an even greater opportunity for regional airlines to compete with major airlines through hub bypassing strategies. Canadair executive vice-president Robert Wohl (Gould, 1989a) has discussed the potential competitive impact of the regional jet:

> When passenger jet travel arrived in the Western world about 30 years ago, it revolutionized the way ordinary people viewed travel, and it changed forever our traveling habits. We at Canadair think the same thing will happen with the advent of the Regional Jet.

For at least the last decade, air transport in North America and Western Europe has been based on a bigger-is-better approach, with bigger and better aeroplanes feeding the rapidly expanding hub airports. As this system has grown, it has shown its limits. The hub-and-spoke system we have built in the name of efficiency has been swamped. Instead of flying 150 passengers into a major hub, when perhaps a third of them want to go to a different destination, why not fly those 50 passengers directly? (Gould, 1989a)

Airline analyst Steve Horner argues that regional jets possess strong competitive potential: "its time has come, with the capacity issue at many airports" ("Newsbriefs," 1989). With the regional jet, regional airlines will be able to establish hubs in cities like Billings, MT; Norfolk, VA; Oklahoma City, OK; and Reno, NV, among others. Such regional hubs have the potential to "bleed off" demand from the larger, congested hubs. Carlos da Silva agrees that new hubs will appear and points to Comair's hub at Orlando when he said, "Who would have thought a year ago that Orlando would be an important hub for them?" (Fotos, 1989a). In addition, many city-pair markets such as Tucson-Los Angeles and Buffalo-Toronto will provide attractive opportunities for regional and inter-regional point-to-point service. Utilized properly, the new regional jets could greatly enhance the range of competitive services that will be offered by the regional airlines. Critical to the development of the regional jet has been the development of new technology high-bypass-ratio turbofan engines. These engines are being engineered for the high-cycle, low-maintenance demands of regional passenger transport and will attain near turboprop levels of economy while providing the same operating parameters as high thrust turbofans used on the large wide body airplanes (Norris, 1990). Each of these engines will utilize new materials, including ceramic reinforced alloys. Direct operating costs, including engine maintenance and fuel cost, are expected to decrease substantially.

The Canadair RJ, a stretch derivative of the Canadair Challenger business jet, is the first of the regional jets (see **Table 4** next page). The fuselage has been stretched 20 feet and more emergency exits have been added. The wing has the same supercritical section, a three foot extension at each tip, including winglet, and is equipped with new high-lift devices. These modifications will provide the airplane with good short field take-off performance with a range of 873 n.m. and a 48 passenger load. A number of additional changes will be made to enhance maintainability and economy of operation. Canadair is selling the airplane as a 50-seater with 31 inch seat pitch, but in reality, it will be a much better 46-seater for the planned route stage lengths. Canadair also plans to develop a 70 seat version of the RJ (Gould, 1989b; Ramsden, 1989b).

A strong competitor in this class will be the Embraer EMB-145, a 45-48 seat aircraft now under development. Carlos da Silva notes that the EMB-145 is being developed with all possible speed to avoid losing sales to the

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

Table 4
Comparison of Turbofan Aircraft [##]

	AIRCRAFT TYPE TANKS	ENGINE[∞]	MAX CRUISE SPEED(Kts)	MAX SEATING PITCH(Ins.)	PERFORMANCE MAX PAYLOAD (Lbs.) RANGE(n.m.)	PERFORMANCE LOAD/RANGE WITH FULL FUEL TANKS
+	Canadair RJ	2 x 9,220 lb.t. CF34-3A	460	50/31	10,000/1,240	8,220/1,574
++	EMB 145	2 x 7,150 lb.t. GMA3007	440	50/31	11,376/750	7,385/1,650
	Fokker 60	2 x 14,000 lb.t. GMA3014 or BR 700	440	60/32	N/A	N/A
	BAe RJ70	4 x 6,970 lb.t.	430	80/32	8,426/1,733	7,355/3,000[*]
	BAe RJ80	ALF502R-5 or LF 507	430	80/32	8,426/1,733	
++	MPC 75[**]	2 x 14,000 lb.t. GMA3014 or BR700	500	80-130/32	N/A	N/A
	TU 334	2 x 16,700 lb.t. LOT. D-436	500	90/32	N/A	N/A

Compiled from various issues of *Flight International* and *Aviation Week & Space Technology*.

