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ROLE OF AVIATION IN DOMESTIC
FREIGHT TRANSPORTATION
SYSTEM OF U.S.

THE ROLE OF AVIATION IN THE
DOMESTIC FREIGHT TRANSPORTATION
SYSTEM OF THE UNITED STATES

by

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INTRODUCTION

INTRODUCTION

It is the objective of this thesis first to indicate the present position of the United States domestic air freight industry, in relation to the whole U.S. domestic freight transportation system, and then to examine the ways in which this particular segment of the system is likely to develop.

An analysis of the air freight industry made in the context of the total domestic freight transportation system, such as the analysis contained in this thesis, has, to my best belief, not been undertaken before.

In order to achieve the first of the two objectives of the thesis - that of indicating the present position of the air freight industry - all United States domestic surface media of transportation are examined, so that their major characteristics may be understood. In particular, the competitive relationship existing between the railroad industry and the trucking industry is analysed.

The overall surface system having been studied, the past history and present position of the air freight industry is examined, and the way in which the industry is regulated is briefly described. In order to develop a comprehensive picture of this industry, an analysis of air freight rate-making systems and costs is then undertaken.

In order to achieve the second of the two objectives of this thesis - that of examining the ways in which the air freight industry is likely to develop - the costs of moving a commodity from one place to another are analysed. This analysis is necessary because the air freight industry is likely to achieve greatest development in those areas where the total costs of moving a commodity from one place to another are less by air than by surface means. Following this cost analysis the results of three case studies into total distribution costs are presented.

CHAPTER I

THE SURFACE FREIGHT TRANSPORTATION
SYSTEM OF THE UNITED STATES

CHAPTER I

THE SURFACE FREIGHT TRANSPORTATION SYSTEM OF THE UNITED STATES

GENERAL

It is the objective of this chapter to analyse the relative competitive situations of the United States ground transportation media. This analysis is necessary since it is from the traffic carried by the ground media that the majority of new air freight traffic is likely to come. However, since it is unlikely that significant volumes of traffic could be diverted to air from the water carriers and the pipelines, since these are largely specialized carriers of bulk commodities, this chapter, while containing a brief description of the water and pipeline transportation systems, confines its analysis to the railroads and the motor carriers.

Table I which follows shows the revenue ton-miles performed by the various transportation media (including air), from 1951 to 1960.

TABLE I

REVENUE TON-MILE DISTRIBUTION OF INTER-CITY TRAFFIC
1951 - 1960
(millions)

YEAR	RAIL-ROADS ¹ Freight	RAIL EXPRESS Express ²	MOTOR CARRIERS ³ Freight	WATER-WAYS ⁴ Freight	PIPE-LINES	AIR CARRIERS ⁵	
						Freight	Express
1951	646,610	1,492	66,865	182,216	152,115	177	41
1952	618,810	1,768	64,163	168,367	157,502	201	41
1953	605,790	1,647	69,184	202,439	169,884	209	43
1954	549,240	1,455	65,098	173,679	179,203	205	41
1955	623,590	1,502	73,455	216,508	203,244	266	51
1956	646,980	1,550	74,552	219,978	229,959	297	53
1957	618,090	1,314	75,834	231,792	222,728	349	46
1958	551,540	1,296	75,934	189,016	211,289	337	49
1959	575,440	1,224	90,537	200,000	226,991	393	57
1960	572,220	1,143	92,438	233,000	236,000	413	59

1. Class I Line-Haul Railroads
2. Railway Express Agency Less-than-Carload Traffic
3. Class I, II and III Inter-City Common Carriers
4. Inland Waterways, including Great Lakes
5. Scheduled Services Domestic Passenger/Cargo Airlines & Domestic All-Cargo Airlines

SOURCES: Railroads - Interstate Commerce Commission, Transport Statistics in the United States, 1960 - Part I Railroads

Rail Express - Railway Express Agency Inc., Unpublished Data

Motor Carriers - I.C.C., Inter-City Ton-Miles 1939 - 1959, and Automobile Manufacturers' Association, Motor Truck Facts

Waterways & Pipelines - I.C.C., Transport Economics, Table 2

Air Carriers - Federal Aviation Agency, Statistical Handbook of Aviation - 1961

CHARACTERISTICS OF EACH MODE

R a i l r o a d s

The United States railroad network virtually covers the entire country. The country's overall railroad density varies from 26 miles of track per hundred square miles in New Jersey, to 1.5 miles of track per hundred square miles in Nevada, with an average country-wide density of 7.4 miles of track. In 1959, there were 231,024 miles of track in operation throughout the country, including yard tracks and sidings.¹

In the face of increasing competition from other modes of transport, efforts are currently being made to strengthen the competitive positions of some railroads by proposed mergers between complementary railroad systems.

Rail's pre-eminent position in American freight transportation is particularly noticeable in the movement of solid bulk freight, which represents a spectrum of commodities that are generally economically unsuitable for movement by air. An example of such bulk freight is the products of mines, which move at comparatively low rates.² In 1960, 27% of the entire tonnage lifted

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1. U.S. Department of Commerce, Statistical Abstract of the United States - 1961, p. 568.
 2. In 1960, for example, the average rate for the products of mines was 1.16 cents per ton-mile, as against 1.31 cents for products of forest, 1.68 cents for products of agriculture, 2.22 cents for manufactures and miscellaneous, 2.69 cents for animals and products, and 2.85 cents for forwarder traffic - Interstate Commerce Commission, Carload Waybill Statistics - 1960, pp. 1-4.

by Class 1 railroads was coal and coke,³ and the most consistently profitable railroads are those which specialize in the low-tariff, high volume movement of coal. It is on the basis of the long haul of bulk freight that rail is categorized as a low-cost form of transportation.⁴ Rail costs are higher for movements of manufactured goods, forwarder traffic, and animals and animal products (the Interstate Commerce Commission commodity groups which made up a total of approximately 40% of the carload freight ton-miles performed by Class 1 railroads in 1960)⁵ than for the movement of the products of mines, forests and agriculture, and it is from the former commodity groups that air transportation may expect to divert traffic. Goods in these former groups usually move in smaller volumes per shipment and involve higher unit costs for

3. U.S. Department of Commerce, op. cit., p. 570.

4. A comparison of the out-of-pocket costs of carrying the different types of commodity groups shows that those related to the carriage of the products of mines are the lowest. For example, in 1959 the out-of-pocket costs experienced by Class 1 railroads were as follows:

Products of Mines: 1.05 cents per ton-mile
Products of Forests: 1.08 cents per ton-mile
Products of Agriculture: 1.41 cents per ton-mile
Manufactures & Miscellaneous: 1.44 cents per ton-mile
Forwarder Traffic: 2.44 cents per ton-mile
Animals & Products: 2.53 cents per ton-mile

These figures were derived from Interstate Commerce Commission documents Carload Waybill Statistics - 1959, pp. 1-4, and Distribution of the Rail Revenue Contribution by Commodity Groups - 1959, p. 3.

5. Interstate Commerce Commission, Carload Waybill Statistics - 1960, pp. 1-4.

pick-up, delivery, handling, etc., than are experienced for the products of mines, forests and agriculture.

The average rates charged for transporting commodities in the groups manufactures and miscellaneous, animals and products, and forwarder traffic are, as previously noted, higher than the average rates charged for transporting the products of mines, forests and agriculture. Although, as has been noted, the out-of-pocket costs for moving the former three commodity groups are higher than for the latter three groups, the railroads' higher rates for the first three are not necessarily based upon the higher costs experienced in their handling.

In 1959, the average wholesale value at destination of each of the six commodity groups, transported in carload lots by Class 1 railroads, was as follows:⁶

Products of Mines:	\$ 11.16 per ton
Products of Forests:	57.97 per ton
Products of Agriculture:	101.31 per ton
Manufactures & Miscellaneous:	280.60 per ton
Animals & Products:	601.44 per ton
Forwarder Traffic:	1,713.28 per ton

From these figures it may reasonably be inferred that the "value of service" principle has been used (at least

6. Interstate Commerce Commission, Freight Revenue and Wholesale Value at Destination of Commodities Transported by Class 1 Line-Haul Railroads, 1959, pp. 16-21.

partly) in establishing higher rates for the transportation of the higher valued goods than the rates for the lower valued goods.

The rates charged by the railroads for the transportation of manufactured goods, animal products, and forwarder traffic are high; and these commodities have, therefore, become the prime target for truck competition.

Another factor aiding such competition is the slowness of the average rail movement: Freight trains, which can travel at speeds in excess of 60 miles per hour, appear to have an actual average road speed in the neighbourhood of only 18 miles per hour. When one considers the time involved in getting a shipment of, say, manufactured goods from the consignor to the freight train at the station of origin, and from the freight train at the station of destination to the consignee, it can be seen that the average speed of a shipment, from consignor to consignee, is well below the figure of 18 miles per hour.⁷

It may be thought that declines in rail traffic, due to truck competition would be compensated for by comparable declines in the cost of carrying the traffic. That this is not so becomes apparent when the transportation operating expenses of Class 1 U.S. railroads are examined. The actual short-run "out-of-pocket" costs

7. For discussion of consignor to consignee (or "dock-to-dock") speeds, see page 150 of this thesis.

of moving a train from A to B - that is, expenses incurred for train enginemen, train fuel, train power produced and purchased, water for train, lubricants for train, and other supplies for train - equalled only 20% of Class 1 line-haul railroad's total transportation operating expenses in 1960.⁸ Therefore, 80% of the total transportation operating cost is an overhead or "indirect" operating cost, which has to be spread over a decreasing number of units of traffic. Of course in the long run, should a railroad's traffic remain at a low level (compared to its past traffic levels), a certain proportion of its "fixed" costs can be reduced, thus reducing the burden on the individual traffic units which are retained.

Subject to Interstate Commerce Commission (ICC) approval, rail rates generally follow principles of "what the traffic will bear", and are less often based on cost. As the oldest, largest and most regulated of the carriers, the railroads have tended to set the rates which establish a pattern (for all modes) for each commodity. These rates are then modified by the other types of carriers insofar as those carriers' costs and service capabilities allow them to do so. For example, on the basis of their lower handling and terminal costs for high-value goods, truckers have been able to cut rail rates on such goods; and water-carriers have cut rail rates for bulk items on the basis of water's

8. Interstate Commerce Commission, Transport Statistics in the United States for 1960, Part 1 - Railroads, p. 126.

lower line-haul costs. The requirement for ICC approval of rates was designed to prevent (1) overcharging by carriers which enjoy monopolistic situations, and (2) price-cutting intended to drive competitors out of business.

In an effort to regain traffic lost to trucks, the railroads have established new "piggyback" rates, in a shift from a "what the traffic will bear" basis to a cost basis for rate-setting. (The original piggyback service, which charged rates in accordance with the commodities transported, had been in effect for decades with only limited success.) An example of the new (1960) rate structure is a flat fee of \$450 to transport two truck-trailers on a railroad's flat-car from New York to Chicago, regardless of the nature of the commodities contained in the trailers. Some transportation experts believe that piggybacking provides a means for reorganizing and co-ordinating the rail and truck industries. The railroads could be "transportation wholesalers" (at least as far as general cargo is concerned), and the truckers could provide the retail elements of the system. That is, for general freight, the railroads could sell piggyback transportation to truck operators for the medium and long distances at which rail is cheaper than truck, and leave all customer contacts for such movement to the truckers (sales, pick-up and delivery, etc.). The railroads would have eliminated the handling jobs, which are particularly costly for them in the case of less-than-carload lots, and the truckers would have avoided long over-the-road movements which are comparatively costly for highway carriers.

As we shall see later, this type of inter-modal co-ordination may become a pattern for air-truck co-operation.

Although inter-mode operations provide many obvious benefits, there are institutional obstacles to continuing its expansion to the point where maximum benefits can be derived. For example, railroad management is reluctant to give up customer contact, etc.

Passing from the subject of inter-mode co-ordination, as exemplified by the piggyback operations of the railroads, it would be well to examine the commodity area in which air transportation could expect to compete with the railroads.

Table 1 of this thesis shows, among other things, total Class 1 railroad freight traffic. However, it is considered reasonable to state that air transportation will not, within the foreseeable future, be able to transport economically and on a routine basis large volumes of bulk commodities such as coal, oil, ores, wheat, lumber, etc. Yet these commodities and others with similar physical and cost characteristics make up a large proportion of the total railroad traffic. The distribution of Class 1 railroad carload traffic among six commodity groups is shown in Table 2 on the following page.

TABLE 2

DISTRIBUTION OF CLASS I RAILROAD CARLOAD TRAFFIC
AMONG COMMODITY GROUPS, AND AVERAGE REVENUE PER
TON-MILE RECEIVED FOR THE CARRIAGE OF EACH GROUP
OF COMMODITIES

YEAR	P R O D U C T S O F						MANUFACTURES & MISCELLANEOUS		ANIMALS & PRODUCTS		FORWARDER TRAFFIC	
	MINES		FORESTS		AGRICULTURE		Millions of Ton- Miles	Cents Per Rev. Ton- Mile	Millions of Ton- Miles	Cents Per Rev. Ton- Mile	Millions of Ton- Miles	Cents Per Rev. Ton- Mile
	Millions of Ton- Miles	Cents Per Rev. Ton- Mile	Millions of Ton- Miles	Cents Per Rev. Ton- Mile	Millions of Ton- Miles	Cents Per Rev. Ton- Mile						
1957	186,800	1.17	42,500	1.33	61,800	1.76	165,400	2.36	8,900	2.88	3,600	3.55
1958	151,700	1.21	42,700	1.34	68,600	1.75	149,400	2.37	8,100	2.89	3,400	3.59
1959	153,000	1.19	45,900	1.33	64,400	1.72	164,900	2.30	8,300	2.76	3,300	3.08
1960	155,600	1.16	42,000	1.31	63,200	1.68	161,500	2.22	8,200	2.69	3,400	2.85

SOURCE: Interstate Commerce Commission, Carload Waybill Statistics, 1957 - 1960.

NOTE: The statistics in these ICC documents are from a one percent sample. The figures in the above table have been derived by multiplying the ICC figures by one hundred. Differences between the sum of the figures in the above table, for any year, and the railroad figures in Table I, result from sampling error and the omission of LCL traffic from the above table.

From this table it can be seen, for example, that in 1960 the products of mines, forests and agriculture (the commodity groups which move at the lowest average rates) made up approximately 60% of all the carload traffic of the railroads.

It seems reasonable to exclude this type of traffic from consideration as "air potential", even if only on the basis of its physical characteristics. Thus, rail carload traffic in 1960 had a theoretical air potential of 173.1 billion ton-miles (the sum of traffic in the commodity groups "Manufactures & Miscellaneous", "Animals & Products", and "Forwarder Traffic").

In addition to this theoretical air potential, there exists potential in the railroads' less-than-carload (LCL) traffic since this traffic is generally of high value.⁹ Also, it is known that average LCL rates are higher than carload rates - it is believed that they are around 10 cents per ton-mile, although there is no known method for checking this fact.¹⁰

Similarly, there is no known authoritative source for statistics on LCL ton-miles. However, Table 3 below presents my estimate of the volume of this kind of traffic. The limitations of the estimate are a reflection of the sampling error to which the

9. In 1959, LCL traffic carried by Class 1 railroads had an average wholesale value at destination of \$1,713 per ton - Interstate Commerce Commission, Freight Revenue and Wholesale Value at Destination of Commodities Transported by Class I Line-Haul Railroads, 1959, p. 21.

10. I have visited the Interstate Commerce Commission in Washington, and the Association of American Railroads, in unsuccessful attempts to determine if there exists a reliable method for calculating average LCL rates.

ICC Carload Waybill Statistics are subject. Total Class 1 railroad freight ton-miles are known (see Table 1), but carload freight ton-miles are taken on a one percent sampling basis. If there were no sampling error in these carload statistics, the figures themselves, multiplied by one hundred, would give total carload traffic, and the subtraction of total carload traffic from total traffic would leave LCL traffic. This is the process I have followed in compiling Table 3 below, but no account has been taken of sampling errors.

TABLE 3

ESTIMATE OF THE VOLUME OF LESS-
THAN-CARLOAD (LCL) TRAFFIC
CARRIED BY CLASS I RAILROADS

YEAR	CARLOAD (CL) TRAFFIC (M I L L I O N S O F T O N - M I L E S)	TOTAL FREIGHT TRAFFIC	LCL TRAFFIC (TOTAL TRAFFIC LESS CL TRAFFIC)
1957	469,000	618,090	149,090
1958	423,900	551,540	127,640
1959	439,800	575,440	135,640
1960	433,900	572,220	138,320

SOURCES: Carload Traffic - Table 2
Total Traffic - Table 1

Thus, it may be said, as a broad generalization, that the "air potential" which exists within the traffic of Class 1 railroads is made up of commodities moving under the group headings of

"Manufactures and Miscellaneous", "Animals and Products", "Forwarder Traffic", and "LCL Traffic". Table 4 below shows the total traffic involved in these groups.

TABLE 4

ESTIMATE OF THE VOLUME OF
"AIR POTENTIAL" COMMODITIES
EXISTING WITHIN THE TRAFFIC
OF CLASS I RAILROADS

YEAR	TOTAL OF MANUFACTURES & MISCELLANEOUS, ANIMALS & PRODUCTS, FORWARDER TRAFFIC	LCL TRAFFIC	TOTAL "AIR POTENTIAL" TRAFFIC
	(M I L L I O N S O F T O N - M I L E S)		
1957	177,900	149,090	326,990
1958	160,900	127,640	288,540
1959	176,500	135,640	312,140
1960	173,100	138,320	311,420

SOURCES: Tables 2 and 3

It must be realized, of course, that the figures in the above table represent a very broad generalization. There are undoubtedly many commodities within these groups which, because of particular situations (such as shortness of haul, unimportance of time, etc.), will never be considered for movement by air. However, there are probably many commodities within the groups excluded from the "air potential" (products of mines, forests, agriculture) which, because of different situations, will be considered for movement by air.

It is impossible to weigh the exclusions from one against the inclusions from the other, but it is considered likely that the differences would probably cancel each other out.

In any case, these figures are presented here only to indicate a sort of "ceiling" below which air freight traffic can grow.

H i g h w a y T r u c k i n g

Highway trucking provides a focal point of the present U.S. freight transportation system. On the one hand it is making the major penetration into the railroads' highest-rated commodities; and on the other, trucking's own movements represent the bulk of the goods which air transportation must capture when and if the latter medium of transportation is to become a major factor in the U.S. freight transportation industry. Moreover, trucks provide the essential pick-up and delivery elements for most air and rail movements of general cargo. In short, by utilizing reasonably-priced vehicles and providing flexible services, and benefitting from the fact that trucks pay only part of their share for the use of public roadways,¹¹ the trucking industry has developed costs and services

11. In 1961, total U.S. expenditures on construction and maintenance of highways and streets was \$9.7 billion. In the same year, receipts from highway-user taxes (e.g. fuel taxes) and from toll charges totalled only \$5.4 billion. The difference between these receipts and expenditures was made up from federal funds, property taxes, bond issues, etc. - U.S. Department of Commerce, op. cit., p. 550.

that are very hard for competitive modes to beat for short-haul, non-bulk movements.

These attributes are causing a growing use of trucks in single-customer situations. These operations for a single-customer - or a limited number of them - include the private and contract carriers, and are largely or entirely free from regulation. Private carriers are employed by a single shipper and may function either as an integral part of the shipper's company or as a separate service. A contract carrier is a separate entity from his customers, and provides continuing services, on a contract basis, to one or more customers.

The non-regulated carriers appear to believe that they have lower operating costs than the common carriers, because they do not have to maintain sales organizations, etc. However, this appearance may be deceptive since a private carrier operation (such as a company-owned fleet of trucks) involves the maintenance of truck equipment and other costs inherent in vehicle operations.

The strength of competition from the non-regulated carriers is indicated in Table 5 below, where it may be seen that private and contract carriers performed approximately 70% of the total truck inter-city freight ton-miles in 1960; and that, of this 70%, the overwhelming majority was performed by the private carrier.

TABLE 5

TRUCK INTER-CITY FREIGHT TON-MILES
(billions)

YEAR	COMMON CARRIER	CONTRACT CARRIER	FOR HIRE TOTAL ¹	PRIVATE CARRIER
1939	14.911	4.736	19.647	33.174
1940	17.348	3.335	20.683	41.360
1941	23.212	3.624	26.836	54.547
1942	25.381	2.702	28.083	31.813
1943	26.284	2.483	28.767	28.017
1944	24.577	2.676	27.253	30.497
1945	24.794	2.495	27.289	39.659
1946	28.208	2.240	30.448	51.544
1947	34.744	2.950	37.693	64.402
1948	42.630	4.076	46.706	69.339
1949	43.952	3.939	47.891	78.745
1950	61.276	4.371	65.648	107.222
1951	66.865	5.426	72.292	115.720
1952	64.163	6.680	70.843	123.364
1953	69.184	7.326	76.510	140.653
1954	65.098	7.203	72.301	142.325
1955	73.455	9.451	82.906	143.282
1956	74.552	8.463	83.015	170.736
1957	76.683	7.577	84.260	160.635
1958	75.934	8.405	84.339	171.205
1959	90.537	10.840	101.377	187.142
1960	92.438	10.059	102.497	182.503

1. Does not include inter-city ton-miles of local carriers, local cartage or pick-up and delivery ton-miles, or ton-miles of carriers other than holders of ICC operating authorities.

SOURCE: Automobile Manufacturers' Association, Motor Truck Facts

In addition to the reasons already mentioned, the overall trucking industry's ability to penetrate deeply into the high-tariff portion of the railroads' business is based on the fact that truckers are much more service-oriented than are the railroads. The large railroad traffic departments are alleged to be unresponsive to customer demands. Most important, truckers' door-to-door service generally involves fewer cargo transfers, thus minimizing the costs and time involved in handling operations.

The extensive highway network gives the truck its great advantages of single-vehicle transportation and flexibility, enabling door-to-door service and virtually complete coverage of the country. Moreover, in its chosen field of high-value commodities, trucking is usually a necessary adjunct to the operations of competing rail, air and water services.

Although there are successful long-haul truckers, the average range in 1959 was rather short: 273 miles for common carriers.¹² The cost advantages which trucks enjoy at short distances stem from their lower terminal costs; conversely, their line-haul costs increase with distance more rapidly than those for rail. Estimates of the distance at which rail becomes more economical vary greatly, and are probably meaningful only if they relate to specific movements of specific commodities.

12. Interstate Commerce Commission, Inter-City Ton-Miles: 1939 - 1959, p. 20.

Although public funds were originally expended on the highways in order to serve private automobiles, only moderate additional costs are involved when commercial vehicles make joint use of the roads. Thus the trucks have not been required to pay their full share for the use they get out of the roads.

Reflecting motor carriers' small profit margin and low level of capital investment, operating costs are a larger percentage of revenues than those of the railroads - in 1960 almost 98% for trucks versus 79% for railroads.¹³

As already indicated, truckers usually set their rates a bit below rail rates for the commodities they desire to move. However, in New England there has been some experience with rates based on the density of the commodity, which provides a sounder relationship to truck costs.¹⁴ Also, truckers have broken down rates by weight groups to reflect lower pick-up and delivery costs for larger shipment, i.e. 1,000 - 6,000 pounds; 6,000 - 12,000 pounds, etc., as against the usual rail practice of differentiating only between carload and less-than-carload shipments.

13. Interstate Commerce Commission, Transport Statistics in the United States for 1960, Part 1 - Railroads, and Part 7 - Motor Carriers, pp. 116 and 10.

14. The New England Motor Rate Bureau Inc. publishes a "Coordinated Motor Freight Classification" in which commodities are classified according to their density. For application of a density classification to air freight, see page 92 of this thesis.

W a t e r T r a n s p o r t a t i o n

For the purposes of discussion in this thesis, examination of United States water transportation will be confined to the domestic waterways system.

The domestic system of transportation by water carriers is classified into three distinct groups: (1) Intercoastal (Atlantic to Pacific, and vice-versa), (2) Intracoastal or Coastal (Atlantic and Gulf Coast, Pacific Coast), and (3) Inland Waterways (Mississippi, Great Lakes, etc.).

Intercoastal shipping is comprised of traffic between the West Coast and the East Coast/Gulf ports. Since 1935, all but one of the intercoastal carriers have been forced out of business as a result of high costs, lengthy transit times, and rail competition.

Intracoastal shipping consists of water movements between the ports of one coast. Most of its problems are similar to those of intercoastal shipping. In addition, cabotage restrictions (all traffic between U.S. ports is restricted to U.S. flag carriers) add an important institutional factor to the difficulties of the coastal trade, for low-cost foreign lines could provide a more economical service than do U.S. coastal ships. For example, for reasons of back-haul and climatic conditions, service between the U.S. Pacific Coast ports and Alaska is expensive and schedules are poor; but if Japanese ships enroute from the U.S. to Japan were allowed to drop off U.S. cargo at Alaska, service would be greatly improved.

The Inland Waterways are comprised of the Great Lakes System, the coastal rivers, the New York Barge Canal, the Mississippi River System, and the intracoastal waterways. In 1960, the total traffic on these waterways amounted to 233 billion ton-miles.¹⁵

At the present time, there are 237 improved commercial seaports in the U.S. which have been developed at a cost of \$910 million. Exclusive of the Great Lakes - St. Lawrence System, the inland waterways consist of about 22,000 miles of improved passages. The mileage suitable for modern barges (channel depth of nine feet or more) is about 12,000 miles. Federal expenditures for construction of the inland and intracoastal systems, excluding the Great Lakes and seacoast projects, have totalled \$1.6 billion. Local and state expenditures are about equal, adding another \$1.5 - 2.0 billion. Thus, the total government expenditures for domestic waterways have amounted to at least 4 billion dollars.

It is apparent that the domestic water carriers do not pay for the development and use of their right-of-way, as do the railroads.¹⁶ As a result of this situation, the taxpayer bears part

15. See Table 1 on page 4.

16. In 1960 Federal expenditures for maintenance and improvement of rivers, canals, harbours, flood control and other miscellaneous work amounted to \$868.5 million - U.S. Department of Commerce, op. cit., p. 595.

of the costs of water transportation, and the rates charged by carriers making use of publicly provided facilities do not reflect the entire cost of transportation.

Dependent upon low line-haul costs to maintain their portion of the freight market, water carriers in general are handicapped by the following disadvantages:

1. Large size of vehicle versus scheduling requirements;
2. Circuitous routes;
3. High costs for transfer of freight;
4. Slowness;
5. Restriction on use in severe winter weather.

Hope for improvements includes automation of loading and operating ships; faster ships at acceptable costs; and fishy-back operations with minimum handling between shipper and destination. A recent trend has been toward longer tows - i.e. greater number of barges per tow.

P i p e l i n e s

Pipelines constitute a specialized transportation system for the movement of fluid commodities, primarily crude oil. The balance is made up of refined petroleum products and natural gas. On a limited scale, pipelines are being utilized for the transportation of pulverized coal, metallic ores, grain, and similar solids suspended in water. The pipeline system is unique because no separate vehicle is involved and there is no back-haul problem. The extensive pipeline systems which exist for the movement of natural gas are, for purposes of this discussion, classified as a

source of energy, similar to electrical power distribution systems. Therefore, consideration will be limited to the transportation of liquid commodities in pipelines.

The importance of this system is shown by the fact that pipeline traffic represented 20% of the total ton-miles of inter-city freight traffic in 1960.¹⁷ Pipelines transported 76% of the crude oil with the remaining 24% handled by bulk water shipments, rail shipments from new fields with no pipeline system, specialized movements, and motor carrier shipments to small refineries. Pipelines do not carry the major portion of refined products. The distribution of tonnage for gasoline and related products among various modes of transportation in 1960 was as follows: Water Carriers, 37%; Trucks, 37%; Pipelines, 21%; Railroads, 5%.

A modern petroleum pipeline system consists of:

- (1) gathering lines, (2) trunk lines, (3) storage tanks, (4) pumping stations, (5) communications facilities, and (6) control offices.

The primary function of pipelines is to distribute crude oil from production fields to refineries, large intermediate storage tanks, or a seaport for trans-shipment by water carrier. A secondary function is the distribution of refined products from refineries to storage facilities, seaports or commercial dispensing depots.

17. See Table 1.

An important characteristic of pipeline development has been the close affiliation between the pipeline companies and major oil companies. In 1957, 71% of the mileage of crude-oil pipelines was owned or controlled by twenty major integrated oil companies. Product lines, like crude-oil lines, are owned by, or affiliated with, oil companies.

