TEXAS AIRPORT SYSTEM PLAN

Air Cargo Analysis And Forecasts

Prepared For

Office of the Governor
Division of Planning Coordination

Texas Aeronautics Commission

By

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PREFACE

This report presents the findings of the Air Cargo Study element of the Texas Airport System Plan - Phase II. The study was conducted by and in cooperation with the Texas Aeronautics Commission and the Office of the Governor, Division of Planning Coordination.

This report on air cargo was developed primarily by Economics Research Associates, Los Angeles, California, which had the major responsibility for study direction and execution and provided most of the staff effort relative to the air cargo analysis and forecasting element. Texas Transportation Institute provided assistance and information in those areas where location and staff experience could be best utilized.

The report was prepared under the direction of Gregory Vore of ERA. The following individuals made major contributions to the report: Frank Hahn, Richard Lyon, Leonard Quick, Thomas Reveles, and Robert Wright all with ERA, and George Dresser and Jack Lamkin of the TTI staff. The authors express their thanks to the several airport managers; air carrier executives; Chambers of Commerce; and many Texas industrialists interested in air cargo; and, officials of local, state, and federal agencies that cooperated in making the necessary information available.

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Part 1

INTRODUCTION AND SUMMARY

INTRODUCTION

The Texas Air Cargo Study was conducted to estimate the present and future (to 1990) demand for air cargo transportation in Texas as an essential element of the Texas Airport System Plan. This report (1) provides estimates of present air cargo movements; (2) assesses the impact of air cargo technology as it may affect present freight distribution patterns for products Texans produce or consume; (3) provides forecasts for anticipated air cargo movements; (4) relates air cargo demand to aircraft operations; and (5) supports policy formulation for promotion of air cargo service for Texans.

The report is organized into seven parts. Part 1, "Introduction and Summary," explains the purpose and organization, and summarizes major findings. Part 2, "Policy Implications," supports policy formulation in the sphere of air cargo service. Part 3, "Present and Historical Air Cargo Movements and Shipment Patterns," provides a picture of air cargo operations as they have developed over the last decade in Texas. Part 4, "Impact of Air Cargo Technology," assesses the likely future of technology and its effect on costs and services. Part 5, "Forecasts," provides the details behind the summary forecasts and the supporting methodology. Part 6, "Demand Capacity Analysis," relates the forecasts to air carrier and airport capacities. Part 7 is the "Bibliography."

The scope of the study was defined by a work statement prepared prior to the start of the study, which outlined specific tasks and subtasks for each of five study objectives. As the various tasks and subtasks were accomplished, results were documented in a series of 36 Technical Notes. Most of the notes are complete in themselves. Some are procedural, that is, they were used to document how something was done, but most were used to document a finding or conclusion. Much of the context of these notes is incorporated in this report. On the other hand, a considerable amount was deemed to be of insufficient interest to the general reader for inclusion. Those with a specialized interest in a particular area may request copies of the original technical notes from the Texas Transportation Institute. A full list of titles is provided here as Exhibit 1-1 to acquaint the reader with the breadth of subjects investigated during the study.

Exhibit 1-1

TECHNICAL NOTES IN SUPPORT OF TEXAS AIR CARGO STUDY

Number	Title	Author	Organization
1	Shares of Air Cargo Originations by Texas Certificated Air Carrier Airports	R. Wright, G. Vore	ERA
2	Shippers Survey for the Texas Airport Systems Plan: Manufacturers	G. Vore	ERA
3	Airborne Export-Import Activity by Texas Customs Districts	R. Wright	ERA
4	Trend-Based Forecasts of Cargo Originated by Certificated Carriers for United States, Texas and Top Three Texas Airports: Share of Market Method	R. Wright	ERA
5	Review of Commodities Exported by Air Through the Texas Customs Districts in 1966	T. Reveles	ERA
6	Shippers Survey Design, Manufacturers	G. Vore, R. Wright	ERA
7	The Department of Defense as a Generator of Domestic Air Cargo Movements on Certificated Air Carrier Airports in Texas	G. Vore	ERA
8	Trend-Based Forecasts of Cargo Originated by Certificated Carriers for the Residual 26 Texas Airports: Share of Market Method	R. Wright	ERA
9	Shippers Survey, Manufacturers: Sample Set 3	R. Wright	ERA
10	Cargo Aircraft Technology	L. Quick	ERA
11	Air Cargo Handling Technology	L. Quick	ERA
12	U.S. Commodity Exports and Imports by Air as an Indicator of Potential Air Cargo Markets for Texas	G. Vore, T. Reveles	ERA
13	Trend-Based Forecasts of Freight, Express, and Mail Originated by Certificated Carriers for United States, Texas, Top Three Hubs, and State Residual: Share of Market Method	R. Wright	ERA
14	Competitive Technologies	L. Quick	ERA
15	Impact of Technology on Distribution Costs and Tariffs	L. Quick	ERA
16	Increments for the Trend-Based Forecasts of Texas Freight, Express and Mail, and Cargo Macro Parameters	R. Wright	ERA
17	Output-Propensity Analysis of Texas Manufacturing and Air Freight; Long-Range Air Potential Commodities	R. Wright	ERA
18	Preliminary Share-of-Market Forecasts of Passenger Originations for United States, Texas, Top Four, and Residual 25: Derivative Factors and Ratios	R. Wright	ERA*
19	All Cargo Operations at Texas Hubs and Their Forecasts	G. Vore	ERA
20	Forecast Aircraft Mix Texas Airport Hubs	L. Quick	ERA*
21	Air Cargo Share of Market at Texas Airports and Performance of Certificated Carrier Serving Texas Air Carrier Airports and Texarkana	G. Vore, F. Hahn	ERA
22	Texas Wholesale Florists as Air Cargo Shippers and Consignees	G. Vore	ERA
23	Industrial and Research Laboratories Survey: Analysis of Responses	R. Wright	ERA
24	Small Shipments in Air Cargo Transport and the Special Case of the Package Shipments	G. Vore	ERA
25	Hinterland Distribution of Air Cargo Shipments from Major Airports: Bluebonnet Express Movements from and to Hobby Airport, Houston	T. Reveles, R. Wright	ERA
26	Supplemental Air Cargo Service and its Importance to Texas	R. Lyon	ERA
27	Forecast of Air Cargo Movements in Export and Import Trades from Texas Gateway Airports	R. Wright	ERA
28	Texas Participation in Industries Exporting Significantly by Air	T. Reveles	ERA
29	Commodities, Air Origin/Destination and Surface Origin/Destination; Shipping Weight Data from Bluebonnet Express	R. Wright, T. Reveles	ERA
30	The Potential for Shipping Texas Agricultural Commodities by Air Cargo	J. Lamkin	TTI
31	Analyses of Manufacturers Survey	G. Dresser	TTI
32	Results of the Air Carrier Survey, Station Specific Analysis	G. Dresser, G. Vore	TTI, ERA
33	An Analysis of the Potential for Shipping Texas Strawberries and Blue Crabs by Air Cargo	J. Lamkin	TTI
34	Perishability Differential Analysis of Agricultural Commodities as a Consideration for Shipments by Air	J. Lamkin	TTI
35	All-Cargo Airports	G. Vore	ERA
36	Bibliography		

*Technical Notes 18 and 20 were prepared in support of other phases of the Texas Airport Systems Plan. Results are not included in this report

SUMMARY

- Forecasts of total cargo enplaning and deplaning at the top four Texas hubs (Dallas/Fort Worth, Houston, San Antonio and El Paso) and the total for the other 25 are shown in Figure 1-1. Figure 1-2 shows the cargo originations on which the total estimates are based, and also permits the following comparisons.
  - a. By 1980 the Dallas/Fort Worth hub will have cargo originations approximating Chicago in 1970.
  - b. By 1980 Houston's cargo traffic will be like San Francisco is now.
  - c. By 1990 San Antonio would have a cargo corresponding to that of Dallas/Fort Worth in 1967.
  - d. By 1990 El Paso would present a cargo picture like Dallas/Fort Worth in 1964.
  - e. By 1990 Austin, the largest of the smaller hubs, would be like Houston in 1968.
- No exceptional growth trend is foreseen within the 1990 time frame.
- Air in 1969 accounted for less than one-half percent of total inter-city freight ton-miles. While air's share is growing, it will probably still be less than one percent in 1990.
- It is in the area of increased level of service where major future competition is anticipated between air and long-range highway transport. There is now and will continue to be selected rate competitiveness for small shipments over long distances.

Figure 1-1

ENPLANED AND DEPLANED AIR CARGO FOR
TOP FOUR, AND RESIDUAL 25, 1962-1990

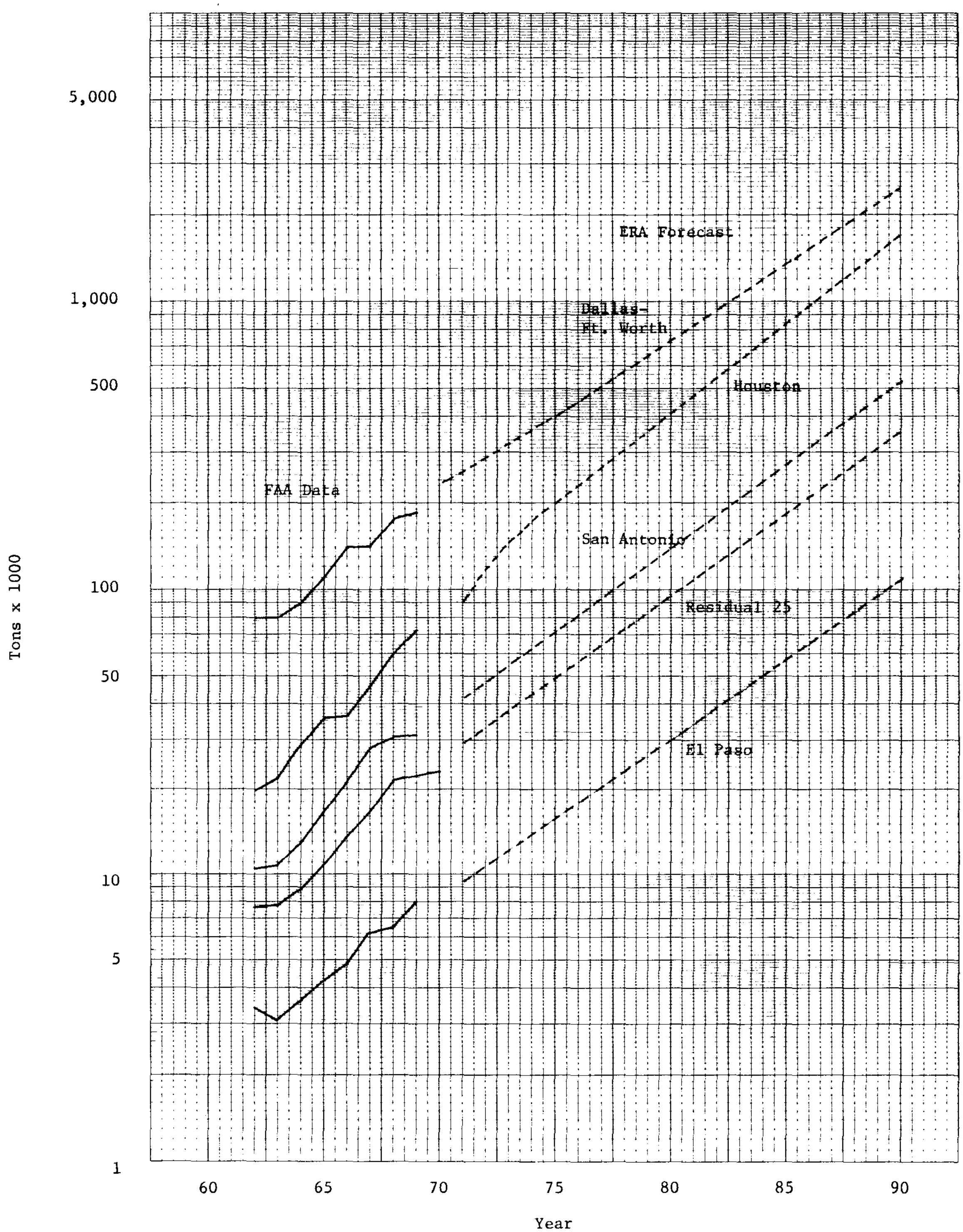
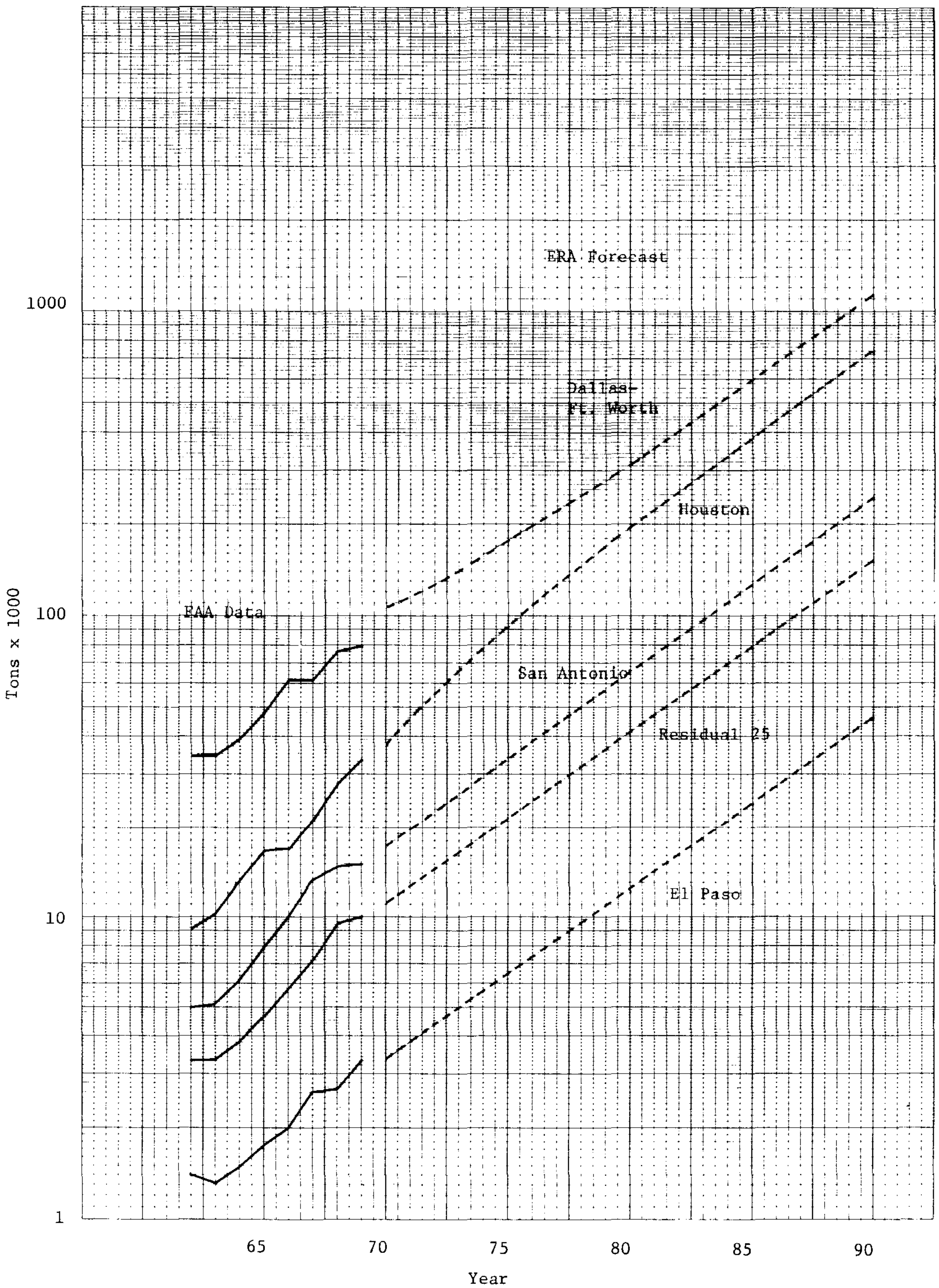


Figure 1-2

ENPLANED AIR CARGO FOR
TOP FOUR, AND RESIDUAL 25, 1962-1990



- Air cargo's greatest future potential market is the international transport of packaged cargo - especially commodities which have any degree of time sensitivity. This holds with greater strength for inland origins and/or destinations.
- Large "uncompromised" all-cargo aircraft would become operational in the 1980-1990 time period probably in international service. Combined with truly intermodal containers, such aircraft could significantly increase air's region of competitive capability vis-à-vis surface modes.
- No dramatic technological breakthrough can be detected at this time.
    a. All evidence indicates that within the foreseeable future, air cargo will be primarily carried by conventional take-off and landing aircraft operating from established airfields. The technical, operational, and economic problems of STOL aircraft would seem to preclude their extensive use as cargo carriers within the 1970-1990 time frame.
    b. The present state-of-the-art of cargo containerization is fairly primitive, both technically and operationally. The technical problems associated with containerization are not difficult - the operational problems are. The lack of standardized containers impedes the growth of interlined air cargo and intermodal movements.
    c. Fixed mechanized cargo handling systems are relatively costly, and their cost can be justified only at a relatively few high activity airports. Most smaller airports will continue to utilize manual, or mobile, cargo handling equipment for at least the next 10 to 20 years.

- Air cargo shipments into Texas exceed air cargo shipments out of Texas by significant margins. (Note the difference in the two forecast graphs.)
- Wide-bodied aircraft (B747, DC10, L1011) will be increasingly apparent at the top four Texas airports and will provide an increased cargo capacity.
- No general shortage of air cargo carrying capacity is anticipated in the 20 year plan period, particularly for outgoing shipments. Specific short-term shortages have occurred and will occur as in other transport modes.
    a. Industry studies have shown that the total belly cargo capacity of new wide-bodied jets in service or on order should exceed projected air cargo demand for approximately the next 10 years.
    b. The over capacity of belly cargo space could lead to more impact on the air freight rate structure than any other development in the next decade.
- At the smaller hubs, stimulative effects on increased use of air cargo in distribution of products of the local economies will come from passenger demand push and consequent more frequent schedules. Upward adjustment on capacity limits of third level carriers would have the effect of relaxing potential bottlenecks.
- Rates are not expected to become seriously competitive with trucks for air cargo feeder service from the smaller communities to the major and medium hubs.
- Air cargo is primarily small shipments, and this effect appears more pronounced in Texas than for the United States as a whole. An increase in consolidation services has the potential for favorable economies to Texas shippers.

- Specialized plane-load-lot shipments have occurred and will continue to occur as in the striking case of shipments of Texas cattle to Korea and Chile. These shipments are sporadic and best handled through charter operations.
- For the most part, plane-load-lot shipments will not have a prominent place in air distribution, particularly in domestic commerce.
- Air cargo will serve Texas shippers predominately by permitting rapid delivery of samples to potential customers, providing emergency shipments of spare parts, drugs, etc., and giving customers the capability of maintaining low inventories. Air cargo also gives Texas shippers the ability to penetrate distant markets for perishables such as live crabs, decorative greens, and baby chicks.
- All-cargo aircraft operations are projected to be increasing at a greater rate than total scheduled operations at the top three hubs during the plan period. El Paso is expected to have all-cargo operations by 1980. Close observers of the Border Industrial Program feel that scheduled all-cargo service may become essential in the Lower Rio Grande to support distribution of electronics and apparel (though they acknowledge the present situation does not support this).

Part 2

POLICY IMPLICATIONS

INTRODUCTION

The objectives of the Texas Air Cargo Study in the matter of policy were twofold: (1) to assist the State in overcoming deficits in air cargo service by (a) ascertaining views of Texas shippers on air cargo problems and potential, (b) determining market development emphasis on the part of carriers, and (c) providing informational background on supplementary services; and (2) to provide cargo planning factors and guidance in airport plans and designs. In addition, study results make it possible to alert Texas state and local authorities to issues of some sensitivity to Texas for which they may wish to make interested party representations to regulatory bodies, legislative committees, etc. Study observations of this nature appear as a third section of this Part 2, "Policy Implications."

PROMOTION OF AIR CARGO SERVICES

The Work Statement directs... "the analysis... [of demand capacity relationships] ... will provide estimates of points at which deficits occur. The degree and direction which the State should bring its influence to bear is, in part, a function of the degree to which shipper and carrier can bilaterally resolve a pending deficit in capacity. To assist the State in this matter, the study will undertake the following: The analysis of responses to questions on the surveys of shippers/consignees regarding air carrier service, and with carriers regarding demand and marketing response. Since less than satisfactory cargo service from scheduled carriers might be answered by charter service, a survey of charter freight services in the United States will be undertaken."

Overall study results indicated that no general deficit in air cargo carrying capacity would occur in the plan period. This is explored in detail in Part 6, "Demand Capacity Analysis." Some spot bottlenecks will appear, however, just as in surface mode transportation. Because Texas is a net "importer" of air cargo, these bottlenecks are more apt to occur on inbound consignments than on outbound Texas shipments. Some suggestions on specific policy initiatives are given below.

Shippers and Consignees Responses

Formal surveys were undertaken of selected high air cargo potential manufacturers, of wholesale florists, and industrial laboratories. One open-ended question asked for their comments on air cargo service, and these responses are summarized and presented here. Analyses of the responses to the formal questions appear elsewhere in the report, particularly in Parts 3 and 5. In addition, selected shippers or potential shippers in agriculture and fisheries were interviewed, and some inferences on capacity and service may be drawn from them.

Manufacturers

Texas manufacturers view air cargo primarily as an emergency means of transportation and not as part of their normal distribution system. As such, air cargo provides an extremely valuable service. At the same time, there are no indications that this view of air cargo will change in the near future. Shippers foresee a relatively slower growth in air cargo shipments than in total shipment growth. There are indications that shippers expect air rates to decline relative to motor carrier rates and, if such occurs, they will increase their use of air cargo. There are shipper complaints of air cargo service, particularly at the smaller airports, but these complaints are very similar to complaints frequently levied against common carrier motor transportation. Overall, the survey results support a conclusion of no dramatic growth in air cargo as a result of the manufacturing sector but rather continued growth at a level equal to or less than recent growth patterns.

These conclusions are very much in agreement with the results of a survey conducted by Distribution Worldwide, January 1972. This survey concluded that "despite considerable effort on the part of airline cargo management in marketing the concept, shipper attitude really hasn't changed materially in the past five years."

Detailed comments were excerpted from the survey responses and are presented as Exhibit 2-1.

Exhibit 2-1

SHIPPER COMMENTS
MANUFACTURERS FROM THE TEXAS AIR CARGO STUDY SURVEY
First Quarter 1972

(Note Numbers Represent Standard Industrial Classification and Employment Size)

23110/5 We have no present plan to increase use of air freight -- either in or outbound.

23110/5 Use air freight very little. Only twice per year to ship out salesmen's samples. Also very few incoming samples of piece goods.

26510/5 The only air shipments we anticipate are emergency machine parts.

27520/7 The future of Air Cargo is perhaps the brightest of all modes. They appear to be more innovative in their thinking and have apparently done a better job in holding the line on rate increases.

The rapid rate increases by other modes (particularly common motor carrier), and increased service demands have steadily decreased the importance (and the size) of the cost differential paid for Air Cargo service.

I personally would like to see the rapid expansion of "Low Priority Air Freight," with a rate structure midway between existing motor carrier rates and established air freight rates. From a practical standpoint, it would fill an existing gap in the service spectrum. An example of this would be as follows on a 200 lb. shipment, Dallas to Chicago, Illinois.

Mode	Cost (Approximate)	Normal Transit Time
Motor Carrier	$ 15.00	4 days
"Low Priority Air Frt."	30.00	2 days
Existing Air Freight	45.00	1 day

This would give shippers more flexibility in balancing cost against service requirements and would give air carriers a means of leveling the cargo input to the scheduling function, and increase the overall air/mileage earnings.

27530/5 It is becoming increasingly more difficult to ship high value (gold content) shipments through any other method than the U. S. Post Office. Many airlines will not accept jewelry or high value shipments.

28151/7 This questionnaire is not particularly applicable to our business of petroleum refining, since we have no regular shipments of incoming or outgoing products by air.

We do use air freight for incoming emergency shipments of repair materials. This will average four to five shipments per month with an average weight of 50 lbs.

Exhibit 2-1 (Continued)

28151/7 Inadequate service at Big Spring due to schedules and aircraft size limit shipments by air.

28181/7 Our use of air transportation is directed toward receipt of emergency shipments of repair parts.

28213/6 Due to the Jet Age and the need for complete utilization of these aircraft, we can expect lower rates to be established in order to generate larger volumes of freight. During the daylight hours, these planes will carry passengers and at night the seats will be removed and these planes will haul freight. It will not be too many years before a loaded trailer will be picked up at a shipper, carried to a waiting plane where the entire trailer will be loaded intact and flown to its destination. At the destination, this trailer will be removed and trucked for final delivery.

28340/6 Rates for ground modes are increasing. If air rates become comparable, there will be a time advantage realized by using air.

34610/5 During 1970, Brownsville was served for the majority of the year with only one commercial airline flight which left Brownsville in the early afternoon. This meant that the majority of our air shipments were held at the airport from 15 to 20 hours.

35330/5 Principal Gripe - Air cargo bumped due to higher priority of mail.

35330/6 We have had to employ an Air Contract Hauler because:

1. Limited destinations of Air Cargo Service.
2. Lack of dependability of scheduled airlines to load freight the first available departing flight.
3. Scheduled airlines do not service all of the locations to which we deliver.

Airlines should adopt a policy of confirming available space for Air Freight when given sufficient time and specifications.

35330/6 Utilization of air cargo will probably increase slightly although there are no statistics on which this opinion can be based.

35330/4 Our air cargo volume is low, but extremely important because of emergency nature.

Our best experience by far is shipping via scheduled air carrier.

Parcel Post, air express, and expanded service have no tracing capability. If cargo doesn't arrive as expected you are out of luck.

Exhibit 2-1 (Continued)

35330/6 Shipments that have gone astray continue to be a problem with domestic airlines. If the shipment does not arrive at destination within a reasonable length of time, a shipper might as well give up and re-ship merchandise as there seems to be no way to locate these astray shipments by current airline procedures.

36795/1 UPS should be given both intra and interstate east and west! This is faster, less handling and much more convenient and much less expensive!

36795/2 We foresee a decrease in usage of Air Express and an increase of Air Freight. Further, we foresee an increase in Air Freight expediting to alleviate ground handling problems. Further alleviation of ground handling and delay seem to be indicated. More direct Air Freight flights to eliminate losses and delays is desirable.

37290/8 The airlines must take steps to bring their rate structures more in line with surface transportation in order to divert more shipments to air service.

37290/9 At the present time some of the major air carriers are experimenting with rate structures that are comparable to motor freight on items in classes 100 and higher. Although the points to which these air rates are available are limited to a very few, both the rate and particularly the service offers advantages over motor freight.

If all the major air carriers follow suit and adopt this type service there will, in our opinion, eventually be a considerable diversion of surface freight to air.

37290/2 Only use of air has been air express shipment of replacement parts for machine tools.

38110/2 Use of air freight has been disappointing as it is always more expensive and no faster than other means of shipping. All gain in speed is lost trying to get shipment from Houston or Dallas to Bryan.

38210/5 Most shipping damage and delay due to transfer to other airlines required on approximately 75% of destinations of our equipment other than southwest region.

38210/2 Our products are generally too large for air shipment. Air shipment is invaluable for emergencies.

36621/8 Ratio of air cargo versus ground modes will remain fairly constant. Total air cargo volume will increase consistent with overall company progress.

General air cargo service in the Dallas area is good. It is likely that costs will increase and door-to-door service decline slightly when airlines begin scheduling flight into Dallas/Fort Worth Regional Airport. Transit times and expense to and from DFW will be a concern to our company. While no diversion of traffic would be anticipated, this move will reflect on overall transportation efficiency.

36794/6 It is our feeling that air movement of cargo should increase 300% during the next 12 to 24 months, due to gross inefficiencies of ground carriers.

36795/4 I believe our air shipments will be confined to small weight type of packages (under 20 pounds). Most of our shipments are handled by parcel and air parcel post. Our heavy extrusions usually ship by motor freight carriers. I don't see the cost trend getting that close to surface carrier, in the near future, to warrant more air freight, except for delinquent shipments.

36795/7 The advent of the "super plane" (747, etc.) has opened the door for increased air shipment. The air freight carriers, in order to increase tonnage, have gone to reduced rates under certain circumstances. These rates, where applicable are, on the surface, very competitive with Class 77 1/2 to Class 100 motor, LTL. However, when the total cost of shipment is determined, pickup, delivery, insurance, etc., the cost is much less attractive.

The Air Express mode is pricing itself higher and higher and, in return, the service is generally deteriorating. The special privileges, granted by regulatory powers, should be removed and Air Express should be made to comply with the normal rules of business regarding priorities.

Regulation of air freight forwarders should be strengthened and more rigidly enforced. The air freight forwarder caters to specific special interest groups by means of specific rates to and from areas not normally considered prime. This preference could place competitors at an economic disadvantage.

This granting of specific commodity rates by air forwarders is "akin" to gasoline wars among retail distributors. At first glance, it would appear that the only benefits would be derived by the customers, in this case, the shipping public. Closer examination reveals that this will lead to a demise of many forwarding companies, resulting in a business monopoly for two or three carriers.

Standardization of tariffs is mandatory insofar as pickup, delivery and actual air rates themselves are concerned. Naturally, provisions for individual exceptions must be maintained.

Conclusion: More regulation ONLY if administered by competent professional traffic men.

Domestic air shipments delivered to the airline on a "space available" basis are usually delayed at origin from 24 to 48 hours. The "reserved air space" and "package express" innovations of recent origin alleviate this problem, but, not many shippers have the personnel to utilize these services as they require time and some training of shipper employees to be effective.

35730/5 Utilization of air freight for long haul will increase primarily because:

1. Inventory turns and levels (carrying costs).
2. Rates become closer.
3. Exposure to lose and damage for small shipments.
4. Future equipment for air carriers.
5. Increase in international business for small and medium-sized firms.

Air carriers, however, have problems:

1. Air freight is unprofitable.
2. Handling systems inefficient for current volumes.
3. Lack of containerization of broad scale.
4. Lack of management commitment to air freight by the carriers.
5. Lack of dependable pickup and delivery service.
6. Lack of staff (tracing, expediting).

The forwarders (air) seem to be in a good position to fill the need in providing:

1. Pickup and delivery.
2. Containerizing.
3. Customer service.

I believe the airlines will, as the truckers, need to act as the line-haul only with forwarders the pickup, consolidator, communicator, and delivery on shipments under 2-3,000 lbs. We use air heavily and will continue. Also see domestic personnel moves as future use for air.

35990/5 MAJOR PROBLEMS: Shipments delayed at terminal due to size, lack of space, etc., and shipments "bumped" along route for same reasons.

This firm manufactures special, one of a kind, equipment and parts for special equipment.

Exhibit 2-1 (Concluded)

36113/5 We use air primarily for overseas shipments when product cost is high in relation to weight (our normal business). It actually costs less to the end customer than sea shipment. In the United States we primarily use air when the customer requests for emergency purposes. Our incoming air shipments are at our request (also for emergency purposes).

I doubt that our mix ratios will change much in the next 10 years due to the nature of our product. We anticipate that air/versus ground costs will very slightly improve. In our business it is not considered a major factor -- that is, affecting the customers choice of our product.

Florists

Florists that use air cargo are more apt to use air for regular delivery than are manufacturers. Incoming air shipments appear more prominent than outgoing. On the whole, these florists see air shipments growing at an equal or lesser rate than their business growth. The 11 responses to remarks were diverse with comments centering on rates and service, particularly service between hubs and hinterland cities. Their remarks are paraphrased here in Exhibit 2-2.

Industrial and Research Laboratories

These laboratories did not turn out to be heavy air cargo users. The general remarks were less frequent and less spirited than in the above. They are quoted in Exhibit 2-3.

Shippers in Agriculture and Fisheries

Parts 3 and 6 of this report analyze the interview responses in detail. Two policy issues emerged. Crab shippers are definitely limited by lift availability from Houston to Baltimore, the principal market. A large shipper indicated major increases in sales were possible with an improvement in air cargo capacity.

Successful export of breeding and feeder stock by air has taken place from several Texas airports. Shippers interviewed indicated favorable reaction to air shipping. Concern was expressed over lack of specialized facilities for handling of livestock, such as export inspection and holding pens.

Carriers

Most of the results of the carrier survey are reported under Parts 3 and 6. Two classes of questions were asked to provide policy background to state and local officials. One set of questions concerned sales strategy, market development, and sales budgeting. The other set was addressed to assessing service effects on demand.

Exhibit 2-2

SHIPPER COMMENTS: WHOLESALE FLORISTS
FROM THE TEXAS AIR CARGO STUDY SURVEY
First Quarter 1972

A large shipper in San Antonio dropped his air shipments from 95 percent to only 10 percent over the last five years because of (1) "higher cost," (2) "poor service," and (3) " mishandling of shipments."

- An Amarillo-based wholesale florist expressed a need for better connections to major cities.
- One florist, remarking on the higher cost by air, said he used air only to avoid weather damage in winter.
- A florist marketing in adjacent states expressed a need for improving refrigerated (cool) service by truck or bus to enable him to cut down on air.
- A family enterprise would use all air, but cost is prohibitive.
- One florist whose major markets are Houston and Dallas says truck transport is far less expensive.
- A Rio Grande Valley florist remarked that he truck-shipped his live plants to San Antonio for air distribution because of the low level of local service.
- A San Antonio florist observed that air rate increases have caused him to shift to truck on incoming shipments and may well do so for outgoing shipments (almost 900,000 pounds in 1970).
- Another San Antonio respondent commented on the 30 percent air freight rate increase over the last two years plus the imposition of a five percent government tax.
- A Waco florist said that it costs almost as much to get an air shipment from Dallas to Waco as it does to get that shipment from Los Angeles to Dallas.

Exhibit 2-3

SHIPPER COMMENTS: LABORATORIES
FROM THE TEXAS AIR CARGO STUDY SURVEY
First Quarter 1972

"Reduction of cost."

"A greater percentage of freight would move via Air Freight if the carriers reduced their rates to be more competitive with Parcel Post, Air Parcel Post, Motor Freight, Rail, Air Express (in the lower brackets), and the ocean going vessels."

"The nature of our business and volume of business are determining factors. An increase in sales would be the single most affecting factor."

"Present use of air cargo for overseas shipments only. Probable use of air cargo for interstate shipments in future if price not prohibitive.

"We use it only on rare occasions."

"Improved air service as related to size and weight handling capabilities would improve our overall effectiveness as a servicing and manufacturing facility."

Cargo Sales Emphasis and Strategy. This question was asked to gain some insight into the relationship between the amount of cargo sales efforts and new airfreight shippers. Although not conclusive, indications are that, except for international shipments, increased sales efforts for cargo sales, although resulting in additional sales, are not cost effective. Braniff Airlines indicated that they expect most growth to come from products not yet made today and cited the fact that 85 percent of products moving in North Atlantic trade by air are products which were not produced eight years ago. Based on responses to interviews, it was estimated that cargo revenues averaged 10 percent of total revenue and were not expected to increase. Information on sales budgeting was not generally available.

Effects of Improved Service on Demand for Air Cargo Service. The following statements summarize carrier responses of policy interest.

- Additional air cargo service is overall not justified at the present time.
- Good door-to-door service is a continual problem for the airlines as it is for most modes of transportation and, together with lost shipments, accounts for a large proportion of shipper complaints. The airfreight forwarders individually contract with a local cartage firm for pickup and delivery service, and the airlines jointly contract for pickup and delivery service through ACI. The ACI committee approach is not as personal or responsive as is direct control by the airline. However, volume of business by any one airline does not justify individual pickup and delivery service.
- Container service has greatly improved the efficiency and security of airfreight handling, but the effect on demand for airfreight service could not be estimated. Innovative container rates may provide a needed stimulus.
- Airlines do not see any general reduction in airfreight rates but foresee continued use of innovative promotional rates such as daytime or morning rates and special container rates such as a flat charge per container.

- None of the airlines commented on whether present air-freight rates were compensatory.

Supplementary Services

The purpose of this section is to provide an overview of the cargo role of the supplemental airlines and its impact on Texas cargo movements.[1/]

What is a supplemental airline? A supplemental airline is an airline company which rents one or more of its aircraft, complete with crew, to an interested party. Thus, a supplemental airline "charters" its aircraft to shippers, airfreight forwarders, affinity groups and the like. In brief, a supplemental airline enters into a one- or many-time contract with a "shipper."

Until recently, if a shipper wished to move his goods by air, he could arrange to have his cargo moved by either renting an entire aircraft from a supplemental airline, a scheduled airline, or by utilizing cargo space available from a scheduled airline (either in the cargo hold of a passenger aircraft or in an all-cargo freighter aircraft). The primary difference in the services offered by these alternatives was cost. A supplemental airline will rent an aircraft based on a 100 percent load factor and, therefore, can offer its craft at a highly reduced (but generally CAB-regulated) cost per plane mile. Hence, if a shipper can fill the plane, he has an economical means of air shipment. By contrast, the scheduled airline offers space on its scheduled flights on the basis of much lower load factors and, hence, higher rates. So, a shipper is faced with conducting a trade-off analysis between the two alternatives.

This section is concerned with supplemental air cargo service; however, it must be noted that at one time supplemental service meant

1/ It should be noted that scheduled carriers may provide charter freight services comparable to the supplementals.

charter service. Today this is not the case. Under CAB restrictions,[1] scheduled airlines are permitted to charter aircraft. In fact, a scheduled airline may operate unlimited charters between any two cities that it serves, even though it does not serve the city-pair. As a result, the future of the supplemental airlines is cloudy as the definition of the two groups becomes more close. For example, scheduled airlines provide non-scheduled charter service, and supplementals provide scheduled charter service. Six of the 11 trunk airlines now have dedicated 37 aircraft specifically for charter service.

Yet, for the shipper, this competition between the scheduled and supplemental airlines means increased service for them. There will be more capacity, more origins and destinations served, and continued low rates. Furthermore, the airfreight forwarders are now contracting with the airlines for scheduled charter service which will bring more options open to the shipper.[2] In brief, the "charter" service should flourish and thereby enhance service to the shipper/consignee.

Performance of the Supplementals

The supplemental airlines carry a significant portion of the total United States cargo moved by air. This is depicted in Figure 2-1. As shown there, presently supplementals carry nearly 500 million revenue ton miles as compared to double that, one billion RTMs, for United States scheduled carriers operating all-cargo flights (scheduled and chartered), and 10 times that for all United States carriage of airfreight

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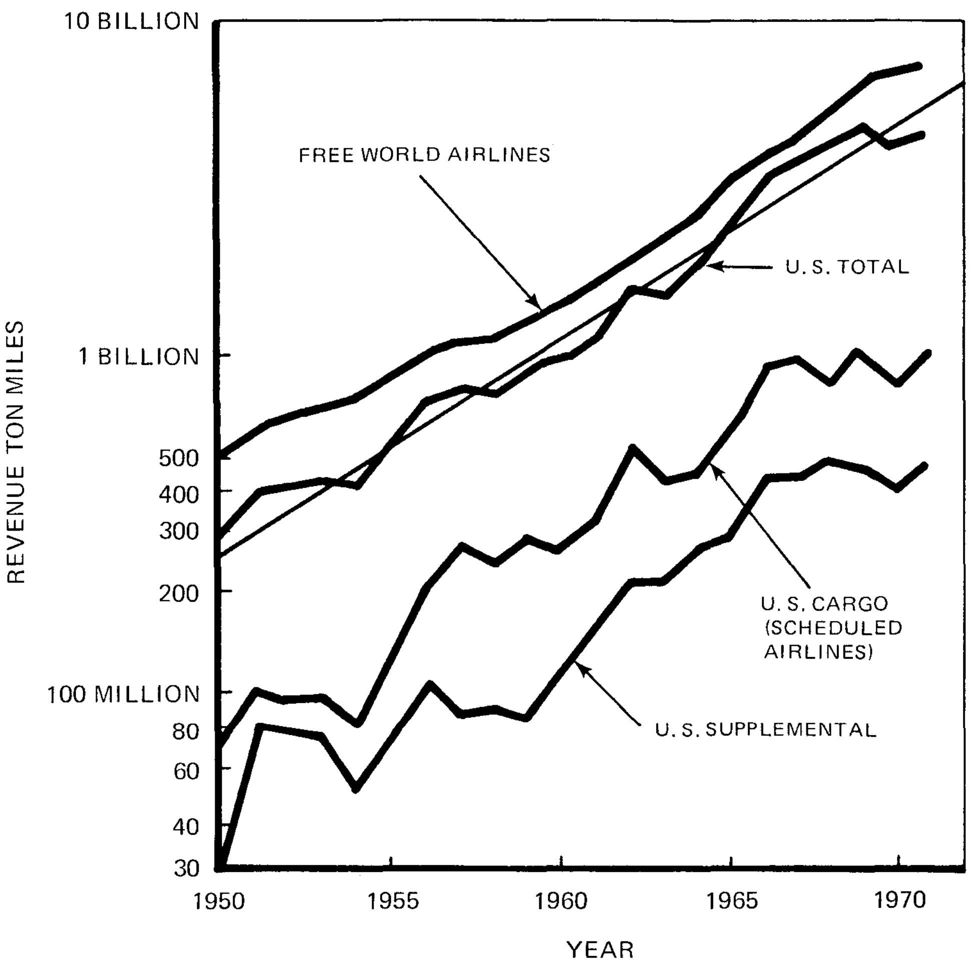
1/ See Aviation Week and Space Technology, April 10, 1972 (page 19). The principal restrictions are (1) that off-route charters are limited by frequency - during any given year, an airline may not operate more than two percent (of its previous year's carriage) of its charters off-route, and (2) that off-route charters between any pair of points in excess of a total of eight flights in the same direction in four successive weeks or in the same direction on the same day in two successive weeks or in excess of three flights in the same direction in any two successive weeks is prohibited. The CAB is likely to attempt a relaxation of the second restriction by excluding the first 10 off-route charters from the prohibition.[3]

2/ See Aviation Week and Space Technology, October 26, 1970 (page 34).

3/ See Cargo Airlift, April 1972 (page 5).



SOURCE: AVIATION WEEK AND SPACE TECHNOLOGY, MARCH 13, 1972 (PAGE 61).

FIGURE 2-1

TRENDS IN AIRFREIGHT TRAFFIC GROWTH

and express. Thus, the supplementals account for roughly 10 percent of the airfreight traffic and roughly one-third of the traffic carried in like service (all-cargo aircraft).

It is to be observed from the figure that airfreight is increasing fivefold per decade, and that all-cargo and supplemental services are holding the pace.

For the domestic picture, Table 2-1 depicts the traffic statistics, 1959-1969, for air cargo revenue ton-miles. The supplementals account for roughly 10 percent of the market in this instance, also.

Table 2-1

DOMESTIC AIR CARGO REVENUE TON-MILES FLOWN
BY TYPE OF CARRIER
1959-1969
(In Thousands)

Year	Total All Carriers	Scheduled Passenger/Cargo Carriers			Scheduled All-Cargo Carriers			Supple-mental Carriers
		Total	Scheduled	Non-scheduled	Total	Scheduled	Non-scheduled	
1959	651,477	347,920	344,728	3,192	240,189	105,487	134,702	63,368
1960	723,670	389,438	386,933	2,505	222,262	89,566	132,696	111,970
1961	829,412	455,952	454,142	1,809	259,518	79,040	180,478	113,942
1962	1,102,356	557,573	554,599	2,974	430,612	82,233	348,379	115,171
1963	1,095,179	609,093	603,726	5,367	315,425	110,844	204,581	170,661
1964	1,287,864	757,874	743,963	13,911	344,848	149,812	195,036	185,142
1965	1,661,430	997,099	943,128	53,971	444,551	168,837	275,714	219,780
1966	1,944,369	1,194,751	1,108,691	86,060	495,828	192,785	303,043	253,790
1967	2,166,613	1,398,763	1,314,409	84,354	503,533	183,819	319,714	264,317
1968	r/2,325,358	r/1,643,748	r/1,579,091	r/64,657	r/376,559	195,581	r/180,978	305,057
1969	2,519,811	1,869,497	1,761,501	107,996	394,112	209,588	184,524	256,202

r/ Revised.

Source: Bureau of Accounts and Statistics, CAB.

Table 2-2 updates the supplemental statistics to the year ending December 31, 1971. Domestic freight ton-miles flown are approaching the 300 million mark.

Table 2-2

THE SUPPLEMENTAL INDUSTRY'S TRAFFIC STATISTICS
1970 and 1971

Item	Supplemental Industry					
	12 Months Ended December 31, 1970			12 Months Ended December 31, 1971		
	Domestic	Int'l & Terr.	Total	Domestic	Int'l & Terr.	Total
Revenue passenger miles (000)						
Civilian	892,195	5,151,472	6,043,667	808,365	6,954,847	7,763,212
Military	164,580	4,080,481	4,245,061	111,368	2,691,067	2,802,435
Total	1,056,775	9,231,953	10,288,728	919,733	9,645,914	10,565,647
Available seat miles (000)						
Civilian	1,277,953	5,927,188	7,205,141	1,045,838	8,141,074	9,186,912
Military	278,894	4,599,398	4,878,292	170,276	3,076,684	3,246,960
Total	1,556,847	10,526,586	12,083,433	1,216,114	11,217,758	12,433,872
Revenue passenger originations	719,529	2,230,695	2,950,224	603,722	2,700,247	3,303,969
Freight ton miles						
Civilian	43,559,351	33,766,285	77,325,636	35,556,516	64,263,334	99,819,850
Military	241,859,782	72,255,640	314,115,422	259,955,344	114,562,208	374,517,552
Total	285,419,133	106,021,925	391,441,058	295,511,860	178,825,542	474,337,402
Overall available ton miles (000)						
Civilian	235,637	691,610	927,247	224,436	1,002,872	1,227,308
Military	381,180	666,830	1,048,010	413,600	635,282	1,048,882
Total	616,817	1,358,440	1,975,257	638,036	1,638,154	2,276,190
Overall aircraft revenue miles						
Civilian	11,545,958	29,875,395	41,421,353	12,103,194	41,945,579	54,048,773
Military	22,414,108	29,010,228	51,424,336	22,663,948	25,271,977	47,935,925
Total	33,960,066	58,885,623	92,845,689	34,767,142	67,217,556	101,984,698
Overall aircraft revenue hours	94,273	122,891	271,164	98,424	143,328	241,752
Overall aircraft nonrevenue hours	8,599	14,933	23,532	7,583	16,588	24,171

Source: CAB

THE SUPPLEMENTAL CARRIERS

The supplemental carriers are listed alphabetically in Exhibit 2-4. From the domestic airfreight carriage point of view, greater than 95 percent of the revenue ton-miles are flown by Overseas National, Universal Airlines, and Saturn Airways.

Exhibit 2-4
THE SUPPLEMENTAL CARRIERS

American Flyers
Capitol International
Johnson Flying Service
McCulloch International[1/]
Modern Air Transport
Overseas National
Purdue Airlines
Saturn Airways
Southern Air Transport
Standard Airways[2/]
Trans International
Universal Airlines
World Airways

1/ Formerly Vance International.
2/ Standard Airways suspended operations on July 31, 1969.

Overseas National Airways has a (passenger and cargo) fleet of five DC8-63F's (convertible), six DC9-30 series (all-cargo), and nine all-cargo L-188-C Electras (three DC-10's on order). They are the largest cargo carrier of the supplementals. Presently, about five percent of ONA's cargo business interfaces with Texas; however, the company looks for this to increase to well over 10 percent in the near future.

Today's business is in a large measure due to ONA's daily flight into Dallas carrying Ford auto parts.[1/] They have hopes of providing additional service out of Houston to the Carribean and also to the North Slope, with the start-up of the pipeline.

Indicative of ONA's charter rates (and those of other supplemental airlines, as well as charter operations of scheduled airlines) are the following:

Typical Charter Rates

Type of Aircraft	Rate Per Mile	Additional Stops
Electra	$2.10	$150
DC-9	$1.95	$150
DC-8-63F	$3.50	$500

The above rates represent live charter rates with some reduction possibly occurring on ferry operations. Also, ONA has attempted to get CAB approval for special backhaul situations; e.g., from San Juan to Miami for DC-9 operations at live and ferry rates of $1.34 and $1.15 per charter plane.[2/]

Charter rates generally range 30-50 percent below cargo rates on scheduled service. As such, charter carriage is finding a fast growing position in transportation.

Universal Airlines[3/] (16 aircraft - 12 Electra freighters and five DC-8-61CF's), Saturn (10 aircraft - three DC-8's and seven Hercules), and Trans International Airlines (14 aircraft - 12 DC-8's and two 727's with four DC-10's on order) are active from time to time in Texas. The principal cargo carried are livestock and outsized equipment. Both of these cargo categories are important to Texas and to the supplemental airlines. Saturn has employed its Hercules fleet successfully in the

1/ Airline Management, March 1971.
2/ Cargo Airlift, April 1972.
3/ Has recently suspended service.

movement of oil rigs, outsized pipes, and the like. And Trans International has been quite active in the shipment of livestock from Houston and Wichita Falls. For example, in 1969 TIA air-shipped 3,300 polled herefords from Wichita Falls to Punta Arenas, Chile. The cost of air transportation averaged $140 a head; ground transportation, $35 a head; and yardage and other incidental costs, $95 a head. Air shipments were made by a modified DC-8 carrying approximately 300 head per flight. Flights required about 30 hours per round trip and were scheduled on an every-other-day basis. TIA is also air-shipping feeder cattle to the Far East (Korea) and has hopes (based on an analysis of worldwide meat deficits) of continued success in this transport market.

Finally, supplementals offer services beyond the aircraft and crew. They will supply an on-board veterinarian in the shipment of livestock. They will contract for pickup and delivery, and, in general, provide the management service for the entire shipment process.

AIRPORT PLANNING AND DESIGN

With regard to guidance on policy with respect to airport design, the Work Statement directs "...air cargo space requirements will be assessed. The economics of off-airport freight consolidation will be assessed, including airport access considerations." Though not specifically covered, the study also looked at the question of all-cargo airports, because of a strong statewide policy interest.

Air Cargo Space Requirements

Air cargo terminal space planning, in contrast to passenger service, is largely an individual airline function. Airport authorities must plan for all-cargo gate positions and apron areas, land for terminal and cargo assembly areas, access of vehicles, parking for cargo employees, airside movement between cargo terminals and combination aircraft, and utilities.

To the extent that significant planning problems will occur at Texas airports through 1990, they would most likely take place at the top four hubs. These four are the only airports expected to have scheduled all-cargo service in the plan period. The air carriers serving these airports are in the best position to sense problems such as under-allocations of space and facilities. The "Carrier Survey" queried these airlines about terminal design, cargo land use planning, terminal sharing, and security. The results are summarized in the following paragraphs.

No major problems with present air cargo terminal design, location, or operation were reported, and facilities were generally described as adequate. Minor problems mentioned included the need for facilities to handle heavy equipment at Houston Intercontinental and improved terminal facilities at San Antonio. No major concern was expressed concerning terminal design, capacity, location, or operation during the next five or 10 years, although some concern was expressed over proposed arrangements for cargo at the new Dallas-Fort Worth airport because of considerable distance between cargo facilities of some airlines. This physical separation may be an impediment to efficient interlining. Eastern Airlines commented that generally in the last few years, airport land-use planning has proven adequate for terminal design and operation and has included the necessary considerations for cargo development.

None of the airlines could foresee any breakthroughs in terminal design that would significantly reduce costs. Many automated and/or mechanized air cargo terminals have been developed throughout the world; while these terminals have benefits in physically handling the growing volumes of air cargo, they have not proven to be a particularly economical form of design. The introduction of sophisticated cargo handling is not expected at any Texas airport in the near future. Present or anticipated traffic volumes do not make such systems economical.

Cargo security is not the problem at Texas airports that it is in New York, Chicago, Los Angeles, and other major airports. There has been an increased emphasis on cargo security through employee training, installation of additional fences, etc.

In response to terminal sharing feasibility, the comment was made that during the past few years of economic depression in the airline industry, there has been an increase in air cargo terminal sharing efforts. While there are economic benefits in the common use of facilities and manpower resources, they have been outweighed by the marketing and corporate identity aspects.

Questioned on the need for off-airport cargo terminals, the response by Eastern Airlines is reflective of the entire industry. "Many studies have been made of the advantages/disadvantages of on-airport versus off-airport cargo terminals. Most of the studies have resulted in operationally acceptable plans; however, the economics of off-airport facilities have been insurmountable. The consistently recurring problem is moving cargo between the off-airport facility and the terminal to meet the many combination passenger/cargo aircraft departures on a timely basis. It is considered that the deterioration of customer service due to time delays is unacceptable." Braniff tried using an off-airport cargo terminal in New York. The experiment was unsuccessful, and they are now using an on-airport terminal. Off-airport cargo terminals are not expected at any Texas airport in the near future.

There are now off-airport terminals operated by airfreight forwarders, ACI contractors, and some airlines. These terminals are serving an intracity pickup and delivery activity where proximity to shippers is of greater concern than proximity to the airport. Frequent shuttle runs are then used between these terminals located near the airport and the airline terminals located at the airport.

Cargo space requirements will vary, depending on cargo volume, the densities of cargo handled, the ratios of peak period to average period, the timing of incoming and outgoing cargo, throughput time, etc. These factors may be peculiar to any given airport. The new Dallas-Fort Worth Regional Airport land use plan allocates 140 acres to the air cargo complex for (their) forecast cargo enplanements of 160,000 tons in 1980 and 410,000 in 1985.[1/] This gives a factor of .00034 acres per annual ton. A consultant's report for Greater Pittsburgh Airport[2/] estimated 50 to 60 acres to handle a 1980 forecast tonnage of 60,300 tons, indicating a planning factor of .0009 acres per annual ton enplaned.

In building area, the Pittsburgh planning effort showed that the airlines requested 300,000 square feet of building space to handle Pittsburgh's 1975 annual enplaned tonnage forecast of 38,900 tons, or 7.7 square feet per annual ton.[3/] This figure appears to be well in excess of building space requirements implied by Figure 2-2, showing FAA cargo building space planning factors for cargo processing and administration.

Airport Access

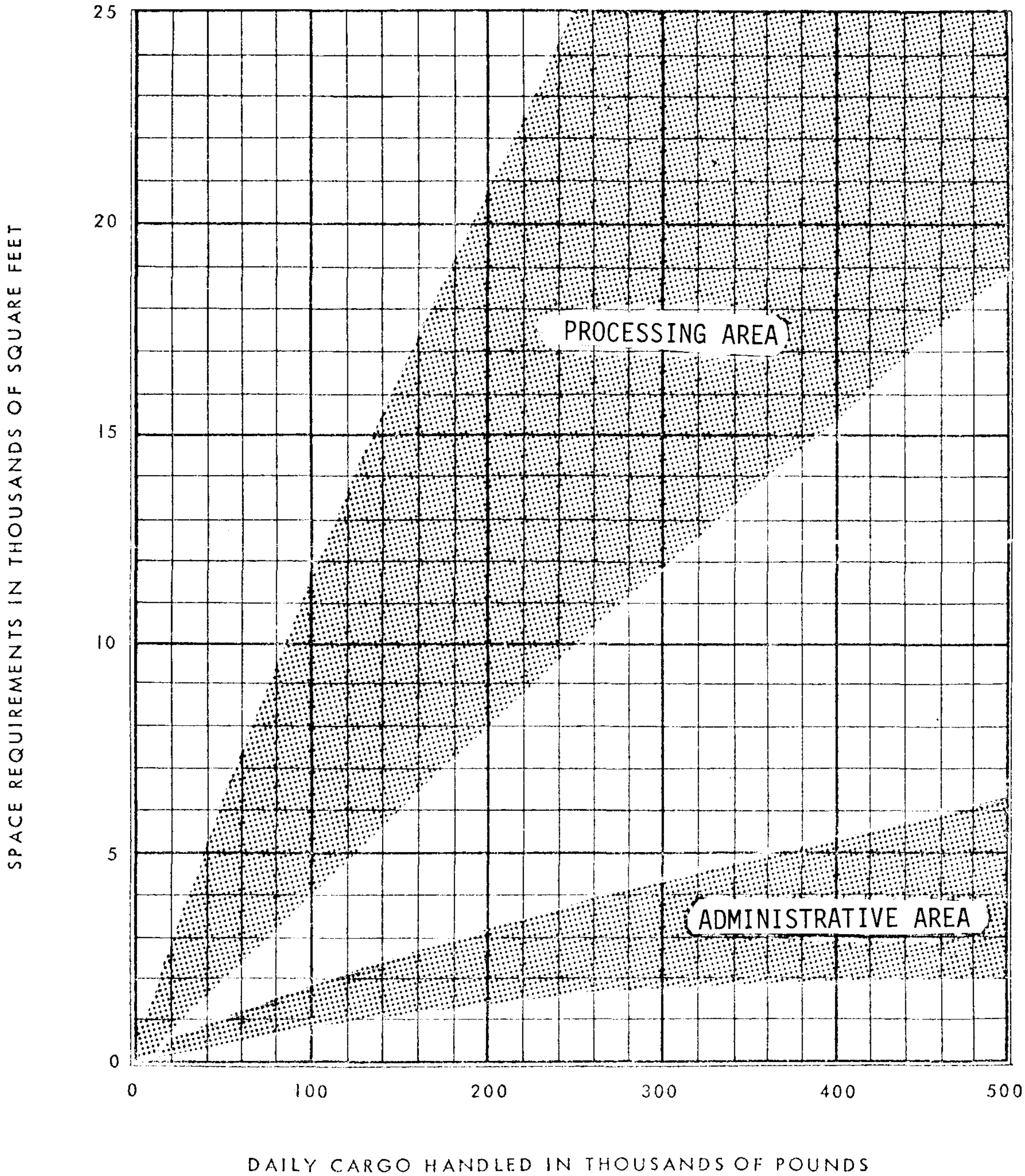
Air cargo deliveries to the airport tend to peak during the evening rush hours. Pickup and delivery trucks are a noticeable part of evening traffic flow on the main arteries in the vicinity of major hub airports. However, a 1966 study states,[4/] "Airports do not seem to be major generators of truck trips, at least not for the travel years considered..." Table 2-3 shows truck trips to person trips to select airports ranging from one truck trip per 100 person trips at Pittsburgh to 11 at Seattle-Tacoma. However, cargo to passenger ratios have increased significantly since 1966, and higher ratios are now to be expected.

1/ "Dallas-Fort Worth Regional Airport."

2/ Carlson, J.W., "The Terminal Complex at Pittsburgh," in Airport Terminal Facilities, American Society of Civil Engineers and the Airport Operators Council International, Houston, 1967.

3/ Carlson, op. cit.

4/ Keefer, Louis E., Urban Travel Patterns for Airports, Shopping Centers and Industrial Plants, National Cooperation Highway Research Program Report 24, p. 9, Highway Research Board, National Academy of Engineering, Washington, D.C., 1966.



Source: Federal Aviation Agency, "Airport Cargo Usage Factors," April 1964.

Figure 2-2

BUILDING AREA SPACE REQUIREMENTS

Table 2-3

RATIOS OF TRUCK TRIPS TO PERSON TRIPS, BY PURPOSE, AND TO AUTO DRIVER TRIPS, ALL PURPOSES, TO SELECTED AIRPORTS 1/

Airport	Truck Trips (No. /100 Person Trips) To Work	To Soc.-Recr.	To Air Travel	Total Person Trips	(No. /100 Auto Driver Trips) 2/
Atlanta	11	129	28	7	9
Buffalo	13	9	7	3	6
Minneapolis-St. Paul	11	27	16	5	8
Philadelphia	21	16	12	5	9
Pittsburgh	8	7	4	2	1
Seattle-Tacoma	31	45	26	11	16

1/ From Transportation study data for the various cities.
2/ All purposes.

Source: Keefer, op. cit., p. 10

Cargo truck traffic separation is desirable on high density hubs. Houston does have good separation and Dallas-Fort Worth will have. San Antonio's long-range plan should define the most cost effective separation given truck trip forecasts. El Paso plans a new cargo building which will permit improved separation.

All-Cargo Airports

From the State's air cargo/airport planning viewpoint, one of the most interesting series of questions turns on the concept of the all-cargo or all-freight airport. Will such specialized airports appear in the United

States within the 1990 time horizon? Will they appear in Texas? Should they serve more than one hub? What is the best location for multi-hub all-cargo airport?

These questions are particularly pertinent to Texas in that the most extensive study on all-cargo airports to date tested the concept in a Waco location.[1/] That study recommended an all-freighter demonstration project, "...a 'Waco Lab' - be established as a breakthrough attempt in testing the all-freighter airport concept for the nation" (page 1). The Waco study provides the point of departure for discussing the all-cargo concept and an evaluation of its applicability to Texas within the 1990 time frame.

As yet, there is no specialized all-cargo civil airport in the United States. Will there be such airports before 1990? A positive answer to that question would hinge on complementary favorable responses by (a) the carriers, including forwarders, (b) the state and local authorities, and (c) the cognizant federal agencies. Finally, shippers would have their say in representations to all three.

As the Waco study points out, airline attitudes toward the introduction of all-cargo airports are strongly negative at the present time (page 2). The negativism is attributed first to poor overall financial results in the period preceding the study and the contribution to losses by all-cargo operations. These poor results were centered on domestic operations, incidentally. The second major factor in the carriers' attitudes concerns the growing cargo belly pit capacity to be derived from the introduction of the wide-bodied aircraft. The study points out, however, that airlines which have given serious consideration to the problem feel that all-freight airports are a long-run eventuality.

Both the airlines and the communities involved must be concerned about airport financing. An all-freighter airport, while cheaper to operate, must depend almost entirely on landing fees and other aviation revenues, to cover operating and capital costs. A more intensive

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1/ Systems Analysis and Research Corporation (assisted by Arnold Thompson Associates, Inc.), Feasibility of an All-Freighter Airport at Waco, Texas, Washington, D.C., December 1971 (referred to herein as the Waco study).

analysis of the break-even operations rate at an all-cargo airport appears indicated. A recosting at Waco should include land at its real opportunity cost and not at the windfall price under which it was acquired by Texas State Technical Institute. To do otherwise would distort land-use economies and, hence, the appropriate local decisions at Waco.

Cognizant federal agencies have cautioned against separate specialized cargo airports in a joint Department of Transportation - National Aeronautics and Space Administration study of research and development needs of civil aviation.[1/] The report had this to say of all-cargo airports ("Supporting Papers," p. 3-29).

> "Combination airports could better utilize runways and other facilities than specialized airports because most passengers fly in the daytime, and most cargo is flown at night. Communications and ground transportation costs would be higher with specialized airports because of the requirement to move cargo between passenger-aircraft belly compartments and all-cargo aircraft. Specialized airports would be preferable from a cost-accounting viewpoint. Land costs for all-cargo airports would probably be less per acre because they could be built farther from the cities. The total acreage required for combination airports, however, should be less than for specialized airports because common facilities would be used more efficiently.
>
> "On balance, combination airports, with the maximum use of off-airport facilities, appear to be preferable to specialized airports, regardless of the levels of passenger and cargo traffic. However, all of the alternatives should be carefully considered before a decision is made in any specific community."

Shippers would probably be indifferent as between combination and all-cargo airports if costs and service remained the same. The Waco study points out that surface haul costs would increase with the

1/ Department of Transportation - National Aeronautics and Space Administration, Joint DOT-NASA Civil Aviation Research and Development Policy Study, Washington, D. C., March 1971.

regional all-freighter concept, but that cost advantages of specialization would offset these (pages 22-25). But there are insufficient data to provide a documentation of specialized savings. Shipper concern with uncertainty of potentially higher costs along with lower pickup and delivery frequencies at a more remote location could bring them into opposition.

The Waco study does examine many of the factors obviating against the all-freighter concept: belly cargo operation, coordination of trucking service, etc. Yet, it does not bring these together in a cohesive fashion and it neglects many negative factors. The major factors militating against all-cargo airports are brought together here:

- In practical effect, most all-cargo operations are already on all-cargo airports. These all-cargo airports are simply the nighttime airports that are passenger airports in the "daytime." This permits economies of scale and, hence, lower aviation charges to both the day and nighttime users than they would obtain if they were geographically separate.

- A high proportion of all-cargo operations are in convertible aircraft usable for both all-cargo and passenger service. All-cargo airports would increase the costs of moving such aircraft between the two services.

- In addition to belly cargo space becoming available in increasing quantity and thus inhibiting growth of all-cargo, belly cargo does and will continue to provide feeder cargo to all-cargo operations. Separate facilities would increase the costs of transfer between mixed and all-cargo operations.

- Most air cargo is and probably will continue to be small shipments. The volume consignments which make all-cargo operations viable must come, in large measure, from consolidations. Pickup and delivery costs, which are assumed in the Waco study to be included in surface line-haul between Waco and the hubs, will still be additional costs. Further, forwarders would probably have to increase their facilities investments to handle the same cargo volumes with the addition of the specialized all-freight airport, along with belly cargo movement at combination airports, thus increasing costs and, therefore, rates.

The scope of the Waco study was limited to consideration of Waco only and did not encompass alternative locations at other sites in and out of Texas. Before any go-ahead on Waco, federal and state airport authorities would want to examine alternative locations for an all-freighter pilot operation. One consideration should be the highest probability of success. Other things equal, the higher the existing frequency of air cargo aircraft operations, the greater the probability of success. The Chicago-Detroit-Cincinnati triangle, approximately the geographic size of the Texas hub triangle, had about four times the all-cargo operations of the Texas triangle in 1970.

Within Texas itself, the top-hub triangle is certainly the best general location. But, where in that triangle would be the economic optimum location? Using 1970 tonnage data (all air cargo operations) at the top three hubs, total ton mileage of surface shipments was calculated for an all-cargo airport at Love Field in Dallas and at Waco. The all-cargo tonnages would, of course, be lower, but the relationship would remain about the same. Cargo was allocated between Dallas and Fort Worth on a weighting scheme using 1967 percentages of air shipments by commodity group multiplied by each SMSA's employment in those groups. The result was 76 percent to Dallas and 24 percent to Fort Worth. Results are presented as follows:

	1970 Tons Originated - Each Hub	Ton-miles Waco Location	Ton-miles Love Field Location
Dallas	36,200	3,500,000	362,000
Fort Worth	11,300	970,000	395,000
Houston	19,634	3,100,000	4,700,000
San Antonio	6,817	1,260,000	1,920,000
Total	73,951	8,830,000	7,377,000

The Waco location generates a greater ton-mile requirement than Love Field at Dallas. Of course, the costs per ton-mile would be inversely related to distance, and a complete costing would reveal a somewhat different evaluation, most probably in favor of Dallas. There are other Love Field advantages. New airport investment at Love Field would probably be less than at Waco. Forwarders could utilize existing facilities more efficiently.