\+ These aircraft contain a high level of new technology.

++ These aircraft contain the highest level of new technology.

∞ The engine manufacturers are: BR=BMW/Rolls Royce partnership; BMA=General Motors Allison; ALF/LF=Textron Lycoming; LOT=Lotarev of Russia.

* Payload and range are for the basic BAe146-100, which will be the airframe for the RJ70 and RJ80.

** MBB is now a part of Deutsche Aerospace (DASA) and will join with France's Aerospatiale and Italy's Alenia to build an 80-130 seat airframe based on the MPC75. Catic will continue to participate but at a lesser level.

Canadair RJ and claims the EMB-145 will have several advantages over other regionals jets. For example, it will require lower operating costs on routes shorter than originally estimated. Market studies by Embraer indicate that on route stage lengths of 160-180 n.m., the EMB-145 will have lower operating costs than many turboprops. Part of this can be attributed to the faster flying speeds of the jet. While costs per hour are lower for turboprops, the turbofan powered EMB-145 will spend less time in the air on the same route. This advantage increases as the stage-lengths become longer. Other advantages that might be exploited by Embraer include its experience with the regional airlines and the high level of commonality between the EMB-145, the EMB-120, and the CBA-123. Seventy-five percent of the two new aircraft are common with the Brasilia (Fotos, 1989b). Embraer will offer a complete line from which regional airline managers will be able to select to meet their specific route needs.

Several larger regional aircraft are under development and will be available before 1995; the BAe RJ70 and RJ80, the Fokker 60, the MPC-75, and the TU-334. A Japanese consortium of Fuji, Kawasaki, Mitsubishi Heavy Industries plans entry with the YSX. Finally, Douglas Aircraft is planning a new regional jet based on its existing MD-87, but with all-composite DC-9-30 size wing (Warwick, 1990). British Aerospace is promoting the RJ 70 on the basis of flexibility and comfort. It will have an 800-1,000 nautical mile stage-length ability which will allow point-to-point service, bypassing congested hubs. The manufacturer claims the aircraft costs less then the Canadair RJ on a per seat basis, and will break even on a 300 n.m. route while carrying only 30 passengers. The RJ70 could fly in early 1991 if adequate orders are placed. The RJ80 is the same airframe as the RJ70, but is powered by an upgraded LF507 to give it longer stage-length capability with 80 passengers ("BAe Tests . . .," 1990)

The Fokker 60 is a 60 seat aircraft that is being marketed as a "hub raider." Fokker is launching this aircraft based on what is seen as an emerging tendency towards greater competition between hubs in the United States and Europe. Management at Fokker believes that, as airlines compete to increase their catchment area, "hub raiding" and "hub bypassing" will become prevalent. The Fokker 60 will use the Fokker 50 fuselage cross-section to ensure that the aircraft will not be faced with what management sees as the "too-small dimensions and capacity of the regional jets and high-speed propjets currently under development" (Moxon, 1990). Airplane configuration will be similar to the high-wing, high-tail BAe-146, but with two high bypass engines instead of four. Speed will be in excess of 400 kts. at 25,000 feet, and the aircraft will have the ability to fly stage-lengths of about 1200 miles. The cockpit and avionics package will be derived from the Fokker 50 with considerable commonality (Moxon, 1990).