The low cost of transporting oil by pipelines is reflected in the charges made by pipeline companies. Although no recent rate comparison is available, a 1938 analysis by a federal agency showed that the rates of 50 pipelines averaged about 36% of corresponding rail rates for crude oil, and 40 - 70% for gasoline. Despite these low rates, the accusation is often made that pipeline rates are higher than the cost of the service justifies. The controlling oil companies gain from maintaining high rates in the following ways; (1) they make a large profit from transporting oil for others, and (2) they place oil companies which have no pipelines at a disadvantage.

Although the first oil pipeline was constructed in 1865, long-distance movement by pipeline is a recent development resulting from wartime federal construction of a large diameter pipeline from Texas oil fields to the New York refineries, and another large diameter line from Texas refineries to the New York market. These lines were significant because of their length and the fact they were constructed by interests outside the petroleum industry.

Shortly after World War II, these lines were sold by the government to Texas Eastern Transmission Company which uses them for transportation of natural gas or refined petroleum products. However, due to fluctuating demand and the high capacity of these lines, they are unused a good deal of the time.

In 1959, the oil pipeline system in the U.S. consisted of 149,000 miles of lines, of which 99,500 miles were trunklines, and 49,500 miles were gathering lines,¹⁸ the latter connecting individual wells with the trunk lines. Pumping stations are located every 35 to 40 miles, depending upon topography, oil viscosity, and pipeline design. Gathering lines range from 2 to 20 inches in diameter with 80% of total mileage in the 2 to 4 inch range. These lines are usually on the surface and are easily relocated as wells are exhausted. Trunk lines vary from 3 to 32 inches in diameter with 8 inch pipe the most common size and are usually underground and permanent. The existing range of throughputs for crude-oil trunk lines is 25,000 to 400,000 barrels per day (5,500 to 88,000 tons per day). An eight inch pipeline would have a throughput of approximately 25,000 to 50,000 barrels per day.

ANALYSIS OF THE COMPETITIVE SITUATION
EXISTING BETWEEN THE RAILROADS AND THE
MOTOR CARRIERS

The examination of the major characteristics of the United States surface transportation media having now been completed,

18. U.S. Department of Commerce, op. cit., p. 583.

the relative competitive positions of the railroads and the motor carriers will be analysed. This analysis is considered necessary since it is from the traffic carried by these media that the majority of new air freight traffic is likely to come.

Table 6 which follows shows gross national product (in 1954 dollars), and railroad and inter-city motor truck traffic - from 1951 to 1960. Graph 1 which follows this table plots gross national product and the total of railroad-plus-truck traffic.

TABLE 6

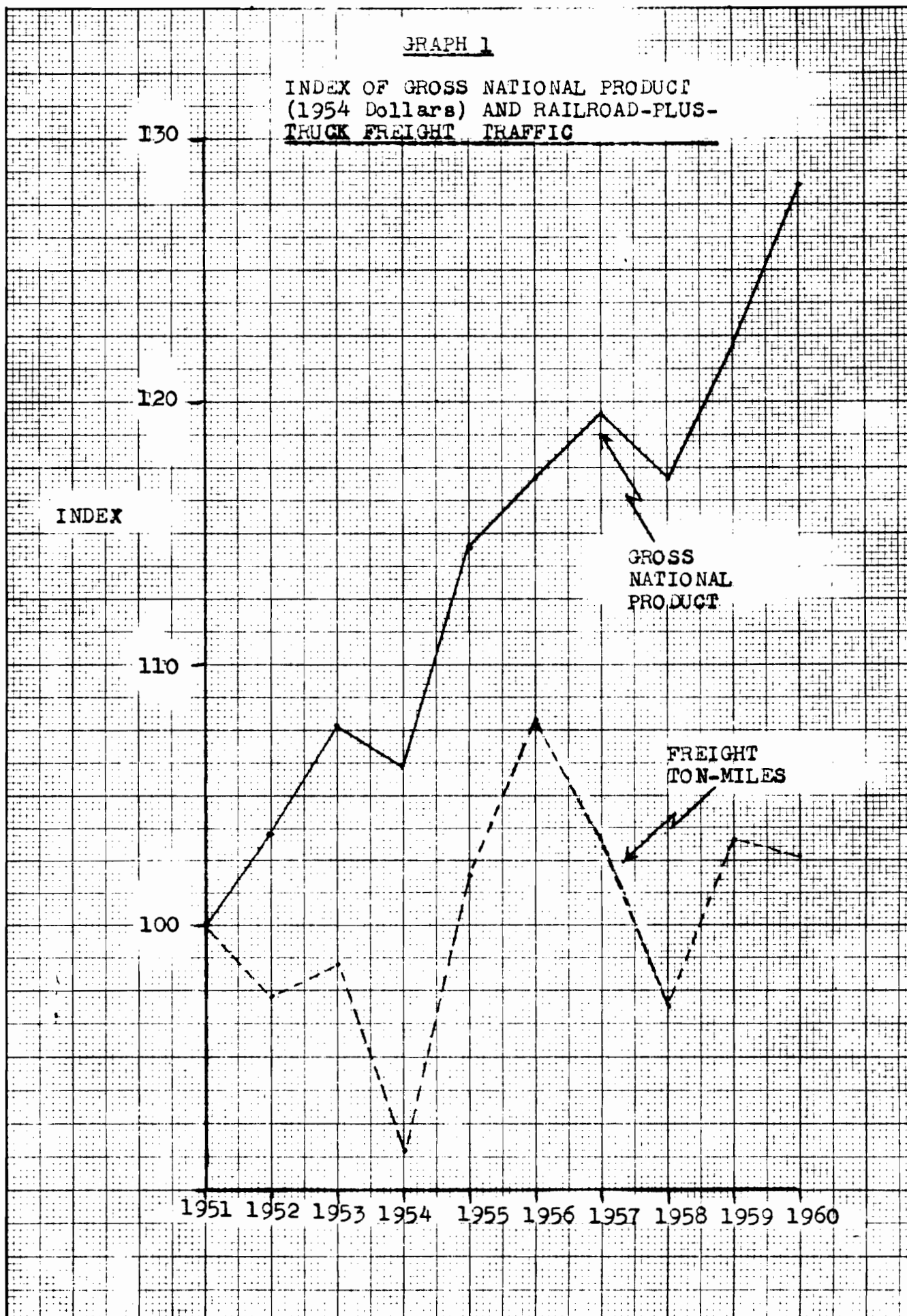
GROSS NATIONAL PRODUCT (in 1954 dollars), TOTAL
FREIGHT TRAFFIC, CLASS I RAILROAD FREIGHT TRAFFIC,
AND ALL TRUCK INTER-CITY FREIGHT TRAFFIC

Year	GNP - 1954 dollars (Billions)	Index (1951 = 100)	Railroads- plus-Trucks Freight Ton-Miles (Billions)	Index (1951 = 100)	Railroad Freight Ton-Miles (Billions)	Index (1951 = 100)	Railroad Traffic as % of Total	All Truck Inter-City Freight Ton-Miles (Billions)	Index (1951 = 100)	Truck Traffic as % of Total
1951	342	100	835	100	647	100	77	188	100	23
1952	354	103.5	813	97.3	619	95.6	76	194	103.2	24
1953	369	107.8	823	98.5	606	93.6	73	217	115.4	27
1954	363	106.1	764	91.5	549	84.8	72	215	114.3	28
1955	393	114.6	850	101.8	624	96.4	73	226	120.2	27
1956	401	117.2	901	107.9	647	100	71	254	135.1	29
1957	408	119.6	863	103.3	618	95.6	70	245	130.3	30
1958	401	117.2	808	96.8	552	85.3	66	256	136.1	34
1959	428	122.1	863	103.3	575	88.8	66	288	153.2	34
1960	439	128.3	857	102.6	572	88.3	66	285	151.6	34

SOURCES: GNP - U.S. Department of Commerce, Statistical Abstracts of the United States, 1959, 1960 & 1961.

Railroads - See Table 1.

Trucks - See Table 5.



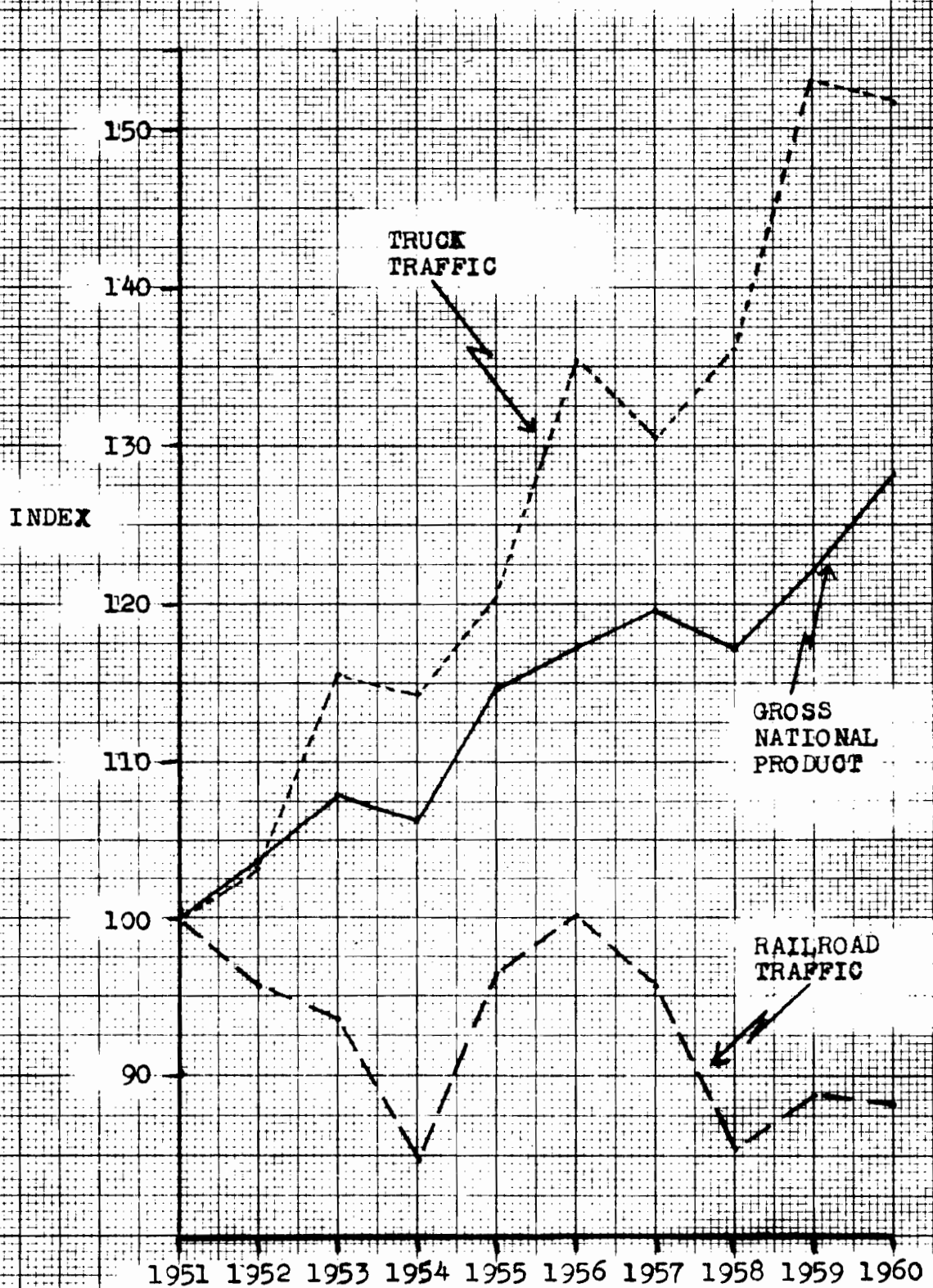
From Graph 1 it appears that there is some fairly close relationship between gross national product and total railroad-and-truck traffic. However, the exact value of the coefficient of correlation between these factors is only 0.56, which is not high. (The calculations which resulted in this figure are shown in the Appendix to this chapter.)

Graph 2 which follows plots railroad and truck traffic separately, on the same graph with GNP. From this graph it can be seen that, during the period 1951 to 1953, GNP and truck traffic were rising, while railroad traffic was falling. Railroad traffic continued to fall up to 1954, as did GNP and truck traffic from 1953 to 1954. From 1954 to 1956, both railroad and truck traffic rose with GNP; but, whilst truck traffic reached a new high level, rail traffic only rose to its 1951 volume.

Truck traffic fell from 1956 to 1957, while GNP continued to rise. Thereafter, truck traffic rose in spite of a fall in GNP from 1957 to 1958. Rail traffic fell from its 1956 level and reached the same low level it had been at in 1954. There was a slight rise between 1958 and 1960, but the level in 1960 was still 12% below the 1951 level; whereas truck traffic in 1960 was 52% above its 1951 level.

GRAPH 2

INDEX OF GROSS NATIONAL PRODUCT
(1954 Dollars), RAILROAD TRAFFIC
AND TRUCK TRAFFIC



Examination of Graph 2 seems to indicate the decreases in rail traffic precede decreases in GNP, and that changes in rail traffic are, proportionally, much greater than changes in either truck traffic or GNP.

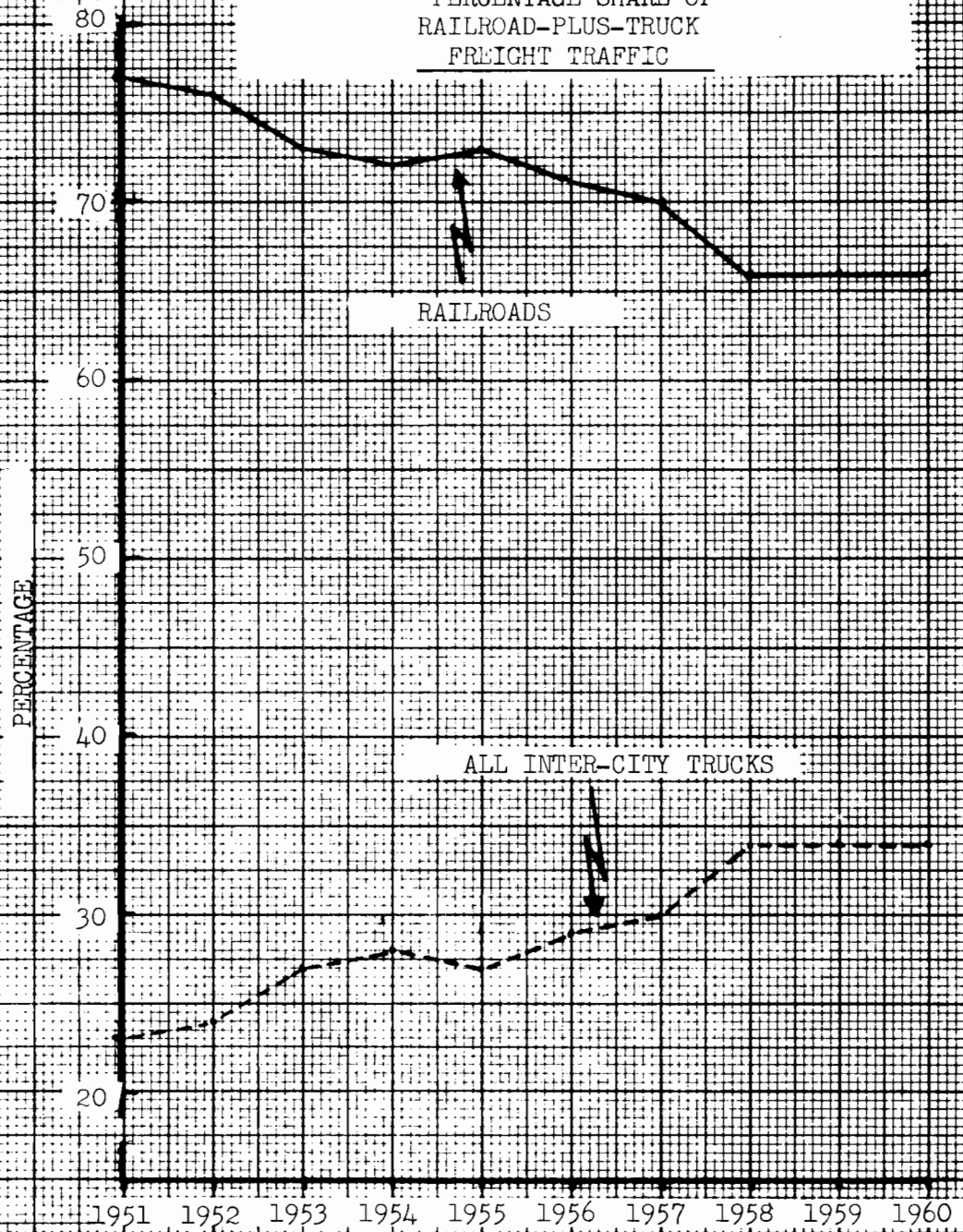
From this it may be speculated that, because the railroads are still the dominant freight transportation medium, changes in their traffic are very marked as economic activity changes.

Additionally, it may be speculated that truck traffic shows much less effect of changes in economic activity, because this medium is still in its growing stages; whereas the railroads, having long since reached their maturity with very little natural growth left in them, are carried back and forth on waves of economic activity.

Graph 3 which follows shows the percentages of the total railroad-plus-truck traffic which were carried by the railroads and the trucks respectively.

GRAPH 3

PERCENTAGE SHARE OF
RAILROAD-PLUS-TRUCK
FREIGHT TRAFFIC



Graph 3 shows quite strikingly that the trucks are increasing their share of the total railroad-plus-truck freight market.

Since it can now be clearly seen that the trucking industry is increasing its share of the market at the expense of the railroads, it is necessary to try and determine why this is taking place.

Table 7 which follows shows the ton-miles of traffic and the revenue per ton-mile of Class I Line-Haul Railroads and Class I, II and III Inter-City Motor Common Carriers. It should be noted that the Motor Carrier Traffic figures in Table 7 are less than those shown in Table 6; since, in Table 6, the traffic of the total of all motor carriers - common carriers, contract carriers, and private carriers - is shown.

TABLE 7

REVENUE FREIGHT TON-MILES AND REVENUE
PER TON-MILE, BY MEDIUM OF TRANSPORTATION,
1951 - 1960

YEAR	RAILROADS ¹		MOTOR CARRIERS ²	
	Revenue Freight Ton-Miles (millions)	Average Revenue per Ton- Mile (cents)	Revenue Freight Ton-Miles (millions)	Average Revenue per Ton- Mile (cents)
1951	646,610	1.34	66,865	5.17
1952	618,810	1.43	64,163	5.62
1953	605,790	1.48	69,184	5.73
1954	549,240	1.42	65,098	5.83
1955	623,590	1.37	73,455	5.80
1956	646,980	1.38	74,552	5.99
1957	618,090	1.45	75,834	6.14
1958	551,540	1.46	75,934	6.19
1959	575,440	1.45	90,537	6.28
1960	572,220	1.40	92,438	6.35

1. Class I Line-Haul Railroads

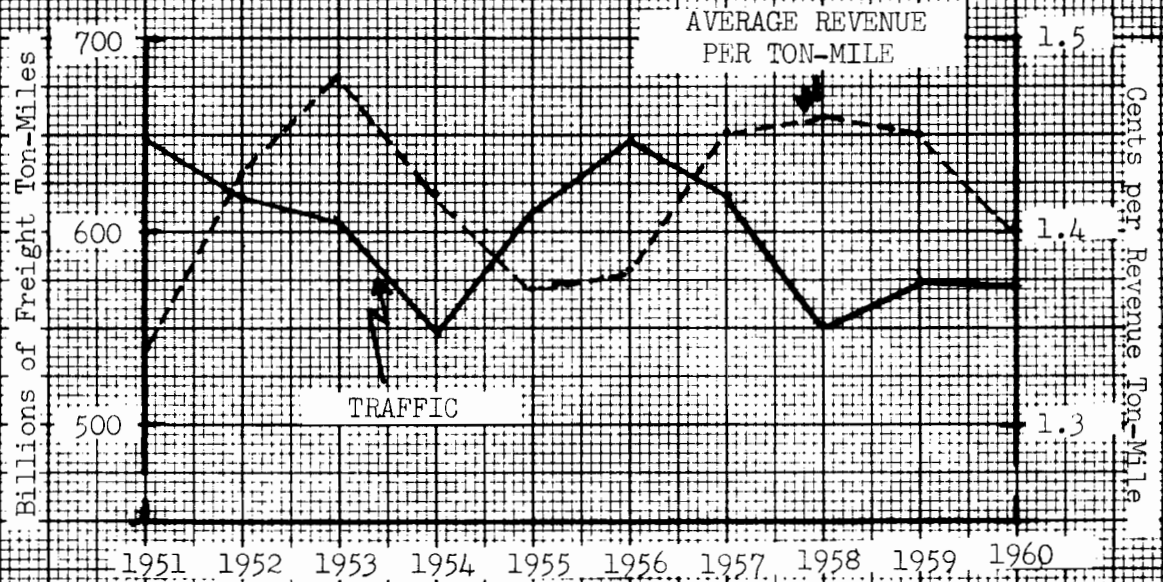
2. Class I, II and III Inter-City Common Carriers

SOURCES: See Table 1

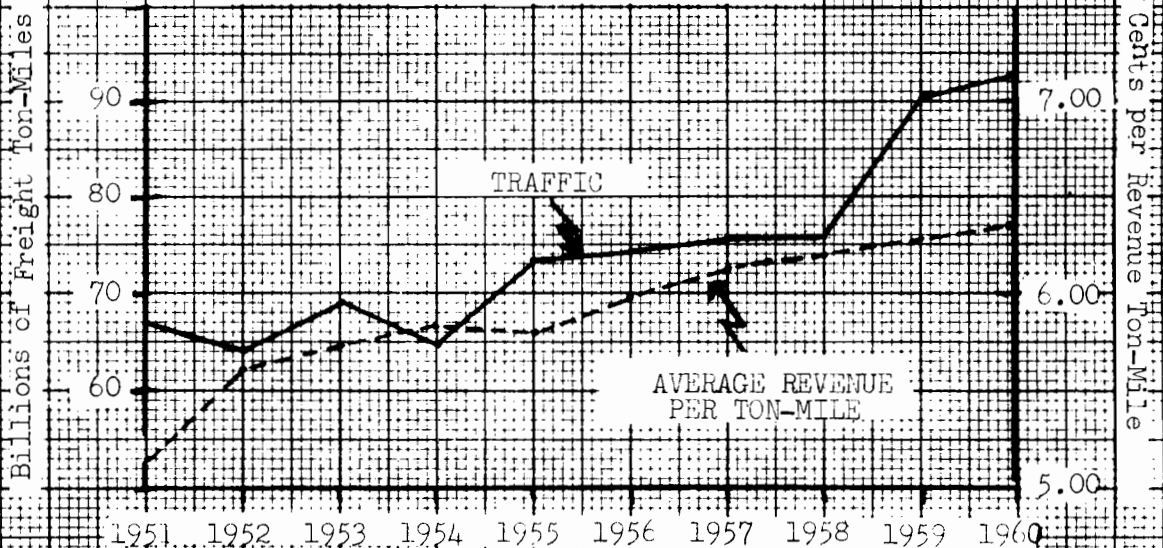
From Table 7 it can be seen that common carrier truck traffic increased approximately 40% from 1951 to 1960, whilst, as previously noted, railroad traffic decreased 12%.

Graphs 4 and 5 which follow show, respectively, railroad traffic plotted with average railroad revenue per ton-mile, and motor common carrier traffic plotted with average motor common carrier revenue per ton-mile.

GRAPH 4
RAILROADS
TRAFFIC & AVERAGE
REVENUE PER TON-MILE



GRAPH 5
MOTOR CARRIERS
TRAFFIC & AVERAGE
REVENUE PER TON-MILE



From Graph 4 it can be seen that, generally speaking, railroad traffic appears to decrease as average unit revenue increases, and that decreases in average unit revenues have not resulted in lost volumes of traffic being fully regained.¹⁹ Graph 5 indicates that there is a trend of increasing truck traffic and increasing truck average unit revenues operating together.

Between 1951 and 1960, railroad average unit revenue rose 4.4% while traffic fell 12%. Common carrier truck average unit revenues rose 22%, whilst traffic rose 40%.

Between 1958 and 1960, railroad average unit revenue fell 4.1%, truck average unit revenue rose 2.5%; railroad traffic rose approximately 4%, and truck traffic rose approximately 21%. In the same period, Class I Motor Common Carrier average costs per inter-city vehicle mile rose approximately 6% - from 73.6 cents per vehicle mile to 78.3 cents per vehicle mile.²⁰

From the point of view of statistical reasoning, it would be highly desirable if one were able to arrive at a clear-cut conclusion with regard to the relationships existing between railroad traffic volumes and average unit revenues on the one hand, and truck traffic volumes and average revenues on the other hand. However, it

19. For example, reference to Table 7 will show that in 1952 the railroads' average unit revenue was 1.43 cents per ton-mile at a traffic level of 618.8 billion ton-miles. In 1960, the average unit revenue was down to 1.40 cents per ton-mile, but traffic was only 572.2 billion ton-miles.

20. Interstate Commerce Commission, Transport Statistics in the United States for 1958, 1959 & 1960, Part 7 - Motor Carriers, p. 38.

does not appear that there is any such clear statistical conclusion to be drawn, although it may be speculated that changes in average unit revenues, as well as reflecting some changes in cost, mainly reflect changes in the "mix" of the traffic carried by the railroads and the trucks respectively. If this surmise is correct, the slight increase in railroad average unit revenue between 1951 and 1960 largely reflected increased railroad costs; whilst the much larger increase in common carrier truck average unit revenue reflected a changing "mix" of traffic, with a greater proportion of higher rated commodities being carried. Many of these higher rated commodities carried by trucks at the end of the period were probably originally carried by the railroads.

Examination of the average unit revenues which the railroads have obtained from the movement of particular commodities over a period of years might be expected to assist in determining specific reasons for the trend of declining railroad traffic and increasing truck traffic. However, the figures in Table 8 which follows do not provide such assistance.

The commodities included in this table are classified by the ICC under the general heading of "Manufactures and Miscellaneous". It is commodities within this classification that generally make up a large part of total truck tonnage, and it is these commodities moving by rail which have been one of the major targets of truck competition.

TABLE 8

AVERAGE RAILROAD UNIT REVENUE (CENTS PER TON-MILE)
FOR CARLOAD TRAFFIC OF SELECTED COMMODITIES
1957 - 1960

YEAR	RUBBER GOODS	MACHI- NERY	MACH- INE PARTS	OFFICE MACH- INES	VEHICLE PARTS	AIR- PLANE PARTS	REFRIG- ERATORS	LAUN- DRY EQUIP.	FURNI- TURE	LUGG- AGE & HAND- BAGS	METAL CANS
1957	3.99	3.97	3.54	3.94	3.76	4.66	4.52	4.56	5.07	5.15	6.08
1958	4.71	4.17	3.44	4.13	3.97	6.56	4.57	4.64	5.22	4.30	6.47
1959	4.25	3.96	3.43	4.50	3.97	4.90	4.62	4.54	4.80	5.41	5.88
1960	4.60	3.82	3.44	4.91	3.97	5.61	4.56	4.42	4.84	5.04	5.88

SOURCE: Interstate Commerce Commission, Carload Waybill Statistics,
1957, 1958, 1959 & 1960

Whilst it is not suggested that the commodities included in the above table are the only ones which trucks can or do take away from the railroads, it is thought that they are representative of the broad range of "manufactures and miscellaneous", and that the average unit revenues being received by the railroads for their transportation in carload lots makes them susceptible to truck competition.

It can be seen from the table that there is no consistent pattern of revenue changes over the period shown. Some commodity revenues went up, some went down, and some stayed fairly stable.

Conclusions Regarding Railroad - Truck Competition

The role which private and contract trucking plays in the total inter-city freight trucking industry is not easy to define. From 1951 to 1960, the total traffic of private-plus-contract motor carriers increased 58% (as compared to the 40% increase of the common motor carriers). The total traffic of private-plus-contract motor carriers was approximately double that of common motor carriers in 1960.

However, I have not been able to discover any way of determining the rates or costs of these types of carriers, and it is therefore not possible to say much more about them than that they represent a major part of the trucking industry, and a part whose

traffic appears to be growing at a somewhat faster rate than the traffic of the motor common carrier.

With regard to competition between the railroads and the motor common carriers, it appears that truck traffic generally rises as production rises, whereas railroad traffic appears to be in a state of gradual decline.

Therefore, the rise in truck traffic can probably be attributed to:

1. The general rise in the level of economic activity; and
2. the ability of the trucks to take certain traffic away from the railroads.

The fact that truck traffic rises as production rises is evident from the graphs.