The Waco study gave a prominent place to the use of the Texas State Technical Institute at Waco as a training ground for air cargo specialists. Again, the scope of the study did not permit an alternative analysis of curricula development at TSTI. But, within the concept of an air cargo curriculum, there is no necessary connection between it and the location of an all-cargo airport at Waco. A Love Field all-freighter usage may be almost equally as beneficial. And, if an all-cargo airport should not be implemented within the 1990 time frame, the air cargo curriculum may be viable.

Conclusions

- This study assesses the probability of the implementation of a regional all-cargo specialized airport as quite low within the 1990 time frame. This assessment is based on the need to utilize airport capacity more evenly over the daily cycle. Generally, it would appear that the ratio of one all-cargo operation to three combination operations would signal an economic use of an all-cargo airport.

- A specialized freight airport at a major hub appears more feasible as a first specialized port than does a regional airport at a point where cargo generation/termination is negligible.
- A regional all-cargo port is more likely to occur in a higher density market than in a lower one.
- In view of the above, the best planning strategy would be not to commit resources (beyond evaluations) on all-cargo airports in Texas until the New York, Chicago, or Los Angeles hubs have utilized this concept.
- The nighttime all-cargo airport on a daytime combination airport is already a reality at Dallas and partially so at Houston and San Antonio. By 1980, this statement should be fully true for all three and, by 1990, partially true for El Paso. Because of higher nighttime noise impacts, compatible land-use planning and zoning in the airport regions of these hubs should be undertaken now to obviate citizen lawsuits.

Other Airport Planning Considerations

- Studies conducted by the manufacturers indicate that, for a limited number of locations, it may be more cost effective to provide increased pavement strength for larger aircraft than to continue increasing the number of wheels to permit operation on today's pavements. Consequently, there will probably be selected airports at which increased pavement thickness will be required by 1980 in order to meet an increase in single wheel loads.

- Gross weight growth trend projections should be considered when planning future underground facilities, overpass structures, and pavement bases that must accommodate the movement and parking of high gross weight aircraft.

CARGO POLICY ALERTS

This section distills policy-sensitive cargo developments arising during the course of the study. Since this section is somewhat beyond the scope of the study, the items commented upon were not explored in the depth necessary to support an official position. The "policy alerts" are listed here in no particular order:

- Dallas-Fort Worth is seeking a gateway role, and Japan Air Lines is seeking a direct connection between Tokyo and Dallas-Fort Worth. Maximum air cargo economies are achieved at inland hubs in trade between transoceanic trading partners. The granting of direct route authority from Texas hubs to overseas hubs would enhance Texas's trading position.
- International rate structures have favored New York over other coastal cities in European cargo carriage. Direct cargo service rates reflecting only the marginal cost of distance to other United States cities is a matter under consideration by the CAB. Such rates would promote a more rational allocation of international cargo carrying resources. It appears that such cost based rates would be favorable to Texas shippers and consignees.
- The study revealed dissatisfaction over the levels of local service. Levels of local service are determined by passenger demand (and passenger demand by service). There are two policy alert areas of interest from the cargo standpoint here.

- The CAB is considering removal of the 12,500 pound gross weight limit on third-level aircraft. New proposed limits would provide increased cargo lift capacity and allow for larger sized (and odd-shaped) shipments.[1/]

- Secor D. Browne, CAB Chairman, has presented to Congress an experimental program on contract air service to small cities. The lowest bid from bidders with necessary know-how and resources would have protected route rights for a period of no more than three years. The orientation, of course, is toward passenger service. How would cargo be affected? Bidders would prepare bids in the light of revenues from cargo which would be high profit carriage. Incentives should be toward cargo market development.

- Charter services by both the supplementals and the certificated route carriers are significant for Texas.

- The CAB is considering relaxing restrictions somewhat (see supplemental service discussion above) on the route carriers. The supplementals sense this as a threat.

- Normally, Texas has more incoming than outgoing charter cargo. Supplementals are seeking backhaul incentive rates (from Puerto Rico). A precedent in such rates would have interesting implications for Texas shippers.

- The air export of Texas livestock has been a charter operation. Specialized facilities are needed. The operations have taken place from a number of airports. Other things equal, the fewer the airports at which specialized facilities are required, the greater the economies of providing them, at least from the carrier perspective.

1/ This restriction has recently been removed by the CAB.

- The study revealed two indications of bottlenecks in service:
  a. Gulf blue crab from Houston to Baltimore is definitely capacity limited at this time. Incentive charter rates may be an answer. Another answer would be marketing the crabs in other directly connected hubs. The Texas crab industry is too small to mount a marketing campaign. Perhaps appropriate state agencies could make a useful contribution here.
  b. There were complaints in the survey of mail bumping freight. The United States Postal Service has employed various strategies in its use of air and now is moving regular first-class mail, on a space available basis, by air in significant quantities. The actual frequency of bumping of freight by mail should be determined, and, if the frequencies are significant, the kind of mail involved should be determined.

- Aircraft technology, including aircraft cargo technology, has benefited significantly in the past from military research and development. Military R&D budgets have dropped considerably over the last several years. NASA and FAA may be able to fill the gap.

- Air cargo planning is limited by information deficiencies particularly on deplaning cargo, origin-destination, shipment size, commodity, charter operations, peaking, and truck traffic. The CAB and DOT are initiating moves to fill gaps. Airline waybill data would be a major source. Commodity information on waybills is often highly aggregated so that much is lost. Forwarders need to be covered also to give adequate detail. Surface traffic surveys in airport cities could be designed to provide improved estimates of cargo truck traffic to and from airports. Cargo trucks (including mail) could be usefully distinguished from service trucks.

- The CAB cargo data effort is centered in the "Domestic Air Freight Rate Investigation" (Docket 22859). Any statewide examination of airfreight rate structures should benefit immensely from the results of that investigation. It is indicated that such an examination should wait until the investigation is completed.
- REA Express is applying for general air forwarding authority. REA is widely represented in Texas communities. It is planning to extend service to 500 additional smaller communities nationwide including cities in Texas. Forwarding, in providing consolidation service, produces air cargo economies.
- REA Express wants the CAB to grant it sole authority in air shipment of small parcels. The question of whether exclusive authority results in economies to shippers is unanswered at this time.
- The rate structure with respect to weight breaks in the 100 to 500 pound range does not appear to encourage the optimal consolidation of small shipments with resultant diseconomies to shippers - and perhaps to direct carriers.
- The Systems Analysis and Research Corporation study of an all-freight airport at Waco raised an interesting policy initiative. This had to do with establishing an airfreight curriculum at Texas State Technical Institute oriented toward an all-freight airport. This suggestion may have even greater merit as a general air cargo curriculum, training workers for all aspects of shipping by air, and divorcing it from all-freight airport constraints. Consultation with airlines could generate preliminary feasibility indications and course content.

Part 3

PRESENT AND HISTORICAL AIR CARGO MOVEMENTS AND SHIPMENT PATTERNS

INTRODUCTION

This section presents air cargo histories to the most recent date of published or collected information. In addition to histories, the section depicts patterns of air cargo shipments in terms of the following: enplaned to deplaned air cargo weight relationships; commodity types; destinations and origins of shipments; small shipments and package component including freight forwarder role; and hinterland distribution of shipments. Data were obtained from appropriate federal, state, and airport sources, from trade publications, other studies, and from a series of surveys (air carriers, shippers including primarily manufacturers, wholesale florists, industrial and research laboratories).

HISTORIES OF AIR CARGO MOVEMENTS

Air cargo consists of freight, express, and mail, as defined by the Civil Aeronautics Board and the Federal Aviation Administration (CAB/FAA). The broadest single statistical picture of air cargo is given by the CAB/FAA's publication, Airport Activity Statistics. This publication provides on-line revenue traffic in freight, express, and mail (as well as passenger and operational data) by airport or air hub for originated traffic of the United States certificated route air carriers. Data are given for total system operations, domestic operations, and foreign operations, as well as territorial operations. However, this major source leaves several significant gaps in the picture of air cargo at Texas airports:

- Last published data are for the year ending June 30, 1970.
- Interline traffic is not separately identified (particularly important for Dallas-Fort Worth).
- Supplemental carriage is not reported.
- Foreign carriers' cargo is not reported.
- Third level cargo is not reported.
- Terminated cargo data are not collected (but the proposed O-D survey should remedy this).

- Only annual (calendar and fiscal) data are published; hence, no seasonality information is recorded.
- Parcel content of mail is not separately identified.
- On passenger operations, cargo competes for space with baggage; however, no baggage data are collected. (The reporting of baggage counter small package service tonnage is uncertain.)

Some of the data gaps can be remedied by consulting other data sources. For example, the Bureau of the Census publishes airborne imports and exports by United States flag and foreign carriers according to customs district (the districts in Texas are uniquely matched to airports). The Texas Aeronautics Commission receives reports from the intrastate carriers since first quarter 1970. To the extent permitted by other publicly available data, these gaps will be filled.

Texas Cargo Originations

Texas total cargo originations growth for Calendar Years 1962 through 1969 and for Fiscal Year 1970 by certified route air carriers are shown in light of United States growth (Figure 3-1) for freight, express, and mail. Figures 3-2 through 3-5 show freight, express, and mail originations for, respectively, Dallas-Fort Worth, Houston, San Antonio, and El Paso hubs. Figure 3-6 provides an overall picture of the same growth for the remaining 25 small hubs and non-hubs. Individually, the smaller airport experiences have been erratic in varying degrees. This is illustrated in Figure 3-7 which shows total cargo time series for selected airports, 1962-1969; the freight, express, and mail components are of even greater variability. Data for all airports include the years 1962 through 1969.

The top ranked airports in Texas account for a very large share of air cargo originations (freight, express, and air mail) and, presumably, terminations. This phenomenon is well known to close observers and repeats itself nationally and in other regions. It has significant implications for the future of Texas air cargo and for the organization of the air cargo study.

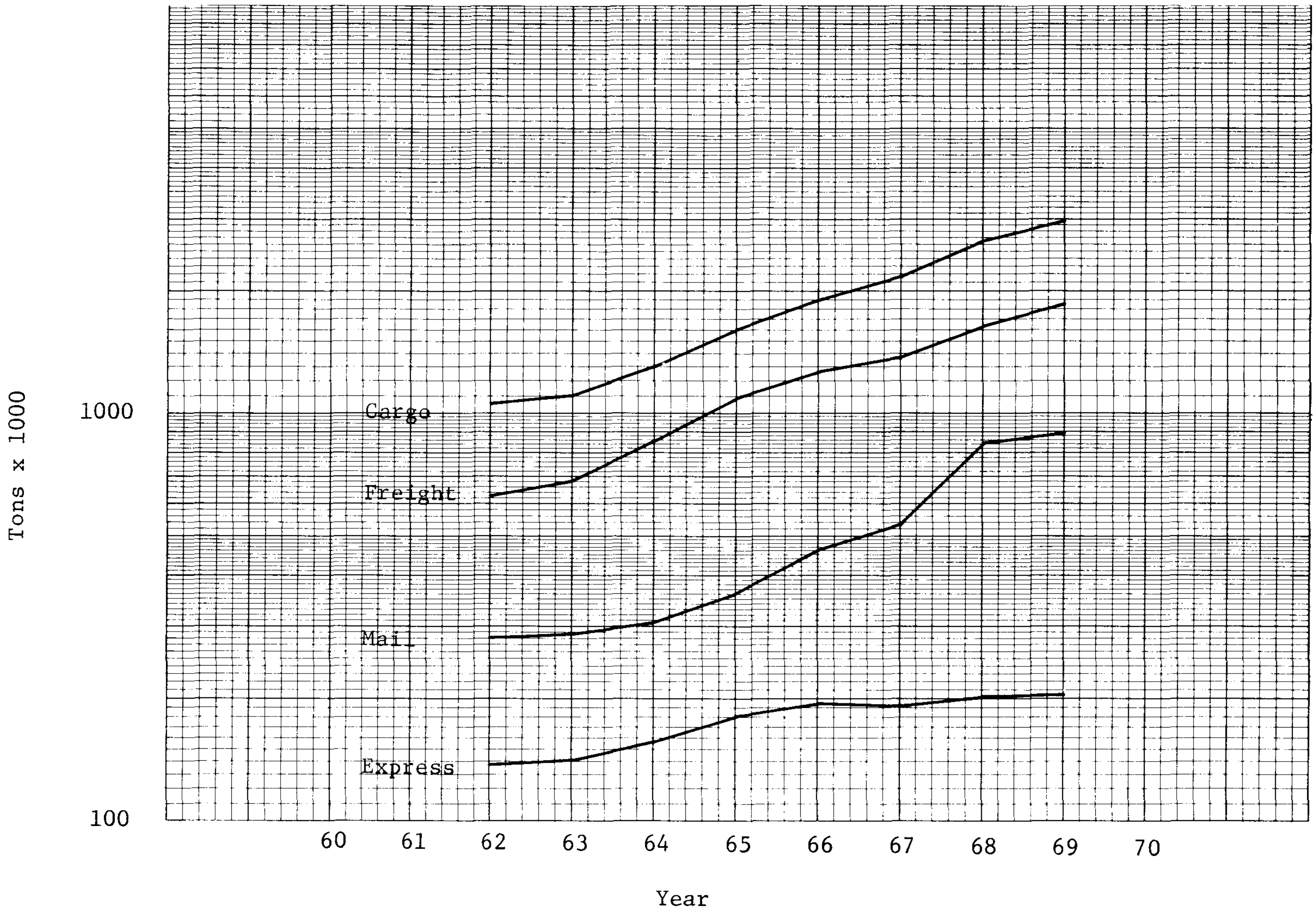


Figure 3-1

FREIGHT, EXPRESS, MAIL AND TOTAL AIR CARGO, U.S.
1962-1969

Figure 3-2

ENPLANED FREIGHT, EXPRESS, MAIL, AND TOTAL AIR CARGO:
DALLAS-FT. WORTH, 1962-1969

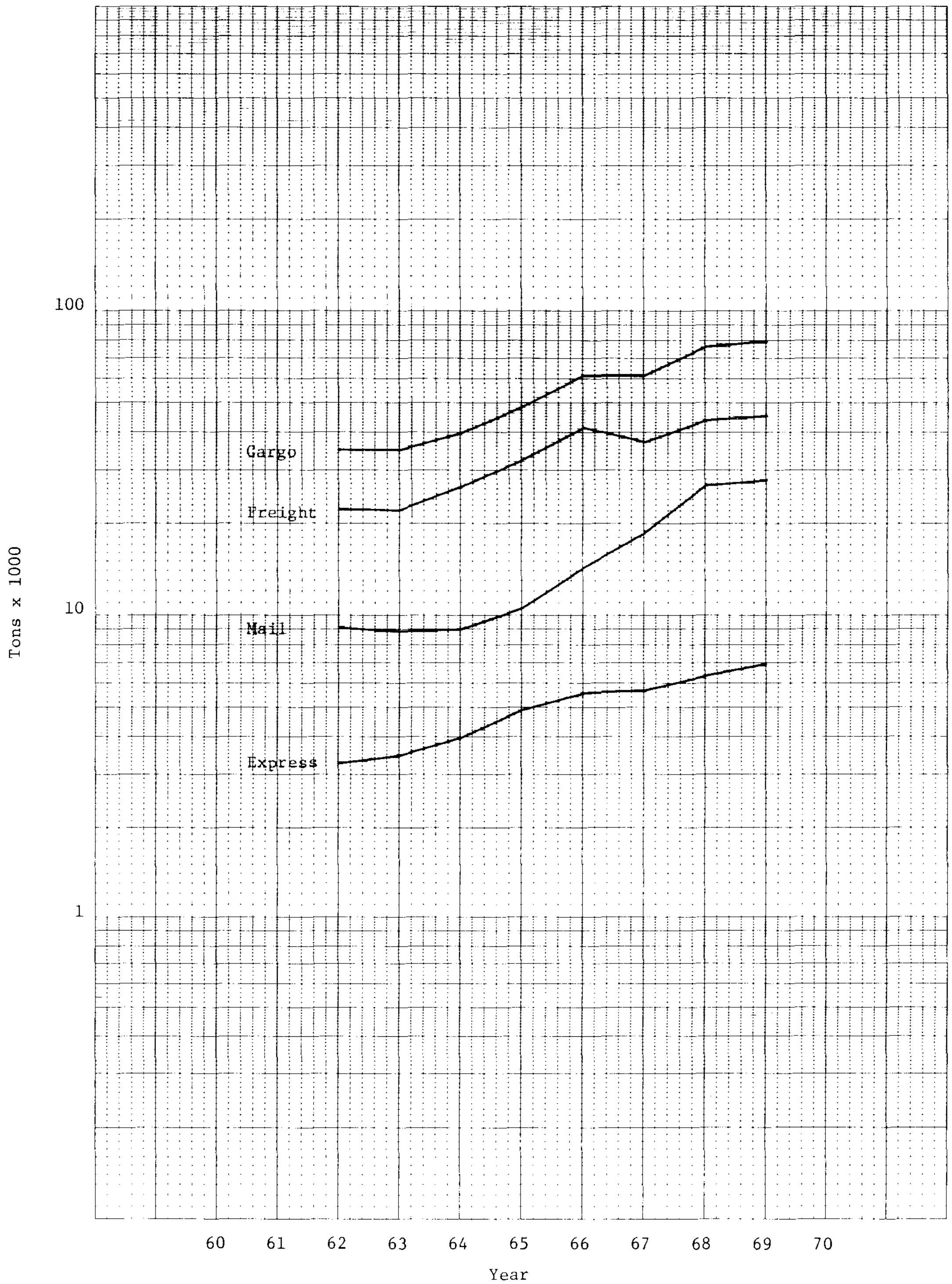


Figure 3-3

ENPLANED FREIGHT, EXPRESS, MAIL, AND TOTAL AIR CARGO:
HOUSTON, 1962-1969

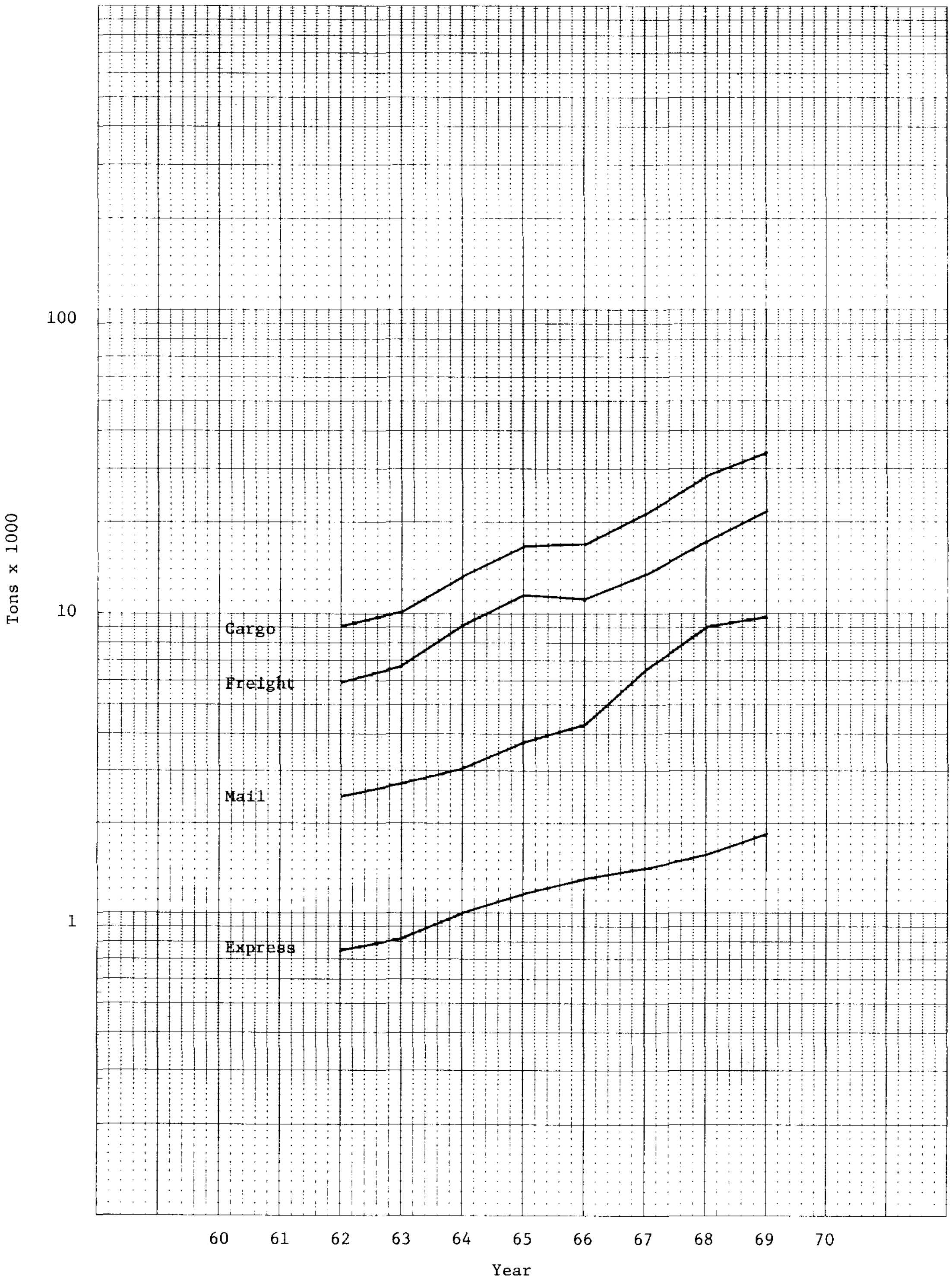


Figure 3-4

ENPLANED FREIGHT, EXPRESS, MAIL, AND TOTAL AIR CARGO:
SAN ANTONIO, 1962-1969

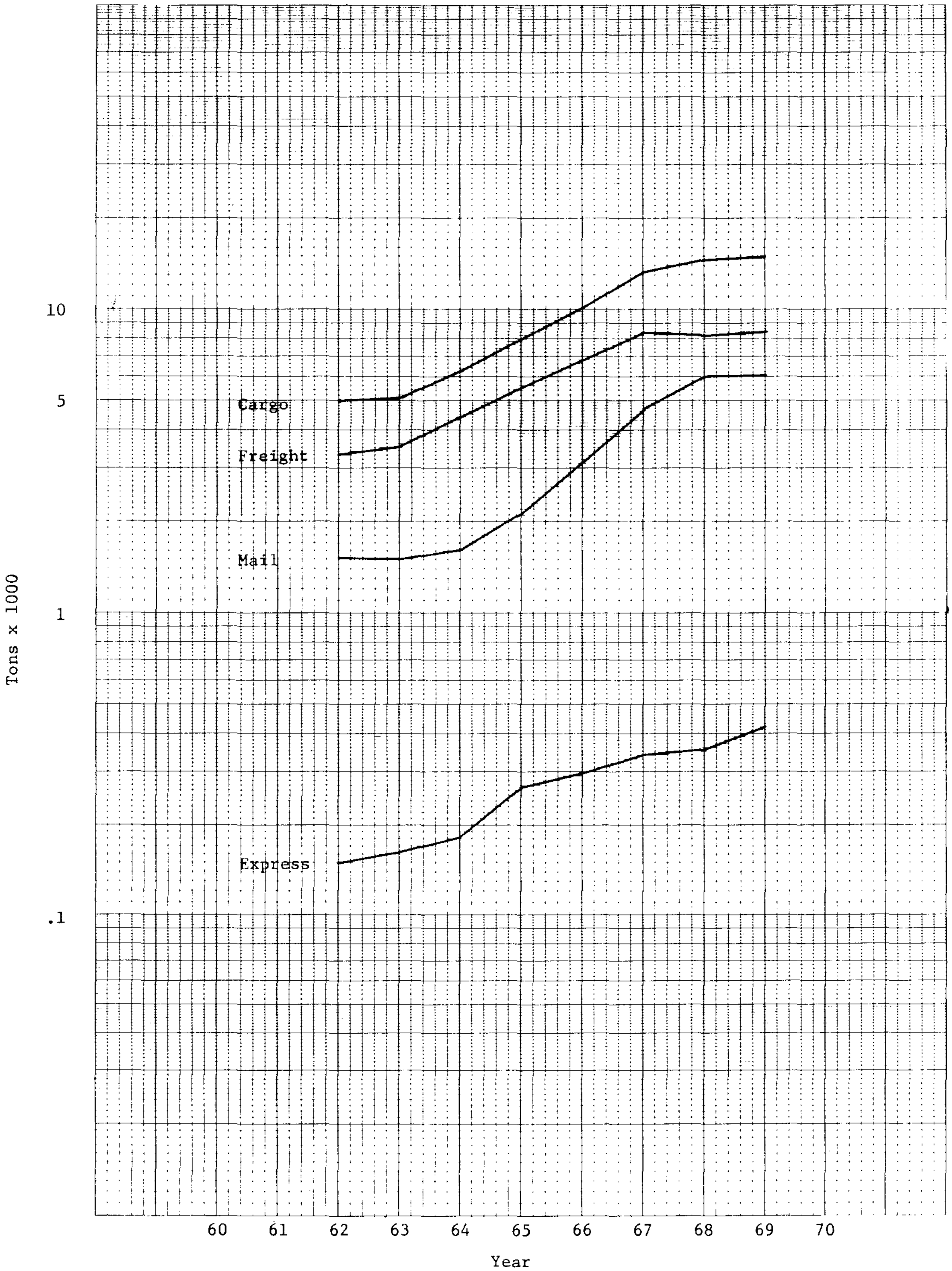


Figure 3-5

ENPLANED FREIGHT, EXPRESS, MAIL, AND TOTAL AIR CARGO:
EL PASO, 1962-1969

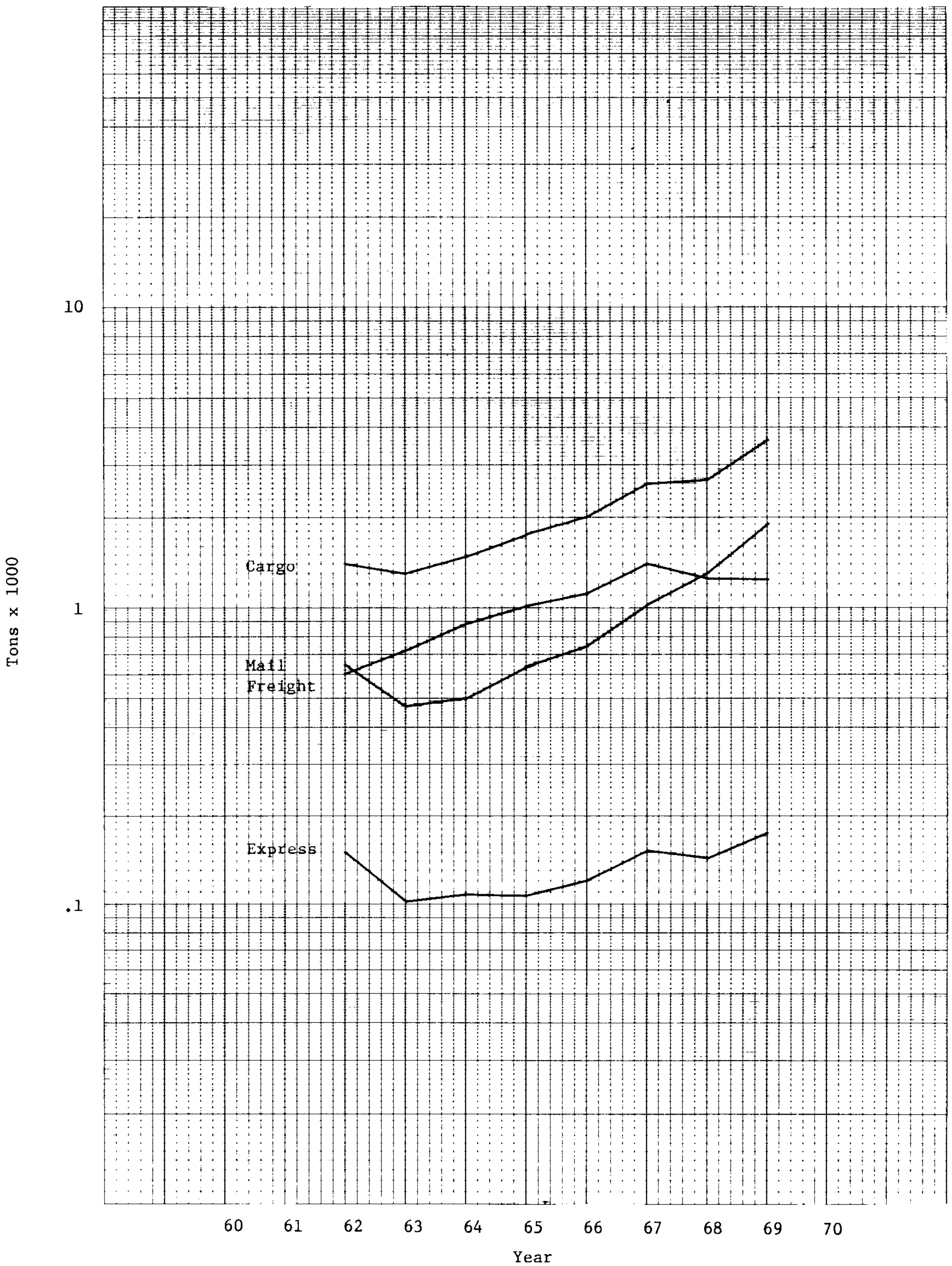


Figure 3-6

ENPLANED FREIGHT, EXPRESS, MAIL, AND TOTAL AIR CARGO:
RESIDUAL 25, 1962-1969

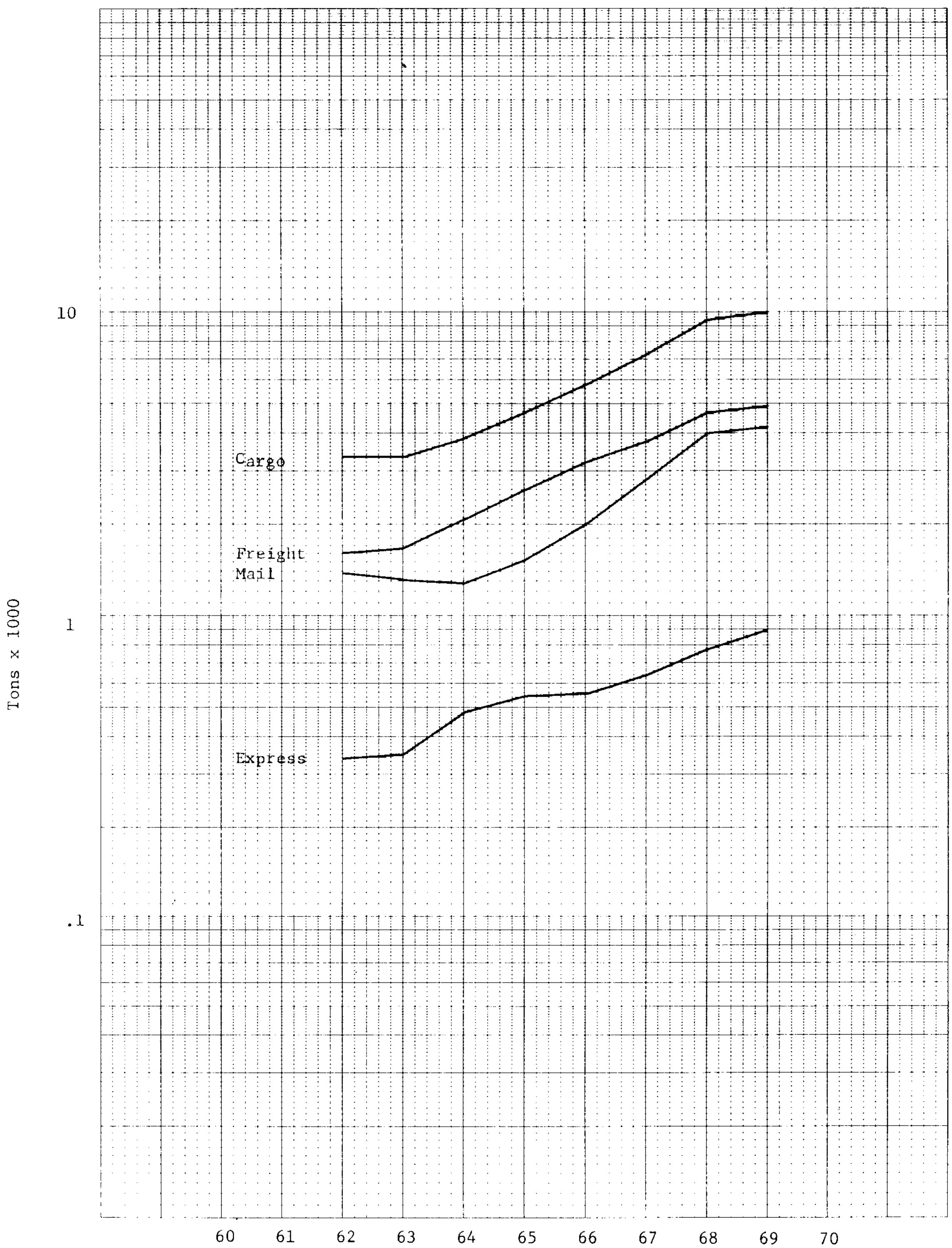


Figure 3-7

SELECTED SMALLER AIRPORTS' CARGO HISTORIES

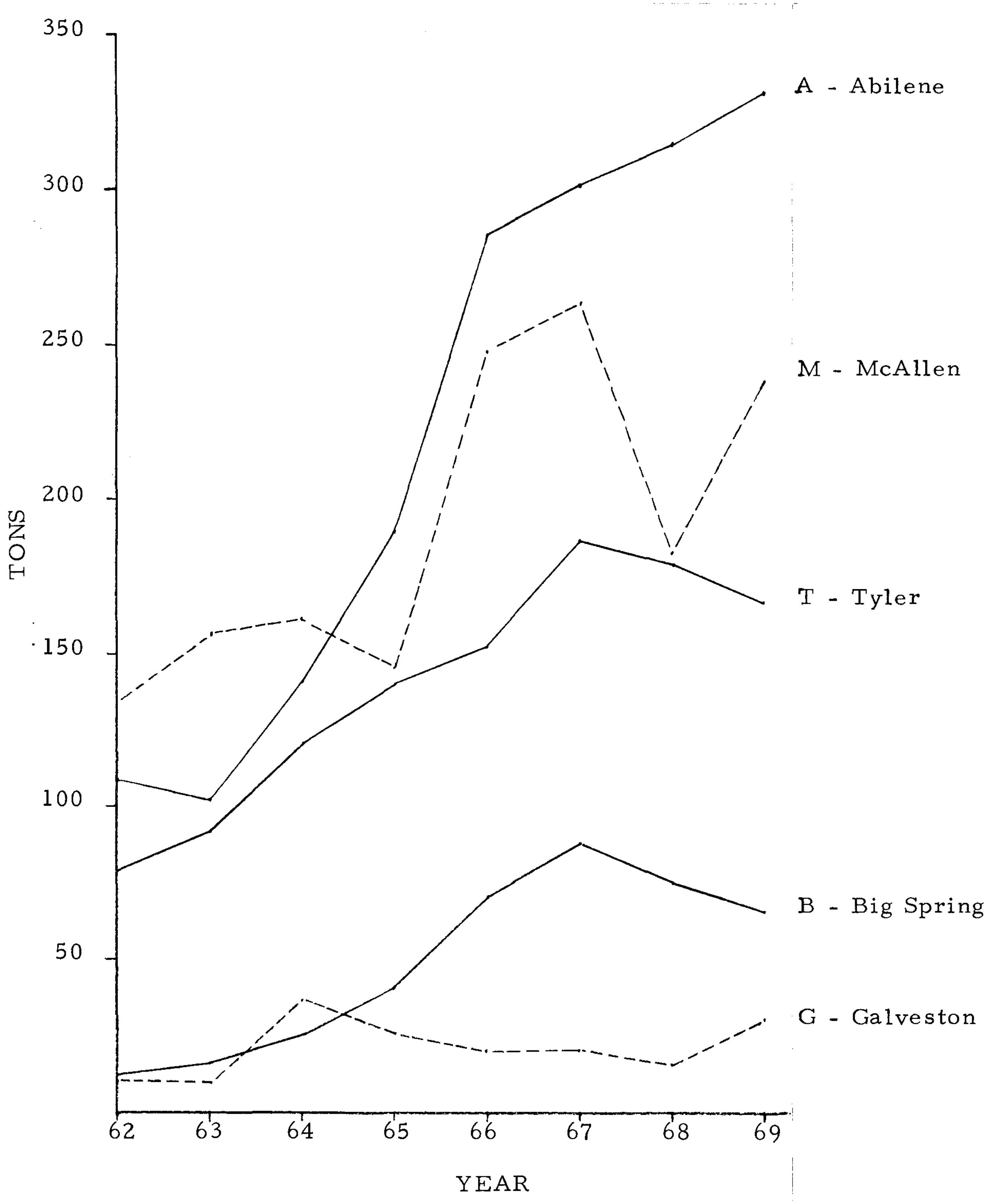


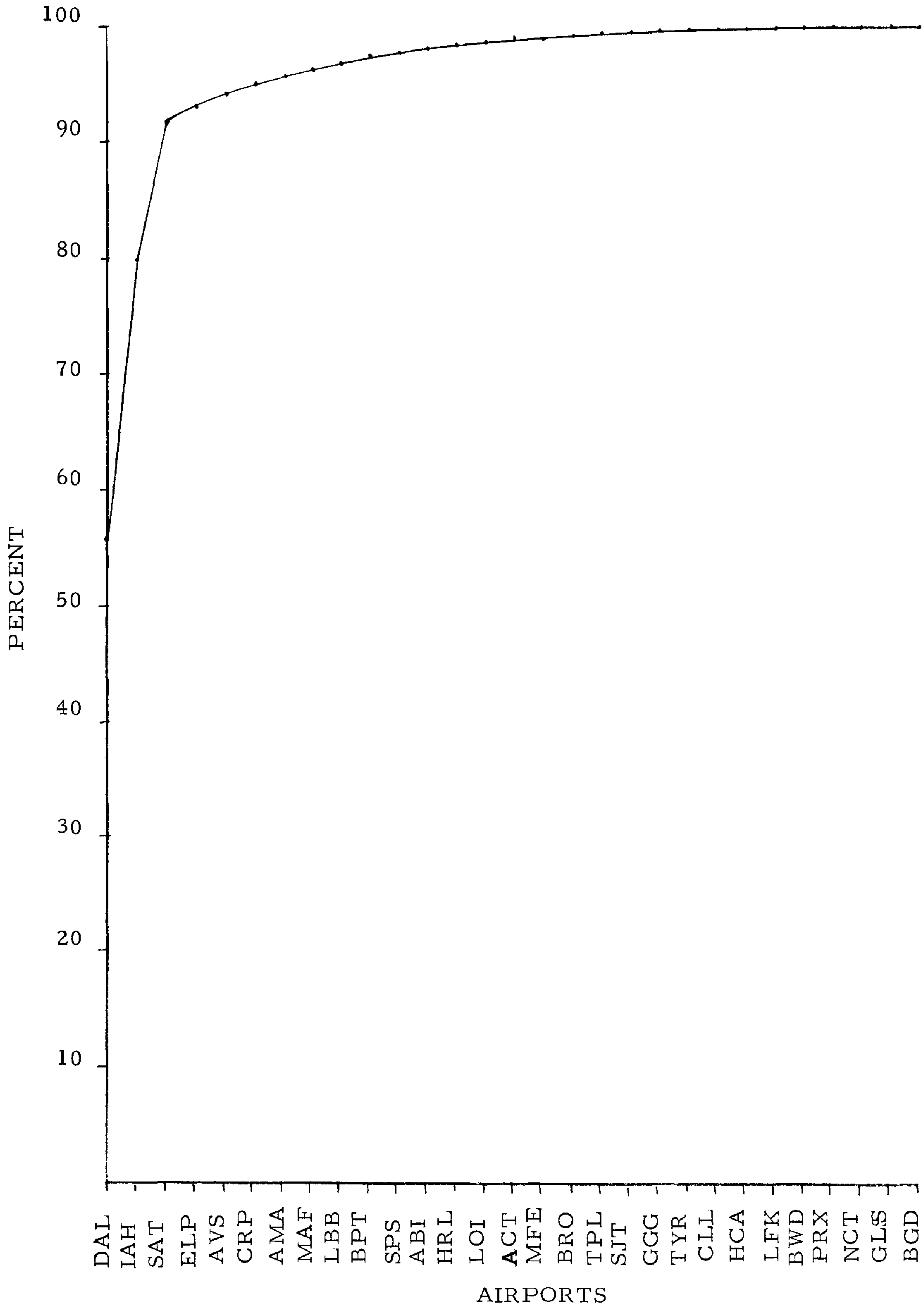
Figure 3-8 shows cumulative distribution of the percentage of total cargo originations for certificated air carrier airports for 1969 (complete data are not yet available for 1970), ranked in order of percentage of total Texas originations of cargo. The top three hubs, or 10 percent of Texas airports, (certificated air carriers) account for 91 percent. (For the Continental United States, the top 27 - five percent of airports - account for 82 percent of the cargo originations.) El Paso accounts for about 2.5 percent.

Historically, this relationship is relatively constant. Table 3-1 shows the amount and percentage of Texas cargo originations accounted for in each year from 1962 through 1969 by Dallas-Fort Worth, Houston, and San Antonio. Even the detail remains fairly constant. This property is important for carrying out one type of trend based forecast, based on a proportionate relation to Texas or to the United States. The table also shows Texas and United States originations and Texas as a percentage of the United States originations. Texas percentage of United States is highly stable. This permits relative confidence in utilizing independent macro-forecasts of air cargo (national and international) such as those published by Air Transport Association of America, CAB, and International Air Transport Association.

The complementary relationship to the high proportion of air cargo generated by the few top airports is the low percentage of cargo emanating from the 25 smaller airports (seven percent of origination). This is partially due to the definition of originations which includes cargo moving from one airline to another. For example, a shipment originating on Texas International at Big Spring destined for a consignee in New York City would probably be transferred to another airline, say Eastern, at Dallas Love Field where it would also count as an origination. However, rarely would a shipment originating at Dallas be transferred to another airline at Big Spring. A correction of this "double counting" would probably depress the cumulative distribution curve only slightly, however.

Figure 3-8

TEXAS AIRPORTS' CARGO: CUMULATIVE SHARE-1970



(Note: Airports & abbreviations are shown in Exhibit 3-1)

Table 3-1

TOP THREE AIR HUBS AS SHARE OF TOTAL TEXAS AIR CARGO ORIGINATED;
TEXAS AS SHARE OF U.S. CARGO ORIGINATIONS ON CERTIFIED AIR CARRIER AIRPORTS
1962-1970

	Cargo (thousands of tons)					Share of Texas (percent)				Share of U.S. (percent)
	Dallas-Fort Worth	Houston	San Antonio	Texas	United States	Dallas-Fort Worth	Houston	San Antonio	Top Three	Texas
Calendar Year										
1962	34.7	9.1	5.0	53.5	1,050	65%	17%	9%	91%	5.1%
1963	34.6	10.2	5.1	54.7	1,120	64	19	9	92	4.9
1964	39.3	13.1	6.2	63.9	1,310	62	21	10	92	4.9
1965	47.8	16.5	7.9	78.5	1,620	61	21	10	92	4.9
1966	61.9	16.9	10.1	95.6	1,900	64	18	11	92	5.0
1967	61.2	21.3	13.3	105.5	2,190	58	20	13	91	4.8
1968	76.2	27.6	14.5	130.3	2,670	58	21	11	91	4.9
1969	79.5	33.4	14.9	141.3	2,940	56	24	11	91	4.8
Fiscal Year										
1970*										
Fiscal Year										
1970*	83.3	33.5	14.0	143.4	3,351	58	23	10	91	4.3

*Contains some under counting in basic source.

Source: CAB/FAA, Airport Activity Statistics.

To some extent, there is an analogy to the old saw, "the rich get richer" in this complementary relationship. The higher demand levels around the busy hubs support higher service levels and permit some specific economics. The higher service levels make location or expansion of air cargo using activities around the hubs more attractive - and so on. However, were service levels at Big Spring to be raised to those of San Antonio, say for a period of years, it is unlikely that this would result in location of new air cargo using industry to a level sufficient to economically warrant the service. This is because air cargo is only a part of the necessary intrastructure for its support.

Data for selected smaller airports were presented in Figure 3-7. Note the volatile patterns: Tyler and Big Spring are declining from 1967 peaks, and Galveston varies around a constant level (with no real increase). Abilene has recently entered a slower growth phase (likely exhibiting the characteristic S-curve of development), and McAllen has, in succession, fallen slightly, risen greatly, risen slightly, fallen greatly, and risen greatly. Such modes of variation are characteristic of small (versus large) hubs, and thus, any specific or collective forecasts for them tend to be dubious. While consideration of their role in state activity - and perhaps allocation of residual cargo traffic to them - is necessary, application of extensive analytical techniques to this eight percent to nine percent portion could prove to be cost-ineffective.

Discussions of Texas individual hubs and non-hubs may involve their standard abbreviations. These are shown in Exhibit 3-1.

Exhibit 3-1

TEXAS AIRPORTS AND STANDARD ABBREVIATIONS

Abilene	ABI
Amarillo	AMA
Austin	AUS
Beaumont/Pt. Arthur	BPT
Big Spring	HCA
Borger	BGD
Brownsville	BRO
Brownwood	BWD
College St. /Bryan	CLL
Corpus Christi	CRP
Dallas/Ft. Worth	GSQ (Love-DAL)
El Paso	ELP
Galveston	GLS
Harlingen/San Benito	HRL
Houston	IAH (Hobby-HOU)
Laredo	LOI
Longview/Kilgore/ Gladewater	GGG
Lubbock	LBB
Lufkin	LFK
Midland/Odessa	MAF
Mission/McAllen/ Edinburgh	MFE
Paris	PRX
San Angelo	SJT
San Antonio	SAT
Temple	TPL
Tyler	TYR
Victoria	VCT
Waco	ACT
Wichita Falls	SPS

International and Territorial Cargo Histories

The preceding discussion covered total system operations. This included international and territorial operations. Texas international and territorial cargo for 1962 through FY 1970 are shown (tons) in this array:

	1962	1963	1964	1965	1966	1967	1968	1969	FY1970
Freight and Express	2,550	2,757	3,363	3,501	3,226	4,582	3,891	2,926	3,202
Mail	313	383	408	441	463	569	582	690	876
Total	2,863	3,040	3,771	3,942	3,689	5,151	4,473	3,616	4,078
Percent of Texas Air Cargo	5.3%	5.6%	5.9%	5.0%	3.9%	4.9%	3.3%	2.1%	2.8%
Percent U.S. International and Territorial	1.3%	1.2%	1.4%	1.1%	0.9%	1.1%	0.8%	0.5%	0.6%

These figures show a relatively small and declining share of Texas total cargo originations in international and territorial operations. Freight declines (express is insignificant) have been offset by increases in mail. Percent of United States territorial/international cargo is much lower than its share of system operations cargo and is continually declining.

The top three Texas hubs are the only hubs generating international and territorial operations and have displayed interesting but puzzling shares in this market. In 1962 all three were practically equal in their share of the freight market. In the peak year Dallas/Fort Worth had 1,623 tons of freight, Houston 1,218, and San Antonio 1,741. Dallas participation nose-dived from 1967 to 648 tons in FY1970. In 1970, Dallas had 20 percent of the market, Houston 39 percent and San Antonio 41 percent. In mail, Houston had increased its share from 47 percent in 1962 to 54 percent of the Texas market in FY1970, while San Antonio dropped from 28 to 19 percent. The Dallas share did not change significantly.

Airborne Foreign Trade from Texas Customs Districts

This trade is composed of airborne exports and imports clearing customs at the Texas gateway airports at Houston, San Antonio, and El Paso. Not all Texas's air exported or imported commodities are represented by this trade because of route structure and services. Exports from Dallas to Europe, for example, might more likely clear customs in New York. This report is focused on the impact of foreign trade on cargo activity at the gateway airports.

Export and import activity for the United States, Texas, and the Houston, Laredo, and El Paso customs districts for the decade 1962-1971 is given in Tables 3-2 and 3-3. The ALL column indicates total weight, the FLAG column shows that amount handled by United States Flag air carriers, and the other six columns present origin or destination by continent, i.e., NA = North America, SA = South America, EU = Europe, AS = Asia, A/O = Australia/Oceania, AF = Africa. The customs districts were summed to obtain the Texas figures (El Paso was not tabulated until the late 1960's - it was insignificant through 1968).

PATTERNS OF SHIPMENTS

Much of what is presented here concerning patterns of shipments is derived from the several surveys undertaken in this study. The historical perspective is much shorter in many cases than is desirable. Considerable data and information from public sources have been drawn on to supplement the survey results.

Shipment patterns give special insight into airport planning problems, the potential and limitations of air cargo for marketing Texas products, and policy initiatives that might be taken to further Texas interests.

Table 3-2

EXPORTS: TOTAL, U.S. FLAG CARRIER TRAFFIC, AND DESTINATION BY CONTINENT
1962-1971

		Millions of Pounds							
		ALL	FLAG	NA	SA	EU	AS	A/O	AF
1962	United States	217	77.8	64.8	39.9	46.3	8.32	1.84	2.71
	Texas	5.54	3.28	3.70	.262	.458	.356	.007	.273
	Houston	3.69	2.29	2.09	.223	.457	.349	.007	.212
	Laredo	1.86	.99	1.60	.039	.001	.007	--	.061
1963	United States	248	94.6	72.1	41.0	64.5	10.6	1.64	3.24
	Texas	7.11	4.71	4.29	.242	1.34	.189	.003	.208
	Houston	4.55	2.99	2.10	.201	1.33	.189	.003	.208
	Laredo	2.56	1.72	2.19	.041	.001	--	--	--
1964	United States	327	126	92.8	55.8	97.9	15.9	2.93	4.09
	Texas	7.41	5.02	5.10	.226	.874	.377	.002	.240
	Houston	4.70	2.79	2.60	.169	.865	.377	.002	.239
	Laredo	2.70	2.22	2.50	.057	.009	--	--	.001
1965	United States	457	176	127	71.3	182	29.1	5.02	7.41
	Texas	9.39	6.79	5.81	.692	1.64	.374	.008	.359
	Houston	6.29	4.28	3.16	.404	1.63	.365	.008	.359
	Laredo	3.09	2.51	2.65	.288	.010	.009	--	--
1966	United States	506	180	137	71.1	206	37.1	5.81	8.06
	Texas	7.38	5.11	4.70	.456	1.22	.470	.032	.527
	Houston	5.24	3.34	2.70	.326	1.21	.466	.032	.527
	Laredo	2.14	1.77	2.00	.130	.007	.004	--	--
1967	United States	549	199	152	71.3	250	51.6	8.56	10.4
	Texas	9.02	5.78	4.96	.370	1.78	.695	.069	1.14
	Houston	6.88	3.93	3.00	.275	1.71	.692	.069	1.14
	Laredo	2.05	1.76	1.95	.094	.001	--	--	--
	El Paso	.085	.085	.004	.001	.074	.003	--	.003
1968	United States	657	254	184	77.9	303	61.2	13.1	14.6
	Texas	12.5	8.26	6.49	1.06	2.09	1.17	.067	1.60
	Houston	10.1	6.48	4.31	.99	2.09	1.08	.067	1.60
	Laredo	2.35	1.78	2.19	.067	.003	.097	--	--
1969	United States	867	337	214	101	422	88.2	14.5	21.0
	Texas	16.4	10.7	6.80	3.01	2.97	1.42	.307	1.91
	Houston	12.9	8.13	3.86	2.90	2.56	1.42	.307	1.91
	Laredo	2.36	1.54	2.23	.110	.016	--	--	.003
	El Paso	1.11	1.06	.708	.002	.391	.001	--	.004
1970	United States	897	324	225	95.5	429	107	16.0	18.9
	Texas	13.9	8.35	7.78	1.21	1.81	1.57	.080	1.43
	Houston	9.96	5.84	3.99	1.12	1.80	1.56	.080	1.42
	Laredo	2.94	1.55	2.83	.096	.002	.010	--	--
	El Paso	.968	.961	.956	.002	.009	.001	--	.002
1971	United States	899	330	226	102	405	126	18.4	22.0
	Texas	14.7	7.40	7.41	1.54	2.04	1.55	.104	1.93
	Houston	10.5	4.92	3.58	1.52	1.96	1.31	.104	1.93
	Laredo	2.97	1.30	2.66	.018	.072	.238	--	--
	El Paso	1.18	1.18	1.17	--	.010	.001	--	--

Source: Bureau of the Census, "U.S. Airborne Foreign Trade (FT-986)".

Table 3-3

IMPORTS: TOTAL, U.S. FLAG CARRIER TRAFFIC, AND ORIGIN BY CONTINENT
1962-1971

		Millions of Pounds							
		ALL	FLAG	NA	SA	EU	AS	A/O	AF
1962	United States	98.1	38.4	35.6	6.65	48.2	7.14	.175	.418
	Texas	4.48	2.52	4.37	.021	.049	.040	--	.006
	Houston	1.80	.883	1.70	.016	.049	.040	--	.003
	Laredo	2.68	1.64	2.67	.005	--	--	--	.003
1963	United States	113	46.3	34.2	11.7	58.2	8.34	.262	.378
	Texas	2.90	1.76	2.85	.011	.034	.003	--	.003
	Houston	1.33	.304	1.28	.010	.033	.003	--	.003
	Laredo	1.57	1.46	1.57	.001	.001	--	--	--
1964	United States	128	59.1	31.0	14.4	68.4	13.8	.270	.653
	Texas	2.01	1.64	1.94	.033	.025	--	--	--
	Houston	.628	.338	.570	.033	.024	--	--	--
	Laredo	1.38	1.30	1.37	--	.001	--	--	--
1965	United States	192	95.7	33.1	19.8	112	26.7	.372	.764
	Texas	2.54	2.18	2.36	.138	.030	.005	--	.003
	Houston	.441	.312	.274	.137	.023	.005	--	.001
	Laredo	2.10	1.87	2.09	.001	.007	--	--	.002
1966	United States	229	110	39.1	15.2	134	39.5	.682	1.14
	Texas	5.60	5.02	5.45	.063	.060	.016	.011	.003
	Houston	.982	.840	.849	.058	.051	.002	.011	.003
	Laredo	4.62	4.18	4.60	.008	.009	.014	--	--
1967	United States	305	128	49.8	19.2	178	54.5	1.34	1.45
	Texas	3.33	2.91	3.19	.052	.080	.011	--	.002
	Houston	.852	.724	.714	.050	.075	.011	--	.001
	Laredo	2.48	2.19	2.48	.002	.005	--	--	.001
	El Paso	.001	.001	.001	--	--	--	--	--
1968	United States	431	199	70.5	21.3	254	80.2	2.32	1.84
	Texas	3.71	3.37	3.37	.093	.196	.050	--	.004
	Houston	1.29	1.08	.990	.090	.156	.048	--	.004
	Laredo	2.42	2.29	2.38	.003	.040	.002	--	--
1969	United States	614	278	90.3	29.5	377	111	3.28	2.28
	Texas	5.41	4.67	4.77	.126	.393	.044	.024	.049
	Houston	2.05	1.54	1.44	.126	.372	.038	.024	.049
	Laredo	3.25	3.03	3.24	--	.005	.005	--	--
	El Paso	.108	.099	.091	--	.016	.001	--	--
1970	United States	620	288	85.2	43.3	354	131	3.36	2.59
	Texas	5.36	3.89	3.92	.183	1.11	.120	.002	.036
	Houston	3.18	2.04	1.78	.182	1.09	.102	.002	.036
	Laredo	2.07	1.76	2.05	.001	.010	.005	--	--
	El Paso	.108	.091	.089	--	.005	.013	--	--
1971	United States	824	375	93.4	68.2	441	215	4.92	2.85
	Texas	5.07	3.18	3.07	.195	1.45	.301	.004	.047
	Houston	3.47	1.76	1.57	.150	1.44	.267	.002	.047
	Laredo	1.48	1.32	1.40	.045	.004	.028	.002	--
	El Paso	.117	.095	.104	--	.006	.006	--	--

Source: Bureau of the Census, "U.S. Airborne Foreign Trade (FT-986)".

A survey of the United States certificated carriers serving Texas hubs was undertaken during the course of the Texas Air Cargo study. Personal interviews were conducted at the major hubs, and two types of printed survey forms were sent out: (a) a long form was sent to the airline representatives appointed to the Air Cargo Technical Resource Group; and (b) if the requested information was not available from the airline representative, a short questionnaire form was sent to the station or cargo manager of that airline at each of the airports served.

Enplaned/Deplaned Statistics

One of the principal aims of the carrier survey was to derive data pertaining to the ratio of incoming to outgoing cargo for each airport. At present, the published statistics such as those in the CAB/FAA Airport Activity Statistics cover only enplaned cargo. One airport, El Paso International, publishes both enplaned and deplaned cargo statistics. In general, deplaning statistics are not available from published sources.

Rational airport space planning for cargo requires some knowledge of cargo volumes in both directions. Texas airports, on the whole, experience a significantly higher volume of incoming cargo than outgoing cargo, and can therefore be expected to experience rate penalties unless airline promotional rates are published. Ratios in 1970 ranged from a high of 2.942 in Galveston to a low of .816 in Abilene, with a median of 1.661. That is to say in the median case for every enplaned ton in 1970, 1.661 tons were deplaned. Table 3-4 summarizes the results of carrier responses by airport for 1969-1971. For Continental Airlines, Frontier Airlines, and National Airlines, deplaned data were not generally available. Also, complete data for 1969 and 1971 were not available from American Airlines and Delta Airlines.

The ratio of Braniff's enplaned to deplaned cargo by month was analyzed for hubs served by that carrier. Table 3-5 summarizes that analysis. At first glance, it would appear that peak months and ratios

Table 3-4

ANNUAL RATIOS OF DEPLANING/ENPLANING CARGO
AT TEXAS AIRPORTS DERIVED FROM CARRIER RESPONSES

Airport	1969	1970	1971
Dallas/Fort Worth	1.261*	1.468	N.A.
Houston	1.082*	1.200	N.A.
San Antonio	1.102*	1.105	N.A.
El Paso	1.252	1.432	1.565
Abilene	1.674	.816	2.118
Amarillo	3.628	2.640	1.895
Austin	1.195	2.129	1.142
Beaumont/Pt. Arthur	1.696*	2.283	1.953
Big Spring	1.102	1.012	.893
Borger	N.A.	N.A.	N.A.
Brownsville	1.259	1.636	1.110
Brownwood	2.104	1.661	1.312
College Station/Bryan	1.450	1.443	1.894
Corpus Christi	1.266	1.286	1.593
Galveston	3.21	2.942	1.171
Harlingen/San Benito	.514	1.362	1.840
Laredo	2.16	1.737	1.540
Longview/Kilgore/ Gladewater	1.39	1.379	2.207
Lubbock	2.568*	2.784	2.511
Lufkin	2.023	2.255	2.394
Midland/Odessa	2.292	1.903	1.712
Mission/McAllen/ Edinburgh	1.523	1.489	1.257
Paris	N.A.	N.A.	N.A.
San Angelo	1.357	1.833	1.387
Temple	1.280	1.428	1.950
Tyler	2.032	2.161	2.222
Victoria	2.984	2.456	1.735
Waco	1.700	1.918	1.545
Wichita Falls	1.139*	1.231	1.257*

*Airline data incomplete.

Source: TTI Air Carrier Survey

Table 3-5

Summary Analysis of Braniff monthly Deplaning and Enplaning Cargo by Texas Station: Average, Peak and Month of Peak

Mail

	1969			1970			1971		
	AVG Depl/Enpl	Peak Depl/Enpl	Month of Peak	AVG Depl/Enpl	Peak Depl/Enpl	Month of Peak	AVG Depl/Enpl	Peak Depl/Enpl	Month of Peak
Amarillo	4.42	5.99	June	3.25	4.78	Jan.	1.60	1.59	March
Austin	.78	1.43	April	.86	.96	Nov.	.74	.97	Feb.
Brownsville	.84	1.44	Feb.	.34	.75	Feb.	.60	.73	April
Corpus Christi	.75	1.15	Sept.	.43	.68	Feb.	.64	.85	Oct.
Dallas	1.18	1.27	March	1.20	1.33	May	1.16	1.21	Dec.
Houston	1.20	1.27	Aug.	1.13	1.41	Oct.	1.32	1.55	March
Lubbock	2.42	7.97	May	3.53	4.76	Jan.	4.75	6.05	Sept.
San Antonio	1.04	1.22	Dec.	1.10	1.19	Dec.	1.26	1.60	Aug.
Express									
Amarillo	7.84	18.62	July	6.26	27.45	June	1.38	10.69	March
Austin	2.41	4.53	Dec.	3.22	4.73	May	1.87	2.79	Dec.
Brownsville	3.61	5.50	July	3.43	8.35	July	2.76	4.69	June
Corpus Christi	3.74	5.36	May	2.46	3.80	Jan.	2.35	3.08	Nov.
Dallas	1.09	1.21	March	1.13	1.30	Oct.	1.18	1.30	Dec.
Houston	1.60	1.92	Nov.	1.97	2.96	April	1.37	1.72	July
Lubbock	1.10	1.93	Jan.	.95	2.12	March	.77	1.21	Dec.
San Antonio	3.03	4.01	Jan.	3.29	5.07	May	2.83	4.15	March

Table 3-5
(Continued)

Summary Analysis of Braniff monthly Deplaning and Enplaning Cargo by Texas Station: Average, Peak and Month of Peak

Freight

STATION	1969			1970			1971		
	AVG Depl/Enpl	Peak Depl/Enpl	Month of Peak	AVG Depl/Enpl	Peak Depl/Enpl	Month of Peak	AVG Depl/Enpl	Peak Depl/Enpl	Month of Peak
Amarillo	3.28	5.96	Dec.	2.05	5.89	March	1.83	3.09	Sept.
Austin	2.12	3.39	Aug.	2.15	2.79	Aug.	2.05	2.65	Feb.
Brownsville	1.25	2.24	Nov.	1.92	4.32	May	1.10	1.42	April
Corpus Christi	2.43	3.29	Aug.	2.79	6.00	Aug.	2.75	3.16	March
Dallas	1.20	1.34	Aug.	1.18	1.32	July	1.05	1.14	Oct.
Houston	1.18	3.06	June	1.54	1.87	April	1.51	1.97	Dec.
Lubbock	3.09	4.10	March	2.88	5.70	April	2.24	3.38	March
San Antonio	1.42	2.09	Dec.	1.30	1.52	July	1.39	1.84	Aug.
				Total					
Amarillo	4.05	5.14	June	2.64	4.34	March	1.67	2.55	Feb.
Austin	1.21	1.52	March	1.42	1.85	Aug.	1.34	1.48	Aug.
Brownsville	1.26	1.92	Nov.	1.64	2.77	May	1.11	1.41	April & May
Corpus Christi	1.53	1.83	Sept.	1.29	2.31	Aug.	1.47	1.83	Oct.
Dallas	1.19	1.27	Aug.	1.19	1.29	July	1.11	1.16	Oct.
Houston	1.21	1.96	June	1.42	1.58	April	1.43	1.68	July
Lubbock	2.56	3.95	June	2.81	4.59	April	2.55	3.49	Jan.
San Antonio	1.29	1.68	Dec.	1.27	1.34	June	1.37	1.77	Aug.

Source: Braniff International Airlines and TTI.

are not particularly stable over time. The reason for this is that the number of working days in a particular month vary from one year to the next, and holidays, such as Easter, vary between March and April from one year to the next. The most critical information for forecasting monthly volume is the number of Mondays, Tuesdays, Wednesdays, etc., in a particular month. Freight volumes vary during the week, generally tending to be light early in the week, becoming heavier as the week progresses. Saturdays and Sundays are very slow. To be most meaningful, the monthly data should be adjusted for these factors; however, this would require day to day traffic volumes which are not readily available. It is apparent that peaking on a monthly basis generally is not significantly different from the average monthly load and, therefore, is not critical when planning capacity requirements. Notice that the deplaning cargo is the critical factor for capacity planning at these airports.

Table 3-6 shows the total incoming plus outgoing freight and mail for Braniff by month, the ratio of peak month to average month, and name of peak month. Enplaning and deplaning cargo peaks do not occur at the same time of day. Table 3-6, while showing total volumes during the month, is not critical for capacity planning. Deplaning cargo peaks are in the early morning hours, whereas enplaning cargo peaks in the early evening.

Ratios of airborne imports to exports are analogous to deplaning/ enplaning ratios. Airborne imports and exports through airports in Texas customs districts present a striking difference to the overall

Table 3-6

Summary Analysis of Braniff Total Monthly Deplaning and Enplaning Cargo by Texas Station: Average, Ratio Peak to Average, and Month of Peak

Freight

STATION	1969			1970			1971		
	Monthly AVG	Ratio Peak to AVG	Month of Peak	Monthly AVG	Ratio Peak to AVG	Month of Peak	Monthly AVG	Ratio Peak to AVG	Month of Peak
Amarillo	76,616	1.39	Aug.	68,017	1.46	May	60,178	1.40	Oct.
Austin	176,442	1.33	Sept.	194,834	1.41	May	185,602	1.19	Aug.
Brownsville	71,698	1.39	April	70,763	1.32	Oct.	123,640	1.34	Oct.
Corpus Christi	175,305	1.13	Sept.	188,926	1.38	May	157,250	1.25	Dec.
Dallas	7,089,626	1.33	March	6,538,486	1.22	May	5,266,561	1.18	Dec.
Houston	1,677,190	1.16	Oct.	1,710,989	1.18	May	1,365,086	1.15	Dec.
Lubbock	104,562	1.24	July	81,653	1.26	April	65,712	1.36	April
San Antonio	1,360,539	1.32	March	1,161,977	1.15	May	818,748	1.09	Jan.
				Express					
Amarillo	12,973	1.58	Aug.	6,579	1.68	Feb.	8,933	1.63	Dec.
Austin	42,521	1.19	April	44,417	1.44	April	26,508	1.29	March
Brownsville	4,713	1.41	Oct.	5,443	1.48	May	7,950	1.21	Feb.
Corpus Christi	21,477	1.20	Dec.	25,185	1.24	Aug.	20,239	1.24	March
Dallas	786,014	1.31	March	709,454	1.24	April	544,505	1.28	Dec.
Houston	179,343	1.15	Dec.	157,025	1.61	April	124,226	1.14	Dec.
Lubbock	15,523	1.17	Jan.	8,554	1.63	April	5,218	1.37	Jan.
San Antonio	101,221	1.30	Jan.	85,260	1.25	April	66,863	1.12	March

Table 3-6
(Continued)

Summary Analysis of Braniff Total Monthly Deplaning and Enplaning Cargo by Texas Station: Average, Ratio Peak to Average, and Month of Peak

Mail

	1969			1970			1971		
	Monthly AVG	Ratio Peak to AVG	Month of Peak	Monthly AVG	Ratio Peak to AVG	Month of Peak	Monthly AVG	Ratio Peak to AVG	Month of Peak
Amarillo	119,757	1.24	Dec.	69,770	1.62	Jan.	76,278	1.52	Dec.
Austin	271,751	1.26	Dec.	214,576	1.54	Jan.	140,513	1.45	March
Brownsville	8,777	1.53	Dec.	9,071	1.22	March	7,568	1.37	Dec.
Corpus Christi	125,573	1.33	Dec.	137,724	1.40	March	116,655	1.19	Dec.
Dallas	4,949,768	1.20	Dec.	4,666,703	1.27	Dec.	4,587,695	1.22	Dec.
Houston	753,176	1.29	Dec.	783,131	1.25	Dec.	860,905	1.12	Dec.
Lubbock	67,756	1.45	Dec.	42,723	1.81	Feb.	29,621	1.36	Dec.
San Antonio	904,083	1.31	April	703,646	1.22	March	662,328	1.30	Dec.