The MPC-75 is under development for the People's Republic of China by MPC Aircraft GMBH, a partnership between China National Aero Technology Import and Export Corporation (CATIC) (20% ownership) and Messerschmitt-Boelkow-Blohm (MBB now DASA) (80% ownership). The MPC will be a state-of-the-art aircraft carrying about 80 passengers at Mach 0.76 over a route stage-length of 1500 n.m. (Middleton, 1989). The Tu-334 is very similar and is in manufacture by Tupolev in Russia with the first airplanes to be delivered to Aeroflot (eventually to be available for export) (Postlethwaite, 1989). Initially, both the MPC-75 and the Tu-334 will find a market in less developed countries, but over time they will incorporated into the fleets of regionals in advanced countries. Not all of these entries will be successful in the market place, but the development projects that do succeed will have an impact on the competitive structure of the airline industry in the United States and in other parts of the world.

SUMMARY: CONCLUSION AND POLICY IMPLICATIONS

Much of the discussion of airline competition and airport congestion since airline deregulation has been undertaken without fully considering the potential impact of emerging technology on the industry's supply side, especially with respect to factor indivisibility. Technology has significantly affected the way factor inputs are utilized in airline operations by increasing both productivity and factor substitutability. Similarly, technology development has promoted the current bias among the major airlines toward the operation of larger, long-haul luxury jet aircraft, which led to a service/capacity dilemma and played a pervasive role in the development of the current highly concentrated hub-and-spoke dominated industry structure.

The overall influence of technology on the industry is, therefore, characterized as mixed. While the airline industry has become a viable and popular mode for passenger transportation, the level of competition among the airlines has diminished. The industry is now dominated by a relatively few major airlines, each operating key airport hubs. However, technology developments at the lower end of the airframe industry have the potential to change existing industry structure. Of particular interest is the impact of technology on the economics and competitive viability of regional airlines.

Current developments in turboprop and turbofan technology are enhancing the competitive potential of regional airlines by providing smaller aircraft that have better economy of operation, are faster, provide

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

greater comfort, are perceived as safer, and have greater customer appeal. The problem of capital equipment indivisibility is, at least in part, overcome. The smaller carriers now have the potential to enter new market point-to-point routes, and the ability to form new hubs at medium size airports, and to provide service at seat-mile cost approaching the level of larger carriers. That factor will improve industry competition and reduce the level of congestion at major hub airports, which should benefit travelers in numerous ways. Strategic use of this new technology will depend on many operational and public policy factors.

Public policy considerations are, perhaps, the most important to the successful use of the new technology in developing competitive strategies of the regionals. Perhaps the greatest barrier to improvements in competition from the regional carriers are the marketing and operating agreements between major and regional airlines. By 1988, the major airlines had gained some form of influence over 48 of the 50 largest regional airlines. The regionals are used to provide traffic feed into the majors' hub airports. At the same time, control by the majors reduces the competitive threat of regional airlines (Poling, 1987; Rose, 1988).

Often, the regionals still maintain sufficient operating control to undertake regional hubbing or hub bypassing strategies, but their competitive opportunities are definitely limited by the prevalence of marketing/operating agreements. The Department of Transportation (DOT) and Congress must examine the competitive implications of the various types of agreements currently in use. The current benefits of increased traffic feed for the majors and the greater visibility for the regionals, must be weighed against the benefits to the system: the potential to reduce congestion at major hubs; the potential to provide better overall service; and the potential to increase operating efficiency through increased market flexibility and competition. The goal should be pro-competitive with the probable discontinuance of marketing/operating agreements and the outright divestment of ownership by the majors. The antitrust laws should be strictly enforced.

The impact of public policy on employee relations in the industry is an issue which can be documented by a number of case studies. The most recent example is Eastern Airlines ("Regional Airlines . . . ., 1989). (This is not to say that management handled the situation in a correct manner.) The DOT, Congress, and other agencies with regulatory responsibility over the airlines must recognize that market forces will not control an industry on the demand side when artificial constraints exist in the acquisition of factors. When factor input prices, wages, and salaries are perfectly flexible, they will move instantaneously to clear the market at all times. Unions and the many existing restraints in labor law block a free flow of the labor factor, especially pilots and mechanics.