The ability of the trucks to take traffic away from the railroads may be inferred from the fact that, in a period of increasing economic activity, the railroads' volume of traffic has actually fallen.

As regards price competition between the two media of transportation, no definite pattern of traffic growth or reduction resulting from price changes can be determined from the traffic and revenue figures available. Truck traffic has risen while average rates (or average unit revenues) have risen. Railroad traffic has fallen while average rates have risen.

Since average truck rates have risen during the period in question (1951 - 1960), it is assumed that the railroad rates for those commodities which the trucks want to carry, between the points the trucks want to carry them, have also risen. Statistically speaking, these commodities would be a small part of the total railroad traffic and would probably not significantly affect the railroads' overall average rates, although even slight changes in the railroads' average rates (or unit revenues) undoubtedly do have significant effects on the profitability of their operations.

For the traffic they wish to carry, between the points they wish to carry it, the trucking companies have habitually quoted rates just below the rates the railroads charge.

Since, in many cases, trucks provide a better service²¹ than the railroads, they have been able to take a considerable volume of traffic away from the railroads and have been able to generate new traffic that would otherwise have been generated by the railroads.

21. "Better service" means here a door-to-door service with less en-route handling, and quicker delivery. (For a comparison of speeds of delivery by various modes of transportation, see Graph 7 in Chapter IV.)

APPENDIX TO CHAPTER I

Calculation of the coefficient
of correlation between Gross
National Product (in 1954
dollars) and Class I Railroad-
plus-total-Motor-Carrier Inter-
City Freight Ton-Miles

YEAR (N)	GROSS NATIONAL PRODUCT (billions of 1954 dollars) X	TOTAL FREIGHT TON-MILES - RAILROADS PLUS TRUCKS (billions) Y	X x Y	X ²	Y ²	THEORETICAL REGRESSION VALUES Y _c	Y - Y _c	d ²
1951 (1)	342	835	285570	116984	697225	806	+ 29	+ 841
1952 (2)	354	813	287802	125316	660969	811	+ 2	+ 4
1953 (3)	369	823	303687	136161	677329	824	- 1	+ 1
1954 (4)	363	764	277332	131769	583696	820	- 56	+3136
1955 (5)	393	850	334050	154449	722500	840	+ 10	+ 100
1956 (6)	401	901	361301	160801	811801	845	+ 56	+3136
1957 (7)	408	863	352104	166464	744769	850	+ 13	+ 169
1958 (8)	401	808	324008	160801	652864	845	- 37	+1369
1959 (9)	428	863	369364	183184	744769	863	0	0
1960 (10)	439	857	376223	192721	734449	870	- 13	+ 169
	3898	8377	3271441	1528650	7030371			+8925

SOURCES: See Table 6

Line of Regression (least squares)

$$\text{Equation (I)} \quad \Sigma(Y) = Na + b\Sigma(X)$$

$$\text{Equation (II)} \quad \Sigma(XY) = a\Sigma(X) + b\Sigma(X^2)$$

$$(I) \quad 8377 = 10a + 3898b$$

$$(II) \quad 3271441 = 3898a + 1528650b$$

$$\begin{array}{rcl} \text{Subtract} & 3265355 & = 3898a + 1519440b \\ & 6086 & = 9210b \end{array} \quad \text{Equation (I) } \times 389.8$$

$$\text{Therefore } b = + 0.6608$$

Substituting the value of b in Equation (I)

$$8377 = 10a + 3898 (0.6608)$$

$$8377 = 10a + 2576$$

$$10a = 8377 - 2576$$

$$10a = 5801$$

$$\text{Therefore } a = 580.1$$

$$\text{Line of Regression } Y = a + b(X)$$

$$\text{Therefore } Y = 580.1 + 0.6608(X)$$

Standard Error of Estimate (Sy)

$$S_y = \sqrt{\frac{\Sigma(d^2)}{N}}$$

$$S_y = \sqrt{\frac{8925}{10}}$$

$$S_y = \sqrt{892.5}$$

$$\text{Therefore } \underline{\underline{S_y = 29.9}}$$

Standard Deviation (σ_y)

$$\sigma_y = \sqrt{\frac{\sum(Y^2)}{N} - \left(\frac{\sum Y}{N}\right)^2}$$

$$\sigma_y = \sqrt{\frac{703071}{10} - \left(\frac{8377}{10}\right)^2}$$

$$\sigma_y = \sqrt{703037 - 701741}$$

$$\sigma_y = \sqrt{1296}$$

Therefore $\sigma_y = 36$

Coefficient of Correlation (r)

$$r = \sqrt{1 - \frac{S_y^2}{\sigma_y^2}}$$

$$r = \sqrt{1 - \frac{892.5}{1296}}$$

$$r = \sqrt{1 - 0.69}$$

$$r = \sqrt{0.31}$$

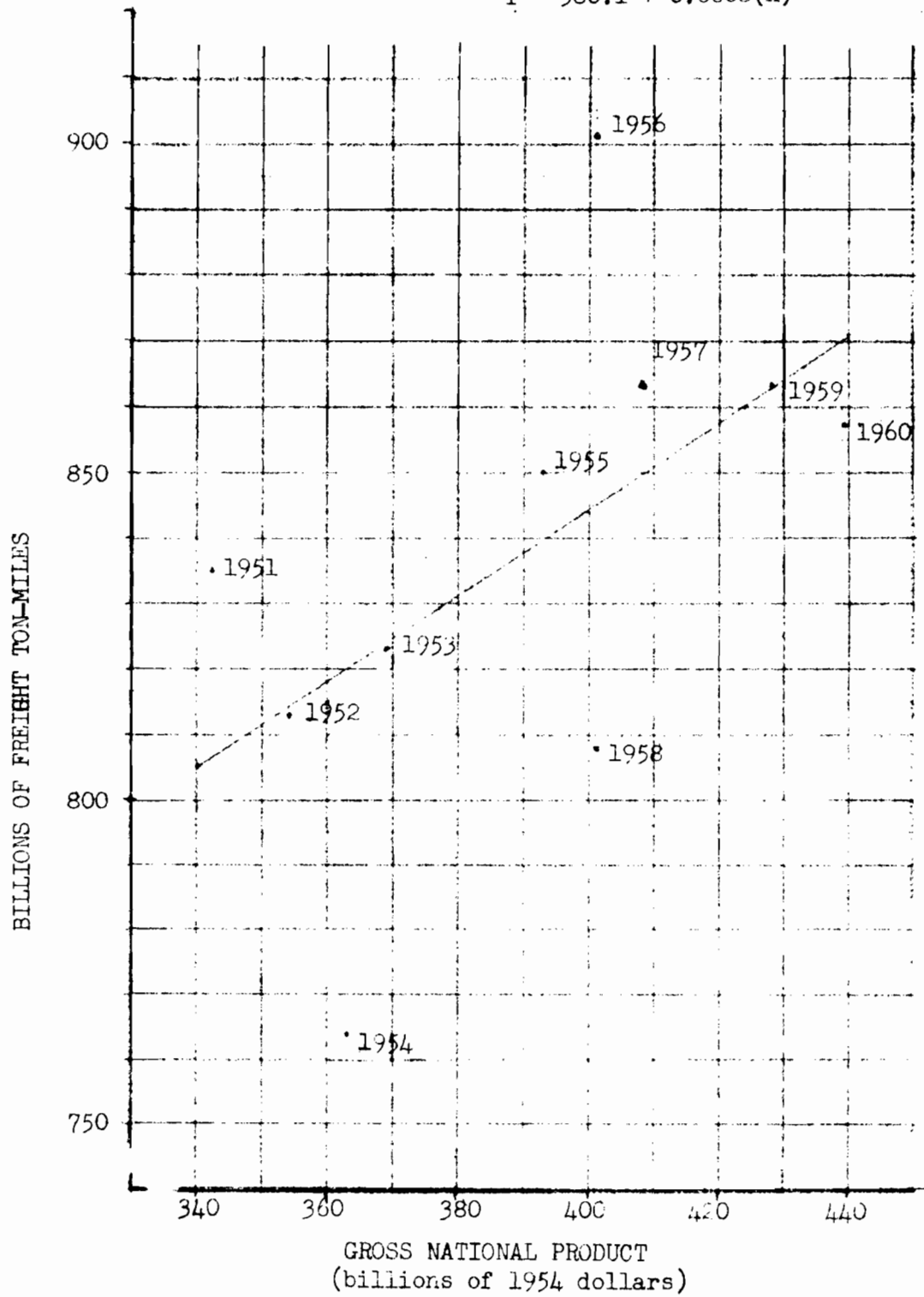
Therefore $r = 0.56$

FREIGHT TON-MILES ---- GNP (in 1954 dollars)

Line of Regression

$$Y = a + b(X)$$

$$Y = 580.1 + 0.6608(X)$$



BIBLIOGRAPHY

- Automobile Manufacturers Association, Motor Truck Facts - 1961 Edition, (Detroit, 1961).
- Brewer, S. H., The Utilization of Motor Common Carriers of General Freight, in Distribution Patterns, (University of Washington, Seattle, 1957).
- Eastern Railroad Presidents Conference, Yearbook of Railroad Information - 1962 Edition, (Jersey City, 1962).
- Federal Aviation Agency, Statistical Handbook of Aviation - 1961, (U.S. Government Printing Office, Washington, 1961).
- Interstate Commerce Commission, Carload Waybill Statistics - 1957, (U.S. Government Printing Office, Washington, 1958).
- Interstate Commerce Commission, Carload Waybill Statistics - 1958, (U.S. Government Printing Office, Washington, 1959).
- Interstate Commerce Commission, Carload Waybill Statistics - 1959, (U.S. Government Printing Office, Washington, 1960).
- Interstate Commerce Commission, Carload Waybill Statistics - 1960, (U.S. Government Printing Office, Washington, 1961).
- Interstate Commerce Commission, Distribution of the Rail Revenue Contribution by Commodity Groups - 1959, (U.S. Government Printing Office, Washington, 1960).
- Interstate Commerce Commission, Explanation of the Development of Motor Carrier Costs with Statement as to their Meaning and Significance, (U.S. Government Printing Office, Washington, 1959).
- Interstate Commerce Commission, Freight Revenue and Wholesale Value at Destination of Commodities Transported by Class I Line-Haul Railroads - 1959, (U.S. Government Printing Office, Washington, 1960).
- Interstate Commerce Commission, Intercity Ton-Miles, 1939 - 1959, (U.S. Government Printing Office, Washington, 1960).
- Interstate Commerce Commission, Transport Economics - 74th Annual Report, (U.S. Government Printing Office, Washington, 1960).
- Interstate Commerce Commission, Transport Statistics in the United States for 1960 - Part I Railroads, (U.S. Government Printing Office, Washington, 1961).

Interstate Commerce Commission, Transport Statistics in the United States for 1958 - Part 7, Motor Carriers, (U.S. Government Printing Office, Washington, 1959).

Interstate Commerce Commission, Transport Statistics in the United States for 1959 - Part 7, Motor Carriers, (U.S. Government Printing Office, Washington, 1960).

Interstate Commerce Commission, Transport Statistics in the United States for 1960 - Part 7, Motor Carriers, (U.S. Government Printing Office, Washington, 1961).

Interstate Commerce Commission, Value of Service in Rate-Making, (U.S. Government Printing Office, Washington, 1959).

LeFevre, W. F., Determining Transportation Trends by the Gompertz Growth Curve, (American Transportation Research Forum, New York, 1961).

Locklin, D. P., Economics of Transportation, (Richard D. Irwin Inc., Homewood, 1954).

Nelson, J. C., Railroad Transportation and Public Policy, (The Brookings Institute, Washington, 1959).

U.S. Department of Commerce, Historical Statistics of the United States - Colonial Times to 1957, (U.S. Government Printing Office, Washington, 1960).

U.S. Department of Commerce, Statistical Abstract of the United States - 1959, (U.S. Government Printing Office, Washington, 1960).

U.S. Department of Commerce, Statistical Abstract of the United States - 1960, (U.S. Government Printing Office, Washington, 1961).

U.S. Department of Commerce, Statistical Abstract of the United States - 1961, (U.S. Government Printing Office, Washington, 1962).

Whitten, H. O., The Creation of Growth in Rail Transport, (Chesapeake and Ohio Railway Company, Cleveland, 1960).

CHAPTER II

HISTORICAL REVIEW OF THE GROWTH OF AIR FREIGHT IN THE UNITED STATES

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OF AIR FREIGHT IN THE UNITED STATES

GENERAL

The previous chapter having been devoted to a discussion of the major characteristics of the surface transportation media and an analysis of the competitive situation existing between the railroads and motor carriers, it is considered necessary that this, the next chapter, provide a brief historical background to the air freight industry. This is done in order that the air freight industry's present position, and conclusions about its future performance, may be viewed, not only against the background of the surface transportation system, but also in the larger context of its own historical development.

So that the role of government in relation to air freight may be understood, Appendix "A" to this chapter contains a brief description of the way in which the U.S. air freight industry is regulated. Appendix "B", which shows the calculations for the coefficient of correlation between Gross National Product (in 1954 dollars) and Scheduled Domestic Air Freight Ton-Miles, is included here in order to show the relationship which has existed between air freight growth and GNP. Appendix "C" contains definitions of the terms such as "air cargo" and "air freight", which are generally used with reference to the air transportation of property.

PRE-WAR AND WARTIME AIR CARGO IN THE UNITED STATES

Before 1926 the only commercial air cargo service performed consisted of a few sporadic air express ventures. This was primarily due to the fact that aircraft had been developed to the stage where they were only moderately efficient in commercial service. Moreover, direct government subsidy of airlines was lacking,

and the charges for shipping property by air were therefore very high, with the result that the use of air transportation by shippers was extremely limited.

However, in the year 1925, the United States Congress enacted a law²² which provided for the transfer of air mail carriage from the air force to private airlines. In the years immediately following the enactment of this legislation, the use of aircraft for property transportation was greatly stimulated, since the constant source of revenue from mail service provided the basis for introducing express service on scheduled flights at rates considerably lower than before. "The Post Office Department generally took the position that adjustments should be made in individual-contract mail rates to enable carriers to meet the costs of transporting the mails and that aid, relatively small in amount and temporary in character, should be extended to cover the deficits on the passenger service, whether such service was rendered jointly with, or apart from, mail service."²³

Air express in the United States took on a distinctive character in 1927 with the signing of agreements between four airlines

22. Air Mail (Kelly) Act, February 2, 1925.

23. J. H. Frederick, Commercial Air Transportation, (Homewood, Richard D. Irwin, Inc., 1961), pp. 200-201.

and the American Railway Express Company (later to become the Railway Express Agency).²⁴ Essentially it is this arrangement which still prevails.

The American Railway Express Company contracted to perform local pick-up and delivery service, as well as any necessary surface transportation to off-airline points. It also contracted to conduct all direct relations with the shippers, including the associated accounting functions. The airlines agreed to take care of the loading and unloading of aircraft and the actual air hauling of the shipments. After the Express Company deducted certain of its costs, the revenues were divided between the airlines and the company on a specified percentage basis. By 1929, the ten most important airlines in the United States were party to the agreement, and it was in that year that Railway Express Agency Inc. became the successor to the original express organization. By this time the ten airlines which were party to the agreement were transporting 75 percent of the total air express of the country.

In 1932 another group of airlines jointly organized a competitive express company which was incorporated under the name of "General Air Express". The rates which it established were "substantially below those of the Railway Express Agency",²⁵ and there then resulted a rate war.

24. The four airlines were: Colonial Air Transport, National Air Transport, Boeing Air Transport, and Western Air Express - The Air Express Story, (New York, Railway Express Agency Inc., 1960), p. 6.

25. Frederick, op. cit., p. 410.

However, in 1935, all but one of the airlines in the arrangement with General Air Express had withdrawn from the agreement and had signed contracts with the Railway Express Agency. The lone survivor fought the alliance of Railway Express and the other airlines until 1937 when it too joined the Railway Express Agency.

It was logical that the airlines should form an alliance with the Railway Express Agency, inasmuch as it was not possible for them to establish a truly efficient, nationwide, surface pick-up and delivery system on their own, due largely to financial reasons. At the same time, it had become obvious that such a ground service was a vital complement to an air express service.

A steady increase in express traffic ensued after 1937 as a result of the uniform and extensive nationwide coverage provided by this combination of the Railway Express Agency and the airlines. However, the efficiencies resulting from the operation of a single air express agency did not produce air express rate reductions, which it was felt would have further stimulated traffic development.

From the foregoing it will be noted that, in the early days of commercial air transportation of goods in the United States, the emphasis was on air express. Despite some encouraging, but isolated ventures in the air freight field, airlines were unable to penetrate this market significantly.

When the United States entered World War II, several air carriers were studying the practical economics of freight aircraft operations. This interest in air freight resulted in the establishment, by a group of large U.S. air carriers, of a joint research organization called "Air Cargo Incorporated". This organization's original function was to survey air cargo potentials, but the wartime requisitioning of 50% of the air carrier fleet by the government disrupted this research program. However, as to the development of the air freight industry, it should be noted that, during the period 1942 to 1945, many air carriers performed extensive cargo service in the United States and throughout the world for the military, on contracts of the cost-plus-fixed-fee type.

In the United States, air freight was separated from air express in 1944 when the first pure freight tariff was filed with the Civil Aeronautics Board by American Airlines. "The essential characteristics of air freight service, vis-a-vis air express service, were a somewhat slower over-all speed than air express, generally larger shipments, and considerably lower cost"²⁶ (to the shipper). The freight rates were lower than the air express rates because air freight was assigned the lowest priority (mail, passengers and express holding first, second and third place respectively).

26. J. H. Frederick, Commercial Air Transportation, (Homewood, Richard D. Irwin, Inc., 1955), pp. 433-434.

POST-WAR AIR FREIGHT

Following World War II a tremendous increase in the number of air freight carriers took place. From the few airlines quoting air freight rates (as distinguished from air express rates) at the end of the war, the number of freight carriers mushroomed to the point where a separate air transportation industry seemed suddenly in being. This was due to the many new airlines, equipped with surplus military transport aircraft, which were established by returning military aviators who believed that business prospects were good.

The trunk airlines had developed a good war record in transporting cargo and they looked forward to developing their freight services after their other services (passenger, mail, and express) had been re-built. However, the aggressive all-cargo newcomers to the field soon proved that freight traffic could be generated in considerable volume, and some of these carriers met with a degree of financial success. The trunk airlines were therefore forced either to advance their planning and really get into the air freight business or be left out of this business entirely.

In June, 1947, the Civil Aeronautics Board (CAB)²⁷ adopted a new Economic Regulation permitting the operation of

27. The Civil Aeronautics Board is a federal board charged with the responsibility of regulating the air transportation industry. Its functions are discussed in detail in Appendix "A" to this chapter.

non-certificated cargo or freight carriers on a scheduled basis as common carriers, rather than operating as irregular carriers. It allowed those operators who had been engaged in the air transport of property on May 5, 1947, and who had applied for certificates of convenience and necessity, to operate as common carriers until the Board had acted upon their applications. The Board handed down its decision on these applications, in the "Air Freight Case", in 1949, temporarily certificating four of these operators as common carriers and thus forcing the others, operating under the exemption, to suspend operations. The four all-freight or air cargo airlines certificated for a five-year period were the Flying Tiger Line Inc., Slick Airways, and two other carriers which are no longer in existence. Later, in 1951, the Board granted Riddle Aviation a temporary certificate to operate as an air freight carrier between New York, Miami, and Caribbean points.

In authorizing operation of these specialized carriers, even for a temporary period, the Board took the position that air freight was separate and distinct from the air express business of the airlines and should be treated as such; that the air freight business should be placed on a sound basis through the issuance of certificates of public convenience and necessity, rather than to permit operators to continue on the basis of a further exemption from economic regulation; and that the great air freight potential warranted the existence of pure air cargo carriers alongside the "combination carriers", which are the airlines that transport

passengers, mail, express, and freight, generally in the same aircraft.

The general policy towards specialized air freight carriage then enunciated by the Civil Aeronautics Board has remained in effect to this day.

AGENCIES, OTHER THAN AIRLINES, ASSISTING
IN THE GROWTH OF AIR FREIGHT

Some of the agencies, other than the airlines, which are directly concerned with and assisting in the development of the domestic air freight industry are discussed below.

Air Cargo Incorporated

Air Cargo Incorporated, as previously noted, was originally set up by the U.S. domestic scheduled airlines as a research organization. However, the agency's main function at the present time is the organization and administration of ground pick-up and delivery service for the airlines and for their air freight customers. A factor which should result in an increased use of air freight facilities is the programme, recently initiated by Air Cargo Incorporated, to negotiate contracts with the motor carriers, in the name of all the scheduled airlines, for a nation-wide air/truck service. This new arrangement between the airlines and motor carriers, which has resulted in Air Cargo Incorporated utilizing the services of

virtually every size and type of trucking operator"²⁸, provides for joint rates, joint liability and a through bill of lading. Under this contract, the trucker specifically undertakes to effect delivery of freight on the day on which he receives it from the airlines. The maximum benefit of the contract is to acquaint the airlines and shippers with the fact that there are motor carriers available who are in a position to handle air freight well beyond the normal airline pick-up and delivery limits. This arrangement should be welcomed by shippers since any airport city can be a distribution centre from which radiates trucking services.

The Air/Truck service, presently being organized by Air Cargo Incorporated, is not intended to replace existing air-truck arrangements which may have been set up by airlines to fulfill specialized needs. Rather, the Air/Truck service, as administered by Air Cargo Incorporated, will supplement existing service. Its reason for being is simply that the continuing growth of air freight, as a routine transportation medium, required its broadening to provide connecting Air/Truck service on a complete, nation-wide basis.

Air Freight Forwarders

An air freight forwarder is a common carrier. He must publish and file his tariffs, precisely as an airline does. He accepts shipments on his own waybill, sees to their transportation to

28. J. H. Frederick, Commercial Air Transportation, (Homewood, Richard D. Irwin, Inc., 1961), p. 455.

destination, and delivers them. He collects his charges in accordance with his tariff, and he is liable for loss or damage. There is only one basic difference between a forwarder and an airline. The airline itself operates the primary vehicle of carriage, and is therefore called a direct carrier. The forwarder does not operate the primary means of carriage, and is therefore called an indirect carrier.

To move the freight entrusted to him by shippers, the forwarder must buy air transportation from airlines, paying their tariff charges. Thus, the forwarder is a customer as well as a competitor of the airlines, and the amount which he pays to airlines in freight charges is his largest single item of expense.

These circumstances lend special significance to airline-forwarder relations. Forwarders are important to airlines because they are an important source of airline freight revenue. At the same time, airlines are important to forwarders because, of course, no air freight forwarder could operate without airline service, and the quality and cost of his service is largely a reflection of the quality and cost of airline freight service.

For the air freight forwarder to realize a profit, there must be a difference, or "spread", between the rate per pound that the forwarder charges his customer and the rate per pound that he pays an airline to transport his freight. This "spread" is achieved by consolidation of numerous small shipments, as received

from shippers, into one large shipment for movement on an airline. Ordinarily in transportation, the rate per pound diminishes as the weight of the shipment increases.

While the services of the two types of carriers - direct and indirect - are competitive, they may also complement each other.

Air Cargo Agents

The air cargo agent acts with regard to cargo in somewhat the same way as the travel agent does in regard to passengers. He provides advice and assistance to the shipper, and sells cargo space at rates quoted by the airline, for which he collects a commission from the airline.

U.S. DOMESTIC AIR FREIGHT GROWTH

Table 9 below (and Graph 6 which follows the table) showing the growth of air freight, Gross National Product (in constant dollars) and total inter-city freight traffic by all modes of transport, has been included here in order to compare the three rates of growth. While the growth rate in total inter-city traffic has been less than that of Gross National Product, the growth rate in air freight has been almost three times that of Gross National Product, and almost four times greater than the growth rate of total inter-city traffic.

TABLE 9

GROWTH OF UNITED STATES G.N.P., TOTAL INTER-CITY FREIGHT
AND SCHEDULED SERVICE DOMESTIC AIR FREIGHT

Year	GNP-1954 dollars (Billions)	Per- centage increase (decrease)	Index (1951 = 100)	Total Inter-City Freight Ton-Miles (Billions)	Per- centage increase (decrease)	Index (1951 = 100)	Ton-Miles U.S. Domestic Passenger/ Cargo Airlines & Domestic All-Cargo Airlines - Scheduled Services (Millions)	Per- centage increase (decrease)	Index (1951 = 100)
1951	342	7.5	100	1,209	10.5	100	177	9.0	100
1952	354	3.5	103.5	1,172	(3.1)	96.9	201	13.5	113.5
1953	369	4.2	107.8	1,232	5.1	101.1	209	3.8	118.0
1954	363	(1.6)	106.1	1,145	(7.1)	94.7	205	(1.9)	115.8
1955	393	8.2	114.6	1,301	13.6	107.6	266	29.7	150.2
1956	401	2.0	117.2	1,381	6.1	114.2	297	11.6	167.7
1957	408	1.7	119.6	1,345	(2.6)	111.2	349	17.5	197.1
1958	401	(1.2)	117.2	1,231	(8.5)	101.8	337	(3.4)	190.3
1959	428	6.7	122.1	1,329	8.0	109.9	393	16.6	222.0
1960	439	2.1	128.3	1,409	6.0	116.5	413	5.0	233.3

Average Annual
Growth Rate:

3.3%

2.8%

9.2%

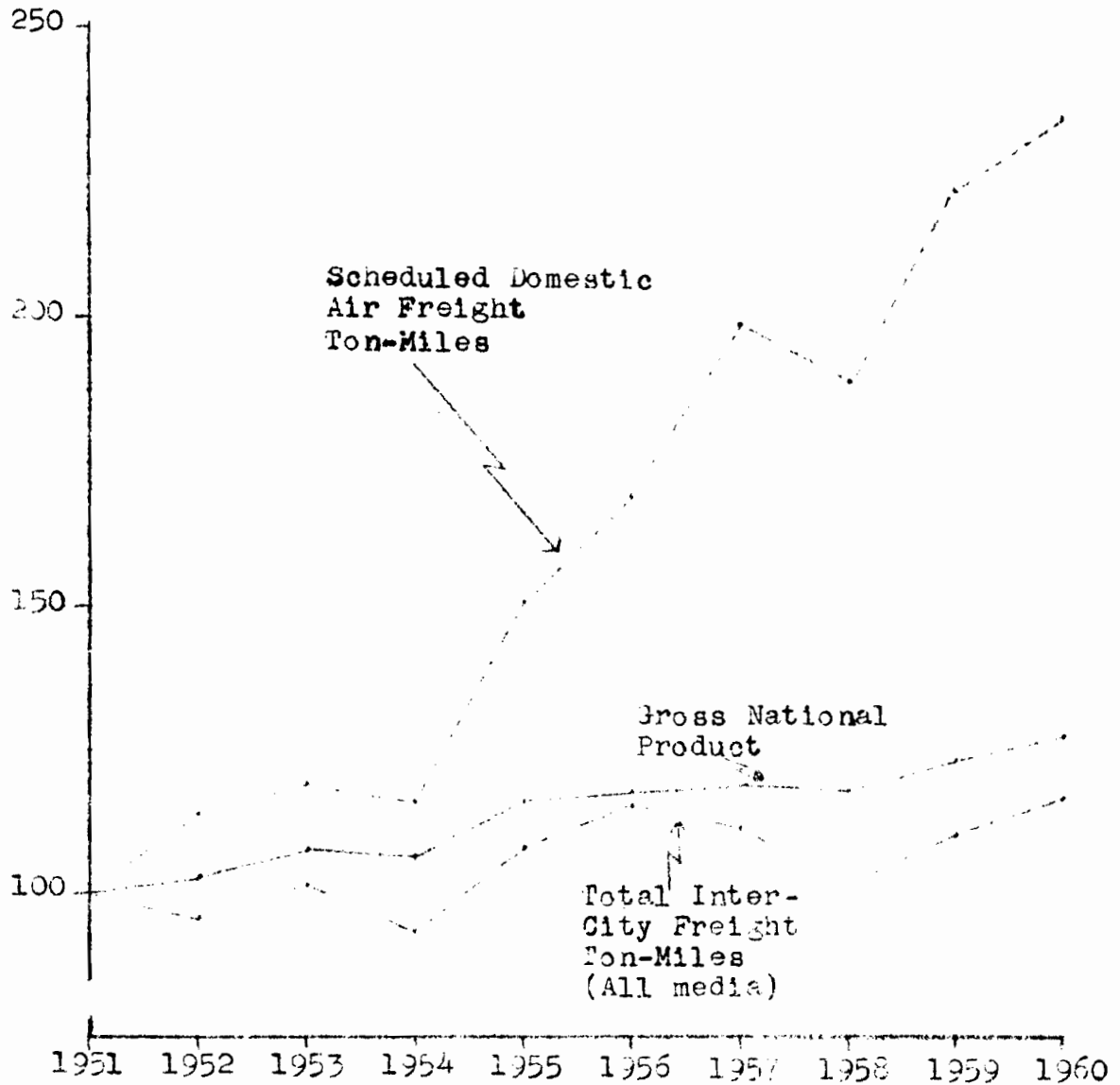
SOURCES: U.S. Department of Commerce, Statistical Abstracts of the United States, 1959, 1960 & 1961.