Total

	1969			1970			1971		
	Monthly AVG	Ratio Peak to AVG	Month of Peak	Monthly AVG	Ratio Peak to AVG	Month of Peak	Monthly AVG	Ratio Peak to AVG	Month of Peak
Amarillo	209,713	1.13	Aug.	147,674	1.30	April	141,925	1.41	Dec.
Austin	490,634	1.14	Dec.	453,829	1.30	April	345,107	1.46	Aug.
Brownsville	85,189	1.32	April	85,277	1.27	Dec.	139,159	1.29	Oct.
Corpus Christi	322,356	1.15	Dec.	351,820	1.13	Aug.	294,147	1.21	Dec.
Dallas	12,824,553	1.24	March	11,914,640	1.17	April	10,398,762	1.23	Dec.
Houston	2,609,710	1.15	Dec.	2,649,956	1.10	April	2,348,836	1.14	Dec.
Lubbock	187,825	1.16	April	132,931	1.38	April	100,525	1.21	April
San Antonio	2,365,845	1.24	March	1,949,696	1.15	April	1,549,607	1.16	Dec.

Source: Braniff International Airlines and TTI.

deplaning, enplaning relationships. The following array, based on Tables 3-2 and 3-3 above, shows imports to exports weight ratios for the years 1962 through 1971 by state total and gateway airport city:

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Texas	.81	.41	.27	.27	.76	.45	.30	.33	.38	.34
Houston	.48	.29	.08	.07	.19	.12	.13	.16	.32	.34
San Antonio	1.42	.61	.52	.68	2.2	1.22	1.03	1.38	.70	.50
El Paso	--	--	--	--	--	--	--	.10	.11	.09

Houston originates considerably more air cargo in foreign trade than it terminates, as does El Paso. San Antonio presents a mixed pattern with imports exceeding exports in four of the 10 years covered.

Commodities by Air

Types of commodities moving by air provide information as to how air cargo serves distribution and indicates specific handling problems. Insights into the commodity composition of Texas air cargo movements were sought from carriers by asking, "What are the major commodities inbound? Outbound?" Another question was asked about inbound and outbound shippers, again to gain insight into the commodity composition, but also to identify significant shipper groups for the individual shipper surveys.

Three factors are at work that prevent good answers to these two questions. First, the airlines in general are not commodity conscious. Relative to railroad and truck tariffs, the airline tariffs are not commodity specific. Many shipments move on a weight basis regardless of the commodity. This is not to say that there are no specific commodity rates, but, relative to general commodity rates, specific commodity rates play a small role. The second factor is that about 50 percent of the air freight is tendered by air freight forwarders. Much of this traffic is consolidated and described on the airbill as "mixed." A visual search of several airline airbill files revealed that commodity descriptions are vague, with descriptions like "mixed, machine parts, wearing apparel, miscellaneous parts, printed matter," etc., predominating. For the most part, descriptions would permit classification at the two digit SIC level only. The third factor which hinders commodity descriptions is the growing use of shipper and forwarder packed containers. Frequently, these containers move on a per container charge regardless of the commodity. Indications are that these containers usually will contain more than one commodity.

Commodities mentioned by carriers include those listed in Exhibit 3-2.

Electronic components, oil field equipment, wearing apparel, printed matter, and machine parts were consistently mentioned as major inbound and outbound commodities at most Texas stations. A few commodities move primarily through one or two stations. For example, turkey eggs move outbound from Dallas, live and processed crab outbound from Houston, and decorative greens outbound from San Antonio. Amarillo, El Paso, and Dallas move high volumes of semifinished wearing apparel between these stations and San Juan.

Emery Airfreight estimated the commodity composition of their shipments as follows:

Estimates by Group:

Machine manufacturers	20%-25%
Electronic equipment	11%
Graphic arts and finance	11%
Drugs and cosmetics	8%
Metal products (Anaconda and Kaiser Aluminum, metalurgical laboratories)	6%
Wearing apparel (increasing)	5%
Automotive	3%
Chemicals	2%
Films, television video tape (football game)	2%
Miscellaneous	Rest

Exhibit 3-2

COMMODITIES REPORTED AS IMPORTANT IN AIR CARGO
BY AIR CARRIERS
1972

Outbound	Inbound
Textiles	Wearing apparel
Auto and truck parts	Flowers
Machine parts	Oil field equipment
Electronic parts	Aircraft parts
Drugs	Seafood
Hospital supplies	Beef steaks
Human blood	Human remains
Turkey eggs	Tropical fish
Baby chickens	Magazines
Dogs and cats	Newspapers
Greyhound dogs	Electronic components
Wearing apparel	Arts and crafts imports
Printed matter	Auto and truck parts
Strawberries	Household and personal effects
Onions and okra	Printed matter
Live crabs	Dogs and cats
Processed crab meat	Machine parts
Fish	
Decorative greens	
Computer equipment	
Semi-finished garments	
College and high school yearbooks	
Oil field equipment	

Source: Survey of Air Carriers in the Texas Air Cargo Study.

These percentages are based on weight and may be fairly representative. Based on frequency of responses to the carrier survey which are more reflective of shipments rather than weight, wearing apparel and automotive would rank higher in a distribution list based on shipments.

The survey of manufacturers' air cargo use revealed a commodity list not inconsistent with the above but providing a usefully different view. Principal products by air were primarily emergency shipments, including repair and maintenance parts, electronic components and equipment, and oil field equipment. Normal distribution was limited to electronic and communications equipment and parts. Exhibit 3-3 lists commodities specifically named as moving by air.

Commodities moving in foreign trade have a somewhat different makeup. Because economies of shipping by air overseas are often greater than domestically, exports and imports may contain a higher proportion of regularly air-distributed complete products. But still small shipments of an emergency nature are much apparent. Foreign trade data permit a more quantitative look at commodity composition and also permit value per pound analyses.

For each 4-digit export trade and import trade which showed 1,000 or more pounds moving by air in 1970, the following data were recorded:

1. Commodity code.
2. Total value in dollars.
3. Value by vessel in dollars.
4. Weight by vessel in thousands of pounds.
5. Value by air in dollars.
6. Weight by air in thousands of pounds.

Exhibit 3-3

PRINCIPAL PRODUCTS BY AIR REPORTED IN THE MANUFACTURERS SURVEY

Drill Bits	Spare Parts
Machine Parts	
Surgical Instruments	Stampings
Drugs	Small Meters
Electronic Components	Plastics
Electronic Instruments	Printed Business Forms
Hardware	Publications
Chemical Samples	Cable
Electronic Equipment	Cabinets
Payroll Checks	Emulsion Testers
Maintenance Parts	Viscometers
Emergency Production Materials	Synthetic Resins
Activated Carbons	Electrical Parts
Oil Tools-Valve-Forgings	Transformers
Printing Cylinders	Geophysical Systems
Intercommunication Equipment	Pump Parts
Phone Parts	Gaskets
Repair Items	Award Letters and Emblems
Aircraft Engines and Parts	Mud Pump Parts
Seismic Profiling Equipment	Earth Drills
Paint	Honeycomb Material
Electronic Control System	Film
Piece Goods	Plotters
Magnesium	Test Instruments

Exhibit 3-3
(Continued)

Recorders	Sample Garments
Semiconductors	Optical Parts
Power Controls	Analyzer Parts
Grinding Wheels	Optical Character Reading Equipment
Computer Systems	Wellhead Parts
Class Rings	Plastic Synthetics
Environmental Control Systems	Graphic Arts Equipment
Electric Heat Controls	Precision Gages
Wire Mesh and Nylon Slings	Jewelry
Electronic Navigation Equipment	Printed Matter
Circuit Board Assemblies	Bonds
Missile Parts	Yearbooks
Air Frame Parts	Precious Metals
Light Fixtures	Integrated Circuits
Waterblast Equipment	Aluminum Heat Sinks
Chemical Equipment	Welding and Cutting Apparatus
Chemicals	Lamp Parts
Auto and Truck Parts	Air Conditioner Valves

The following relationships were calculated for each:

1. Value per shipping weight pound by air.
2. Percent of total air shipping weight accounted for by the commodity.
3. Percent that air shipment of a commodity was of total shipping weight of that commodity shipped by both vessel and air.

Value per pound of products shipped is an important determinant of modal split. Figure 3-9 shows a frequency distribution of export shipping weight by air in terms of value per shipping weight pound. Figure 3-10 is the same for imports. Less than 20 percent of all shipments by air are less than $1 per pound. The modal case is the interval $1-$3 per pound. The contrast to vessel shipments may be seen from 1967 import data in which less than one percent of weight of vessel-borne shipments was greater than $1 per pound and .1 percent greater than $3 per pound.

For domestic shipments, it is a reasonable hypothesis that the distribution is skewed even further to the right. This is because surface shipments are more competitive domestically than in transoceanic trade, since domestically door-to-door unimodal shipments (by truck) are possible (contrasted to few cases in transoceanic commerce).

Texas's needs for air mode transport are importantly related to its production of commodities valued at $1 or more per pound. Unfortunately, data on weight and value of shipments by United States producers are not available directly, by Standard Industrial Classification.

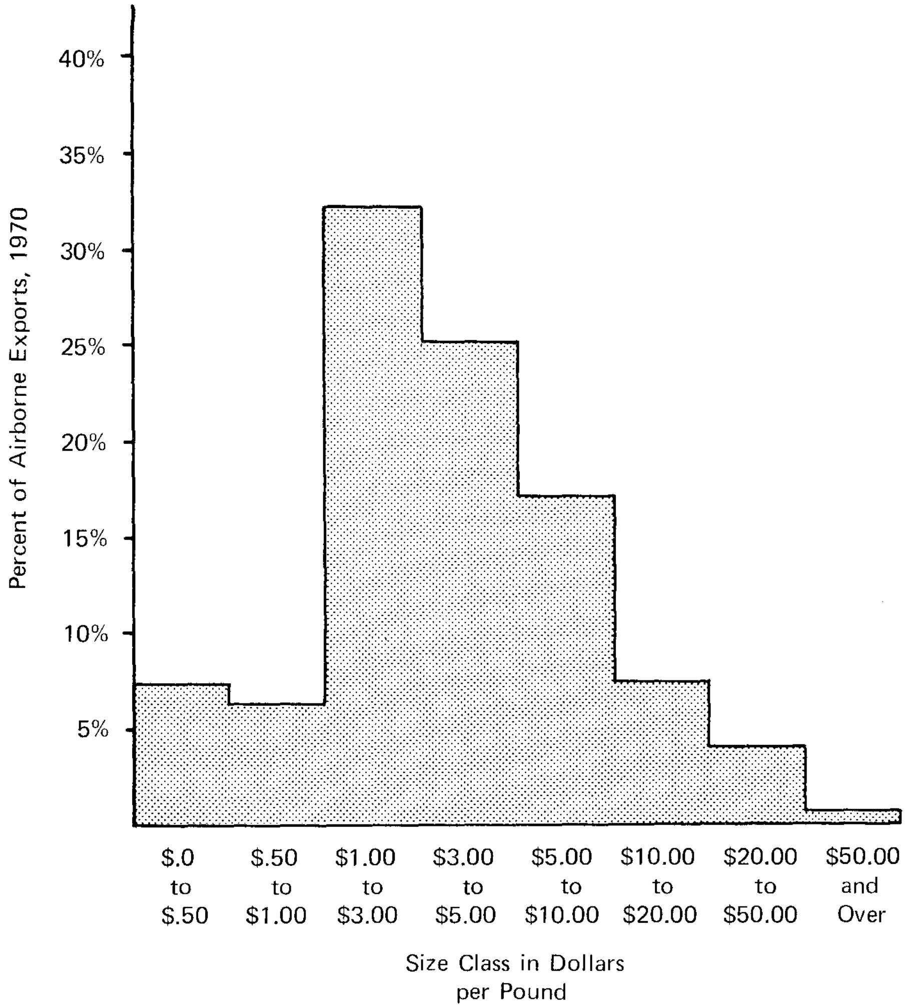


Figure 3-9

FREQUENCY DISTRIBUTION OF PERCENT OF WEIGHT OF AIR SHIPMENTS OF U.S. 1970 EXPORTS, BY VALUE PER POUND SIZE CLASS

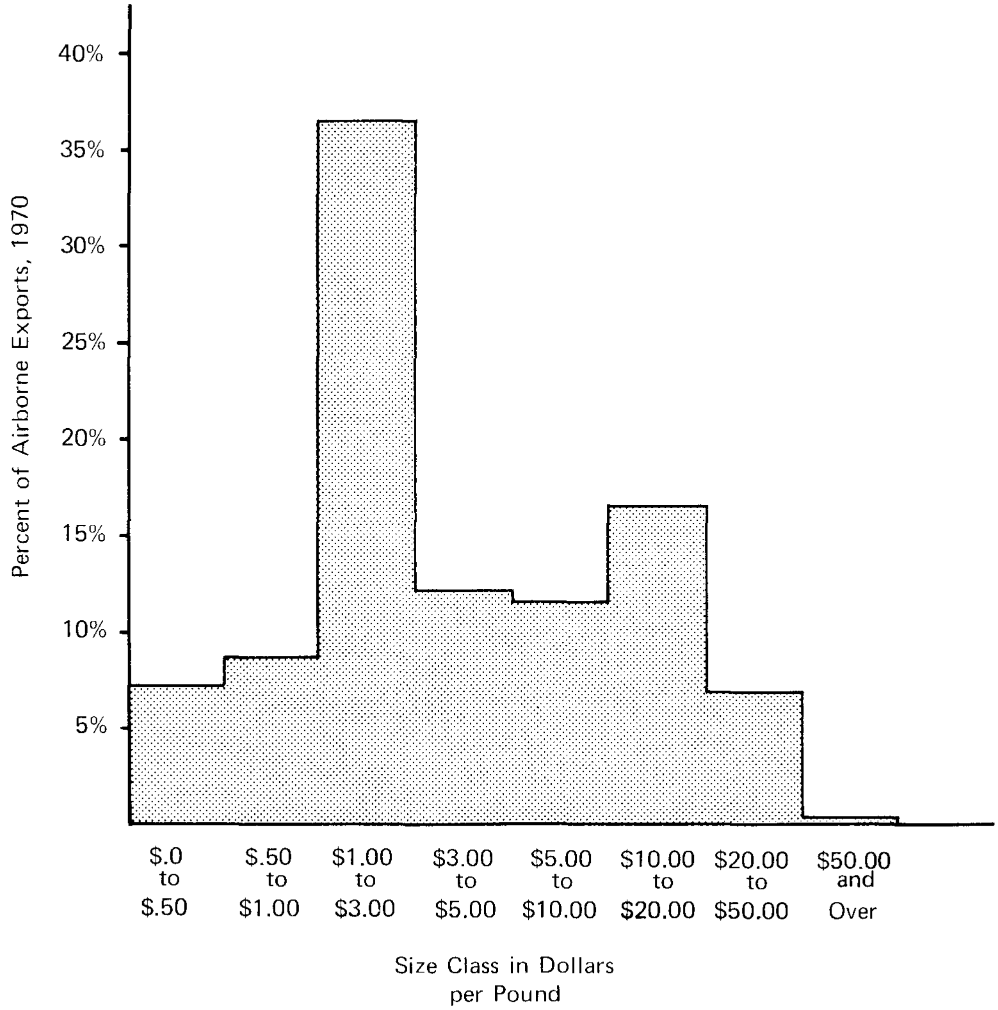


Figure 3-10

FREQUENCY DISTRIBUTION OF PERCENT OF WEIGHT OF AIR SHIPMENTS OF U. S. 1970 IMPORTS, BY VALUE PER POUND SIZE CLASS

Commodities (or categories) which account for 40 percent of air-carried exports are shown in Table 3-7 along with shipping weight by air, percent of total air shipments, and share of the air-plus-vessel market. The 1970 data are compared with 1967. Table 3-8 shows the same information for imports.

Some observations:

- The data illustrate the importance of small shipments. "Special Transactions" (this ranks nine in imports) is the most important air export as is "Estimated Value less than $251" for imports. Parts are also significant in exports, as are "Manufactures, NES*" in imports.

- Agricultural products are in the top-ranked imports, but not in exports. This may result from promotions made to counter empty backhaul. On the surface, the data do not point the way to agricultural exports by air for Texas producers.

- Air cargo's share of the vessel-plus-air market for shipping the top-ranked air commodities is much higher for exports than for imports.

- United States exports by air are larger than imports by air in terms of shipping weight but imports by air increased 103 percent from 1967 to 1970 compared to corresponding three-year growth of air exports of 64 percent.

- In airborne imports, there were dramatic growths in "Footwear" (345 percent) and "Manufactures, NES" (380 percent); and in airborne exports, there were dramatic growths in "Records and Tape Recordings" (318 percent) and "Duplicating and Office Machinery" (290 percent).

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*"Manufactures, not elsewhere specified" represent products which are not produced or traded in sufficient quantity to justify the effort of separate classification. Thus, individual shipments would be predominantly of small size.

Table 3-7

WEIGHT OF AIR SHIPMENTS, PERCENT OF TOTAL AIR SHIPMENTS AND SHARE OF MARKET (VESSEL PLUS AIR) COMMODITIES (4-DIGIT SCHEDULE B) ACCOUNTING FOR TOP 40 PERCENT OF AIR SHIPMENTS OF EXPORTS, 1970 and 1967, AND TOTAL VALUE AND WEIGHT, 1970 and 1967

Commodity		1970			1967			
Code	Name (Abbreviated)	Weight by Air (000 lbs)	Percent of Air Shipment	Percent of Commodity by Air	Weight by Air (000 lbs)	Percent of Air Shipment	Percent of Commodity by Air	Percent Change 1967-70
931.0	Special Transactions	114,348	13.0%	17.1%	35,602	6.6%	12.4%	221%
714.9	Duplicating & Office Machinery	40,193	4.6	67.2	10,298	1.9	42.9	290
732.8	Motor Vehicle & Tractor Parts	29,883	3.4	5.2	22,280	4.1	4.8	34
734.9	Aircraft (& parts)	24,145	2.7	53.0	14,518	2.7	52.5	66
891.2	Audio Recordings	21,160	2.4	40.5	5,061	.9	38.3	318
714.2	Electronic Computers	19,980	2.3	58.7	13,928	2.6	60.9	43
719.9	Foundry Molds	17,013	3.8	13.2	11,679	2.2	12.8	45
724.9	Telephone & Telegraph Equipment	16,711	1.9	33.3	11,245	2.1	30.5	48
861.9	Instrument, Meas. & Contr.	15,772	1.8	38.5	11,642	2.2	34.1	135
719.2	Pumps (& parts)	15,042	1.7	5.8	9,916	1.8	4.6	151
729.3	Electronic Tubes, Transistors	14,527	1.6	39.0	5,585	1.0	32.4	160
729.5	Electrical Meters, Instr.	12,956	1.5	46.1	11,149	2.1	44.0	16
722.2	Switching Apparatus	12,845	1.5	24.6	7,361	1.4	14.7	174
Total Shipping Weight		887,373	100%	.18%	542,467	100%	.14%	64
Total Value (billions of dollars)		$5.9	100%	15.7%	$3.2	100%	14.6%	85

Source: Economics Research Associates tabulations of U.S. Bureau of the Census, FT 150.

Table 3-8

WEIGHT OF AIR SHIPMENTS, PERCENT OF TOTAL AIR SHIPMENTS AND SHARE OF MARKET (VESSEL PLUS AIR) COMMODITIES (4-DIGIT SCHEDULE B) ACCOUNTING FOR TOP 40 PERCENT OF AIR SHIPMENTS OF IMPORTS, 1970 and 1967, AND TOTAL VALUE AND WEIGHT, 1970 and 1967

Commodity		1970			1967			
Code	Name (Abbreviated)	Weight by Air (000 lbs)	Percent of Air Shipment	Percent of Commodity by Air	Weight by Air (000 lbs)	Percent of Air Shipment	Percent of Commodity by Air	Percent Change 1967-70
990	Estimated Value Less than $251	61,279	9.9%	21.6%	44,936	14.7%	16.1%	36%
851.0	Footwear, New	57,004	9.2	12.6	12,909	4.2	5.0	345
841.4	Clothing Accessories	34,715	5.6	19.5	21,588	7.1	23.2	62
841.1	Clothing of Textile Fabrics	20,976	3.4	7.5	9,354	3.1	5.7	123
899.9	Manufactures, NES	17,628	2.8	62.4	3,684	1.2	4.1	380
054.3	Vegetables, NES	13,466	2.2	12.6	4,957	1.6	6.5	172
011.1	Beef & Veal, Fresh & Frozen	12,988	2.1	1.3	7,429	2.4	.9	73
717.1	Textile Machinery	12,960	2.1	9.9	4,781	1.6	4.5	170
931.1	Special Transaction	12,289	2.0	3.4	7,129	2.3	2.8	72
951.3	Bananas & Plantain	11,485	1.9	.3	4,032	1.3	.1	185
Total Shipping Weight		619,754	100%	.10%	305,687	100%	.05%	103
Total Value (billions of dollars)		$3.4	100%	12.2%	$1.9	100%	10%	80

Source: Economics Research Associates tabulations of U.S. Bureau of the Census, FT 150.

- In terms of total weight of exports and imports, shipments by air were minute (exports were .18 percent and imports only .10 percent in 1970) but in terms of total value of shipments, air was quite significant (exports 15.7 percent and imports 12.2 percent).

- Value of United States exports by air increased faster than weight, 1960 to 1967, whereas imports displayed an inverse relationship.

The air share of the total United States foreign trade market carried by aircraft and vessel provides one of the few publicly available statistics on competitive position of air in the carriage of particular commodities. As Tables 3-7 and 3-8 indicate, air has been increasing its share of the total market (though at low quantitative levels). Most of the gain has come from commodities (at the 4-digit Schedules A and B level) wherein air has less than 50 percent of the market. Export commodities, 1970, which were carried 50 percent or more by air accounted for only 15.5 percent of airborne exports; and in the case of 1970 imports, 4.2 percent. Commodities which were shipped more by aircraft than vessel which also accounted for .5 percent or more air shipped exports, are:

Exports	Code Name	Percent of Total Air	Share of Market
025.0	Bird Eggs	1.2	92.8
899.6	Orthopedic Appliances	.5	77.0
714.3	Statistical Machines	.7	69.8
714.9	Duplicating and Office Machines	4.6	67.2
711.4	Aircraft and Missile Engines	1.0	62.8
714.2	Electronic Computers	2.3	58.7
734.9	Aircraft Parts, etc.	2.7	53.0
Imports			
899.9	Other Manufactures, NES	2.8	62.4

A better indication of modal dominance can be achieved with more precise definition of a "commodity." For example, many of the machinery and equipment categories include both the primary product along with parts and accessories. Usually the parts and accessories will be more "air eligible" than the primary product.

Shippers

What classes of shippers (and consignees) use air cargo with any frequency in Texas? The answer to this question is somewhat obscured by the high proportion of air shipments being specified by buyers on an F 013 vendor basis, but with the vendor responsible for arrangements. And, as discussed elsewhere in this report, air is usually a supplementary mode even for large shippers.

In a 1970 special issue on air cargo, Aviation Week and Space Technology,1/ the following shippers were called out:

An optical manufacturer and distributor
Drug industry
A luggage manufacturer
Record producer and distributor
Printing and publishing
Pet industry
Furriers
Exporters of perishables
Strawberry producers
Flower grower
Aerospace industry
Auto manufacturers, parts distributors
Oil field equipment manufacturers
NASA
Fashion firms/distributors
Electronics/computer manufactures
Sears (Hawaii)
Apparel maker
U.S. Department of Defense

1/ AW&ST, Air Cargo at the Crossroads, October 26, 1970, pp. 26-148.

Many of these have relevance for Texas. Identification of principal Texas shippers was by interview with carriers, forwarders, REA Express, trade associations and public sources such as the Census of Transportation. A list of actual and potential air shippers was identified for purposes of more thorough study. These are:

Selected Manufacturers (see Exhibit 3-4)
Wholesale Florists
Industrial and Research Laboratories
Crabbers
Strawberry Growers and Importers
Cattle Breeders/Farmers
Citrus Growers
Beef Packers
Live Poultry Breeders
Shrimp Industry
Department of Defense

Other shippers were not studied in depth or results were not at a reporting stage. The U.S. Postal Service is by far the largest air shipper in Texas as it is in the U.S. However, staff studies and reports on which a close analysis could be based were not available as of this final report.

Other air shippers not covered in special studies:

- Large department stores.
- Banks. Air shipments are used to speed bank clearances.
- Morticians. Human remains were mentioned by the carriers as important commodities.
- Nationwide auto repair operations. Air is important in maintaining an economic inventory system. Aamco, a transmission repair specialist, sends more than half of distant shipments by air freight.
- Electronic parts distributors.

Exhibit 3-4

SELECTED MANUFACTURERS BY STANDARD INDUSTRIAL CLASSIFICATION COVERED IN THE TEXAS AIR CARGO STUDY ASTERISKED ITEMS ONLY

23 APPAREL AND OTHER TEXTILE PRODUCTS
231 **Men's and Boys' Suits and Coats**
* 2311 Men's and boys' suits and coats
232 **Men's and Boys' Furnishings**
2321 Men's and boys' shirts and nightwear
2322 Men's and boys' underwear
2323 Men's and boys' neckwear
2327 Men's and boys' separate trousers
2328 Men's and boys' work clothing
2329 Men's and boys' clothing, nec
233 **Women's and Misses' Outerwear**
* 2331 Women's and misses' blouses and waists
2394 Canvas products
2395 Pleating and stitching
2396 Automotive and apparel trimmings
2397 Schiffli machine embroideries
* 2399 Fabricated textile products, nec

26 PAPER AND ALLIED PRODUCTS
265 **Paperboard Containers and Boxes**
* 2651 Folding paperboard boxes
2652 Set-up paperboard boxes

27 PRINTING AND PUBLISHING
271 **Newspapers**
2711 Newspapers
* 272 **Periodicals**
* 2721 Periodicals
* 273 **Books**
* 2731 Book publishing
* 2732 Book printing
* 274 **Miscellaneous Publishing**
* 2741 Miscellaneous publishing
* 275 **Commercial Printing**
* 2751 Commercial printing, ex lithograpic
* 2752 Commercial printing, lithographic
* 2753 Engraving and plate printing
* 276 **Manifold Business Forms**
* 2761 Manifold business forms
* 277 **Greeting Card Publishing**
* 2771 Greeting card publishing
* 278 **Blankbooks and Bookbinding**
* 2782 Blankbooks and looseleaf binders
* 2789 Bookbinding and related work
279 **Printing Trade Services**
2791 Typesetting
2793 Photoengraving
2794 Electrotyping and stereotyping

28 CHEMICALS AND ALLIED PRODUCTS
281 **Industrial Chemicals**
2812 Alkalies and chlorine
2813 Industrial gases
* 2815 Cyclic intermediates and crudes
* 2816 Inorganic pigments
* 2818 Industrial organic chemicals, nec
* 2819 Industrial inorganic chemicals, nec
* 282 **Plastics Materials and Synthetics**
* 2821 Plastics materials and resins
* 2822 Synethtic rubber
* 2823 Cellulosic man-made fibers
* 2824 Organic fibers, noncellulosic
* 283 **Drugs**
* 2831 Biological products
* 2833 Medicinals and botanicals
* 2834 Pharmaceutical preparations
284 **Soap, Cleaners, and Toilet Goods**
2841 Soap and other detergents

34 FABRICATED METAL PRODUCTS
3425 Hands saws and saw blades
* 3429 Hardware, nec
343 **Plumbing and Heating, Except Electric**
* 3431 Metal sanitary ware
3432 Plumbing fittings and brass goods
3433 Heating equipment, except electric
344 **Fabricated Structural Metal Products**
3441 Fabricated structural steel
3442 Metal doors, sash, and trim
3443 Fabricated plate work (boiler shops)
3444 Sheet metal work
3446 Architectural metal work
3449 Miscellaneous metal work
345 **Screw Machine Products, Bolts, Etc.**
3451 Screw machine products
* 3452 Bolts, nuts, rivets, and washers
346 **Metal Stampings**
* 3461 Metal stampings
347 **Metal Services, nec**
3471 Plating and polishing
3479 Metal coating and allied services
348 **Misc. Fabricated Wire Products**
3481 Misc. fabricated wire products
349 **Misc. Fabricated Metal Products**
3491 Metal barrels, drums, and pails
3492 Safes and vaults
3493 Steel springs
* 3494 Valves and pipe fittings
3496 Collapsible tubes
3497 Metal foil and leaf
3498 Fabricated pipe and fittings
* 3499 Fabricated metal products, nec

35 MACHINERY, EXCEPT ELECTRICAL
351 **Engines and Turbines**
3511 Steam engines and turbines
3519 Internal combustion engines, nec
352 **Farm Machinery**
3522 Farm machinery
353 **Construction and Related Machinery**
* 3531 Construction machinery
3532 Mining machinery
* 3533 Oil field machinery
3534 Elevators and moving stairways

Exhibit 3-4
(Continued)

	3535	Conveyors and conveying equipment
	3536	Hoists, cranes, and monorails
	3537	Industrial trucks and tractors
	354	**Metal Working Machinery**
	3541	Machine tools, metal cutting types
	3542	Machine tools, metal forming types
	3544	Special dies, tools, jigs & fixtures
*	3545	Machine tool accessories
	3548	Metalworking machinery, nec
	355	**Special Industry Machinery**
	3551	Food products machinery
	3552	Textile machinery
	3553	Woodworking machinery
	3554	Paper industries machinery
	3555	Printing trades machinery
*	3559	Special industry machine, nec
	356	**General Industrial Machinery**
*	3561	Pumps and compressors
	3562	Ball and roller bearings
	3564	Blowers and fans
	3565	Industrial patterns
*	3566	Power transmission equipment
	3567	Industrial furnaces and ovens
	3569	General industrial machinery, nec
	357	**Office and Computing Machines**
	3572	Typewriters
*	3573	Electronic computing equipment
	3574	Calculating and accounting machines
	3576	Scales and balances
	3579	Office machines nec
	358	**Service Industry Machines**
	3581	Automatic merchandising machines
	3582	Commercial laundry equipment
	3585	Refrigeration machinery
	3586	Measuring and dispensing pumps
	3589	Service industry machines, nec
	359	**Misc. Machinery, Except Electrical**
*	3599	Misc. machinery, except electrical
	36	**ELECTRICAL EQUIPMENT AND SUPPLIES**
	361	**Electric Test & Distributing Equipment**
*	3611	Electric measuring instruments
	3612	Transformers
	3613	Switchgear and switchboard apparatus
*	3636	Sewing machines
	3639	Household appliances, nec
	364	**Electric Lighting and Wiring Equipment**
	3641	Electric lamps
	3642	Lighting fixtures
*	3643	Current-carrying wiring devices
	3644	Noncurrent-carrying wiring devices
	365	**Radio and TV Receiving Equipment**
*	3651	Radio and TV receiving sets
	3652	Phonograph records
	366	**Communication Equipment**
	3661	Telephone and telegraph apparatus
	3662	Radio and TV communication equipment
	367	**Electronic Components and Accessories**
	3671	Electron tubes, receiving type
	3672	Cathode ray picture tubes
	3673	Electron tubes, transmitting
*	3674	Semiconductors
*	3679	Electronic components, nec
	369	**Misc. Electrical Equipment & Supplies**
	3691	Storage batteries
	3692	Primary batteries, dry and wet
*	3693	X-ray apparatus and tubes
	3694	Engine electrical equipment
*	3699	Electrical equipment, nec
	37	**TRANSPORTATION EQUIPMENT**
	371	**Motor Vehicles and Equipment**
*	3711	Motor vehicles
	3712	Passenger car bodies
	3713	Truck and bus bodies
*	3714	Motor vehicle parts and accessories
	3715	Truck trailers
	372	**Aircraft and Parts**
*	3721	Aircraft
*	3722	Aircraft engines and engine parts
	3723	Aircraft propellers and parts
*	3729	Aircraft equipment, nec
	38	**INSTRUMENTS AND RELATED PRODUCTS**
	381	**Engineering & Scientific Instruments**
*	3811	Engineering & scientific instruments
	382	**Mechanical Measuring & Control Devices**
*	3821	Mechanical measuring devices
	3822	Automatic temperature controls
	383	**Optical Instruments and Lenses**
*	3831	Optical instruments and lenses
	384	**Medical Instruments and Supplies**
	3841	Surgical and medical instruments
*	3842	Surgical appliances and supplies
	3843	Dental equipment and supplies
	385	**Ophthalmic Goods**
*	3851	Ophthalmic goods
	386	**Photographic Equipment and Supplies**
*	3861	Photographic equipment and supplies
	387	**Watches, Clocks, and Watchcases**
*	3871	Watches and clocks
	3872	Watchcases
	39	**MISCELLANEOUS MANUFACTURING INDUSTRIES**
	3991	Brooms and brushes
*	3993	Signs and advertising displays
	3994	Morticians' goods

Source: Technical Notes 31, 2, 6, 9. (TN 31 has details on response rate) and U.S. Bureau of the Budget, Standard Industrial Classification Manual, 1967

Subsequent discussion covers the special shipper surveys. Some of the survey results are reported in other sections of this report as appropriate. For example, because of policy implications, the volunteered statements of survey respondents were reported in the previous section.

Manufacturers Survey

Results of a survey of Texas manufacturers are given in this section. The details of the survey design are not included. However, the design was basically a random sample stratified by employment size and Standard Industrial Classification (SIC). Only those SIC groups that showed use of air in the 1967 Census of Transportation were included.

Shipper Survey Form. Field testing of the survey form was done by personal interviews with Hughes Tool Company, Texas Instruments, Collins Radio, LTV Aerospace, and the Dallas Chamber of Commerce. These interviews were very helpful in refining the questions and deciding on the optimum mail-out strategy. The final survey form is shown as Exhibit 3-5.

Several alternative cover letters were evaluated. Based primarily on feedback obtained during the pretest interviews, the decision was made to mail an individually typed cover letter addressed to the president or plant manager of each survey firm, on executive department stationery over the signature of the Governor of Texas. The Governor's Planning Coordination Division arranged for the preparation of these cover letters. It was thought that this procedure would result in the highest possible response rate. A sample cover letter is shown as Exhibit 3-6. No follow-up letters or calls were made.

Response Rate. Sample selection was based on SIC and employment size. Table 3-9 shows the response rate by these two criteria, as well as the total number of responses received whether usable or not. The overall response rate was 29 percent, or 178 firms out of a sample of 612.

Exhibit 3-5

SHIPPER SURVEY FOR THE TEXAS STATE AIRPORT SYSTEM PLAN: MANUFACTURERS
1970 INFORMATION REQUESTED FOR THIS PLANT OR LOCATION

(Items 1-10 Relate to Sales/Shipments by All Modes;
Items 11-14 to Purchases/Receipts by All Modes; Items 15-24 to Air Shipments)

1. Principal Product Lines:
   1) ______ 2) ______ 3) ______
2. 1970 Sales (thousands of dollars): ______ 3. Employment: ______
4. Estimated Annual Weight of Shipment (all modes) (tons) ______
5. Distribution of Sales (percent of weight):
   1) United States ___% 2) Latin America ___% 3) Europe ___%
   4) Far East ___% 5) Canada ___% 6) Other Foreign ___%
6. Distribution of Sales for United States (percent of weight):
   1) Less than 500 miles ___% 2) 500 - 999 miles ___% 3) 1,000 - 1,500 miles ___%
   4) Over 1,500 miles ___%
7. Terms of Shipments: 1) FOB Plant ___% 2) FOB Destination ___% 3) Other ___%
8. Mode of Shipment (percent of weight):
   1) Air ___% 2) Truck, Common Carrier: ___%
   3) Truck, Own or Lease: ___% 4) Truck, Contract Haulage: ___%
   5) Other than Truck or Air: ___%
9. Percent of Shipment Weight Containerized: ___%
10. Percent of Total Annual Shipment Weight (shipment size class):
    1) Less than 100 lbs. ___% 2) 100 - 499 lbs. ___%
    3) 500 - 2,000 lbs. ___% 4) Over 2,000 lbs. ___%
11. 1970 Purchases of Materials: 1) Value ($000) ______ 2) Weight (tons) ______
12. Sources of Purchases (percent of weight):
    1) Texas ___% 2) Other U. S. ___% 3) Foreign ___%
13. Shipping Mode for Purchases (percent of weight):
    1) Air ___% 2) Truck, Own Fleet ___% 3) Truck, Other ___% 4) Other ___%
14. Terms: 1) FOB Supplier ___% 2) FOB Your Plant ___% 3) Other ___%

AIR CARGO

15. Principal Products by Air: ______ ______ ______
16. Principal Destinations (states or foreign regions; use continuation sheet for others):
    1) ______ 2) ______ 3) ______
17. Air Role in Distribution: 1) Regular Delivery, Main Products [ ] 2) Regular Parts Delivery [ ]
    3) Emergency [ ] 4) Other (specify) [ ] ______
18. Percent of Air Shipment Weight by: 1) Forwarder ___% 2) Express (REA) ___%
    3) Scheduled Air Carrier ___% 4) Chartered Carrier ___% 5) Air Parcel Post ___%
19. Percent Size of Shipment by Air: 1) Less than 50 lbs. ___% 2) 50 - 199 lbs. ___%
    3) 200 - 499 lbs. ___% 4) 500 - 2,000 lbs. ___% 5) Over 2,000 lbs. ___%
20. Percent Unitized by Air (e.g., containerized, palletized): ___%
21. Shipments: 1) Estimated Number, 1970 ______ 2) Estimated Number, Peak Month ______
    3) Name of Peak Month ______
22. Average Number of Packages per Shipment: ______
23. Timing of Pick-Up:
    1) Pre-Noon ___% 2) Noon to 4 p.m. ___% 3) Post 4 p.m. ___%
24. Principal Airports: ______ ______
25. Growth in shipments: 1) Estimated annual growth rate in air shipments ___%
    2) Estimated annual growth rate in total shipments ___%

Exhibit 3-5
(Continued)

26. Information on special experiences and problems with air cargo and estimates of its present and future usefulness cannot be covered very efficiently in a survey form. Please feel free to comment below. Among others, you might desire to remark on how you see trends in relative costs of transport and distribution by air versus ground modes. If you have forecasts, no matter how rough, of your future utilization of air cargo, these would be most appreciated.

Exhibit 3-6

February 28, 1972

Mr. John Doe, President
Texas Manufacturing Co.
4701 Ridgeway Avenue
Dalworth, Texas 77023

Dear Mr. Doe:

In June 1971, my office began work on a comprehensive Airport System Plan for Texas. This work, supported by the State and the Federal Aviation Administration is concerned with developing a viable air transportation system to meet the needs of Texas. This planning effort is being coordinated by my office and involves Texas transportation agencies and Regional Councils in addition to qualified persons representing industry and commerce.

One of the several study objectives is to forecast air cargo demand in Texas to 1990. As part of this air cargo demand analysis we are conducting a survey of present and potential air cargo users in Texas. Your firm was selected to participate in this survey.

I am enclosing a survey form which I urge you to carefully complete and return in the envelope provided. The information you provide will be combined with the information furnished by others. No individual disclosure will be made.

I sincerely hope that you will assist us in this effort, and I assure you that this information will help us in planning for the aeronautical needs of Texas. Should you have questions concerning the survey form, please contact George Dresser, Texas Transportation Institute, at 713/845-1713.

Sincerely,

Preston Smith
Governor

Enclosures

Table 3-9

Sample Size and Responses by SIC and Employment Class*

SIC	Employment Class < 100		Employment Class 100 >		Total Responses		Usable Responses		Partial Responses
2311	0	0	12	2	12	2	12	2	
2331	0	0	12	2	12	0	12	0	
2385	1	0	1	0	2	0	2	0	
2399	15	4	5	2	20	6	20	4	2
2651	0	0	6	3	6	3	6	3	
2721-2789	0	0	29	8	29	8	29	8	
2815-2829	0	0	67	37	67	37	67	19	18
2831-2834	15	3	7	5	22	8	22	3	5
2871	0	0	4	1	4	1	4	0	1
3429	0	0	4	1	4	1	4	0	1
3431	0	0	4	1	4	1	4	0	1
3452	0	0	3	0	3	0	3	0	
3461	0	0	11	7	11	7	11	4	3
3494	0	0	20	6	20	6	20	6	
3499	0	0	9	4	9	4	9	2	2
3531	0	0	1	1	1	1	1	1	
3533	20	6	57	16	77	22	77	18	4
3541	6	0	0	0	6	0	6	0	
3545	9	2	3	0	12	2	12	1	1
3559	0	0	10	2	10	2	10	1	1
3561	0	0	15	3	15	3	15	3	
3566	0	0	7	0	7	0	7	0	
3573	0	0	6	3	9	3	9	3	
3599	0	0	15	2	15	2	15	0	2

* First number is number of firms in sample, second number is number of responses.

Table 3-9
(Continued)

Sample Size and Responses by SIC and Employment Class

SIC	Employment Class <100		Employment Class 100>		Total Responses		Usable Responses		Partial Responses
3611	12	2	3	2	15	4	15	4	
3636	1	0	0	0	1	0	1	0	
3643	0	0	7	3	7	3	7	3	
3651	0	0	1	0	1	0	1	0	
3662	6	1	6	4	12	5	12	5	
3674	2	1	4	2	6	3	6	2	1
3679	27	9	7	2	34	11	34	11	
3693	3	1	0	0	3	1	3	1	
3699	3	1	1	0	4	1	4	0	1
3711	0	0	1	1	1	1	1	0	1
3714	0	0	4	2	4	2	4	2	
3721	0	0	6	1	6	1	6	1	
3722	0	0	6	1	6	1	6	1	
3729	24	3	21	6	45	9	45	6	3
3811	14	4	4	1	18	5	18	4	1
3821	25	8	11	2	36	10	36	9	1
3831	4	1	1	0	5	1	5	1	
3842	0	0	1	1	1	1	1	1	
3851	4	0	3	0	7	0	7	0	
3861	6	0	1	0	7	0	7	0	
3871	0	0	1	0	1	0	1	0	
3993	7	0	7	0	14	0	14	0	

The response rate varied among SIC groups with some groups responding very well, some groups very poorly, and some not at all. Major Group 23, Apparel and Other Finished Products Made From Fabrics and Similar Materials, had a 17 percent response rate. Based on the air carrier interviews, we know that this group is a major user of air cargo. Major Group 27, Printing, Publishing, and Allied Industries, had a 27 percent response rate. This group is also known to be a significant user of air cargo. Major Group 28, Chemicals and Allied Products, had the highest response rate, with 49 percent. Major Group 38, Professional, Scientific, and Controlling Instruments; Photographic and Optical Goods; Watches and Clocks, had an overall response rate of 23 percent, but no responses for SIC's 3851, 3861, and 3871. There were no responses from SIC 3993 (Signs and advertising displays), the only SIC in Major Group 39.

Of the 178 responses, 48 indicated that air cargo was a very minor part of their business or that they did not use air cargo at all and did not foresee its use in the future. Five other respondents did not complete the forms for miscellaneous reasons (plant closed, merged, retail establishment, information not available). Of those that did not use air cargo, 30 answered questions 1-14, and the other 18 returned the form with no questions answered. This reduced the number of completely usable responses to 125.

Data Tabulation. The responses fell into three categories of usefulness considering quality of responses: 1) the firm was not a user of air cargo and returned the form with no questions answered; 2) the firm was not a user of air cargo and answered questions 1-14; and 3) the firm was a user of air cargo and answered most or all of the questions. In general, the firms answered the questions in a careful and consistent manner with a minimum of blanks. Occasionally, percentage questions (5, 6, 8, 10, 12, 13, 18, 19) did not total to 100 percent. A computer program was written to facilitate analysis of the responses.

The 48 responses from groups that did not use air cargo were analyzed manually. Only limited information was available because 18 of these did not answer any of the questions. The results of this analysis are discussed in the next section.

Analysis of Non Air Cargo User Responses. The effect of the 53 partially usable responses is shown by the last column of Table 3-9. Some responses from SIC's 2831, 2834, 3533, 3729, and 3821 were unusable for miscellaneous reasons and, in effect, no information was obtained. The other partial responses indicate that these firms do not now nor do they foresee use of air cargo. Eighteen of 37 responses from the chemical group, 2815-2829, and four of seven responses from the drugs group, 2831-2834, do not use air cargo. All respondents from SIC's 2871, 3429, 3431, 3599, and 3711 (in most cases only one or two) do not use air cargo.

For the 48 partial respondents, employment was greater than 100 for 36 firms and less than 100 for the other 12 firms. Recalling that the basis for sample selection was industries that, according to the 1967 Census of Transportation, were users of air cargo, it is important to note that large Texas firms within these industries do not use air cargo. Some understanding may be gained by a closer look at the 30 respondents that answered questions 1-14.

Some inferences can be drawn by considering SIC's or SIC groups. SIC 2399, fabricated textile products, sales are almost 100 percent in the United States, distribution of sales in miles is 23 percent less than 500 miles, 51 percent 500-999 miles, 23 percent 1,000-1,500 miles, and three percent greater than 1,500 miles. All of the product moves by truck or parcel post. The fact that 74 percent of the products move less than 1,000 miles may be the important factor. Truck is also the primary mode of purchase.

For SIC 2651, folding paperboard boxes, 90 percent of the product moves less than 500 miles; truck is the primary mode for both purchases and sales; and 95 percent of the shipments weigh over 500 pounds.

For SIC's 28151-28182, industrial, inorganic and organic chemicals, all of the product moves by truck, or other than truck or air, which indicates a high dependence on rail and pipeline. With one exception, 100 percent of the shipment weight was over 2,000 pounds which, considering the nature of the product, excludes air. The reason that chemicals were included is that air cargo commodity data for products moving through Houston showed a high frequency of chemical products. It was not anticipated that firms within this SIC group would use air either for purchase or distribution of primary products. It was expected that these firms would use air for distribution of samples and also for parts used to maintain the plants. These seven firms with employment over 3,200 indicated that air cargo is not important to their operations.

SIC 2834, pharmaceutical preparations, respondents were small firms with total employment of 66. One firm's sales were valued at $5 per pound with 40 percent of the product moving over 1,000 miles, and 90 percent of the shipments weighing less than 500 pounds. Although truck and parcel post were the predominant means of shipment, this firm appears to be a candidate for air cargo.

SIC's 3429, 3431, 3461, 3499, fabricated metal products, 98 percent of shipments were greater than 2,000 pounds with value of 36 cents per pound. A partial dependence on air cargo for emergency delivery of parts and products was expected for this SIC group.

SIC's 3533, 3545, 3599, machinery, except electrical, value of sales was $1.01 per pound, with 70 percent of the product moving less than 500 miles and all of the product moving by truck. Employment was over 407 persons. Again, this is an SIC group where partial dependence on air cargo was anticipated.

SIC 3674, semiconductors, this respondent was a small firm with 100 percent of purchases and sales moving by mail.

SIC 3699, electrical equipment and supplies, not elsewhere coded, this respondent was a small firm manufacturing Christmas tree lights and distributing 100 percent of the product by common carrier truck.

SIC 3729, aircraft parts, these two firms manufactured parts for a parent company and sold all products to a branch plant located less than 100 miles away and is therefore not typical of this SIC.

SIC 3811, engineering laboratory and scientific equipment, this firm is a manufacturer of animal cages and comments that "Use of air freight has been disappointing as it is always more expensive and no faster than other means of shipping. All gain in speed is lost trying to get shipment from Houston or Dallas to Bryan." He now uses truck 100 percent.

There is danger in trying to make any broad inferences based on a limited number of responses. For the small firms, the non-use of air cargo may be explained by considering the specific product produced and the distribution pattern. For the large firms, particularly chemicals, fabricated metal products, and machinery, some dependence on air cargo was expected. This may indicate that some potential for air cargo exists within these SIC groups, primarily for emergency type shipments, but not for primary product distribution.

Aggregate Analysis. In this section an analysis of the entire sample will be undertaken. Inferences may be drawn about the representativeness of the entire sample, and comparisons with the 1967 Census of Transportation statistics will be provided.

Table 3-10 summarizes the responses to question numbers 2-14 and 17-23. The first column contains the weighted responses for all respondents; the remaining columns are by SIC group. The number in the upper left corner of each cell is the number of respondents answering that question.

Respondents represented firms with sales of $2,425,854,000; 87,240 employees; and shipments of 16,966,208 tons. Purchases were $1,269,270,000 and 9,620,683 tons. Air shipments numbered 395,805 and weighed 69,604 tons.

Table 3-10
(Co.

Weighted Responses to Manufacturers Questionnaire*

SIC Question No.	ALL	2311-2399	2651	2721-2789	28151-28216	2834	3461-3499	3531-3533	3545-3599	36112-36795	3714-3729	3811-3842
2	[102] 2,425,854.00	[4] 3,752.00	[2] 12,400.00	[7] 73,000.00	[17] 703,175.00	[1] 15,000.00	[11] 206,255.00	[16] 162,052.00	[6] 52,482.00	[25] 337,876.00	[7] 745,260.00	[13] 114,602.00
3	[119] 87,240.00	[4] 380.00	[2] 290.00	[7] 3,181.00	[19] 201,000.00	[2] 310.00	[12] 7,840.00	[17] 9,497.00	[7] 2,208.00	[26] 13,173.00	[8] 22,968.00	[14] 7,293.00
4	[120] 16,966,208.00	[4] 227.00	[2] 28,000.00	[7] 154,412.00	[17] 15,620,580.00	[2] 1,850.00	[12] 173,934.00	[19] 164,808.00	[8] 10,880.00	[27] 7,640.00	[8] 741,375.00	[15] 62,644.00
5.1	[118] 88.83	[4] 98.99	[0] 0.00	[7] 99.25	[17] 88.57	[2] 85.41	81.95	[19] 66.08	[7] 70.27	[26] 90.46	[8] 99.95	[15] 70.77
5.2	3.18	.42	0.00	.65	3.30	1.95	4.78	5.52	15.30	.50	0.00	6.37
5.3	4.60	0.00	0.00	0.00	4.77	2.92	8.62	8.34	6.38	4.21	.03	8.23
5.4	1.68	0.00	0.00	0.00	1.75	4.86	1.17	3.18	.19	.99	0.00	6.21
5.5	1.57	.42	0.00	0.00	1.53	1.95	2.78	10.77	7.74	2.67	.02	6.14
5.6	.14	.18	0.00	.10	.07	2.92	.69	6.10	.13	1.18	0.00	2.29
6.1	[115] 20.03	[4] 83.83	[2] 96.07	[7] 49.33	[17] 19.55	[2] 5.14	[11] 13.80	[18] 23.69	[6] 21.69	[26] 32.59	[8] 20.20	[15] 38.05
6.2	19.94	33.37	3.93	25.22	19.09	20.00	21.99	25.30	43.53	18.86	34.91	29.31
6.3	42.28	15.24	0.00	14.59	43.39	40.27	53.21	23.57	33.34	33.55	30.22	11.81
6.4	17.74	3.24	0.00	10.86	17.97	34.59	11.00	27.44	1.44	15.00	14.67	20.83
7.1	[119] 76.54	[4] 99.56	[2] 72.14	[7] 43.05	[17] 78.54	[2] .97	[12] 62.79	[19] 79.87	[7] 73.24	[27] 90.18	[8] 45.49	[15] 61.43
7.2	19.85	.44	27.86	55.93	17.63	98.97	35.54	17.93	26.76	9.20	54.51	30.20
7.3	3.61	0.00	0.00	1.02	3.83	.05	1.67	2.20	0.00	.62	0.00	8.37
8.1	[121] .41	[4] 1.92	[2] 20.86	[7] 7.90	[17] .16	[2] 5.00	[12] 4.30	[19] 4.10	[8] 8.81	[27] 21.06	[8] 1.08	[15] 3.00
8.2	9.82	42.73	58.93	52.13	7.43	10.81	72.51	33.40	21.60	35.56	26.47	40.84
8.3	3.80	0.00	20.21	37.76	.15	0.00	2.68	7.59	1.67	27.34	72.15	4.68
8.4	.82	0.00	0.00	.65	.66	0.00	5.53	12.25	34.58	.20	.02	1.70
8.5	85.15	55.35	0.00	1.56	91.60	84.19	14.98	42.66	33.34	15.83	.29	49.78
9	2.72	69.60	0.00	1.88	2.76	0.00	.89	.89	6.40	10.26	2.96	1.81
10.1	[118] .52	[4] 78.19	[2] 0.00	[7] 24.27	[17] .02	[2] 80.27	[12] 9.45	[17] 5.13	[8] 10.29	[27] 38.65	[7] 1.48	[15] 10.33
10.2	2.31	21.81	3.21	46.45	.65	14.86	20.16	12.02	22.05	17.99	20.22	14.70
10.3	4.27	0.00	3.93	14.13	1.10	4.86	50.28	18.75	6.67	15.01	53.80	16.26
10.4	92.90	0.00	92.86	15.15	98.23	0.00	20.11	64.10	60.99	28.34	24.50	58.72
11.1	[105] 1,269,270.00	[4] 1,365.00	[2] 7,700.00	[6] 24,880.00	[16] 572,541.00	[1] 650.00	[10] 82,110.00	[17] 88,480.00	[6] 16,460.00	[24] 165,857.00	[7] 255,731.00	[12] 53,496.00
11.2	9,620,683.00	220.00	32,300.00	48,100.00	8,819,100.00	50.00	240,875.00	352,790.00	5,306.00	13,179.00	77,627.00	31,136.00

Table 3-10
(Continued)

Weighted Responses to Manufacturers Questionnaire*

SIC Question No.	ALL	2311-2399	2651	2721-2789	28151-28216	2834	3461-3499	3531-3533	3545 3599	36112-36795	3714-3729	3811-3842
	100											
12.1	59.12	3 5.00	2 23.42	4 19.22	12 59.25	1 20.00	12 52.54	18 77.59	7 30.00	23 74.64	7 20.50	11 52.41
12.2	37.13	92.73	76.58	79.51	37.37	80.00	27.71	18.13	68.55	23.90	78.13	47.30
12.3	3.75	2.27	0.00	1.27	3.38	0.00	19.75	3.57	1.44	1.45	1.37	.28
	100											
13.1	.56	3 1.36	2 1.57	4 .59	12 .33	1 0.00	12 7.21	18 .58	7 3.35	23 7.04	7 3.30	11 4.69
13.2	.73	0.00	21.25	8.15	.55	0.00	1.25	.71	16.57	6.74	3.03	4.14
13.3	12.83	92.73	6.68	14.33	7.70	100.00	59.36	89.38	71.72	83.65	80.30	33.38
13.4	85.88	5.91	70.50	76.92	91.42	0.00	32.18	9.33	8.37	2.58	13.37	57.79
	99											
14.1	65.96	3 99.09	2 3.73	4 8.24	12 68.24	1 10.00	12 76.88	17 13.50	7 38.65	23 40.07	7 68.29	11 94.11
14.2	33.62	.91	96.27	50.80	31.71	0.00	16.87	86.33	61.35	59.59	31.51	5.88
14.3	.41	0.00	0.00	40.96	.05	0.00	6.25	.17	0.00	.33	.19	.01

* Question	Units
2	Dollars (000)
3	Persons
4	Tons
5-10	Percent
11.1	Dollars (000)
11.2	Tons
12-14	Percent
Air Weight	Tons
21.1	Shipments
17	Responses
18-20, 23	Percent
22	Average pieces/shipment

Table 3-10

(Cont'd)

Weighted Responses to Manufacturers Questionnaire*

SIC Question No.	ALL	2311-2399	2651	2721-2789	28151-28216	2834	3461-3499	3531-3533	3545-3599	36112-36795	3714-3729	3811-3842
AIR WEIGHT	100 114 69,604.44	3 4.35	2 5,840.00	7 12,205.00	4 24,780.00	2 92.50	9 7,478.27	18 6,754.49	7 958.10	26 1,609.20	8 7,994.64	11 11 1,879.01
21.1	395,105.00	3 50.00	2 35.00	7 4,650.00	18 26,900.00	2 8,600.00	12 45,834.00	19 16,235.00	8 26,896.00	24 183,887.00	8 60,088.00	21,930.00
17.1	122 36.00	3 1.00	2 0.00	7 2.00	19 2.00	2 0.00	12 1.00	19 3.00	9 2.00	27 16.00	9 1.00	13 8.00
17.2	22.00	0.00	0.00	1.00	0.00	0.00	1.00	4.00	2.00	9.00	1.00	4.00
17.3	94.00	2.00	2.00	6.00	14.00	2.00	9.00	17.00	9.00	15.00	7.00	11.00
17.4	23.00	1.00	0.00	1.00	6.00	1.00	3.00	3.00	1.00	2.00	5.00	0.00
18.1	97 38.53	3 0.00	2 73.97	4 3.64	4 18.09	2 88.38	9 69.43	18 36.08	7 80.60	26 36.89	8 90.65	14 66.18
18.2	2.66	0.00	9.25	.07	.49	.27	.40	9.28	1.71	25.81	.35	3.47
18.3	55.40	18.39	16.78	92.32	80.03	0.00	20.98	47.40	14.81	19.91	8.89	28.22
18.4	.64	0.00	0.00	0.00	.65	0.00	.31	3.72	0.00	.63	0.00	.06
18.5	2.77	3.55	0.00	3.98	.74	11.35	8.99	3.52	2.36	16.47	.11	2.06
19.1	114 64.03	3 0.00	2 8.57	7 77.53	18 62.50	2 85.81	12 35.22	18 15.92	8 75.07	24 74.70	8 55.19	12 71.21
19.2	18.53	70.00	32.14	6.99	18.52	12.09	29.46	32.97	10.21	16.74	21.73	6.13
19.3	12.25	30.00	2.14	3.55	15.26	2.09	15.14	34.20	7.02	7.31	16.27	7.81
19.4	3.70	0.00	34.29	10.65	2.77	0.00	9.33	13.42	.39	1.05	5.16	8.14
19.5	1.49	0.00	22.86	1.29	.96	0.00	.84	3.48	7.30	.09	1.65	6.71
20	7.22	22.99	0.00	.01	10.79	0.00	16.73	8.86	31.05	.05	.65	2.58
22	111 2.23	3 1.33	2 6.50	6 3.00	17 1.88	2 1.50	12 3.75	18 1.83	8 2.25	24 1.92	8 25.57	11 1.91
23.1	112 14.26	3 30.00	1 33.00	4 6.53	17 20.56	2 2.09	11 7.01	17 5.11	8 .97	22 8.22	8 25.57	11 70.15
23.2	50.50	70.00	33.00	75.88	61.84	66.51	20.17	27.07	62.61	62.51	42.83	12.95
23.3	35.24	0.00	34.00	17.59	17.60	31.40	72.81	67.83	36.42	29.27	31.60	16.91

A comparison of sample results with the 1967 Census of Transportation for Texas is useful in judging the representativeness of the sample. The Census of Transportation for Texas, due to the large impact of chemical and coal products on Texas shipping patterns, gives distributions for all manufactured commodities and also for all commodities except petroleum and coal products. Aggregate sample results were also heavily weighted by chemical products which were 92 percent of total tons shipped.

A comparison with the 1967 Census of Transportation by percentage distribution of shipments by means of transport and percentage distribution of shipments by distance of shipments is given below:

All Commodities

Means of Transport	Motor Carrier	Private Truck	Air	Other
Census	8.4%	6.0%	--	85.6%
Sample	9.8	4.6	.41%	85.2
Distance Shipped	**Under 500**	**500 to 999**	**1,000 to 1,500**	**Over 1,500**
Census	28.6%	15.7%	39.1%	16.6%
Sample	20.0	19.9	42.3	17.7

All Commodities Except Petroleum and Coal Products

Means of Transport	Motor Carrier	Private Truck	Air	Other
Census	23.9%	19.9%	--	56.2%
Sample	40.2	46.2	3.3%	10.3
Distance Shipped	**Under 500**	**500 to 999**	**1,000 to 1,500**	**Over 1,500**
Census	68.2%	17.3%	11.2%	3.3%
Sample	25.6%	30.0	29.1	15.0

The comparisons for all commodities are very close, again primarily due to the large impact of chemical and coal products on both the Census of Transportation data and the sample data. With the chemical shipments removed, the comparisons are not nearly as close. Here the criteria for selection of sample firms become evident. One must recall the primary criteria for selection were SIC number products that showed some movement by air in the Census of Transportation. The high percentage of truck and low percentage of rail and water transport in the sample is reasonable considering that truck is the competing mode with air. This lack of agreement between the census and sample distribution may also be indicative of a high potential for air shipment by the sample firms. It also suggests that perhaps a higher percentage could move by air. At the present time, 44.1 percent of the weight moves over 1,000 miles, but only 3.3 percent moves by air.

Principal destinations of air cargo were coded by region, state, foreign country, and foreign region (Table 3-11). The South and West were the predominate regions, with the Northeast and Northcentral close seconds. The entire United States was the principal destination for 47 of the respondents. Region responses were tabulated to include state responses. Principal states were California, 25 responses; New York, 19 responses; Texas, 14 responses; and Illinois, 13 responses. Canada and Europe were the primary foreign destinations, with 17 and 20 responses, respectively.

Principal Texas airports (Table 3-12) were Houston, 36 percent of respondents; and Dallas, 34 percent of respondents. San Antonio had only one respondent (San Antonio had 31 firms in the sample, one of which replied), and Corpus Christi had none (Corpus Christi had nine firms in the sample, one of which replied). The principal cargo airports are reflective of two facts, (1) a high concentration of manufacturing

Table 3-11

PRINCIPAL DESTINATIONS OF AIR CARGO ORIGINATING FROM TEXAS MANUFACTURERS

Region	Responses
Northeast	26
Northcentral	26
South	35
West	37
United States	47

State	Responses	State	Responses	State	Responses
Alabama	2	Louisiana	9	Ohio	1
Arizona	1	Massachusetts	6	Oklahoma	3
California	25	Maryland	1	Pennsylvania	1
Colorado	3	Michigan	2	Tennessee	1
Florida	8	Mississippi	2	Texas	14
Illinois	13	Missouri	3	Utah	2
Indiana	3	New Jersey	3	Virginia	2
Kansas	2	New Mexico	2	Washington	4
Kentucky	1	New York	19	Wyoming	2

Territory or Foreign Country	Responses	Territory or Foreign Country	Responses	Territory or Foreign Country	Responses
Australia	2	Holland	1	Africa	1
Brazil	1	Japan	4	Europe	20
Canada	17	Puerto Rico	1	Far East	4
France	1	United Kingdom	5	Latin America	3
Germany	2	Venezuela	2	Middle East	1

Table 3-12

PRINCIPAL TEXAS AIRPORTS USED BY
TEXAS MANUFACTURERS

Airport	Responses	Percent
Abilene	1	.8
Austin	5	4.1
Beaumont	4	3.3
Big Spring	2	1.6
Brownsville	2	1.6
Dallas	42	34.5
El Paso	1	.8
Harlengen	1	.8
Houston	44	36.3
Longview	5	4.1
Lubbock	2	1.6
Midland	7	5.7
Paris	1	.8
San Angelo	2	1.6
San Antonio	1	.8
Wichita Falls	2	1.6
		100.0

activity in the Dallas and Houston metropolitan areas, and (2) a reliance by many manufacturers on the service provided at the two largest airports.

Peak months for air shipment of manufactured products (Table 3-13) are May, June, July, October, and November in terms of number of shippers; and February, May, June, October, and December in terms of number of shipments. If shipments moved with the same frequency throughout the year, 8.33 percent would move each month. May, the peak month, had 17.47 percent of the shipments, or slightly more than twice the average month.

Timing of pick-up of shipments was 14 percent pre-noon, 51 percent noon to 4:00 p.m., and 35 percent after 4:00 p.m. Considering the fact that most shipments picked up during the noon to 4:00 p.m. period will not be at the airport ready to load prior to 5:00 p.m., 86 percent of the outbound traffic is moving from the airport after 5:00 p.m.

The use of containers by Texas manufacturers is very limited for all modes of transportation, 2.7 percent, and only slightly higher for air, at 7.2 percent. This is not reflective of total container usage, since 38 percent of the weight is tendered to air freight forwarders, and a part of this traffic is subsequently containerized. The use of shipper packed containers appears to be very limited. Also contributing to this is the small size of shipments, with 64 percent of the air shipments weighing less than 50 pounds. The average number of packages per shipment is 2.23.

Perhaps most indicative of the future of air cargo as a mode of transport for Texas manufactured products were the responses to question 25 which asked for the estimated annual growth rate in air shipments and total shipments. This question was not answered by 22 percent of the respondents. For those that answered, 51 percent indicated that air shipments would grow at a lesser rate than total shipments, 30 percent indicated that air shipments would grow at

Table 3-13

ANALYSIS OF PEAK MONTH BY RESPONSES, DISTRIBUTION OF RESPONSES, RATIO PEAK TO TOTAL SHIPMENTS AND DISTRIBUTION OF SHIPMENTS

	Responses	Distribution of Responses	Ratio Peak to Total[1]	Distribution of Shipments
January	4	5.19%	10.82%	8.26%
February	3	3.90	10.69	10.37
March	4	5.19	9.21	8.41
April	5	6.49	9.79	2.39
May	10	12.99	11.96	17.47
June	10	12.99	13.64	12.94
July	8	10.39	12.93	5.57
August	5	6.49	10.69	4.39
September	4	5.19	53.00[2]	2.27[3]
October	10	12.99	10.23	14.65
November	8	10.39	29.48	1.33
December	6	7.79	9.58	11.90

1/ Peak month shipments divided by total shipments per year.

2/ This figure is heavily weighted by one respondent in the electronics industry with 100,000 shipments per year and 30,000 of them in September.

3/ Electronics shipper not included.

the same rate as total shipments, and 13 percent indicated that air shipments would grow at a greater rate than total shipments. From this it may be inferred that air shipments will grow at a lesser rate than total Texas manufacturing shipments. Responses are summarized by SIC in Table 3-14. An explanation of this may be the way manufacturers view air cargo. Question 17 asked for the air role in distribution. Multiple answers were permitted. Of 175 responses, 94, or 53 percent, saw air as an emergency means of transportation, with another 23, or 13 percent, using air cargo primarily at the request of the customer. Only 33 percent used air for the regular delivery of main products or parts.