Other public policy issues include the allocation of slots at major hubs to regional carriers, the pricing of scarce airport capacity, and the continuance of essential air service. Ultimately, public policy should be continuous, proactive, and directed at avoiding all artificial constraints whether the constraints arise from marketing/operating agreements between major airlines and regional carriers, or from the use of computer reservation systems and frequent flyer programs.

From an operational standpoint, human resource management is second only to the public policy issues. Technology must be integrated with the work force, and employee development is key. Historically, the industry has a very poor record in managing employee relations. Cutting edge technology will not compensate for poor management practice. Human capital has the potential to be a firm's greatest strength, and must be treated as well, if not better than, other operating assets. It is more important than financial management, and, when integrated with technology investment, a firm can gain significant strategic advantage.

Operational considerations dictate that new aircraft must be used effectively as well as efficiently. Aircraft configuration represents a very important operation consideration--regional airlines must avoid the temptation to place too many seats on the new aircraft in efforts to improve immediate returns. While the new aircraft are considerably faster and more comfortable with respect to cabin noise and vibration, seating comfort remains critical to the achievement of a high level of passenger acceptance. Avoiding the tendency to add seats is necessary to increase passenger appeal.

Further, the selection of markets to be targeted by the regionals is crucial. Route characteristics that should be considered include point-to-point demand, congestion and concentration at the major hub to be bypassed, and stage-length. Regionals will find the greatest competitive opportunities where (a) point-to-point demand is sufficient to fly one of the new regional aircraft, but insufficient to support larger jet aircraft, (b) the hub to be bypassed is highly congested, and (c) the stage-length ranges between 200 to 1,000 nautical miles.

The future for regional airlines appears extremely bright; however, it will not be without many challenges, for management must develop good employees to integrate with the much improved (and continuing to improve) flight equipment. It is also essential that management become proactive in the public sector as well as within the organization.

Stanley A. Fawcett, President of a transportation economics and logistics consulting firm, received his doctorate from Northern Colorado University in Business and Economics, and has over 20 years teaching experience in the areas of transportation, logistics, and international trade. He has extensive management and operating experience in the airline and motor carrier industries, and is published in several transportation and logistics journals.

Stanley E. Fawcett, assistant professor of logistics and international management at Michigan State University, received his MBA in operations management and MA in international relations from Brigham Young University, and his doctorate in logistics and operations management from Arizona State University. He is published in transportation, logistics, and operations journals.

REFERENCES

BAe Tests RJ Waters, *Flight International*, July 11-17, 1990, 25.

Borman, F. (1988). *Countdown: An Autobiography*. New York: Morrow Books.

Brenner, M. A. (1988). Airline Deregulation--A Case Study of Public Policy Failure. *Transportation Law Journal*, 16, 179-227.

Caves, R. E. (1962). *Air Transport and its Regulators: An Industry Study*. Cambridge: Harvard University Press.

Comair Orders More Brasilias. (June 24, 1989). *Flight International*. p 13.

Douglas, C. W. and Miller, J. C. III. (1978). *Economic Regulation of Domestic Air Transport: Theory and Policy*. Washington, D.C.: The Brookings Institution. pp 6-15.

https://commons.erau.edu/jaaer/vol1/iss3/5
DOI: https://doi.org/10.15394/jaaer.1991.1030

Fawcett, S. E. and Farris, M. T. (Fall 1989). Contestable Markets and Airline Adaptability Under Deregulation. *Transportation Journal*. 12-24.

Fawcett, S. E. and Fawcett, S. A. (Summer 1988). Congestion at Capacity, Constrained Airports: A Question of Economics and Realism. *Transportation Journal*. 45-46.

Embraer Signs Up CBA-123 Customer. (June 24, 1989). *Flight International*. p II.