U.S. Department of Commerce, Historical Statistics of the United States.

Federal Aviation Agency, Statistical Handbook of Aviation - 1961.

GRAPH 6

INDEX OF GROSS NATIONAL PRODUCT (1954 Dollars), TOTAL INTER-CITY FREIGHT TON-MILES, AND SCHEDULED DOMESTIC AIR FREIGHT TON-MILES (1951 equals 100)



Graph 6 shows that air freight volumes grew as GNP grew, and that air freight volumes declined as GNP declined. It appears from the graph that there is some relationship between air freight and GNP. The exact value of the coefficient of correlation between GNP and air freight, from 1951 to 1960, has been calculated in Appendix "B" to this chapter. The value of the coefficient is 0.979, which is high.

It would seem, therefore, that GNP would be a good indicator on which to base a forecast of air freight traffic. Given the current rate of change in aviation technology, GNP probably is a good indicator for the next ten years or so. However, any radical changes in aviation technology which result in radical cost reductions would probably change the rate of growth considerably. Conversely, in the long run, no transportation medium can maintain a high rate of growth because this would imply, theoretically, that that medium would eventually carry more than the total volume of traffic. I believe, therefore, that GNP could be used as a basis for forecasting air freight traffic only for a ten-year period.

During the period from 1951 to 1960, the average revenue per ton-mile received by the domestic airlines for the carriage of freight on their scheduled services has risen. Table 10 below shows the traffic and revenue per air freight ton-mile, from 1951 to 1960.

TABLE 10

REVENUE FREIGHT TON-MILES AND AVERAGE REVENUE PER FREIGHT
TON-MILE - U.S. DOMESTIC AIRLINES, SCHEDULED SERVICES ONLY

Year	Revenue Freight Ton-Miles (millions)	Average Revenue per Freight Ton-Mile (cents)
1951	177	19.32
1952	201	20.27
1953	209	20.69
1954	205	21.77
1955	266	21.96
1956	297	20.85
1957	349	21.62
1958	337	22.53
1959	393	22.48
1960	413	23.02

SOURCES: See Table 1

It can be seen that, while traffic rose some 133% from 1951 to 1960, the average revenue received by the airlines for performing one freight ton-mile also rose, by approximately 18%.

As a matter of comparison, it will be recalled from Chapter I that, in the same period, Common Carrier Inter-City Truck traffic rose some 40%, while average ton-mile revenues increased approximately 22%.

In the period from 1951 to 1960, air freight traffic grew at a faster rate than real GNP, although average air freight rates (reflected by the carriers' average revenues per ton-mile) were rising.

In the same period truck traffic also increased while average truck rates rose. Railroad traffic decreased while average rail rates increased.

It seems logical to conclude, therefore, that the increase in air freight traffic resulted from:

1. the general rise in the level of economic activity;
and
2. the ability of the airlines to take certain traffic away from the railroads (and probably from the trucks).

APPENDIX "A" TO CHAPTER II

Regulation of the United States
Domestic Air Freight Industry

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Regulation of the United States
Domestic Air Freight Industry

General

It is the objective of this Appendix to describe the way in which the U.S. domestic air freight industry is regulated, in order that a comprehensive picture of this industry may be developed.

Functions of the Civil Aeronautics Board

In 1958 the Civil Aeronautics Act of 1938 (including its revisions) was restated and re-enacted under the name of "The Federal Aviation Act of 1958". Among other things the 1958 Act revised the functions of the Civil Aeronautics Board (CAB). This Board remains an independent federal regulatory agency, but one of its former functions - that of formulating safety regulations - was transferred to the newly established Federal Aviation Agency (FAA). By the new Act the Civil Aeronautics Board was directed to concern itself with the economic regulation of civil aviation, to adjudicate appeals from safety enforcement decisions of the Federal Aviation Agency, and to investigate accidents.

The economic regulation of civil aviation has become the routine function of the Board, and thus the CAB exercises a high degree of Government control over U.S. common air carriers.

Stated briefly, the philosophy of the 1958 Act, as it pertains to economic regulations, is one of regulated competition.

The regulation of rates by the Civil Aeronautics Board applies only to common carriers, that is, to those aircraft operators who hold themselves ready to carry persons or property for all members of the public up to the limit of the capacity of their aircraft, provided the toll is paid in legal tender. Regulation, except as regards safety, does not apply to private or to contract carriers. Furthermore, the Board has no regulatory economic control over intrastate air commerce.

Tariff Filing Requirements of the Civil Aeronautics Board

The Federal Aviation Act of 1958²⁹ states that every air carrier³⁰ shall file with the Civil Aeronautics Board a tariff³¹ or tariffs showing all rates for air transportation between points served by the carrier, or by the carrier jointly with another carrier or carriers.

29. Federal Aviation Act of 1958, Section 403(a).

30. The 1958 Act divides the term "air carrier" into two types - direct and indirect. The direct carrier is one who is directly engaged in the operation of aircraft in air transportation (e.g. an airline), whilst the indirect carrier is not thus directly engaged (e.g. an air freight forwarder or an air cargo agent).

31. A "tariff" is defined as "a schedule of rates or charges and/or provisions pertaining to rates or charges".

Adherence to these tariffs is demanded, and charges of greater or lesser amounts than set forth therein are illegal. All rebates, refunds or remittances are prohibited³².

No change can be made in any charge specified in a currently effective tariff except after thirty days' notice of the proposed change³³.

The CAB is authorized, when actual emergency or good cause is shown, to permit changes in rates, fares or other tariff provisions, on less than the thirty days notice normally required by the Act. Good cause has to be established by the filing carrier and "good cause" may include the desire to inaugurate promptly an authorized service if a delay might cause undue hardship to the filing carrier. Other grounds might be to correct errors or inconsistencies in existing tariffs³⁴.

The air carriers are required to keep currently on file with the Board, the established divisions of all joint fares, rates and charges for air transportation to which they are party³⁵. The carriers are, furthermore, required to maintain equitable divisions

32. Federal Aviation Act of 1958, Section 403(b).

33. Ibid, Section 403(c).

34. Civil Aeronautics Board, Economic Regulation 197, Part 221, Subpart P.

35. F.A.A. Act of 1958, Section 403(d).

between air carriers participating in joint agreements so that none of the participating carriers will be unduly preferred or prejudiced³⁶.

A solemn duty is placed upon the carrier to provide air transportation as authorized by its certificate. It must provide reasonable through services, and the rates which it charges must be reasonable. At the same time, it must maintain a safe and adequate service for the carriage of persons and property, including the establishment of reasonable rules, regulations and practices³⁷.

It is forbidden for an air carrier to cause any undue discrimination or undue advantage to any person, locality or kind of traffic³⁸.

Power of the CAB to Prescribe Rates and Practices to Air Carriers

The Civil Aeronautics Act of 1958 empowers the CAB to determine and prescribe the lawful rate, fare or charge in the following circumstances: whenever, after notice and hearing, upon complaint or upon its own initiative, the Board shall be of the opinion that any individual or joint rate (or fare or charge) demanded (or charged, collected, received) by any air carrier for interstate

36. Ibid, Section 404(a).

37. Ibid, Section 404(a).

38. Ibid, Section 404(b).

or overseas air transportation is (or will be) unjust or unreasonable (or unjustly discriminatory, or unduly preferential or unduly prejudicial³⁹). The Board has the power to remove discriminations⁴⁰, to suspend rates⁴¹ and to prescribe equitable divisions of joint rates, fares or charges⁴².

The Board likewise has the power, whenever required by public convenience or necessity, after notice and hearing, to establish through service and joint rates and the terms under which such through service shall be operated⁴³.

For the most part, however, there has been little direct control by the Board in fixing rates. Investigations have been made by the Board to ensure that rates are reasonable and non-discriminatory, but complaints as to unreasonableness have been settled voluntarily by informal adjustment by the carrier concerned. The carriers, it would seem, have fixed their own rates at a fair and reasonable level and in accordance with economic competitive principles. As is noted in the next chapter, the CAB has, through enactment of a minimum rate order, established a floor below which rates cannot fall, but the Board has set no maximum rate level.

39. Federal Aviation Act of 1958, Section 1002(d).

40. Ibid, Section 1002(f).

41. Ibid, Section 1002(g).

42. Ibid, Section 1002(h).

43. Ibid, Section 1002(i)

Price competition among air freight carriers does exist. The CAB is charged with ensuring that this competition stays within "reasonable" limits, as defined in the previously-noted sections of the Federal Aviation Act.

APPENDIX "B" TO CHAPTER II

Calculation of the coefficient
of correlation between Gross
National Product (in 1954
dollars) and Scheduled Domestic
Air Freight Ton-Miles

YEAR (N)	GROSS NATIONAL PRODUCT (billions of 1954 dollars) X	SCHEDULED DOMESTIC AIR FREIGHT TON-MILES (millions) Y	X x Y	$\sum X^2$	$\sum Y^2$	THEORETICAL REGRESSION VALUES Y_c	$\sum \bar{Y} - Y_c$	$\sum d^2$
1951 (1)	342	177	60534	116984	31329	160	+ 17	+ 289
1952 (2)	354	201	71154	125316	40401	192	+ 9	+ 81
1953 (3)	369	209	77121	136161	43681	230	- 21	+ 441
1954 (4)	363	205	74415	131769	42025	216	- 11	+ 121
1955 (5)	393	266	104538	154449	70756	294	- 28	+ 784
1956 (6)	401	297	119097	160801	88209	314	- 17	+ 289
1957 (7)	408	349	142392	166464	121801	333	- 16	+ 256
1958 (8)	401	337	135137	160801	113569	314	+ 23	+ 529
1959 (9)	428	393	168204	183184	154449	385	+ 8	+ 64
1960 (10)	439	413	181307	192721	170569	413	0	0
	3898	2847	1133899	1528650	876789			+2854

SOURCES: See Table 6

Line of Regression (least squares)

Equation (I) $\sum(Y) = Na + b\sum(X)$

Equation (II) $\sum(XY) = a\sum(X) + b\sum(X^2)$

(I) $2847 = 10a + 3898b$

(II) $1133899 = 3898a + 1528650b$

Subtract $\frac{1109761}{24138} = \frac{3898a + 1519440b}{9210b}$ Equation (I) x 389.8

Therefore $b = 2.61$

Substituting the value of b in Equation (I)

$2847 = 10a + 3898(2.61)$

$2847 = 10a + 10174$

$10a = 2847 - 10174$

$10a = -7327$

Therefore $a = -732.7$

Line of Regression $Y = a + b(X)$

Therefore $Y = -732.7 + 2.61(X)$

Standard Error of Estimate (S_y)

$S_y = \sqrt{\frac{\sum(d^2)}{N}}$

$S_y = \sqrt{\frac{2854}{10}}$

$S_y = \sqrt{285.4}$

Therefore $S_y = 16.9$

Standard Deviation (σ_y)

$$\sigma_y = \sqrt{\frac{\sum(Y^2)}{N} - \left(\frac{\sum Y}{N}\right)^2}$$

$$\sigma_y = \sqrt{\frac{876789}{10} - \left(\frac{2847}{10}\right)^2}$$

$$\sigma_y = \sqrt{87679 - 81054}$$

$$\sigma_y = \sqrt{6625}$$

Therefore $\sigma_y = 81.4$

Coefficient of Correlation (r)

$$r = \sqrt{1 - \frac{S_y^2}{\sigma_y^2}}$$

$$r = \sqrt{1 - \frac{285.4}{6625}}$$

$$r = \sqrt{1 - 0.043}$$

$$r = \sqrt{0.957}$$

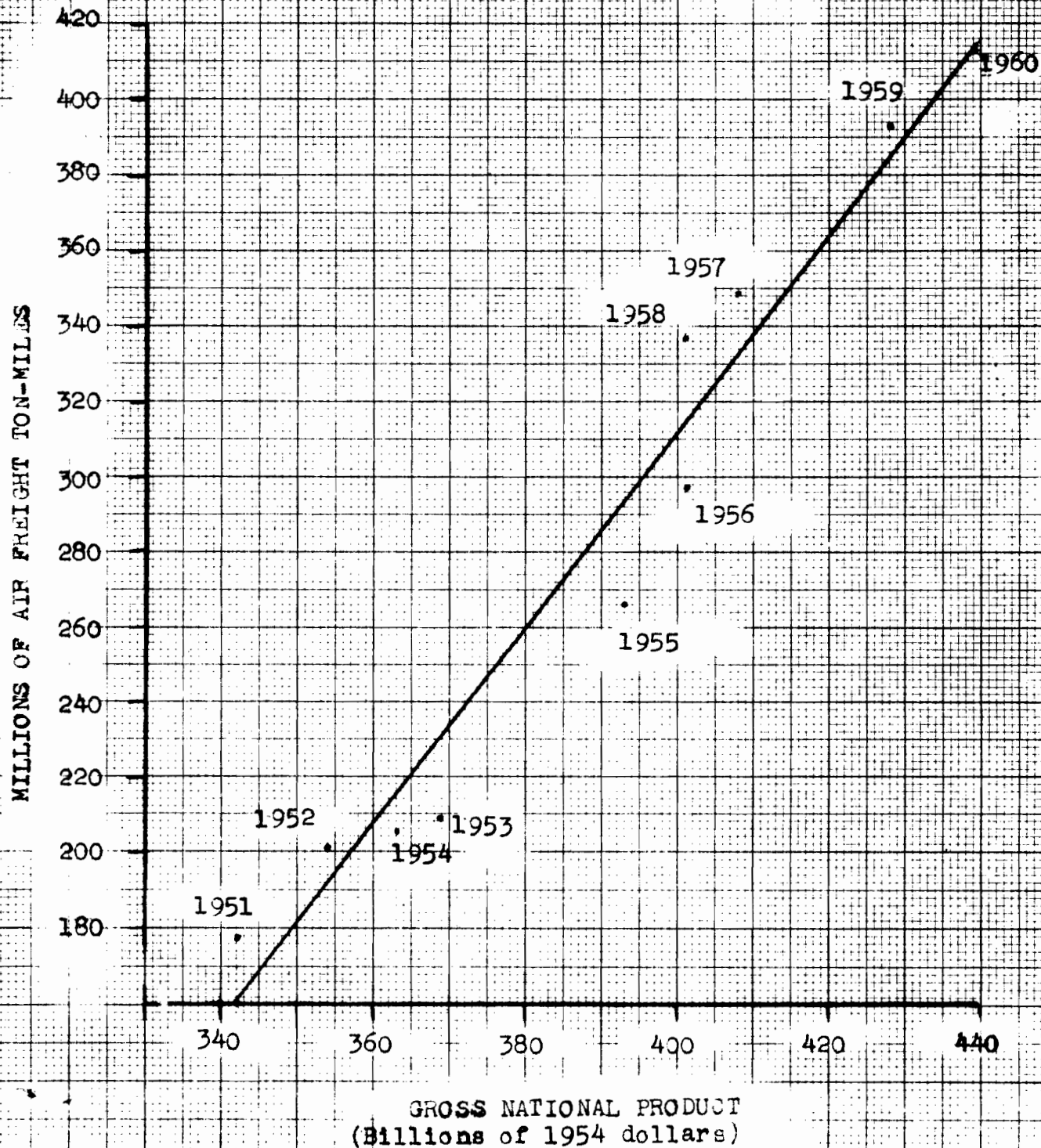
Therefore $r = 0.979$

**SCHEDULED DOMESTIC AIR FREIGHT TON-MILES
- GROSS NATIONAL PRODUCT (in 1954 dollars)**

Line of Regression

$$Y = a + b(X)$$

$$Y = -732.7 + 2.61(X)$$



APPENDIX "C" TO CHAPTER II

Definitions of the terms
used with reference to
the air transportation of
property

APPENDIX "C" TO CHAPTER II

Definitions of the terms used with reference
to the air transportation of property

In order that readers of this thesis may be aware of the meaning of the terms used with reference to the air transportation of property, these terms are defined below:

Air Cargo

"Air Cargo" is the term commonly used to describe property, other than postal material and passenger baggage, which is carried by air. The two components of air cargo are "air express" and "air freight".

Air Express

"Air Express", a term which applies exclusively to North American operations, refers to property which is carried by air and which is guaranteed prompt surface pick-up and delivery services, at no additional charge, in all cities and principal towns within the regular express agency limits.

Until 1944, the term "air express" referred to the movement by air of all property other than mail and passenger baggage. It was only in 1944 that air freight was separated from air express by the filing of the first air freight tariff.

Relatively small packages presently make-up the major portion of air express traffic, and this is so because rates for this traffic are most suited to small shipments, due to the fact that minimum charges applicable to air express are somewhat lower than air freight minimum charges.

Air Freight

"Air Freight", which is the subject of this thesis, refers to property which is carried by air and which does not fall under the heading of either "Air Mail" or "Air Express". Some 600 United States and Canadian cities are directly provided with air freight service, whilst surface pick-up and delivery facilities provide service to more than 2,000 other points. Additionally, scheduled domestic services provide air freight connections with flights to all overseas points. Surface pick-up and/or delivery service, during normal business hours, is available at every city served by a scheduled air carrier.

Air Mail

"Air Mail", as the name implies, refers to postal material which is carried by air. Most countries have encouraged the development of air mail services by establishing contractual arrangements for the carriage of mail which are profitable to the air carriers. Each nation sets its own domestic rates, while the Universal Postal Union sets international rates.

BIBLIOGRAPHY

- Air Transport Association of America, Facts and Figures about Air Transportation - 1962, (Washington, 1962).
- Federal Aviation Agency, Statistical Handbook of Aviation - 1959, (U.S. Government Printing Office, Washington, 1959).
- Federal Aviation Agency, Statistical Handbook of Aviation - 1960, (U.S. Government Printing Office, Washington, 1960).
- Federal Aviation Agency, Statistical Handbook of Aviation - 1961, (U.S. Government Printing Office, Washington, 1961).
- Frederick, J. H., Commercial Air Transportation, (Richard D. Irwin, Inc., Homewood, 1955).
- Frederick, J. H., Commercial Air Transportation, (Richard D. Irwin, Inc., Homewood, 1961).
- Roadcap & Associates, World Airline Record, (Roadcap & Associates, Chicago, 1955).
- Thomas, A. J., Economic Regulation of Scheduled Air Transport, (Dennis & Co. Inc., Buffalo, 1951).

CHAPTER III

AIR FREIGHT RATES AND AIR FREIGHT COSTS

CHAPTER III

AIR FREIGHT RATES AND AIR FREIGHT COSTS

GENERAL

Having reviewed the historical development of the air freight industry, I consider it desirable that some of the cost and pricing practices of the industry be studied, since no examination of any industry can be regarded as complete unless the ways in which the costs of providing the goods or services which it produces are discussed, and unless its pricing practices are understood.

It is the objective of this chapter, therefore, to discuss the pricing characteristics of the U.S. domestic air freight industry, and the costs of that industry.

AIR FREIGHT RATES

Return on Investment

As in other industries, the managements of airlines are interested in maximising profits. One of the objectives of airline regulation (by the CAB) is to ensure that the airlines do not earn profits in excess of what is regarded as a "fair" rate of return on their investment.

In the Federal Aviation Act of 1958 no mention is made of a specific rate of return. The Act simply places before the Board five principles of rate regulation. In regulating rates, the CAB is required to take into consideration:

- (1) the effect of the rates upon the movement of traffic;
- (2) the need, in the public interest, of adequate air transport service at the lowest rates consistent with such service;
- (3) the standards of air transport service prescribed by law;
- (4) the inherent advantages of transportation by aircraft;
- (5) the need of each carrier for revenue sufficient to enable such carrier, under honest, economical, and efficient management, to provide adequate and efficient air-carrier service.

These rules and other provisions of the Act prescribe the governing principles, but an exact method of fixing such rates is not provided for, "leaving extensive discretionary powers to the Board in deciding just what are fair and reasonable rates in the public interest"⁴⁴.

However, although the Federal Aviation Act does not specify what constitutes a "fair" return on investment for air

⁴⁴. A. J. Thomas, Economic Regulation of Scheduled Air Transport, (Buffalo, Dennis & Co. Inc., 1951), p. 121.

carriers, the CAB itself has defined such a return for the domestic trunk airlines. No such specific definition has been evolved to cover only the air freight operations of the carriers, but it is still useful to examine the CAB recommendations on rate of return.

In 1960 the Civil Aeronautics Board released the results of the "General Passenger Fare Investigation Case". These findings were the outcome of four years of research into the matter of passenger fares. In its final decision in this case, the Board concluded that specific rates of return would be required by the domestic airlines. For example, a rate of return of 10.25% would be required by American Airlines, Eastern Airlines, United Airlines and Trans World Airlines. A rate of return of 11.25% is prescribed for the other eight (intermediate)trunk lines. This means that, on an average, the desirable rate of return for the group would be 10.5%. Recent earnings of these airlines, as shown in Table 11 below, have been well below the standards then established.

TABLE 11

Return on Investment

Domestic Trunk Airlines, 1955 - 1960

Year	Net Income ¹ (Millions)	Total Investment ² (Millions)	Rate of Return on Total Investment ³
1955	\$ 69.9	\$ 590	11.9%
1956	68.0	711	9.6
1957	43.4	904	4.8
1958	69.3	1,067	6.5
1959	94.0	1,321	7.1
1960	44.0	1,580	2.8

1. The CAB defines Net Income as income after income tax and special items, but before interest expense.
2. The CAB defines Total Investment as the average (arithmetic mean) of five quarterly balances of stockholder equity, long-term debt and advances from associated companies representing investment.
3. The CAB defines Rate of Return on Total Investment as the ratio (expressed as a percentage) of net income to total investment.

SOURCE: Civil Aeronautics Board (CAB), Handbook of Airline Statistics - 1960 Edition.

It is not the objective of this thesis to enter into a detailed analysis of the reasoning behind the CAB's decision in specifying particular rates of return for the domestic airlines. It is assumed that the CAB, after careful examination of all the relevant data, recommended rates of return on investment which, if achieved, would enable the airline to keep in a reasonable condition of financial health.

It is believed that the determination of the condition that really represents "financial health" is a task of considerable size, and not one that needs to be examined in detail here. However, the data in Table 12 below, which shows the rate of return on investment in other industries, seems to indicate that the average rate of return for trunk airlines in 1960 (2.8%) represents a state of bad financial health, since the 1960 figure for the airlines is lower than any rate of return figure in the table.

TABLE 12

RETURN ON INVESTMENT FOR SELECTED INDUSTRIES
(net income plus interest and fixed
charges as a percent of capitalization)
AVERAGE 1950 - 1955

Industry	% Return
Railroads (25 Class I systems)	4.9
Public Utilities	5.5
Telephone	6.0
Cement	13.1
Chemicals	19.8
Drugs	16.8
Petroleum, Integrated	13.7
Nonferrous Metal	8.3
Steel	10.0
Motor Cars	22.7
Tobacco	8.9
Distilling	7.1
Baking	9.3
Meat Packing	5.5
Sugar Refinery	6.5
Mail Order	11.6
Chain Stores, Variety	9.0
Department Stores	9.6
Chain Stores, Food	10.1

SOURCE: CAB, General Fare Investigation, (Docket No. 8008),
Bureau Counsel BC 113.8 (Revised)

What was noted by Peck in relation to the difficulty of determining adequate profit levels for the U.S. railroads and his comment about the 4.9 per cent railroad return on investment shown in Table 12 is equally applicable to the U.S. airlines. Peck noted that the problem of establishing a necessary profit level is an extremely complex one, and that "the evidence (regarding the rate of return on investment for selected industries) at least strongly suggests too low a level of profits in the railroads to meet necessary capital requirements and the investor's legitimate income claims"⁴⁵.

In view of the airlines' 1960 return on investment (2.8%) it is, therefore, considered reasonable to assert that the industry in that year was receiving less than a "fair" return on its investment.

Action intended to assist in remedying this situation was taken early in 1962 when the domestic airlines requested and were granted permission to increase passenger fares by 3%.

Air Freight Rate Policy

Prior to 1947, there was no clear policy on air freight rates. As previously noted, air freight, as distinct from

45. M. J. Peck, J. R. Meyer, J. Stenason, C. Zwick, The Economics of Competition in the Transportation Industries, (Cambridge, Harvard University Press, 1960), p. 186.

air express, did not come into being until 1944, when American Airlines filed the first pure air freight tariff.

From 1944 to 1947, the confused freight rate situation reflected the situation in the industry, where a great number of air freight carriers - large and small, irregular and regular, certificated and non-certificated - were competing for business.

In 1947, therefore, the Civil Aeronautics Board was faced with the necessity of deciding on a firm policy in regard to the status of the freight (or "all-cargo") carriers, and a firm policy in regard to freight rates.⁴⁶

In the summer and fall of 1947 rates reached new low levels - levels which were regarded by the CAB as not meeting "the need of each carrier for sufficient revenue to enable such carrier, under honest, economical and efficient management, to provide adequate and efficient air carrier service". Since the Board believed that this principle (one of the five the CAB are directed to observe in regulating rates) was not being observed, it interceded by suspending a number of newly filed rate tariffs. The Board subsequently instituted an investigation into the entire air freight rate structure, in the case known as the "Air Freight Rate Case of 1948".

46. The CAB policy on the status of the freight carriers has already been described.

Within the industry it was agreed that, as a general proposition, air cargo rates should bear a "reasonable relationship" to the cost of providing the service. Serious differences of opinion, however, existed between the all-cargo operators and the "combination" airlines (i.e. those airlines which carry both passengers and freight) as to what formula would most nearly determine the "cost" to which airline cargo rates should bear a "reasonable relationship".

The airlines, both large and small, which relied primarily upon passenger and mail operations, contended that air freight was a "by-product service"⁴⁷ of these operations. The larger passenger carriers assumed that the overall economics of any flight were determined before a decision to carry freight or not to carry freight was made. Any residual space available after the passenger, mail and express load had been determined, was allotted to air freight. The only cost incurred, it was contended, was for loading and unloading the freight. When profits were added to this cost figure, tariffs could be determined. The smaller passenger carriers, who generally performed their operations at lower load factors (i.e. at lower capacity utilization levels), held that little or no cost was incurred in hauling freight. In their operations, substantial unused freight space could always be guaranteed, and so, with little or no additional cost involved, air

47. World Airline Record, (Chicago, Roadcap & Associates, 1955), p. 286.

freight contributed to overall profits. The application of this "by-product" cost theory, advocated by both large and small passenger carriers, would have resulted in extremely low air freight tariffs.

The second cost theory was put forward by those seeking certification as all-cargo carriers. They argued that freight rates should reflect the fully-allocated cost of an all-cargo operation. Based upon this theory, the Total Operating Cost, composed of Direct Operating Cost and Indirect Operating Cost, plus profit, yielded the minimum freight tariff rates.

The Civil Aeronautics Board accepted this latter theory as a guide for tariff making because it felt that air freight must be provided with a realistic, fully-allocated cost basis if it were to develop its potential. The reasoning behind the CAB's theory was that, unless air freight rates reflected fully-allocated freight aircraft operating costs, the development of air freight traffic would be continually tied to development of air passenger traffic.

In 1948, when the CAB enunciated this policy, there was a general feeling that the U.S. domestic air freight industry was on the threshold of a great "break-through" which would see air freight rates of growth exceed those of passenger growth. It was expected, therefore, that the freight capacity available in combination passenger/cargo aircraft would not be sufficient to carry the freight which would be forthcoming.

The CAB, therefore, in 1948 issued a minimum rate order which was designed to ensure that air freight rates should not fall below the fully-allocated operating costs of freight aircraft. The CAB's order set a minimum rate of 16 cents per ton-mile for the first 1,000 miles that a shipment was carried and a rate of 13 cents per ton-mile over and above that distance. To help solve the serious backhaul problem (generally from West to East and from South to North), the Board issued supplemental orders permitting further reductions in rates in order to stimulate the flow of certain commodities to fill otherwise empty space on return flights.

If the expectations with regard to the growth of air freight had, in fact, been realized, the CAB's air freight rate policy would seem to have been justified. In fact, however, as shown in Table 13 below, the rate of growth of air freight from 1951 to 1960 was less than that of passenger growth.