Industry (SIC) Specific Analysis. Because of the low response rate for many SIC's at the four-digit level, the responses were collapsed into 11 SIC groups. Weighted responses were shown in Table 3-10. Responses will be discussed by question numbers with significant variations from the overall pattern being noted.

Question 5: SIC groups 3531-3533, 3545-3599, and 3811-3842 had relatively high exports, primarily to Europe and Canada.

Questions 6 and 8: These two questions are partially comparable to the 1967 Census of Transportation depending on the SIC detail available. Notice that the use of air agrees fairly well except for SIC 3714-3729 where the sample shows a low use of air relative to the census estimate. The sample consistently shows a higher percentage in the over 1,500-mile bracket. Undue reliance must not be placed on these census/sample comparisons although the similarities and discrepancies are of some interest. Comparisons are shown in the following two arrays:

SIC	Means of Transport	Motor Carrier	Private Truck	Air	Other[1]
281	Census	11.9%	3.6%	--	84.5%
28151-28216	Sample	8.1	.2	.2	91.6
34	Census	29.8	44.5	.1	25.6
3461-3499	Sample	78.0	2.7	4.3	15.0
3533	Census	70.1	16.7	.5	12.7
3531-3533	Sample	45.6	7.6	4.1	42.7
366	Census	72.7	.9	21.6	4.8
36112-36795	Sample	35.8	27.3	21.1	15.8
372	Census	75.5	11.5	10.6	2.4
3714-3729	Sample	26.5	72.2	1.1	.2

1/ The census includes railway express, parcel post, freight forwarders, etc. in "other". Air freight forwarder traffic included under air in sample. For comparison purposes rail and water were included in other in this table. Census "other" was SIC 281, .1; SIC 34, .1; SIC 3533, .1; SIC 366, 2.7; SIC 372, 2.4. Part of this may be air freight forwarder traffic.

SIC	Distance Shipped	Under 500	500 to 999	1000 to 1500	Over 1500
281	Census	53.4%	22.2%	21.7%	2.7%
28151-28216	Sample	19.6	19.1	43.4	18.0
34	Census	72.4	20.3	5.8	1.5
3401-3499	Sample	13.8	22.0	53.2	11.0
3533	Census	57.3	15.5	18.4	8.8
3531-3533	Sample	23.7	25.3	23.6	27.4
366	Census	23.6	37.5	36.8	2.1
36112-36795	Sample	32.6	18.9	33.6	15.0
372	Census	20.4	6.8	72.7	.1
3714-3729	Sample	38.0	29.3	11.8	20.8

Question 7: Terms of shipments were predominantly FOB plant suggesting that the manufacturer generally does not pay the transportation cost. SIC groups 2721-2789 and 3714-3729 were about evenly split between FOB plant and FOB destination.

Question 8: The tons of air freight generated per employee were calculated with the following results:

SIC	Tons per Employee	SIC	Tons per Employee
All	.795	3461-3499	.953
2311-2399	.011	3531-3533	.711
2651	20.137*	3545-3599	.433
2721-2789	3.836	36112-36795	.122
28151-28216	.123	3714-3729	.348
2834	.298	3811-3842	.257

*Two responses.

These ratios may be considered as rough indicators of propensity to use air cargo.

Question 10: A comparison of question 10 and question 19 is helpful in understanding the size of air shipments relative to the size of total shipments. Not counting chemicals, total shipment weight less 100 pounds is six percent. The reader should recall that 64 percent of the air shipments weighed less than 50 pounds. SIC groups 36112-36795, and 2721-2789, showed the highest percentage of small shipments with 38 percent and 24 percent, respectively.

Questions 11-14: Texas manufacturers purchased 59 percent of their materials in Texas, 37 percent in other states, and four percent in foreign countries. SIC group 3461-3499 purchases were 20 percent foreign.

Air is not an important mode of shipment for purchases in any SIC group. SIC groups 3461-3499 and 36112-36795 were the highest users of air, both having seven percent.

Question 15: Principal products by air were primarily emergency shipments including repair and maintenance parts, electronic components and equipment, and oil field equipment. Normal distribution was limited to electronic and communications equipment and parts.

Question 17: SIC group 36112-36795 was the only group that used air freight predominantly for regular delivery of products and parts. This group was also the highest user of air freight with 21 percent of their product moving by air. For all other groups air was used primarily as an emergency means of shipping.

Question 18: Texas manufacturers tendered 55 percent of their air freight directly to scheduled air carriers, 39 percent to forwarders, and three percent to REA and Air Parcel Post.

Question 19: The distribution of shipments by weight: 64 percent, less than 50 pounds; 19 percent, 50-199 pounds; 12 percent, 200-499 pounds; and five percent, greater than 500 pounds; confirms the small emergency shipment description of air freight. SIC group 3531-3533, oil field machinery, had 47 percent of their shipments in the 200-499 pound block significantly above the average of 12 percent as might be expected. SIC group 36112-36795, the largest shipper by air freight, had primarily small shipments, with 74 percent less than 50 pounds and 90 percent less than 200 pounds.

Question 20: SIC group 3545-3599 was the only group with a significant amount of containerized weight at 31 percent.

Table 3-14

ESTIMATED ANNUAL GROWTH RATE IN AIR SHIPMENTS
RELATIVE TO ESTIMATED ANNUAL GROWTH RATE
IN TOTAL SHIPMENTS

SIC	Responses	Air Less Than Total	Air Same As Total	Air Greater Than Total
2311-2399	2	1	1	0
2651	1	1	0	0
2721-2789	5	2	2	1
28151-28216	14	8	4	2
2834	2	1	1	0
3461-3499	12	8	2	2
3531-3533	17	8	7	2
3545-3599	7	5	0	2
36112-36795	21	12	7	2
3714-3729	6	4	1	1
3811-3842	11	6	4	1
Total	98	56	29	13

Texas Wholesale Florists As Air Cargo Shippers and Consignees

Early in the Air Cargo study, there were indications that wholesale florists were important air shippers. Presumably, air cargo was assisting in a significant way in extending the market for Texas products. More information on the way in which air cargo is used might help expand this market even more. Consequently, a questionnaire survey of all members of the Texas State Florists' Association that appeared to be wholesale florists (many suppliers of material and service inputs to the industry are also members) was undertaken.

Background. Cut flowers and greens, like orchids from Hawaii, were air cargo's star performer over a long period. Since then, other commodities have overtaken florist products, but they have continued to be significant air travelers. In the air carrier surveys, the Texas carriers reported decorative greens and other florist products as important air carried commodities. Table 3-15 shows Texas International's system shipments of floral products over a seven-day period in 1969. In a study of San Antonio's aviation potential,[1/] it was estimated that 10 percent of San Antonio's outgoing cargo in 1969 was decorative greens. They were 90 percent of the 1966 air imports into the Laredo Customs District (San Antonio International). Florists' commodities constitute about three percent of both United States imports and exports by air. In communications with the Texas State Florists' Association and Texas Transportation Institute, Mr. Steve Eichelberger, Executive Secretary, states (of the air planning process and the survey):

1/ Planning Research Corporation, Study of the Potential of the San Antonio Region as an Air Transportation Center, Los Angeles, California, January, 1971.

Table 3-15

TEXAS INTERNATIONAL

SUMMARY OF SYSTEM FLORAL PRODUCTS TRAFFIC AND REVENUE

July 13-17, 1969

ITEM	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100 and Over	Total
Number of Shipments	---	2	---	---	1	3	8	1	2	1	23	41
Number of Pounds	---	31	---	---	40	150	490	79	172	98	4,862	5,922
Revenue	---	$16	---	---	$8	$24	$64	$8	$18	$8	$303	$449
Total No. of Pieces	---	2	---	---	1	3	17	1	4	3	111	142

Source: C. A. B. Docket No. 20398, Exhibit Texas International No. I-2.

".... there is no question about air freight express service, as you propose, as a vital part of our future, but users will have to see it work before being a part of it. No one used the Ford until people saw it work and facilities provided to run them on. This can apply to almost every item that has been manufactured, including today's style of wearing apparel.

We know that there is a great need for air transportation expanded service, and when it is provided, people will use it. We know that Railway Express service failed - not because of a lack of need, but because of the deterioration of service by both the railroad and railway express service; ignoring of legitimate claims and general attitude of its personnel."

The survey form went through several drafts and review of both TTI and ERA. The Texas State Florists' Association provided a review and critique, and their suggestions were incorporated. The form was mailed to 103 Texas members of the Association who were florists (potters, truckers, ribbon suppliers, etc., were not covered). Twenty-three usable responses were received, for a 23 percent response rate.

Survey Results.

(Question is given followed by analysis of response.)

1. Significance of Air Cargo:

   1) We use air cargo ( ); 2) We do not now use air cargo, but see its use in the future ( ); 3) We would use air cargo if better facilities and/or service provided ( ); 4) We do not use air cargo now nor do we plan to use in the foreseeable future ( ). (If you check last item, please put survey form in attached envelope and return.)

2. Total Annual Sales (thousands of dollars)____________________.

3. Employment: 1) Average Annual ______________ 2) Peak__________.

Of the air cargo users, all but three reported their annual sales (11 for 1970, two for 1971) which ranged from $50,000 to $2,000,000 per year and averaged $375,000.

Twelve air cargo users reported average employment. It ranged from three to 35, and averaged 13. The labor force for this portion of the industry averages 156 annually. Average sales per average employee are $30,000 per year.

4. Total Annual Weight Shipped (all modes in pounds) ________________.

Nine responded (correctly) to this question. Annual weight shipped ranged from 20,000 to 6,000,000 pounds per year. The mean for respondents was 1,025,000 pounds per year. Shipment weights were 79,000 pounds per average employee.

5. Commodity (Weight and method of distribution).

	Est. Weight in Pounds	Distribution Local	Distribution By Air
Decorative Greens	___________	_____%	_____%
Cut Flowers	___________	_____%	_____%
Live Plants	___________	_____%	_____%
Other	___________	_____%	_____%

Decorative greens made up 54 percent of the weight of shipment - 42 percent was in cut flowers, and three percent in live plants.

The responses aggregated a total of 1,525,000 pounds of air shipments, or 16 percent of total, broken down as follows:

Decorative Greens	63.0%
Cut Flowers	35.3%
Live Plants	1.7%

An inferred factor from this source, as well as employment information, is that an average employee of a floral company generates about 10,000 pounds of air shipments per year.

6. Principal Destinations: (states, foreign countries; use other side for others.)

____________ ________________________ ____________

The frequency of mention of destination was:

Texas	8
Oklahoma	5
Missouri	3
Maryland	2
Louisiana	2

(others were Arizona, New Mexico, United States)

The phrasing of the question does not permit a reliable estimate of the destinations of air shipments.

7. Terms: 1) FOB your firm _____%; 2) FOB customer _____%; 3) Other _____%.

There were 12 responses, about equally divided between 7.1 and 7.2.

8. Percent of Air Shipment by: 1) Forwarder _____%; 2) Express (REA) _____%; 3) Scheduled Air Carrier _____%; 4) Chartered Carrier _____%; 5) Air Parcel Post _____%.

There were nine usable responses to this question. Five showed 100 percent by scheduled air carrier, and two showed greater than 50 percent. None of these indicated use of air express or parcel post. One showed 20 percent by charter. Four indicated use of forwarders as follows: 20, 25, 80, and 100 percent.

9. Percent Size Distribution of Air Shipments:
1) Less than 50 lbs. _____%; 2) 50-199 lbs. _____%;
3) 200-500 lbs. _____%; 4) Over 500 lbs. _____%.

Eleven responses were received. The modal class was 50-199 pounds. Two of the larger air shippers, 900,000 pounds and 510,000 pounds, showed 20 and 30 percent, respectively, of shipments over 500 pounds, and 50 and 60 percent, respectively, in the 200-500-pound interval.

10. Number of shipments:
1) Estimated number, 1970 _____________; 2) Estimated number, Peak Month _____________; 3) Name Peak Month _____________.

Eight fully usable responses and 11 partly usable responses showed a number of annual shipments ranging from 50 to 4,000 (of the fully usable), and the largest wholesale shippers indicated 5,000 shipments in the peak month alone. The ratio of peak month to average (one-twelfth annual) ranged from 1.1 to 2.0.

The peak months mentioned were quite scattered; three in December and two in March. Two of the large shippers did not respond.

11. Average Number of Packages per Shipment: ______________

Responses (12 in all) ranged from one to ten. There was no dominant model clustering but, for the larger shippers, it is in the range of 4-8.

12. Timing of Pick-Up:

1) Pre-Noon ______%; 2) Noon to 4 pm _____%;

3) Past 4 pm ______%.

Nine responses showed the noon to 4 pm period as the dominant one, taking into consideration size of shipment; 75 percent of shipping weight was picked up in this period.

13. Principal Airport(s):______________________________________

Frequency of mention from 13 responses (incoming as well as outgoing was in the minds of most responders) are:

San Antonio	6
Dallas	2
Houston	2
Amarillo	2
Tyler	1
McAllen	1
Brownwood	1

14. Growth in Shipments:

1) Estimated Annual Growth Rate in Air Shipments __________%;

2) Estimated Annual Growth Rate in Total Shipments ________%,

Four of the shippers showed equal rates, including two of the larger ones at about 10 percent per year. Five showed total shipments growing faster than air, one of which was a large shipper who indicated around 20 percent total growth annually versus a decline of 15 percent by air. None showed air shipments growing faster than total.

15. Incoming Shipments:

1) Estimated Weight, All Modes _______________; 2) Estimated percent by Air ________%.

A total of 14 reported incoming shipments ranging from 25,000 to 6,000,000 pounds per year, for a total of 10,163,000 pounds and an annual average of 726,000 pounds. Air percentages ranged the complete gamut from zero to 100 percent yielding a total of 2,461,000 air carried deliveries for an overall average of 24 percent.

Industrial and Research Laboratories

On the basis of previous Economics Research Associates aviation studies and consultation with the Texas Transportation Institute, it was decided to survey the patterns of air cargo use by industrial and research laboratories. The questionnaire and a typical response are shown in Exhibit 3-7; based on a compilation of listings by the Texas Transportation Institute, 217 survey forms were mailed. Twenty-six were returned; of these, six were incomplete (e.g., no responses to questions 4 and 5) or inapplicable (e.g., "Return to Sender" because addressee now unknown). Thus, 20 usable responses - approximately a 10 percent sample - were obtained.

In Table 3-16, for each response answers to questions 2 through 12 are tabulated. (All answered question 1 in the affirmative.) The last row - with the symbol Σ for total - summarizes, where applicable, the 20 answers to a specific question. Question 2 and, interestingly, question 8 - which often elicited product (versus principal item) information or merely generalities - show the respondents falling into five categories:

Electronics	6	30%
Chemicals	4	20%
Oil (i.e., well equipment)	3	15%
Other	3	15%
Unknown	4	20%
	20	100%

While the percentage figures cannot, by this limited sample, be extended to the entire industrial and research laboratory sector, Electronics, Chemicals, and Oil would seem dominant.

Exhibit 3-7

SAMPLE RESPONSE

INDUSTRIAL AND RESEARCH LABORATORIES SURVEY
FOR THE TEXAS AIRPORT SYSTEM PLAN: 1970
INFORMATION REQUESTED

(If 1970 Is Not Available Indicate Period of Report)

1. Significance of Air Cargo:
1) We use air cargo [x]; 2) We do not now use air cargo, but see its use in the future [ ]
3) We would use air cargo if better service were provided [ ]; 4) We do not use air cargo now nor do we plan to use it in the foreseeable future [ ]:
(If you checked item 4, please put survey form in attached envelope and return.)

2. This laboratory is an adjunct of a manufacturing establishment; 1) Yes [ ]; 2) No [ ].
If yes, what are principal products of manufacturing establishment.
Core Analysis Apparatus, Reservoir Fluid Apparatus, Mud Logging Equipment (Oil Industry Appara us
Note: The remaining questions pertain to this laboratory only and not to a parent organization.

3. Employment: Average Annual 537

4. Total Annual Weight Shipped by Air (pounds) 60,000 Lbs .

5. Total Annual Weight Received by Air (pounds) 20,000. Lbs .

6. For All Air Shipments, Percent Size Distribution of Air Shipments:
1) Less than 50 lbs. 50 %; 2) 50-199 lbs. 20 % 3) 200 - 500 lbs. 20 %;
4) Over 500 lbs. 10 %.

7. For All Air Shipments Percent of Air Shipments By: 1) Forwarder ______%;
2) Express (REA) 5 %; 3) Scheduled Air Carrier 90 %
4) Chartered Carrier --- %; 5) Air Parcel Post 5 %.

8. Principal items shipped or received by air (models, samples, lab specimens, etc.)
Glassware, Core Analysis Apparatus, Mud Logging Equipment, Printed Matter, Misc.

9. Principal Destinations of Shipments: World Wide including U.S.A. (Texas, Louisiana, Oklahoma, Colorado, California, New Mexico, Utah, Wyoming, Florida, Alabama, Georgia, Etc, Etc.

10. Principal Origins of Shipments: Dallas, Texas Houston, Texas, California. Louisianna. Colorado.

11. Principal Texas Airports Used: Dallas(Lovefield) Houston(Intl Airport) Midland-Odessa

12. Remarks: Please comment on any factors which would change your utilization of air cargo.
A greater percentage of freight would move via Airfreight if the carriers reduced their rates to be more competitive with Parcel Post, Air Parcel Post, Motor Freight, Rail, Air Express (in the lower weight brackets), and the ocean going vessels.

Table 3-16
TABULATION OF THE 20 USABLE RESPONSES
LABORATORY SURVEY

Response/Question →	2.	3 (EMP)	4 (LB×1000)	5 (LB×1000)	6_1	6_2 (%)	6_3	6_4	7_1	7_2	7_3 (%)	7_4	7_5	8	9	10	11	12
1	ANIMAL & POULTRY FEEDS	10	.1	.5	100	—	—	—						FOOD SAMPLES	DALLAS, HOUSTON, NEW YORK	ABILENE, CHICAGO, KANSAS CITY	ABI DFW HOU	REDUCE COSTS
2	OIL INDUSTRY APPARATUS	537	60	20	50	20	20	10	—	5	90	—	5	GLASSWARE, OIL EQPT., PRINTED MATTER	WORLD WIDE; U.S.–TEXAS & NEARBY STATES	DALLAS, HOUSTON, CALIFORNIA	DFW HOU MAF	REDUCE RATES
3	CUSTOM MFG.	10	.9	2	70	25	5	—	30	30	10	—	30	PRODUCT SAMPLES	NORTHEAST STATES	HOUSTON	HOU	
4		100	30	32	5	—	90	5	—	5	80	5	10	WELL-LOGGING & OTHER OIL WELL EQPT.	LOS ANGELES, NEW ORLEANS, CASPER	THESE 3 + HOUSTON	HOU	
5		200	1	.2	75	25	—	—	—	—	95	—	5	SAMPLES, SPECIAL PARTS, REPORTS	WYOMING, NEW MEXICO	TEXAS, LOS ANGELES	HOU MAF	
6	XFORMERS, SWITCHES, RELAYS	125	12	6	10	20	60	10	—	—	90	—	10	MODELS, SAMPLES, TEST ITEMS	CONTINENTAL U.S.	CONTINENTAL U.S.	DFW	
7	BIOMED INSTRUMENTS	25	.5	.5	100	—	—	—	—	30	30	—	40	OUT: BIOMED. IN: ELECTRONIC	U.S.A.	HOUSTON	HOU	INCREASE IN SALES
8	PAINTS, RESINS, ADHESIVES	22	.5	.3	90	10	—	—	—	90	—	—	10	SAMPLES	CHICAGO	PHILADELPHIA, CHICAGO, NEW YORK	DFW	
9	OIL WELL & MINING TOOLS	6	5	2.5	10	50	30	10	—	—	95	5	—	PROTOTYPES, MODELS	U.S. & CANADA	U.S. & CANADA	HOU MAF	
10	CHEMICALS & PLASTICS	1600	100	100	—	30	40	30	90	5	—	—	5	POLYMER SAMPLES, LIQUID CHEMICALS	MIDWEST, EAST COAST	MIDWEST, EAST COAST	HOU	
11	BOTANICALS, ISOPRENE, BY-PRODUCTS	43	.06	.03	100	—	—	—	—	—	100	—	—	SAMPLES, REPAIR PARTS	OVERSEAS	PORT NECHES	BPT	PROBABLE INTERSTATE FUTURE USE
12	CHLORINE, SODA ASH, CHEMICALS	125	.09	.12	95	5	—	—	—	25	50	—	25	SAMPLES	LAKE CHARLES, PITTSBURGH, NEW YORK	NO PRINCIPAL ORIGIN	CRP HOU	
13	SNACK FOODS, MACHINERY PARTS	100	.1	1	95	5	—	—	100	—	—	—	—	SAMPLES, PARTS	U.S. CITIES, FOREIGN CITIES	U.S. CITIES, FOREIGN CITIES	HOU DFW	
14		12	.3	.25	100	—	—	—	10	15	—	—	75	LAB EQPT., SUPPLIES	NO SPECIFIC AREA	CHICAGO	CLL HOU DFW	USE ONLY RARELY
15	ELECTRO-MECHANICAL EQPT.	325	25	15	60	25	10	5	10	10	20	—	60	INSTRUMENTS, COMPONENTS	WASHINGTON, LOS ANGELES, SAN FRANCISCO	DALLAS	DFW	
16		350	.19	6.5	.67	29	4		60	31	6	—	3	SAMPLES & REPAIR MATERIALS	NEW YORK, LOS ANGELES, NEW ORLEANS	EAST COAST	BPT	
17	ELECTRONIC EQPT.	35	7	20	25	70	4	1	—	70	30	—	—	LAB SPECIMENS, EQPT.	COLLEGE STATION (40%); OTHER (60%)	COLLEGE STATION (40%); OTHER (60%)	DFW	
18	SEMI-CONDUCTORS	23	10	15	75	25	—	—	50	25	10	—	15	SAMPLES	LOS ANGELES, NEW YORK, CHICAGO	DALLAS	HOU SAT DFW	
19		38	2	1	—	75	25	—	—	20	30	—	—	EQPT., MATERIAL, SUPPLIES	WEST COAST, NEW ENGLAND, ILLINOIS	CALIFORNIA, ILLINOIS, NEW ENGLAND	HOU	
20		100	20	75	75	15	9	1	—	30	50	—	20	ELECTRONIC & MECHANICAL EQPT.	FLORIDA, TEXAS, MICHIGAN	GALVESTON, HOUSTON	GLS HOU CRP	WANT IMPROVED AIR HANDLING
Σ		3796	275	298	61	21	15	3	18	21	44	1	16				HOU DFW MAF	

Questions 3 and 4 are used (dividing the latter by the former) to show how much air shipment per employee the labs generate; computations are included in Table 3-17, with units in LB/EMP (pounds per employee). The reader should note that all responses with over 100 LB/EMP are either Oil or Electronics; subsequently, the LB/EMP is computed for each of the five categories. The Oil and Electronics groups both register over 100 LB/EMP, while Other and Unknown fall below 10 LB/EMP, and the Chemicals group (if response 10 data are included) is midway between the two extremes; the relative roles of various fields is now apparent. Further study should concentrate on the Oil and Electronics - and, perhaps, Chemical - lab activities; other fields have negligible impact.

For perspective, the most recent figure for Texas manufacturing as a whole[1/] is 218 LB/EMP in 1968. The overall average of the 20 responses is substantially lower, 73 LB/EMP, which at first - assuming laboratories as intensive air cargo generators - is contradictory. The reason is statistical: responses often seemed to give total (i. e., laboratory plus manufacturing) employment, rather than strictly lab personnel, thus deflating the LB/EMP ratio; examples: responses 2, 6, 10, and 15. Nevertheless, in two of the three Oil responses, LB/EMP was still definitely above the Texas manufacturing standard.

Question 5 reveals the laboratories, as a group, use air cargo less than their customers: 275,000 pounds versus 298,000 pounds. The deficit would imply, relative to the rest of the United States, underutilization of the air mode; this ties in with previous findings that Texas air freight performance is below the United States average.

1/ Source: Technical Note 17, Table 2B.

Table 3-17

AIR SHIPMENT GENERATED PER EMPLOYEE:
THE 20 RESPONSES AND THE FIVE GENERAL CATEGORIES

Response	LB/EMP	
1	10	
2	112	Oil
3	90	
4	300	Oil
5	5.0	
6	96	
7	20	
8	23	
9	833	Oil
10	62	
11	1.4	
12	.7	
13	1.0	
14	25	
15	77	
16	.5	
17	200	Electronics
18	435	Electronics
19	53	
20	200	Electronics
Σ	73	
Σ *	90	

Category	Responses	Employment	LBx1000	LB/EMP
Oil	2, 4, 9	643	95	148
Electronics	6, 7, 15, 17, 18, 20	633	74	118
Chemicals	8, 10, 11, 12	1,790	101	56
Other	1, 3, 13	120	1.1	9.2
Unknown	5, 14, 16, 19	600	3.5	5.8
Chemicals*	8, 11, 12	190	.65	3.4

* Excluding response 10, which may be overstated.

Terms: LB = Pounds.
EMP = Employees.

Source: Economics Research Associates.

Referring again to the Table 3-17 summary, Question 6 shows that most (61 percent) of laboratory air shipments are 50 pounds or less - likely because their cargo is samples, spare parts, scientific equipment, etc. Primary exceptions, with 30 percent of air shipments above 200 pounds: three Oil (responses 2, 4, and 9), one Electronics (response 6), and one Chemicals (response 10); this is due to the bulk nature of these labs' specific products and items (as listed in Questions 2 and 8). Rounding off the overall weight (in pounds) distribution:

< 50	60%
50-199	20%
200-500	15%
> 500	5%
Total	100%

From the Question 7 data, scheduled air carriers are the prevalent laboratory air mode; conversely, chartered air carriers are hardly used at all. The other three types are clustered together around 20 percent. This distribution can be approximated as:

Scheduled Carrier	40%
Express	20%
Forwarder	20%
Parcel Post	20%
Chartered Carrier	0%
Total	100%

No geographic pattern emerges from the destinations and origins of Questions 9 and 10; responses were diverse in location - and in style (answers by city, state, region, and even U.S. as a whole). Origins tended to be closer, often in Texas, e.g., responses 2, 3, 4, 7, 11, 15, 18, and 20; this could indicate the question was interpreted in reference to all - versus strictly air - incoming shipments.

The airports most cited in question 11 were, as expected, Houston (abbreviated as HOU) and Dallas-Fort Worth (DFW); HOU was mentioned 14 times and DFW nine. HOU ranked above DFW because of its local technology base, specifically in oil equipment, electronics, and chemicals. Other airports with multiple responses: Midland-Odessa (MAF)-three; Beaumont-Port Arthur (BPT)-two; and Corpus Christi (CRP)-two. The BPT answers (responses 11 and 16) were the only ones not also citing HOU or DFW; this airport must have some definite cargo service or proximity advantage to stand on its own.

Maricultural Products

Several maricultural products are prime candidates for air shipment, having the characteristics of high value, highly perishable, wide demand, and limited harvesting locations. Lobsters have been successfully marketed by air for many years. In this section, a summary of interviews held with members of the Texas crab and shrimp industry is given.

Crab. Live blue crabs are currently moving in volume shipments from Houston Intercontinental Airport. Delta Airlines reports that they anticipate airlifting a quarter million pounds of live and processed crabs per month during May and June to the Baltimore market, and they routinely handle approximately 9,000 pounds of live and 2,000 pounds of processed crabs per day from the Houston terminal.

Published reports indicate that Delta uses a Convair 880 X for this movement. Shipments of live crabs, however, have increased to the extent that cargo space is a major constraint to air shipments. Delta currently allocates space to Houston area shippers. According to one shipper in Houston, his shipments would increase if more space were available. This shipper currently ships 150 dozen crabs per day by air.

Live crabs are an extremely perishable item, and air cargo provides the opportunity to penetrate distant markets. Prior to enplaning, the crabs are cooled to 45 degrees to reduce death losses. This process also makes the crabs easier to handle. Crabs cannot survive when the temperature reaches 80 degrees. These critical factors make air cargo an attractive and, in some cases, the only alternative for long distance shipments.

When moving live crabs by air, time is of the essence. The success of the operation entails cooperation and coordination of both the pickup and delivery aspects of the shipment. A minimum amount of surface transportation time will add to the success of the venture. Live crabs should be transferred immediately to refrigerated trucks for distribution after arrival at the destination terminal.

In 1970, 5.5 million pounds of crabs were landed on the Texas coast with a value of more than $500,000. Figure 6-9 shows monthly average landing at Texas points. While crabs are harvested monthly, the period between May and September represents the peak of activity. Although crabs are caught from the Sabine Lake area to Baffin Bay, more than one-third of the total catch is from Trinity and Galveston Bays. Approximately 63 percent of the blue crab catch is within 125 miles of the Houston Intercontinental Airport.

In addition to seasonal variations in the landings of blue crabs on the Gulf Coast, the supply may vary from year to year. Yearly fluctuations are due in part to climatic conditions and primarily affect the size and meat yield of the crabs, rather than the number of crabs landed.

Air shipments would represent about half of the total landings of blue crabs if the expected quarter million pounds of blue crab shipments develop for May and June. This would also indicate that a minimum of 10 percent of the yearly total production is now moving by air to out of state markets. As previously mentioned, available air cargo space currently restricts the total volume of air shipments. One shipper on the Texas Gulf Coast has stated that he currently sells all of his crabs in Baltimore during May, June, July, and August and could sell more if air cargo space were available.

Published reports and interviews with crab shippers operating on the Gulf Coast were contradictory on several points regarding the potential growth in live crab shipments. There was, however, unanimous agreement that additional air cargo space was required, primarily into the Baltimore market. Also, the shippers emphasized the need for direct, nonstop flights as a critical factor in the successful movement of live blue crabs. Since most of the shippers were located south and southwest of Houston, they preferred the old Hobby Airport facility. At least an additional hour in transit is required to reach the Houston Intercontinental Airport. The shippers expressed a desire for some resumption of direct flights from Hobby. One shipper indicated a desire to ship from Corpus Christi Airport if the facilities and direct connections were available.

Delta Airlines is the leading carrier of live crabs due primarily to the direct Houston-Baltimore flight. Both Braniff and Eastern Airlines participate in the movement to other markets. Currently, Chicago, Philadelphia, Boston, and other major cities are receiving either live crabs or processed crab meat from the Texas Gulf Coast. There was general agreement that additional markets for Texas blue crab could be developed if more direct flights were available to major consumption points. Due to the characteristics of this commodity, air cargo is the only practical method of moving live crabs to out of state markets. None of the shippers have considered using surface transportation for moving live crabs over long distances.

One of the largest blue crab shippers on the Texas Gulf Coast was contacted during the study period. This firm is engaged in both the live and processed crab markets, and 80 percent of the processed crab meat moves by air cargo to out of state destinations. Currently, no live crabs are shipped by air by this firm. The high perishability and poor handling at the airport were cited as factors not conducive to moving live crabs by air. The shipper claimed that broken cartons were common occurrences. It was the opinion of management that a decline of live crab shipments can be expected in the near future. It should be pointed out, however, that this firm has never shipped live crabs and has no first-hand experience in this area. Also, the firm has extensive facilities for processing and packing crab meat for shipment to out of state markets. However, this is perhaps the largest firm in the state dealing in blue crabs and, as such, has a direct impact on the entire industry.

Other smaller dealers located up and down the Texas coast are currently moving live crabs by air, and those contacted expect this business to continue. The major complaint and constraint was, again, limited air cargo space. This problem is apparently serious enough to stimulate some discussion and consideration of air charter service. One shipper said that five small shippers in the upper coast were considering consolidation of shipments in order to use charter service. No decline in air shipments was anticipated, and the general opinion was one of continued growth over the next few years. It was mentioned that the volume of air shipments to out of state markets had approximately tripled in the past two years. It was estimated by one shipper that 75 percent of the live crabs went to out of state markets. There was no other indication of displeasure with air cargo service or an expectation of a decline in the amount of cargo moving by air. According to one shipper, quoted in Jet Cargo News, "selling crabs by air is a rising business."

Even when moved by air nonstop to destinations, perishability is an important factor to the industry. Loss due to death is approximately five percent. It is not uncommon, however, for loss to be as high as 10-15-20 percent. The death loss in transit is a function of handling prior to and during shipment and time elapsed prior to pickup at the terminal. Also, at certain times crabs are hardier than at other periods.

There is a tremendous potential for the development of additional markets for Texas blue crabs. In supplying out of state markets with either live crabs or processed crab meat, airlift is the only practical mode. The problems of adequate air cargo space must be eliminated, however, before the industry can reach its full potential. Also, handling procedures at the airports should be improved, and personnel should realize that they are handling a living creature that requires special care.

Shrimp. According to a spokesman of the Texas shrimp industry who was interviewed in Brownsville, Texas, air freight is not being used at this time by shippers in the state. Although shrimp is a high valued commodity and highly perishable, the ability to freeze the product, coupled with consumer acceptance of the product, have reduced the time requirements. Currently, trucks provide almost all of the transportation requirements of the industry, and little change is expected.

Shrimp possesses most, if not all, of the economic and physical characteristics usually associated with products which are a potential air cargo candidate. The fact that there is a potential is demonstrated in shipments of similar commodities in other areas. The level of usage which would develop if adequate facilities and service were available, or if the airlines could develop the market, is not known at this time. More important, however, is the marketing arrangements and characteristics of the industry.

Agricultural Products

Interviews were held with shippers, shipper organizations, state and federal officials, and others interested in the transportation of agricultural commodities. Objective data regarding air shipments by individual shippers are relatively scarce. The interviews were subjective and were used to determine which commodity groups were currently using air freight and to what extent. In addition, the future prospects for using air cargo were explored.

For some commodity groups, the current level of usage was found to be, at best, low, and, in some cases, nonexistent. The Texas production of most fruits and vegetables is a small percentage of total United States production. Also, many of the commodities with high production volumes are classed as "hardware" items; that is, they are relatively nonperishable and low valued.

Strawberry Growers. No Texas strawberries are presently being shipped by air; however, some Mexican strawberries are air shipped from Texas.

Historically, strawberries have been the major agricultural commodity adaptable to air lift. This is a highly perishable commodity with a high economic value which is produced in practically all states.

California is the leading producer of strawberries and the leading user of air cargo in moving agricultural commodities. California has long recognized the advantages associated with air cargo and makes extensive use of this facility. The State is in a unique position of having a long growing season, the right climate, and a good supply of labor. The intensive cultural practices yield a high level of production.

At one time, Texas produced a significant volume of strawberries in the Lower Rio Grande Valley and below San Antonio in Atascosa County. The current commercial strawberry production in the State is centered on approximately 200 acres in Atascosa County. The yield per acre approached 2,500 pounds compared with 9,000 pounds per acre in California. Gross revenue is estimated at $875 per acre, and production costs at $675. Net revenue is approximately $200 per acre. The entire Texas production is currently marketed in San Antonio and Houston.

Texas producers would have an advantage in national markets with increased production since the season follows Mexico and leads California. It is estimated that an additional 1,000 acres of strawberry production could be reasonably expected if certain of the institutional and technological constraints were removed or overcome.

Labor is the constraining factor to increased strawberry production in the State. Development of a mechanical harvester would stimulate the strawberry industry and lead to increased acreage. According to the Assistant Horticulturist with the Texas Agricultural Extension Service, the commercial development of a mechanical harvester is 10 years away.

When and if strawberry acreage is increased, the Texas industry will be confronted with a problem of expanding current markets. In serving new markets, especially distant markets, air cargo will and should receive serious consideration.

It is concluded that at the present time the production and distribution of Texas strawberries is limited by nontransportation constraints.

Fruits and Vegetables. During the month of October, individuals connected with the fruit and vegetable industry in the Lower Rio Grande Valley of Texas were contacted. This group included shippers, shipper organizations, United States Department of Agriculture employees, and Texas A&M University personnel located at the research substation in the area. From these meetings, the following consensus concerning the current situation emerged:

(1) The current level of air cargo usage of agricultural commodities is almost nil.

(2) Most agricultural commodities produced in the area are not adaptable to air movement.

(3) The current rates discourage air freight.

(4) Airlines have not attempted to develop the market.

(5) Terminal facilities, service, and equipment are not conducive to air freight.

(6) Current practices by the shippers involve a surface movement to San Antonio or Dallas in order to make freight connections.

(7) Belly cargo is not considered satisfactory for certain commodities currently moving by air.

(8) Some shipments are made using charter operations out of McAllen.

(9) Logistical problems discourage use of air freight.

(10) Good future potential if deficiencies in the system can be corrected.

This list indicates that the shippers feel that improvements by the airlines regarding service, equipment, schedules, and other areas are needed before a high level of activity is achieved. However, it should be pointed out that the shippers already are served by a relatively adequate surface system that meets their basic requirements better than air freight would in the near future. This is due primarily to the commodity mix of the area and the established distribution pattern. The relationship of surface and air rates appears to play a major role in the decision process. An increase in surface rates with no increase in air rates would improve the position of air carriers.

Commodities such as strawberries, asparagus, peppers, and tomatoes imported from Mexico also have air movement potential, and some (although volume is small) currently move by air. Shippers on the United States side of the border who market and distribute Mexican strawberries were contacted, and they felt that air shipments had benefited their operation. However, unless they generated sufficient volume to charter a flight, they had to move the produce to either San Antonio or Dallas for freighter service to their markets. Their experience with "belly cargo" on passenger flights from the area had been unsatisfactory and resulted in damage, delay, and pilferage.

Currently, a newly developed strain of cherry tomatoes is being grown and marketed in the Rio Grande Valley. This item is adaptable to machine harvesting and may revitalize this segment of the industry which declined at the end of the "bracero program." The level of production at this time is low, but market research economists with the Texas A&M Experiment Station in Weslaco expect production to increase over the next few years. These researchers indicated that this commodity could be economically shipped by air, given consumer acceptance.

Livestock. The movement of high valued breeding stock, as well as show and racing animals, by air has been recognized as an economical and efficient method of transportation by the industry. While the movement of show stock and race horses is important, it is also extremely specialized.

Texas supplies a large percentage of breeding stock shipped to foreign markets. Interviews conducted with individuals connected with these types of shipments were held in South Texas and the High Plains. The number of shipments and their apparent success implies that these movements will expand in the foreseeable future. Of course, changes in the requirements of foreign buyers or institutional barriers could have an impact on this movement.

The feasibility of shipping cattle by air is amply demonstrated through observation of activity in this area. In recent months, major shipments of livestock have been made in Amarillo, Dallas/Fort Worth, and Houston; others are currently scheduled. These have all been reported in newspapers and magazines and on television. Undoubtedly, other shipments of less significance have been made during this time.

Livestock shippers, when contacted, were quick to point out the advantage of moving cattle, especially high priced and pure bred breeding stock. A spokesman for the feedlot industry pointed out the air movement of feeder calves from the southeastern United States to High Plains feedlots has been discussed. Rapid expansion of this industry has increased the demand for these calves, and buyers are forced to move farther out for their supplies. The surface movement of these calves into Texas results in stress on the animals and an unacceptable death rate.

Of primary concern to shippers of livestock is the availability of facilities at air terminals. Because of various export requirements, extensive facilities are usually required at terminals where export shipments take place. However, in providing facilities for livestock, it should be pointed out that this is a shipment completely different from general cargo and requires unique handling and unique facilities.

Processed Beef. During this phase of the study, the potential for moving processed beef by air was explored. According to individuals in the industry and airline personnel, only a small amount of beef currently moves by air. Firms in the meat packing industry are located in all areas of the State and distribute within a defined area. However, the growth of feedlots in the High Plains region has been accompanied by an increase in packing house capacity in that area. Many of the firms which have come into the area have a wide distribution pattern.

According to individuals contacted, processed beef moves by surface modes. The current rate schedules of the airlines are not attractive to meat packers. Although this commodity, like others discussed, has all the physical and economical characteristics adaptable to movement by air, the market has not developed. Time saving is not considered an advantage for air shipment of processed beef, and surface modes allow some aging in transit. The export of United States beef has usually been to hotels frequented by American tourists.

Origins and Destinations

The study was interested in learning from the air carriers the principal origins and destinations of Texas cargo, particularly on a commodity basis. Perhaps not surprisingly, the same cities were consistently mentioned as origins and destinations for all Texas stations. The old rule of thumb that 20 percent of the points account for 80 percent of the traffic appears to be valid for air cargo.

The CAB, in Docket No. 24322, has under consideration the "enactment of a new part...of the Economic Regulation to establish a system of reporting freight origin-destination (O-D) traffic movement by air carriers." If the procedures discussed in this docket are adopted, comprehensive air freight commodity flow data will be available in the near future. During the interview period, the airlines were preparing statements for CAB hearings and, in some cases, implementing procedures for collection of the requested data. For this reason and due to the fact that detailed origin-destination data were not considered essential for forecasting air cargo, the decision was made not to request the airlines to conduct or compile any special origin-destination data, but to limit the questions to major origins and major destinations.

The carriers were asked if they had conducted any origin-destination studies. It was hoped that such studies would combine commodity data with real origins and destinations. One carrier, Texas International, does have a computerized true-origin destination study. Some of the carriers have participated in the so-called "McDonnell-Douglas O-D Study" which gives data on on-line origins and destinations. (The cargo study team made a number of attempts to get access to the study, but neither McDonnell-Douglas, the CAB, nor any of the carriers would authorize access because of concern about proprietary interests.) None of the carriers had made studies linking the commodity composition of air freight with the origins or destinations.

Responses to questions on major origins and destinations, although dependent on the route structure of the particular airline, included the following non-Texas cities:

Albuquerque	Los Angeles
Anchorage	Miami
Atlanta	Milwaukee
Baltimore	Minneapolis
Boston	New York
Cape Girardeau, Mo.	Philadelphia
Cedar Rapids	Phoenix
Charlotte	Pittsburgh
Chicago	Portland
Cleveland	St. Louis
Columbia, Mo.	San Francisco
Denver	San Juan
Detroit	Seattle
Greensboro	Tampa
Greenville	Tulsa
Hartford	Tucson
Honolulu	Washington
Kansas City	Waterloo, Iowa

The cities of New York, Philadelphia, Los Angeles, San Francisco, Chicago, Atlanta, and Miami were consistently mentioned for both inbound and outbound freight.

No estimates of volume of traffic between particular city pairs were attempted. As indicated previously, for a particular airline the route structure from an airport plays the deciding role. For example, Eastern indicated Miami, San Juan, Atlanta, Charlotte, and Jacksonville as the top five markets out of Corpus Christi. Similarly, Frontier indicated El Paso, Lubbock, Amarillo, Midland, and Albuquerque as the top five markets out of Dallas. The "McDonnell-Douglas O-D Study" gives a share of the market estimate for city pair routes for those airlines participating in the survey. Again, this is apparently proprietary information, and estimates of city pair volumes will not be available until implementation of the proposed CAB surveys.

The destinations mentioned in the several shipper surveys have been summarized above. Since responses were uneven and showed a tendency toward high levels of aggregation (United States), they are not relisted here.

In the Bluebonnet five percent sample study it was possible to estimate percentage of weight going to and coming from each United States region and outside the country vis-à-vis Houston. This distribution is shown as follows:

	Percentage of Weight	
Region	Outgoing	Incoming
New England	2	19
Middle Atlantic	34	33
East North Central	26	21
West North Central	5	3
South Atlantic	2	9
East South Central	2	1
West South Central*	4	1
Mountain	1	1
Pacific	12	11
Foreign	12	1

*Texas in this region.

Small Shipments

Introduction

The Air Cargo Study Work Statement calls for an attempt to develop time series on "small package" shipments. For a number of reasons, this was not feasible in a satisfactory degree of accuracy. It is possible, however, to provide a frame of reference for putting approximate bounds on the problems. Small package air shipments lie at the extreme end of the size distribution of air shipments. They are significantly different in their handling requirements in many respects than other small shipments.

This discussion explores the magnitude of small shipments in the United States and in Texas. It analyzes some of the special implications in the use of small shipment air cargo in distribution and the types of services required. It provides an approximate definition of "small package." This section discusses some special characteristics of small package shipping and some rate data. It discusses services available. Rough estimates of histories of package originations for Texas are made.

Magnitude of Small Shipments in the United States Domestic Air Carriage

Air cargo carriage is predominately small shipment carriage. This fact stands out clearly for manufactured goods air shipments covered in the 1967 Census of Transportation as shown in Table 3-18. The Texas Air Cargo Study's surveys of manufacturers, florists, and industrial/research labs displayed distributions of high frequencies of shipments in the lower weight classes. Air shipments in total also follow similar patterns, as shown in a recent airline survey and reported in a July 1970 magazine article (See Table 3-18):

> "A quick glance at a tabulation that was part of a recent airline freight rate hearing shows where a large part of the problem is. Among a total of nine trunk air carriers, more than half their traffic, over the one-week period surveyed, was in the weight category under 100 pounds."[1]

1/ Howell, B. E., "Too Many Small Shipments," Distribution Worldwide, July 1970, p. 31.

Table 3-18

U.S. SUMMARY--Percent Distribution of Weight of Shipment by Means of Transport: 1967

Weight of shipment	Number	Percent distribution by means of transport							
		All means of transport	Rail	Motor carrier	Private truck	Air	Water	Other	Unknown
TONS OF SHIPMENTS	(thousands of tons)								
Total	1,242,455	100.0	34.2	27.5	13.8	0.1	24.1	0.2	0.1
Under 50 pounds	1,027	100.0	2.5	39.2	12.7	5.1	.1	40.2	.2
50 to 99 pounds	1,271	100.0	3.3	63.7	18.9	3.0	.1	10.7	.3
100 to 199 pounds	2,880	100.0	2.9	71.3	19.9	2.0	.1	3.6	.2
200 to 499 pounds	7,767	100.0	2.7	74.7	19.2	1.2	.2	1.8	.2
500 to 999 pounds	9,127	100.0	2.9	74.1	20.5	.9	.2	1.2	.2
1,000 to 1,999 pounds	12,333	100.0	2.7	71.6	23.8	.5	.3	.9	.2
2,000 to 2,999 pounds	10,533	100.0	7.1	65.2	25.9	.4	.3	.9	.2
3,000 to 3,999 pounds	13,119	100.0	24.1	58.5	16.3	.1	.3	.6	.1
4,000 to 4,999 pounds	10,315	100.0	20.0	57.6	21.3	.1	.2	.6	.2
5,000 to 9,999 pounds	28,204	100.0	6.0	57.9	34.7	.1	.3	.9	.1
10,000 to 19,999 pounds	57,175	100.0	11.7	45.0	42.1	-	.3	.6	.3
20,000 to 29,999 pounds	67,275	100.0	14.5	51.0	33.8	-	.3	.3	.1
30,000 to 39,999 pounds	105,984	100.0	14.6	54.4	30.3	-	.3	.3	.1
40,000 to 49,999 pounds	157,076	100.0	11.3	59.8	28.2	-	.5	.1	.1
50,000 to 59,999 pounds	62,494	100.0	34.8	45.7	18.9	-	.4	.1	.1
60,000 to 69,999 pounds	36,058	100.0	74.9	19.2	5.0	-	.5	.1	.3
70,000 to 79,999 pounds	34,778	100.0	84.9	11.0	2.9	-	1.0	.1	.1
80,000 to 89,999 pounds	39,291	100.0	89.5	8.1	1.8	-	.5	-	.1
90,000 pounds and over	585,748	100.0	43.2	4.4	1.6	-	50.7	-	.1
TON-MILES	(millions of ton-miles)								
Total	586,089	100.0	39.9	15.9	4.5	0.1	39.3	0.2	0.1
Under 50 pounds	614	100.0	4.1	39.7	2.3	9.7	.6	43.3	.3
50 to 99 pounds	677	100.0	6.3	69.4	4.4	6.0	.7	12.9	.3
100 to 199 pounds	1,431	100.0	6.2	78.3	5.3	4.0	.8	5.2	.2
200 to 499 pounds	3,600	100.0	6.3	81.5	5.8	2.4	.9	2.9	.2
500 to 999 pounds	3,980	100.0	6.9	80.4	7.1	2.0	1.2	2.2	.2
1,000 to 1,999 pounds	5,009	100.0	6.5	78.7	10.2	1.4	1.1	1.9	.2
2,000 to 2,999 pounds	4,085	100.0	13.9	69.6	11.3	1.3	1.9	1.8	.2
3,000 to 3,999 pounds	5,164	100.0	42.0	48.4	6.6	.3	1.5	1.1	.1
4,000 to 4,999 pounds	4,206	100.0	41.1	48.0	8.9	.3	.8	.8	.1
5,000 to 9,999 pounds	9,233	100.0	13.3	65.6	18.1	.3	1.4	1.2	.1
10,000 to 19,999 pounds	16,398	100.0	27.4	49.1	20.8	.1	1.4	.7	.5
20,000 to 29,999 pounds	21,286	100.0	31.6	48.5	17.2	-	2.0	.6	.1
30,000 to 39,999 pounds	34,140	100.0	30.9	52.0	15.6	-	1.1	.3	.1
40,000 to 49,999 pounds	38,465	100.0	28.9	49.5	18.7	-	2.6	.2	.1
50,000 to 59,999 pounds	18,386	100.0	69.0	22.6	7.1	-	1.1	.1	.1
60,000 to 69,999 pounds	18,175	100.0	89.1	8.3	1.5	-	1.0	-	.1
70,000 to 79,999 pounds	21,722	100.0	91.2	5.8	.9	-	2.1	-	-
80,000 to 89,999 pounds	25,254	100.0	93.9	4.5	.5	.1	.9	-	.1
90,000 pounds and over	354,264	100.0	34.4	1.4	.3	-	63.9	-	-

Note: Includes only shipments represented by bills of lading and invoices. Summary records which did not show individual weights of shipments are not included.

Source: U.S. Bureau of the Census, Census of Transportation, 1967, <u>COMMODITY TRANSPORTATION SURVEY: Part 1, Shipper Groups</u>, USGPO, Washington D.C., 1970.

The definition of "small shipment" in terms of weight is varied. According to a 1970 article[1/], motor carriers would call any shipment under 5,000 pounds a small shipment; and a prevailing industry definition is anything in less than truckload lots. The ICC uses a break at 10,000 pounds. If this is taken as the definition and 1967 manufacturing products shipments are representative of all shipments, then 100 percent of air freight should be "small shipments." The weight break in the Howell article quoted above is implicitly 100 pounds which reflects an airline perspective. Distribution Worldwide recently devoted an issue to small shipments in which the lead article[2/] defines small shipments as those under 500 pounds. Express should be over 98 percent, and the package component of United States mail is 100 percent under 500 pounds.

Small shipments are frequently referred to as the small shipments problem. They are costly. For the most part (see small package distribution below), they must involve the same fixed charges (shipping documents, billing, collection, etc., pickup and delivery); pilferage is easier than with large consolidated shipments; they tend toward significantly lower density, and so on. Many truckers tend to avoid carrying small shipments. Truck carriers allege that they lose money, as shown in a recent article by Barrie Vreeland.[3/]

> "Carrier-produced abstracts reveal that shipments weighing under 1,000 pounds actually account for about 84 percent of a general commodity carrier's total number of shipments, but only 20 percent of the total weight moved. The small shipments contribute only 30 percent of the revenues and result in operating ratios of about 105.6. These carrier data, while unofficially compiled, have been recognized by the Commission to form the basis for carrier allegations about rate inequities."

1/ Gifford, G. L., "The Small Shipment Problem," Transportation Journal.
2/ Dixon, James M., "Small Shipments - Big Problems," Distribution Worldwide, March 1972, pp. 33-36.
3/ Vreeland, B., "An Imaginative Possible Solution to the Small Shipment Problem," Transportation Journal, Winter 1971, p. 37.

Table 3-19

DEPARTMENT OF DEFENSE
FREIGHT TRAFFIC - CONTINENTAL UNITED STATES

FREIGHT TRAFFIC – CONTINENTAL UNITED STATES																
	DURING												CUMULATIVE			
	FISCAL YEAR 1971				QTR ENDING 30 September 1971				QTR ENDING 30 June 1971							
CATEGORY OF TRAFFIC AND METHOD OF SHIPMENT	NUMBER OF SHIPMENTS (Thousands)	TONS (Thousands)	TON-MILES (Millions)	COST (Millions)	NUMBER OF SHIPMENTS (Thousands)	TONS (Thousands)	TON-MILES (Millions)	COST (Millions)	NUMBER OF SHIPMENTS (Thousands)	TONS (Thousands)	TON-MILES (Millions)	COST (Millions)	NUMBER OF SHIPMENTS (Thousands)	TONS (Thousands)	TON-MILES (Millions)	COST (Millions)
FREIGHT TRAFFIC – TOTAL	1,726.2	23,638.7	12,607.1	$444.5	384.9	5,217.7	2,654.5	$99.9	418.3	6,182.2	3,143.9	$107.6				
A. VOLUME TRAFFIC	340.2	23,047.2	12,005.2	376.2	71.8	5,078.8	2,515.5	82.8	83.1	6,040.9	3,003.7	90.8				
1. RAILROAD (CL)	94.3	6,249.0	5,030.5	169.8	16.2	1,133.3	913.3	32.2	21.0	1,456.4	1,124.3	37.5				
2. HIGHWAY (TL, D'wgy, etc)	236.4	5,394.3	2,938.6	135.2	53.6	1,226.7	662.2	36.5	59.5	1,342.9	760.0	35.3				
3. WATER (Barge & Ships)	1.8	3,052.4	1,227.8	5.9	0.4	676.2	271.2	1.3	0.5	829.5	358.1	1.5				
4. CONTRACT AIR	b/	219.8	259.0	46.8	b/	45.3	50.3	8.5	b/	57.1	66.0	11.9				
LOGAIR		175.3	197.2	33.5		45.3	50.3	8.5		46.0	50.6	8.6				
QUICKTRANS a/		44.5	61.8	13.1		a/	a/	a/		11.1	15.4	3.3				
AIR CHARTER		0.1	0.1	0.1		c/	c/	c/		c/	c/	c/				
5. PIPELINE	4.1	8,103.8	2,513.9	16.7	1.0	1,965.2	610.7	4.0	1.1	2,345.2	682.6	4.1				
6. MIXED METHODS	3.7	27.9	35.4	1.7	0.6	32.1	7.7	0.3	0.9	9.8	12.7	0.5				
B. SMALL SHIPMENTS TRAFFIC	1,386.0	591.6	601.9	68.3	313.0	138.8	139.0	17.0	335.3	141.3	140.2	16.8				
1. RAILROAD (LCL)	0.6	1.0	1.2	0.1	c/	c/	c/	c/	c/	c/	0.1	c/				
2. REA EXPRESS	312.0	28.9	28.8	4.3	67.3	6.0	5.3	1.0	70.5	6.6	6.5	1.0				
3. FREIGHT FORWARDER	35.4	37.6	84.4	5.3	5.7	9.0	16.0	1.0	6.2	5.7	13.2	0.9				
4. HIGHWAY (LTL)	825.2	507.0	463.4	51.1	194.0	120.2	112.7	13.4	199.0	125.0	114.5	13.0				
5. AIR FREIGHT	160.2	15.7	22.7	6.5	36.6	3.3	4.7	1.5	45.5	3.6	5.6	1.7				
6. AIR EXPRESS	34.4	0.6	0.7	0.6	5.4	0.1	0.1	0.1	9.2	0.1	0.2	0.1				
7. AIR FORWARDER	5.9	0.3	0.5	0.3	1.1	0.1	0.2	0.1	1.6	0.1	0.1	0.1				
8. BUS	12.3	0.4	0.2	0.1	2.8	0.1	c/	c/	3.2	0.1	0.1	c/				

a/ QuickTrans data for Qtr ending 30 Sep 71 not available. QuickTrans data for Qtr ending 30 Jun 71 are estimated.
b/ Not applicable.
c/ Less than 50 Short Tons; 50,000 ton-miles; 50,000 dollars.

Source: Military Traffic Management and Terminal Service

Regulated truckers are by far the largest carriers of small shipments as defined by the ICC. Truckers (Class I & II motor carriers) carried 85.9 percent of small shipments in 1969, up from 81.3 percent in 1961. Rail had decreased to less than air freight in 1969. Air freight, plus air parcel post, plus REA air express carried just over two percent in 1969 (less than UPS), but up from .8 percent in 1961. However, in 1969 truckers accounted for about 60 percent of revenues from small shipment traffic, down from 62 percent in 1961. On the other hand, air freight moved to six percent of revenues in 1969, from 3.4 percent in 1961, and air parcel post to almost four percent from one percent (REA remained at about 1.4 percent.)1/

This indicates that air mode's share of the long-haul, small shipment market is much higher than indicated by total tonnage. The second part of Table 3-19 confirms this, showing air at about twice the percentage of ton-miles as of tons. Since about 66 percent of all shipping weight of manufacturers in 1967 was at distances under 500 miles, and air carriers' participation at these distances was virtually nil, they become a very important carrier of small shipments over 500 miles. With the growth exhibited thus far, airlines may become the dominant carrier of small shipments at distances greater than 500 miles between origins and destinations in reasonable proximity to air carrier airports.

There are indications that the carriers are not entirely comfortable in this growing role. Just as with the truckers, there is a feeling that small shipments are not contributing to earnings with present rate structures. Howell writes, 2/

1/ Incidentally, the ICC data show small shipment air freight in 1962 and 1969 to be 85 percent of total shown by CAB/FAA, but the Census of Transportation shows that almost all air shipped manufacturers are under the ICC definition. Also, the ICC shows REA air express shipments at 60 to 67 percent of "Express" shipments in the CAB/FAA data on originations. The difference might be explained by high levels of interlining on express shipments.

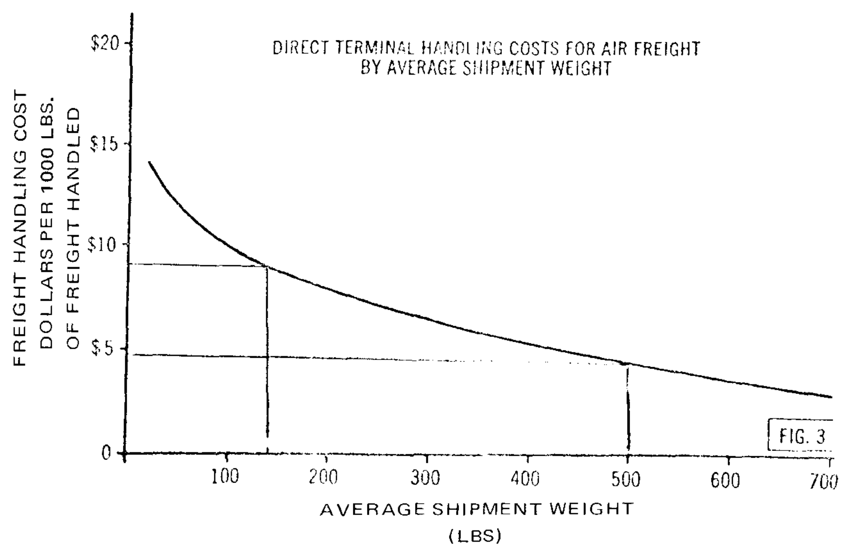
2/ Howell, Op. Cit., p. 31.

"There is a fair amount of opinion, both inside and outside the airlines, that the freight rate structure is out of balance, being too low in lightweight traffic and too high in the heavier freight...

...For instance, there is, at this writing, no weight break in the domestic airline rate structure between 100 pounds and 1,000 pounds. Let us assume - for convenience - that the cost component for office overhead - telephone, manifesting, accounting, billing, collection, etc. - at the first 100 pounds is $5. With no weight break between 100 pounds and 1,000 pounds, at 700 pounds that cost component would be multiplied seven times - but the true cost is still only $5 because that cost is constant for a shipment of any weight, etc. So beyond a certain point, depending upon your needs and inclinations as a shipper, this traffic becomes less and less attractive, if not downright prohibitive."

One answer for the airlines is to count on greater consolidation and shipment handling by forwarders. This would increase the share of small shipments handled by those with expertise and specialized facilities for consolidation. Carrier terminal and loading costs would be reduced considerably. In a study by the Austin Company[1/], the functional relationship between freight handling costs and shipment weight was derived as shown in Figure 3-11.

Figure 3-11



1/ Adams, A.T. "Ground Handling Problems and Their Costs", Airline Marketing and Management, June, 1968, pp. 24-27.

Thus, if shipment size to the airline could be increased from 140 pounds average (the average of air shipments carried by Bluebonnet Express July 1966 through March 1968) to 500 pounds as illustrated on this graph, the costs to the carrier could have been reduced from about \$9.00 per thousand pounds to \$5.00 per thousand pounds.

Small Shipments in Texas

The data base for assessing the magnitude of the small shipment problem in Texas is not as deep nor extensive as it is for the United States as a whole. The three surveys undertaken in this Air Cargo Study provide the most direct observations. The size distribution of air shipments for manufacturers and industrial and research laboratories (all usable responses) in the Texas Air Cargo Study is compared to the air carrier survey distribution as follows:

	Less Than 50 Lbs.	50-199 Lbs.	200-499 Lbs.	500-2,000 Lbs.	Over 2,000 Lbs.
Carrier Survey (Table 3-20)	54%			46%	
1970 Texas Air Cargo Study					
Manufacturers	64%	19%	11%	4%	2%
Laboratories	60%	20%	15%	5%	

Subject to qualifications on reliability of the Texas survey because of low response rate, it is clear that the small shipments problem impacts more severely on Texas air cargo movements than in the United States as a whole.

In the florists survey, the modal class (the class in which most of the shipping weight occurred) was in the 50 through 199 pound interval. This is expected to be comparable to floral shipments nationally.

A further appreciation of the size of shipment distribution in Texas relative to the United States may be gained from a carriers' survey of shipment size undertaken July 13-19, 1969 (summarized here as Table 3-20 and ordered by a carriers' percentage of Texas cargo originations to total). Texas International (TI) is at the top and also shows the highest percentage of shipments under 100 pounds. Braniff, the second most important in percentage and most important in total tonnage in the Texas market, shows slightly above the overall average. Continental ranked third in Texas cargo as percentage of total and ranks second in percentage under 100 pounds. This tends to confirm the hypothesis that Texas has a higher percentage of small shipments than does the United States.

Further insight into small shipment impact in Texas is gained by an analysis of Bluebonnet Express shipments into and out of Hobby International Airport for January through March, 1968. The distribution of number of shipments by size class deplaning and enplaning are graphed in Figure 3-12. Again, there is a broad picture much the same as shown by the survey.

A tentative summary may now be made of the small shipments picture:

- Air carriers, particularly the scheduled combination characters, are primarily small shipment carriers. While shipment size will increase as a result of increased consolidation services, air carriers will continue to be small shipment carriers (vis-à-vis surface carriers/transporters) through the 1990 time frame.
- Small shipments are "problem" shipments which means primarily that they are costly.

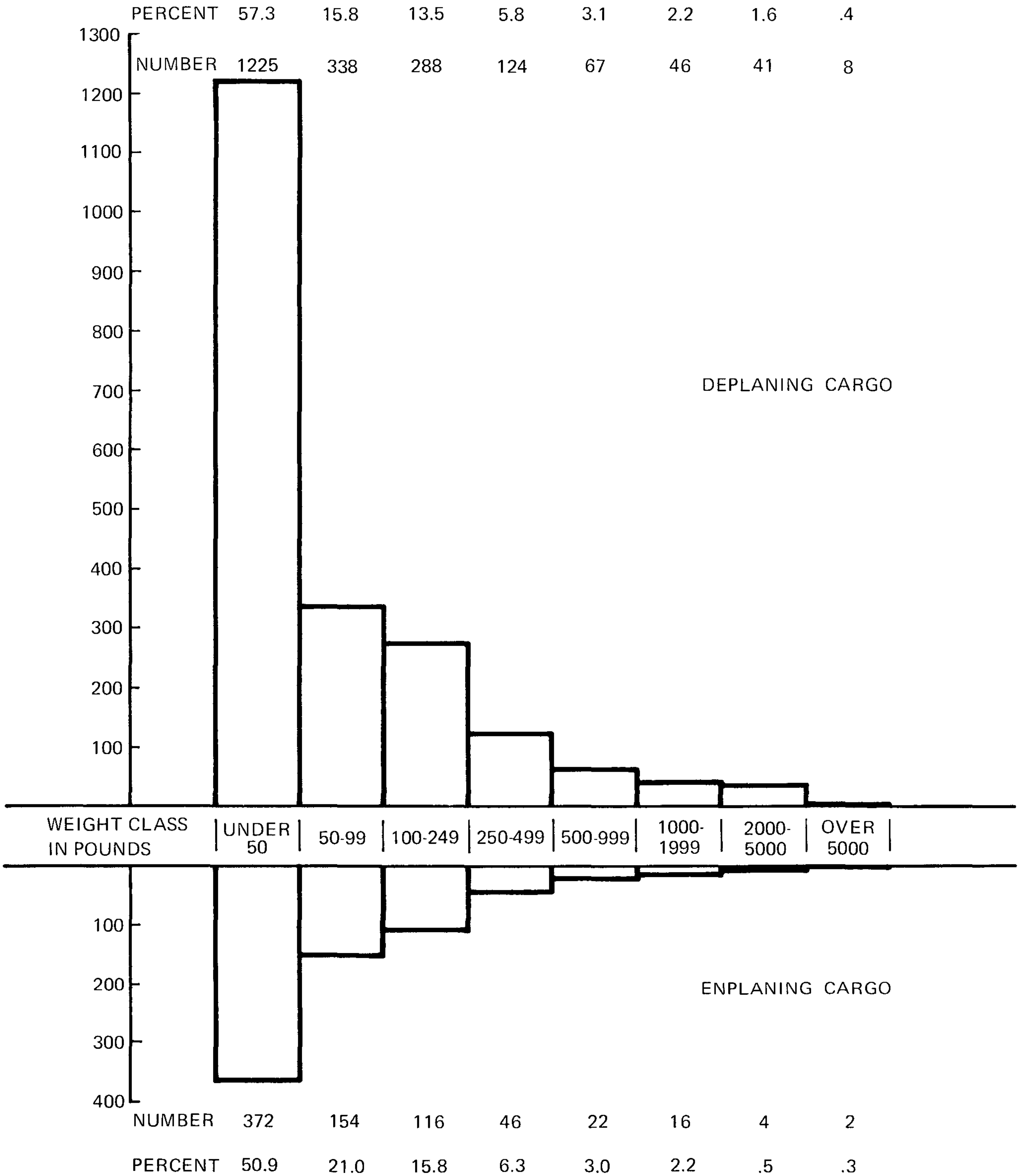


Figure 3-12

FREQUENCY DISTRIBUTION OF NUMBERS OF SHIPMENTS BY SIZE OF BLUEBONNET EXPRESS SHIPMENTS TO AND FROM HOBBY INTERNATIONAL AIRPORT, FIRST QUARTER, 1968

Table 3-20

SELECTED CARRIERS: AIR CARGO
(Number of Shipments by Weight of Shipment
and Percent under 100 Pounds)
July 13-19, 1969

Airline	1 to 99 Pounds Weight	1 to 99 Pounds Percent	Above 99 Pounds	Total	1970 Texas Cargo Origination as Percent of Carriers Domestic Origin
TT	2,174	70	939	3,113	65.5%
BN	8,375	55	6,861	15,236	32.0
CO	4,103	62	2,609	6,712	19.7
DL	9,033	54	7,722	16,755	6.8
AA	14,320	52	13,092	27,412	6.7
EA	10,129	53	8,811	18,940	4.9
TW	7,113	47	7,833	14,946	.1
UA	22,203	53	19,582	41,785	0
NE	1,170	51	1,120	2,290	0
NW	3,366	56	2,644	6,010	0
WA	4,609	61	2,942	7,551	0
EAF (Emery)	32,189	81	7,512	39,701	Unknown
Total	86,595	54	74,155	160,750	65.5

Source: Distribution Worldwide, July 1970, p. 35; CAB Docket No. 20398, Exhibit Texas International, No. I-1; Technical Note No. 21.