Fotos, C. P. (September 4, 1989a). Embraer Launches Regional Jet. *Aviation Week & Space Technology*.

Fotos, C. P. (September 4, 1989b). Embraer Will Launch Two Civil Aircraft Programs. *Aviation Week and Space Technology*. pp 65-67.

Gould, I. (August 27, 1988). Regionals Interested in Jets. *Flight International*. p 21.

Gould, I. (April 15, 1989a). Canadair Launches Regional Jet. *Flight International*. pp 38-40.

Gould, I. (June 17, 1989b). Canadair Extends the Range. *Flight International*. pp 47-51.

Levine, M. (1987). Airline Competition in Deregulated Markets: Theory, Firm Strategy, and Public Policy. *Yale Journal on Regulation*. 4.

Mecham, M. (September 3, 1990). Dornier Emphasizes Speed, Low Noise in 328 for Evolving Regional Market. *Aviation Week and Space Technology*. pp 206-208.

Middleton, P. (March 4, 1989). The Case for the Turboprops. *Flight International*. pp 42-44.

Middleton, P. (April 8, 1989). MPC Gears Up. *Flight International*. pp 19-21.

Moxon, J. (June 11, 1988). Rise of the Regionals. *Flight International*. pp 40-42.

Moxon, J. (June 17, 1989). U. S. Technology on the Critical List. *Flight International*. pp 59-62.

Moxon, J. (August 15-21, 1990). Fokker 60 Aimed at "Hub Raiders." *Flight International*. p 22.

Moxon, J. and Bailey, J. (May 27, 1989). The Business-Jet Power Battle. *Flight International*. pp 37-43.

"News Briefs." (October 23, 1989). *Aviation Week and Space Technology*. p 32.

Nomani, A. (October 9, 1990). Fare Warning: How Airlines Trade Price Plans. *The Wall Street Journal*. Bl.

Nomani, A. (June 28, 1990). Airlines May be Using a Price Data Network to Lessen Competition. *The Wall Street Journal*. Al.

Norris, G. (April 18-24, 1990). Regionals Draw Engine Studies. *Flight International*. p 5.

Phillips, L. T. (Winter 1985). Structural Changes in the Airline Industry: Carrier Concentration at Large Hub Airports and its Implications for Competitive Behavior. *Transportation Journal*. 18-28.

Poling, B. (January 5, 1987). Code Sharing Threatens Independents. *Travel Weekly*. p 2.

Postlethwaite, A. (September 9, 1989). Russian Revolution: Competition Replaces Conflict. *Flight International*. pp 26-27.

Proposed Delta Union Contract will Make Pilots Top Paid in U. S. (August 13, 1990). *Aviation Week & Space Technology*. pp 79-80.

Ramsden, J. M. (February 11, 1989a). 100-Seat Jet Maker. *Flight International*. pp 38-42.

Ramsden, J. M. (March 4, 1989b). The 50-Seat Jetliner. *Flight International*. pp 38-40.

Regional Airlines Spur Development of New Derivative Engine Class. (October 2, 1989). *Aviation Week and Space Technology*. pp 80-81.

Rose, R. L. (February 17, 1988). Major U. S. airlines Rapidly Gain Control Over Regional Lines. *Wall Street Journal*. 1.

Shifrin, C.A. (October 23, l989). Saab Completes Definition Work, Selects contractors for Saab 2000. *Aviation Week and Space Technology*. pp 72-73.

Stynes, E. (January 7, 1989). A Tale of Two Regionals. *Flight International*. pp 31-34.

Unions Continue Legal Fight to Stop Eastern Shuttle Sale. (March 28, 1988). *Aviation Week & Space Technology*. p 90.

U. S. Commuter Airline Growth to Parallel Majors in 1990s. (November 20, 1989). *Aviation Week & Space Technology*. pp 83-84.

Warwick, G. (January 3, 1990). Material Progress. *Flight International*. pp 30-33.