TABLE 13
GROWTH OF SCHEDULED DOMESTIC AIR
PASSENGER-MILES AND AIR FREIGHT TON-MILES

Year	Revenue Air Passenger-Miles (millions)	% Change	Index (1951 = 100)	Revenue Air Freight Ton-Miles (millions)	% Change	Index (1951 = 100)
1951	10,566	-	100	177	-	100
1952	12,528	+ 18	118	201	+ 14	114
1953	14,760	+ 18	139	209	+ 4	118
1954	16,768	+ 14	158	205	- 2	116
1955	19,819	+ 18	187	266	+ 30	150
1956	22,361	+ 13	211	297	+ 12	168
1957	25,339	+ 13	239	349	+ 18	197
1958	25,343	0	239	337	- 3	190
1959	29,269	+ 15	277	393	+ 17	222
1960	30,375	+ 4	287	413	+ 5	233

SOURCE: Federal Aviation Agency, Statistical Handbook of Aviation - 1961

In view of the actual performance of air freight and passenger traffic in the decade from 1951 to 1960, it appears that, during this period, the CAB's "fully-allocated" cost policy for air freight was not successful in assisting in the expected (but un-realized) air freight "break-through".

Passenger traffic grew faster than air freight traffic. As more passenger aircraft (and overall capacity) became available to carry the additional passenger traffic, more freight capacity automatically became available also.

Table 14 below shows the growth of available capacity from 1951 to 1960, and the extent to which this capacity was used during the period.

TABLE 14
TOTAL CAPACITY AVAILABLE AND
TOTAL CAPACITY USED, IN SCHEDULED
DOMESTIC REVENUE SERVICE

Year	Available Capacity (millions of ton-miles)	% Change	Total Capacity ¹ Used (millions of ton-miles)	Capacity Used as Percentage of Available Capacity
1951	2,052		1,233	60
1952	2,493	+ 21	1,447	58
1953	3,005	+ 20	1,685	56
1954	3,427	+ 14	1,903	56
1955	4,008	+ 17	2,247	56
1956	4,543	+ 13	2,520	55
1957	5,324	+ 17	2,800	53
1958	5,454	+ 2	2,832	52
1959	6,195	+ 14	3,271	53
1960	7,292	+ 17	3,538	49

1. That is, by passengers, excess baggage, mail, express and freight.

SOURCE: Federal Aviation Agency, Statistical Handbook of Aviation - 1961

From Table 14 above it can be seen that, between 1951 and 1960, available capacity increased by 255%. Reference to Table 13 shows that, during the same period, air freight volume increased only 233%.

Thus, it appears reasonable to assume that, during this period, because passenger traffic grew more than freight traffic, and because available capacity grew more than freight traffic, the unused freight-carrying capacity of the industry increased.

In other words, there appears to have been a chronic state of excess freight capacity during the period.

Under these conditions, and if the CAB's sole concern had been to encourage short-run increases in freight traffic, up to the limit of passenger aircraft capacity, a freight rate policy based upon the incremental cost of carrying freight in passenger aircraft would probably have been more successful than the "fully-allocated" cost policy they actually followed.

However, an "incremental cost" policy has certain disadvantages. Had such a policy been implemented in 1948, several all-cargo airlines would probably have gone out of business shortly thereafter. This could have been politically disadvantageous.

Additionally, in the long run, if it is the nation's desire to encourage the growth of an air cargo industry which does not depend upon the passenger industry for its existence and growth,

the rate policy for the cargo industry must be based upon fully-allocated cargo costs.

In 1953, Slick Airways Inc. filed a petition with the CAB asking that minimum rates for air freight be increased by 25 per cent. The other most important all-cargo carrier concurred in this request. The CAB granted this increase on the grounds that the costs of carrying freight on all-cargo aircraft had risen sharply since establishment of the minimum rates in 1948.

The recent decision (September, 1961) by the CAB to terminate the minimum rate order is largely a result of pressure by the largest domestic all-cargo carrier (The Flying Tiger Line) to reduce rates in relation to the lower operating costs provided by the newly-introduced, larger, turbine-powered, all-cargo aircraft. Specifically, it was the pending introduction of the Canadair CL-44 into regular all-cargo service with the Flying Tiger Line which helped to hasten the revocation of the minimum freight rate order.

The CAB felt that, with the introduction of these new aircraft into scheduled cargo service and the rapid increase in cargo capacity, it was important that the industry have maximum flexibility and opportunity to experiment with promotional rates. At the same time, the CAB reiterated its philosophy that it did not intend to permit air freight rates to fall below the economic levels made possible by the new, lower-operating-cost aircraft, in spite of the revocation of the minimum freight rate order.

The Flying Tiger Line used the cost of operating its new freight aircraft as the basis for constructing a new class rate tariff. It is believed that this is the first example of a freight tariff being based upon the cost of operation of an aircraft. Other air freight tariffs are not based on any single principle except, until recently, that no rate they quoted could be lower than the level specified in the Minimum Rate Order. Prior to 1947, the CAB had exercised little control over rates for the carriage of property, since it had been considered that these rates were largely influenced by rail express rates. A description of the new Flying Tiger Line tariff follows.

The Flying Tiger Line's New Tariff

As products vary in size, shape and density (pounds per cubic foot), the air carrier has traditionally experienced the problem of fully utilizing aircraft capacity. Under air freight tariffs other than the one discussed here, aircraft whose available space is fully taken up with a high proportion of light and bulky commodities do not produce payload weights sufficient to recover costs. Other tariffs do take account of a commodity's density, there being a general rule that, if a commodity has a displacement of more than 250 cubic inches per pound of its weight, then the rate charged for that commodity is the rate per pound applied to each 250 cubic inches of its displacement. However, even if this rule were strictly enforceable, it would not save an air carrier from losing money on an operation where an aircraft carried bulky goods almost

exclusively. The 250 cubic inch rate is only designed to cover what is considered to be the statistically infrequent shipment in an otherwise "normal" cargo mix. The 250 cubic inch rate would be inadequate to cover costs if the full cargo load were made up of bulky shipments.

Therefore, under such tariffs, if air carriers are to maintain a profitable operation, a proper ratio of dense and bulky commodities must be carried. Obviously, this presents a problem since it means that carriers must be very selective in what they carry in order to assure reasonable revenues. They must find a means of controlling proportions of light and dense freight. An alternative to this selection process lies in devising a pricing system that will produce rates sufficient to recover costs, irrespective of commodity size, shape or density. The concept that an airline can select the freight it wishes to carry is difficult to put into practice, since a common carrier holds itself out to the general shipping public to transport all types of commodities. The alternative system, therefore, through a cost-oriented tariff, seemed, to the Flying Tiger Line, to be a more logical approach in pricing air freight service.

As the ratio of space to weight is of prime importance, the most fundamental consideration was to build a tariff predicated on a rational relationship between the price charged for the service and the cost incurred in performing that service. "The use of density

as a common criterion for all commodities has been the primary means of accomplishing this⁴⁸. A "class rate" system based upon density was established.

However, although it was desired to base the class rate structure upon the related costs of service, it was also desired that the new tariff be versatile enough to take advantage of varying market demands. Specific commodity rates (which represent exceptions to the "cost-of-service" principle upon which the class rates are based), which are designed to generate volume movements through individual negotiation and which are tailored to specific market requirements, were therefore incorporated into the new tariff.

In the establishment of the class rate (density) system, the first step was to determine the cost of operation. For eighteen months before they received their new aircraft, the Flying Tiger Line (hereafter referred to as "Tigers") conducted detailed research into all costs associated with operation of the aircraft.⁴⁹ Thus, using the aircraft and engine manufacturer's guaranteed performance and cost figures, and using their own known costs, the Tigers were able to determine, with a high degree of accuracy, their total costs⁵⁰ for operating the aircraft over the routes on their system.

48. Application of the Flying Tiger Line Inc. Tariff, (Burbank, The Flying Tiger Line Inc., Oct. 1961), p. 1-1.

49. A discussion of air freight costs will be found on page 102 of this thesis.

50. All operating costs plus an allowance for profit.

Also prior to receiving their new aircraft, the Tigers had conducted a detailed, twelve-month, one hundred per cent sample survey of their own traffic. They, therefore, knew the characteristics of their existing traffic in great detail. They also had joined in sponsoring an extensive study of the market potential. They, therefore, had a reasonably good idea of the areas in which potential air freight traffic existed.

For purposes of illustrating the mechanics of establishing the class rate structure, the following explanation is given.

Seven Class Rates were established. These are as follows and were so established as a result of investigation of a particular motor truck tariff system, which is discussed later.

<u>Class Rate</u>	<u>Density (lbs./cu. ft.)</u>
2 to 1	0 - 3
$1\frac{1}{2}$ to 1	3 - 4
1	4 - 5
2	5 - 10
3	10 - 15
4	15 - 20
5	20 and over

Within the Class Rate system, weight breaks (weights of shipment sizes above which lower per pound rates are in effect) were established at 100 pounds and 5,000 pounds. For example, the rate for a single shipment weighing less than 100 pounds, from New York to Los Angeles, could be 30 cents per pound. The rate for a shipment weighing more than 100 pounds but less than 5,000 pounds

could be 25 cents per pound. The rate for a shipment weighing more than 5,000 pounds could be 20 cents per pound.

The following aircraft performance and average cost figures were assumed:

Aircraft Payload Capacity: 64,000 lbs.

5,066 cubic feet (useable)

Airline's annual system-wide load factor (i.e. actual payload as percent of payload capacity), assumed as a result of studies of existing and potential markets:

70%⁵¹

Aircraft Average Total Costs over a year (including profit), established as a result of detailed study:

\$3.07 per aircraft mile

For an aircraft loaded with Class 1 commodities (density of 4 to 5 lbs.), with an average assumed density of 4.5 lbs.,

51. Market studies conducted by the airline convinced them that there would be enough traffic available to provide average load factors of about 70% per flight. In U.S. domestic operations, system-wide load factors much in excess of 70%, for extended periods, are regarded as an indication that the carrier is providing inadequate service to the public. Very high average load factors, in a country where there are distinct imbalances in the direction of flow of commodities, could mean that flights out of the heavy traffic stations are turning away a lot of business. The art of rate-making has not yet reached that state which will enable a carrier to ensure that a particular traffic station will generate a 100% load factor for his vehicles, rather than a 120% or 150% load factor.

the maximum payload would be $4.5 \times 5,066$ (useable number of cubic feet capacity), or approximately 22,800 lbs. At a 70% load factor, this would mean an actual payload of 15,960 lbs., or 7.98 short tons.

Therefore, to cover the aircraft costs, the cost of carrying one ton of Class 1 commodities for one mile should be \$3.07 divided by 7.98, or 38.47 cents (per ton-mile).

This system was used to calculate the ton-mile revenue required from Class 1, Class 2 and Class 5 traffic. Class 3 and 4 ton-mile revenues were obtained by spacing them equally between Class 2 and Class 5 rates. Class $1\frac{1}{2}$ to 1 and 2 to 1 are percentage relationships to Class 1 (i.e. 150% and 200% of Class 1 respectively), and were refined from Class 1, due to their extreme bulk characteristics.

The following table shows this Class Rate tariff system applied to the New York - Los Angeles route.

TABLE 15

FLYING TIGER CLASS RATE SYSTEM
NEW YORK - LOS ANGELES

Class Rating	Density Range (lbs.)	Density Average (lbs.)	Maximum Payload (lbs.)	70% Maximum Payload (lbs.)	Revenue Return Per Ton-Mile (cents)	Revenue Per 100 lbs.	Revenue Per Aircraft-Mile
2 to 1	0 to 3	2.0	10,132	7,092	76.95	\$ 94.30	\$ 2.73
1½ to 1	3 to 4	3.5	17,730	12,411	57.71	70.73	3.58
1	4 to 5	4.5	22,800	15,960	38.47	47.15	3.07
2	5 to 10	7.5	38,000	26,600	23.08	28.28	3.07
3	10 to 15	12.5	63,325	44,328	19.96	24.46	4.42
4	15 to 20	17.5	64,000	44,800	16.83	20.63	3.77
5	20 & over	20.0	64,000	44,800	13.71	16.80	3.07

From the above table it can be seen that the arbitrary way in which the ton-mile revenues for Classes 3, 4, $1\frac{1}{2}$ to 1, and 2 to 1 were apparently selected, could result in some unsatisfactory revenue aircraft-mile situations. If an aircraft were to carry a 70% payload of commodities with the Class Rating of 2 to 1, between New York and Los Angeles (air distance of 2,451 statute miles), the revenue per aircraft-mile would be only \$2.73, while the cost, as previously noted, would be \$3.07 per aircraft-mile.

In order to utilize a density rating system, a means must be provided to classify all the different types of articles that could conceivably be offered for transport. Carriers must either obtain densities through weight and measurement or find a source which will furnish this information. To weigh and measure each commodity is obviously costly and operationally impractical. To employ a source which will supply this data is then the most practical approach. This is normally accomplished by means of a classification guide which specifically describes commodities by name, density and other pertinent characteristics and establishes a rating for each article. The Co-ordinated Freight Classification, published by the New England Motor Rate Bureau, is especially suitable for this purpose, because its ratings are based primarily on density. This classification was therefore accepted and incorporated into the Tigers' tariff system, and it provided the basic density scale from which the class rates were derived. Articles are named in the classification (approximately 10,000 articles, in approximately

26,000 different configurations - i.e. assembled, knocked down, etc.) and ratings are listed against each article. Class rates are computed for each rating, and together they form the basic tariff structure.

It has been thought necessary to examine the Tigers' new class rate tariff structure in some detail because this airline has done more freight rate research than any other U.S. air carrier, and more important because, in the Fall of 1961, the Civil Aeronautics Board seemed to regard the Tigers' tariff levels as those by which to measure tariff proposals of other airlines.

This was so because the Tigers is the largest domestic all-cargo airline (actually, the world's largest all-cargo airline), and the only airline which is presently proposing to operate new freight aircraft (as opposed to converted passenger aircraft) in domestic common carriage. These new aircraft have operating costs significantly lower than any other aircraft presently carrying freight,⁵² and the Tigers' class rates are based on the cost of operating these aircraft. The CAB, bearing in mind the principle that air freight rates should reflect the fully-allocated costs of an all-cargo operation,⁵³ thus seemed to regard the Tigers' tariff as the yardstick by which to measure "fully-allocated costs", and, therefore, the relative reasonableness of other tariff proposals.

52. See discussion of aircraft costs on page 102 of this thesis.

53. See previous discussion on this, on page 84 of this thesis.

Thus, the CAB, in accepting the Tigers' tariff as a yardstick, appeared also to be accepting the implication that minimum rates should be based upon the operating costs of the most efficient vehicle. This, of course, has implications for the aircraft manufacturing industry and the airline industry. For the manufacturers it means that if the policy is persistently followed, a new aircraft type with lower operating costs can be expected to receive "rate" support from the Board. This would be expected to encourage the advance of aviation technology. From the airlines' point of view, however, the implication could be less favourable. It could mean that an airline which today has the most efficient freight aircraft, with today's minimum rates based upon its operating costs, could tomorrow be in a money-losing position if one of its competitors acquired new, lower-operating cost vehicles. However, whilst this is possible, the present state of knowledge in aviation technology, and the rate of increase of this knowledge, seems to indicate that no major advance (such as the advance represented by the advent of turbine power) will take place during the next few years. Therefore, assuming that potentially rewarding volumes of traffic exist, airlines which are presently operating turbine-powered cargo aircraft should be able to expect several years of profitable operation from these aircraft before they become obsolete.

AIR FREIGHT COSTS

CAB Cost Classifications

Air freight rates are, as previously noted, to be based upon the "fully-allocated costs of all-cargo aircraft".⁵⁴ It is therefore necessary to determine, as far as is possible, what these costs are.

The CAB requires that each U.S. airline report its financial position to the Board in a specific manner. The way in which such information is to be passed to the CAB is laid down in a CAB document entitled "Uniform System of Accounts and Reports for Certificated Route Air Carriers".⁵⁵

Under this system, the operating expenses of all U.S. airlines (except helicopter airlines, some of the smaller airlines, and some of the Alaskan and Pacific Island airlines) are broken down into seven main classifications. These classifications are:

CAB Account No.

5100	Flying Operations
5400	Maintenance
5500	Passenger Service
6400	Aircraft and Traffic Service
6700	Promotion and Sales
6800	General and Administrative
7000	Depreciation and Amortization

54. See page 88 of this thesis.

55. Federal Register, Washington, May 16, 1961

There follows here a brief explanation of each of the seven classifications.

5100 Flying Operations: This classification includes "expenses incurred directly in the in-flight operation of aircraft and expenses attaching to the holding of aircraft and operational personnel in readiness for assignment to an inflight status".⁵⁶ Included under this classification are:

Aircrew Costs - salaries and fringe benefit costs.

Training Costs - salaries and fringe benefit costs of aircrew training personnel.

Personnel Expenses - travel and related expenses incurred by aircrew.

Aircraft Fuels and Oils - the cost of fuels and oils used in flight operations.

Insurance Costs - cost of public liability and property damage and all other general insurance, except

56. CAB, Uniform System of Accounts and Reports for Certificated Route Air Carriers, p. 4249.

passenger, freight and
employee insurance.

5400 Maintenance: This classification includes "all expenses, both direct and indirect, incurred in the repair and upkeep of property and equipment as may be required to meet operating and safety standards".⁵⁷ It includes the direct cost of labour, materials and outside services, and maintenance overhead or other costs associated with maintenance operations, regardless of the location at which incurred. This classification is broken down into two sub-classifications:

Direct Maintenance (CAB Account No. 5200) -

costs of labour, materials and outside services consumed directly in periodic aircraft maintenance operations, and the maintenance and repair of certain property and equipment, regardless of the location.

Maintenance Burden (CAB Account No. 5300) -

all overhead and general expenses incurred directly in the activities involved in periodic aircraft maintenance operations, and in the maintenance and repair of certain other property and equipment, but not including expenses

57. Ibid, p. 4249

attributable to operations other than current
air transport operations.

5500 Passenger Service: This classification includes "all expenses chargeable directly to activities contributing to the comfort, safety and convenience of passengers while in flight and when flights are interrupted".⁵⁸ It does not include expenses incurred in boarding or dis-embarking passengers, or in securing and selling passenger transportation and caring for passengers prior to flight.

6400 Aircraft and Traffic Service: This classification includes "the compensation of ground personnel and other expenses incurred on the ground incident to the protection and control of the in-flight movement of aircraft, scheduling and preparing aircraft operational crews for flight assignment, handling and servicing aircraft while in line operation, servicing and handling traffic on the ground, and in-flight expenses of handling and protecting all non-passenger traffic including passenger baggage".⁵⁹ This classification, for the large air carriers (both passenger and all-cargo), is broken down into three sub-classifications:

58. Ibid, p. 4250

59. Ibid, p. 4250

Aircraft Servicing (CAB Account No. 6100) -

compensation of ground personnel and other expenses incurred on the ground incident to the protection and control of the in-flight movement of aircraft.

Traffic Servicing (CAB Account No. 6200) -

compensation of ground personnel and other expenses incurred on the ground incident to handling traffic of all types and classes on the ground, subsequent to the issuance of documents establishing the air carrier's responsibility to provide air transportation.

Servicing Administration (CAB Account No. 6300) -

expenses of a general nature incurred in performing supervisory or administrative activities relating solely and in common to "Aircraft Servicing" and "Traffic Servicing".

6700 Promotion and Sales: This classification includes "expenses incurred in creating public preference for the air carrier and its services; stimulating the development of the air transport market; and promoting the air carrier or developing air transportation generally. It shall also include the compensation of personnel and other expenses incident to documenting sales; expenses incident to

controlling and arranging or confirming aircraft space for traffic sold; expenses incurred in direct sales solicitation and selling of aircraft space; and expenses incurred in developing tariffs and schedules for publication".⁶⁰ This classification, for the large air carriers (both passenger and all-cargo), is broken down into two sub-classifications:

Reservations and Sales (CAB Account No. 6500) -

expenses incident to: direct sales solicitation, documenting sales, controlling and arranging or confirming aircraft space sold, developing tariffs and schedules for publication, operation of city traffic offices.

Advertising and Publicity (CAB Account No. 6600) -

expenses incurred in: creating public preference for the air carrier and its services, stimulating development of the air transport market, promoting the air carrier or developing air transportation generally.

60. Ibid, p. 4250

6800 General and Administrative: This classification includes "expenses of a general corporate nature and expenses incurred in performing activities which contribute to more than a single operating function, such as general financial accounting activities, purchasing activities, representation at law, and other general operational administration, which are not directly applicable to a particular function".⁶¹

7000 Depreciation and Amortization: This classification includes "all charges to expense to record losses suffered through current exhaustion of the serviceability of property and equipment due to wear and tear from use and the action of time and the elements, which are not replaced by current repairs, as well as losses in serviceability occasioned by obsolescence, supersession, discoveries, change in popular demand, or action by public authority. It shall also include charges for the amortization of capitalized development and preoperating costs, and other intangible assets applicable to the performance of air transportation".⁶²

61. Ibid, p. 4250

62. Ibid, p. 4251

Analysis of Direct Operating Costs

In order to provide a means for comparing the operating economics of different aircraft under a standard set of conditions, and to assist airlines and aircraft manufacturers in assessing the economic suitability of a particular aircraft on a particular route, there has been devised a standardized method for estimating the "Direct Operating Costs" (DOC) of an aircraft. This method⁶³ divides DOC into three main components:

- 1) Flying Operations
- 2) Direct Maintenance
- 3) Depreciation - Flight Equipment

Under Flying Operations are included these elements, which were previously described:

Crew Costs (consisting of Aircrew Costs, Training Costs and Personnel Expenses)

Aircraft Fuel and Oil Costs

Insurance Costs

Direct Maintenance is the CAB Account No. 5200 previously described.

Depreciation - Flight Equipment is part of the CAB Account No. 7000 previously described.

63. Air Transport Association of America, Standard Method of Estimating Comparative Direct Operating Cost of Transport Airplanes, (Washington, June, 1960)

Crew Costs include the crew's annual base pay plus additional pay based on: number of hours flown in excess of minimum, hours flown in daytime and night time, aircraft speed, aircraft weight, etc.

In planning an aircraft operation, for cost purposes it is assumed that the aircraft will fly a specified number of hours per year, this number being based upon consideration of the aircraft's operating characteristics and scheduling requirements. Aircraft fuel and oil costs will vary directly with the number of hours flown, as will direct maintenance, direct maintenance generally being a function of aircraft hours flown. Given the aircraft's annual utilization in hours, it is therefore possible to calculate hourly costs for fuel and oil and for direct maintenance.

Given the number of hours that an aircraft is planned to fly in one year, it is possible to calculate the hourly insurance cost and the hourly flight equipment depreciation cost for that aircraft. Given the aircraft's characteristics with regard to speed, weight, scheduling requirements, etc., it is possible to calculate the hourly crew cost.

These costs (Crew, Fuel and Oil, Direct Maintenance, Insurance and Depreciation), then, can be directly attributable to the aircraft's operation and are hence called "Direct Operating Costs".

The other operating costs are called Indirect Operating Costs, and are not directly attributable to a specific aircraft or aircraft type, but are dependent upon the particular kind of service the airline is offering. These costs are made up of:

Maintenance Burden: Although this cost is an overhead and not a direct cost, it does form a significant part of maintenance costs and is therefore often included in direct operating cost calculations.

Depreciation - Ground Equipment: This cost will vary from airline to airline, depending upon each airline's depreciation policy.

Passenger Service: This cost is attributable, as its name implies, to passenger service, and may vary considerably, depending upon the level of passenger service offered by an airline.

<u>Aircraft Servicing</u> :	All these
<u>Traffic Servicing</u> :	costs vary
<u>Servicing Administration</u> :	from airline
<u>Reservations and Sales</u> :	to airline.
<u>Advertising and Publicity</u> :	
<u>General and Administrative</u> :	

The "Standard Method of Estimating Comparative Direct Operating Cost of Transport Airplanes" previously referred to contains

a great number of complicated engineering formulae which are used to obtain the required results. I do not consider it necessary in this thesis to examine these formulae, since they are, fundamentally, aeronautical engineering formulae. However, I do consider it desirable briefly to show how, accepting these formulae as valid, the direct operating costs of two aircraft types are compared. Such a comparison therefore follows.

The aircraft types compared here are all-cargo aircraft - the Douglas DC7F (a converted passenger aircraft) and the Canadair CL44D - operating over the North Atlantic. The source from which these data were selected is a Canadair publication - Sales Engineering Report No. 241, dated August 9, 1960.

The comparison below is not intended to indicate the superiority of one aircraft type over another, but merely the method by which such a comparison is made. In examining the figures below, it should be borne in mind that they were prepared by the manufacturer of one of the aircraft types.

COMPARISON OF DIRECT OPERATING COSTS
OF DC7F AND CL44D AIRCRAFT

<u>Basis of Comparison</u>	<u>DC7F</u>	<u>CL44D</u>
Maximum Payload (weight limit) lbs.	<u>31,350</u>	<u>60,375</u>
Aircraft Price (New)	U.S. \$ 2,350,000	\$ 3,962,000
Spares (40% of aircraft price)	U.S. \$ <u>940,000</u>	<u>\$ 1,585,000</u>
Total Investment	\$ 3,290,000	\$ 5,547,000
Annual Utilization - hrs.	3,500	3,500
Depreciation period (years to 10%)	7*	10*
Insurance Rate (% of value of hull)	2.5†	4†
Fuel Price (Kerosene for CL44) (Gasoline for DC7) ‡ per gal.	23.1	14.6
Oil Price - \$/gal.	0.41	6.00

Crew Costs - based on actual experience for DC7F and adjusted
upward for CL44, due to weight and speed differential.

Direct Maintenance Costs - based on actual experience for DC7F -
CL44 based on engine manufacturer's
figure of \$72 per hour for engines
(labour and material), and an airframe
figure of \$63 per hour.

† - The different insurance rates shown are those actually used, and
they presumably reflect the underwriters' experience.

* - Different depreciation periods for the two aircraft types were used
since the useful life of an aircraft powered by a reciprocating
engine (DC7F) is now considered to be less than the useful life
of a turbine-powered aircraft (CL44D).

Landing Fees - variation with gross weight is 50 cents per 1,000 lbs.

Interest Rate (on total investment) - 7% for DC7F and CL44D.

Performance (distance of 3,160 nautical miles-non-stop)

		<u>DC7F</u>	<u>CL44D</u>
		E A S T B O U N D	
Block Time ⁶⁴	hrs.	10.9	9.25
Block Fuel ⁶⁴	lbs.	33,100	48,300
Reserve Fuel	lbs.	5,250	8,510
Allowance Payload	lbs.	28,000	54,265
		W E S T B O U N D	
Block Time ⁶⁴	hrs.	14.85	11.45
Block Fuel ⁶⁴	lbs.	38,700	58,800
Reserve Fuel	lbs.	5,500	8,960
Allowable Payload	lbs.	22,150	43,315

Direct Operating Costs

	<u>DC7F</u>	<u>CL44D</u>
	\$ per hr.	\$ per hr.
Crew	79.0	87.0
Maintenance	100.0	135.0
Landing Fees	7.1	10.2
Fuel & Oil	<u>110.7</u>	<u>115.8</u>

64. "Block Time" and "Block Fuel" refer respectively to the time elapsed and fuel used from the moment the aircraft engines are started prior to take-off until the moment the aircraft engines are stopped after landing.

	<u>DC7F</u> \$ per hr.	<u>CL44D</u> \$ per hr.
Cash DOC (inc. landing fees)	296.8	348.0
Depreciation	121.0	142.5
Insurance	18.8	45.3
Interest (average over depreciation period)	<u>39.3</u>	<u>61.0</u>
Total DOC (inc. landing fees & interest)	<u>\$ 475.9</u>	<u>\$596.8</u>
Average block speed m.p.h.	282	352
Direct Operating Cost per aircraft mile	\$ 1.68	\$ 1.69
Maximum average payload attainable - lbs.	24,950	48,790
Payload at 80% of attainable payload	19,960	39,030
Direct Operating Cost per revenue ton-mile at 80% of attainable payload	16.8 cents	8.7 cents

In order that actually experienced direct operating costs may be seen, Table 16 on the following page is included. This table shows the direct operating costs experienced by U.S. domestic trunk airlines, U.S. local service (regional) airlines, and U.S. all-cargo airlines, during the year 1960.