- Small shipments problem impact can be lessened by increasing the level of consolidation in air cargo processing.
- Very probably the small shipments problem impinges more heavily on Texas shippers and carriers serving Texas than in the nation as a whole.
- It follows, therefore, that Texas has proportionately more to gain from increased consolidation practices and organizations.

Consolidation Services with Reference to Texas

Freight forwarders constitute the major consolidation service available to air shippers. But there are a variety of pooling arrangements with other shippers or "shipper cooperatives" which may have a potential for reducing shipper costs; however, these seem more appropriate to surface shippers. A discussion of "hybriding," of which pooling is a special case, was contained in the special Distribution Worldwide issue on small shipments.[1/] This discussion focuses on forwarders.[2/]

United States airfreight forwarders are indirect carriers certificated by the Civil Aeronautics Board. Unlike the direct carriers, they enjoy no protected routes; consequently, forwarding is a highly competitive industry. They may charter but cannot own/operate carrier aircraft. Forwarders may publish tariffs between any two points; nationally if domestic, worldwide if international. They are brokers who, in effect, buy space at quantity rates and sell to shippers at rates and service levels which often offer an advantage over direct shipper-carrier dealings. In shipments under 100 pounds it is price advantageous. Forwarders offer a single standard of service including tracing of incoming and outgoing shipments. Pickup and delivery services are offered.

1/ Vreeland, Barrie, "The Age of Hybriding," Distribution Worldwide, March 1972, pp. 43-46.

2/ McNulty, J. J. (Board Chairman, Emery), "Where Air Forwarders are Headed," Distribution Worldwide, April 1971, p. 20. Much of this discussion draws from this source.

Forwarders have increased their participation in air cargo carriage over the past decade as well as their numbers and revenues by significant rates. These trends are quantified in Table 3-21. In 1962, forwarders originated less than 15 percent of total freight and express; by 1969, their share had risen to just under 25 percent. Cargo tons increased fivefold from 1961 to 1969, whereas gross revenues and operating profits increased almost tenfold. Air freight forwarding revenues increased a little more than eightfold.

Of the 182 forwarders in 1969, 65 grossed more than one million dollars from air freight forwarding. Of the 65, 14 showed financial losses, three of over one million dollars. Segments of the industry are warning of competition at destructive levels. Certainly, other things being equal, the more forwarders there are in a given market, the less they are able to create economies of scale by effecting larger point to point consolidations. On the other hand, the fewer there are the less pressures to pass on the economies to the shipper. No doubt, the Civil Aeronautics Board will be considering the level of restrictions on new certifications and merger rates of existing forwarders which are best for the country and air transport industry. Because Texas appears to have a special need for consolidation services, the Office of the Governor and the Texas Aeronautics Commission may want to study this sensitive issue carefully to bring its influence to bear for a solution in the Texas interest.

The break-even point between forwarders and carriers (around 100 pounds) appears much too low. The rate structure that permits this results in a burden of packages on the carriers in the 100-300 pound range which still have very high ground handling costs (see Figure 3-11 above). Promotion of rate schedules which encourage consolidation in this range appears to be desirable from present information concerning ground handling and loading costs.[1/] This is in line with the point Howell made in the paragraph quoted above.

1/ The CAB investigation of air freight rates and costs (Docket 22859) should provide a better empirical basis for setting an efficient break-even rate.

Table 3-21

AUTHORIZED AIR FREIGHT FORWARDERS; NUMBERS, TONS ORIGINATED, REVENUES AND PROFITS, AND SHARE OF TOTAL CARGO ORIGINATIONS
1961-1969

(Dollars in Thousands)(Tons in Thousands)

CY	Authorized Airfreight Forwarder Companies	Cargo Tons Originated	Gross Revenues	Airfreight Forwarding Revenues	Operating Profit 1/	Freight and Express Thousand Tons Originated Total System Operations	Forwarders as Percent of Total
1961	78	103.6	$ 159,701	$ 46,470	$ 12,128		
1962	93	124.5	165,513	74,528	10,846	839.1	14.8
1963	94	147.9	188,116	92,891	10,568	908.8	16.2
1964	100	174.1	238,242	112,116	21,730	1,096.3	15.9
1965	108	234.4	328,792	144,547	31,211	1,388.2	16.9
1966	137	304.9	434,880	185,908	38,494	1,589.6	19.2
1967	145	351.6	572,483	243,530	43,737	1,718.3	20.4
1968	171	501.3	1,155,676	298,324	83,930	2,034.6	24.6
1969	182	572.1	1,567,399 2/	389,598	120,652 2/	2,306.8	24.8

1/ Before taxes.
2/ Represents data reported by the top 43 airfreight forwarders only.

Source: Civil Aeronautics Board, Annual Report, FY 1970, and CAB/FAA, Airport Activity Statistics, 1962-1969.

Information on forwarder activity is much less available for Texas than for the nation. The air carrier survey and the manufacturers' survey will broaden the knowledge base. In the wholesale florists' survey, four of nine who responded to this question showed use of forwarder services at these rates: 20, 25, 80, and 100 percent. The industrial laboratories used forwarder services for an estimated 20 percent of their air shipments which were predominantly less than 100 pounds.

The carrier survey queried airlines serving Texas as to their forwarder relations. At one time, many carriers viewed forwarders as competitors, but there has been a recent and dramatic shift in this attitude to a view of forwarders as team members. One question asked for an estimate of total freight that is tendered by air freight forwarders. Responses varied from a high of 95 percent for Pan American in Houston to a low of two percent for Continental in Midland. Braniff estimated an average of 52 percent for their entire system. Emery estimated that 50 percent of all air freight is tendered by air freight forwarders. This estimate appears to hold reasonably well for Texas points. Individual responses are tabulated below:

Amarillo	CO	60%	El Paso	AA	30%
Austin	CO	20%	El Paso	CO	5%
Dallas	CO	70%	Houston	DL	20%
Dallas	EA	20%	Houston	CO	30%
Dallas	AA	30%	Houston	AA	50%
Dallas	OZ	51%	Houston	PA	90%
			Midland	CO	2%

Braniff (system)	42%
Texas International (system)	35%
Emery (industry)	50%

To the extent that they possess the charter, the various levels of government in Texas could enhance air freight service and costs by improving the environment for consolidation. Comparative rate structure analysis (between forwarders and carriers) in each airport community undertaking local long-range airport plans could provide specific guidance. Local chambers of commerce and industrial development organizations might explore opportunities for air shipper cooperatives.

Third level air carriers are coming into the air cargo picture more distinctly than in the past. The data histories on third level cargo movements are short and spotty. A brief series on Emery's payments to commuter airlines is illustrative of the growth.[1/]

1968	1969	1970	1971 Emery Estimates	Emery Forecast 1972
$240,000	$481,000	$1,000,000+	$2,200,000	$5,000,000

Cargo reporting by the third level carriers had not been required until recently. Compliance has been less than 100 percent since then. CAB publishes cargo and mail poundage for all commuter air carriers reporting as well as other data for Fiscal Years 1970 and 1971, as follows:[2/]

Item	FY 1970	FY 1971	Percent Change
Carriers Reporting	183	161	-12.0
Number of Flights	807,078	701,690	-13.1
Passengers	4,217,431	4,352,782	+ 3.2
Cargo (lbs.)	38,661,227	47,558,226	+23.0
Mail (lbs.)	69,532,851	82,186,205	+18.2

1/ Talbert, Ansel E., "Commuter Cargo and Mail Experience Boom in U.S.," Air Transport World, January 1972, pp. 30-32.

2/ Civil Aeronautics Board, "Commuter Air Carrier Traffic Statistics, Year Ended June 20, 1971," January 1972.

Much of the freight (and mail) carried by commuters is feeder traffic destined for distant line-haul points. No direct measure of size distribution of commuter freight traffic was available to this study. It is a highly probable assumption, however, that the percentage of shipments and percentage total weight of shipments in the smaller size categories (under 50 pounds, 50-100) are significantly higher than for the certificated route carriers. Cargo capacities of the aircraft are limited for one thing. And, opportunities for consolidation over the commuter routes are probably also quite limited. But as feeder continuation traffic, it contributes to consolidation in more economical lots directly within air carrier airports. This may underlie Emery's growing commerce with the carriers.

At this writing, there is a 12,500 pound "gross" weight limit on commuters and air taxis, a restriction that is 22 years old. The capability of these carriers in introducing economies, both in passenger and cargo service, is correspondingly limited. A CAB examiner "...has strongly recommended the removal of the 12,500 pound 'all up' weight limit..."[1/] The United States Postal Service has requested 6,000 pound minimum payload capacity for commuters.

It would appear that an upward adjustment in the capacity limit of commuter aircraft would hold a potential for improving Texas air cargo service and costs, particularly in improving the consolidation potential and taking better advantage of container rates on the line-haul.

Small Package Shipments

Small packages represent a special case of the small shipments spectrum and occupy most of the space in the lefthand extreme of the distribution curve. There is no solid, universally accepted definition of "small package." United Parcel Service, specialists in small package shipments, limits service to packages of less than 50 pounds and length plus girth not in excess of 108 inches. Bus Package Express has a 100-pound weight limit and a 141-inch length plus girth, with 85-inch length limits. United States Postal Service Parcel Post has a 40-pound, 84-inch

1/ Talbert, Ansley E., "Big Step Forward for U.S. Commuter Airlines Impends," Air Transport World, November 1971, pp. 26-27.

length plus girth limit, but Priority Mail (which is air parcel post) has a 70-pound limit. REA Express defines "small packages" (there are no limits of size) to anything that can move on a conveyor belt (their shipments average 100 pounds surface and 30 pounds air). This discussion bypasses the size question in making estimates of small package shipments by air, as discussed below.

Small Packages by Express. United Parcel Service has developed a high level of expertise in handling package shipments. The firm has been returning substantial profits in a field that the other truck common carriers have claimed as a loss activity. The reason is specialization and tailoring service to the distinctive character of small package movement. UPS has authority for interstate service fully in 39 states and partially in seven, and is applying for authority in all of the remaining contiguous 48 states. UPS offers an air service between the Pacific Coast states and 28 states in the East. A recent article quoted a paragraph from the UPS annual financial review which summarizes the efficiencies of specialized small package carriage:[1/]

> "Operating efficiency, not rate increases, is the best insurance for our further financial soundness." And such efficiency is the bedrock on which UPS has built annual small-package volume in excess of 500 million units - and a substantial operating profit. Other carriers marvel at how UPS can make "maybe three times as many deliveries a day in the same territory that we do." There are five basic reasons why: (1) Simplified billing (and prepayments); (2) simplified rate structure; (3) cost-oriented rates; (4) highly automated handling; and (5) freedom to locate terminals, to set up routes and pickup and delivery areas without regulatory oversight."

REA Express has been a small package/small shipment specialist over a considerably longer period than UPS. Yet its success has fallen considerably short of UPS. REA surface express share of ICC small shipments dropped from 3.15 percent in 1950 to 1.04 percent in 1969.

1/ Distribution Worldwide, March 1972, p. 52.

UPS in 1955 had .14 percent of the small shipments market, rising dramatically to 2.65 percent in 1969. As was seen above, the UPS limit is 50 pounds, but REA Express averages 72 pounds which may indicate that REA cannot specialize to the degree that UPS can.

REA Express has an exclusive contractual arrangement with the airlines to handle express shipments and jointly they (REA and the airlines) have a service called REA Air Express. Their share of small shipments (ICC) has risen gradually from .06 percent to .14 percent over the 1950-1969 period. Their share of the air portion of this traffic (ICC base) declined from 10.7 percent in 1962 to 6.8 percent in 1969. Air express originations nationally as a proportion of total air cargo (CAB) dropped from 11.9 percent in 1962 to 6.1 percent in 1969.

It may be conjectured that one of the compelling reasons for the exclusive arrangement with REA Express was to assure economies of scale in parcel air shipping. Certainly, UPS's success has been attributable in large measure to high volumes and resultant scale economies. In air cargo, concomitant high volumes were not forthcoming, preventing a UPS-like performance for REA Express. Recently, REA requested the CAB to (1) authorize it to become an air freight forwarder, and (2) designate REA Express as the exclusive air express shipper. In its brief, REA stated that the carriers and forwarders were diverting parcel business away from REA.[1/]

The express component of air cargo is lower proportionally in Texas than in the United States, though the gap is closing. This is illustrated in the following array showing ratio of express to freight $\left(\frac{E}{F}\right)$ and express to mail $\left(\frac{E}{M}\right)$ for Texas and the United States for the years 1962 through 1969.

		1962	1963	1964	1965	1966	1967	1968	1969
$\left(\frac{E}{F}\right)$	U.S.	.25	.24	.21	.19	.18	.16	.14	.13
	Texas	.14	.14	.13	.13	.12	.13	.12	.12
$\left(\frac{E}{M}\right)$	U.S.	.56	.57	.60	.58	.50	.35	.27	.26
	Texas	.31	.33	.37	.37	.32	.24	.20	.21

1/ *New York Times*, January 22, 1972.

Some Texas stations show a significantly higher dependence in air express than the state and national averages. Those more than 50 percent above United States 1969 express to freight ratios are: Austin, .34; Big Spring, .26; Borger, .39; College Station/Bryan, .30; Laredo, .20; Longview (etc.), .22; Lubbock, .22; Lufkin, .26; Paris, 3.73; Tyler, .64; Victoria, .32; Waco, .58; and Wichita Falls, .33. Dallas was slightly above the United States at .15, but the other three of Texas's larger hubs ranged from .06 to .09.

REA Express has telephone listings in most Texas airport cities (exceptions: Borger, Kilgore, Paris, and Victoria). Airlines handle REA Air Express at all airports where REA Express does not maintain an office. Frequently, REA maintains the only local non-airline listing under "Air Freight Forwarder" in the airport city's Yellow Pages, though they are not certificated by CAB as forwarders. REA plans to extend services to an additional 500 United States cities (the list should be published by mid-June, 1972) including several Texas cities.

Because of the relatively key role REA Express plays in some of the smaller Texas airport cities, the question arises as to whether granting of forwarder authority to them is favorable to Texas. On the surface, it would appear that the range of air cargo services to those cities in which there are no forwarder offices would be broadened (that is, if REA is not *de facto* a forwarder), and that rates in certain weight breaks would be reduced. But, the question bears further examination than was possible here.

Small Packages by United States Postal Service. The United States Postal Service is by far the largest single purchaser of air cargo services, the largest air shipper. It is also a large small package indirect carrier with simplified published post office to door rates. Under 20 pounds Air Parcel Post is the most economical way to ship by air. The United States Postal Service has classified Air Parcel Post under "Priority Mail" since 1968, a category which also includes heavy weighted air mail over seven ounces. Using the ICC data on Air Parcel Post and total originations of United States and foreign mail in scheduled domestic service of certificated route air carriers, and making estimated adjustments for 1968 and 1969 mail content in excess of seven ounces, a time series on parcel post originations may be made as follows:

(Thousands of Tons)[1/]

	1962	1963	1964	1965	1966	1967	1968	1969
ICC Air Parcel Post	31	34	37	43	52	71	123	174
Adjusting for Air Mail	31	34	37	43	52	71	91	111
Mail Originated CAB	241	247	263	310	387	547	737	773
Parcel Post as % of Orig. of Mail	13.0	13.6	14.1	13.9	13.5	13.0	12.4	14.3

In addition to normal air parcel post, the United States Postal Service has introduced a family of services to selected United States hubs, entitled "Experimental Express Mail." A door-to-door next morning service, guaranteed or money back is provided between about 200 hubs. The service probably has a very high information content as opposed to commodity packages. A rate from Los Angeles to Washington, D.C., with sustained daily demand is $25.00 up to a 10-pound minimum.

It was intended that the package or parcel component of the air-carried mail be estimated for each station in Texas. The basis for the estimate was to be the United States Postal Service "ODES" or origin destination survey. At this writing, legal counsel in the United States Postal Service is reviewing the question of releasing the ODES data.

1/ Weight of domestic airmail in 1969 was 78.9 million pounds and priority mail was 347.2 million pounds; sum of these 426.1.

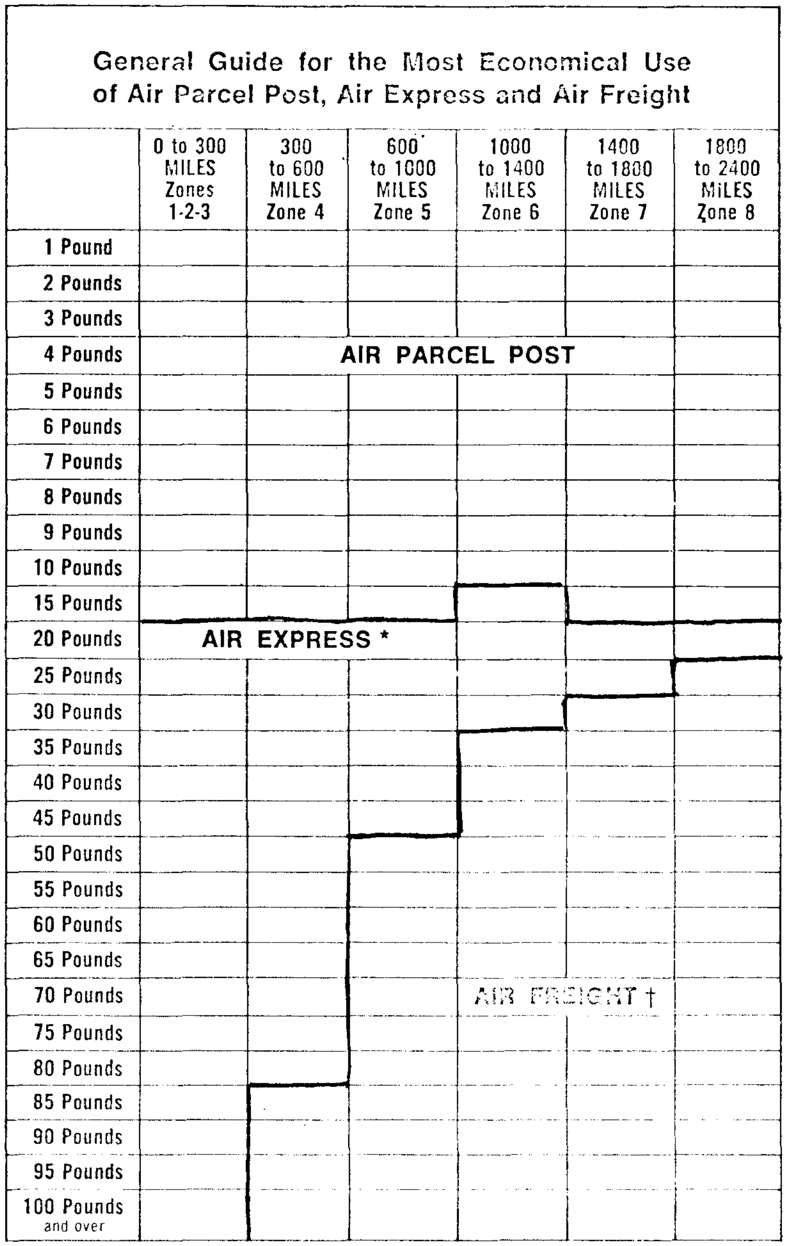
It is an assumption of this study that there is considerable variability in the per capita use of Air Parcel Post among the communities served by each airport. An analysis of FY 1970 "United States and Foreign Mail" originated domestically by certificated route air carriers per 1,000 population was undertaken. Considerable variability was displayed in total mail per capita. Dallas was 12.2 tons per 1,000 population (T/KP), twice the rate of San Antonio, the next highest Texas hub, and about three times the national rate. Dallas is a special case because of the high rate of interlining, particularly of mail. Thus, air mail from Abilene to New York would be counted as an origination of both Abilene and, in all likelihood, of Dallas Love Field. Dallas must also receive much feeder air mail by surface mode. San Antonio, at 6.1 T/KP, is probably subject to some interline effect.

Texas as a whole is 4.3 T/KP, compared to 3.9 for the United States. The Dallas/Fort Worth effect is so pronounced that air mail originations and populations there were netted from the state, giving an adjusted State value of 2.25 T/KP (A comparable figure for United States would need adjustments for all the key interlining hubs). All Texas Standard Metropolitan Statistical Areas (SMSA's) of over 200,000 population, except Beaumont/Port Arthur, were significantly higher than the adjusted state M/KP. Beaumont/Port Arthur, with only .5 M/KP, may very well have their air mail surface shipped to Houston Intercontinental Airport. No area under 100,000 population had a higher M/KP than Texas adjusted. Of the areas between 100,000 and 200,000 population, only two (Amarillo and Texarkana) were higher than the (adjusted) state, and eight were under. There is some discernible tendency for per capita air mail originations to vary directly with population. Through mail will tend to funnel through hubs with higher levels of service, and levels of service are highly correlated to population. The availability of the "true" origin destination data in the United States Postal Service ODES data by type of mail will enable the more accurate assessment of population and other socioeconomic variables on air mail and air parcel post use in Texas.

Small Packages by Air Carriers. Air carriers appear to be directly acquiring single parcel shipments of less than 50 to 70 pounds as air freight. REA Express alleges this to be the case for carriers and forwarders in its application to the CAB for exclusive authority in this area. The Air Cargo Study surveys indicate this. The seven-day survey cited above also points to this. A precise magnitude is not available. Figure 3-13 shows which service (air freight, air express, air parcel post) is most economical in distance-shipment size combinations. Air freight is the most economical in 19 percent of the cases under 70 pounds. An estimate of 20 percent of parcel post plus air express under 70 pounds nationally appears very conservative. Texas would be somewhat higher.

In addition to small parcels content of air freight, many carriers have introduced a baggage counter service for single package shipments. Exhibit 3-8 shows Air Cargo Guide's summary of this service. The maximum weight is 50 pounds, and dimensions (except Delta) are 30 by 30 by 30 inches. Prepayment is required, and usually air credit cards are accepted. Check-in time is 30, and sometimes 20, minutes prior to flight time. Pickup may be made by consignee at the baggage claim area 30 minutes after arrival. Of the certificated route airlines serving Texas, American, Braniff, Delta, Eastern, Frontier, Ozark, and Texas International have such a service in Texas.

Figure 3-13



* Includes pick-up and delivery. † Includes an estimated $5 additional for pick-up and delivery. This chart emphasizes rate advantage.

Source: Air Transport Association, <u>Air Cargo from A to Z</u>, Washington, D.C., May 1971 (from Delta Airlines, Inc.).

Exhibit 3-8

SMALL PACKAGE SERVICE

A specialized service to guarantee fast delivery of small packages from airport to airport, bypassing regular freight channels. Available within the U.S. including Alaska and Hawaii. (Governed by C.A.B. Tariff No. 140.) MAXIMUM WEIGHT: 50 lbs. MAXIMUM DIMENSION: 30 x 30 x 30 inches (except DL; see below). Single package per shipment, no lot shipments. RESTRICTIONS: Flowers, fruits and vegetables, live animals, meat (except DL, FL). Charges must be prepaid. CHECK - IN TIME: 30 minutes before departure of specified scheduled flight at baggage area or ticket counter. At destination available for pick up 30 minutes after actual flight arrival. No pick up or delivery to and from airports. For shipments not delivered on flights specified, a REFUND of $10.00 (or otherwise indicated) will be issued. Rates shown do not include 5% Federal tax.

PARTICIPATING CARRIERS:

ALASKA AIRLINES "Gold Streak Package Express"

Available between major AS cities. Direct flights only. MAXIMUM DIMENSION: 24 x 24 x 24. CHECK-IN TIME: 20 minutes before flight departure. RATES: $25.00 Interstate, $15.00 Intrastate. Alaska Airlines credit card accepted. (not shown in C.A.B. Tariff No. 140)

AMERICAN AIRLINES "Priority Parcel Service"

Available between any two AA cities. Direct flights only.

SAMPLE RATES:

	BNA	BOS	CHI	CLE	DAL	DCA	HNL	LAX	NYC	PHX	ROC	STL
BOSTON	20.00	—										
CHICAGO	—	20.00										
CLEVELAND	20.00	20.00	—	—								
DALLAS	20.00	30.00	20.00	25.00								
HONOLULU	—	60.00	50.00	60.00	—	—						
LOS ANGELES	30.00	40.00	30.00	30.00	25.00	30.00	—					
NASHVILLE	—	20.00	—	20.00	20.00	20.00	—	30.00			—	
NEW YORK	20.00	20.00	20.00	20.00	25.00	20.00	60.00	30.00	—		20.00	
PHOENIX	—	30.00	25.00	30.00	20.00	30.00	—	20.00	30.00		—	
ROCHESTER	—	—	20.00	20.00	25.00	—	—	30.00	20.00	—	—	
ST. LOUIS	—	25.00	20.00	20.00	20.00	—	50.00	30.00	20.00	25.00	—	—
TULSA	20.00	25.00	20.00	—	20.00	25.00	—	25.00	25.00	20.00	—	20.00
WASHINGTON	20.00	20.00	20.00	—	25.00	—	—	30.00	20.00	30.00	—	—

FOR ADDITIONAL RATES CONTACT AMERICAN AIRLINES

Refund According to Rates.

BRANIFF INTERNATIONAL AIRWAYS "Pronto Package"

Available between any two BN cities. Direct or connecting flights. RATE: $25.00 between any two BN cities, except $40.00 to or from Hilo/Honolulu.

DELTA AIRLINES "DASH-Delta Airlines Special Handling"

Available between any two DL cities. Direct or connecting flights. MAXIMUM DIMENSION: Length x Width x Height not to exceed 90 inches.

SAMPLE RATES:

	ATL	CHI	CHS	CLT	DAL	DCA/BAL	DTW	MEM	MIA	MSY	PHX	SFO
CHICAGO	25.00	—					—					
CHARLESTON, S.C.	25.00	25.00	—				25.00					
CHARLOTTE	25.00	25.00	25.00	—			25.00					
DALLAS	25.00	20.00	25.00	25.00	—	—	20.00					
MEMPHIS	25.00	25.00	25.00	25.00	20.00	20.00	25.00	—				
MIAMI	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	—			
NEW ORLEANS	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	—	—	
NEW YORK	25.00	—	25.00	20.00	25.00	20.00	—	20.00	25.00	25.00	25.00	
PHOENIX	25.00	25.00	25.00	25.00	20.00	25.00	25.00	25.00	25.00	25.00	—	
ST. LOUIS	25.00	20.00	25.00	25.00	20.00	—	—	25.00	25.00	25.00	—	
SAN FRANCISCO	30.00	—	30.00	30.00	25.00	30.00	30.00	30.00	30.00	30.00	—	—
WASHINGTON/BALTIMORE	20.00	—	25.00	25.00	25.00	—	—	20.00	25.00	25.00	25.00	30.00

FOR ADDITIONAL RATES CONTACT DELTA AIRLINES

EASTERN AIR LINES

Available on Air Shuttle flights between Boston-New York and New York-Washington. MAXIMUM WEIGHT: 20lbs. MAXIMUM DIMENSIONS: Length 26" Girth 40" RESTRICTIONS: Live animals. CHECK-IN TIME: until flight departure. RATES: $15.00 BOS-NYC or NYC-DCA. Credit Cards accepted. No refund issued. (not shown in C.A.B. Tariff No. 140)

FRONTIER AIRLINES "Courier Service"

Available between any two FL cities. Direct or connecting flights. MAXIMUM WEIGHT: Five lbs. RATE: $5.00 (not shown in C.A.B. Tariff No. 140.)

NORTH CENTRAL AIRLINES "VIP Service - Very Importand Package"

Available between any two NC cities. Direct or connecting flights. RATE: $20.00

NORTHWEST AIRLINES "EPS - Expedited Package Service"

Available between any two NW cities. Direct or connecting flights.

SAMPLE RATES:

	ANC	ATL	CHI	HNL	LAX	MIA	MLW	MSP	NYC	PIT	PDX SEA	SFO
ATLANTA	40.00	—										
CHICAGO	40.00	20.00	—									
HONOLULU	50.00	50.00	50.00	—								
LOS ANGELES	—	—	30.00	40.00	—							
MIAMI	50.00	20.00	25.00	50.00	—	—						
MILWAUKEE	40.00	20.00	20.00	50.00	30.00	25.00	—					
MINNEAPOLIS	40.00	20.00	20.00	50.00	30.00	30.00	20.00	—				
NEW YORK	40.00	—	20.00	50.00	30.00	—	20.00	25.00	—			
PITTSBURGH	40.00	25.00	20.00	50.00	30.00	30.00	20.00	20.00	20.00	—		
PORTLAND/SEATTLE	30.00	30.00	30.00	40.00	—	40.00	30.00	25.00	30.00	30.00	—	
SAN FRANCISCO	—	—	30.00	30.00	—	—	30.00	30.00	40.00	30.00	—	—
WASHINGTON/BALTIMORE	40.00	—	20.00	50.00	30.00	—	20.00	20.00	20.00	20.00	30.00	30.00

FOR ADDITIONAL RATES CONTACT NORTHWEST AIRLINES

Exhibit 3-8
(Continued)

SMALL PACKAGE SERVICE

OZARK AIR LINES "First Flight"

Available between any two OZ cities. Direct or connecting flights. RATE: $25.00 (Refund 12.50) Maximum value accepted. $500.00

SOUTHERN AIRWAYS "Lickety-Split Package Service"

Available between any two SO cities. Direct or connecting flights. RATES: $25.00. Credit cards accepted. PICK-UP TIME: 20 minutes after flight arrival.

TEXAS INTERNATIONAL AIRLINES "OTC - Over The Counter Service"

Available between any two TT cities. Direct or connecting flights. RATE: $25.00. PICK-UP TIME: 20 minutes after flight arrival.

TRANS WORLD AIRLINES "Next Flight Out"

Available between major TW cities. Direct flights only.

SAMPLE RATES:

	BAL	BOS	CHI	CVG	DEN	MKC	LAX	NYC	PHX	PIT	SFO	STL
BOSTON	—	—										
CHICAGO	20.00	20.00	—									
DENVER	—	—	20.00	—								
KANSAS CITY	20.00	—	15.00	—	—	—						
LOS ANGELES	30.00	30.00	30.00	30.00	30.00	25.00	—					
NEW YORK/NEWARK	—	15.00	20.00	20.00	30.00	25.00	30.00	—				
PHOENIX	—	—	25.00	—	15.00	—	15.00	30.00	—			
PITTSBURGH	—	15.00	15.00	15.00	30.00	20.00	30.00	15.00	—	—		
ST. LOUIS	20.00	25.00	—	15.00	20.00	15.00	30.00	20.00	25.00	20.00	—	—
SAN FRANCISCO	30.00	30.00	30.00	30.00	15.00	30.00	15.00	30.00	20.00	30.00	—	30.00
WASHINGTON/BALTIMORE	—	—	20.00	—	30.00	20.00	30.00	—	—	—	30.00	20.00

FOR ADDITIONAL RATES CONTACT TRANS WORLD AIRLINES

Refund According to Rates.

UNITED AIR LINES "SPS - Small Package Service"

Available between major UA cities. Direct flights only.

SAMPLE RATES:

	BOS	CHI	CLE	DEN	HNL	LAX	NYC/EWR	PHL	PIT	SEA/PDX	SFO/OAK	SLC
CHICAGO	20.00	—										
CLEVELAND	20.00	20.00	—									
DENVER	25.00	20.00	25.00	—								
DETROIT	—	20.00	—	25.00	—							
HONOLULU	60.00	50.00	—	—	—	—						
LOS ANGELES	40.00	30.00	30.00	20.00	40.00	—	—					
NEW YORK/NEWARK	—	20.00	20.00	30.00	60.00	30.00	—	—				
PHILADELPHIA	—	20.00	20.00	30.00	60.00	30.00	—	—	—			
PITTSBURGH	—	20.00	20.00	—	—	30.00	20.00	—	—	—	—	—
SAN FRANCISCO/OAKLAND	40.00	30.00	30.00	—	40.00	—	40.00	40.00	30.00	—	—	20.00
SEATTLE/PORTLAND	—	30.00	30.00	25.00	—	20.00	30.00	30.00	—	—	20.00	20.00
WASHINGTON/BALTIMORE	—	20.00	20.00	25.00	—	30.00	—	—	20.00	30.00	30.00	—

FOR ADDITIONAL RATES CONTACT UNITED AIRLINES

Refund According to Rates.

WESTERN AIRLINES "SPS - Speed Pak Service"

Available between all WA cities. Direct and connecting flights. CHECK-IN TIME: up to 10 minutes before flight departure.

SAMPLE RATES:

	ANC	BIL	DEN	HNL	JNU	LAS	LAX	MSP	PDX	PHX	SLC	SFO
BILLINGS	—	—										
DENVER	45.00	15.00	—									
HILO/HONOLULU	40.00	45.00	45.00	—								
JUNEAU	15.00	—	40.00	45.00	—							
LAS VEGAS	40.00	20.00	20.00	40.00	30.00	—						
LOS ANGELES	40.00	20.00	20.00	40.00	30.00	15.00	—					
MINNEAPOLIS/ST. PAUL	40.00	20.00	20.00	50.00	40.00	25.00	25.00	—				
PHOENIX	40.00	20.00	15.00	45.00	30.00	15.00	15.00	25.00	—	—		
PORTLAND	25.00	—	25.00	40.00	20.00	20.00	20.00	25.00	—	20.00		
SALT LAKE CITY	40.00	15.00	15.00	45.00	30.00	15.00	15.00	20.00	20.00	20.00	—	
SAN FRANCISCO/SAN JOSE	30.00	20.00	20.00	40.00	25.00	15.00	15.00	25.00	15.00	20.00	15.00	—
SEATTLE	25.00	—	25.00	45.00	20.00	20.00	20.00	25.00	15.00	25.00	25.00	20.00

FOR ADDITIONAL RATES CONTACT WESTERN AIRLINES

Refund According to Rates.

Source: Air Cargo Guide, April 1972.

Part 4

IMPACT OF AIR CARGO TECHNOLOGY

CARGO AIRCRAFT TECHNOLOGY

A review of current and anticipated developments in aircraft design applicable to air cargo technology was conducted to provide a sound technological base for subsequent economic analysis. Air cargo is still in an embryonic state of development where it is strongly influenced by both technological change and marketing innovation. A thorough understanding of the technical state-of-the-art, developing operational trends, problem areas, and constraints therefore is essential in determining how well, and within what time frame, the air cargo industry can achieve anticipated demand levels. The review was accomplished by a survey of available literature on cargo aircraft design and by discussions with the major United States commercial aircraft manufacturers.

Commercial aviation historically has been an industry paced by technology. As such, it has developed almost without constraint since the driving force has been open competition between the aircraft manufacturers to develop the most efficient vehicle possible within the state-of-the-art. Similarly, the airlines have reequipped their fleets with advanced aircraft to gain every possible advantage over their competition. This competitive buying often has been in excess of initial requirements and has occurred in a cyclical period of approximately 10 years. We are now entering an era, the early 1970s, in which the technical advances are, in total, greater than any prior period in commercial aviation history. New aircraft currently under development or those now being delivered to the airlines represent the culmination of over a decade of military and commercial research and development.

Aircraft Technology

Technical development recently has progressed in two directions: the development of wide bodied transport and cargo aircraft incorporating high by-pass ratio engines which result in greater aircraft cruise efficiencies - with potential operating cost reductions;

and the development of Supersonic Transports - offering significant flight time reduction. Both of these advanced aircraft types have several commonalities. They are much larger in size than current jet aircraft, ranging from 250 to 400 passengers and up to 125 tons of cargo and thus afford marked economy of size. Secondly, they require high levels of propulsive thrust - ranging from 150,000 to 250,000 pounds per aircraft. Although both types are designed to operate from existing airports, the batch loading of passengers and cargo, and the relatively high take-off noise levels will have a significant impact on both the airport and surrounding community.

Cargo aircraft technology has been spurred by two separate but related developmental efforts: (1) Military cargo aircraft R&D programs initiated by the Department of Defense; and (2) Commercial aircraft requirements of the airlines. In the past, the military aircraft requirements normally established a basic aircraft configuration, and the subsequent commercial aircraft was a direct derivative. Prime examples of this evolutionary development from military to commercial application are the Boeing 707, the Lockheed Hercules, and the proposed Lockheed L-500 (a derivative of the C-5A). Within the past decade, as the commercial jet aircraft markets developed, commercial aircraft have been designed specifically to airline specifications. Examples are the Douglas DC-8, DC-9, DC-10; the Lockheed L-1011; and the Boeing 727, 737, and 747 models. It is significant, however, that each of these commercial aircraft types was initially designed to passenger payload specifications, and the all-cargo, or convertible passenger-cargo (QC) versions were adaptations of the basic passenger aircraft design. Accordingly, the cargo versions represent some design compromise (e.g., cabin size, floor location, loading door location, sill height, etc.).

Similarly, cargo aircraft designed to military requirements usually incorporate a commercial design compromise such as excess landing gear weight (due to lower flotation load requirements of military aircraft), short field performance capabilities, etc. Even with these design compromises, there has been a steady and significant improvement in the performance, payload capability, and ton-mile cost of cargo aircraft over the past two decades. Block speed has increased by a factor of four; cargo payload has increased by a factor of over 10; and ton-mile cost has been more than halved.

Characteristics of Air Cargo

A discussion of the characteristics and composition of air cargo is appropriate since the payload characteristics are key elements in cargo aircraft design. Air cargo, as defined in the United States, includes freight, mail, and express. The relative distribution of United States air cargo is approximately 65 percent freight, six percent express, and 29 percent mail. This distribution has held fairly steady over the past decade with a slight increase in the percentages of freight and mail, and a proportionate decrease in express (from 12 percent in 1962 to 6.2 percent in 1969).

Air freight shipments are predominantly composed of high value, or highly perishable commodities. The average warehouse density is approximately 14.6 lbs./cu. ft. The average stacked cargo density aboard an aircraft, however, currently varies from approximately 7.3 lbs./cu. ft. for bulk cargo, to 12.4 lbs./cu. ft. for containerized cargo. This decrease is due to stacking inefficiencies within the aircraft. Both warehouse densities and stacking densities are expected to increase with time as aircraft become larger and the relative proportion of freight to express and mail increases. The belly compartments of new wide-bodied jet aircraft are designed for containerized cargo densities up to 20 lbs./cu. ft. The Boeing 747F all-cargo aircraft is designed for a palletized cargo density of 21.4 lbs./cu. ft. and a containerized density of 19.2 lbs./cu. ft. Aircraft performance, however, is calculated on an average cargo density of approximately 12.5 lbs./cu. ft. with an expected variation range of from 10 to 14 lbs./cu. ft.

Belly Versus Upper-Deck Cargo

Approximately 50 percent of all scheduled air cargo is now carried in belly compartments of passenger aircraft. With the advent of the current wide-bodied passenger aircraft, the B-747, DC-10, and L-1011, with their relatively large lower-deck cargo compartments, some industry observers have expressed concern over the effect that these aircraft may have on the future demand for all-cargo aircraft. The new generation of wide-bodied aircraft can carry from 26 to 30 LD-3 containers in lower-deck compartments. The LD-3 containers have a volume of approximately 158 cubic feet each (maximum weight approximately 2,800 pounds). The design of the LD-3 container has been standardized to permit interchange between the B-747, DC-101, and L-1011 aircraft. The resultant near-term over-capacity expected with these aircraft possibly could lead to lower tariffs on LD-3 containerized cargo. While this could result in increased air shipment of small low-density cargo, it does not satisfy the growing demand for high-density and outsize cargo which must be carried in all-cargo aircraft. Recent studies by Boeing, Douglas, and Lockheed, as well as those conducted by the airlines, have shown an increasing demand for all-cargo aircraft to carry the heavy and outsize "airfreight" as differentiated from the low-density "package type" cargo.

Based on available information it would appear that in the future the major portion of the "package type" cargo (except for high volume or specialized shipments) and mail will be carried in the belly compartments of passenger aircraft. The extensive existing route patterns and high schedule frequency of the scheduled airlines provides a high level of service for this type of cargo. A trend toward diversion of this type of business through air freight forwarders also appears to be developing, especially for less-than-container lots.

Conversely, air transport of high-density, high-volume, and outsize freight probably will be primarily accomplished by all-cargo aircraft (both scheduled and nonscheduled). With the advent of containerization and the large freighters such as the Boeing 747F, the character of air cargo may change drastically from "package" cargo to true "air freight." The B-747F could be the bellwether of the air cargo industry in providing the long awaited breakthrough into the realm of true freight haulage. Its operational success will be closely monitored by all segments of the air cargo industry - as well as by the trucking, rail, and maritime industries.

Containerization

The development and timing of future cargo aircraft is closely related to the development of suitable cargo containers. Containers can provide significant improvements in stacking efficiency (both within the container and in the aircraft), handling ease, intermodal capability, and theft security. The relative infancy of containerization, both with respect to air cargo and other shipping modes, is not fully realized. Intermodal (sea/land) containers were introduced only as recently as 1955, and the current IATA family of A, B, C, and D type air cargo containers were developed only within the past five years. LD-3 containers used in the B-747 have been in operational use only since 1970, and a suitable 8' x 8' x 10' or 20' intermodal container (air/land) has yet to be developed. Environmentally controlled air shipment containers also are still in the developmental stages. Future aircraft designs, therefore, are highly dependent upon container development and standardization progress.

Developing Aircraft Design Trends

Aircraft design trends and growth projections have been developed as an industry wide endeavor by the Air Transport Council of the United States Aerospace Industries Association.[1/] The following discussion of design trends has been directly excerpted from the referenced report:

- Air Cargo Unitization Trend

  With the introduction of jet aircraft it became necessary to reduce aircraft ground time and air cargo handling costs. Pallets and small containers were developed to achieve the required economies.

  As very large jet cargo transports enter service in the future, it will be possible for air cargo operators to offer shippers door-to-door movement of large quantities of air freight in standard containers. This capability

1/ CTOL Transport Aircraft Characteristics, Trends, and Growth Projections, 1st Revision, Aerospace Industries Association of America, Inc., Transport Aircraft Council, April 1970.

will result in cargo being consolidated at the shipper or other off-airport sites with the on-airport cargo terminal serving as a container throughput facility. These containers will be suitable for movement and interchange between air and surface vehicles.

- Gross Weight Growth Trend

  A continuing increase in transport airplane size and weight is anticipated. Airplanes with gross weights greater than one million pounds could be operational by 1980 and may exceed one and one-half million pounds by 1985. These weights are within the capability of present technology; therefore, size limitations will be influenced primarily by specific transportation requirements, operational economics, and airport/airways constraints. These projections should be considered when planning future underground facilities, overpass structures, and pavement bases that must accommodate the movement and parking of high gross weight aircraft.

- Cargo Payload Growth Trend

  Cargo aircraft have not yet reached the same point in their development as passenger aircraft. Cargo payloads, which include mail, express, and freight, are increasing in size and weight as larger aircraft enter service with the airlines. Future freighters will be specifically designed to carry payloads in excess of 200 tons.

  To ensure continued growth in payloads and the profitability of cargo operations, improvements in methods, equipment, and terminal facilities will be required in order to reduce cargo handling costs and aircraft ground time and to provide improved service for the shippers.

- Cargo Payload Growth Versus Gross Weight

  The projected growth of air cargo is expected to necessitate airplanes designed specifically to meet airline requirements for increased lift in the short, medium, and long-haul categories.

  It is assumed that current cargo airplanes will continue in operation for the next 10 to 20 years and will gradually be replaced as more efficient types become available.

  Many factors affect the ratio of payload to maximum ramp gross weight. A study of existing and projected cargo aircraft designs indicates that this ratio varies from 30 to 40 percent.

- Flotation Trend

  Wheel loads have been steadily increasing through the years. Wheel loads were determined by dividing 90 percent of the aircraft weight by the total number of main landing gear wheels. These increases, particularly in the last few years, have been obtained without exceeding runway strength requirements by multiple landing gear, wide lateral and longitudinal wheel spacings, and large tires. For aircraft with gross weights in the 500,000 to 800,000 pound range, aircraft manufacturers are attempting to provide landing gear configurations consistent with present pavement thickness requirements. Studies conducted by the manufacturers indicate that, for a limited number of locations, it may be more cost-effective to provide increased pavement strength for larger aircraft than to continue increasing the number of wheels to permit operation on today's pavements. Consequently, there will probably be selected airports at which increased pavement thickness will be required by 1980 in order to meet an increase in single wheel loads.

Future Cargo Aircraft Technology

Prior to the B-747F, all commercial cargo aircraft have been "cube limited." In other words, the relationship of the cargo compartment volume to the payload weight capacity is such that with the relatively low density of most air cargo, a fully loaded cargo aircraft normally would operate considerably below its payload weight capability - with a proportionate increase in ton-mile cost. This has caused aircraft manufacturers to study designs of extremely large long-range cargo aircraft of gross weights up to two million pounds. These aircraft would be designed to carry intermodal containers (8' x 8' x 20' and 40') and would be "uncompromised" designs. In other words, they would be designed specifically to air cargo requirements to obtain maximum operational and economic efficiency. While these aircraft are yet in the design study stage, there is little doubt that they will be operational prior to 1990. The initiation of construction, however, is dependent upon several factors: continued growth rate of the air cargo market; the development and operational acceptance of the large 8' x 8' intermodal containers, and the ability of the aircraft and engine manufacturers to finance such a major undertaking (development cost is estimated to be in the one to two billion dollar range); and the financial ability of the airlines or charter operators to purchase the aircraft. Advantages in the economy-of-size of these large aircraft, however, are such that their ultimate development seems assured. The design is well within the current technological state-of-the-art as exemplified by the military C-5A. Recent advances in power plant design, primarily the higher efficiencies of the high by-pass ratio engines, and in airfoil design (drag reduction at speeds approaching Mach 1) would most likely be incorporated and could result in performance and direct operating cost improvements on the order of 15 to 25 percent.

At the other end of the spectrum, there appears to be a requirement developing for a relatively short-range cargo aircraft capable of carrying intermodal containers (possibly up to 8' x 10' or 20') for collection and distribution networks. Range would be on the order of 100 to 1,500 miles. The market for the smaller aircraft would primarily consist of charter operators, second and third level airlines, and individual corporations capable of supporting their own air cargo operations.

All evidence indicates that within the foreseeable future, air cargo will be primarily carried by CTOL aircraft (Conventional Take-off and Landing) operating from established airfields. The technical, operational, and economic problems of STOL (Short Take-off and Landing) aircraft would seem to preclude their extensive use as cargo carriers within the 1970-1990 time frame. Similarly, supersonic aircraft, at least initially, will be primarily passenger carriers. Cargo compartments of presently planned supersonic types are primarily sized for baggage, although they do have a limited cargo capacity. Supersonic aircraft probably will carry only extremely high value time-sensitive cargo due to the high relative ton-mile costs.

A second generation of both wide-bodied subsonic and supersonic aircraft probably will be developed in the 1980-1990 time period. Those aircraft probably will have a 25 percent increase in both capacity and performance. Development of commercial Hypersonic Transports (HST) probably will not occur until at the year 2000 and possibly much later.

Current and Future Cargo Aircraft Characteristics

The FAA has recently compiled a summary of current and future cargo aircraft characteristics to aid airport planners. This summary is reproduced as Table 4-1.

Propulsion Technology

Development of the current generation of large wide-bodied jets and their all-cargo derivatives was possible only as a result of corresponding advances in propulsion technology. The development of the high by-pass ratio fan engine with its reduced specific fuel consumption and higher thrust-to-weight ratios was a significant breakthrough in engine design. Development of future large all-cargo aircraft is directly dependent on corresponding development of suitable power plants. Fortunately, technology is currently available to produce the larger higher

Table 4-1

CURRENT AND FUTURE CARGO AIRCRAFT CHARACTERISTICS

Time Period	Range Max. Miles	Cargo Capacity lb.	Weight: Empty lb.	Weight: Gross lb.	Speed: Max. mph.	Speed: Cruise mph.	Speed: Landing mph.	Physical Size: Wing Span ft.	Physical Size: Length ft.	Physical Size: Height ft.	Runway Requirements: Takeoff ft.	Runway Requirements: Landing ft.	Noise PNdB: Max.	Noise PNdB: Min.
1970-1975														
	7,000	259,258	314,690	775,000	640	625	174	195	231	61	11,500	7,400	112	108
	8,000	281,100	312,900	818,500	550	505	155	222	247	65	9,400	6,700	115	108
	4,000	33,000	68,292	125,850	358	250	138	117	109	28	6,200	6,400	95	85
	5,000	68,000	89,750	205,000	405	385	140	142	136	39	6,500	5,800	90	80
1975-1980														
	3,500	42,000	55,000	115,000	550	500	150	93	100	37	7,000	4,000	108	97
	7,000	270,000	300,000	800,000	650	630	170	195	230	60	10,000	6,000	108	97
	5,000	50,000	73,000	155,000	377	350	140	132	113	38	5,000	4,000	90	80
1980-1985														
	8,000+	450,000	750,000	1,300,000	650	630	170	280	290	85	8,000	6,500	105	95
	8,000	300,000	350,000	850,000	550	500	150	230	250	65	7,500	5,500	105	95
	5,000	65,000	85,000	170,000	390	370	140	135	120	38	5,000	4,000	90	80
	3,500	50,000	75,000	155,000	375	350	140	132	110	35	4,500	3,500	90	85
1985-1990														
	8,000+	700,000	800,000	1,700,000	650	630	170	300	300	85	8,000	6,500	100	90
	5,000	85,000	95,000	250,000	400	380	140	145	140	39	5,000	4,000	90	80
	3,500	70,000	85,000	100,000	375	350	140	140	125	35	4,000	3,000	90	80

Source: FAA

thrust engines required. Specific engine designs, however, must be sized to the aircraft and developed and produced concurrently with (or in advance of) the aircraft design. Engines with thrust ratings in the neighborhood of 50,000 to 70,000 pounds will be required to power the projected one million pounds plus gross weight cargo aircraft of the 1980s and 1990s.

Aircraft manufacturer studies have indicated that there appear to be no fundamental technical problems limiting the size of future cargo aircraft. As aircraft become larger, the possibility of nuclear propulsion becomes more attractive, especially in the 1.5 to 2.0 million aircraft gross weight range. Nuclear power plants have a fixed fuel and reactor shield weight with relatively unlimited power capability. Accordingly, aircraft operating efficiency and payload increases significantly with respect to engine weight at the higher gross weight ranges. A nuclear powered aircraft also would have practically an infinite range.

Development of nuclear power plants is entirely dependent upon military R&D funding, and if developed, probably would not be operational prior to the 1990-2000 time frame at the earliest. It is an interesting possibility, however, and not beyond the realm of technical practicality. Initial operation probably would be limited to military transport.

Inclusion of the above discussion is not intended as a consideration for present day physical or marketing planning, but is presented as an example of the relative infancy of current aircraft design and the almost unlimited future possibilities of applying known technology to future development.

Overview-Aircraft Design

- Conventional fixed wing aircraft (CTOL) will continue to dominate air transportation through the foreseeable future. Their high relative efficiency at the longer ranges (500 miles or more), as well as developing new technology, will permit them to be highly competitive with highway, rail, and water modes for transport of high value or perishable commodities.

- VTOL aircraft (other than helicopter) are expected to develop slowly due to the high cost of development and the inherent technical problems of stability and control, performance (and operating economics), and high noise levels. The rate of commercial development is primarily influenced by the level of military funding. No one type has been successfully demonstrated to date. VTOL aircraft are not expected to be commercially developed until the 1980-1990 time period.

- STOL (Short Takeoff or Landing) aircraft are technically feasible and may be suitable for some short to medium distance applications. They require only limited airstrips but have relatively high noise levels. Commercial development of high capacity relatively quiet STOL aircraft is anticipated within the next decade and could result in the phase-out of the present medium jets for short range operations.

- Large all-cargo aircraft, commercial counterparts of the C-5A military transport now undergoing tests, are currently in advanced design stages at the major United States airframe manufacturers.[1/] These huge aircraft, grossing up to 1.25 million pounds, are expected to be operational in the 1980-1990 time period.

- Utilization of SST aircraft on domestic routes is anticipated to develop slowly, and is dependent upon development of satisfactory methods of reducing sonic boom. The SST offers greatest potential on overseas routes and should carry a large portion of international passenger traffic by 1990. Within the foreseeable future, SST aircraft will carry mail and baggage but relatively little freight.

- The present subsonic jet cruising speed of 500-600 mph is not expected to increase significantly over the next two decades. Departure and arrival times of scheduled aircraft therefore should not change significantly, except where SST equipment is used. All-cargo aircraft will continue to operate primarily at night to provide overnight service.

1/ However, initiating beyond the design stage are being held in abeyance by all major United States aircraft manufacturers.

AIR CARGO HANDLING TECHNOLOGY

A survey of the literature on ground handling technology applicable to air cargo was conducted to provide background information on the changing level and character of air freight distribution. The major U.S. cargo aircraft manufacturers were contacted with respect to current and future planning of cargo handling systems and devices.

The survey disclosed that although many advances in air cargo handling technology have been made by commercial manufacturers and airlines, the majority of aircraft and related cargo handling advances were developed under military supported research and development programs. The handling concepts and equipment were subsequently adapted to commercial use. This trend will probably continue in the foreseeable future, since the commercial air cargo industry still has not matured to the stage where it can fully support the required technical development. Much progress, however, is being made by private industry, including the aircraft manufacturers, airlines, and private suppliers.

Military Development

The 463L materials handling system developed by the USAF pioneered the use of air cargo pallets and related handling devices. The 463L system now in use by the Air Force exploits five separate but interdependent families of equipment. The system provides minimum aircraft turnaround service both under normal peacetime operations and under austere emergency or wartime conditions without the use of prepositioned equipment. The existing 463L system is compatible with surface transportation modes as well as with various side-loading and end-loading aircraft and is designed for both field and terminal loading.

An advanced 463L system also is under development by the USAF. This system, designed under contract to major U.S. aircraft and equipment manufacturers and systems research organizations, is oriented toward providing a ground cargo handling capability compatible with the C-141 and C5A cargo payload and turnaround requirements.

Similar commercial design requirements are applicable to the commercial air cargo terminals needed for the new generation of wide-bodied cargo aircraft such as the B-747F, the DC-10C, and future large cargo aircraft.

Research and development in the field of containerization of air cargo is being conducted by the United States Army Mobility Equipment Command Research and Development Command at Fort Belvoir, Virginia. This effort is primarily oriented toward materials research and construction methods which are fundamental to development of low tare weight containers. The ultimate goal of the research program is development of an intermodal container with a tare weight of 1-1/2 to 2 pounds per cubic foot of usable volume. Current containers have a tare weight ratio of approximately four to one.

Commercial Development

There are many facets to commercial air cargo handling, including the paperwork functions of inventory, documentation, and facilitation. This discussion, however, is limited to only the technical and mechanical aspects of air cargo handling. These can be broadly categorized as follows:

1. Unitization and Containerization
2. Cargo Transfer Systems (Loading and Unloading)
3. Terminal Systems
4. Warehousing Systems
5. Airport Systems

The subsequent text is similarly categorized and consists primarily of excerpts from referenced documents reviewed during the literature search. The opinions and final overview are those of the author.

Unitization

Technology in air cargo unitization has had a much slower evolutionary growth than the payload growth and technology of aircraft design. Air freight unitization had its start with pallets which enabled a reduction of piece handling without a severe weight penalty. Surface freight, being less sensitive to tare weight penalties, could employ containers from the outset.

> The plywood air pallet was the first meaningful step in unitizing air cargo loads for ease of handling. Developed for the military in the mid-1950's, it preceded development of the highly successful 463L military air cargo pallets. The advances brought by the metal-faced sandwich construction 463L pallets included (1) restraint netting of the cargo loads to the pallets, (2) introduction of mechanical restraint latching of the pallet in the aircraft, and (3) aircraft roller conveyor systems, all of which substantially reduced aircraft loading/offloading time and related costs. These military pallets measure 88 x 108 inches full size and 54 x 88 inches for the half-size unit.1/
>
> Commercial air cargo pallets were developed during this same time period and became the physical base for the present day structural and non-structural commercial air cargo containers. The standard commercial pallets and containers measure 88 x 125 inches at the base and are used by the leading air cargo carriers in present day jet-freighter operations. When the pallets are used without a structural enclosure, pallet restraint nets are installed. 1/

An interesting new development is the use of shrink packaging for pallet restraint. In shrink packaging, a variety of transparent firms such as polyethylene or polypropylene are pulled over the pallet load. The plastic is then shrunk by heat providing a seal and protection against the elements.2/

Another packaging innovation applicable to air cargo shipments is the use of plastic air cell cushioning materials. The cushioning is made of two permanently laminated layers of Saran-coated polyethylene film. One layer is embossed with rows of cells that are filled with air. These air pockets, or cells, absorb shock and prevent damage. The material is

1/ Ashenbeck, L.B. and Bader, H.E., The Next Generation of Air Freight Containers, Douglas Aircraft Company Paper 5537, February 6, 1969.

2/ Shrink Packaging Adopted for Palletizing, Aviation Week and Space Technology, October 26, 1970.

extremely light and offers significant packaging cost savings in the shipment of fragile articles, such as instruments, electronics equipment, etc.1/

Containerization

> The primary motivation toward air cargo containerization has been economic. Costs can be reduced through minimizing handling, damage, pilferage, documentation, terminal space requirements and insurance rates. In addition, higher cargo density and revenue payload can be realized in the air mode through the use of containers because of better stacking efficiency.
>
> The adoption of containers for air cargo is only a start toward the realization of the full potential economics of cargo unitization. A growing recognition of the need to transfer unit loads between carriers has also become evident. This is particularly true in cases of international cargo traffic having extensions into the domestic market. In such cases, containers must be capable of being transferred from one carrier to another, frequently involving a change in mode of transport.
>
> To accomplish container transfer between carriers and between transport modes requires standardization of both the containers and the handling system in the transportation vehicles. Intermodal standardization of containers and handling features will require some compromises between transport modes and will probably involve a long evolutionary period.2/

At the present time there are over 500 air cargo containers of various sizes, shapes, and materials. Many of these are special purpose containers (i.e., garment containers, livestock containers, etc.); however, the large majority represent developments by individual airlines, manufacturers, and shippers.

Most air cargo containers can be categorized into three general types:

1/ Air Cell Cushioning Cuts Package, Shipping Costs, Transportation and Distribution Management, May 1968.
2/ Ashenbeck, op. cit.

1. Non-Structural

Non-Structural containers usually are modular packing boxes. Most containers of this type are relatively small and are designed to fit inside a larger standard container. Although considered non-structural, the containers are sufficiently strong to stand normal handling loads and can be stacked. The smaller "D" size containers can be carried in commuter type aircraft as well as within the bulk cargo compartments of larger aircraft. Their use should increase significantlly within the next decade. The Post Office is currently investigating their use as a standard method of packaging air mail and air parcel post shipments.1/

2. Semi-Structural

Developed in about 1965 for the upper deck of the B-707F and DC-8F aircraft, these shapes are rigid enough to support themselves but do not fasten to the pallet base. They are commonly referred to as "igloos," "cocoons," or "hula-huts." They are usually designed to individual airline specifications for a specific airplane type and have a relatively low degree of interchangeability. Containerized cargoes are loaded and off-loaded through the use of pallets which are secured to the aircraft and distribute the structural flight loads.

3. Structural

Structural containers are designed to FAA load requirements and must be certified by the FAA. These containers are secured to the aircraft by special restraint fittings and are capable of absorbing full flight design load factors. The LD-3 (Lower Deck) container carried in the lower lobe or "belly" of the B-747, DC-10, and L-1011 is an example of a structural container.

1/ "The D (For Diverse) Container," Air Cargo, January 1971.

Initial steps at standardization of air cargo containers were taken by the airlines in recognition of the pressing need for interchangeability of containers between airlines.

> The Air Transport Association (ATA) in the United States has adopted the current standard series of modular air containers. Type "A" containers, including variations such as the igloo and the hula-hut, and the half-size "B" containers are contoured at the top to fit the aircraft fuselage shape of current jet aircraft. Type "C" and "D" containers are modular to the Type "A" containers. This series of containers has a relatively low weight-to-cube ratio and has stimulated air cargo unitization. The International Air Transportation Association (IATA) has recently adopted a number of refinements in the container program for international air freight.
>
> The United States of America Standards Institute (USASI), Materials Handling Committee (MH-5), has been working toward a standard specification for an 8- x 8-foot cross-section maritime container capable of being handled also by truck and rail. Other standardized features such as the upper and lower corner fittings and gross weight have also been agreed upon. Initially, the air mode was excluded from the MH-5.1 specification. Recently, however, activity has been revived toward inclusion of the air transport mode within the specification.
>
> Meanwhile, the Society of Automotive Engineers (SAE) has adopted SAE specification AS-832 for an air-land demountable cargo container having the same exterior dimensions as the USASI MH-5.1 specification (8 x 8 x 10, 20, 30, and 40 feet). The SAE specification calls for a container having a lower gross weight than the USASI MH-5.1 Sea-Van Container because the density of air cargo has historically been lower than other modes. Conversely, the air-land container has a higher strength, which is needed to withstand the flight load factors involved with air transport.
>
> Today's series of standard air cargo containers have done much to stimulate industry growth. The introduction and use of standard 8-foot by 8-foot containers in the late 1970s, however, will enable air cargo to reap the full benefits of unitization. These containers, which will come in 10-, 20-, 30-, and 40-foot lengths, will substantially increase the average load density of air cargo and permit faster door-to-door service through

intermodal movement. These factors will reduce costs and improve quality of service. Major efforts by the International Standards Organization (ISO) are currently under way to develop international standards for 8-foot by 8-foot containers. The air-land container (ISO specification TC-20) and the sea-land container (ISO specification TC-104) will be much more compatible than present air-land and sea-land containers. However, a true intermodal (quad mode) container is not expected to be developed before 1980.

When this milestone is reached, the air cargo industry will then be able to function in its proper role as an intermodal freight transportation system. As can be seen from the above discussion, the present state-of-the-art of cargo containerization is fairly primitive, both technically and operationally. The technical problems associated with containerization are not difficult - the operational problems, including standardization of true intermodal containers, however, must be solved on an evolutionary basis and are considerably more difficult since they involve a certain amount of compromise.

Cargo Transfer Systems

Aircraft loading and unloading equipment usually is designed to the dimensional requirements (i.e., deck or sill height) of a specific airplane. Standardization of equipment, therefore, has been almost nonexistent. Only recently have equipment manufacturers attempted to develop units which achieve some degree of standardization through design versatility. Movable adjustable loading docks, aligning jacks, and scissors lifts are typical examples.

Some degree of mechanization also has been achieved in the development of aircraft pallet loading and unloading systems now in use at Los Angeles International Airport, San Francisco International Airport, Kennedy Airport in New York, and a number of foreign airports. The most recent designs incorporate some degree of automation.

Boeing initially designed a fully automatic loading and unloading system for the B-747F all-cargo freighter, but subsequently designed a more simple system as incorporated in the first B-747F for Lufthansa. The original system was considered too sophisticated and costly.

Terminal Systems

Air cargo terminal systems have been in operation only since about 1965. Design and operational data therefore are rather limited. The Pan American Airlines cargo terminal at New York Kennedy Airport was a major pioneering effort. Since that time, terminal systems of various degrees of sophistication have been installed at Atlanta, Los Angeles, Travis AFB, Brussels, and Copenhagen, to name a few.

Terminal systems usually include sorters, conveyors, and stackers. Most systems are mechanized and some are partially automated. Different design approaches have been taken by various equipment manufacturers, and the state-of-the-art is still fairly primitive - at least when compared to the degree of design sophistication in a modern jet cargo aircraft.

It is doubtful that a completely automated system can be designed to handle all types of packages, containers, outsize cargo, etc., which represent the present day air cargo spectrum. However, with the advent of standardized container sizes, full automation could be achieved and could result in a significant reduction of terminal handling costs in the future. Such systems could be designed using existing technology.

Warehousing Systems

Warehouse facilities are of lesser importance in air cargo handling than in other transportation modes since minimum door-to-door delivery time is the primary reason for air shipment of cargo. Warehousing, however, is still essential at major terminal points, especially international ports where a certain amount of delay is encountered in customs and agricultural inspection.

The air cargo warehousing function could be better described as primarily a classification system since pallets or containers must be classified or sorted according to destination and flight number. Air cargo normally is stored only for a very limited period. Warehousing requirements therefore consist either of sufficient floor area where cargo can be assembled according to flight, or a warehousing system where pallets or containers can be randomly stacked and can be selectively recalled when needed to load a specific flight. With the advent of fully containerized shipments and standard size containers, it becomes possible to mechanize the warehouse stacking system. Mechanized stacking systems have been installed at the Seaboard World Airlines Cargo Terminal at Kennedy International and at the Scandanavian Airlines Terminal at Copenhagen. This latter system utilizes a seven-story stacker.

Ultimately, when the large 8' x 8' AS-832 containers are in common useage, it will be possible to standardize on stacker designs. Complete automation of the warehouse function will then be possible. Computer controlled fully automated factory warehousing systems have been developed and are in operational use today. The Rohr Corporation has pioneered this development and is currently marketing the system. Although not specifically designed for cargo handling, it could be readily adapted to handle pallets or containers.

Airport Systems

Cargo facilities at major airports have developed on an evolutionary basis. Initially, the facilities consisted of only a truck loading/unloading dock, an open area or building where the cargo could be sorted and assembled (or broken down), and an apron area where the aircraft could be loaded using dollies or forklifts. Cargo facilities at the majority of medium and small hub airports are still in this initial stage.

The second evolutionary stage which has occurred at some major high activity airports was the designation of a special area on the airport devoted exclusively to cargo facilities. Each airline usually developed its own handling facility with the more sophisticated facilities incorporating mechanized loaders, conveyors, sorters, and stackers. The "Cargo City" at Los Angeles International Airport and the "Air Cargo Center" at Kennedy International are presently the most advanced examples of current airport cargo handling technology. The Kennedy Airport Cargo Center is perhaps the world's largest and most comprehensive.

Due to the ground traffic congestion in the vicinity of the major airports and the high cost of on-airport land, there has been a recent tendency to decentralize the cargo functions of an airport. The cargo assembly and breakdown functions have been relocated off-airport, usually in an area of the city close to the cargo origin points. Decentralization not only reduces cost but provides a significant reduction in ground access traffic as loads transported between the facility and the airport have been previously consolidated and require fewer trucks. The advantages of the trend toward decentralization of cargo consolidation functions are so great that it is anticipated that the majority of major hub airports will develop decentralized facilities within the next decade. A large decentralized consolidation facility recently was placed in operation by Emery Air Freight in New York City.

All-Cargo Airports

Airport planners long have advocated the development of all-cargo airports designed exclusively for air cargo. It was recognized that the functional requirements of a cargo airport are significantly different than those of a passenger airport and could be handled most efficiently at a separate facility; a corollary being the development of separate cargo and passenger depots by the railroads. In practice, however, until the air cargo industry develops from a "package" service to a "freight" service, it is not practical to separate the cargo and passenger functions. As previously noted, approximately half of today's air cargo is carried in the bellies of passenger aircraft. This state of developments is comparable to carrying express in the baggage cars of passenger trains. All-cargo airports most certainly will be developed in the future as the air cargo industry matures and the economics of cargo handling justify such action. This probably will not occur prior to the 1980-1990 time period.

An interesting possibility which has not been explored to date is the construction of a single landing strip adjacent to an agricultural or industrial area. This could be done with minimum expense since ground facilities would consist only of a mobile loader/unloader. All aircraft service and support functions could be handled at existing major airports. Field loading of produce or other products could be accomplished with minimum cost and time.

Overview - Cargo Handling Technology

- Palletization of deck-loaded air cargo will continue through the foreseeable future, especially for the smaller cargo aircraft.
- Containerization of air cargo is still in a relatively primitive stage of development - primarily with respect to container design, standardization, and shipper acceptance.
- Development of a true intermodal container with a tare-weight of two pounds/cu. ft. volume probably will not be accomplished until the late 1970s.
- Until containerization reaches a higher degree of standardization, air cargo handling systems will continue to be primarily mobile devices having high operational flexibility.
- Fixed mechanized cargo handling systems are relatively costly, and their cost can be justified only at a relatively few high activity airports. Most smaller airports will continue to utilize manual, or mobile, cargo handling equipment for at least the next 10 to 20 years.
- Technology exists today to develop completely automated mechanical cargo handling systems. Most components have been individually developed but have yet to be integrated into a complete "system."

- Development of a completely automated cargo handling system is dependent upon the following factors:
  1. Development and industry adoption of standard containers.
  2. Development of an all cargo aircraft capable of carrying the large 8' x 8' intermodal containers. (The Boeing 747F is the first aircraft with this capability.)
  3. Maturing of the air cargo market to the degree to which full automation is economically feasible - and advantageous.
- All-cargo airports probably will not be constructed prior to the 1980-1990 time period. Their development is dependent not on technology but upon economic feasibility.

COMPETITIVE TECHNOLOGIES

An investigation of competitive technologies of major significance to ground line-haul transport, preservation, security, and inventory was conducted. This investigation included all surface modes including highway, rail, waterway, and ocean shipping (but excluding pipeline). While the primary intent was to determine the competitive impact of these technologies on air cargo growth, it soon became evident that the various modes were not truly competitive, but were mutually interdependent. Each has its relative advantages and disadvantages, but none can by itself perform a complete transport service. The emphasis, therefore, has been placed on the intermodal and systems aspects of air cargo transportation.

Limitation of Various Modes

A comparison of the physical constraints inherent with each mode provides the best frame of reference for understanding the reasons why a "total systems" look is important:

- Maritime transportation is limited to ocean, coastal, or inland waterway routes and therefore can serve only coastal or inland cities bordering on a waterway.
- Rail transportation is limited to only those cities connected by a rail network. It cannot provide transportation between continents or across large bodies of water.
- Highway or truck transportation is limited to overland transport over a roadway network. As with rail transportation, it cannot provide transportation between continents separated by water.
- Air transportation has a significant advantage over other modes - its ability to fly airport-to-airport (point-to-point with VTOL) over great circle routes without having to go through coastal ports or intermediate transfer points. Air, however, is dependent on highway or rail transportation for the collection/distribution function.

While each mode may be competitive with one or more of the others over specific route segments and for specific types of cargo, they must be considered as a total system with respect to door-to-door service, either domestic or international. It follows, therefore, that the intermodal capabilities and interfaces between each of the various modes are key links in the system.

Modal Split

Data on the distribution of total worldwide freight traffic by mode is not readily available. Data for the United States domestic intercity public and private freight traffic are compiled by the United States Civil

Aeronautics Board. The 1968 United States intercity freight revenue ton-mile distribution was as follows:

Railways (including mail and express)	41.26%
Motor Vehicles	21.60%
Inland Waterways	15.65%
Pipelines (oil)	21.33%
Air (including mail and express)	0.15%

As can be seen, air accounted for only slightly higher than one-tenth of one percent of the total United States intercity revenue ton-miles.

The relative magnitude of the freight traffic also is important. Air carried only 2.9 billion revenue ton-miles in 1968, whereas the rails carried 756.8 billion, and motor vehicles carried 396.3 billion. Although the air cargo share is relatively insignificant at the present time, it has shown a much higher rate of growth. For example, the air percentage increased from .002 percent to .158 percent between 1939 and 1968, whereas the rails' share dropped from 62.34 percent to 41.26 percent. The motor vehicle share in that period increased from 9.72 percent to 21.60 percent - a significant increase, but at a much lower growth rate than air.

Modal Cost Comparison

Due to the complexities of rates and tariffs of the various shipping modes and their not-too-close relationship to actual costs, it is extremely difficult to compare costs except for specific commodities between designated points. Extremely wide rate variations also exist between short-haul, long-haul, and domestic and international freight traffic rates. For the purposes of this technical discussion, however, a broad generalization is acceptable. According to data compiled in a recent aircraft industry study[1/], air freight rates (airport-to-airport,

1/ Schriever and Seifert, Air Transportation 1975 and Beyond: A Systems Approach, MIT Press, 1967.

not door-to-door) average approximately 20¢ per ton-mile, whereas trucks average approximately 6.5¢ per ton-mile, and rail averages about 1.24¢ per ton-mile. The cost disparity between air and water transport would be much greater.

Significant gains have been made in the reduction of aircraft ton-mile direct operating costs within the past two decades due to advances in technology. Aircraft ton-mile D.O.C.'s have been more than halved in the past decade, and further reduction on the order of 10 to 20 percent is projected for the next generation of cargo aircraft in the 1980-1990 time frame. D.O.C.'s of the B-747F are in the neighborhood of three to 3.5¢ per ton-mile for a transcontinental haul which is approaching the D.O.C. range of highway transport. The above cost comparisons exclude the time factor which is a significant element in total distribution cost.

Technological Comparison

A discussion of the current state-of-the-art and anticipated developments in aircraft and air cargo handling technology was previously presented. A brief summary of the state-of-the-art of competitive modes is presented herein to provide a basis for comparison.

Highway Transportation

Several facets of highway transportation must be considered: the highway or roadway networks; the vehicles themselves; and the methods of operation.

Highway technology as exemplified by the newest Federal Interstate highways is quite far advanced with respect to civil engineering design. The United States Interstate Highway System, constructed within the past 15 years, represents perhaps the largest and most costly domestic construction program in history. This program, now nearing completion, has provided a highway network superior to any in the world. Future highway development in the United States is expected to be in the areas of increased capacity, safety, and reduction of maintenance. None of these should materially improve the competitive position of the trucking industry.

Motor vehicle technology also is representative of a highly advanced state-of-the-art. While technical development is progressing in the areas of improved piston engine combustion efficiency, turbine engines, and closed cycle engines, none of these (with the exception of the turbine power plant) is expected to have much impact on the motor vehicle's competitive position. The turbine power plant is quite far advanced technically and could result in some reduction in operating cost. Its general adoption by the trucking industry would appear to be at least 10 to 15 years in the future. Increases in power plant efficiency, however, tend to be negated by increasing environmental pressures to reduce the harmful exhaust emissions. Legal and highway safety standards impose strict limitations on increasing the size or capacity of highway transport vehicles. Major chassis and van development appears to be in the area of environmentally controlled and special purpose vans, including container carrier vehicles for transport of ISO containers.

The major competitive advance in the trucking industry is believed to be in the area of cost reduction through increased operating efficiency and tie-in with other modes (i.e., piggy-back rail, intermodal container haulage, and air/land bridge as discussed in subsequent sections). The trucking industry also is recognizing the importance of high standards of service and is capturing some of the air cargo market accordingly. It is in this area of increased level of service where major future competition is anticipated between air and long-range highway transport.

Rail Transportation

As with highway transportation, both the network and vehicles must be considered in a technological evaluation. The steel wheel on steel rail technology is not new but is to date the most efficient and least costly method of surface transportation. Although development is proceeding on air cushion technology (TACV) and magnetic levitation in the United States, Europe, and Japan, these technologies appear to have the most application to high-speed passenger systems and not to heavy freight line-haul - at least within the foreseeable future. The existing rail network within the United States is relatively old and is suffering from lack of maintenance. Now that the nation's rail passenger system has, in effect, been nationalized by the creation of AMTRAC, it is anticipated that additional federal funding may be applied to updating and improving the nation's road beds. This is essential prior to initiating higher speed passenger or freight service as demonstrated on the Turbotrain operation between New York and Boston.

The current locomotive power plant technology, as exemplified by the large diesel locomotives now universally used, is quite far advanced and is not likely to be replaced, at least for freight line-haul, within the next decade. It is possible, but not likely, that pure turbine power plants could ultimately replace them, especially for high-speed short intercity runs. Another significant development which could have far-reaching implications for high-speed transit is the linear induction motor. The United States Department of Transportation is sponsoring a number of R&D programs to develop this technology. Although several types of test vehicles have been authorized, and component tests are currently being conducted on a high-speed track at Pueblo, Colorado, it does not appear that this technology will be in operational passenger service prior to the 1980's and would not be developed for freight service until much later. In summary, it can be stated that technological developments in rail roadbed and locomotive design do not appear likely to affect the competitive balance between rail freight and air cargo within the foreseeable future.

Significant advances, however, have been made recently by the railroads in the fields of computerized train controls, automated switching yards, computerized car inventory systems, and similar operational innovations. These, coupled with improvements in levels of service and increased management efficiency, could have considerable impact on the long-term trend toward diversion of rail freight and express to air. Rail transportation is much more adaptable to automation than highway transportation.

Another operational development taking place within the railroad industry is the increased use of unit trains - special purpose trains hauling a single commodity between specific points. The economic advantages of this type of operation are obvious. Since unit trains are primarily advantageous for hauling bulk high density materials (e.g., coal, chemicals, oil, etc.), which are not amenable to air transport, their competitive impact on air cargo is expected to be negligible.

The major area of competitive impact by the railroads is the development of the piggy-back car (TOFC - Trailer on Flat Car) for transporting highway vans. With this method, one train and one crew can replace hundreds of truck tractors and drivers. This intermodal operation has benefitted both the rail and long-haul trucking industry and undoubtedly has had some impact on air cargo's penetration into the surface modes.

A much more recent trend is the development of container cars (COFC - Container on Flat Car) for intermodal transportation of the 8 x 8 x 20 and 40 foot ISO (International Standards Organization) ocean shipping containers. Of all modes, this is potentially the least labor intensive and hence could have the most impact on air cargo haulage - at least until suitable aircraft and intermodal containers have been developed for air transport.

Marine Transportation

Marine transportation is not normally considered to be competitive with air cargo transportation, primarily because high-density, low-value bulk solids and liquids (petroleum, coal, lumber, chemicals, grain, etc.) are transported by ship while air is more adaptable to high-value, low-density, perishable cargo. It is the author's opinion that air cargo's greatest future potential market is the international transport of packaged cargo - especially commodities which have any degree of time sensitivity. While these commodities represent only a small fraction of current maritime cargo, they represent a significant future market for air shipment. Advances in ocean shipping technology, therefore, could have considerable impact on air cargo growth with respect to international shipments.

Categories of Marine Transportation. Maritime shipping falls within three broad categories: transoceanic, coastal, and inland waterway. Their relative impact on air transportation also could be considered in that order of priority since air transportation is more competitive on long-haul routes. Materials carried on inland waterways are usually high-density bulk commodities which are not amenable to air transport. This also is true of most coastal shipping. A possible exception might be the shipment of packaged commodities between the United States West Coast ports and Alaska. Transoceanic shipping is believed most important with respect to the competitive aspects of technological development.

Current Technological Status. The maritime shipping industry, uninhibited by regulatory and safety constraints imposed on highway and rail transportation, has taken advantage of the "economy of size" in the development of larger ships, both tanker and break-bulk vessels. This development has been rather recent, and its full impact has not yet been felt. Ten years ago an oil carrier of 30,000 dead-weight tons was a large ship. Now tankers up to 200,000 tons displacement are operating, and 500,000-ton ships are planned. Since very little petroleum or liquids are transported by air, the impact of these huge vessels on air cargo is expected to be relatively insignificant. Indirectly, they could be beneficial since aircraft fuel is a major product of the petroleum industry, and a reduction in fuel cost would decrease proportionately aircraft direct operating cost.

Lighter/Barge. Development of the LASH (Lighter Abroad Ship) and See/Bee (Sea Barge) barge carrying ship is a major technological stride in marine transportation which has occurred within the past decade. For certain types of shipping (e.g., coastal transport where deep water harbors or container facilities are not available) the LASH concept offers significant advantages. Each lighter, or barge, can carry approximately 370 tons of break-bulk cargo against nine in a container. Lighters also can carry the ISO containers. The LASH ships can anchor two to three miles off the coast and discharge their load. The lighters are either self-propelled or can be towed to shore by conventional tugs.[1/]

While the LASH concept could have some effect on air cargo shipments in relatively undeveloped areas of the world, its overall future impact on air cargo is believed to be insignificant.

Container Ships. Another major recent development in the shipping industry is the trend toward containerization of bulk cargo and the construction of special ships and facilities for container shipping and handling. The economic advantages of container ships are many. Containerships can load and unload over 30 times faster than their break-bulk counterparts. Containerships average 85 percent of their time at sea, compared to 40 percent for conventional cargo carriers. Per diem port costs are reduced as are stevedoring costs. This development has within a decade changed break-bulk shipping from a labor intensive to a capital intensive operation.

Containerships also are having a major impact on harbors since one containership replaces approximately four break-bulk vessels. Loading and unloading is highly mechanized and requires special cranes and transfer equipment. Warehouses are being replaced with large open areas for container storage and intermodal transfer to truck or rail.

Many advances are being made in containership design. A third generation of containerships is now in design which will incorporate mechanized conveyors and elevators for transfer of containers below decks. All containers would be stowed below deck, thereby improving the ship's center of gravity and handling characteristics. Unloading time with this arrangement will be considerably reduced.[2/]

1/ "Barge Carrier May Upstage Container Ship," Los Angeles Times, January 20, 1972.
2/ "Beyond the Third Generation," Container News, January 1972.

Air Cushion Ships. Extensive research is being undertaken in the U.S. and in Europe on the development of air cushion vehicles for marine transportation. These vehicles are capable of relatively high speeds (80-100 knots) in relatively smooth seas, but have difficulty operating in high seas and in maneuvering in close quarters during a docking operation. Air cushion vehicles are more efficient as size increases so they do have an ultimate potential as transoceanic cargo carriers. A 165-ton Hovercraft SN4 has been operating across the English Channel for several years. It is not believed, however, that air cushion vehicles will have any impact on the air cargo market within the foreseeable future.

Hydrofoil Ships

Hydrofoil Ships. The U.S. Navy has sponsored development of hydrofoil ships for military use. These are now in relatively advanced stages of development. Their main advantage is high cruising speed, but at relatively high propulsion cost. Commercial applications have been primarily in the field of passenger transportation, although they do have limited use as cargo carriers for special applications. Hydrofoils are highly susceptible to vane damage caused by striking floating objects and have not been too successful from reliability and economic considerations. Their anticipated impact on air cargo is considered to be negligible.

Intermodal Containers

Perhaps the most important recent development in marine cargo transportation was the development of the container itself. The large ISO containers have a true intermodal capability and could in time revolutionize all transportation modes with respect to their methods of operation. In fact, containerization should not be identified with any one mode of transport. An opportunity exists to develop completely new methods of worldwide freight distribution utilizing intermodal containers. The interface problems of transferring cargo from one mode to another are simplified, and the adoption of standard container sizes and configurations now makes mechanized and automated freight handling a realistic possibility. Although many problems exist in developing a worldwide intermodal transportation system, the problems are mostly legal and jurisdictional, rather than technical. The advantages are so great that it is almost a certainty that they will be overcome. The impact of containerization on air cargo has been previously discussed.

Land Bridge/Air Bridge Concepts

Significant reductions in shipping time of ocean-going cargo are possible by the use of the land bridge concept (i. e., transferring cargo from ship to rail or highway for transcontinental carriage, then transferring again to ship for delivery to an ultimate destination port). Containerization now makes this concept feasible. Its future impact on air cargo is not believed significant although it would be used primarily for time sensitive cargo. Direct air shipment has tremendous leverage in this market, especially for high-value cargo.

Sea-Airbridge

The Boeing Company has conducted technical and economic feasibility studies of transporting ISO containers off loaded at West Coast ports to East Coast destinations using a 747-F all-cargo airplane. A relatively large market for this service appears possible if it is assumed that all cargo valued at over $2. 00/lb. is amenable to air shipment.[1/]

Integrated Motor Carrier/Airline Transportation

The Boeing Company in conjunction with a major transcontinental trucking company has conducted in-depth feasibility studies of using the B-747F as an aerial piggy-back carrier for highway vans (both empty and loaded) on transcontinental routes. The collection and distribution would be accomplished by truck at each terminal end of the route. Door-to-door

1/ Sea-Airbridge: Overland Airlift of Containerized OCP Cargos, The Boeing Company, 1971.

transit times of three days are possible with this method of operation, compared to six days for standard motor freight and one to two days by standard air freight. The study indicated that the method of operation was both technically and economically feasible.[1/]

Preservation Technology

Significant progress has been made within the past few years in the processing and preservation of perishable foods. The major innovation has been the development of the freeze drying process in which the food is dehydrated under cryogenic temperatures and later reconstituted by the addition of water. Dehydrated foods are very low in density and can be stored indefinitely. Although their light weight and high cost per pound makes them amenable to air transport this factor is negated by their low perishability.

Perhaps of greater significance to air cargo is the development of environmentally (temperature and humidity) controlled containers. Many special products, such as flower bulbs, chocolate biscuits, fruit, cheeses, and serums have to be maintained at constant temperatures. Although there are many types of container refrigerator systems, they all fall within three basic categories -- ventilated, insulated, and refrigerated (mechanical and non-mechanical).

Insulated containers provide satisfactory temperature control for periods up to three days. Low temperature normally is maintained by air circulation over dry ice. Thermal efficiencies of 77 percent and a total heat transfer of 35 B. T. U. /hr. /degree F are commonplace.[2/]

Refrigerated containers are used when longer preservation times are required. Liquid carbon dioxide is often used as a refrigerant. Accuracy to within $\pm 3^{\circ}$ F can be achieved inside a temperature range of -13° F to $+60^{\circ}$ F. This range covers most, if not all, perishable foodstuffs.

Liquid nitrogen refrigeration is commonplace in the container world. The system incorporates a thermostat which releases nitrogen from a cylinder once a certain temperature has been reached. Temperature of

1/ Integrated Motor Carrier/Airline Transportation Feasibility Study, The Boeing Company, March 1971.
2/ Annual Container Guide - 1968-69, Containerization International, London.

-20° can be maintained for periods up to 96 hours for loads of 18 to 20 tons on one bottle of nitrogen.

Mechanical refrigeration units such as the "Thermo King" are universally used for highway vans and containers. Temperatures in the range of + 20°F can be maintained with outside air temperatures of 120°F.

Insulated, refrigerated, and cryogenic shipping containers are quite commonplace in rail and highway transportation, therefore their impact on air transportation has already been determined. Their use is somewhat limited to relatively short-haul transportation in view of the need to replenish the refrigerant at specific intervals.

There is a definite need for development of environmentally controlled containers for air shipment. Although limited development is in progress, it is not believed to have significant impact prior to the development of suitable air carried intermodal containers -- possibly in the 1980-1990 time period.

Security

Loss of revenue due to theft and pilferage during shipment has long plagued shippers, irrespective of transportation mode. Senate investigators estimate that $1. 2 billion was lost through cargo theft from sea, land, and air shippers in 1969. Pilferage is quite commonplace in break-bulk maritime shipments, and to a lesser degree in highway and rail transportation. Pilferage of air cargo has been much lower than that experienced by other modes due to the high degree of personal handling of high value shipments and the relatively short terminal handling and transit times. In recent years, however, theft of air cargo has reached major proportions, especially at major terminals. Kennedy International Airport in New York City has been the scene of 45 percent of air cargo thefts and pilferage according to registered claims by airlines and air freight forwarders and exceeds the total of losses at all other airports throughout the country.[1/]

1/ Pressure Rising for Tightened Security, Aviation Week and Space Technology, October 26, 1970.

The only significant change in technology which has had an impact on cargo security is the advent of containerization. Containers have resulted in significant reductions in pilferage in all transportation modes, especially where sealed containers have been used. However, the container has proved to be a mixed blessing for cargo security. While it has deterred petty pilferage, it has attracted large-scale organized theft.

Inventory

Technological changes with respect to inventory and cargo tracing have primarily been in the area of computerized inventory control systems. The air transportation industry has been the leader in this developing technology; however, the equipment, systems, and methodology are equally adaptable to all shipping modes and can be expected to be universally used within the coming decade.

Overview - Cargo Handling Technology

- Highway transportation will continue to dominate the field of short-range collection and distribution of all types of cargo. Environmental, regulatory, and labor constraints may negate economic gains possible through technical advances.
- Highway transportation has the most to gain through the adoption of intermodal containers, since both sea and air cargos must be carried at both terminal points by motor vehicle for door-to-door pickup and delivery.
- Rail transportation will continue to be utilized primarily for transporting low-value bulk commodities over medium distances -- 200 to 500 miles, or longer where water transportation is infeasible.

- Rail transportation is most efficient when it is utilized for high-capacity short to medium distance line haul serving fixed points of origin and destination. Rail, therefore, can supplement air transportation in short-haul collection and distribution and should benefit more than suffer from future growth of air cargo.

- Major advances in railroad technology appear to be in the realm of high-speed vehicles for passenger travel with relatively limited application to cargo transport.

- Significant technological advances are being made in maritime transportation. Examples being the supertanker, containership, LASH concepts, and Hovercraft vehicles. These developments, collectively, could ultimately have a significant effect in reducing air cargo's future penetration into intercontinental shipping markets. Their impact is believed to be relatively far-term since it will primarily affect lower value cargos not now carried by air.

- Air will continue to exploit its inherent advantage of time saving over other modes. This could result in air ultimately being the primary mode for long-distance shipment of high-value and perishable commodities. This market capture already has occurred with respect to passenger travel.

- Air has an advantage over highway and rail transport in its ability to carry outsize loads.

- Air transportation will have its greatest future impact on international overwater cargo transportation.

- Individual modes can no longer be considered to be independent or self-sufficient. Improved interchange between modes, made possible through containerization, will provide the most efficient - and most economical - transportation method for future shipments.

- Technological changes in preservation, security, and inventory are equally adaptable to all transportation modes. Air has a significant initial competitive advantage over other modes with respect to these items due to its relatively lower total transit time. Advances in these technologies may tend to offset this initial advantage of air in the future.

IMPACT OF TECHONOLOGY ON DISTRIBUTION COSTS AND TARIFFS

An assessment of the impact of air cargo and competitive technologies on relative costs of distribution and on line-haul tariffs and an analysis of past trends in air and surface line-haul tariff rates are presented in this section. Supportive information on cargo aircraft technology, air cargo handling technology, and competitive technologies have been previously discussed.

The tariff rate structure of air cargo transportation, as with most other modes of transportation, is extremely complex and is based on many considerations other than cost. The existing air cargo rate structure has grown "like Topsy" from the aviation pioneering days of the early 1930's to the present time. During this period it has been subjected to numerous forces both within the aviation industry and from outside sources within the U.S. and internationally. Influencing factors have been political, regulatory, competitive, promotional, and economic, with little consideration as to actual cost of transit.

Domestic Rate Authority

In June of 1938 Congress enacted the Civil Aeronautics Act of 1938 and established the Civil Aeronautics Authority as a single independent agency to regulate civil aviation. The power of economic regulation as a public utility was granted to the CAA under the Act. In June of 1940 the regulatory powers were broadened and were placed under a newly created five-man board designated as the Civil Aeronautics Board. Since that date, the CAB has maintained complete control over U.S. domestic air freight rates.

International Rate Authority

International air freight rates are established by the International Air Transport Association (IATA). Unlike the United States, the vast majority of foreign airlines are government-owned and operated. International air freight rates are therefore continually subjected to pressures by foreign governments with respect to nationalistic, political, promotional, and economic desires of the individual governments. The end result has been that the international air passenger and cargo rate structures have little relationship to true costs.

In view of the difficulty in relating technological development to the diverse intangible and unpredictable factors mentioned above, this discussion attempts to relate technological impact only to cost - which is the fundamental criterion of any rate structure.

Determination of Air Cargo Costs

Between 50 and 60 percent of all air cargo is carried in the belly compartments of passenger aircraft operating in regularly scheduled service. This is true both in the United States and in foreign countries. Accordingly, it is very difficult to segregate costs of carrying cargo from costs associated with carrying passengers.

In 1948, the CAB attempted to examine the domestic air freight rate structure on a broad scale. This examination did not delve into the detailed statistical analysis necessary to establish a national rate structure even loosely related to costs. In the 24-year period since 1948, the rate structure has grown from a relatively simple cost-oriented structure to its present state of complexity having little cost substantiation.

The CAB, under pressure from both the shippers and the airlines, recently instigated an in-depth examination of the fundamental cost factors affecting air freight rates. This examination will be the most extensive examination of air freight costs conducted to date by any group or agency. This investigation, known as the "Domestic Air Freight Rate Investigation, Docket 22859," was initiated January 10, 1972 and is tentatively scheduled for a final hearing in January of 1973. In view of the thoroughness of this examination, it is suggested that, whenever possible, any local or statewide examination of air freight rate structures be withheld until the results of the CAB investigation are made available. It is highly probable that the examination will result in a complete restructuring of domestic air freight rates since a critical need exists to develop rate structures to reflect cost and value of service offered.

Impact of Technology on Cost of Distribution

Future technological developments are expected to have a significant effect on costs. Whether the potential and actual cost reductions are subsequently reflected in rate structure revisions remains to be seen. Major areas of potential air cargo cost reductions are considered to be the following:

Aircraft Technology

A review of anticipated future developments in the field of air cargo aircraft design has been previously discussed. Since economic efficiency is the driving force behind aircraft technological development, any gain in operational efficiency should result in a proportionate cost reduction - unless indirect or related operational costs associated with the development diminish or negate the reduction. The latter-mentioned indirect cost items are extremely difficult to ascertain, and, for the purposes of this discussion, have been disregarded other than to mention their possible existence.

Wide Bodied Jets

The direct operating cost (D.O.C.) on a seat/mile or ton/mile basis of the new generation of jet transports now entering the commercial fleet (B-747, DC-10, L-1011, etc.) is approximately 20 to 30 percent below that of prior generation aircraft (B-707, 727, DC-8, DC-9, etc.). It had been anticipated by the airlines that the lower D.O.C.'s would permit a reduction in passenger fares and cargo rates as well as increased profit levels. Unfortunately, the recent economic slowdown and resultant traffic loss, coupled with greater than anticipated facility and ground handling costs, have to date more than offset the potential cost reductions. Once the economy improves and the high initial ground facility investment is partially amortized, competitive pressures should result in requests for tariff revisions to reduce cargo ton/mile rates, perhaps in the order of five to 10 percent.

Another benefit resulting from the wide bodied jet configuration is the relatively large cargo and baggage space below decks. Each aircraft can carry from eight to 22 LD-3 cargo containers (in addition to baggage and galley containers). Industry studies have shown that the total belly cargo capacity of new wide bodied jets in service or on order should exceed projected air cargo demand for approximately the next 10 years, 1980-1985. The excess capacity could result in requests for sizeable tariff rate reductions for LD-3 containers as competitive pressures mount - possibly as soon as the next year or so when the bulk of new generation aircraft enter the fleet. The overcapacity of belly cargo could have more impact on the air freight rate structure than any other development in the next decade since the overcapacity exists with all air carriers utilizing new generation passenger aircraft. Any reduction in tariff rates for belly cargo, however, will be strongly opposed by both scheduled and nonscheduled air carriers operating all cargo aircraft. This could result in differential rate reductions (with respect to cargo density and/or volume) being applied to shipments in all cargo aircraft.

Supersonic Transports

The increased purchase price and operating cost of the SST as compared to conventional jet aircraft have been estimated at approximately 25 to 30 percent. This higher cost, coupled with significantly shorter cargo delivery times, could result in a premium rate structure for SST air cargo on the order of 50 to 75 percent over current ton/mile rates. The priority placed on turn-around times combined with limited baggage plus cargo space (about 775 cubic feet) may dictate a higher rate to discourage all but the highest priority mail and express.

Intermodal Containers

The higher stacking efficiencies and other cost savings possible with introduction of the large 8 x 8 x 20 and 40 foot air cargo containers ultimately could reduce air cargo rates. Adaptation of quad-mode containers is dependent both on design of future all-cargo aircraft and compatible container development. This is not anticipated prior to the 1980-1990 time period. The future impact of intermodal containerization on air cargo operations and its tariff rate structure could be significant and possibly comparable in degree to that experienced in the maritime shipping industry since 1957.

Cargo Handling Technology

Concurrent with the adoption of standard quad-mode containers for air cargo, mechanized and automated cargo handling systems undoubtedly will be installed at high activity terminals. Since their use would be limited to a relatively few locations, their future impact on the overall cargo rate structure is believed to be negligible.

Competitive Technologies

The prior discussion of the impact of competitive technologies was primarily centered on the competitive aspects relating to distribution and market share rather than costs per se. The cost impact of competitive technologies could differ significantly from the marketing and distribution impact. The impact of competitive technologies also differs for domestic (North American Continent) line-haul and transoceanic shipment. Also, a certain technological development could have only a negligible impact on cost of a competitive shipping mode, but could have a major impact on air cargo costs (and vice versa). Key examples are:

Domestic Shipping. Construction of the Federal Interstate Highway System has been highly instrumental in reducing costs of long distance highway line-haul. This program is now nearing completion, and the resultant cost reductions have already been reflected in the trucking rate structures. Future technological cost reductions in surface line-haul for distances exceeding 500 miles are, therefore, believed to be relatively insignificant.

Conversely, technological changes applicable to the long distance air mode should result in significant future relative rate reductions and, therefore, should lessen the existing cost disparity between the air mode and long-haul surface modes, both highway and rail.

Overseas Shipping. The LASH concept is not anticipated to have a major impact on air cargo due to differences in physical characteristics and time sensitivity currently associated with air and water cargo. This statement probably should be qualified when considering the possible future cost differential. The LASH concept offers high potential for future cost reduction in shipping break-bulk cargo (both bulk and containerized). The air mode has not yet penetrated this market but is forecast to in the future, especially with respect to high cost/low density shipments. A reduction in maritime shipping rates could significantly delay or reduce the anticipated penetration of air cargo into the overseas break-bulk freight market.

Total Distribution Cost Management

A relatively new approach to analysis of total distribution cost has been developed by the aircraft manufacturers and airlines. This analytical tool, designated Total Distribution Cost Management (TDC), capitalizes on the total door-to-door time differential between air and competitive shipping modes. Handling costs, inventory costs, warehousing costs, insurance costs, etc., all are inputs to the analysis. Although the analysis can be accomplished manually, it is quite complex and beyond the capability of the average shipper. The air industry has, therefore, developed computer programs and portable input/output displays as sales tools. Many large shippers have accepted this method of analysis and have demonstrated that significant savings in overall distribution costs are possible on many seemingly marginal air shippable commodities. The aviation industry is actively promoting this analytical tool; however, acceptance to date by the large majority of shippers has been marginal - primarily because the level of management responsible for determination of shipping mode is responsible only for line-haul costs and not total distribution cost.

As competition increases and shippers become more cost conscious with respect to total distribution cost, the time advantage of air shipment is expected to be reflected in increased penetration of the air mode into the long-haul surface and water modes.

Impact on Revenues Per Ton Mile

Revenues per ton mile (RTM) for air freight have displayed a long term downward trend at the same time that truck rates, the principal competitive mode domestically, have shown an almost steady upward trend. In 1945, average air freight revenues per revenue ton-mile in scheduled service were 52-57 cents (38.11 cents in 1946), dropping to a low of 19.0 cents in 1969. Class I intercity motor common carriers ton-mile revenues were 4.13 cents in 1945 (4.286 in 1946), and rose to a 1970 preliminary figure of 7.46 cents. The growth of domestic air freight relative to trucking will in strong measure depend on the continued closing of the gap between these rates.

Figure 4-1 graphs the RTMs of certificated route air carriers, domestic operations in total, and all cargo carriers and Class I intercity common motor carriers 1955-1970. Over this period, the closure is much less dramatic than the period 1945-1955. The air RTM for all domestic operations was 15 cents per RTM higher than truck common carrier in 1955; the RTM in 1970 was 13.6 cents. For domestic trunks, the corresponding figure was 17.5 cents in 1955 and 13.3 cents in 1970. The most striking closure was domestic all cargo carriers with a 10.6 cent difference in 1955 and a 6.7 cent difference in 1970.

Inferences about relative tariffs (truck and air) from RTM must be qualified by at least four considerations. First is the relative content of nonline-haul revenues in the total revenue picture. Intuitively, it would appear that pickup and delivery revenues run at a higher rate in trucking than in air freight. This would imply a slightly lower line-haul RTM for trucks.

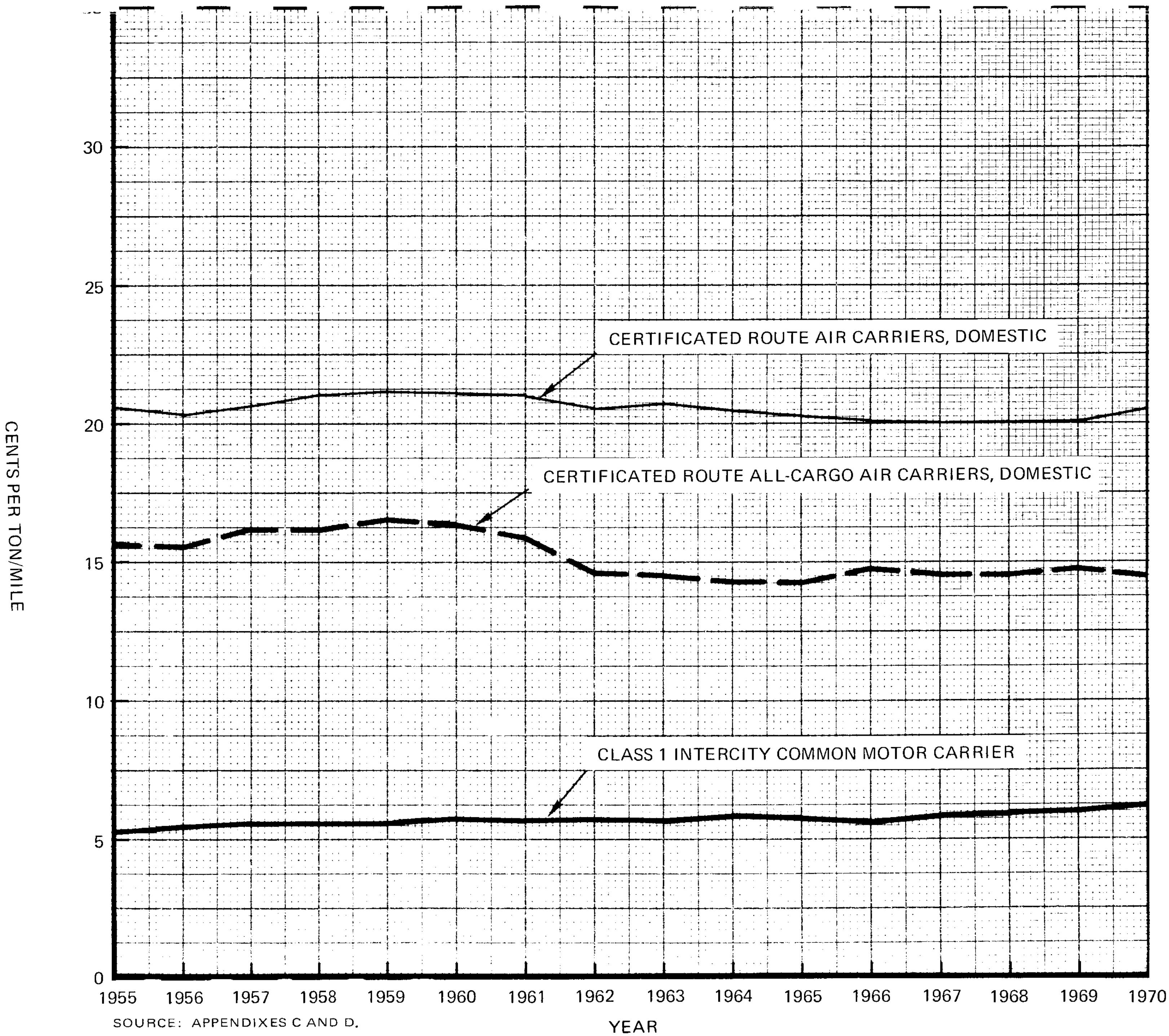


Figure 4-1

COMPARATIVE AIR AND TRUCK REVENUES PER TON MILE
1955-1970

Second, length of haul differences in costs and RTM are not discernible from the averages. Marginal costs of an additional 100 miles of belly air cargo are close to zero. Rates reflect this in some measure but also reflect all cargo operations. Delta's LD-N container rate from Los Angeles to Atlanta is .68 cents per hundredweight-mile, whereas the Atlanta to New York rate is 1.06 cents per hundredweight-mile.1/ This represents a 35 percent reduction from the shorter to the longer distance. Using 1958 ICC data,2/ a 27 percent drop in truck cost per hundredweight-mile over comparable distance is observed. This more rapid decline for air also reflects higher loading costs.

In addition, mileage has different connotations for truck and air revenues per ton-mile. The former is approximated by road miles, the latter by great circle miles. Tabulations were made of air mileage to road mileage from top three Texas cities to 11 selected large United States cities. The ratios (air divided by road) are shown in the following array:

	Dallas	Houston	San Antonio
Chicago	.86	.87	.88
Detroit	.84	.83	.88
Los Angeles	.88	.88	.88
New York	.86	.87	.88
Washington, D.C.	.86	.87	.88
Atlanta	.90	.86	.89
San Francisco	.83	.84	.85
Seattle	.80	.84	.82
Minneapolis	.90	.88	.92
Memphis	.90	.86	.89
Boston	.85	.84	.88

(A side note on competitive technology: A pre-interstate road mileage calculation was made which showed lower ratios on the whole. The Interstate system has not only improved road times of transit but distance of transit for Texas cities. The Interstate system is now nearly complete.

1/ Aviation Week, December 20, 1971, p. 29.
2/ Interstate Commerce Commission, Cost of Transportative Freight by Class I and II Motor Common Carriers of General Commodities, Middlewest Territory, Washington, D. C., May 1960.

Over the period shown in Figure 4-1, the new highway network has had an appreciable effect on holding down the rate of growth of truck RTMs. A faster rise may be expected through 1990.) The effect of these distance relatives is to cause an estimated 10 percent decrease in air RTMs relative to truck RTMs.

Packaged and unitized density of shipments affects the relative rates. Air freight and express run at average densities of about eight pounds per cubic foot, whereas truck runs at about 13. A 1968 study by D. H. Reeher[1/] adjusted truck costs from their average costs per ton-mile to a figure reflecting costs for handling and transporting average densities experienced by air. The effect on total costs is shown as follows:

	Motor	Air
Average Unadjusted	2.5	17.7
Adjusted to eight lbs/cu. ft.	4.0	17.7

The RTMs would show a comparable closure under density adjustments.

Size of shipment is of considerable importance in interpreting relative air and truck RTMs. Air cargo consists of a much higher percentage of "small" shipments than does trucking. While air carries less than .2 percent of domestic intercity ton-miles,[2/] it carried in 1969 about 2.1 percent of the air-carried tonnage (air freight, air express, and air parcel post) of regulated intercity small shipments as defined by ICC.[3/] This means an even larger percentage of the ton mileage (or of the long-haul tonnage). The Reeher study presented a comparison of charges by selected air and truck carriers for drug shipments between Los Angeles

1/ Source: Reeher, D. H., Trends in the Domestic Rail and Motor Freight Industries, October 1968, Independent Research Program Analytic Services, Inc., Falls Church, Virginia.

2/ United States Bureau of the Census, Statistical Abstract of the United States: 1971, Washington, D.C., 1971.

3/ Interstate Commerce Commission, Transport Economics, Washington, D.C., May 1971.

and New York City at various size breaks. His tabular analysis is reproduced here in Table 4-2. The air forwarders line-haul charges beat truck costs at the one pound class between Los Angeles and New York. At 100 pounds, the air carrier charge is 53 percent higher than truck, compared to a range of 200 percent (all cargo) to 320 percent (total domestic carriers) higher than truck as shown in the Figure 4-1 RTM graph.

The other side of the size of shipment coin, however, is that city-to-city continental truckload lots, door-to-door charges by truck will be at very much lower levels than air within the present technological horizon. This is due in large measure to the extra intermodal transfers required in air mode. (There have been press articles on a revival of lighter-than-air transport developmental work in Germany. It has been reported that low cost helium, new plastics, and improved propulsion make 90-mile per hour door-to-door, or rather pylon-to-pylon, delivery feasible.)

A summary, in hypothetical quantities of truck versus air RTMs, is presented in Figure 4-2. The average RTMs shown in Figure 4-1 result from a large number of commodity and route specific rates/revenues. These are depicted in Figure 4-2 as skewed distributions. (They are not shown to scale, since truck would have a very much greater area under its curve.) It is at the point of approximately 12 cents to 20 cents per ton-mile that air becomes heavily competitive with truck in long-haul markets and where other elements of service come strongly into play in the shippers modal choice decision. The hypothetical analysis shows the region of air competitiveness increasing over the decade, and this would be largely the effect of aircraft technology. The long skewed tail of high RTMs to the right would be largely a product of local air service high costs of operation (low volume, short lengths of haul; see Figure 4-3). This is the area wherein technology has least affected air cargo costs.

Table 4-2

COMPARISON OF DOOR-TO-DOOR CHARGES BY DIRECT AIR CARRIERS, AIR FREIGHT FORWARDERS, AND LONG-HAUL MOTOR CARRIERS FOR DRUG SHIPMENTS IN MAJOR FREIGHT MARKETS

Weight of Shipment (lbs.)	Carriers				
	AA, UAL, FTL 1/	Airborne Freight Corporation 2/	Air Express International Corporation 3/	Consolidated Freightways 4/	Navajo
	Los Angeles to New York				
1	$ 21.40	$ 7.50	$ 7.50	$ 13.43	DNF
25	21.40	14.39	14.35	13.43	DNF
50	21.40	20.13	20.68	13.43	DNF
100	21.40	21.40	32.92	13.43	DNF
300	57.15	50.25	76.11	27.05	DNF
1,000	146.00	155.00	221.15	83.00	$ 83.00
5,000	592.50	700.00	NP	415.00	415.00
10,000	1,120.00	1,370.00	NP	830.00	830.00
	New York to Los Angeles				
1	23.15	7.50	7.50	13.43	DNF
25	23.15	15.31	15.31	13.43	DNF
50	23.15	23.41	23.28	13.43	DNF
100	30.05	36.73	39.81	13.43	DNF
300	83.10	110.19	96.66	22.49	DNF
1,000	260.00	271.00	$274.60	67.80	67.80
5,000	1,150.00	$1,287.50	NP	339.00	339.00
10,000	$2,260.00	NP	NP	$678.00	$678.00

1/ Rates are for American Airlines, United Air Lines, and the Flying Tiger Line; specific commodity rate group number 272 for AA and UAL and group number 638 for FTL; pickup and delivery based on Zone A charges.

2/ Specific commodity rates applied with the following exceptions: Shipments weighing 1, 25, and 50 pounds were rated at the lower general commodity charge.

3/ General commodity rates applied; pickup and delivery based on Zone A charges.

4/ Class rates applied including surcharges applicable to shipments weighing less than 1,000 pounds. Includes charges for drugs or medicines where released value does not exceed 50 cents per pound.

NP means no rate published for that weight break. DNF means that surcharges, if any, were not included in data furnished. Accordingly, appropriate LTL rates could not be determined.

Source: D. H. Reeher, *op. cit.*

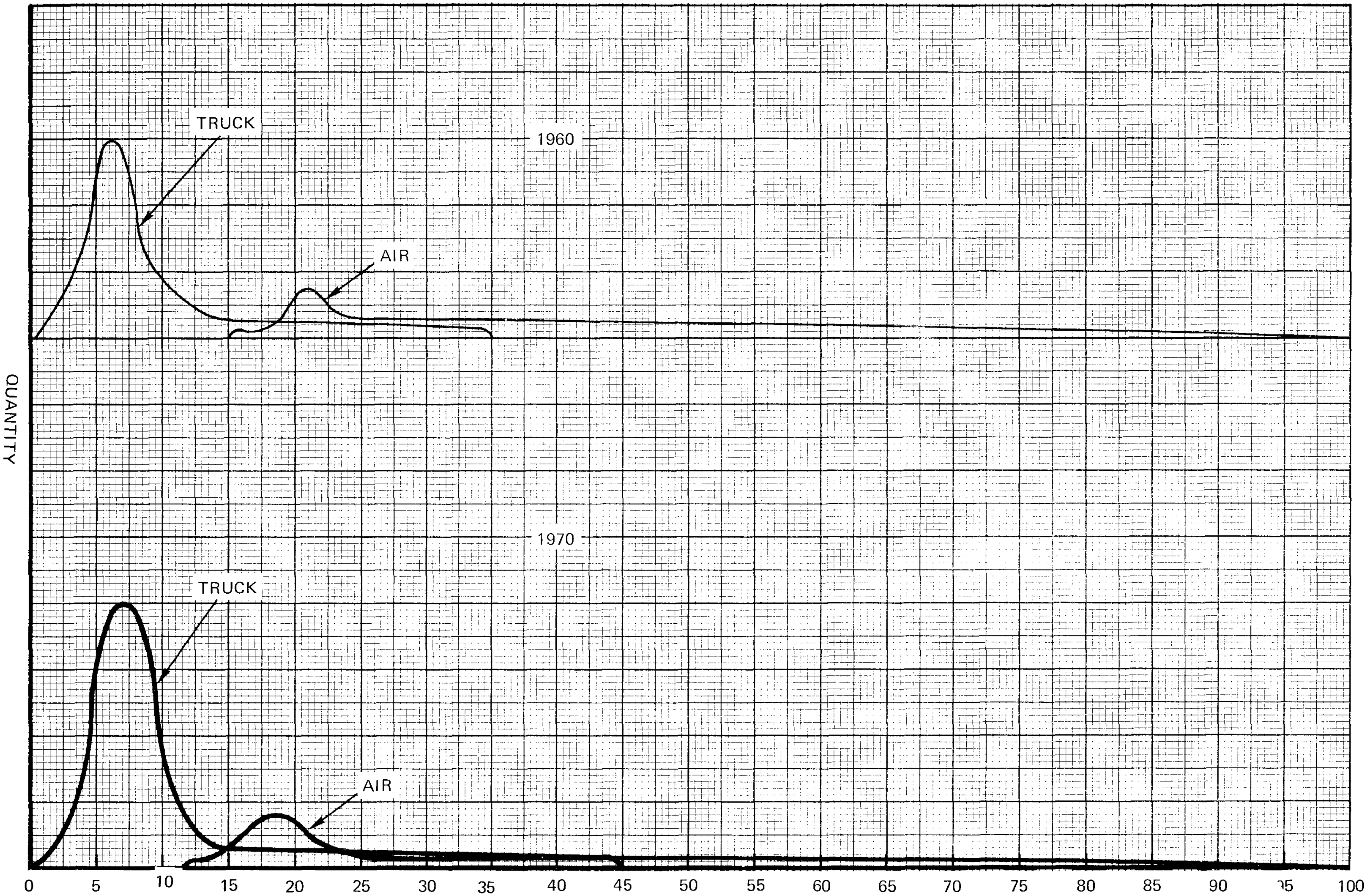


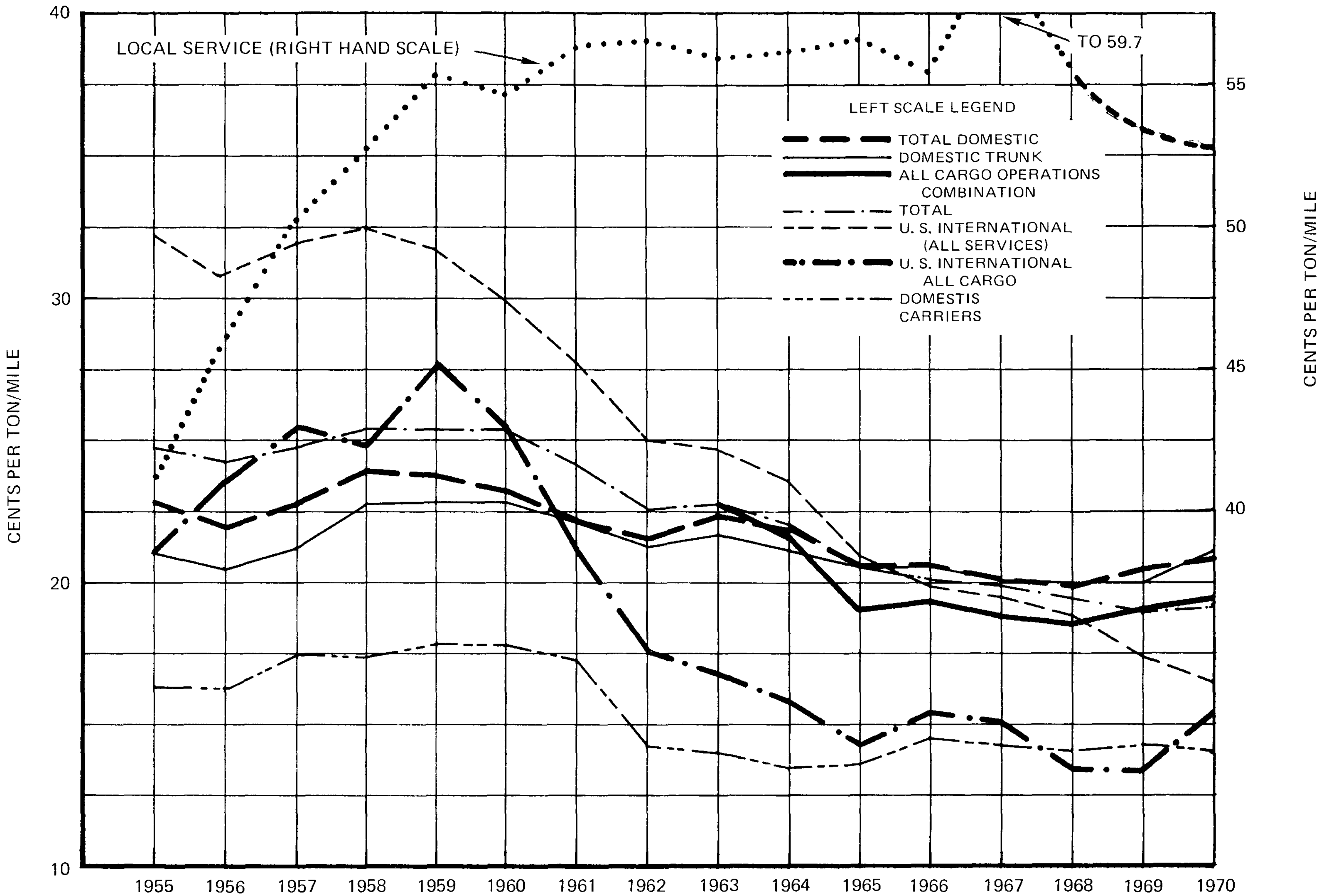
Figure 4-2

HYPOTHETICAL DISTRIBUTION OF TON-MILE RATES

Revenues per ton-mile for several classes of air carrier from 1955 to 1970 are shown in Figure 4-3. The most dramatic increase in RTMs has been in international service, whereas the most dramatic increase was in local service. United States all-cargo carriers displayed a two-level history with a drop from about 17 cents RTM in 1961 to between 14 and 15 cents RTM. All-cargo service of the combination carriers, in contrast, has followed somewhat erratically the path of the combination carriers as a whole.

The changing histories, mostly gradual declines, in RTM, have been the result of the combined impacts of institutional factors, changing route structure, cargo composition, economic trends, and technology. Figure 4-4 superimposes the introduction of major aircraft types on the RTM histories of Figure 4-3. The average time from aircraft technology to impact on performance is about one year.

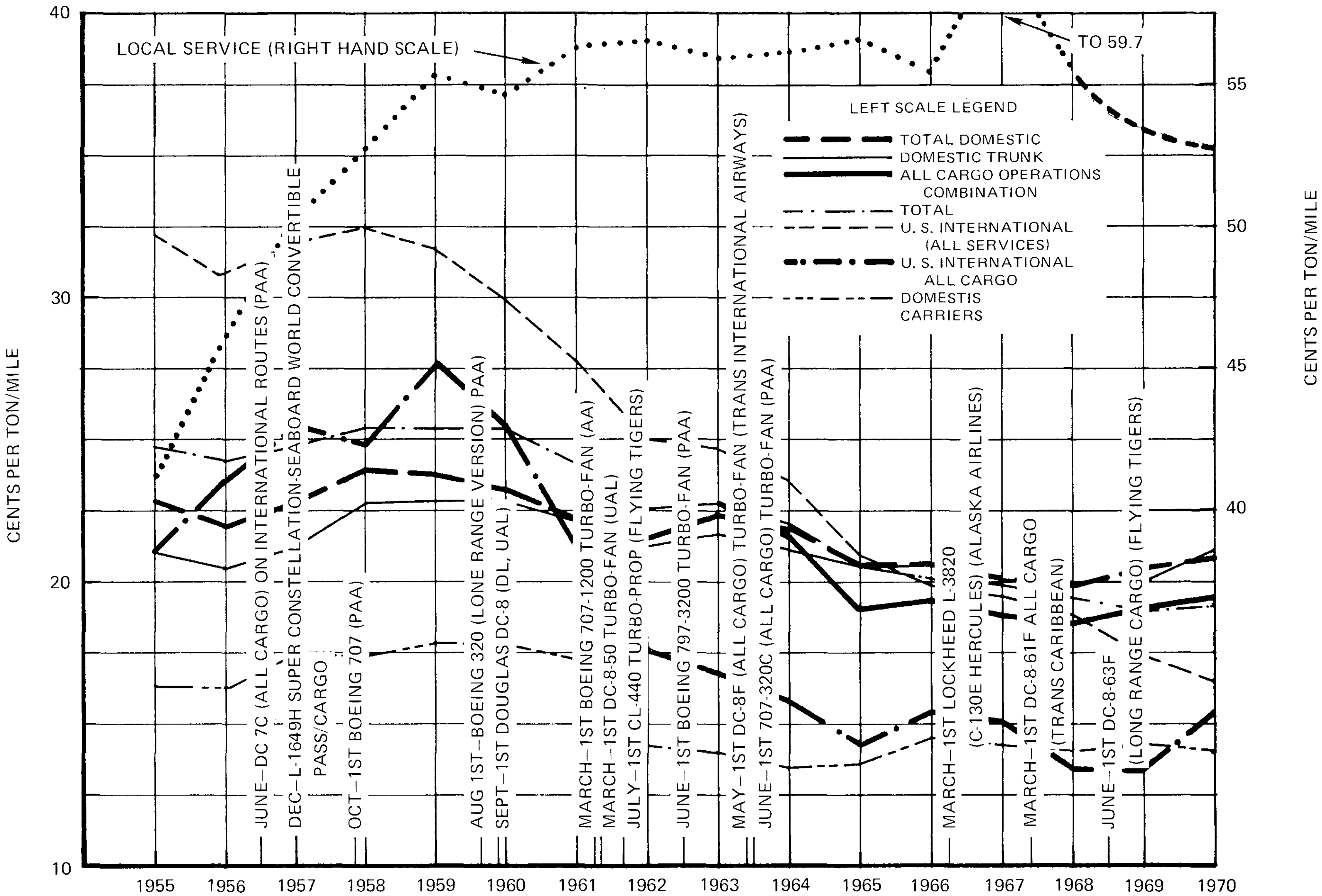
There was a general rise in RTMs in the period 1956 to 1960. Two high cost of operation aircraft in all-cargo, or convertible service, the DC-7C and L1649H (Super Connie convertible), were introduced into service in 1956. International all-cargo RTMs appeared to be particularly affected; perhaps the passenger versions introduced earlier in the fifties were affecting belly cargo RTMs in the more modest domestic trunk increase. The Boeing 707 was introduced in October of 1957. The declines in RTMs commencing around 1959 were no doubt under the B-707's very prominent influence. The DC-8s operated in a similar fashion. Domestic all-cargo operators RTMs have remained relatively constant since 1962 although efficient all-cargo aircraft (DC-8F, B-707-320C) were introduced in mid-1963. The domestic all-cargo operation of the combination carriers and international all-cargo operations do appear to have responded with RTM decreases. The DC-8, 61-F, and 63-F do not appear to have exerted much downward pressure as of 1970. In fact, the United States international all-cargo carriers displayed about a two cents jump in RTMs from 1969 to 1970.



Source: CAB, Handbook of Airline Statistics

Figure 4-3

FREIGHT REVENUES PER TON MILE FOR SELECTED CLASSES OF
U.S. CERTIFICATED AIR CARRIERS AND OPERATIONS
1955-1970



Source: CAB, Handbook of Airline Statistics

Figure 4-4

FREIGHT REVENUES PER TON MILE FOR SELECTED CLASSES OF
U.S. CERTIFICATED AIR CARRIERS AND OPERATIONS
1955-1970

B-747s should be exercising downward pressures on RTMs in international and domestic trunk belly cargo service. In the latter part of the 1970's decade, the international all-cargo scheduled service should be affected, depending in large measure on Lufthansa's B-747F experience. World Airways has ordered three B-747Cs (convertible) with three options. International charter service would be able to offer lower tariffs in the 1970's decade. Domestically, the other wide bodied jets (DC-10, L-1011) should be carrying increasing proportions of air cargo and attracting it with special commodity, unitized route specific rates.

Local service carriers have been flying, at least through 1967, with high cost of operation equipment over uneconomically short routes. A very definite change occurred in fleet operations between the year ending December 31, 1966, and the year ending June 30, 1970. Table 4-3 shows data on scheduled departures performed (SDP) by aircraft in use in local service in these periods. The Convair 340/440 series was introduced into service in 1952 (340) and 1956 (440) and was first pressed into local service in 1959. The Martin 404, introduced in 1951, was first operated in local service in 1960. By 1967, the CV340/440 and the M404 performed about 550,000 scheduled departures, or about one-third of those performed in local service. By Fiscal Year 1970, they had dropped to 90,000, or slightly less than six percent. DC-3s dropped from 311,000 in 1966 to almost zero in Fiscal Year 1969. On the other hand, most SDPs in local service were performed by CV-540s. This plane is a turbo prop which went into local service at its introduction in 1959 and increased its operations almost threefold to around 450,000 SDP in Fiscal Year 1970. The DC9-10 and DC9-30, which together performed about 230,000 SDPs in 1967, increased to approximately 400,000 in Fiscal Year 1970. The indicated drop from 1967 to 1970 in local service RTMs was heavily influenced by these and other shifts in local service fleet. The drop is forecasted to continue. However, the rates are not expected to become seriously competitive with truck for air cargo feeder service from the smaller communities to the major and medium hubs.

Table 4-3

AIRCRAFT DEPARTURES PERFORMED BY
SELECTED PRINCIPAL AIRCRAFT IN
LOCAL SERVICE
Fiscal Year
(Thousands)

	FY1970			CY1966		
	Total	Trunk	Total less Trunk	Total	Trunk	Total less Trunk
B-206A	4.4	0	4.4	0	0	0
B737	353.8	264.4	89.4	0	0	0
BAC111	204.8	122.7	82.1	124.6	94.4	30.2
C285ACF	.8	0	.8	5.4	0	5.4
C46	.1	0	.1	7.9	2.8	
B727-100	618.6	604.0	14.6	426.6	422.2	4.4
B727-200	388.5	380.4	8.1			
DC-9 (10)	347.2	220.0	127.2	84.9	61.2	23.7
DC-9 (30)	738.2	464.3	273.9			
CV580 (540)	484.7	1.0	483.7	133.1	0	133.1
CV-600	93.2	0	93.2	45.3	0	45.3
FH227	203.7	12.7	191.0	14.1	3.7	10.4
F-27	112.9	0	112.9	263.4	0	263.4
Nihon YS11A	65.1	0	65.0	.2	0	.2
Nord N-262	7.0	0	7.0	18.6	0	18.6
CV340/440	5.9	5.3	.6	450.4	189.9	270.5
DC-3	3.1	0	3.1	327.9	16.4	311.5
M-202	0	0	0	7.1	0	7.1
M-404	89.8	0	89.8	278.1	0	278.1
PA31	6.9	0	6.9	0	0	0
S-61	65.9	0	65.9	79.2	0	79.2
V107	7.3	0	7.3	52.1	0	52.1

Source: CAB, FAA; Airport Activity Statistics, FY1970 and CY1966, Aircraft type selection from CAB Handbook of Airline Statistics.

It is reasonable to attribute quite a large share of the downward movement in RTMs to aircraft technology. A complement of this observation is that hardly any ground technology could be listed in a manner similar to aircraft introductions which would explain, perceptibly, the RTM movements. Of course, mobile conveyors, containers, etc., have had effects. Standardization of aircraft and cargo compartments will be necessary for strong influences by loading/unloading technology in the coming decades. Automated assembly areas will be providing some significant cost reduction in large hubs.

Overview - Impact of Technology on Distribution Costs and Tariff

- An air cargo tariff rate reduction on the order of five to 10 percent is possible within the next decade as the transition from conventional to wide bodied jets occurs.
- An overcapacity of belly cargo space will exist until approximately 1980-1985 and could result in a significant reduction of the rate structure for LD-3 shipping containers as competitive pressures mount.
- A premium rate structure for supersonic air cargo is highly probable - with rates of 25 to 50 percent over current averages.
- Cargo handling technology is not expected to materially change overall air cargo rates.
- Potential air cargo cost savings are possible when standard quad-mode containers are developed and handling methods are automated - in the 1980-1990 time period.
- Competitive technologies may result in reduced air cargo commodity tariffs, due to competitive pressures. Their potential impact in reducing air cargo cost is considered to be relatively low.

- Some competitive technologies may have the effect of reducing total distribution costs by line-haul modes alternative to air.
- Rates are not expected to become seriously competitive with truck for air cargo feeder service from the smaller communities to the major and medium hubs.

PERISHABILITY DIFFERENTIAL ANALYSIS OF AGRICULTURAL COMMODITIES AS A CONSIDERATION FOR SHIPMENTS BY AIR

Air cargo may have an advantage over competing modes for the shipment of perishable agricultural commodities. In this section, a procedure is developed for comparing total air and truck costs including differences in spoilage rates.

In a comparison of air versus truck as a choice for moving agricultural commodities, the perishability of the product is critical. The decision process can be presented both mathematically and graphically using transport charges, perishability, and wholesale value as determinates in the selection of the preferred alternative mode.

Two costs groups can be identified:

1. Direct Costs. Included in this group are the transport rate, value of inventory in transit, pickup and delivery costs, and packaging and insurance costs. The sum of these costs is divided by the total marketable commodity. If 10 percent were spoiled, only 90 percent of the weight could be sold.

2. Indirect Costs. This is the wholesale value of the commodity which is multiplied by the amount spoiled to give total spoilage economic loss. This is then divided by the marketable commodity.

This process distributes the transfer costs and the spoilage cost over the commodity which is delivered. The sum of direct and indirect costs is the total transfer costs by truck. This is an increasing function over the spoilage range.

Direct Cost. Although called direct cost, there are certain traditional indirect costs included in this category.

1. Basic equipment charges - truck, 65 cents per mile; air, 16 cents per ton-mile.

2. Packaging costs differentials - if any, between truck and air. If there are none, this factor goes to zero.

3. Inventory costs during transit time.

4. Insurance costs.

5. Additional assignable costs.

Direct cost function:

A = Transport Charges.

M = Distance.

B = Marketable Commodity at Destination ($\leq$ 1.0).

C = Packaging Cost.

D = Inventory Cost.

E = Insurance Cost.

F = Pickup Cost.

G = Delivery Cost.

W = Weight of Shipment in Hundred Pound Units.

a = Air Cargo Shipment.

t = Truck Shipment.

$$\theta = \frac{AM + C + D + E + F}{BW} = \text{Direct Costs in Cents Per CWT}$$

Direct costs involved in 20,000 pound truck shipment from Atascosa County, Texas to Chicago, Illinois:

A_t = 65 Cents Per Mile

M = 1250

B_t = .9

C_t = 0

D_t = \$10.20

E_t = 0

F_t = 0

G_t = 0

$$\theta_t = \frac{(.65)(1250) + 10.20}{(.9)(200)} = \frac{\$822.70}{180} = \$4.57 \qquad \text{Equation (1.0)}$$

The direct transportation costs incurred in a truck shipment of agricultural commodities with a 10 percent spoilage rate is \$4.57.

Direct costs incurred in shipping by truck can also be computed when transportation charges are quoted on a basis of rate per hundred pounds. This precludes the necessity of using either distance or weight of shipment in the effective transportation rate.

As an example, one could assume that a specific shipment rate is \$4.00 per hundred pounds. The wholesale value and the spoilage rate are the same as in the previous example:

$$\theta_t^* = \frac{\text{Quoted Rate}}{\text{Marketable Commodity: (1 - Spoilage Rate)}} + \text{Additional charges} = \text{Effective rate} \qquad \text{Equation (1.1)}$$

$$\theta_t^* = \frac{\$4.00}{.9} + .05 \approx \$4.49$$

The effective rate for this hypothetical shipment is \$4.44, plus additional charges of five cents per hundred pounds, which yields a direct cost of approximately \$4.49. In the previous example, the effective rate was \$4.51, plus additional charges of five cents plus.

Either the method specified in Equation 1.0 or Equation 1.1 will provide an estimate of the direct costs incurred in a movement by truck. Since most rates are quoted on a hundred pound basis, rather than cents per mile, equation 1.1 may be preferred. In addition, the solution of Equation 1.1 is not dependent on the weight of the shipment or the miles traveled since these are factors in the development of the original rate.