TABLE 16

DIRECT OPERATING COST PER HOUR
BY AIRCRAFT TYPE

DOMESTIC TRUNK LINES, LOCAL SERVICE LINES,
ALL-CARGO LINES, SCHEDULED & NON-SCHEDULED
OPERATIONS FOR YEAR ENDING 31 DECEMBER, 1960

	AIRCRAFT TYPE	DIRECT OPERATING COST \$ PER HOUR				
		FLYING	MAINT.	DEPR.	INTR CH'NGE	TOTAL
DOMESTIC TRUNK LINES	DC-3	63.43	44.28	5.37	-	113.09
	CV-240	99.43	89.15	3.91	-	192.49
	CV-340	97.79	65.39	22.12	2.17	187.47
	CV-440	86.65	43.45	37.61	-	167.71
	DC-4	101.32	87.34	7.65	-	196.32
	Viscount	119.42	85.24	49.40	-	254.07
	DC-6	154.64	119.09	6.13	12.78	292.64
	DC-6B	163.37	99.41	55.19	6.74	324.71
	DC-7	186.08	158.39	120.38	39.88	504.73
	DC-7B	195.25	121.80	90.94	-	407.98
	DC-7C	200.47	147.39	101.51	-	449.37
	Electra	176.19	177.93	134.36	-	488.47
	L-1049	185.70	152.88	11.86	-	350.44
	L-1049C	186.04	137.37	5.14	-	328.55
	L-1049G	209.94	161.52	131.72	-	503.18
	L-1049H	214.99	136.73	209.46	-	561.18
	L-1649	222.00	198.38	193.42	-	613.80
	CV-880	426.58	242.95	215.17	-	884.70
	DC8-10	406.73	305.44	195.82	-	907.99
	DC8-20	407.57	207.88	228.52	43.43	887.40
	B-720	342.73	141.54	168.16	-	652.43
	B707-100	379.80	289.34	192.67	2.29	864.10
	B707-200	448.61	289.37	202.03	-	940.01
	B707-300	440.49	236.14	227.97	-	904.60
ALL-CARGO AIRLINES & LOCAL SERVICE LINES	DC-3	56.44	34.00	5.53	-	95.97
	CV-240	96.73	95.27	32.22	-	224.22
	M-202	91.31	73.02	14.04	-	178.37
	M-404	94.19	68.86	13.25	-	176.30
	CV-340	93.36	99.50	19.92	-	212.78
	CV-440	93.07	62.48	31.90	-	187.45
	CV-540	119.25	101.58	20.79	-	241.62
	F-27	88.85	84.62	23.17	-	196.64
	C-46 INT	82.22	43.26	12.32	-	137.80
	DC-4 INT	114.66	73.10	51.59	-	239.35
	DC-4	102.56	74.63	44.85	-	222.04
	DC-7A	197.43	166.01	213.44	-	576.88
	DC-7F	214.99	169.51	133.22	-	517.72
	L-1049C	168.66	90.97	36.52	-	296.15
	L-1049H	225.88	119.18	116.44	-	461.50
	DC-7F Overseas	201.80	117.47	132.53	-	451.80

SOURCE: Comparative Statement Showing Air Carriers' Direct Operating Costs - 1960, Air Transport Association of America

From all that has been said so far on aircraft costs, it is apparent that the determination of the direct operating cost portion of total operating costs is a rather mechanical process.

However, direct operating costs are only one part of total operating costs, and it is the total operating costs of an all-cargo aircraft that the CAB wishes to use in determining air freight rates. Therefore, in order to find out how the total costs are determined, and having already examined the direct operating cost portion, it is now necessary to examine the remaining portion of total costs - indirect operating costs.

Analysis of Indirect Operating Costs

Unfortunately for the purpose of analysis, there is more than one type of scheduled service being used for the carriage of freight by air in the United States.

There are the services of those airlines which are primarily concerned with the carriage of passengers, but which also carry freight (these airlines will hereafter be referred to as "combination" airlines), and the services of those airlines which are, in their scheduled operations, entirely devoted to the carriage of freight. (These airlines will hereafter be referred to as "all-cargo" airlines).

Combination Airlines

The allocation of a number of the indirect costs among the various types of traffic carried by the combination airlines (e.g. the allocation of costs between passenger and freight traffic) can, for the airlines' internal accounting purposes, be made on a somewhat arbitrary basis. This is so because the main business of these airlines is the carriage of passengers, and the carriage of other types of traffic is, in most cases, incidental to the carriage of passengers. These airlines carry large volumes of freight in the belly-holds of their passenger aircraft⁶⁵, as well as carrying freight in all-cargo aircraft, and some of the airlines even regard their all-cargo aircraft service as being only a "back-up" service to the service provided by the passenger aircraft's belly-holds.

Therefore, unless and until the Civil Aeronautics Board specifies a particular way in which indirect costs should be allocated and reported between the various types of services performed by the airlines, the airlines themselves are, of necessity, forced into making the cost allocations as they see fit.

In order to present a clear picture of the difficulties involved in determining the indirect costs applicable to the freight aircraft operations of combination airlines, there is first presented below Table 17, which shows the revenues received from the various kinds of traffic carried by the domestic trunk airlines in 1960, and there then follows Table 18, which shows the distribution of operating expenses of the same airlines for the same year.

65. For example, in 1959, United Air Lines performed 53% of its total freight ton-miles in passenger aircraft - Exhibits of United Air Lines Inc. before the Civil Aeronautics Board, Docket No. 10067 et al, Rebuttal Exhibits.

TABLE 17
OPERATING REVENUES - DOMESTIC TRUNK AIRLINES
1960

Passenger	Mail	Express	Freight	Other	Total	Freight as % of Total
M I L L I O N S O F D O L L A R S						
1756	45	22	75	45	1943	4.2

SOURCE: Facts and Figures About Air Transportation - 1961, Air Transport Association of America

TABLE 18
OPERATING EXPENSES - DOMESTIC TRUNK AIRLINES
1960

Flying Operations	Main- tenance	Passenger Service	A/C & Traffic Servicing	Promotion & Sales	Adminis- trative	Depreciation & Amortization	Total
M I L L I O N S O F D O L L A R S							
548	397	151	306	215	74	217	1908

SOURCE: Facts and Figures About Air Transportation - 1961, Air Transport Association of America

It has previously been noted in this thesis that the CAB has laid down the principle that air freight rates should reflect the fully-allocated costs of an all-cargo aircraft operation.⁶⁶

Table 17 above shows clearly the various sources of the airlines' revenues. However, the data in Table 18 does not provide enough information to enable all operating costs to be allocated to that type of operation (e.g. combination passenger/freight operation or all-cargo operation) in whose service they were incurred.

Those costs designated as "direct operating costs" can be allocated to a particular type of aircraft operation. Thus, as previously discussed, operating expenses concerned with Flying Operations, Direct Maintenance, and Depreciation and Amortization of Flight Equipment can be allocated to a particular airline's all-cargo aircraft operation. Additionally, expenses incurred under the heading of "Passenger Service" can be excluded from those to be allocated to all-cargo operation.

Therefore, the difficulty lies in allocating to the all-cargo aircraft operation its correct share of: the Maintenance Burden expense⁶⁷ (which is part of the total "Maintenance" expense, the other part being "Direct Maintenance", which is itself a direct operating cost); the Aircraft and Traffic Servicing expense; the

66. See page 88 of this thesis.

67. See page 104 of this thesis.

Promotion and Sales (Reservations & Sales, Advertising and Publicity) expense; the Administrative expense; and the expense under the heading of "Depreciation - Ground Equipment".

As previously stated, the ways in which a combination airline actually does allocate its indirect costs can, for internal accounting purposes, be quite arbitrary. However, there is given below a description of the way in which a particular airline (United Air Lines) explained its allocation of indirect costs to the Civil Aeronautics Board.⁶⁸

Under the heading of "Methods and Bases of Allocation", United Air Lines stated the following:

"Domestic air freight operating costs are those costs which United would not have incurred had it not operated a freight service.

The DC-6A Cargoliner (an all-cargo aircraft) is scheduled and flown primarily for hauling air freight; therefore, all DC-6A flying costs (Flying Operations, Flight Equipment Maintenance, Flight Equipment Depreciation, and Landing Fees) are charged 100 percent to the freight operation.

68. Exhibits of United Air Lines Inc. Before the Civil Aeronautics Board, Docket No. 10067 et al, Rebuttal Exhibits, Exhibit U-102, pp. 3-6.

Combination aircraft are scheduled and flown primarily for passenger traffic; therefore, no combination aircraft flying costs are charged to the freight operation".⁶⁹

What this last paragraph means, in effect, is that freight carried by United Air Lines in its combination aircraft is not charged with any of the direct operating costs of such aircraft flights.

There follows here an item-by-item description of United's method of allocating indirect operating costs to its freight operation.

UNITED AIR LINES

ALLOCATION OF INDIRECT OPERATING
COSTS TO THE FREIGHT OPERATION⁷⁰

Maintenance Burden: Determined by applying a known ratio of maintenance base overhead cost per hour of direct maintenance labour to each hour of direct maintenance labour applied to the all-cargo aircraft only. Thus, no maintenance burden expenses for combination aircraft are chargeable to air freight operations.

69. United Air Lines, op. cit., Exhibit No. U-102, p. 2.

70. The source for this information is the same United Air Lines Exhibit (Exhibit No. U-102), pp. 3-6.

Aircraft and Traffic Servicing: Landing fees for the all-cargo aircraft charged to freight. No part of combination aircraft landing fees so charged. Salaries applicable to air freight operations were calculated by estimating the reduced number of personnel that would be required if no freight were carried by United, i.e. if no all-cargo aircraft were operated and if no freight were carried in combination aircraft. All other charges directly applicable to the air freight operation were so charged.

Reservations and Sales: Determined by calculating the salaries and expenses of the cargo sales division, of district freight sales offices, of the cargo tariff unit, and of customer air freight service units. Air freight agents' commissions charged to air freight.

Advertising & Publicity: Actual costs involved in exclusively publicising the air freight service.

General & Administrative: Air freight accounting section salaries charged to the air freight operation, as were freight claim salaries and expenses. Machine accounting costs attributable to air freight operations were computed on the basis of labour, machine rental and material expended for air freight reports.

Depreciation - Ground Equipment: The building and improvement asset account was analysed in order to determine the depreciation expense applicable for air freight facilities. Ground equipment depreciation expense was calculated on the basis of a survey by station, that ascertained the ground equipment chargeable to the air freight service.

It is apparent from the above description of the way in which United Air Lines allocates its freight service in-direct operating costs that no attempt has been made to determine what are the fully-allocated costs of an all-cargo aircraft operation.

What the above reveals, in my opinion, is that United has unrealistically refrained from allocating any direct operating freight costs to its combination aircraft operation (although, as previously noted, in 1959 it carried 53% of all its freight in combination aircraft), whilst, at the same time, the airline infers, by its system of indirect cost allocation, that all, or most, of its freight indirect operating costs are chargeable to the all-cargo aircraft operation.⁷¹

71. In support of this statement reference should be made back to page 122 which describes the way in which United Air Lines determines the amount of maintenance burden expense chargeable to air freight operations. The basis for the calculation of this charge is the time spent maintaining the all-cargo aircraft alone, thus excluding the combination aircraft operation from responsibility in contributing to the freight operation overhead.

Thus, this airline's position with regard to the total cost of operating all-cargo aircraft seems to be that this cost is comprised of:

- a) the direct operating cost of the all-cargo aircraft; plus
- b) all or most of the indirect operating costs associated with the provision of freight service by the airline, in both its all-cargo aircraft and in its combination aircraft.

That all-cargo aircraft total operating costs should include the direct operating costs of the aircraft themselves is logical, but that they should also include all or most of the indirect costs associated with the whole of the airline's freight service is not, in my opinion, logical.

It appears, in this case, that the airline, being a combination carrier and being faced with an all-cargo carrier as a competitor, was anxious to convince the Civil Aeronautics Board that the carriage of freight in all-cargo aircraft was an unprofitable operation, whereas it was an extremely low cost operation in combination aircraft, and therefore that the CAB should not renew the operating certificate of the all-cargo carrier.⁷² The airline seems to suggest that, although the direct costs of flying all-cargo aircraft may be low, the overheads associated with this operation are very high.

72. The CAB apparently did not accept this argument since, early in 1962, the all-cargo carrier (the Flying Tiger Line) was granted a permanent operating certificate.

All-Cargo Airlines

Having examined the way in which one of the biggest combination airlines calculates the indirect operating costs of its freight operations, it is now necessary to see how an all-cargo airline does the same thing.

However, here again the situation is complicated by the fact that all the U.S. scheduled domestic all-cargo airlines also perform a great deal of charter and contract work (much of it for the military), and there therefore arises the problem of allocating indirect costs among their various services.⁷³

The way in which the Flying Tiger Line Inc. allocates the indirect operating costs of its aircraft to its freight operations will therefore be examined.

FLYING TIGER LINE

ALLOCATION OF INDIRECT OPERATING COSTS TO FREIGHT OPERATIONS⁷⁴

Maintenance Burden: Identifiable costs are charged direct to freight operations, charter operations, or contract operations. Costs which are not identifiable

73. For example, during the year ended June 30, 1958, the Flying Tiger Line Inc. earned a total operating revenue of \$33.9 million. Of this total, \$24.1 million was earned from charter and contract work, leaving only \$9.8 million earned in scheduled operations.

74. The source for this information is Exhibits of the Flying Tiger Line Inc. before the Civil Aeronautics Board, Docket No. 10067 et al, Exhibit FTL 51, p. 9.

with any specific type of operations are allocated on the basis of the proportion of direct maintenance costs incurred by the three types of operation.

<u>Aircraft and Traffic Servicing:</u>	Identifiable costs are charged direct
<u>Reservations and Sales:</u>	to freight operations, charter operations, or contract operations. Common
<u>Advertising and Publicity:</u>	or unidentifiable costs are allocated
<u>General & Administrative:</u>	on the basis of miles flown.
<u>Depreciation - Ground Equipment:</u>	Loading equipment is charged direct
	to freight operations. Other costs
	are allocated on the basis of direct
	maintenance costs.

Lacking a detailed knowledge of the costing practices and procedures of the Flying Tiger Line, it is not possible to give complete or partial approval to the method so briefly described. However, in my opinion, the method outlined seems logical, and should, if soundly based, provide a realistic fully-allocated cost base for all-cargo aircraft.

Table 19 below shows the reported freight indirect operating costs incurred by the two airlines over a twelve-month period.

TABLE 19

COMPARISON OF FREIGHT INDIRECT OPERATING COSTS -
UNITED AIR LINES & THE FLYING TIGER LINE

Cost Designation	United Air Lines Year Ended 31/12/58	Flying Tiger Line Year Ended 30/6/58
	\$	\$
Maintenance Burden	162,501	490,398
Aircraft & Traffic Servicing	2,765,455	1,530,148
Reservations & Sales	283,147	701,311
Advertising & Publicity	155,665	290,418
General & Administrative	668,942	525,902
Depreciation - Ground Equipment	137,847	84,953
Total Indirect Operating Costs	\$4,173,557	\$3,623,130
Total Air Freight Ton-Miles Performed During the Period	66,984,123	60,710,251
Indirect Operating Cost in Cents per Ton-Mile Performed	6.2	5.9

SOURCES: United Air Lines - Exhibits of United Air Lines Inc.
before the CAB, Docket No. 10067 et al,
Rebuttal Exhibits

Flying Tiger Line - Exhibits of the Flying Tiger Line Inc.
before the CAB, Docket No. 10067 et al

During the same periods as are covered in Table 19 above, United Air Lines reported incurring Direct Operating Costs of \$4,204,163, or approximately 6.3 cents per revenue ton-mile performed in its all-cargo operations. Flying Tiger's Direct Operating Costs were \$6,065,829, or approximately 10 cents per all-cargo revenue ton-mile.

Thus, on the evidence presented by each airline to the CAB (in the Dockets noted), United's indirect operating costs per all-cargo aircraft revenue ton-mile performed are slightly higher than those of Tigers'. However, as a percentage of total costs (i.e. direct costs plus indirect costs), United's indirect costs are 50%, while Tiger's are only 37%.

If the cost figures submitted by the two airlines were accurate, and if each airline's method of allocating these costs were reasonable, the first conclusion that would have to be drawn from the figures would be that, by comparison, United Air Lines had a low cost all-cargo aircraft (direct operating costs of only 6.3 cents per revenue ton-mile), but that, due to the nature of air freight operations, the overheads associated with such an operation were a high proportion of total operating costs.

The second conclusion that would be drawn would be that the Flying Tigers had a comparatively high cost aircraft (direct operating costs of 10 cents per revenue ton-mile), and that the overheads

associated with the Tigers' operation, although a much lower percentage of total cost, were still comparable to those experienced by United.

However, the figures from which such conclusions would be drawn were contained in documents submitted to the CAB by the airlines in support of: (a) United Air Lines' submission opposing the permanent certification of all-cargo carriers; and (b) Flying Tiger Line's submission in support of permanent certification. Therefore, the figures may be suspect and should be checked against another source.

It is not possible to check the figures for indirect costs, but it is possible to do so for direct costs.

In 1958, United was operating DC-6A cargo aircraft, and the Tigers were operating L-1049H cargo aircraft. The direct operating cost of DC-6A aircraft, as reported by the domestic trunk airlines to the Air Transport Association of America⁷⁵, was 120.5 cents per aircraft mile. The direct operating cost of L-1049H cargo aircraft, as reported to the Air Transport Association by the all-cargo airlines, was 171.8 cents per aircraft mile.

The payload capacity of DC-6A cargo aircraft is approximately 14 tons, and that of L-1049H aircraft approximately 20 tons. Therefore, the direct operating cost per available ton-mile for each aircraft type in 1958 was:

75. Air Transport Association of America, Comparative Statement showing Air Carriers' Direct Operating Costs - 1958

$$\begin{array}{lcl} \text{DC-6A} & \frac{120.5}{14} & = 8.6 \text{ cents} \\ \text{L-1049H} & \frac{171.8}{20} & = 8.6 \text{ cents} \end{array}$$

Thus, it can be concluded that it seems impossible for United Air Lines DC-6A cargo aircraft to have had direct operating cost per revenue ton-mile of only 6.3 cents, in view of the fact that the direct operating cost of this aircraft type per available ton-mile was 8.6 cents.

In other words, it appears that United's actual direct operating cost per revenue ton-mile is at least 33% higher than indicated in their CAB exhibit.

It is believed that United's underestimate of direct operating costs per revenue freight ton-mile results from their distortion of freight costs, by the previously noted method of not applying any combination aircraft direct operating costs to the total freight operating costs.

Conclusions Regarding Air Freight Costs

As already noted, the calculation of an aircraft's direct operating costs, given all the necessary inputs such as fuel consumption, utilization, crew costs, depreciation policy, etc., is a mechanical process.

The allocation of indirect operating costs (which, together with direct operating costs, comprise total operating costs)

to an all-cargo operation is not a mechanical process, but is one which nevertheless requires logical treatment.

I believe that the method used by the Flying Tiger Line in the allocation of indirect operating costs is logical, and one which, as nearly as possible, enables these costs to be fairly allocated.

General Conclusion

Since, as previously noted in this chapter, it appears that the CAB is accepting the implication that minimum rates should be based upon the operating costs of the most efficient vehicle, I believe that growth of the domestic United States air freight market will be closely related to advances in aviation technology.

However, if such advances are initially applied exclusively to passenger-transporting vehicles, the air freight growth rate will not be significantly affected. The air freight rate of growth will only be significantly affected by a particular technological advance when that advance is directly incorporated into the design of an all-cargo aircraft.

The CAB's policy of basing minimum freight rates on the fully-allocated cost of operating all-cargo aircraft was, I believe, designed to ensure that the air freight growth rate is not restricted by the rate of growth of the passenger market.

Such a restriction would exist in the long run, I believe, if air freight minimum charges were based upon the cost of carrying freight in combination passenger-cargo aircraft. Under these conditions, the rate of freight growth could not long exceed the rate of passenger growth, because freight capacity would be restricted by the number of passenger aircraft available. Combination passenger-cargo aircraft are, in fact, passenger aircraft which incidentally have space available in the fuselage bellies wherein freight can be carried. Nearly all the costs incurred in flying these aircraft, therefore, are incurred whether or not freight is carried. The addition to cost resulting from the carriage of freight is, thus, quite low; and any minimum freight charge based upon this additional cost would also be low. Such charges would not be able to support a fleet of all-cargo aircraft, since such aircraft would not be generating "freight subsidies" from passenger revenues.

Additionally, minimum air freight charges based upon the operating costs of all-cargo aircraft owned by combination airlines could restrict the rate of growth of air freight traffic. This restriction would occur if the minimum charges were based on unrealistically allocated overhead costs. For example, an airline operating forty passenger aircraft and four all-cargo aircraft might decide that all **general** administrative costs would be allocated to the passenger operation overhead, since passengers were their main business. Thus, the all-cargo operation would be shown to be costing less than it would if a reasonable proportion of administrative costs

were assigned to it. Freight rates based on this low cost operation would be low, but the volume of freight that the airline could carry would be restricted. Beyond a certain freight volume, it would not be possible for the airline to "subsidize" the freight operation through the allocation of all administrative costs to the passenger operation. Therefore, beyond that volume, freight costs would have to include some additional overhead burden, but the minimum freight charges, being based on the lower cost, would result in an unprofitable operation to the airline. Under these circumstances, therefore, the airline would not attempt to expand its freight business beyond the point where it was no longer feasible to carry all the administrative costs on the passenger operation. The exact location of this "break-even" point would depend on the volume of passenger traffic; and, therefore, the capability of expanding freight traffic would, under these conditions, depend upon the volume of passenger traffic.

This chapter has analysed an air freight tariff which was based upon the fully-allocated cost of operating an all-cargo aircraft owned by an all-cargo airline. This chapter has also analysed the ways in which an all-cargo airline and a combination airline allocate their indirect operating costs (or "overhead" costs) to the all-cargo aircraft operation.

As has been previously noted, the CAB has stated that its policy is to use the total operating costs of all-cargo aircraft

in determining air freight rates. I have stated I believe that this policy is designed to ensure that air freight growth is not restricted by passenger growth. I believe that the cost analyses in this chapter show two cost structures which would have two different effects on the long-term growth of the air freight market. The United Air Lines cost procedure would, I believe, result in restricting the long-term growth of air freight. I believe that the Flying Tiger Line's cost procedure is one under which the air freight market could grow economically.

I further believe that the CAB has also reached this conclusion. The CAB's apparent acceptance in 1961 of the Flying Tiger's freight tariff (based on the cost of operating their freight aircraft) as the yardstick by which to measure the reasonableness of other tariff proposals appears to support my belief.

I believe that the CAB's implied acceptance of this costing procedure will ensure that the growth of the air freight market will not be hindered by uneconomic price regulation.

BIBLIOGRAPHY

- Air Transport Association of America, Comparative Statement showing Air Carriers' Direct Operating Costs - 1960, (Washington, 1961)
- Air Transport Association of America, Standard Method of Estimating Comparative Direct Operating Costs of Transport Airplanes, (Washington, 1960)
- Civil Aeronautics Board, Handbook of Airline Statistics - 1960, (U.S. Government Printing Office, Washington, 1961)
- Civil Aeronautics Board, Uniform System of Accounts and Reports for Certificated Route Air Carriers, (Federal Register, Washington, 1961)
- Federal Aviation Agency, Statistical Handbook of Aviation - 1961, (U.S. Government Printing Office, Washington, 1961)
- Flying Tiger Line Inc., Application of the Flying Tiger Line Tariff, (Burbank, 1961)
- Flying Tiger Line Inc., Exhibits before the Civil Aeronautics Board, Docket No. 10067 et al, (Burbank, 1960)
- Meyer, J. R., Peck, M. J., Stenason, J., Zwick, C., The Economics of Competition in the Transportation Industries, (Harvard University Press, Cambridge, 1960)
- Roadcap & Associates, World Airline Record, (Roadcap & Associates, Chicago, 1955)
- Thomas, A. J., Economic Regulation of Scheduled Air Transport, (Dennis & Company Inc., Buffalo, 1951)
- United Air Lines Inc., Exhibits before the Civil Aeronautics Board, Docket No. 10067 et al, (Chicago, 1960)

CHAPTER IV

THE COSTS OF DISTRIBUTION

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THE COSTS OF DISTRIBUTION

GENERAL

Having examined the surface transportation system, the historical background of the air freight industry, and some of the price and cost practices of the industry, I believe it is now time to examine, in detail, some of the factors inherent in the movement of a commodity which are likely to be relevant to the growth of the air freight industry. It is the objective of this chapter, therefore, to examine the major elements of distribution costs in order to determine, as far as is possible, the relative advantages and disadvantages of air and surface distribution methods.

To achieve this objective there is first presented discussion on packaging, damage and pilferage costs. Inventory costs are then analysed, and case studies presented.

The chapter ends with a summary and conclusions drawn from the discussion, analyses and case studies.

TOTAL DISTRIBUTION COST

By "total distribution cost" is meant the total cost of moving a commodity from point of manufacture (or processing, or growth) to point of consumption. Elements of this cost are:

Packaging (Materials & Labour)

Damage

Pilferage

Inventory

Transportation

One of the obstacles to the achievement of the lowest possible total distribution cost is the fact that there are a number of functions in the distribution process (e.g. selection of routing, selection of transportation media, selection of shipment size, etc.). Attempts to minimize any one of these costs, made without regard to the effects of such an attempt on the total cost of distribution, could result in an increase in the total cost of distribution. For example, efforts might be made to minimize unit transportation costs by those responsible for this function, and, as a result, excessive costs may occur in inventory accumulation, inventory obsolescence, warehousing, etc.

If total distribution cost is to be reduced, it is first necessary to analyse each element of this cost. When such analysis is undertaken, there may be revealed ways in which changes in the distribution method can be instrumental in reducing total cost.

A discussion of the costs incurred under the headings of "Packaging", "Damage" and "Pilferage" follows here. Inventory Costs are discussed later and in detail, since these costs are a major element in most distribution processes.

Packaging Costs

The character of the product, the number of handlings required from the shipping dock of the consignor to the receiving

dock of the consignee, the method of shipment, and the availability of equipment for handling shipments will determine the kind of packaging required. "Packaging can be regarded as most efficient only when it is done with both the particular method of transport and the individual needs of the consignee in mind."⁷⁶

Air freight packaging requirements usually are simpler than surface requirements. Generally speaking, air shipments are not subjected to the steady bumping and horizontal swaying, or the jarring caused by sudden starting and stopping, experienced by surface shipments. Damage from load shifting in an airplane is the exception rather than the rule. Therefore, less crating, or the use of lighter materials, will usually suffice for air shipments. Less crating results in reduced labour costs at both ends of the operation.

A specific example of packaging costs by two media of transportation will be found later in this chapter - in the section devoted to case studies.

Damage Costs

The following table shows the ratio of damage claims to freight revenue, experienced by three forms of U.S. domestic transportation in three years.

76. H. T. Lewis, J. W. Culliton & J. D. Steele, The Role of Air Freight in Physical Distribution, (Boston, Harvard University - 1956), p. 84.

TABLE 20

DAMAGE CLAIMS AS A PERCENTAGE OF FREIGHT REVENUE

	1950	1952	1953
Railroads	1.08	1.18	1.17
Motor Trucks	1.13	1.17	1.18
Air Carriers	0.72	0.71	0.70

SOURCE: H. T. Lewis, J. W. Culliton & J. D. Steele, The Role of Air Freight in Physical Distribution.

The lower levels of damage claims experienced by air freight probably results from the nature of the vehicles used. Cargo space in aircraft, be they combination aircraft or all-cargo aircraft, is limited to about three or seven feet in height. The amount of downward pressure that can be experienced by a package travelling by air is therefore less than that experienced by packages travelling in trucks or railroad cars, since the vertical dimensions of vehicles in these latter forms of transportation is greater than aircraft vertical dimensions.

Pilferage Costs

Pilferage with some types of products constitutes a substantial financial loss; whereas with other products and with other methods of handling, pilferage is of small concern. Poor

handling with careless supervision and control offers a real opportunity for pilferage, particularly where the items are of small bulk and high value.

In a study performed by American Airlines⁷⁷ it was noted that the value of pilferage on their system amounted to 0.23 of 1% of their total air freight revenue. In 1960, the combined value of loss and damage experienced by the freight services of Class I line-haul railroads was approximately 1.5% of the total freight revenues of these railroads. If it is assumed that damage loss was 1.17% of the railroads' freight revenue (as shown in Table 20 for 1953), then pilferage loss would be 1.5 minus 1.17, or 0.33%, as compared to American Airlines 0.23%.

It may be concluded, therefore, that, on the rather meagre evidence available, losses from air freight are relatively smaller than those losses experienced by the railroads.

INVENTORY COSTS

The basic function of inventory accumulation is to provide service to customers. Under competitive conditions, the availability of the product demanded is an important factor in its sales. The significance of this factor depends upon the market

77. American Airlines, A Study of the Effect of Air Transportation Upon Profits Resulting from Changes in Costs at Various Levels of Volume when Prices Remain Constant, (September, 1954), p. 9.

characteristics of the commodity and the time that elapses between the placing of an order and the time of its final delivery. There, therefore, arises the problem of the proper balance between the competitive necessity of having the product available and the cost of having it available. The ideal situation from the customers' and potential customers' points of view would be to have complete and immediate availability of all products. However, this would be economically unrealistic, and a balance between customer service considerations and cost considerations must, therefore, be struck. There follows here an analysis of the ways in which the level of inventory, under conditions of certainty and uncertainty with regard to product demand, may be determined, and an analysis of the cost of maintaining different inventory levels.

Determination of Required Inventory Level
Under Conditions of Certainty⁷⁸

Assume that:

- (1) a regular weekly demand for 700 units
of a product exists;
- (2) a rail carload contains 700 units (i.e.
one carload ordered and shipped every
week);

78. The examples used in these analyses have been derived from the book Physical Distribution Management, by E.W. Smykay, D.J. Bowersox, & F.H. Mossman, published in 1961 by the MacMillan Company, New York.

- (3) the time in transit from the manufacturer to the warehouse is 7 days;
- (4) the time needed to process the order is 7 days.

The total lead time is, therefore, 21 days (order frequency - 7 days; in transit - 7 days; order processing - 7 days).

Assume that the warehouse starts with an initial order of 2100 units, and allows its inventory to drop to 1400 units (i.e. waits one week before placing its next order).

At the 1400 unit point (or seven days later), an order for 700 units is placed. Fourteen days later, just as the last of the remaining 1400 units of inventory have been disposed of, the shipment of 700 units previously ordered arrives. The warehouse, therefore, has enough inventory to satisfy a week's demand.

The moment that the shipment of 700 units left the manufacturer, it was charged to the warehouse. So, seven days before receiving its shipment, the warehouse was bearing the cost of the 700 units remaining in its inventory plus the cost of the 700 units in transit from the manufacturer.

The average inventory chargeable to the warehouse is calculated by the formula

$$\text{Average Inventory} = \text{Minimum Inventory} + \frac{\text{Order Quantity}}{2}$$

In this example, there are always 700 units in the system and, therefore, the average inventory equals

$$700 + \frac{700}{2}, \text{ or } 1050 \text{ units.}$$

In the example used here, the minimum inventory level is 700 units.

Determination of Required Inventory Levels under Conditions of Uncertainty

Assume that the demand for a product varies week-by-week, and that Table 21 below shows the frequency distribution based on the varying demand for the product, by weeks, experienced historically.

TABLE 21

FREQUENCY DISTRIBUTION BASED ON VARYING DEMAND BY WEEKS

Number of Units demanded (Class)	Number of weeks number of units was demanded (frequency-F)	Fx Class	Deviation of the class from the average (D)	FxD	FxD ²
100	1	100	- 6	- 6	36
200	2	400	- 5	- 10	50
300	3	900	- 4	- 12	48
400	4	1600	- 3	- 12	36
500	5	2500	- 2	- 10	20
600	6	3600	- 1	- 6	6
700	10	7000	0	0	0
800	6	4800	+ 1	+ 6	6
900	5	4500	+ 2	+ 10	20
1000	4	4000	+ 3	+ 12	36
1100	3	3300	+ 4	+ 12	48
1200	2	2400	+ 5	+ 10	50
1300	1	1300	+ 6	+ 6	36
TOTALS	52	36400	0	0	392

Applying probability theory to the problem, it is possible to determine the probability of weekly demand exceeding any particular level.

In order to determine this probability it is first necessary to calculate the standard deviation. The formula for this calculation is

$$SD = I \sqrt{\frac{\sum (F \times D^2)}{N}}$$

Where SD = standard deviation
I = size of class interval
N = number of occurrences

From the data in the table, SD becomes

$$SD = 100 \sqrt{\frac{392}{52}}$$

$$SD = 100 \sqrt{7.54}$$

$$SD = 100 \times 2.75$$

$$SD = 275 \text{ units}$$

The Standard Deviation is a measure of dispersion which states that, under normal conditions of probability, and within the limits of plus or minus one standard deviation, approximately 68% of all occurrences will be found. Applied to this example it means that, by increasing average inventory from 700 units to 975 units (i.e. increasing inventory by one standard deviation), about 84% of all demands will be satisfied. As can be seen from the table, an average inventory of 700 units already satisfies 50% of the demands, and 50% plus half of 68% equals 84%.

The inventory levels required to satisfy higher or lower percentages of demand can also be calculated. Under conditions of a normal probability distribution, an additional 275 units will satisfy 95% of customer demands, and a further additional 275 units will satisfy 99% of customer demands.

In tabular form, it can be expressed as follows:

<u>Percentage Level of Customer Service*</u>	<u>Inventory Level Required</u>
50	700 units
84	975 units
95	1,250 units
99	1,525 units

* "Customer Service Level" refers to the number of weeks out of a 100 in which no customer will be inconvenienced by having to wait more than the normal time to have his order filled.

Calculation of the Cost of Maintaining
Different Customer Service Levels

Assume that the cost per unit, at the warehouse, is \$1,000.

Assume that the cost of carrying the inventory is 25% of the cost of the units.

Table 22 which follows shows the cost of maintaining inventories at different levels of customer service.

TABLE 22

COSTS OF MAINTAINING INVENTORIES AT DIFFERENT
CUSTOMER SERVICE LEVELS

% Level of Service	Standard Devia- tion	Average Annual Invest- ment (Number of Units in inven- tory at \$1000 each) \$	Added Investment over 50% Level Investment \$	Additional Investment for each successive stage \$	Added Inventory Carrying Cost at 25% \$	Total Annual Sales at each Level \$	Added Annual Sales at each Level \$	Added Gross Profit at 1% Margin \$	Net Gain or Loss \$
1	2	3	4	5	6	7	8	9	10
50	0	700,000	0	0	0	18,200,000	0	0	0
84	1	975,000	275,000	275,000	68,750	30,940,000	12,740,000	127,400	+58,650
95	2	1,250,000	550,000	275,000	68,750	34,580,000	3,640,000	36,400	-32,350
99	3	1,525,000	825,000	275,000	68,750	36,036,000	1,456,000	14,560	-54,190

For explanation of columns, see the following page.

Column 1 of the table indicates the percentage level of customer service, while column 2 shows the number of standard deviations from the 50% level of customer service. Column 3 shows the average annual investment (at \$1,000 per unit) for inventory levels of 700, 975, 1250 and 1525 units respectively.

Columns 4 and 5 are self-explanatory, while column 6 shows the additional cost of carrying each addition to inventory (i.e. 25% of the figures in column 5).

The figures in column 7 are based on the assumption that, at 100% level of customer service, 36,400 units would be sold annually at \$1,000 per unit.

Columns 8 and 9 are self-explanatory, while the figures in column 10 show the difference (at different customer service levels) between the added profit (column 9) and the added inventory carrying cost (column 6).

It can be seen from column 10 that net profits will be positive up to a customer service level somewhere between 84% and 95%. Beyond that point losses will occur.

Dock-to-dock Speeds

The foregoing analyses assumed that the in-transit time from manufacturer to warehouse was unchanged under all conditions - certainty, uncertainty, and different levels of customer service.

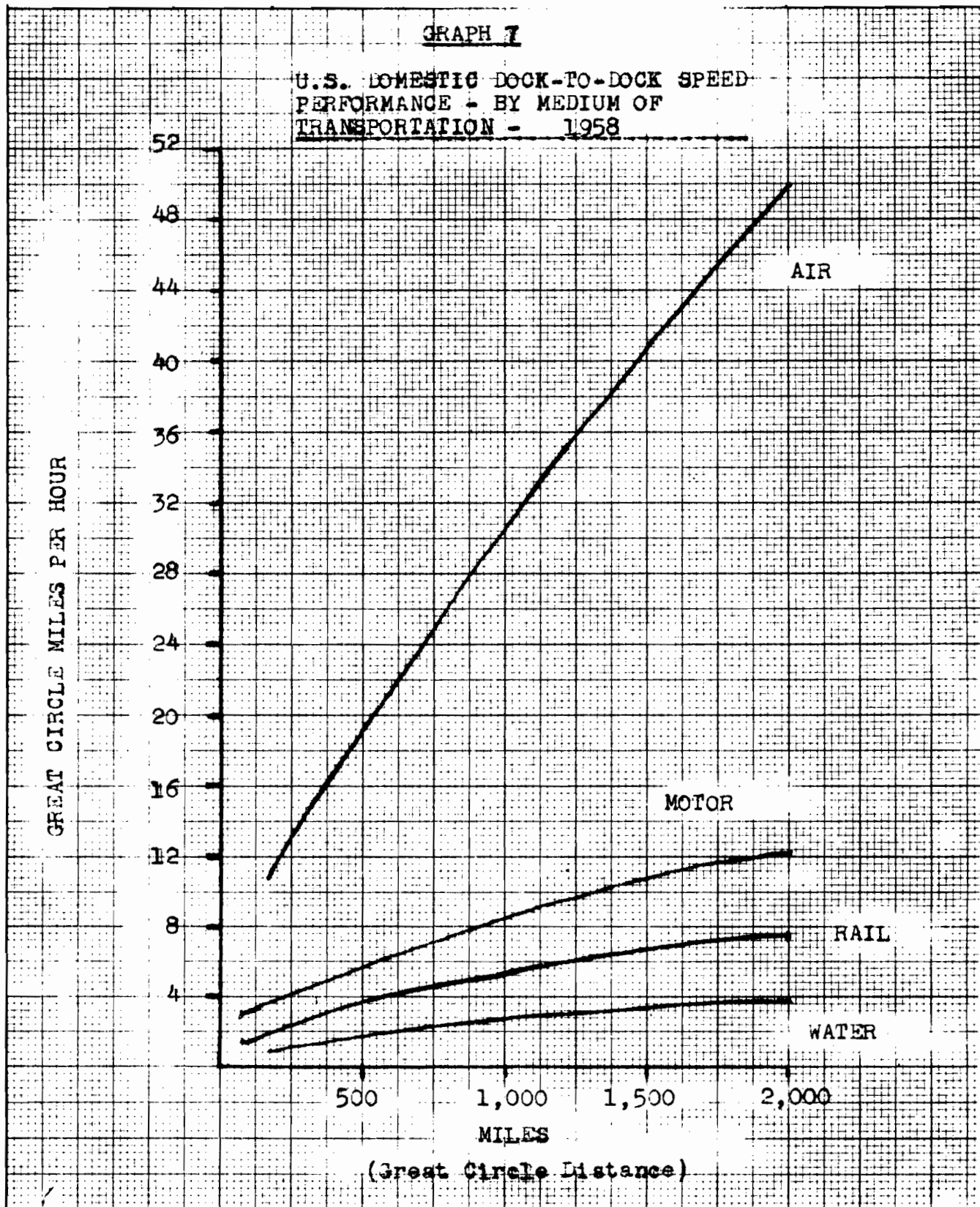
However, a change in the mode of transport by which the commodity is moved from the manufacturer to the warehouse could result in a change in the in-transit time, with resultant changes in inventory requirements and costs.

The main advantage which a fast method of transportation has over a slower method derives from the fact that the length of time required to move a commodity from point of manufacture (or processing) to point of final distribution has a great influence on the size of the inventory required at the point of distribution. A faster method of transportation will, under a given set of conditions, make it possible for inventory levels to be reduced, relative to the levels required when a slower method is used. Reduction in the size of inventory will, naturally, result in reduction in costs.

Whilst it is obvious that the aeroplane is faster than the railway train and the motor truck and the barge, the exact degree of this speed advantage, from the point of view of a businessman sending a commodity from A to B, cannot be reflected by the fact

that an aeroplane's average speed may be 300 miles per hour while a train's average speed may be 30 miles an hour. From the businessman's point of view, the speed of his shipment is not measured by the speed of the transporting vehicle, when that vehicle is moving, but by the total elapsed time from the moment the shipment leaves his shipping dock to the moment it is received at the dock of the consignee. The speed of movement between shipper's dock and consignee's dock is referred to here as "dock-to-dock" speed.

Graph 7 which follows shows typical dock-to-dock speeds achieved in the U.S. in 1958, by the various media of transportation, up to distances of 2,000 miles.



Source: G.A. Busch & K.M. Mayer, An examination of the economic and technical factors underlying the future U.S. domestic market for air cargo transportation service, Paper presented at a meeting of the Institute of the Aerospace Sciences, Los Angeles, June, 1961.

From this graph it can be seen that air's dock-to-dock speed in 1958 was about four times that of rail's at great circle shipping distances of 500 miles, about five-and-a-half times that of rail's at 1,000 miles, and about six-and-a-half times that of rail's at 2,000 miles.

Since 1958, turbine-powered passenger/cargo aircraft and all-cargo aircraft have come into service, with the result that the speed advantages of air have undoubtedly increased from those shown here.

Graph 7 indicates that commodities transported by air can move, from consignor to consignee, at speeds significantly faster than commodities transported by surface media. Knowing this, it is desirable to determine if there are ways in which this speed advantage can be (or is being) translated into a cost advantage.

Analysis of the Effects on Inventory Levels of the Use of Rail and Air Transportation

Having analysed the cost implications of different customer service inventory levels under unchanging transportation conditions, it is now necessary to analyse the effects on inventory levels of the use of transportation media with different "dock-to-dock" speeds. The transportation media used in this analysis will be rail and air transportation.

Assume that, owing to improved equipment and techniques, the dock-to-dock speeds achieved by rail and air transport over different distances (as shown in Graph 7 on page 152) have increased since 1958 to the following:

	<u>500 miles</u>	<u>1,000 miles</u>	<u>2,000 miles</u>
Rail	7 mph	10 mph	14 mph
Air	25 mph	40 mph	60 mph

Then Table 23 below shows the actual time it takes for a shipment to move from the consignor's despatching dock to the consignee's receiving dock, by rail and by air, over great circle distances of 500 miles, 1,000 miles, and 2,000 miles.

TABLE 23

DOCK-TO-DOCK TIME (IN HOURS) -
RAIL AND AIR

	G R E A T C I R C L E D I S T A N C E S O F		
	500 miles	1,000 miles	2,000 miles
Rail	72	100	143
Air	20	25	33

Assume that:

- (1) a regular weekly demand for 700 units
of a product exists;

- (2) a rail carload contains 700 units
(i.e. one carload ordered and shipped
every week if rail transportation
used);
- (3) a shipment by air contains 100 units
(i.e. one air shipment ordered and
shipped every day if air transportation
is used);
- (4) the time needed to process the order
(receive, pack and place on shipping
dock) is 7 days.

The total time from time of ordering to time of
delivery by the two forms of transportation, over the three distances,
will therefore be as shown in Table 24 below.

TABLE 24

TOTAL TIME FROM ORDERING TO DELIVERY
(DOCK-TO-DOCK TIME PLUS ORDER
PROCESSING TIME) - RAIL AND AIR (IN DAYS)

	G R E A T C I R C L E D I S T A N C E S O F		
	500 miles	1,000 miles	2,000 miles
Rail	10	11	13
Air	8	8	9

NOTE: Fractions of days have been treated as full days
(e.g. 33 hours dock-to-dock time is regarded as two
days).

Case 1 - Warehouse located 500 miles from manufacturing facility

Using rail

Assume that the warehouse is initially stocked with 1,000 units. At a distance of 500 miles, the time from ordering to receipt of the goods is 10 days (7 days order processing plus 3 days dock-to-dock).

At the beginning of the day when the warehouse opens, a new order for one rail carload lot of 700 units is placed. At the end of the seventh day (or the beginning of the eighth day), just as the inventory level at the warehouse has fallen to 300 units, the carload lot ordered (700 additional units) leaves the manufacturing facility, and is charged to the warehouse.

Three days after this (end of the tenth day), inventory at the warehouse has fallen to zero just as the rail carload shipment of 700 units is received.

The average inventory chargeable to the warehouse is calculated by the formula

Average Warehouse Inventory = Minimum Warehouse

$$\text{Inventory} + \frac{\text{Order Quantity}}{2}$$

In the case shown here, there is always a minimum of 300 units in the system. (Inventory level falls to 300 at end of seventh day just as carload lot leaves manufacturing facility.) The average inventory chargeable to the warehouse is therefore:

$$300 + \frac{700}{2} \quad \text{or} \quad 650 \text{ units.}$$

Using air

Assume that the warehouse is initially stocked with 800 units.

At a distance of 500 miles, the time from ordering to receipt of the goods is 8 days (7 days order processing plus 1 day dock-to-dock).

The day the warehouse opens, a new order for one shipment lot of 100 units is placed. Seven days after this, just after the inventory level at the warehouse has fallen to 100 units, the air shipment lot (100 additional units) leaves the manufacturing facility and is charged to the warehouse.

One day after this, inventory at the warehouse has fallen to zero just as the air shipment of 100 units is received.

In the case shown here, therefore, there is always a minimum of 100 units in the system chargeable to the warehouse. Thus, the average inventory chargeable to the warehouse is:

$$100 + \frac{100}{2} = 150 \text{ units.}$$

In Case I, it therefore appears that the use of air can reduce average inventory levels by 500 units, from 650 to 150.

Case 2 - Warehouse located 1,000 miles from
manufacturing facility

Using rail

Assume that the warehouse is initially stocked with 1,100 units. Order to receipt time - 11 days.

Order for 700 units placed day the warehouse opens.
Order despatched from manufacturing facility 7 days later when warehouse inventory has fallen to 400 units.

Order received at warehouse 4 days later when warehouse inventory is down to zero.

Minimum inventory is, therefore, 400 units.

Average inventory chargeable to warehouse
is therefore:

$$400 + \frac{700}{2} \quad \text{or} \quad 750 \text{ units.}$$

Using air

Assume that the warehouse is initially stocked
with 800 units. Order to receipt time - 8 days.

Order for 100 units placed day the warehouse
opens. Order despatched from manufacturing
facility 7 days later when warehouse inventory
has fallen to 100 units.

Order received at warehouse 1 day later when
warehouse inventory is down to zero.

Minimum inventory is, therefore, 100 units.

Average inventory chargeable to warehouse is
therefore:

$$100 + \frac{100}{2} \quad \text{or} \quad 150 \text{ units.}$$

In Case 2, it therefore appears that the use of
air can reduce average inventory levels by 600
units - from 750 to 150.

Case 3 - Warehouse located 2,000 miles from
manufacturing facility

Using rail

Assume that the warehouse is initially stocked with 1,300 units. Order to receipt time - 13 days.

Order for 700 units placed day the warehouse opens.
Order despatched from manufacturing facility 7 days later when warehouse inventory has fallen to 600 units.

Order received at warehouse 6 days later when warehouse inventory is down to zero.

Minimum inventory is, therefore, 600 units.

Average inventory chargeable to warehouse is therefore:

$$600 + \frac{700}{2} \quad \text{or} \quad 950 \text{ units.}$$

Using air

Assume that the warehouse is initially stocked with 900 units. Order to receipt time - 9 days.

Order for 100 units placed day the warehouse opens.
Order despatched from manufacturing facility 7 days later when warehouse inventory has fallen to 200 units.

Order received at warehouse two days later when warehouse inventory is down to zero.

Minimum inventory is, therefore, 200 units.

Average inventory chargeable to the warehouse is therefore:

$$200 + \frac{100}{2} \quad \text{or} \quad 250 \text{ units.}$$

In Case 3, it therefore appears that the use of air can reduce average inventory levels by 700 units - from 950 to 250.

Assuming that the manufacturing facility produces finished goods at an even rate, then the factory, when using rail, needs to accumulate a stock of 700 units by the end of every week to make up one rail car shipment. This means that the average inventory held by the factory when shipping by rail must be 350 units.

When shipping by air, the factory needs to accumulate a stock of 100 units by the end of every day to make up one air shipment. This means that the average inventory held by the factory when shipping by air must be 50 units.

It appears, therefore, that the use of air would also enable factory inventory levels to be reduced.

Analysis of the Effects of the Use of Rail and Air
Transportation on the Costs of Maintaining Warehouse
Inventories at Different Customer Service Levels

Table 22 showed the costs of maintaining inventories at different customer service levels. The table implicitly assumed an unchanging in-transit time for the products from the factory to the warehouse.

It is considered desirable to see what would be the effect on costs if different transportation media, giving different in-transit times, were injected into the analysis. Accordingly, Tables 25 and 26 below present statistical comparisons of the situation which would arise at different levels of customer service if rail and air transportation were used for the movement of products to a warehouse located 500 miles from the manufacturing facility.

As previously calculated in this chapter, and under the conditions previously assumed, an average warehouse inventory level of 150 units supplied by air, over a distance of 500 miles, provides warehouse inventory service equivalent to an average warehouse inventory of 650 units supplied by rail over the same distance.

In compiling Table 25, it was assumed that the figures in Table 22 were representative of warehouse inventory levels supplied by rail from a factory 500 miles away.

However, where Table 22 showed a need for an annual average inventory level of 700 units to provide a customer service level of 50 percent, the tables which follow assume that a rail-supplied average inventory of 650 units would achieve the same customer service level, and that an average inventory of 150 units supplied by air would be equivalent to 650 rail-supplied units.

Additionally, the standard deviation of daily demand (as opposed to the weekly demand, shown in Table 21) has been calculated to be 212 units. This standard deviation has been applied to the "Air" figures in Tables 25 and 26, whilst the standard deviation of 275 units, based on weekly demand, has been applied to the "Rail" figures.

TABLE 25

COMPARISON OF COSTS OF MAINTAINING WAREHOUSE INVENTORIES AT DIFFERENT
CUSTOMER SERVICE LEVELS - PRODUCT MOVED TO THE WAREHOUSE BY RAIL AND
BY AIR, FROM A MANUFACTURING FACILITY 500 MILES AWAY

Trans- port- ation Mode	% Level of Service	Standard Devia- tion	Average Annual Invest- ment (number of Units in inven- tory at \$1,000 each) \$	Added Investment over 50% Level Investment \$	Additional Investment for each Successive Stage \$	Added Inventory Carrying Cost at 25% \$	Total Annual Sales at each Level \$	Added Annual Sales at each Level \$	Added Gross Profit at 1% Margin \$	Net Gain or Loss \$
1	2	3	4	5	6	7	8	9	10	11
Rail	50	0	650,000	0	0	0	18,200,000	0	0	0
Air	50	0	150,000	0	0	0	18,200,000	0	0	0
Rail	84	+1.00	925,000	275,000	275,000	68,750	30,940,000	12,740,000	127,400	+58,650
Air	84	+1.00	362,000	212,000	212,000	53,000	30,940,000	12,740,000	127,400	+74,400
Rail	95	+2.00	1,200,000	550,000	275,000	68,750	34,580,000	3,640,000	36,400	-32,350
Air	95	+2.00	574,000	424,000	212,000	53,000	34,580,000	3,640,000	36,400	-16,600
Rail	99	+3.00	1,475,000	825,000	275,000	68,750	36,036,000	1,456,000	14,560	-54,190
Air	99	+3.00	786,000	636,000	212,000	53,000	36,036,000	1,456,000	14,560	-38,440

From the foregoing table, and under the conditions assumed therein, it appears that a manufacturer moving supplies by air to a warehouse 500 miles away would find it more profitable to improve service from a 50% level to, say, an 84% level, than would the same manufacturer using rail service.

Table 25, however, only shows the change in the costs of providing different levels of service by each medium. The costs of the two transportation media are not compared to each other.

Table 26, which follows, does make this comparison. In this table it has been assumed that the total annual cost of maintaining the inventory is made up of the direct investment in the inventory (at \$1,000 per unit), plus an inventory carrying cost of 25% of the value of the inventory, plus the freight charges. For the purposes of this comparison, it has been assumed that the rail freight charge is \$50 per unit, and that the air freight charge is either \$75 or \$100 per unit.

TABLE 26

COMPARISON OF COSTS OF TRANSPORTING AND MAINTAINING
WAREHOUSE INVENTORIES AT DIFFERENT CUSTOMER SERVICE
LEVELS, BY RAIL AND AIR

Trans- port- ation Mode	% Level of Service	Average Annual Investment in Inventory \$	Inventory Carrying Cost at 25% \$	Number of Units sold per Annum	Total Annual Freight Charges Rail - \$50 per Unit; Air - \$75 & \$100 per Unit \$	Total Annual Cost - Inventory + Inventory Carrying + Freight \$
1	2	3	4	5	6	7
Rail	50	650,000	162,500	18,200	910,000	1,722,500
Air	50	150,000	37,500	18,200	1,365,000 @ \$ 75 1,820,000 @ \$ 100	1,552,500 2,007,500
Rail	84	925,000	231,250	30,940	1,547,000	2,703,250
Air	84	362,000	90,500	30,940	2,320,500 @ \$ 75 3,094,000 @ \$ 100	2,773,000 3,546,500
Rail	95	1,200,000	300,000	34,580	1,729,000	3,229,000
Air	95	574,000	143,500	34,580	2,593,500 @ \$ 75 3,458,000 @ \$ 100	3,311,000 4,175,500
Rail	99	1,475,000	368,750	36,036	1,801,800	3,645,550
Air	99	786,000	196,500	36,036	2,702,700 @ \$ 75 3,603,600 @ \$ 100	3,685,200 4,586,100

From the above table it can be seen that, in this case, and up to some point between the 50% and 84% level of service, the total annual cost of a rail-supplied inventory is more than the total annual cost of an air-supplied inventory when the air rate is 150% of the rail rate. However, in all the other cases shown, a rail-supplied inventory costs less than an air-supplied inventory.

The two foregoing tables do not prove any general proposition. They do serve to indicate, however, that only by examination of specific cases is it possible to determine the relative advantages to be gained by the use of one or other of the transportation media. Examinations of such cases follow here.

CASE STUDIES

Having examined the general concepts of the costs involved in the distribution of commodities from one place to another, it would be well to look at some specific cases in order to see in what way, if at all, the use of air for the transportation of commodities can be seen as an economic proposition.

Case Study "A" - The Moseby Company

This case study has been summarized from the book The Role of Air Freight in Physical Distribution, previously referred to, and was undertaken by J. D. Steele.

The Moseby Company, originally a machine shop making standard hardware items for mail order houses, expanded rapidly during and after World War II, and in 1951 began the manufacture of fuel pumps.

This study is concerned with a single product of the Moseby Company - fuel pumps. This product was chosen for study because of its value-density characteristics and its method of distribution. Fuel pumps had a density (pounds per cubic foot) of 21.7 and a value per pound of 58 cents. Thus, fuel pumps are an example of a commodity which has only modest value for its density characteristics. For purposes of illustration, at least, analysis of this product's distribution might show whether only products with low density and high value were commodities economically capable of being distributed by air.

Moseby Company manufactured 36 models of a fuel pump which were higher priced than those of its competitors and 20 models of a competitively priced fuel pump. These 56 models fitted all makes of automobiles except for a few of foreign manufacture. The quality line of fuel pumps was sold under the Moseby V-12 brand name and the lower priced fuel pump was sold under the Moseby 6X brand name. The average price of V-12 models was \$3.65, and the average price of 6X models was \$2.90. The weight per fuel pump was approximately three pounds.

All sales of fuel pumps were for the replacement market, and the models that fitted the numerically most popular cars produced the most sales of fuel pumps; thus, there was a wide variation in demand among the 56 models. Some models were not profitable to handle because demand for the models was very small. However, it was

necessary to offer all models for a complete line of fuel pumps; otherwise dealers were reluctant to carry the line. The company found it difficult to drop any model fuel pump; as an alternative, a constant effort was made to modify models to fit more makes of cars. Of the 36 models in the V-12 line, 5 models produced 52% of the V-12 sales volume. Of the 20 models in the 6X line, the 5 most popular models produced 53% of the 6X sales volume.

DISTRIBUTION

Moseby Company fuel pumps were sold by 14 strategically located manufacturers' agents. The company maintained a sales force of seven to support the manufacturers' agents. The manufacturers' agents sold to approximately 1,200 jobbers and distributors. There was no direct selling by the company or by manufacturers' agents to retail dealers - service stations, garages, automobile accessory stores, etc. When an inquiry or an order was sent direct to the company, the company answered the inquiry by giving the name of the nearest jobber or distributor involved.

The Moseby Company, however, did sell directly to buying groups. The groups were representatives of chain stores or groups of small jobbers that had formed a central buying office.