Table 4-4 presents the effective rate for various spoilage differential factors. For example, if the quoted rate is $1.00 and the expected spoilage differential is 20 percent, the effective rate is $1.25 per hundred pounds.

Direct costs for using air freight for the movement are defined as:

Aa	=	16 Cents Per Ton Mile
M	=	1020
Ba	=	1.0
Ca	=	0
Da	=	$3.40
Ea	=	0
Fa	=	$49.16
Ga	=	$54.08

$$\theta_a = \frac{(.16)\,(10)\,(1020) + 3.40 + 49.16 + 54.08}{(1)\,(200)} = \frac{1738.64}{200} = \$8.70 \quad \text{Equation (1.2)}$$

A comparison of direct costs incurred in a similar movement by truck and air indicates that the truck has the cost advantage. In this case, the spoilage differential is 10 percent. Using air freight, the spoilage is zero, whereas 10 percent of the commodity is spoiled when shipped by motor truck.

Direct Costs

Air	$4.57
Truck	8.70

Table 4-4

EFFECTIVE TRANSPORTATION RATES DUE TO SPOILAGE

Actual Rate	Effective Rate Spoilage Differential Factor (%) 0	3	10	20	25	30
$0.50	0.50	0.52	0.56	0.63	0.67	0.71
1.00	1.00	1.03	1.11	1.25	1.33	1.43
1.50	1.50	1.55	1.67	1.88	2.00	2.14
2.00	2.00	2.06	2.22	2.50	2.67	2.86
2.50	2.50	2.58	2.78	3.13	3.33	3.57
3.00	3.00	3.09	3.33	3.75	4.00	4.29
4.00	4.00	4.12	4.44	5.00	5.33	5.71
5.00	5.00	5.15	5.56	6.25	6.67	7.14
6.00	6.00	6.19	6.67	7.50	8.00	8.57

Indirect Cost. The indirect costs factor is composed of economic loss due to spoilage. The wholesale value is used as a measure of this loss. The loss is the product of wholesale value and weight loss due to spoilage. It should be noted that the spoilage rate is actually a differential between truck and air and not the absolute spoilage rates. Using this method, the indirect cost of air shipments is defined as zero and only the indirect costs of truck shipments are required.

Wholesale Value (W.V.) = \$30.00 Per Hundred Pounds (30 cents/pound).

Spoilage Rate by Truck (S.R.) = 10 Percent of Total Weight.

$$\alpha_t = \frac{(W.V.)\,(S.R)}{(1\text{-}S.R.)} = \frac{(\$30)(.1)}{(.9)} = \$3.33 \qquad \text{Equation (1.3)}$$

In this example, the economic loss due to spoilage is \$3.33 per hundred pounds. This is defined as the indirect cost of using truck when air freight was available, and the spoilage differential was 10 percent. The indirect cost is independent of the weight of the shipment.

The total economic cost of using truck is the sum of direct and indirect costs:

$$\text{Total Costs} = \text{Direct Costs} + \text{Indirect Costs}$$

$$\pi = \theta + \alpha \qquad \text{Equation (1.4)}$$

$$\pi_t = \theta_t + \alpha_t$$

$$\pi_t = 4.57 + 3.33$$

$$\pi_t = \$7.90 \text{ Per Hundredweight}$$

$$\pi_a = \theta_a + \alpha_a$$

$$\pi_a = \$8.70 + 0$$

$$\pi_a = \$8.70 \text{ Per Hundredweight}$$

In this example, the total economic cost of using air is greater than the cost of the same shipment by truck.

An expected spoilage rate differential of 15 percent, using equations 1.1 and 1.3, would result in a costs advantage for air freight.

$$\theta_t^* = \frac{\$4.00}{.85} + .05 = \$4.76$$

$$\alpha_t^* = \frac{(\$30)(.15)}{.85} = \$5.29$$

$$\pi_t = \$4.76 + \$5.29 = \$10.05$$

$$\pi_t > \pi a$$

Perishability is an extremely critical factor in the transportation decision process. However, it is virtually impossible to assign a realistically constant spoilage rate for a specific commodity over a seasonal product period. Besides the physical handling and equipment used, the cultural practices and the climatic conditions affect the perishability. During the season, the perishability of a commodity will change and the shipper may be confronted with an array of perishability factors over a period of time.

It is assumed that the informed shipper knows the wholesale value and has a reliable knowledge of his perishability experience by various modes. If these factors are known or can be estimated for a specific market, a matrix of direct and indirect costs can save considerable time and effort.

Table 4-5 shows the indirect loss per hundred pounds for selected wholesale values and spoilage differential factors. If the wholesale market value for a specific commodity is \$30.00 per hundred pounds, and the expected spoilage differential factor between truck and air is 20 percent, the indirect cost is \$7.50. Additional wholesale values could be computed for a specific commodity, such as strawberries, peppers, tomatoes, and others based on either historical or expected values.

Table 4-5

INDIRECT COSTS OF TRANSPORTATION DUE TO SPOILAGE

Wholesale Value Loss Due To Spoilage

Wholesale Value Per Hundred Pounds	Spoilage Rate (%) 3	5	10	20	25	30
$10.00 Costs Per CWT	.31	.53	1.11	2.50	3.33	4.29
$20.00 Costs Per CWT	.62	1.05	2.22	5.00	6.67	8.57
$30.00 Costs Per CWT	.93	1.57	3.33	7.50	10.00	12.86
$32.50 Costs Per CWT	1.00	1.71	3,61	8.12	10.80	13.93
$35.00 Costs Per CWT	1.08	1.84	3.88	8.75	11.66	15.00
$37.50 Costs Per CWT	1.16	1.97	4.16	9.37	12.50	16.07
$40.00 Costs Per CWT	1.24	2.10	4.44	10.00	13.33	17.14
$45.00 Costs Per CWT	1.39	2.36	5.00	11.25	15.00	19.28
$50.00 Costs Per CWT	1.55	2.63	5.55	12.50	16.66	21.43
$55.00 Costs Per CWT	1.70	2.89	6.11	13.75	18.30	23.57
$60.00 Costs Per CWT	1.86	3.15	6.66	15.00	20.00	25.70

A Graphic Approach to Evaluating Total Transportation Charges

In the example in the preceding section, it was shown that, when spoilage or any loss was a factor in transportation, the effective transport charges are higher than the quoted or tariff charges. It was assumed also that the economic loss associated with the spoilage was an indirect transport charge. A mathematical formula for computing these substituted values and a matrix of substituted values were also presented. Although relatively simple, the mathematical formula is time consuming, whereas the matrix is limited in scope.

Two nomographs are presented in this section as aids to the user of air freight in selection of the desirable transport mode. Since time saving is one of the primary advantages in moving agricultural commodities by air, and spoilage is functionally related to time, the nomographs can also be used as promotional tools for airline management.

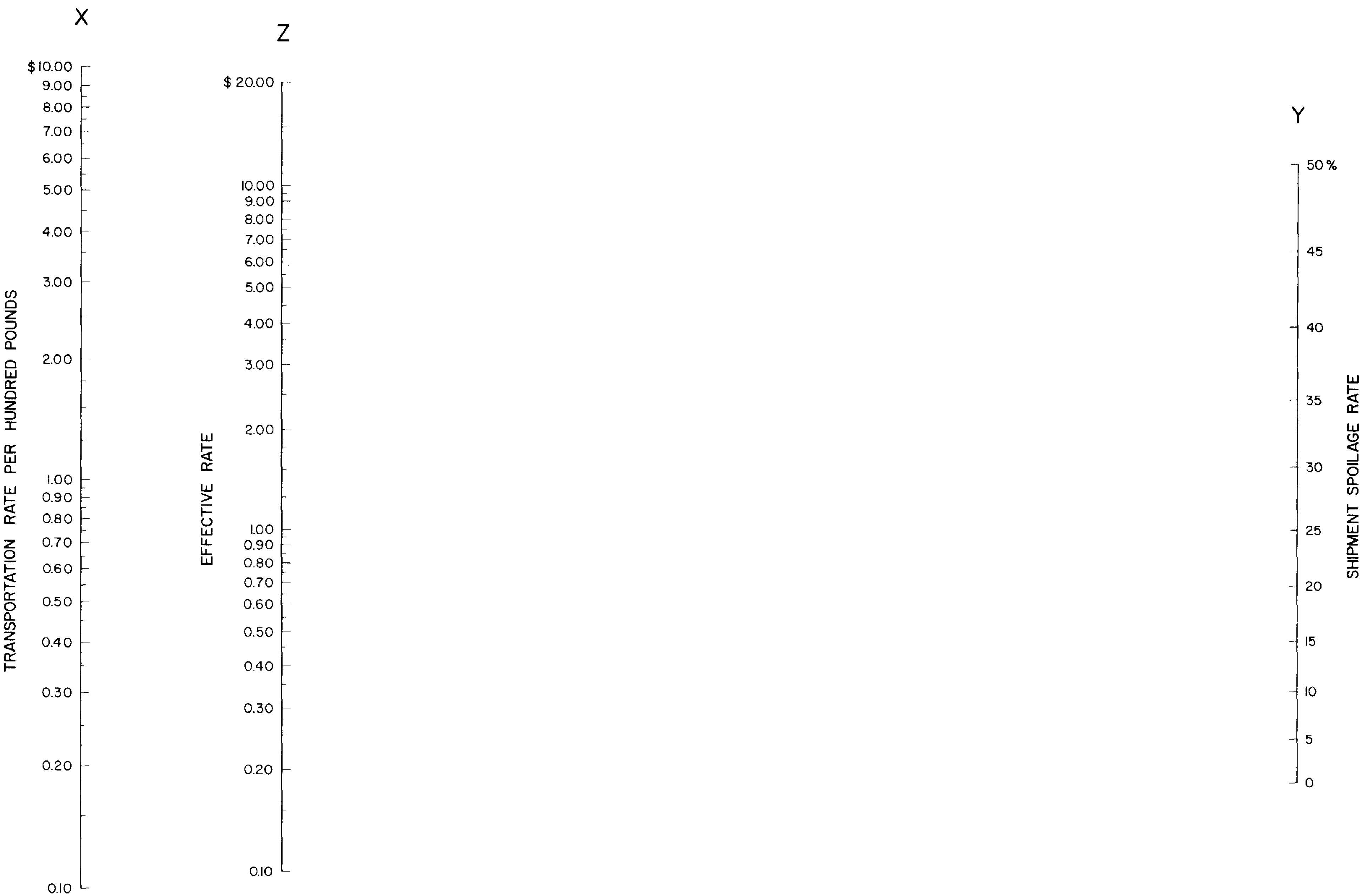
A nomograph is a device for rapid conversion of mathematical relationships by graphic means. The parallel alignment of the scale of the original variables leads to the third scale which provides the results of the calculations. Nomographs are especially useful in areas which put mathematical formulas to repeated use.

Obviously, more than one or two factors enter into the decision making process of shippers. The procedure described does, however, provide the opportunity for systematic quantification of relevant variables.

These particular nomographs were designed for rapid use in a simple and straightforward manner. The equations from which the scales were derived were presented in the previous section, and for the purpose at hand a discourse on the theoretical aspects of the nomographs is unnecessary.

Figure 4-5 depicts the method for determining the effective rate for a specific tariff charge, given some level of spoilage or loss. The known variables, X and Y, are transport charge and spoilage. The Z scale is the effective rate. Rates are computed in dollars per hundred

Figure 4-5



NOMOGRAPH FOR COMPUTING EFFECTIVE TRANSPORTATION COSTS CONSIDERING SPOILAGE IN TRANSIT pounds. To use, one aligns a straight edge on the X and Y scale and reads the effective rate from the Z scale. Using this procedure, it can be seen that, with an initial surface rate of $5.00 and zero spoilage, the effective rate would be $5.00. If, however, the expected spoilage was 10 percent, the effective rate would be $5.56. For maximum benefit, the user is urged to include all cost elements in the initial rate calculation.

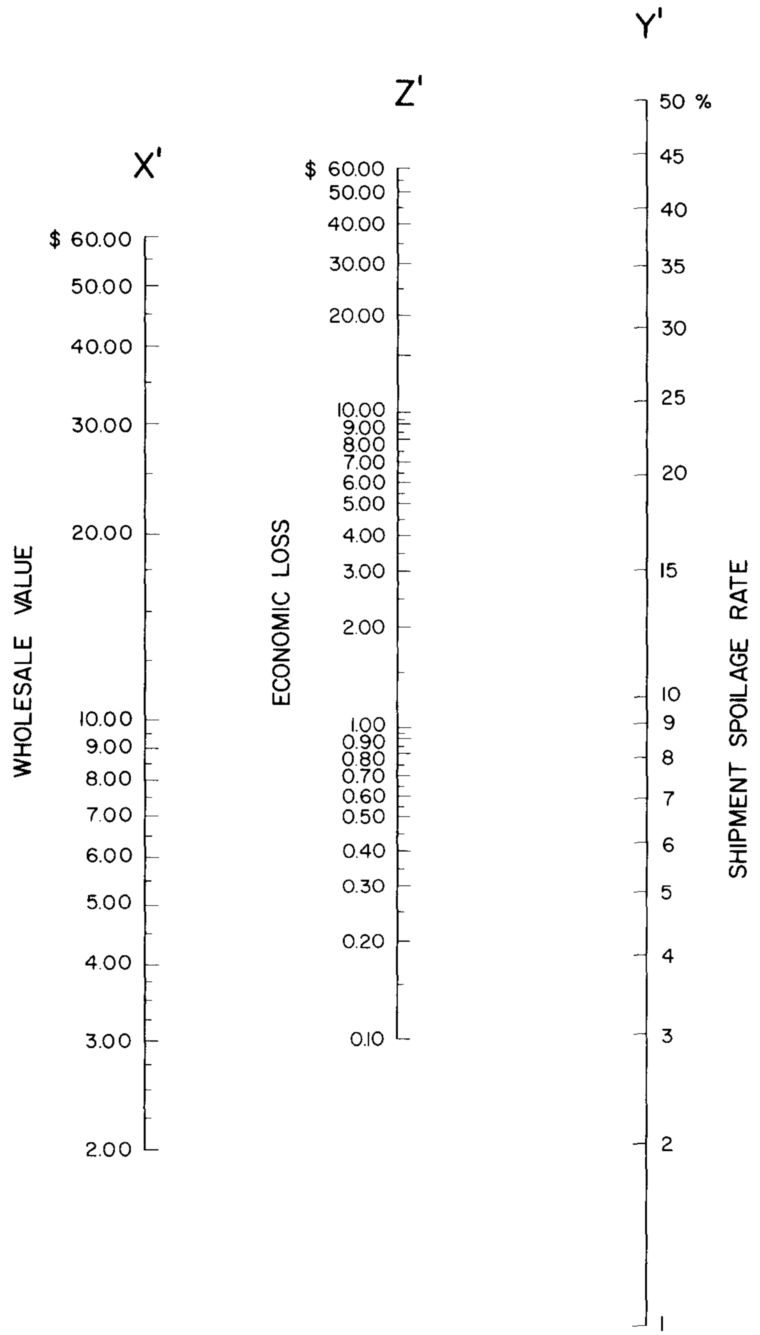
The economic loss resulting from spoilage is depicted on Figure 4-6. By placing a straight edge on the wholesale value and the anticipated spoilage rate used on Figure 4-5, the economic loss can be read from the Z' scale. The economic loss (Z' scale) is in dollars per hundred pounds. The total cost of the shipment with some specified level of spoilage is the sum of Z and Z'.

The use of nomographs in the analysis of transportation alternatives allows the user to directly determine the impact of spoilage on his cost structure. It provides the degree of flexibility necessary in agricultural enterprises. On a day to day basis, truck rates and wholesale values may shift by significant amounts, and the user can make the necessary adjustments within the range of the scales.

An alternative graphic approach is also available using the concept developed for establishing "decision bounds" based on spoilage. However, this procedure is limited to a two-dimensional presentation. The bounds computed are based on wholesale values and initial transport charges.

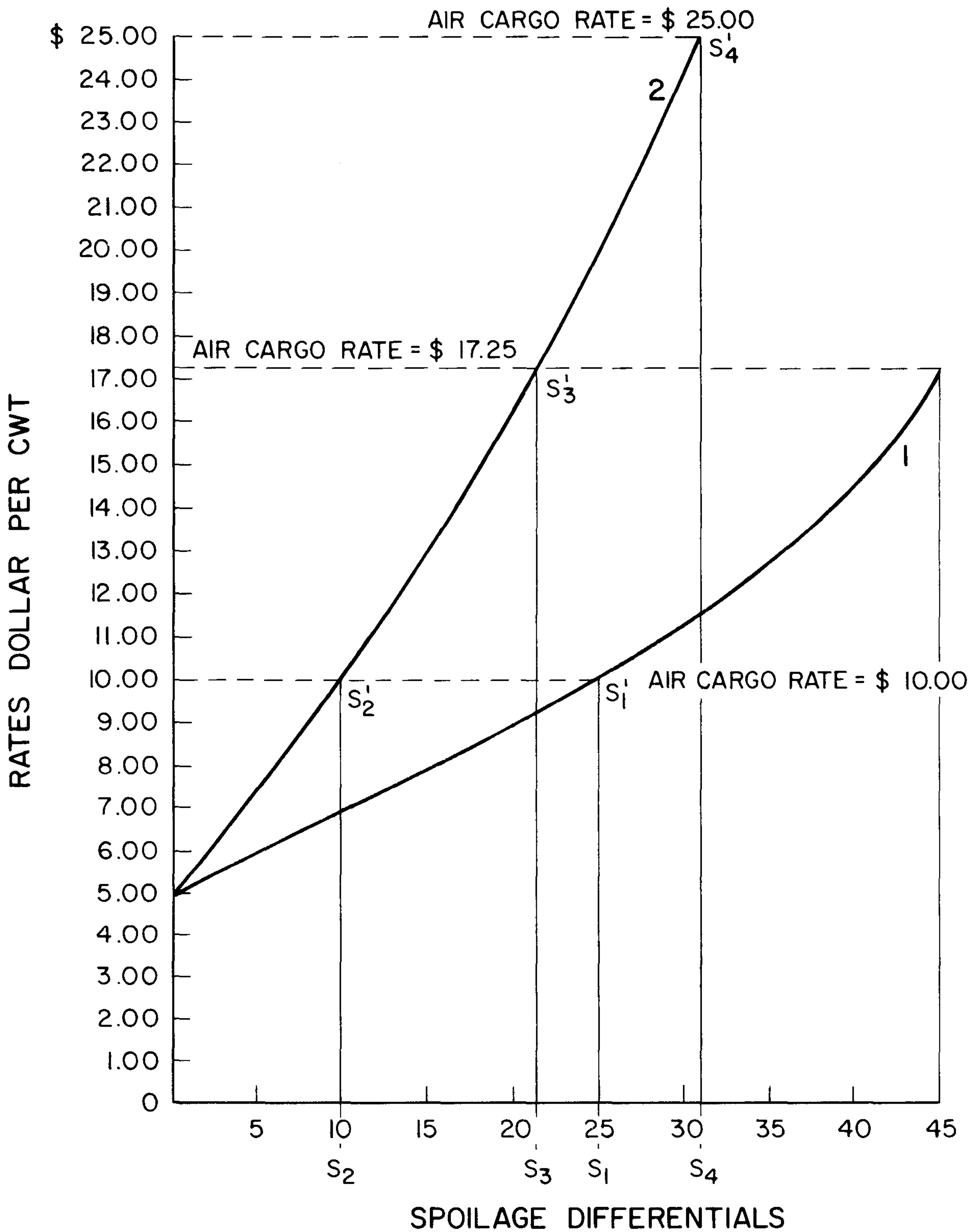
In Figure 4-7, the basic truck costs total $5.00 per hundred pounds, and the wholesale values are $10 and $40. Curve 1 is associated with the $10 wholesale value, whereas curve 2 refers to the $40 value. If the air cargo rate is $10 per hundredweight, the shipper of the commodity depicted by curve 1 would continue to ship by truck so long as the spoilage differential was less than 25 percent (S_1). The shipper of the commodity with a $40 wholesale value would choose air, once his expected spoilage differential exceeded 10 percent.

Figure 4-6



NOMOGRAPH FOR COMPUTING ECONOMIC LOSS CONSIDERING SPOILAGE IN TRANSIT

Figure 4-7



ESTIMATION OF DECISIONS BOUNDS FOR MOVING AGRICULTURAL COMMODITIES BY AIR CARGO

If the air cargo rate for commodity 1 to a different market was \$17.25 or less, and if the spoilage differential was 45 percent, the shipper would choose air for the shipment.

As an example, one can assume that a shipper supplies a particular market with an array of goods, with wholesale values between \$10 and \$40 and subject to various spoilage rates over the shipping period. The points S_1' and S_2' mark decision points for the shipper and specify the bounds of decision. Between these bounds are an infinite number of curves representing total economic cost. At spoilage rates greater than 25 percent, air would be used exclusively, whereas truck would be used if the expected spoilage differential was less than 10 percent. For spoilage differential between these extremes, the modal choice would be at the intersection of the appropriate curve and the air cargo rate.

This graphic procedure is limited in application since the typical shipper is usually confronted with a wide array of truck rates and wholesale values. However, a shipper with few commodities to a limited number of markets, confronted with stable surface rates and known air cargo rates, could delineate the decision bounds for use in evaluating alternative modes.

The air freight rate is held constant at zero spoilage since the analysis is based on spoilage differential between truck and air, and air is assumed to have a spoilage factor which is always less than the truck factor.

Part 5

FORECASTS

INTRODUCTION

Forecasts of air cargo movements form a key element in airport planning. Future cargo land use, number of freight gates, aprons, airside and landside surface vehicle traffic, proportion of all-cargo aircraft operations all hinge on such forecasts. While airlines are interested in revenue ton-miles, airport planners are interested in tons (for many purposes, cubic feet would be the best measure; however, direct information is not available). Airport planning is interested in enplaning, deplaning, and interplaning cargo, but only the former is available uniformly from public sources. Appropriately, forecasts herein for Texas and Texas hubs and non-hubs are given in tons. Basic historical data are from the Civil Aeronautics Board and Federal Aviation Administration, Airport Activity Statistics, calendar years 1962-1969. Because of a change to a more sophisticated data processing system, the calendar year 1970 data are not yet available. The 1970 data would have reflected the recession which impacted the aviation industry more severely than the economy as a whole. With revitalization of the economy, air cargo appears to be back on course.

The basic procedure adopted was to prepare a set of trend based forecasts and then to explore through several methods the various factors which might lead Texas shippers and consignees to utilize air cargo at rates above (or below) past trends.

Forecasts for total enplaned plus deplaned cargo were presented above in the SUMMARY, as were freight, express, and mail enplanement forecasts for Dallas-Fort Worth, Houston, San Antonio, and the summary for the 26 Texas smaller hubs and non-hubs. Total air cargo forecasts (freight, plus express, plus mail) along with methods are given for the United States, Texas, the top three hubs, and the residual summary immediately below. (El Paso is now classed as a medium hub on a passenger enplanement basis; however, it is still a low density cargo market with seven tons of cargo enplaned per 1,000 passengers in 1970 compared to the Texas average of 14.5.)

Next, individual forecasts for the 26 smaller Texas airports plus Texarkana are presented, with their methods. Freight, express, and mail originations are then given for the United States, Texas, the top three hubs, and the residual summary. The preceding topics cover air cargo originated by United States certificated route air carriers in total system operations including international. However, the international excludes cargo by foreign carriers. For completeness, weight of exports (comparable to cargo originations) and imports are forecasted for Texas gateway airports.

The discussions then shift to the exploration of latent demand. Texas changes in air freight, express, and mail performance vis à vis the United States are examined in light of relative performance in population, manufacturing, and income based on total and per capita calculations. Decreasing relative air freight performance in the light of increasing manufacturing relative performance (a previous discussion finding) is explored in detail, along with manufacturers' own estimate of air use. Air movement potential of agricultural commodities is assessed. Air exports by industry group are matched against Texas employment in those groups, and export potential is estimated.

Forecasts of technology were contained in the previous Part 4. Forecasts of all-cargo movements are shown in Part 6, Demand and Capacity Analysis.

TREND-BASED FORECASTS OF CARGO ORIGINATED BY CERTIFICATED CARRIERS FOR UNITED STATES, TEXAS AND TOP THREE TEXAS AIRPORTS

This section provides total cargo forecasts for Texas and its three major air hubs (and complementary, the total of the smaller hubs) based on a share of the market approach. The histories shown in Section III of air cargo originations by Texas certificated air carrier airports established a relatively stable pattern of shares of the market for the subject categories.

These trend-based forecasts are carried utilizing the share of the market method. The share of the market method is an accepted approach utilized by FAA in its hub forecasts[1/] and is the preferred method in cases of demonstrated stability. Other methods will be applied and reported in later technical notes. The method has been applied herein to total cargo. Because of special policy considerations, it is necessary to forecast mail separately from freight and express, and desirably for express. This forecast focuses on the major hubs; forecasts for the smaller hubs will be covered in a further section.

The results of the forecasts are given in Table 5-1 and Figure 5-1. Houston continues to gain on Dallas as it has historically, but Dallas remains number one. San Antonio continues to grow at about the same rate as the State, as does the total for the smaller airports.

Some independent hub forecasts, along with actual 1969 data, are available for comparison. The latest hub forecasts of FAA and the corresponding ERA (expected case) forecasts are shown in the following array (cargo in thousands of tons):

	Actual	FAA			ERA	
	1969	1970	1975	1980	1975	1980
Dallas-Fort Worth (large hub)	80	135	273	547	174	313
Houston (large hub)	33	31	74	178	92	195
San Antonio (medium hub)	15	30	48	77	34	66

For the United States, cargo growth from 1969 to 1970 was about three percent. Thus, the 1969 figures for the three cities are probably good indicators of their 1970 activity. The key assumption of the FAA estimates was a 19-20 percent annual growth rate in cargo tonnage; of the three cities, only Houston (20 percent) maintained such a rate over the 1962-1969 period; thus, its forecast was the only relatively accurate one, whereas Dallas-Fort Worth (13 percent growth) and San Antonio

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1/Federal Aviation Administration: Aviation Demand and Airport Facilities Requirements Forecasts for Large Air Transportation Hubs Through 1980 (Aug. 1967) and Aviation Demand and Airport Facilities Requirements Forecasts for Medium Air Transportation Hubs Through 1980 (Jan. 1969).

Table 5-1

FORECASTS OF DOMESTIC PLUS FOREIGN AIR CARGO ON U. S. CERTIFICATED CARRIERS; U. S., TEXAS, TOP THREE TEXAS HUBS, AND TEXAS RESIDUAL
1975, 1980, 1985, and 1990

		Thousands of Tons			
		1975	1980	1985	1990
Low Growth 12%	U. S.	6100	10700	18800	33100
	Texas	299	525	922	1622
	DFW	159	262	452	795
	HOU	84	163	295	519
	SAT	32	55	97	170
	Residual	24	45	78	138
Median Growth 14%	U. S.	6700	12800	24600	47200
	Texas	328	627	1206	2313
	DFW	174	313	591	1133
	HOU	92	195	386	740
	SAT	34	66	127	243
	Residual	28	53	102	197
High Growth 16%	U. S.	7300	16100	33800	71000
	Texas	358	789	1657	3479
	DFW	190	395	811	1706
	HOU	100	244	531	1112
	SAT	38	83	174	365
	Residual	30	67	141	296

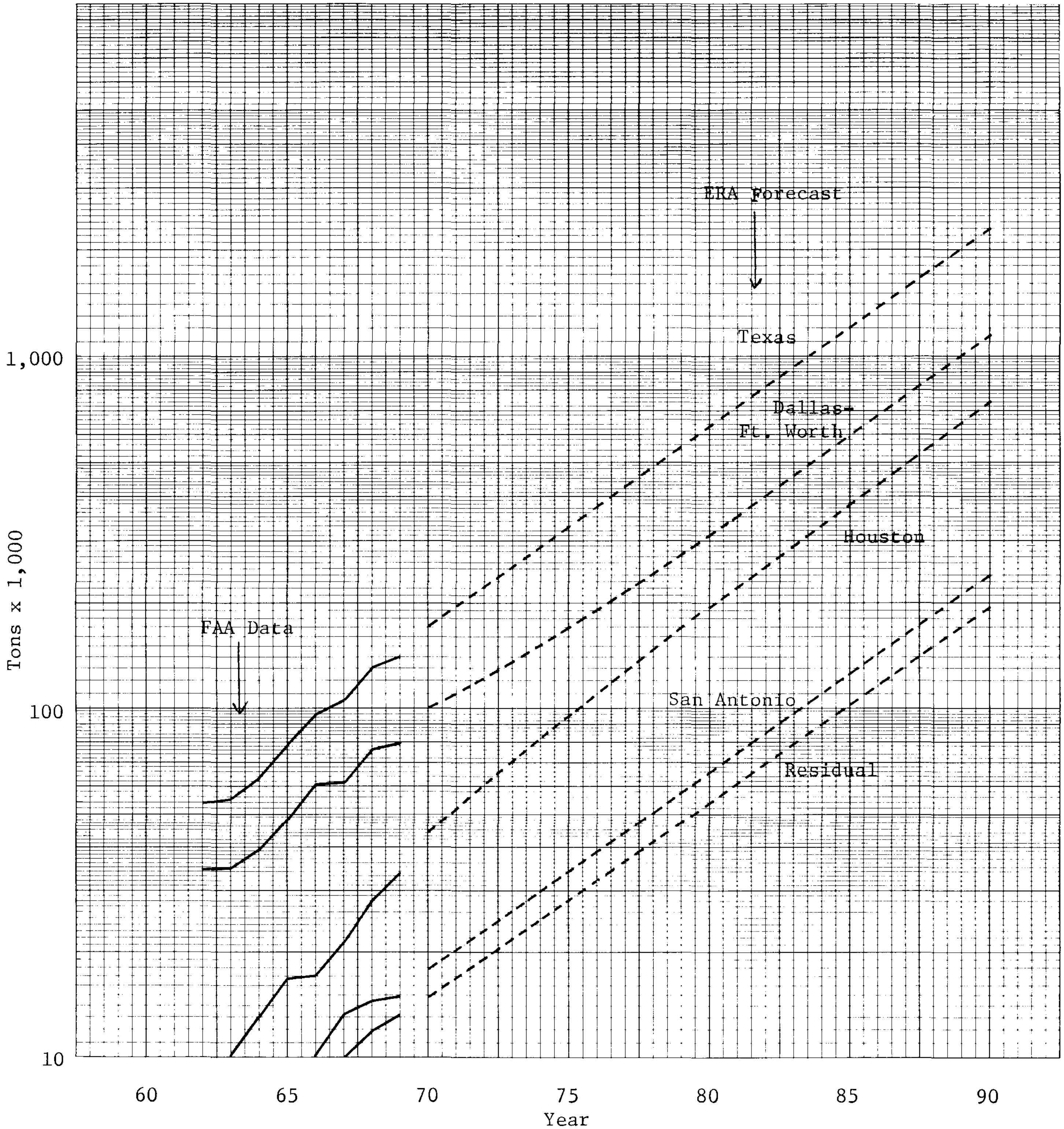

Figure 5-1

MEDIAN FORECASTS OF DOMESTIC PLUS FOREIGN AIR CARGO
ON U.S. CERTIFICATED CARRIERS: TEXAS,
TOP THREE TEXAS HUBS, TEXAS RESIDUAL
1970-1990

(17 percent growth) activity projections turned out too high. It should be noted that, because ERA includes both domestic and foreign carrier cargo, its forecast for Houston is above the corresponding 1975 and 1980 figures, which reflect only domestic carrier activity.

As previously stated, the forecasts were arrived at by share-of-the-market method. This method permits the utilization of independent global or national forecasts, either singly or in combination. The independent aggregate forecasts usually represent an investment of resources far beyond that which could be afforded on smaller studies. The adoption of forecasts of an official or semiofficial nature also permits better cross-analysis of state and regional aviation plans. To these aggregate forecasts were applied the shares of the market trends observed over the jet aircraft period. A detailed exposition of the methodology follows.

The aggregate forecasts were taken from the Civil Aeronautics Board (CAB) forecast, published in February 1971, for the 1971-1975 period, and Air Transport Association (ATA) projections, published in 1969, for 1970-1985. These forecasts are compared to several others, as shown in Figure 5-2. While the bases are different, it is instructive to compare growth rates of the several forecasts. (Note: cargo is defined as the sum of freight, express, and mail.) The two selected for this study are the more conservative, reflecting more recent experience.

The CAB report analyzes cargo in terms of ton-miles (one ton-mile = one ton carried one mile) rather than tons. The CAB ton-mile figures for 1962-1969 were divided by corresponding FAA ton data to yield an average length-of-haul (trip length in miles) for each year; see Table 5-2.

While the average length-of-haul rose from 1962 to 1967, it has since been declining slightly; this has likely resulted from lowered air cargo rates, making previously uneconomic short-haul shipments feasible.

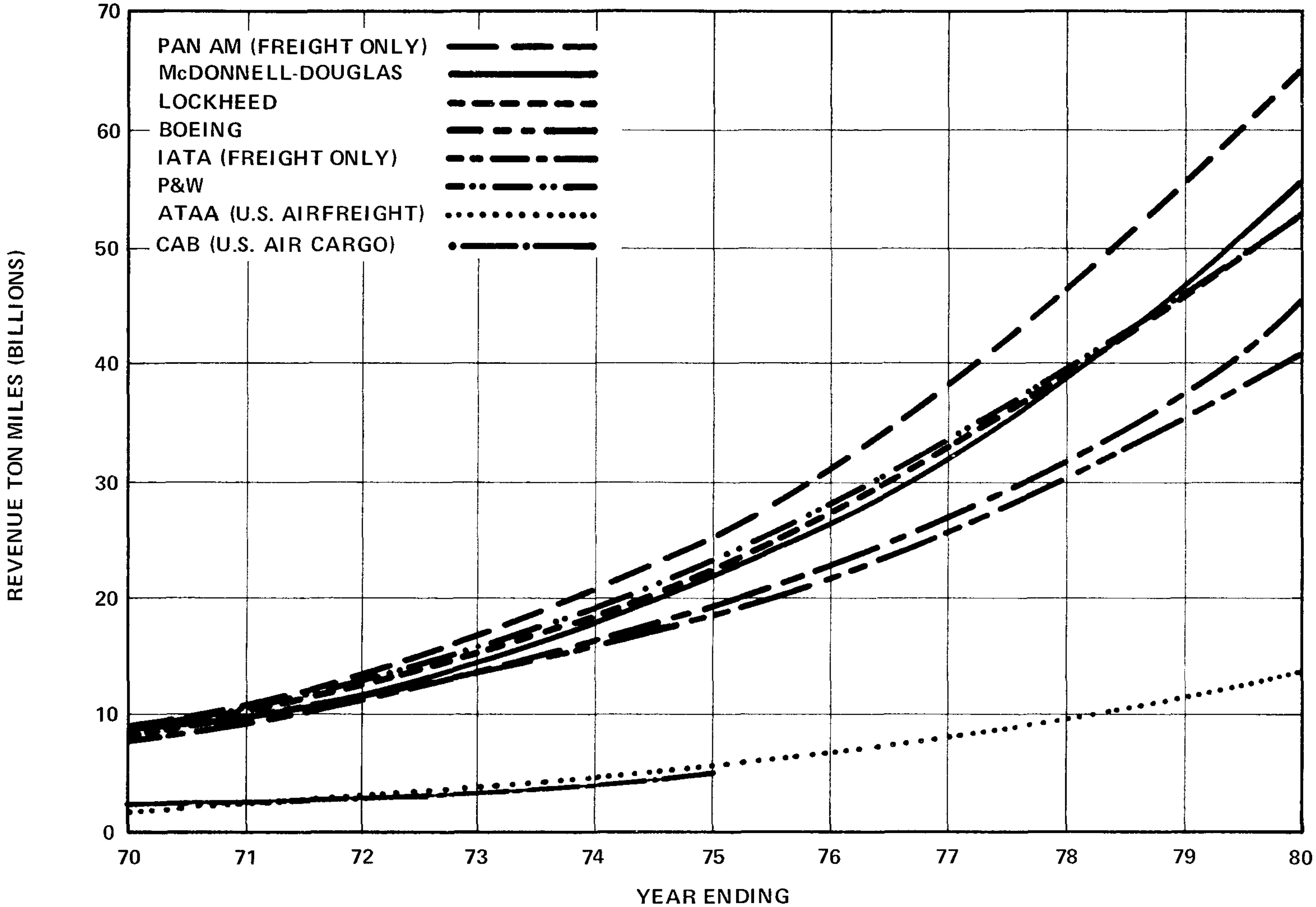

FIGURE 5-2

COMPARATIVE FORECASTS TO 1980 OF FREE WORLD AIR CARGO TON-MILES AND U.S. DOMESTIC AIR FREIGHT

Table 5-2

HISTORIES OF DOMESTIC AIR CARGO ON U.S. CERTIFICATED CARRIERS; FOR U.S., TON-MILES, TONS, AND CALCULATED AVERAGE LENGTH-OF-HAUL
1962-1969

	CAB Ton-Miles (millions)	FAA Tons (millions)	Average Length-of-Haul (miles)
1962	877	1.05	835
1963	962	1.12	859
1964	1173	1.31	895
1965	1469	1.62	907
1966	1866	1.90	982
1967	2154	2.19	984
1968	2609	2.67	977
1969	2832	2.94	963

Sources: Civil Aeronautics Board: Forecast of Scheduled Domestic Air Cargo for the 50 States, 1971-1975, February 1971; Federal Aviation Administration: Airport Activity Statistics of Certificated Route Air Carriers, 1962-69 editions.

These haul statistics will also be used - because of the lack of FAA data - to estimate 1970 cargo tonnage. The tentative CAB ton-mile total for 1970 is 2,915 million, conservatively applying the average length-of-haul of 1969 (rather than assuming a further drop) of 963 miles:

Tonnage = 2,915 ton-miles (millions) ÷ 963 miles = 3.03 tons (millions)

The ATA study covers cargo carried by both domestic and foreign carriers, and, thus, its figures are higher than corresponding FAA or CAB data. While it examined the past in terms of ton-miles (like CAB), its forecast is on a ton basis (like FAA); in millions: 1975 - 8.44, 1980 - 18.03, 1985 - 37.71.

The ATA cargo projection implicitly assumes an annual growth of 16 percent. Others go higher: airplane manufacturers (e.g., McDonnell-Douglas) use 20 percent,and industry publications (e.g., Aviation Week and Space Technology) often use an 18 percent rate. The CAB study has an "expected" rate of 14 percent, with a 12 percent "low" and a 16 percent "high" as feasible alternatives.

Interestingly, the 1962-1969 FAA data show an annual 16 percent increase; incorporating the estimate for 1970 (a low-growth year for business in general), the 1962-1970 period would have a 14 percent rate. The latter would seem more realistic: it incorporates a mediocre year to go along with an exceptional high-growth period of the mid- and late-1960's. As this is the CAB standard, and their analysis (incorporating separate studies of freight, express, and mail and their correlative to GNP and to cargo rates) supporting this rate in addition to the low and high boundaries is impressive, their set of growth factors - 12 percent, 14 percent, and 16 percent - will be utilized here.

Before applying these, it is necessary to adjust the 1970 domestic cargo estimate of 3.03 million tons to one covering both domestic and foreign air carrier activity. The last ATA study figure was for 1969: 3.42 million tons versus the 1969 FAA count of 2.94 million tons. From these two data, it may be inferred that 3.42 - 2.94 = .48 million tons, or

14.0 percent (.48 ÷ 3.42) of the United States total, is accounted for by the foreign carriers. Thus, the FAA figure can be regarded as representing 86.0 percent of total tonnage; i.e., 1970 domestic and foreign tonnage = 3.03 million tons ÷ 86.0 percent = 3.53 million tons.

With this as base year activity, the three growth rates can be applied to yield low, median, and high forecasts (See Table 5-3). These, along with the FAA data and the ATA projection, are presented graphically in Figure 5-3.

FAA histories of originated cargo (for domestic certified air carriers) for Texas and the three major hubs for the period 1962-1969 serve as the basis for establishing shares of the market. Historic shares are shown in Table 5-4.

While the Texas/United States share can be set for the 1970-1990 forecast period at a constant 4.9 percent, it is noted that the Dallas-Fort Worth and Houston (and, to a lesser extent, San Antonio) percentages are changing. Thus, separate values for the 1975, 1980, 1985, and 1990 base points must be considered.

While San Antonio has risen from the 1962-1963 value of nine percent, it seems to be leveling off now. Computing its shares for the last four years: 1966 - 10.56 percent, 1967 - 12.60 percent, 1968 - 11.11 percent, 1969 - 10.55 percent. The very high value for 1967, and somewhat high one for 1968, resulted from air shipments generated by the April-June 1968 Hemisfair; the more representative years, 1966 and 1969, show remarkably close agreement around 10.5 percent. This figure will be set as the San Antonio share of Texas cargo for the 1970-1990 horizon.

In the "History" section, the top three hubs consistently accounted for 91 percent or 92 percent of state activity and were thus assigned a constant 91.5 percent long-term share. Subtracting the 10.5 percent San Antonio portion leaves a combined 81 percent to be allocated between Dallas-Fort Worth and Houston. Table 5-3 shows that for 1962-1969.

Table 5-3

LOW, MEDIAN, AND HIGH FORECASTS OF DOMESTIC PLUS FOREIGN AIR CARGO ON U.S. CERTIFICATED CARRIERS FOR U.S. 1975, 1980, 1985, 1990

	Millions of Tons		
	Low (12%)	Median (14%)	High (16%)
1975	6.1	6.7	7.3
1980	10.7	12.8	16.1
1985	18.8	24.6	33.8
1990	33.1	47.2	71.0

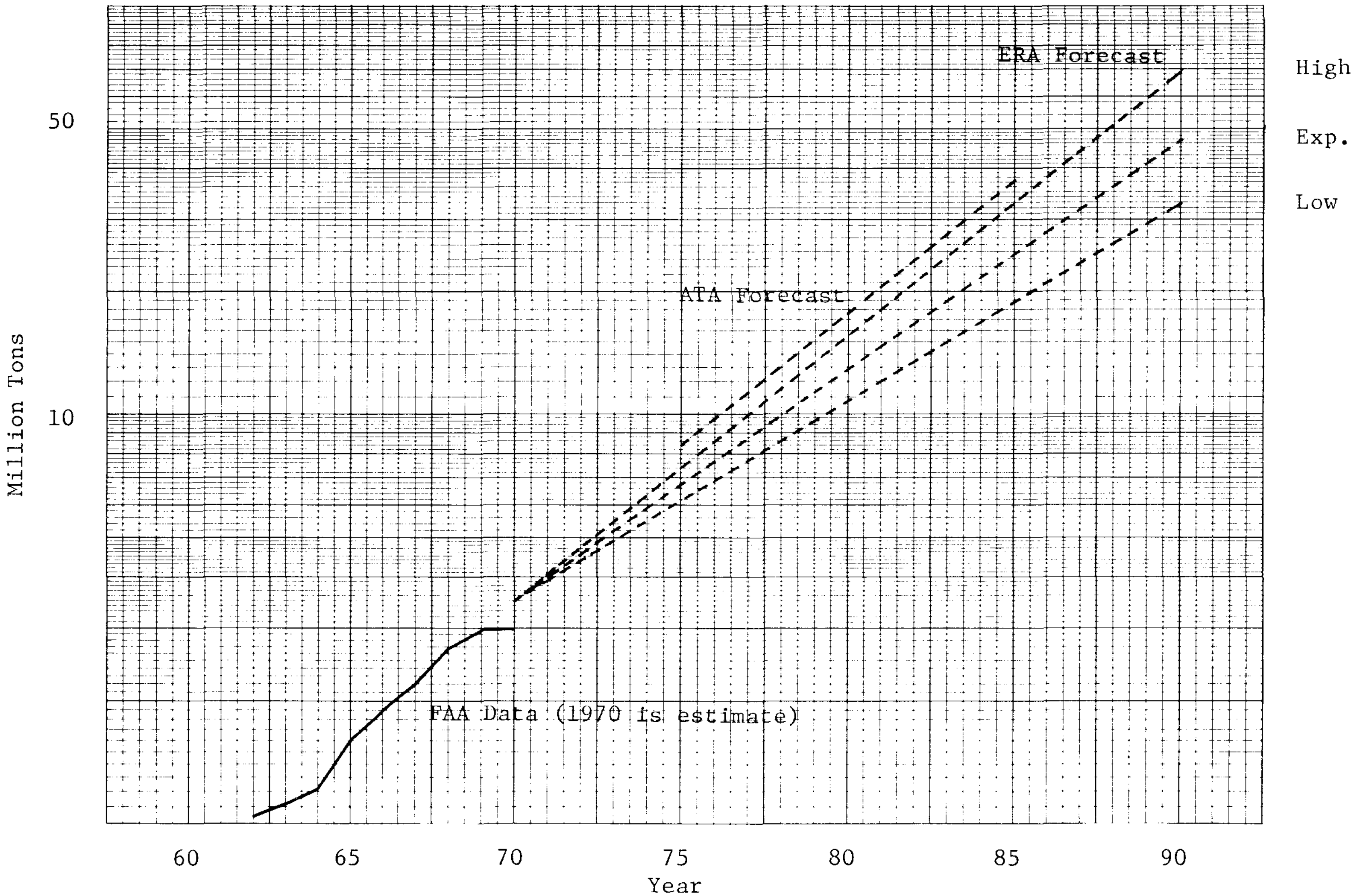

Figure 5-3
HISTORY AND LOW, MEDIAN, HIGH, AND ATA FORECASTS OF
(HISTORY--DOMESTIC ONLY, FORECASTS--DOMESTIC PLUS FOREIGN) AIR CARGO ON
U.S. CERTIFICATED CARRIERS FOR U.S., 1962-1990

Table 5-4

HISTORY OF TEXAS AS SHARE OF U.S. AIR CARGO MARKET AND TOP THREE TEXAS HUBS' SHARE OF TEXAS AIR CARGO MARKET*
1962-1969

		As Portion of Texas		
	Texas/ U.S.	Dallas-Ft. Worth	Houston	San Antonio
1962	5.1	65	17	9
1963	4.9	64	19	9
1964	4.9	62	21	10
1965	4.9	61	21	10
1966	5.0	64	18	11
1967	4.8	58	20	13
1968	4.9	58	21	11
1969	4.8	56	24	11

*For certificated air carriers.

the Houston role rose from 17 percent to 24 percent, whereas Dallas dropped from 65 percent to 56 percent. During this time, Houston cargo increased at a 20 percent annual rate, 9,100 tons in 1962 and 33,500 tons in 1969; Dallas-Fort Worth grew 13 percent annually, 34,700 tons in 1962 to 79,600 tons in 1969. (Houston's greater growth reflects, to an extent, starting from a low 1962 activity base. There was at that time, apparent underutilization of air shipment potential.) The median 1970-1990 United States rate was previously set at 14 percent; it is assumed that both Houston and Dallas-Fort Worth will approach this rate in the long run.

The specific estimates for such a forecast scenario are delineated in Table 5-5; the resultant cargo activity is shown directly below. (Note: tonnage figures here derive from city-specific rates based on 1969 domestic cargo data and do not correspond to the United States-derivative forecasts, which use a 1970 domestic and foreign base, formulated before in this study.) And from their respective tonnages, the two cities' shares (using the guideline that they together account for 81 percent of Texas cargo activity) are then computed. These 1970-1990 shares are graphed along with the corresponding 1962-1969 shares in Figure 5-4. One should note the evolution to a "steady-state" situation after 1980, with 49 percent for Dallas-Fort Worth and 32 percent for Houston. Essentially the same pattern, and steady-state shares, emerged when the two cities' rates were tapered to the alternative low (12 percent) and high (16 percent) United States forecasts.

TREND-BASED FORECASTS OF CARGO ORIGINATED BY CERTIFICATED CARRIERS FOR THE RESIDUAL 26 TEXAS AIRPORTS

In the preceding section, cargo activity for Texas and its top three hubs (Dallas-Fort Worth, Houston, and San Antonio) was projected for the years 1975, 1980, 1985, and 1990. Correspondingly, a forecast of "Residual" - that is, the sum of traffic at the state's other 26 hubs - was made; this sum will now be allocated to the individual airports.

As before, the market share technique will be the foundation for the projections. The Residual 26 airports' shares of Texas cargo for the

Table 5-5

HISTORY AND FORECAST SCENARIO OF DALLAS-FORT WORTH AND HOUSTON
GROWTH RATES, AIR CARGO, AND SHARE OF TEXAS MARKET
1962, 1969, 1975, 1980, 1985, AND 1990

		1962	→	1969	→	1975	→	1980	→	1985	→	1990
Growth Rates	DFW		13%		13%		13%		14%		14%	
	HOU		20%		18%		16%		15%		14%	
Cargo (Tons x 1000)	DFW	34.7		79.6		166		306		588		1130
	HOU	9.1		33.5		90		190		382		734
Share of Texas	DFW	65%		56%		53%		50%		49%		49%
	HOU	17%		24%		28%		31%		32%		32%

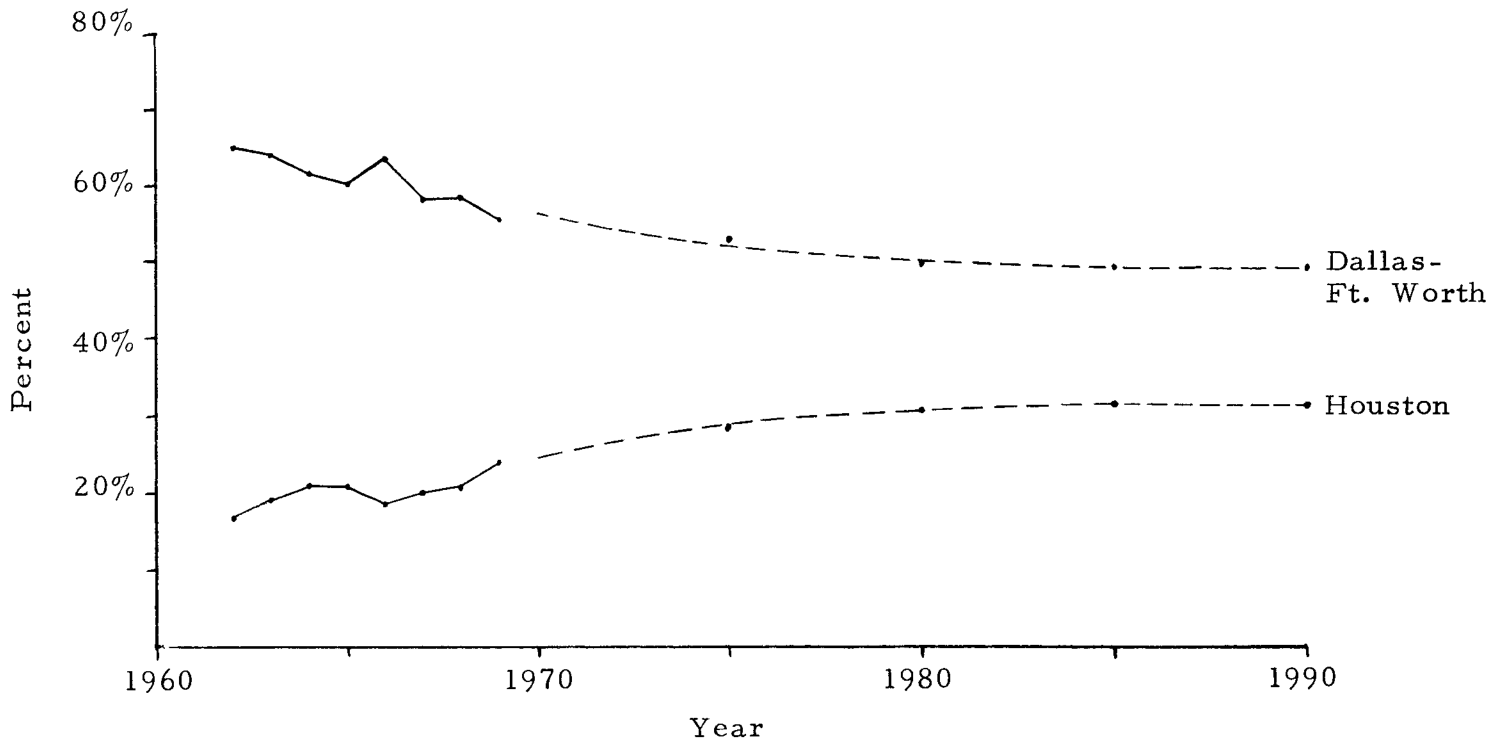

Figure 5-4

HISTORY AND FORECAST OF DALLAS-FORT WORTH AND HOUSTON SHARES OF TEXAS MARKET
1962-1990

1962-1969 period are shown in Table 5-6, computed percentages are based on Texas Transportation Institute data. These shares are predominantly under one percent; in 1969 only Austin and El Paso were above that level.

Next, constant long-run percentage shares are forecast for each of the Residual 26 (see Table 5-7). Most of these, as indicated in the "Basis" column, rely on an average of past portions, e.g., Abilene's .25 percent is the mean of its 1964-1969 values (1962-1963 values were much lower and were considered unrepresentative). Exceptions - where a hub share was changing rather than remaining at a constant level - are duly noted, and the individual forecast basis explained.

The forecast of the long-run Top Three total share of Texas traffic at 91.5 percent sets the Residual 26 total cargo portions at 100% - 91.5% = 8.5%. The sum derived from Table 5-7, however, is 10 percent. This difference results from the forecast's separate bases: the earlier one was built on the steady (and predictable) 1962-1969 pattern of the Top Three hubs, whereas the latter is the total of 26 smaller hubs' individual projections - which had to be estimated in various ways as many exhibited erratic 1962-1969 behavior. Because of its higher element of certainty, the 8.5 percent will be regarded as the Residual 26 total share of Texas cargo. The long-run percentage shares in Table 5-7 will be prorated accordingly, by a factor of 8.5% x 10% = .85; e.g., Abilene's share of .25 percent becomes .25% x .85 = .21%.

With this adjustment, given the 1975, 1980, 1985, and 1990 "Residual" tonnage totals, each of the smaller hubs' future cargo activity is projected as shown in Table 5-8. Texarkana airport traffic statistics are not a part of this Texas total. Table 5-8a presents cargo and passenger statistics and shows these as a share of Texas total. Behavior of cargo was very erratic: note the big jump in mail, 1965 to 1966, and of freight, 1968 to 1969. The higher values were not considered representative and the 1968 share was used for forecast purposes.

Table 5-6

RESIDUAL 26 HUBS' SHARES
OF TEXAS CARGO ACTIVITY, 1962-1969

Hub	1962	1963	1964	1965	1966	1967	1968	1969
	Percentage							
Abilene	.204	.187	.221	.241	.300	.285	.241	.234
Amarillo	.537	.510	.544	.605	.625	.916	.897	.779
Austin	.595	.612	.641	.645	.669	.861	1.17	1.41
Beaumont/ Pt. Arthur	.606	.739	.516	.574	.415	.421	.420	.389
Big Spring	.024	.029	.041	.051	.073	.083	.057	.046
Borger	.015	.018	.016	.013	.010	.009	.009	.009
Brownsville	.189	.130	.158	.107	.110	.136	.173	.161
Brownwood	.024	.020	.027	.024	.021	.028	.033	.038
College Station/ Bryan	.052	.059	.048	.051	.050	.063	.064	.062
Corpus Christi	.680	.604	.635	.768	.831	.871	.930	.950
El Paso	2.62	2.36	2.32	2.25	2.10	2.46	2.06	2.35
Galveston	.021	.018	.056	.033	.021	.019	.012	.021
Harlingen/ San Benito	.357	.344	.286	.227	.173	.160	.405	.216
Laredo	.092	.091	.185	.170	.136	.138	.161	.185
Longview/ Kilgore/ Gladewater	.198	.225	.205	.177	.179	.194	.163	.137
Lubbock	.384	.477	.461	.472	.515	.549	.581	.618
Lufkin	.054	.049	.048	.041	.030	.037	.041	.039
Midland/Odessa	.797	.667	.746	.645	.596	.800	.677	.760
Mission/McAllen/ Edinburgh	.251	.287	.254	.185	.259	.250	.139	.167
Paris	.060	.046	.047	.046	.041	.046	.056	.031
San Angelo	.211	.196	.145	.104	.151	.133	.140	.152
Temple	.134	.154	.133	.127	.116	.134	.169	.156
Tyler	.148	.168	.188	.179	.159	.176	.136	.117
Victoria	.058	.075	.052	.048	.052	.051	.046	.025
Waco	.194	.194	.189	.210	.188	.213	.219	.178
Wichita Falls	.183	.174	.178	.185	.186	.198	.232	.308
Texas Totals	100	100	100	100	100	100	100	100

Table 5-7

RESIDUAL 26 HUBS' SHARES
OF TEXAS CARGO ACTIVITY, FORECAST HORIZON

Hub	Long-Run Percentage	Basis
Abilene	.25	64 - 69
Amarillo	.87	67 - 69
Austin	1.60	Tapered growth: 67-68 @ 40 %; 68-69 @ 20 %; set 69-70 @ 10 %, 70-71 @ 5 %
Beaumont/Pt. Arthur	.41	66 - 69
Big Spring	.03	Fall back to original level
Borger	.01	66 - 69
Brownsville	.15	62 - 69
Brownwood	.03	62 - 69
College Station/Bryan	.06	62 - 69
Corpus Christi	1.00	Rise at more gradual rate
El Paso	2.32	62 - 69
Galveston	.02	62 - 69; 64 deleted
Harlingen/San Benito	.24	62 - 69
Laredo	.16	64 - 69
Longview/Kilgore/Gladewater	.18	62 - 69
Lubbock	.72	Steady 65-69 rise, extend for 3 years
Lufkin	.04	62 - 69
Midland/Odessa	.71	62 - 69
Mission/McAllen/Edinburgh	.15	68 - 69
Paris	.05	62 - 69
San Angelo	.14	64 - 69; 65 deleted
Temple	.14	62 - 69
Tyler	.16	62 - 69
Victoria	.05	62 - 69
Waco	.20	62 - 69
Wichita Falls	.31	Use uptrend 69 value
Residual 26 Total	10.00 %	

Table 5-8

RESIDUAL 26 HUBS: FORECAST OF DOMESTIC PLUS FOREIGN AIR CARGO ON U.S. CERTIFICATED CARRIERS

	Tons			
Hub	1975	1980	1985	1990
Abilene	700	1,325	2,550	4,925
Amarillo	2,436	4.611	8,874	17,139
Austin	4,480	8,480	16,320	31,520
Beaumont/Pt. Arthur	1,048	2,173	4,182	8,077
Big Spring	84	159	306	591
Borger	28	53	102	197
Brownsville	420	795	1,530	2,955
Brownwood	84	159	306	591
College Station/Bryan	168	318	612	1,182
Corpus Christi	2,800	5,300	10,200	19,700
El Paso	6,496	12,296	23,664	45,604
Galveston	56	106	204	394
Harlingen/San Benito	672	1,272	2,448	4,728
Laredo	448	848	1,632	3,152
Longview/Kilgore/Gladewater	504	954	1,836	3,546
Lubbock	2,016	3,816	7,344	14,184
Lufkin	112	212	408	788
Midland/Odessa	1,988	3,763	7,242	13,987
Mission/McAllen/Edinburgh	420	795	1,530	2,955
Paris	140	265	510	985
San Angelo	392	742	1,428	2,758
Temple	392	742	1,428	2,758
Tyler	448	848	1,632	3,152
Victoria	140	265	510	985
Waco	560	1,060	2,040	3,940
Wichita Falls	868	1,643	3,162	6,107
Residual 26 Total	28,000	53,000	102,000	197,000

Table 5-8a

TEXARKANA DATA AND FORECASTS
1962-1969

	1962	1963	1964	1965	1966	1967	1968	1969	Forecast
Cargo (tons)	166	195	223	461	548	461	562	846	
Freight	21	32	43	201	90	73	107	412	
Express	31	22	23	27	15	23	28	33	
Mail	114	141	157	233	443	365	427	401	
PAX (x 1,000)	9.0	10	12	14	17	20	23	24	
Cargo Share (%)	.31	.36	.35	.59	.57	.44	.43	.60	.43
PAX Share (%)	.27	.27	.28	.27	.26	.27	.26	.26	.27
Role Ratio	1.15	1.33	1.25	2.19	2.19	1.63	1.65	2.31	1.59

	1975	1980	1985	1990
Cargo (tons)	1,409	2,695	5,280	9,951
PAX (x 1,000)	44	73	119	192
Factor (lb./pass.)	64	77	89	104

Source: FAA, Annual Airport Activity Statistics, 1962-1969 editions.

FORECASTS OF FREIGHT, EXPRESS, AND MAIL ORIGINATED: UNITED STATES, TEXAS, TOP THREE HUBS, AND RESIDUAL

This study extends the analysis of the first section, in which general cargo projections were made; here, the three components of cargo traffic - freight, express, and mail - are separately examined. As before, the share of market technique is the foundation of the forecasts. For freight, express, and mail, respectively, these forecasts are tabulated in Tables 5-9, 5-10, and 5-11 and graphed in Figures 5-5, 5-6, and 5-7. From the three graphs, it is seen that the five Texas entities - the State as a whole, Dallas-Fort Worth (abbreviated as DFW), Houston (HOU), San Antonio (SAT), and the Residual (which is the other 26 Texas hubs) - generally have similar growth rates. The one exception is Houston's rising share of freight traffic, at the expense of Dallas-Fort Worth.

As before, the adopted aggregate United States forecasts - to which the market shares will be applied - are the February 1971 Civil Aeronautics Board (CAB) paper covering 1971-1975 and the June 1969 Air Transport Association (ATA) one for 1970-1985. Both were comprehensive and set growth rates and projections for each of the three cargo components.

For freight, the CAB estimated low, median, and high long-run annual growth: respectively, 12.7 percent, 15.4 percent, and 18.2 percent. The ATA, on the other hand, made only one forecast, with slightly tapering annual growth rates over time: 19.3 percent for 1970-1975, 18.5 percent for 1975-1980, and 17.0 percent for 1980-1985. Because the CAB figures are more up-to-date and reflect recent moderate growth along with the rapid uptrend of the mid- and late-1960's, they will be utilized here but rounded as follows: low - 13 percent, median - 15.5 percent, and high - 18 percent. (Note: The CAB rates apply to traffic in terms of ton-miles; because average length of haul for freight has been constant lately, the same rates apply to tons.)