WAREHOUSES

Inventories of Moseby fuel pumps were maintained at the factory warehouse in Tosca, Kansas, and at seven regional

warehouses located in New York, Atlanta, Chicago, Dallas, San Francisco, Los Angeles, and Seattle. Orders for shipment to distributors were placed by manufacturers' agents at the nearest warehouse, factory or regional. Orders from the buying groups were placed directly with the company and shipments were made from the factory warehouse. The seven regional warehouses produced 44.6% of the total sales volume of the company; the factory warehouse produced the remaining 55.4% of the sales volume. The percentages of total sales, of V-12 sales, and of 6X sales of fuel pumps produced by each warehouse is given in Table 27 below.

TABLE 27
PERCENTAGE OF TOTAL SALES - BY WAREHOUSE

Warehouse	% of Total Sales	% of V-12 Sales	% of 6X Sales
New York	13.9%	15.4%	9.5%
Atlanta	3.3	3.1	3.8
Chicago	12.7	14.1	8.7
San Francisco	2.2	2.7	.7
Los Angeles	5.1	6.1	2.4
Dallas	5.3	4.6	7.4
Seattle	2.1	2.6	.5
Total Regional Warehouses	44.6%	48.6%	33.0%
Factory	55.4	51.4	67.0
TOTAL	100.0%	100.0%	100.0%

Regional warehouses were not owned, leased, or rented by Moseby Company. The warehouses in San Francisco, Chicago and New

York were owned and operated by the manufacturers' agents that represented the company to the trade in those areas. These agents acted also as distributors in those areas. Warehouses in Atlanta, Dallas, Los Angeles, and Seattle were owned by large distributor customers that supplied Moseby fuel pumps to other distributors and to jobbers in those areas. Title to the inventory at the regional warehouses was held by the company. The costs of insurance, taxes, interest on capital tied up in inventory, and policing of inventory were borne by the company. To the owners of each warehouse, Moseby Company paid a warehouse fee equal to 5% on gross sales shipped from the warehouse. This was to cover the expenses of handling the inventory and of picking, packing, and shipping the orders to customers. The inventory level and the replenishing of inventory at the regional warehouses were the responsibilities of the sales department of the Moseby Company.

The factory warehouse in Tosca, Kansas, was owned directly by the company. However, the company was suffering a capital shortage and in order to minimize its capital requirements for carrying the finished goods inventory at the factory warehouse, the company had a field warehouse arrangement with the Excello Warehousing Company. Daily output of the production line went directly to the factory warehouse where it was turned over to the representative of the Excello Company and became the basis for a loan to Moseby. Rates for use of capital tied up in inventory at the factory warehouse were from 10% to 12%.

All shipments to customers or to replenish stocks at regional warehouses were made from the factory inventory. When orders were received at the factory from customers, fuel pumps in the amount of the orders were released by Excello Warehousing Company for shipment. The same procedure was followed when fuel pumps were shipped to the seven regional warehouses for replenishment of regional stock.

MAINTENANCE OF REGIONAL INVENTORY LEVELS

The inventory policy for the seven regional warehouses was to maintain a minimum level of 60 days' inventory and a maximum level of 90 days' inventory. Control of the 60-day minimum and 90-day maximum level of inventory at the seven regional warehouses was administered by the sales department.

There was no regular order schedule for replenishing regional warehouse inventory. The sales department made up replenishment orders based on the balances shown in the inventory record of each regional warehouse plus a general knowledge of the model mix of sales. In addition, replenishment orders were made upon receipt of information from the warehouses that particular models were short or out of stock. In placing regular orders, the sales department planned on 20 days for physical replenishment: 5 days for picking, packing, and shipping an order, 14 days' transit time, and 1 day to put stock on the shelves at the regional warehouse.

Data were available for end-of-month inventory balances from the sales department records (and shipments in units for each month to each warehouse) for the period July through December 1955, and sales in units for each month from each warehouse for the period August - December 1955. Using these data the relationship between average inventory per month and sales per month could be calculated for each month - August-December - for each warehouse. The averages of the five monthly figures expressing inventories as so many days supply for each warehouse are as follows:

TABLE 28
AVERAGE INVENTORY LEVEL - V-12 LINE

WAREHOUSE	DAYS
New York	78
Atlanta	360
Chicago	81
San Francisco	120
Los Angeles	57
Dallas	102
Seattle	135

From the data available, it was concluded that the stated inventory policy of 60 days' minimum and 90 days' maximum was not being followed. The variation from the stated policy resulted in capital being tied up unnecessarily in inventory, particularly in the Atlanta, San Francisco, Seattle, and Dallas warehouses. Inventory on hand in these warehouses was 12 months, 4 months, $4\frac{1}{2}$ months, and $3\frac{1}{2}$ months respectively.

COSTS OF PHYSICAL DISTRIBUTION THROUGH
REGIONAL WAREHOUSES

Regional Warehouse Fee

Five per cent of gross sales of Moseby fuel pumps distributed by the regional warehouses was paid to the manufacturers' agents and distributor customers who operated the warehouses. In 1955, gross sales by all seven warehouses amounted to \$14,488,398. Fees paid to the warehouses or 5% of gross sales amounted to \$724,420.

Interest

Total interest charges on the capital invested in the average inventory in 1955 was estimated to have been \$213,706. The head of the accounting department estimated that the cost of financing the inventory at the warehouse locations was between 10% and 12%. The lower figure was used in computation of cost of capital invested in inventory.

Taxes

The total amount of state, county, and city taxes levied upon the inventories of the regional warehouses in 1955 was \$48,538.80.

Insurance

Insurance premiums paid for protection of inventory at regional warehouses were taken from the accounting department's

insurance account. Insurance premiums for 1955 paid for protection of the inventory at all regional warehouses totaled \$13,000. Total insurance expense was prorated among the regional warehouses in proportion to the value of average inventories.

Cost of Taking Physical Inventory

Inventory was handled and shipped by employees of the distributor in whose warehouse the regional inventory was kept, but the Moseby Company engaged a national public accounting firm to take a physical inventory at each warehouse. The fee for this service was \$10,000 per year for all warehouses. One-seventh of the fee was charged to each regional warehouse in the amount of \$1,428.60 per year.

Obsolescence

No data were available to estimate the annual loss resulting from obsolescence of inventory. Although physical deterioration of the pumps was negligible, older models of pumps showed reduced demand, and even though not calculated explicitly the cost of obsolescence could not have been negligible. It was not feasible to prepare even a rough estimate, however, hence total cost of carrying inventories are understated by an indeterminate amount.

Truck Transportation Expense

Total transportation expense of the Moseby Company was kept by the accounting department. The accounting department

did not break down transportation expense by means of transportation used, by warehouse, or by product. However, the Traffic Manager stated that all shipments were made by truck on an LTL (less than truckload lot) basis.

To determine the cost of truck transportation from the factory warehouse to regional warehouses, 1955 sales in units of each warehouse were converted to pounds and multiplied by the LTL rate to each location. Total transportation expense calculated for transportation of fuel pumps from factory warehouse to regional warehouse in 1955 amounted to \$408,634.13.

The costs described above are shown in Table 29 which follows:

TABLE 29

ESTIMATED COSTS OF PHYSICAL DISTRIBUTION OF
FUEL PUMPS TO REGIONAL WAREHOUSES, 1955

Warehouse	Warehouse Charges (5% fee)	Interest Charges	Taxes	In- surance	Public Accounting Fee	Trans- portation Expense	Total
New York	\$227,072.70	\$ 45,671	\$ 6,293.00	\$ 2,779	\$ 1,428.60	\$126,234.01	\$ 409,478.31
Atlanta	50,468.40	46,954	22,164.20	2,859	1,428.60	39,130.35	163,004.55
Chicago	208,296.00	45,343	3,895.40	2,758	1,428.60	91,892.88	353,613.88
San Francisco	37,567.80	15,361	6,140.00	933	1,428.60	25,762.36	87,192.76
Los Angeles	85,603.50	16,847	6,049.20	1,024	1,428.60	59,068.44	170,020.74
Dallas	79,915.50	22,724	3,003.80	1,382	1,428.60	42,295.77	150,749.67
Seattle	35,496.00	20,806	992.80	1,265	1,428.60	24,250.32	84,238.72
TOTAL	\$724,419.90	\$213,706	\$48,538.40	\$13,000	\$10,000.00	\$408,634.13	\$1,418,298.63

COST OF PHYSICAL DISTRIBUTION OF FUEL PUMPS IF AIR
FREIGHT WERE USED AS THE MEANS OF TRANSPORTATION

For comparison with distribution costs using warehouses, estimates were made of an alternative method of distribution by means of air freight to the distributors who owned the regional warehouses. It was assumed that by using air freight the Moseby Company could dispense with regional warehouses and the inventories carried therein, and at the same time provide approximately equal service to its distributor customers (the present warehouse owners) who sold Moseby pumps in their respective areas.⁷⁹

If air freight were used as the regular means of transportation by the Moseby Company, the costs incurred to distribute the same volume of fuel pumps would include:

1. The air freight rate (including pickup and delivery) from Kansas to each warehouse location applied to the total tonnage (sales volume in units converted to pounds) of the V-12 and 6X lines of each warehouse;
2. Labor cost of an additional employee to handle the increased number of shipments at the factory warehouse estimated at \$2,500.

It was assumed that there would be no increase in the inventory level at the factory warehouse. Shipments of fuel pumps

79. See discussion of this assumption later in this chapter under the sub-heading "Summary and Conclusions".

to replenish inventories at the regional warehouses were already being shipped from the factory warehouse. If monthly shipments to replenish inventories were approximately equal to monthly sales from the regional warehouse, then, under a system of air freight shipments to regional distributors and no warehouse inventories, no change would be expected in the amount of shipments from factory inventories. Consequently, there would be no need to increase factory inventory.

Air Freight Costs

Estimates of the 1955 costs of shipping Moseby's fuel pumps using air freight are shown in Table 30. The table includes, for each warehouse point, 1955 sales of pumps in units of 100 pounds, applicable air freight and pickup and delivery rates, and the total transportation expense for the shipments to all warehouse points combined.

With the exception of the ~~small~~ allowance of \$2,500 to cover the additional employee at the factory warehouse, the transportation costs by air freight represent the total alternative physical distribution costs of this system and may be compared with those of the regional warehouse system.

Table 31 sets forth, for each warehouse point, the 1955 sales volume in units of fuel pumps, distribution costs using

the warehouse system both in total dollars and in dollars per unit of sales, and distribution costs using a system of air freight shipments both in total dollars and in dollars per unit of sales. It will be noted that only for New York does the warehouse system give a cost advantage. For Chicago a very slight unit cost advantage exists for the air freight system, and for the other five warehouse points the air freight system gives a more marked advantage.

TABLE 30

ESTIMATED COST OF TRANSPORTATION OF FUEL PUMPS TO
REGIONAL WAREHOUSE POINTS BY AIR FREIGHT, 1955

Warehouse Point	Sales in Hundreds of Pounds	Air Freight Rate per 100 Pounds	Pickup and Delivery Rate Per 100 Pounds	Total Rate per 100 Pounds	Transportation Expense
New York	38,369	\$ 14.75	\$ 1.03	\$ 15.78	\$ 605,462.82
Atlanta	8,715	16.40	.70	17.10	149,026.50
Chicago	35,208	8.80	.90	9.70	341,517.60
San Francisco	6,253	10.30	.90	11.20	70,033.60
Los Angeles	14,337	9.55	.90	10.45	149,821.65
Dallas	13,959	8.60	.65	9.25	129,120.75
Seattle	5,886	10.95	.90	11.85	69,749.10
TOTAL					\$1,514,732.02

TABLE 31

COMPARISON OF COSTS OF PHYSICAL DISTRIBUTION
FOR THE YEAR 1955

Warehouse	Sales in Units	Warehouse System		Air Freight System		Cost Advantage of Warehouse over Air Freight System
		Total	Per Unit of Sales	Total	Per Unit of Sales	
New York	1,279,260	\$409,478.31	\$ 0.31	\$605,462.82	\$ 0.47	+ \$ 195,984.51
Atlanta	290,520	163,004.55	0.56	149,026.50	0.51	- 13,978.05
Chicago	1,173,600	353,613.88	0.30	341,517.60	0.29	- 12,096.28
San Francisco	208,440	87,192.76	0.42	70,033.60	0.34	- 17,159.16
Los Angeles	477,900	170,020.74	0.36	149,821.65	0.31	- 20,199.09
Dallas	465,300	150,749.67	0.32	129,120.75	0.28	- 21,628.92
Seattle	196,200	84,238.72	0.43	69,749.10	0.35	- 14,489.62
Sub-Total		\$1,418,298.63		\$1,514,732.02		+ \$ 96,433.39
Factory In- ventory In- creased Labor Charge				2,500.00		+ 2,500.00
TOTAL		\$1,418,298.63		\$1,517,232.02		+ \$ 98,933.39

On the basis of the calculations set forth in Table 31, if Moseby were to abandon entirely its regional warehouse system and shift to an air freight system, its physical distribution costs would be increased by nearly \$99,000 at the 1955 sales volume. This would amount to 2.4¢ per unit of sales.

On the other hand, this must be analyzed further because the results for individual warehouses are not uniform. The cost disadvantage of the air freight system for New York is so great that it outweighs the cost advantages of air freight at the other six warehouse points. It is more meaningful to appraise the relative advantages of the two systems for each warehouse point separately. On this basis an alternative method of distribution by Moseby Company might be to continue the maintenance of inventory at the New York warehouse with replenishment of inventory by motor carrier, and to discontinue the maintenance of inventory at the six regional warehouses in Atlanta, Chicago, Dallas, Los Angeles, San Francisco, and Seattle, and to ship to these six points by air freight.

A comparison of the distribution costs for the year 1955 under such a system with the costs of the present system using seven regional warehouses is as follows:

New York Warehouse Expense	\$ 409,478
Air Freight Cost to the Other Six	909,269
Regional Warehouses	

Total	\$1,318,747
Additional Labor Cost at Factory	2,500
Warehouse	
Total Physical Distribution Cost for New	\$1,321,247
York Warehouse and Air Freight to	
Other Six Warehouse Points	
Total Physical Distribution Cost for	\$1,418,298
Operating All Seven Warehouses	
NET SAVINGS WITH USE OF NEW YORK	\$ 97,051
WAREHOUSE AND AIR FREIGHT TO OTHER	
SIX WAREHOUSE POINTS	

The comparison of the calculations in Table 31 with the calculations above illustrates the importance of developing cost data for individual cost centres. Each warehouse is a centre of cost and the pattern of costs of each is not uniform.

If the potential reduction in total cost were realized, it would be equal to an increase of profit of 0.8% on the 6X line and an increase of profit of 0.6% on the V-12 line.

In addition to potential savings, a change in the method of distribution would potentially affect three related areas: capital invested in inventory, control of the total inventory position, and total sales volume.

Capital Invested in Inventory

If the Moseby Company decided that the use of air freight would enable it to abandon its regional warehouses, other than that at New York, capital invested in inventory would be released. Additionally, as was previously shown in this chapter, the use of air would enable the size of inventory carried at the factory warehouse to be reduced also.

Inventory Control

Inventory would be consolidated and reduced at the factory warehouse, making possible a more effective control of the total inventory position of the company.

Sales

The regional warehouses were owned and operated by large distributor customers of Moseby Company. In addition to the warehouse fee paid by Moseby Company, the owners of the warehouses had the advantage of not having to invest in inventory for their sales. If air freight were used rather than maintaining regional stocks which were owned by Moseby, presumably the distributors would want to carry at least some inventory of their own. If this took place, the transfer of ownership of part or all of the inventory from Moseby to the distributors would be recorded as a one-time jump in sales. On the other hand, if the warehouse owners carried the Moseby Company line of fuel pumps in preference to a competitor's line because

of the warehouse arrangement, with Moseby financing the distributors' inventory, and if the distributors would not carry Moseby fuel pumps if the warehouse arrangements were no longer used by the Moseby Company, then sales would suffer a sharp decline. If this should occur, it would be a major blow to the company because, in the areas served by the respective warehouses, these distributors were prime outlets, and it would be difficult to find comparable replacements.

The above are qualitative factors that would have to be evaluated, along with the quantitative data, by the company in making a decision to change the method of physical distribution of fuel pumps.

The Moseby Company study is illustrative of the mechanics and value of developing the cost of physical distribution within the framework of the total cost concept. In addition, the Moseby Company presents some evidence that commodities which are economically capable of being distributed by air are not necessarily only those with a high value-to-weight relationship.

Case Study "B" - Renault Incorporated

Although the case study which follows is not concerned with a domestic U.S. commodity movement, I think it is of interest and relevant and I have, therefore, included it. The data presented here were obtained by me from the Renault Company of New York, and

were, subsequently, the subject of several articles in various aviation magazines.

At the start of 1960, Renault Incorporated expected to ship, during that year, about fifteen hundred tons of automobile parts across the Atlantic, in one hundred and fifty chartered aircraft. The manager of their central parts depot in New York reported, at the end of 1960, that these expectations had been realized.

This French automobile manufacturer began moving all parts for its cars to the United States by air in November 1958, and by the end of 1959 it had airlifted about 900 tons of parts in 90 chartered flights.

By shortening the period of time that parts are in transit, by reducing inventory, packaging costs, handling costs, and damage losses, the operation has been made into a net dollar saver over the old system of sea shipments. Additionally, Renault claims that it has made possible better service to Renault distributors and dealers in North America.

The Renault parts formerly moved by a combination of routine sea transport for regular stock replenishment and by scheduled air freight when emergency required. By changing to the regular use of weekly charter air freight flights, Renault has reduced the replenishment cycle from their Paris manufacturing facility to the

central parts depot in New York to a maximum of five working days. This cycle should be compared with the twenty working days which were required using the old system.

Using air freight, Renault does not have to crate the parts and, indeed, many parts are shipped loose. In some cases, light cartons are required.

After shipments arrive at Idlewild Airport, and when immediate customs clearance is available, they are moved directly from plane to truck. Otherwise, shipments are moved from the aircraft onto an air freight dock. After customs clearance is carried out, the plane load is moved to the Renault parts depot in two trailer trucks. It required twelve platform trucks to hold the same amount of parts under the old system, and this was so because they had to be packed for surface shipment.

Using sea freight, transit time across the Atlantic was two weeks, and this resulted in Renault having to maintain a much larger inventory than has been necessary ever since they have used air freight. In addition, it is no longer necessary to ship the parts by rail from Paris to the port of embarkation - Le Havre.

The Renault Company reports that, during the period of the sea freight operation, damage to certain types of parts received ran about 50%. In their new air freighting system, damage amounts to about 5%. This impressive reduction in the percentage of

damaged parts helps the parts operation in several ways. The larger inventories of parts which are susceptible to damage can now be reduced. Time is saved, time which was formerly lost when damaged parts were sent out to be repaired locally.

When the air freight operation began, it cost Renault forty cents per pound for the actual air shipment. This contrasted with seventeen cents by sea freight. As Renault developed better handling methods and gained experience in programming payloads, they gradually succeeded in obtaining better rates. At the beginning of 1960, Renault was paying thirty-four cents per pound by air. By then, the central parts depot was ordering heavy parts once a month and lighter parts once a week. This manner of ordering enabled the load planners in France to mix the parts in order to effect the most economical loading scheme. Charter arrangements are made some five to ten days in advance of requirements, but, normally, two or three days is sufficient time.

The Renault Company made a cost comparison based on the first three-month period in which all parts moved by air freight. During that time, Renault imported \$203,000 worth of auto parts into the U.S.A. Renault's comparison of the cost of shipping parts by air freight and sea freight follows:

	NEW SYSTEM (AIR)	OLD SYSTEM (STEAMSHIP)
Packing (materials & labour)	\$ 917.39	\$ 7,216.82
Freight Charge	49,539.19	11,864.94 (Stock Orders, Ship)
		21,201.96 (Emergency Orders, Air)
Unpacking		6,992.57
U.S. Inventory Carrying Costs	5,096.63 (2-3 months)	10,193.25 (about 5 months)
U.S. Warehouse Costs (space, personnel)	<u>6,319.82</u>	<u>12,293.06</u>
Gross Total	\$ 61,873.03	\$ 69,762.60
Less Damage Savings	- \$ 10,000.00	
Net Total	<u>\$ 51,873.03</u>	<u>\$ 69,762.60</u>

Case Study "C" - The Raytheon Company

Information on the Raytheon Company which follows here has been derived from a booklet published by the company entitled "Unimarket - An Integrated Distribution System".

Although no detailed cost figures are contained in this study, it is considered to be of importance since it illustrates the way in which new order processing techniques are being used to improve overall distribution processes.

The Raytheon Company, a large manufacturer of electronic products located in Massachusetts, has a separate division known as the Distributor Products Division. This Division has introduced a new system of distribution which they named "Unimarket". This system entails the establishment of a headquarters which effectively integrates the latest methods of order communication, order processing, and order delivery.

Working with American Airlines' Distribution Consulting Service, Raytheon personnel made a complete evaluation of shipping schedules and shipping costs from their facility (which they call "Unicenter") at Westwood, Massachusetts, to each of their franchised distributors throughout the United States, with the aim of establishing a single shipping point for their entire U.S. market.

They next investigated order transmission facilities and a way was found, through the utilization of Western Union's electronic transmitters, to transmit order data from district offices directly to Westwood by a method which would provide simultaneous reproduction of data processing cards for automatic replenishment of inventory.

All indications resulting from the investigations were that the proposed system was economically sound and practical. The system was therefore put into effect.

Under this system, which has now been in full operation for some time, the ordered products, when ready, are delivered to the airline at Logan (Boston) Airport. The products are transported by air freight to Raytheon distributors in Los Angeles, Chicago, Dallas, Atlanta and other points, within hours after the orders are placed.

Before the advent of their Unimarket system, Raytheon had experienced distribution problems created by weaknesses in the multiple warehouse system.

In April, 1960, a senior executive of Raytheon claimed the following advantages for the new system which uses air freight:

"First, we have made the United States one market.

No longer do we consider a Western Region, Southwestern Region, Middle West and Northeast Region.

From Unicenter in Westwood, Massachusetts, we communicate with our customers and we supply them with products no matter ~~where~~ they may be located.

From this single point we place manufacturing schedules on eight manufacturing divisions of Raytheon, representing the total requirements for each of these product lines for the whole country.

By the end of this year (1960) we will have eliminated 50% of our dollar investment in inventory. We will have taken a long step forward providing immediate reaction in the manufacturing schedule to the atmosphere in the market place.

In addition to all this, our customers find that it is and will be easier to do business with Raytheon."

In three months - January to April, 1961 - Raytheon's Distributor Products Division experienced total cost savings of 17.2% over the same period in 1960. During the 15 months from January, 1960, to March, 1961, the Division's inventories were reduced by some 44.1%, and Raytheon's business had increased substantially

SUMMARY AND CONCLUSIONS

Discussion in this chapter has indicated that the packaging, damage and pilferage costs incurred in the movement of commodities by air have been less (on a percentage basis) than the same costs incurred by surface transportation media.

Analysis in this chapter has indicated that, in the examples shown, the use of air transportation would enable inventory costs to be cut and customer service levels to be increased.

The case studies have generally indicated that the use of air for the transportation of the commodities examined would cut total distribution costs. In this regard, though, the most detailed of the case studies (Case Study "A") made the fundamental assumption that the use of air transportation would enable the company to dispense with its regional warehouses and their inventories.

Having made this assumption, the distribution costs by air (that is, the air freight costs plus the local pickup and delivery costs) were compared to the distribution costs by truck (that is, the truck costs, insurance costs, warehouse costs, etc.). The result was favourable to air - to six out of the seven warehouse points.

The study did note, however, that the distributors might need to maintain some inventory themselves under an air distribution system. If the distributors were unwilling or unable to maintain these inventories themselves, even at a reduced level, the Moseby Company would have to re-assume their maintenance and the associated costs.

This would alter the comparative cost figures shown in the study and might eliminate some or all of air's advantage.

However, it is believed that the discussion, analyses and case studies presented in this chapter do indicate that, under certain conditions, the use of air for the distribution of commodities is economically feasible.

Commodities are presently being transported by air, but in 1960, only 413 million ton-miles of air freight were performed in the United States⁸⁰, out of a total of 311 billion ton-miles of air freight "potential" in the same year⁸¹. Actual air freight thus represented only 0.13% of the theoretical potential.

It is believed, therefore, that there presently exists in the United States a sufficient volume of commodities that

80. See Table 1.

81. See Table 4.

could be moved economically by air to fill foreseeable air freight capacity. The following chapter presents the overall conclusions with regard to growth of the air freight industry.

BIBLIOGRAPHY

- American Airlines, A Study of the Effect of Air Transportation Upon Profits Resulting from Changes in Costs at Various Levels of Volume When Prices Remain Constant, (New York, 1954).
- Bowersox, D. J., Mossman, F. H., Smykay, E. W., Physical Distribution Management, (MacMillan Company, New York, 1961).
- Busch, G. A., Mayer, K. M., An Examination of the Economic and Technical Factors Underlying the Future U.S. Domestic Market for Air Cargo Transportation Service, (Institute of the Aerospace Sciences, Los Angeles, 1961).
- Culliton, J. W., Lewis, H. T., Steele, J. D., The Role of Air Freight in Physical Distribution, (Harvard University Press, Cambridge, 1956).
- Johnson, R. A., Parker, D. D., Optimizing Customer Delivery Service with Improved Distribution, (University of Washington, Seattle, 1961).
- Raytheon Company, Unimarket - An Integrated Distribution System, (Westwood, 1960).
- Aviation Week, (American Aviation Publications Inc., Washington, January 4, 1960).

CHAPTER V

CONCLUSIONS REGARDING THE FUTURE
DEVELOPMENT OF THE UNITED STATES
DOMESTIC AIR FREIGHT INDUSTRY

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THE ECONOMY AND AIR FREIGHT DEVELOPMENT

From 1951 to 1960 real Gross National Product rose 28%, while air freight traffic increased 133%, even though average air freight rates rose.

On the basis of this past performance only, and if real GNP continues to rise during the next ten years, it might be expected that air freight traffic would rise four times as fast as GNP.

There are, however, other factors which bear upon this rate of growth. These are discussed below.

TEMPO OF AIR FREIGHT SALES ACTIVITIES IN THE AIRLINES

Should the air freight industry greatly increase its sales activities, using total cost of distribution analyses as one of its sales tools, it is believed that its rate of growth would be increased beyond the GNP/air freight traffic growth relationship indicated above.

The degree to which airlines will increase their air freight sales activities will probably depend upon the rate of growth

of the air passenger market. Historically, the airlines have been concerned almost exclusively with this market. Should the rate of growth in the passenger market continue the decline it has experienced over the past two years, it may be expected that the airlines will turn their attention more seriously to the air freight market.

AIR FREIGHT RATES

It is expected that the lower direct operating costs of new turbo-jet and turbo-prop cargo aircraft will result in lower average air freight rates. In turn, lower rates are expected to increase the rate of traffic growth, in excess of the rate which was experienced during the period 1951 to 1960.

AIR FREIGHT CAPACITY

Unless there is a really sudden, unexpected and dramatic increase in the volume of air freight traffic, it is not expected that available capacity will be a limiting factor in traffic growth.

Aircraft manufacturers are able to supply all-cargo aircraft comparatively quickly, and sufficient excess passenger capacity presently exists for the airlines to be able to convert quickly to freight capacity.

OTHER FACTORS EXPECTED TO ASSIST IN THE GROWTH OF AIR
FREIGHT TRAFFIC

It is expected that air freight traffic will grow as an indirect result of the introduction of new production and distribution processes. Computer-controlled inventory processes and electronic ordering processes, already introduced by a few firms in order to gain a competitive advantage, may be adopted by other firms in order to remain competitive. It is expected that such adoption will, in many cases, result in increased use of air freight.

Increases in air freight traffic, beyond certain levels, may be self-generating. Increased traffic volumes will lower unit costs, which could enable airlines to carry commodities which were previously beyond their economic reach.

AIR FREIGHT COMPETITION WITH RAIL AND TRUCK TRANSPORT

It appears that the main competition facing the railroad industry and the trucking industry is from each other, and that neither of these media have yet much to fear from the air freight industry, in terms of losing large volumes of traffic.

In 1960, scheduled domestic air freight traffic represented only 0.4% of inter-city Class I, II and III motor common

carrier freight traffic, and only 0.07% of Class I railroad freight traffic.

However, should the air freight industry greatly increase its sales activity, using total cost of distribution analyses as one of its sales tools, it is expected that this industry could take a lot of high-rated traffic away from the railroads and the trucks.