Table 5-9

FORECASTS OF DOMESTIC PLUS FOREIGN AIR FREIGHT ON U. S. CERTIFICATED CARRIERS; U. S., TEXAS, TOP THREE HUBS, AND RESIDUAL 1975, 1980, 1985, and 1990

		Thousands of Tons			
		1975	1980	1985	1990
Low Growth 13%	U. S.	4300	8270	15550	28820
	Texas	197.9	384.4	728.2	1358.6
	DFW	99.3	180.0	338.4	639.6
	HOU	63.5	134.6	256.4	468.5
	SAT	20.6	39.1	75.2	140.3
	Residual	14.5	30.7	58.2	110.2
Median Growth 15.5%	U. S.	4810	10200	21050	42460
	Texas	220.8	475.4	991.7	2017.6
	DFW	111.0	224.4	464.9	958.0
	HOU	70.4	164.7	344.5	684.5
	SAT	22.0	48.9	102.5	209.2
	Residual	17.4	37.4	79.8	165.9
High Growth 18%	U. S.	5340	13140	29570	65200
	Texas	245.9	615.1	1403.1	3113.8
	DFW	123.9	293.1	661.3	1489.0
	HOU	77.6	209.7	482.4	1044.3
	SAT	25.4	63.2	144.9	322.9
	Residual	19.0	49.1	114.5	257.6

Table 5-10

FORECASTS OF DOMESTIC PLUS FOREIGN AIR EXPRESS ON U.S. CERTIFICATED CARRIERS; U.S., TEXAS, TOP THREE HUBS, AND RESIDUAL 1975, 1980, 1985, and 1990

		Thousands of Tons			
		1975	1980	1985	1990
Low Growth 5%	U.S.	330	430	570	730
	Texas	17.9	24.8	33.8	45.0
	DFW	12.1	16.7	22.9	30.6
	HOU	3.5	4.8	6.3	8.2
	SAT	0.7	1.0	1.4	1.8
	Residual	1.6	2.3	3.2	4.4
Median Growth 5.5%	U.S.	340	440	580	750
	Texas	18.9	25.9	35.1	47.2
	DFW	12.8	17.4	23.8	32.3
	HOU	3.6	5.0	6.5	8.4
	SAT	0.8	1.0	1.4	1.9
	Residual	1.7	2.5	3.4	4.6
High Growth 6%	U.S.	340	460	650	840
	Texas	19.9	26.9	37.0	53.6
	DFW	13.5	18.2	25.1	36.8
	HOU	3.8	5.1	6.8	9.4
	SAT	0.8	1.1	1.5	2.2
	Residual	1.8	2.5	3.6	5.2

Table 5-11

FORECASTS OF DOMESTIC PLUS FOREIGN AIR MAIL ON U.S. CERTIFICATED CARRIERS; U.S., TEXAS, TOP THREE HUBS, AND RESIDUAL 1975, 1980, 1985, and 1990

		Thousands of Tons			
		1975	1980	1985	1990
Low Growth 5.5%	U.S.	1470	2000	2680	3550
	Texas	83.2	115.8	160.0	218.4
	DFW	47.6	65.3	90.7	124.8
	HOU	17.0	23.6	32.3	42.3
	SAT	10.7	14.9	20.4	27.9
	Residual	7.9	12.0	16.6	23.4
Median Growth 6.5%	U.S.	1550	2160	2970	3990
	Texas	88.3	125.7	179.2	248.2
	DFW	50.2	71.2	102.3	142.7
	HOU	18.0	25.3	35.0	47.1
	SAT	11.2	16.1	23.1	31.9
	Residual	8.9	13.1	18.8	26.5
High Growth 7.5%	U.S.	1620	2500	3580	4960
	Texas	92.2	147.0	216.9	411.6
	DFW	52.6	83.7	124.6	180.2
	HOU	18.6	29.2	41.8	58.3
	SAT	11.8	18.7	27.6	39.9
	Residual	9.2	15.4	22.9	33.2

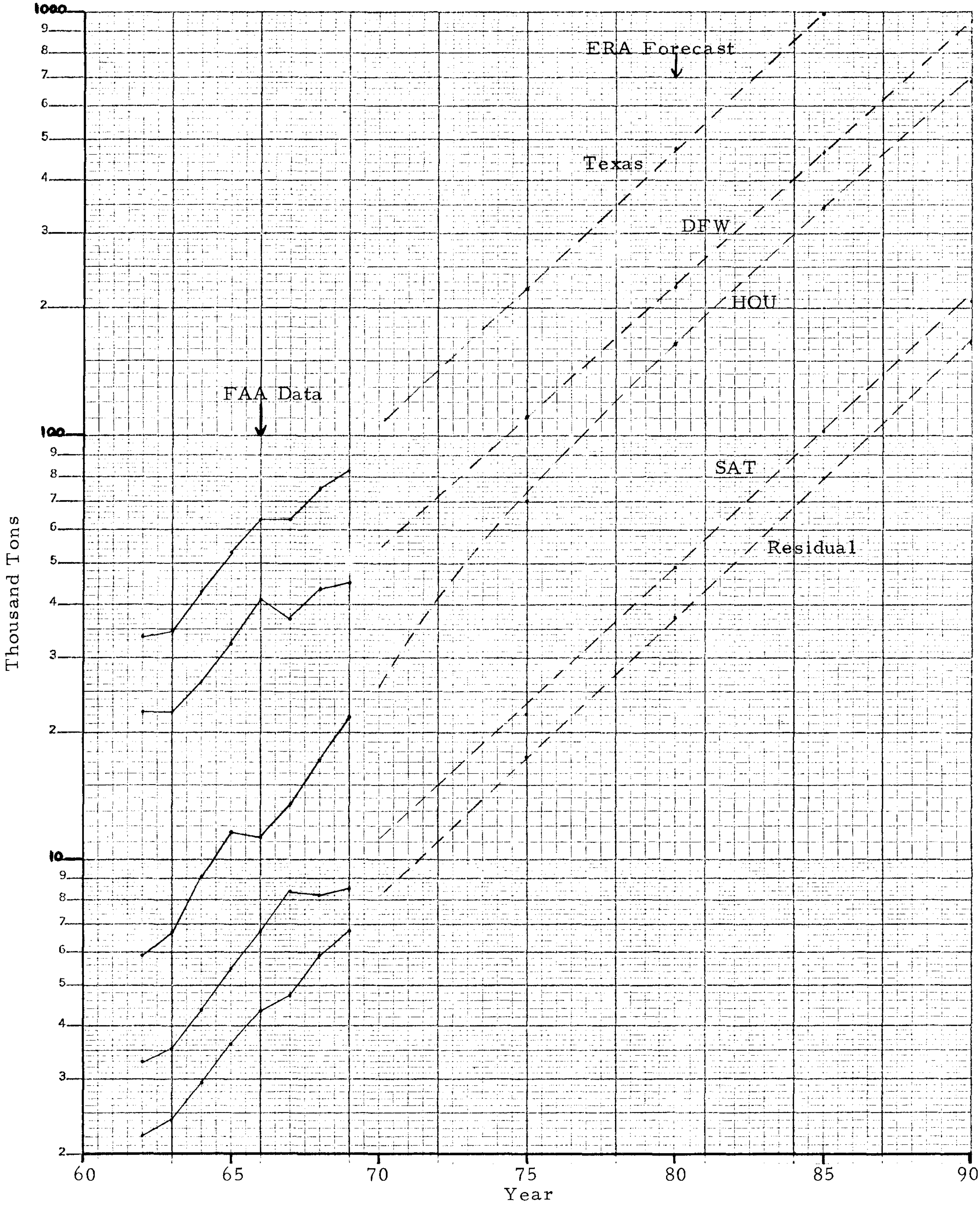

Figure 5-5
AIR FREIGHT HISTORY AND MEDIAN FORECASTS FOR TEXAS, TOP THREE HUBS, AND RESIDUAL, 1962-1990

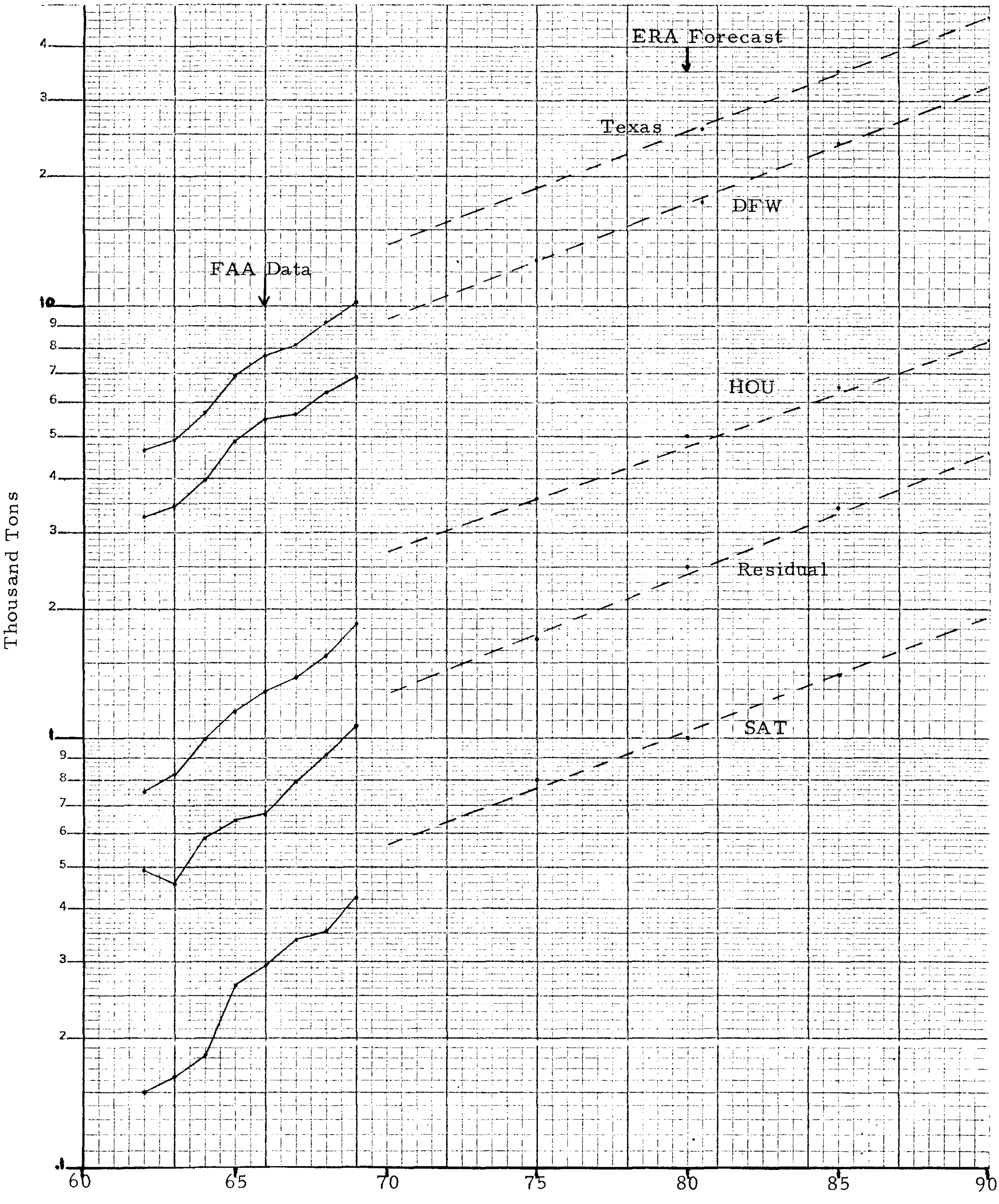

Figure 5-6

AIR EXPRESS HISTORY AND MEDIAN FORECASTS FOR TEXAS, TOP THREE HUBS, AND RESIDUAL, 1962-1990

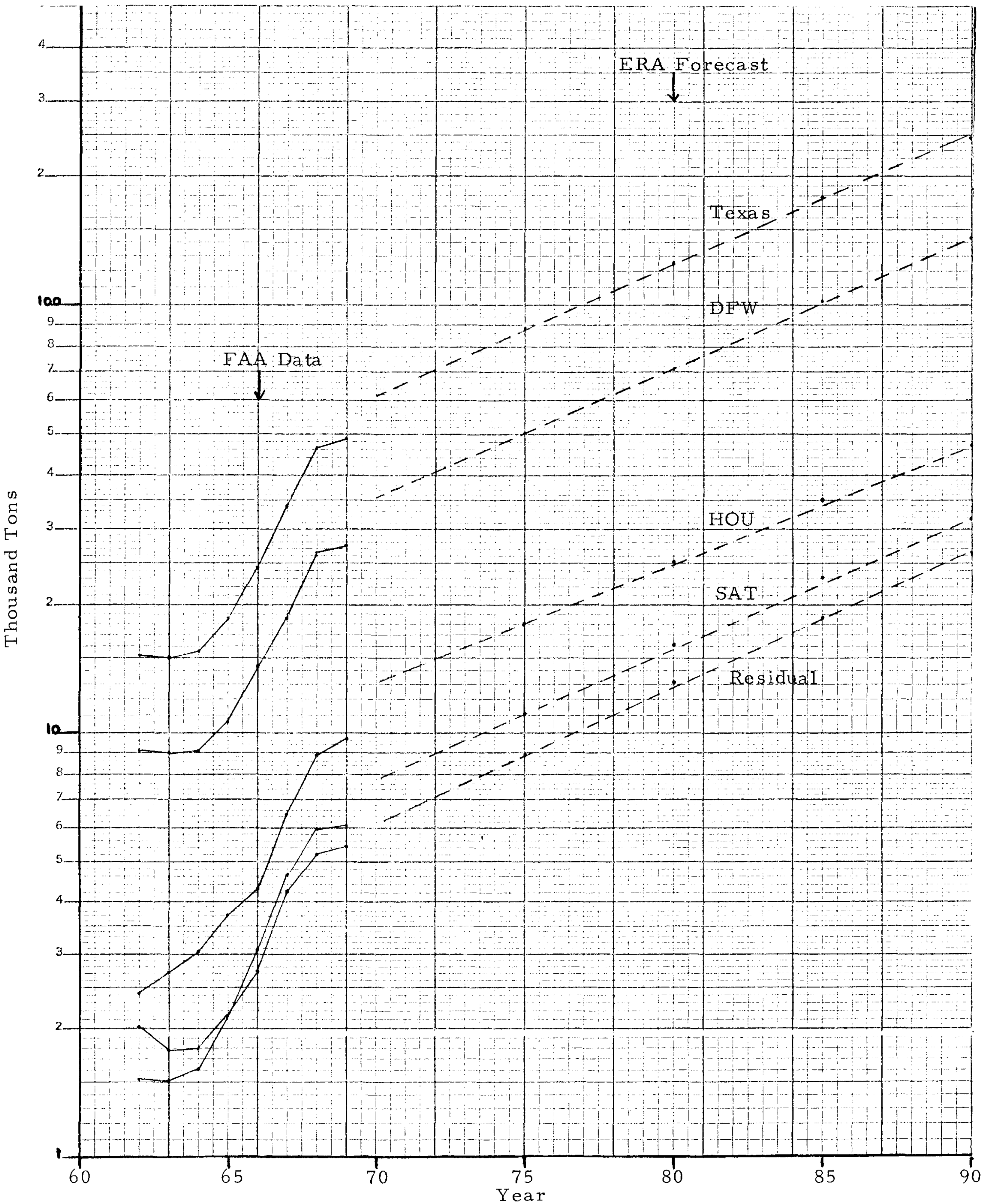

Figure 5-7

AIR MAIL HISTORY AND MEDIAN FORECASTS FOR TEXAS, TOP THREE HUBS, AND RESIDUAL, 1962-1990

The CAB did not project express growth per se, instead combining it with the much larger - by a factor of nine to one[1/] - freight component. The ATA estimated long-run growth at 5.5 percent annually and stated that express expansion, in contrast to freight and mail, was fairly smooth. The ATA rate is adopted as the median in this analysis; low and high growth factors reflecting this component's relative stability were taken as low, five percent, and high, six percent.

Both freight and express were forecasted by the CAB and ATA on the basis of their relation to economic activity, specifically Gross National Product. Mail traffic, however, is mainly a function of post office (i.e., United States Postal Service) policy - thus, there is no definitive quantitative basis for forecasting it. The ATA used a general yearly growth factor of five percent; the CAB, on the basis of consultation with postal authorities, set annual ton-mile growth at 9.2 percent. In Table 5-2, CAB ton-mile figures for 1962-1969 are divided by corresponding FAA ton data to compute average mail haul; one should note the general (discarding strike year 1966) uptrend. The annual haul increase was 2.5 percent; deleting this portion from the CAB figure yields an annual growth in tons of 9.2 - 2.5 = 6.7 percent. This is rounded off to 6.5 percent for use as this report's median rate. Immediately before and immediately after the explosive 1965-1968 period (which featured successive annual growths of, respectively, 18.1 percent, 27.6 percent, 38.2 percent, and 32.6 percent), mail volume increased by about 5.5 percent: 5.6 percent in 1964 and 5.7 percent in 1969.[2/] This 5.5 percent will serve - with the implicit assumption that the post office will make no further radical changes in air mailing policies - as the low growth rate; the high rate will be set by symmetry, i.e., one percent above the median rate of 6.5 percent. Thus, the set of annual growth rates for mail traffic will be: low - 5.5 percent, median - 6.5 percent, and high - 7.5 percent.

1/ Source: FAA; 1969 tonnages (x million) were freight - 1,850 and express - 203.

2/ Source: FAA, Airport Activity Statistics of Certificated Route Air Carriers, 1962-1969 editions.

Table 5-12

HISTORIES OF DOMESTIC AIR MAIL ON U.S. CERTIFICATED CARRIERS; FOR U.S., TON-MILES, TONS, AND CALCULATED AVERAGE LENGTH-OF-HAUL
1962-1969

	CAB Ton-Miles (millions)	FAA Tons (millions)	Average Length-of-Haul (miles)
1962	198	.281	705
1963	205	.288	711
1964	219	.304	721
1965	271	.359	754
1966	386	.458	843
1967	513	.633	811
1968	694	.839	827
1969	724	.887	838

Sources: Civil Aeronautics Board: Forecast of Scheduled Domestic Air Cargo for the 50 States, 1971-1975, February 1971; Federal Aviation Administration: Airport Activity Statistics of Certificated Route Air Carriers, 1962-69 editions.

The rates derived for freight, express, and mail must be applied to 1970 base year tonnages. The figure used for cargo as a whole was 3.53 million tons; this represents all domestic plus foreign traffic. The most recent FAA data, which cover activity by certificated route carriers, give the following breakout for 1969 (in millions of tons): freight - 1.85, express - .20, mail - .89; their respective portions of cargo activity, then, are freight - 63 percent, express - seven percent, mail - 30 percent. Applying these to the base figure of 3.53 yields (in millions of tons): freight - 2.22, express - .24, mail - 1.07. In Table 5-13, the set of low, median, and high growth rates is combined with these freight, express, and mail base year tonnages to compute our United States forecast series. One should notice the correspondence to Table 5-3 above; the freight, express, and mail values were rounded and adjusted so they would total exactly to the earlier report's cargo projections, e.g., for 1975 median forecast (in millions of tons):

	Freight -	4.81				
Table 5-13	Express -	.34	Total: 6.70	=	Table 5-3	Cargo: 6.70
	Mail -	1.55				

The ERA forecasts - along with 1962-1969 FAA data and 1975-1985 ATA projections - for freight, express, and mail are graphed, respectively, in Figures 5-8, 5-9, and 5-10; these are in the format of the preceding Figure 5-3. From 5-8, it is seen that the ATA freight forecast, made at a time of very rapid growth, is rather high; interestingly, their express and mail figures (see 5-9 and 5-10) are on the low side; the former because it covers domestic traffic only, the latter because it is based on an apparently low growth rate (as previously discussed, mail forecasts have inherent uncertainty).

With 1970-1990 freight, express, and mail for the United States thus projected, the next step is to examine Texas's share of national activity and, subsequently, allocate State tonnage to each of the top three airports - Dallas-Fort Worth, Houston, and San Antonio - and to the Residual 26 hubs.

Table 5-13

LOW, MEDIAN, AND HIGH FORECASTS OF DOMESTIC PLUS FOREIGN AIR ACTIVITY ON U.S. CERTIFICATED CARRIERS FOR U.S. 1975, 1980, 1985, 1990

Category	Growth	Rate (percent)	Millions of Tons 1975	1980	1985	1990
Freight	Low	13	4.30	8.27	15.55	28.82
	Median	15.5	4.81	10.20	21.05	42.46
	High	18	5.34	13.14	29.57	65.20
Express	Low	5	.33	.43	.57	.73
	Median	5.5	.34	.44	.58	.75
	High	6	.34	.46	.65	.84
Mail	Low	5.5	1.47	2.00	2.68	3.55
	Median	6.5	1.55	2.16	2.97	3.99
	High	7.5	1.62	2.50	3.58	4.96

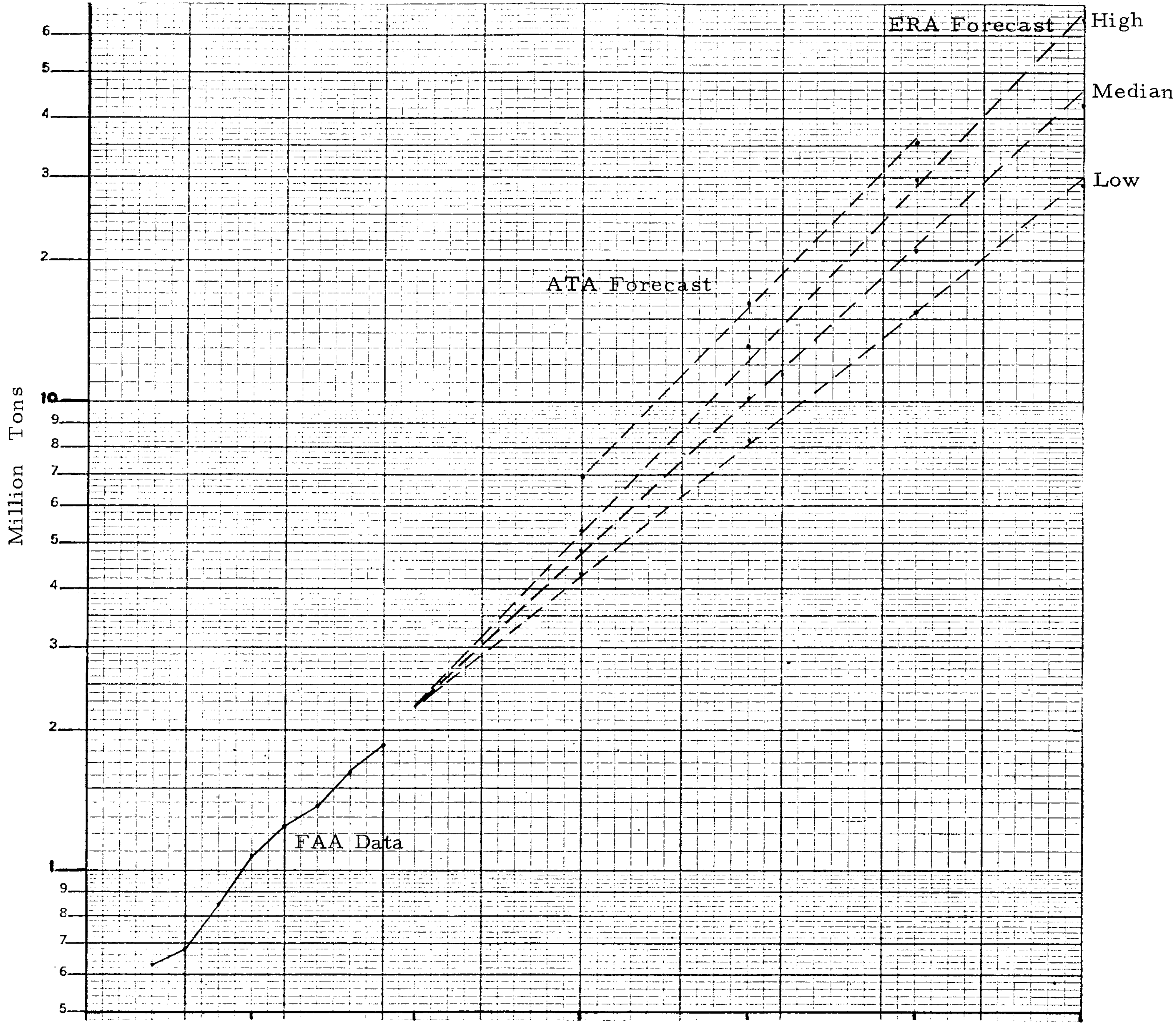

Figure 5-8
AIR FREIGHT: HISTORY AND FORECASTS FOR U.S., 1962-1990

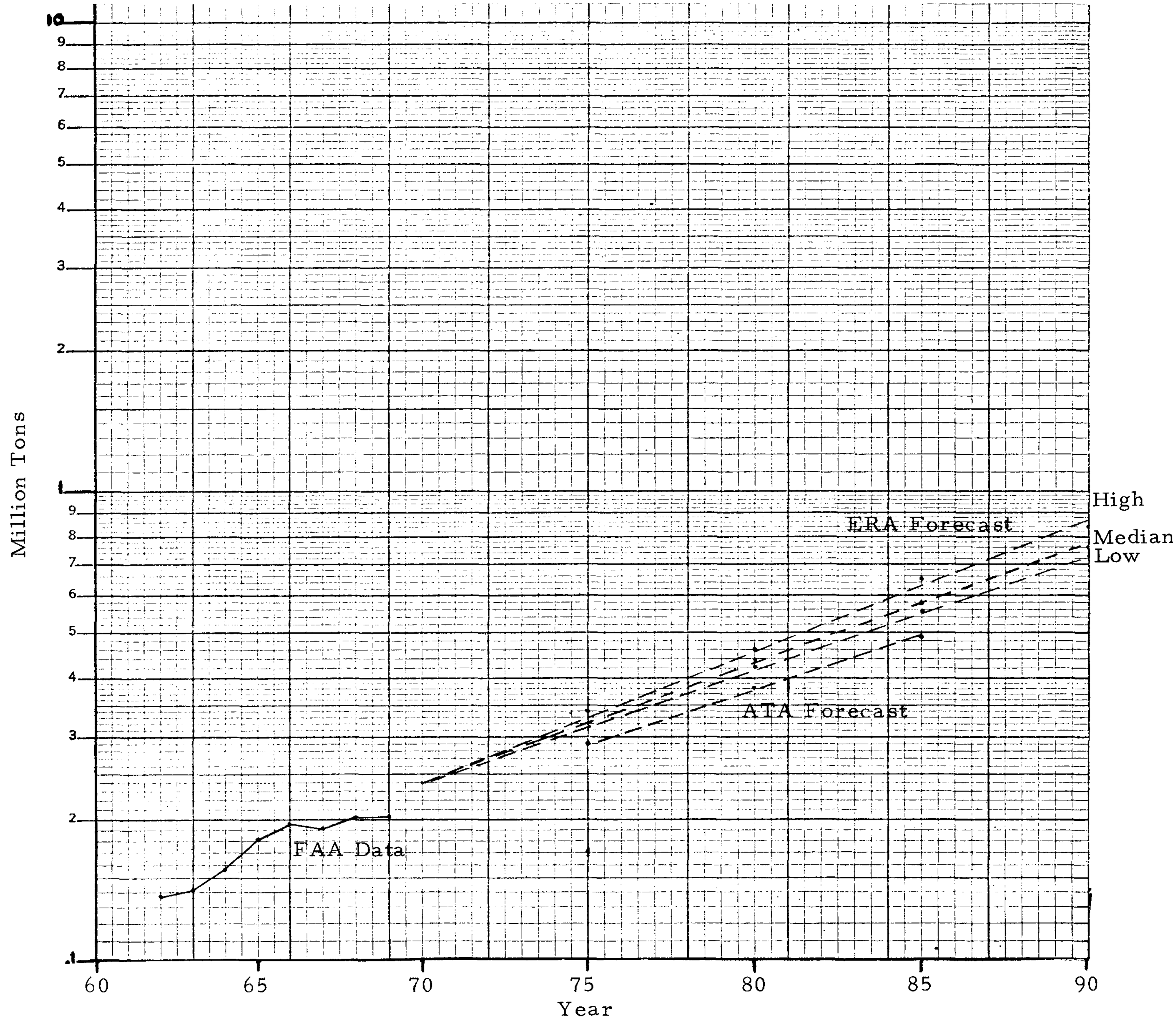

Figure 5-9

AIR EXPRESS:HISTORY AND FORECASTS FOR U.S., 1962-1990

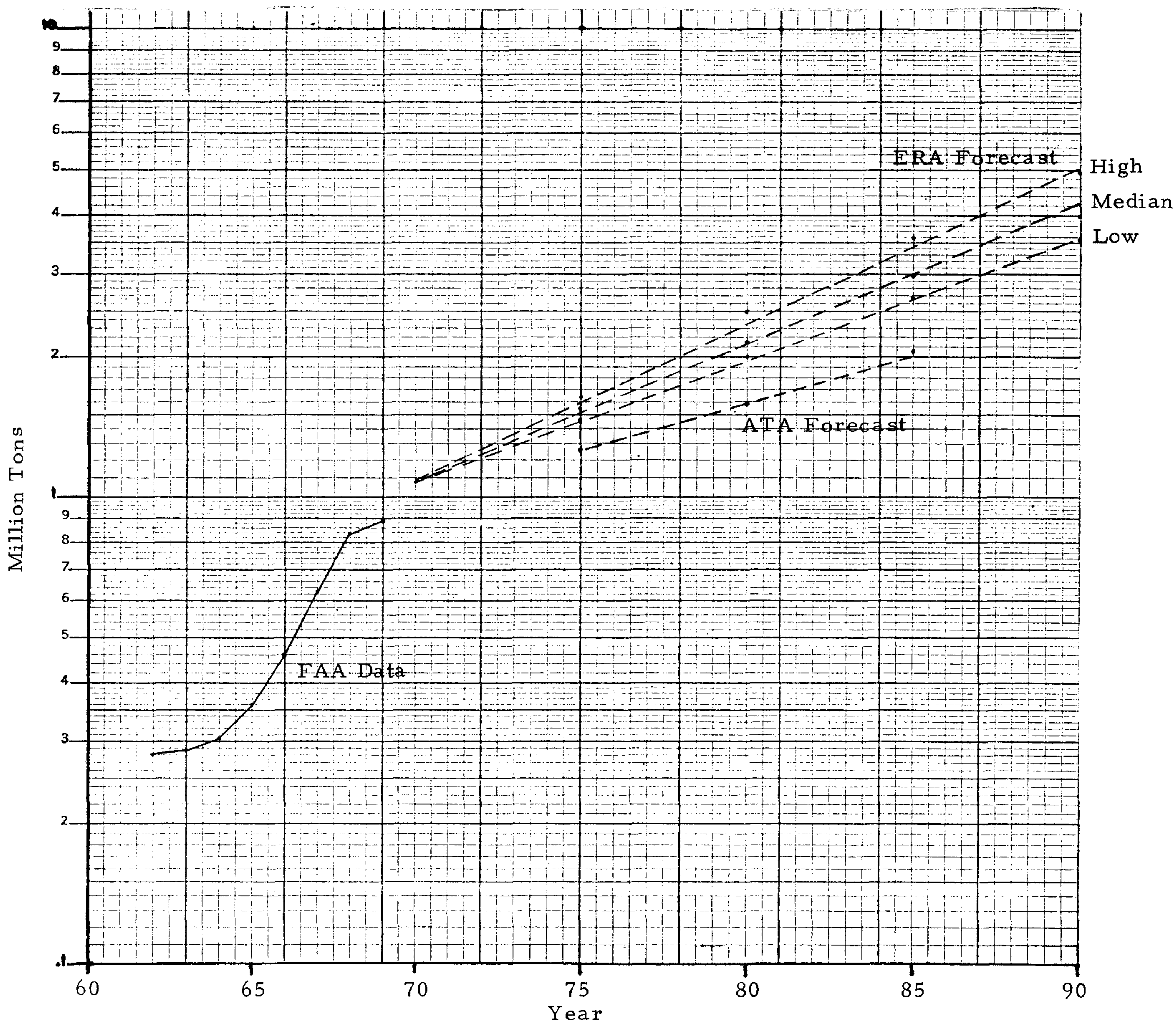

Figure 5-10

AIR MAIL: HISTORY AND FORECASTS FOR U.S., 1962-1990

In Tables 5-14, 5-15, and 5-16, their market shares of freight, express, and mail, respectively, are computed and tabulated for the 1962-1969 period.[1/] These match Table 5-4, preceding section, in which cargo shares of market were calculated.

From Table 5-14, it is seen that Texas's freight share has declined (disregarding the strike year 1966 increase) since 1962; however, it has recently (1967-1969) shown signs of leveling off. Thus, its portion of the United States freight traffic will be set at 4.5 percent for the 1970-1990 forecast horizon. Within the state, the freight pattern is strikingly similar to that observed in the discussion on cargo as a whole: Houston increasing at the expense of Dallas-Fort Worth, with San Antonio and Residual relatively constant. Indeed, the previous analysis of Houston and Dallas-Fort Worth trending (see text discussion of Table 5-5 and Figure 5-4 above) can be utilized here: cargo shares and the derivative - based on similar tapered growth by Houston - freight picture are shown below:

		Actual		Forecast			
		1962	1969	1975	1980	1985	1990
Cargo	Dallas-Fort Worth	65%	56%	53%	50%	49%	49%
	Houston	17%	24%	28%	31%	32%	32%
Freight	Dallas-Fort Worth	66%	55%	51%	48%	47%	47%
	Houston	17%	27%	30%	33%	34%	34%

With Dallas-Fort Worth and Houston accounting for 81 percent of state freight, the remaining 19 percent is split thusly: San Antonio shows the average of its 1962-1969 figures (deleting Expo-influenced 1967) and is set at 10.5 percent, and Residual, with some pattern of recent increase, is allocated the remaining 8.5 percent.

1/ Source: Ibid.

Table 5-14

FREIGHT: HISTORY OF TEXAS AS SHARE OF U.S. MARKET AND TOP THREE AND RESIDUAL SHARE OF TEXAS MARKET 1962-1969

	Texas/U.S. (percent)	As Portion of Texas (percent)			
		DFW	HOU	SAT	Residual
1962	5.3	66	17	9.8	6.6
1963	5.1	64	19	10	6.9
1964	5.0	61	21	10	6.9
1965	4.9	61	22	10	6.8
1966	5.1	65	18	11	6.9
1967	4.6	58	21	13	7.5
1968	4.6	58	23	11	7.9
1969	4.5	55	27	10	8.2

Table 5-15

EXPRESS: HISTORY OF TEXAS AS SHARE OF U. S. MARKET AND TOP THREE AND RESIDUAL SHARE OF TEXAS MARKET 1962-1969

	Texas/U. S. (percent)	As Portion of Texas (percent)			
		DFW	HOU	SAT	Residual
1962	3.4	70	16	3.2	11
1963	3.4	71	17	3.3	9.3
1964	3.6	69	17	3.2	10
1965	3.8	70	17	3.8	9.3
1966	4.0	71	17	3.8	8.6
1967	4.3	69	17	4.1	9.7
1968	4.6	69	17	3.8	10
1969	5.0	68	18	4.1	10

Table 5-16

MAIL: HISTORY OF TEXAS AS SHARE OF U.S. MARKET AND TOP THREE AND RESIDUAL SHARE OF TEXAS MARKET 1962-1969

	Texas/U.S. (percent)	As Portion of Texas (percent)			
		DFW	HOU	SAT	Residual
1962	5.4	60	16	10	13
1963	5.2	60	18	10	12
1964	5.1	58	20	10	12
1965	5.2	57	20	12	12
1966	5.3	59	18	13	11
1967	5.4	55	19	14	12
1968	5.5	58	19	13	11
1969	5.5	56	20	12	11

In contrast to freight, the Texas share of United States express has been steadily advancing - in fact, accelerating (see Table 5-15). Projection of this factor will be done later, along with the analysis of mail trends. Within the state, Dallas-Fort Worth, Houston, San Antonio, and Residual shares have been steady, especially since 1967. Extending recent shares as standards for the 1970-1990 forecast horizon shows Dallas-Fort Worth - 68 percent, Houston - 18 percent, San Antonio - 4 percent, and Residual - 10 percent.

The Texas portion of national mail, as seen from Table 5-16, has increased somewhat in 1962-1969; the state's role here is strikingly close to its population share:[1/] 5.3 percent in 1960, 5.4 percent in 1965, and 5.5 percent in 1970. This relative trend, i.e., Texas population increasing faster than the United States as a whole, is expected to continue over the next 20 years[2/]; thus, the following shares of population may be extrapolated and utilized also as Texas's mail portions: 1975 - 5.6 percent, 1980 - 5.7 percent, 1985 - 5.8 percent, and 1990 - 5.9 percent. Furthermore, this series will be used for Texas/United States express, as it provides a reasonable maximum for the jumping state express share and because other parameters were computed and found impractical as limits (see Table 5-17).

Again referring to Table 5-16, the intrastate mail portions have been stable; since 1965, variations - rather than indicating trends - seem to be random. Using 1965-1969 averages as long-run shares of Texas mail traffic, the following data have been obtained: Dallas-Fort Worth - 57 percent, Houston - 19 percent, San Antonio - 13 percent, and Residual - 11 percent.

The estimated 1970-1990 freight, express, and mail shares are tabulated in Table 5-18. These were applied to the United States projections of Table 5-13 to obtain the Texas, Dallas-Fort Worth, Houston, San Antonio, and Residual forecasts exhibited in Tables 5-9, 5-10, and 5-15.

1/ Source: U.S. Bureau of the Census.
2/ Source: Texas Bureau of Business Research.

Table 5-17

TEXAS AS SHARE OF U.S. ACTIVITY: AIR EXPRESS, MANUFACTURING, AND PERSONAL INCOME FOR 1962-69

	Air Express (tonnage)	Manufacturing (value added)	Personal Income
1962	3.4	3.6	4.7
1963	3.4	3.7	4.7
1964	3.6	3.8	4.7
1965	3.8	3.8	4.6
1966	4.0	3.9	4.7
1967	4.3	4.2	4.8
1968	4.6	*	4.8
1969	5.0	*	4.9

* Data not available.

Sources: U.S. Bureau of the Census, 1967 Census of Manufactures, September 1970.
U.S. Department of Commerce, Survey of Current Business, August 1971.

Table 5-18

FREIGHT, EXPRESS, AND MAIL: FORECAST OF TEXAS AS SHARE OF U.S. MARKET AND TOP THREE AND RESIDUAL SHARE OF TEXAS MARKET 1975, 1980, 1985, 1990

		Texas/U.S. (percent)	As Portion of Texas (percent)			
			DFW	HOU	SAT	Residual
Freight	1975	4.5	51	30	10.5	8.5
	1980	4.5	48	33	10.5	8.5
	1985	4.5	47	34	10.5	8.5
	1990	4.5	47	34	10.5	8.5
Express	1975	5.6	68	18	4	10
	1980	5.7	68	18	4	10
	1985	5.8	68	18	4	10
	1990	5.9	68	18	4	10
Mail	1975	5.6	57	19	13	11
	1980	5.7	57	19	13	11
	1985	5.8	57	19	13	11
	1990	5.9	57	19	13	11

FORECAST OF AIR CARGO MOVEMENTS IN EXPORT AND IMPORT TRADES FROM TEXAS GATEWAY AIRPORTS

This section produces forecasts and studies the origin-destination composition of Texas customs districts' airborne trade. This trade is composed of airborne exports and imports clearing customs at the Texas gateway airports at Houston, San Antonio, and El Paso. Not all Texas's air exported or imported commodities are represented by this trade because of route structure and services. Exports from Dallas to Europe, say, might more likely clear customs in New York (The DOT/Bureau of Census "Commodity Flow Study" was expected to yield information on the ultimate originations or destinations, but the data have not yet been released but probably will appear in summer 1972). The focus of interest here, however, is on foreign trade impacts on cargo activity at the gateway airports.

Export and import activities for the United States, Texas, Houston, Laredo, and El Paso customs districts for the decade 1962-1971 are given in Tables 3-2 and 3-3. ALL indicates total weight, and FLAG indicates the amount on United States flag carriers. One should note that the difference between ALL and FLAG is the amount on foreign flag carriers. This is the element of scheduled carriage missing from CAB/FAA Airport Activity Statistics. The other six column heads indicate regional origin or destination, i.e., NA = North America, SA = South America, EU = Europe, AS = Asia, A/O = Australia/Oceania, and AF = Africa. Customs districts were summed to obtain Texas figures.

As in earlier cargo analyses, the share-of-market method will be used to forecast Texas - and its customs districts - activity. The relevant shares for exports are computed in Table 5-19 and for imports in Table 5-20. Values for the forecast horizon (base years 1975, 1980, 1985, and 1990) are also projected. The export shares, in Table 5-19, have been relatively stable since 1965, the forecasts are simply 1965-1971 period averages (for El Paso: 1969-1971). For imports, the intrastate situation is dynamic: since 1965, the Houston district has been gaining at the expense of Laredo. Allowing for a two percent El Paso role, it is assumed that the Houston-Laredo import shares will evolve similar to the export pattern:

Imports		Exports
Houston/(Houston + Laredo)	=	Houston/(Houston + Laredo)
Houston/98%	=	71%/93%
Houston = 75%		
Laredo/(Houston + Laredo)	=	Laredo/(Houston + Laredo)
Laredo/98%	=	22%/93%
Laredo = 23%		

For Texas, the share for 1971 is discounted and the constant 1968-1970 value used.

With a Dallas customs district, and if direct service foreign route applications follow domestic demand patterns, export/import shares would approximate the hub cargo shares shown above.

Table 5-19

EXPORTS: TEXAS AS SHARE OF UNITED STATES
AND CUSTOMS DISTRICTS AS SHARE OF TEXAS
1962-1971 AND FORECAST FOR 1975-1990

	Percent			
		As Portion of Texas		
	Texas/U.S.	Houston	Laredo	El Paso
1962	3.0%	66%	34%	
1963	3.3	64	36	
1964	2.5	63	37	
1965	2.1	67	33	
1966	1.6	71	29	
1967	1.8	76	23	.94%
1968	2.1	81	19	
1969	2.1	79	14	6.8
1970	1.8	72	21	7.0
1971	1.9	71	20	8.0
1975-1990	1.9	71	22	7

Table 5-20

IMPORTS: TEXAS AS SHARE OF UNITED STATES
AND CUSTOMS DISTRICTS AS SHARE OF TEXAS
1962-1971 AND FORECAST FOR 1975-1990

	Percent			
		As Portion of Texas		
	Texas/U.S.	Houston	Laredo	El Paso
1962	4.6%	40%	60%	
1963	2.6	46	54	
1964	1.6	31	69	
1965	1.3	17	83	
1966	2.4	18	82	
1967	1.3	26	74	--
1968	1.0	35	65	
1969	1.0	38	60	2.0%
1970	1.0	59	39	2.0
1971	.7	68	29	2.3
1975-1990	1.0	75	23	2

Dallas-Fort Worth	=	50%	
Houston	=	31%	
San Antonio	=	10-1/2%	(Laredo district)
El Paso	=	2-1/2%	
Residual 26	=	6%	
		100%	

Allocating the Residual to the four other districts, the hypothetical export and import distribution for customs districts would be as follows:

Dallas	=	53%
Houston	=	33%
Laredo	=	11%
El Paso	=	3%
		100%

Tables 5-21 and 5-22 show the second step of the share-of-market technique, assessing and forecasting national growth rates; this is graphically represented in Figure 5-11. As readily seen, both exports and imports have erratic growth patterns; as the first step, mean 1962-1970 increase was computed (again discounting 1971 and its possible distortions) - 19 percent for exports and 26 percent for imports - and assumed to apply through 1975. Thereafter, the data are tapered to the long-range air freight growth range. This tapering (Figure 5-11) corresponds well to the 1962-1971 downtrend (e.g., decreasing peaks) of growth rates.

Applying the growth rates of Tables 5-21 and 5-22 to the United States data from Tables 3-2 and 3-3, and computing Texas (and its districts) activity with market shares from Tables 5-19 and 5-20,

Table 5-21

EXPORTS OF UNITED STATES:
HISTORICAL GROWTH, 1962-1971, AND
FORECASTED GROWTH RATES, 1975, 1980, 1985, 1990

		Growth	
	Millions of Pounds	Millions of Pounds	Percent
1962	217		
1963	248	31	14%
1964	327	79	32
1965	457	130	40
1966	506	49	11
1967	549	43	8
1968	657	108	20
1969	867	210	32
1970	897	30	3
1971	899	2	0
1975			19
1980			18
1985			17
1990			16

Table 5-22

IMPORTS OF UNITED STATES:
HISTORICAL GROWTH, 1962-1971, AND
FORECASTED GROWTH RATES, 1975, 1980, 1985, 1990

	Millions of Pounds	Growth	
		Millions of Pounds	Percent
1962	98		
1963	113	15	15%
1964	128	15	13
1965	192	64	50
1966	229	37	19
1967	305	76	33
1968	431	126	41
1969	614	183	42
1970	620	6	1
1971	824	204	33
1975			26
1980			23
1985			20
1990			17

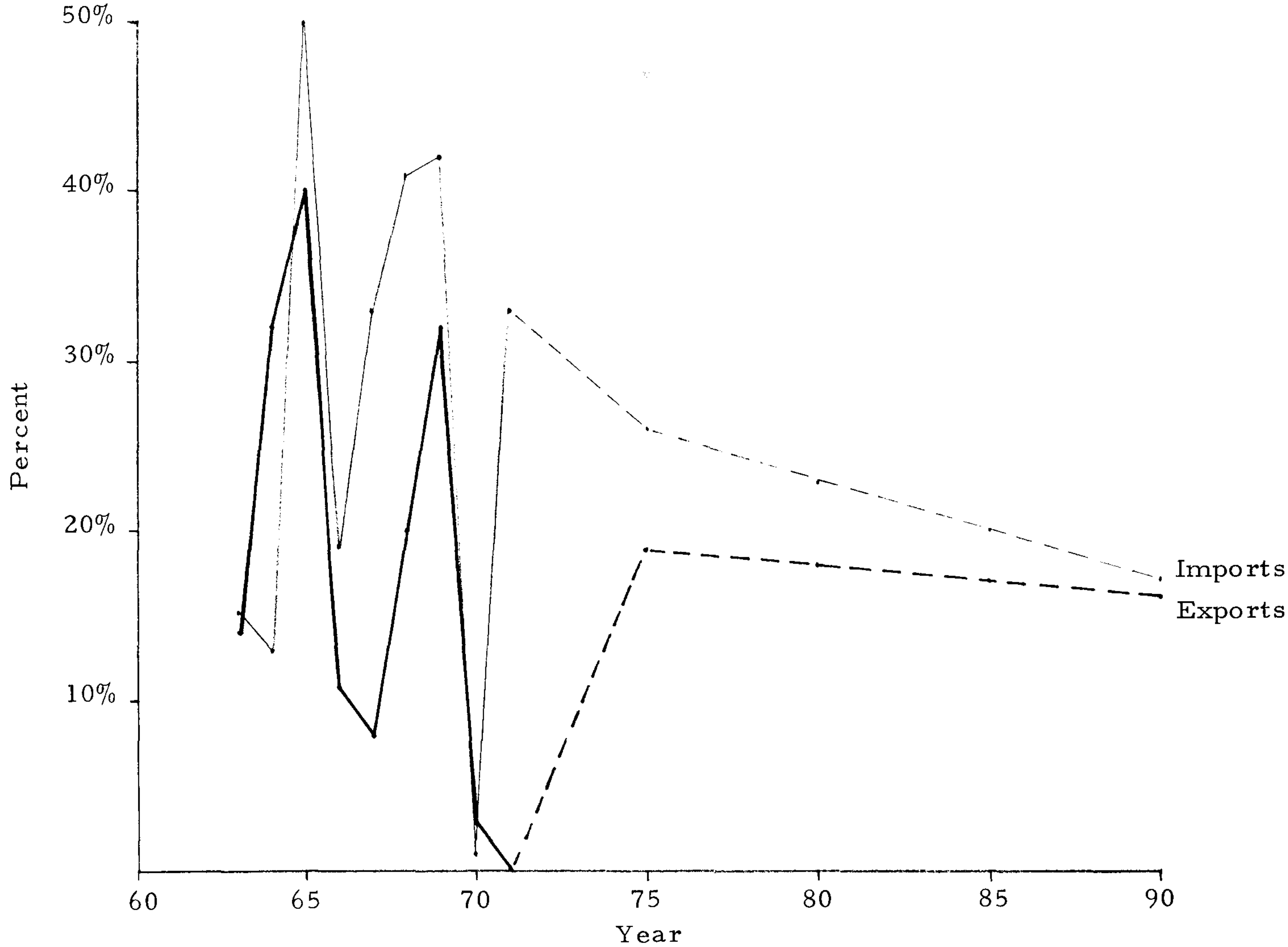

Figure 5-11

AIRBORNE EXPORTS AND IMPORTS OF UNITED STATES:
HISTORICAL AND FORECASTED GROWTH RATES
1962-1990

yield projections of Tables[1] 5-23, and 5-24. The United States forecasts, both exports and imports, are graphed in Figure 5-12, whereas Texas and its customs districts are covered in Figures 5-13 and 5-14, exports and imports, respectively. For the country as a whole, imports should start edging ahead of exports in the 1970's (this implicitly assumes no changes in United States trade policy, the international monetary system, etc.; analysis of such factors is beyond the scope of this study). Texas gateway airports with their relative shares - 1.9 percent of United States exports versus 1.0 percent of United States imports - will run a net surplus over the forecast horizon. Within the state, one may contrast the smooth 1962-1971 trendlines of Figure 5-13 with the mixed picture of Figure 5-14, while emergence of Houston was to be expected, total state import activity is volatile, e.g., heavily affected by the 1966 airline strike.

From the data in Table 3-2, the United States Flag air carrier portion and continent distribution (continents' sum equal to 100 percent) of exports are computed for the United States, Texas, and the Houston, Laredo, and El Paso customs districts in Table 5-25. For the United States, the flag percentage has been consistent (exception: strike year 1966): 36 percent-39 percent, with a 1962-1971 mean of 38 percent. Over the decade, the prime market for United States air exports has shifted from North and South America to Europe and Asia, i.e.,

	NA+SA	EU+AS
1962	73%	33%
1971	36%	59%

1/ For direct comparisons with earlier FAA-ERA cargo - freight, mail, and express - figures, divide exports by two (that is, million of pounds = thousands of tons/two).

Table 5-23

EXPORTS: FORECAST FOR U.S., TEXAS, AND HOUSTON, LAREDO, AND EL PASO CUSTOMS DISTRICTS

	Millions of Pounds				
	U.S.	Texas	Houston	Laredo	El Paso
1975	2,140	40.6	28.8	8.94	2.84
1980	4,920	93.3	66.4	20.40	6.52
1985	10,800	204.0	145.0	44.80	14.20
1990	22,600	430.0	306.0	94.20	30.00

Table 5-24

IMPORTS: FORECAST FOR U.S., TEXAS, AND HOUSTON, LAREDO, AND EL PASO CUSTOMS DISTRICTS

	Millions of Pounds				
	U.S.	Texas	Houston	Laredo	El Paso
1975	1,960	19.6	14.6	4.61	0.40
1980	5,520	55.2	41.4	12.60	1.17
1985	13,600	136.0	102.0	31.40	2.83
1990	30,000	300.0	225.0	69.00	6.18

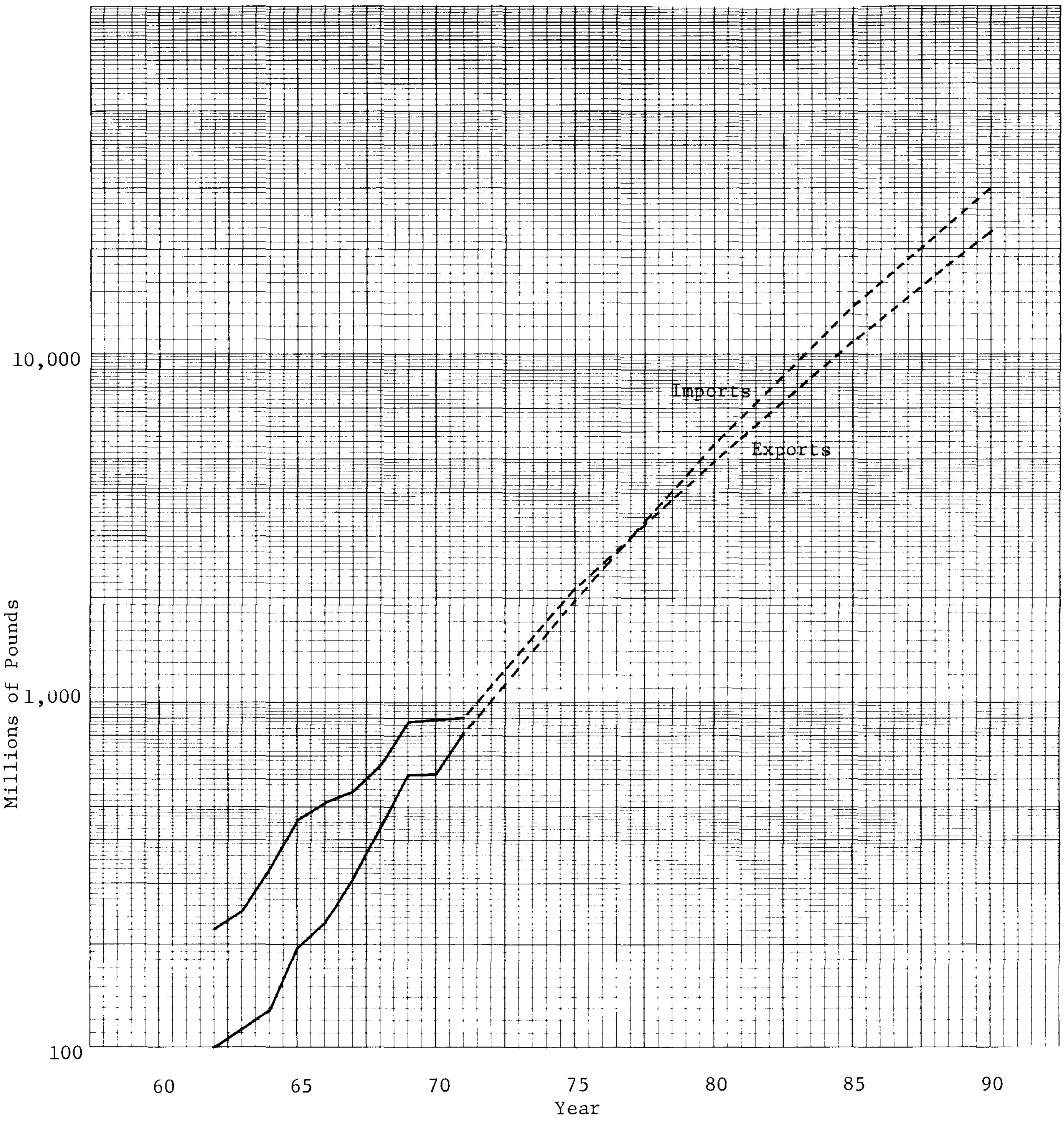

Figure 5-12

EXPORTS AND IMPORTS OF UNITED STATES:
HISTORICAL DATA AND FORECAST TREND
1962-1990

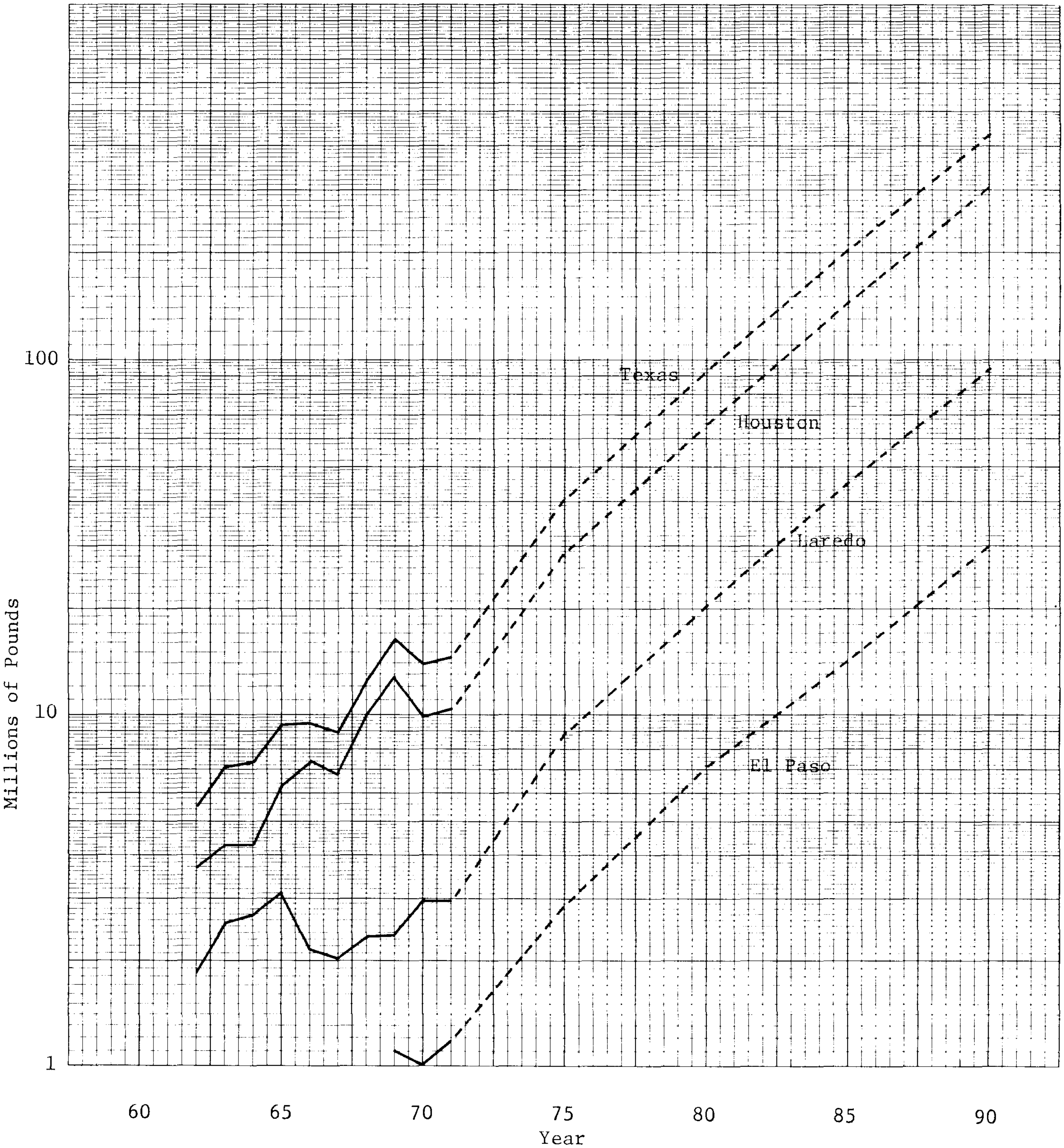

Figure 5-13

EXPORTS OF TEXAS AND HOUSTON, LAREDO, AND EL PASO:
HISTORICAL DATA AND FORECAST TRENDS
1962-1990

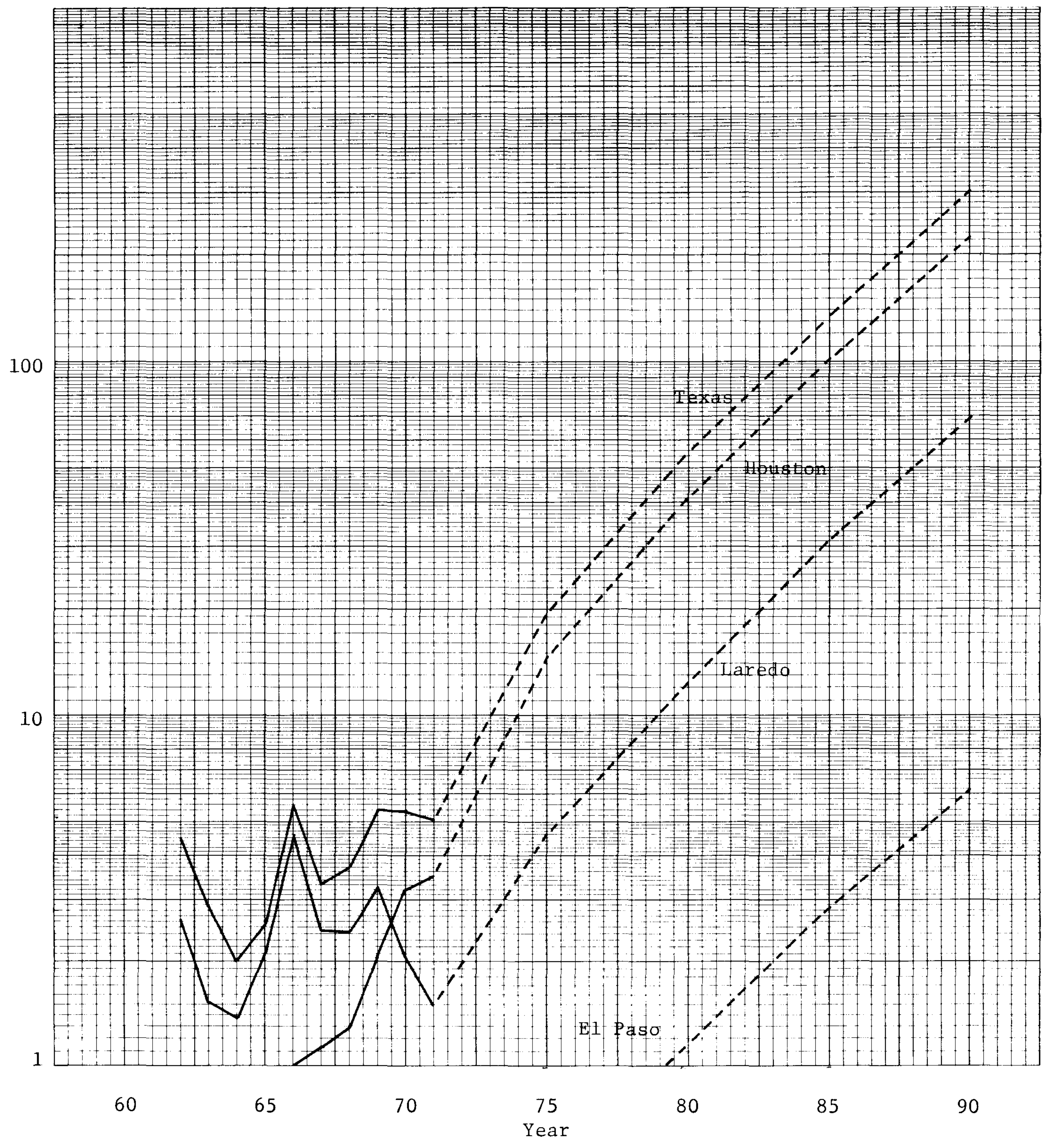

Figure 5-14

IMPORTS OF TEXAS AND HOUSTON, LAREDO,
AND EL PASO CUSTOMS DISTRICTS:
HISTORICAL DATA AND FORECAST TRENDS
1962-1990

Table 5-25

EXPORTS: FLAG PORTION AND CONTINENT DISTRIBUTION
1962-1971

		Percent						
		FLAG	NA	SA	EU	AS	A/O	AF
United States	1962	36%	39%	24%	28%	5%	1%	2%
	1963	38	37	21	34	5	1	2
	1964	39	35	21	36	6	1	2
	1965	38	30	17	43	7	1	2
	1966	32	29	15	44	8	1	2
	1967	36	28	13	45	9	2	2
	1968	39	28	12	46	9	2	2
	1969	39	25	12	49	10	2	2
	1970	36	25	11	48	12	2	2
	1971	37	25	11	45	14	2	2
Texas	1962%	65%	73%	5%	9%	7%	-	5%
	1963	66	68	4	21	3	-	3
	1964	68	75	3	13	6	-	4
	1965	72	65	8	18	4	-	4
	1966	69	64	6	17	6	-	7
	1967	64	55	4	20	8	1%	13
	1968	66	52	9	17	9	1	13
	1969	65	41	18	18	9	2	12
	1970	60	56	9	13	11	1	10
	1971	50	50	10	14	11	1	13
Houston	1962	62%	63%	7%	14%	10%	-	6%
	1963	66	52	5	33	5	-	5
	1964	59	61	4	20	9	-	6
	1965	68	53	7	27	6	-	6
	1966	64	52	6	23	9	1%	10
	1967	57	44	4	25	10	1	17
	1968	64	43	10	21	11	1	16
	1969	63	30	22	20	11	2	15
	1970	59	40	11	18	16	1	14
	1971	47	34	14	19	12	1	19
Laredo	1962	53%	94%	2%	-	-	-	4%
	1963	67	98	2	-	-	-	-
	1964	82	98	2	-	-	-	-
	1965	81	90	10	-	-	-	-
	1966	83	93	6	-	-	-	-
	1967	86	95	5	-	-	-	-
	1968	73	93	3	-	4%	-	-
	1969	65	94	5	1%	-	-	-
	1970	53	96	3	-	-	-	-
	1971	44	90	1	2	8	-	-
El Paso	1967	100%	5%	1%	87%	4%	-	4%
	1968	Not Listed						
	1969	95	64	-	35	-	-	-
	1970	99	99	-	1	-	-	-
	1971	100	99	-	1	-	-	-

Note: Due to rounding, the sum of the continents may not be exactly 100%.

The 1967-1971 percentages for Texas have been, on the whole, stable; the significant African role as destination for oil equipment is easily seen. The state, of course, represents the combination of the dominant Houston district - with its international trade mix - and the Laredo and El Paso districts that mainly handle North American (i. e., Mexico) exports. Interestingly, the Laredo district has exhibited a steady 1967-1971 downtrend in its flag portion, probably indicating inroads by Mexicana Airlines; the low Houston (and Texas) flag percentage for 1971, departing markedly from the 1962-1970 plateau, is likely an exception value.

Table 5-26, covering imports, is derived from Table 3-3. For the United States - as in the exports case - the flag percentage is constant, especially since 1968, and Europe and Asia are now the main origins (actually dominating trade). While Laredo and El Paso traffic is still around 90 percent North American (Mexico) origin, Houston has recently developed significant European activity; it also handles most of the state's imports from South America and Asia. In fact, the Houston district (and, thus, the Texas total) percentages, for flag as well as continents, have been in a state of change - versus its relative stability in exports - in the 1968-1971 period. Finally, one may note that El Paso has some European and Asian components in its traffic.

Forecasts, covering the horizon through 1990, of flag portion and continent distribution for the United States, Texas, and state customs districts are in Tables 5-27 and 5-28, exports and imports, respectively. Given recent steadiness in export activity (as seen from Table 5-25), projected percentages generally consist of averages

Table 5-26

IMPORTS: FLAG PORTION
AND CONTINENT DISTRIBUTION
1962-1971

		Percent						
		FLAG	NA	SA	EU	AS	A/O	AF
United States	1962	39%	36%	7%	49%	7%	--	--
	1963	41	30	10	52	7	--	--
	1964	46	24	11	53	11	--	1%
	1965	50	17	10	58	14	--	--
	1966	48	17	7	59	17	--	--
	1967	42	16	6	58	18	--	--
	1968	46	16	5	59	19	1%	--
	1969	45	15	5	61	18	1	--
	1970	46	14	7	57	21	1	--
	1971	46	11	8	54	26	1	--
Texas	1962	56%	98%	--	1%	1%	--	--
	1963	61	98	--	1	--	--	--
	1964	82	97	1%	1	--	--	--
	1965	86	93	5	1	--	--	--
	1966	90	97	1	1	--	--	--
	1967	87	96	2	2	--	--	--
	1968	91	91	3	5	1	--	--
	1969	86	88	2	7	1	--	1%
	1970	72	73	3	21	2	--	1
	1971	63	61	4	29	6	--	1
Houston	1962	49%	94%	1%	3%	2%	--	--
	1963	23	96	1	2	--	--	--
	1964	54	91	5	4	--	--	--
	1965	71	62	31	5	1	--	--
	1966	85	87	6	5	--	1%	--
	1967	85	96	2	2	--	--	--
	1968	84	77	7	12	4	--	--
	1969	75	70	6	18	2	1	2%
	1970	64	56	6	34	3	--	1
	1971	51	45	4	42	8	--	1
Laredo	1962	61%	100%	--	--	--	--	--
	1963	93	100	--	--	--	--	--
	1964	94	100	--	--	--	--	--
	1965	89	100	--	--	--	--	--
	1966	90	100	--	--	--	--	--
	1967	88	100	--	--	--	--	--
	1968	95	98	--	2%	--	--	--
	1969	93	100	--	--	--	--	--
	1970	85	99	--	--	--	--	--
	1971	89	95	3%	--	2%	--	--
El Paso	1967	100%	100%	--	--	--	--	--
	1968	Not Listed						
	1969	92	84	--	15	1	--	--
	1970	84	82	--	5	12	--	--
	1971	81	89	--	5	5	--	--

Note: Due to rounding, the sum of the continents may not be exactly 100%.

Table 5-27

EXPORTS: FLAG PORTION
AND CONTINENT DISTRIBUTION
1975, 1980, 1985, 1990

	Percent						
	FLAG	NA	SA	EU	AS	A/O	AF
United States	38%	25%	12%	48%	11%	2%	2%
Texas	66	52	9	16	10	1	12
Houston	62	42	11	20	11	1	15
Laredo	38	96	4	--	--	--	--
El Paso	98	99	--	1	--	--	--

Table 5-28

IMPORTS: FLAG PORTION
AND CONTINENT DISTRIBUTION
1975, 1980, 1985, 1990

	Percent						
	FLAG	NA	SA	EU	AS	A/O	AF
United States	46%	15%	6%	59%	19%	1%	--
Texas	50	52	3	41	3	--	1%
Houston	46	42	6	48	3	--	1
Laredo	91	98	1	--	1	--	--
El Paso	86	86	--	8	6	--	--

from 1967-1971 values; exceptions include the following: Laredo's diminishing flag portion was assumed to be approaching the 38 percent United States standard, and the exceptional continent figures for El Paso in 1967 and 1969 were not counted. The dynamic state of imports required various estimating techniques - United States: 1967-1970 (1971 discounted, as discussed earlier) means; Laredo: 1967-1971 means; and El Paso: 1969-1971 (1967 insignificant) means. For Texas and Houston:

FLAG	Declining to a lower plateau
NA	Same as export percentage
SA	1967-1971 averages
AS	
A/O	
AF	
EU	Remainder, i.e., 100% - other five continents

For exports, the 1962-1971 statistics, along with the 1975-1990 horizon projections for the United States and Texas are graphed in Figures 5-15 and 5-16, respectively. Nationally, the continents' percentages separate into four levels, with Europe the most frequent destination. Texas, on the other hand, has - as expected - North America (Mexico) dominating; the other continents, except Australia/ Oceania, cluster in the 10 percent-15 percent range.

Figures 5-17 and 5-18 are the corresponding United States and Texas import graphs. The United States profile is similar to that for exports, although Asia has a larger role here. As readily seen, the Texas situation is quite dynamic: an expanding European role with declining North American dominance.

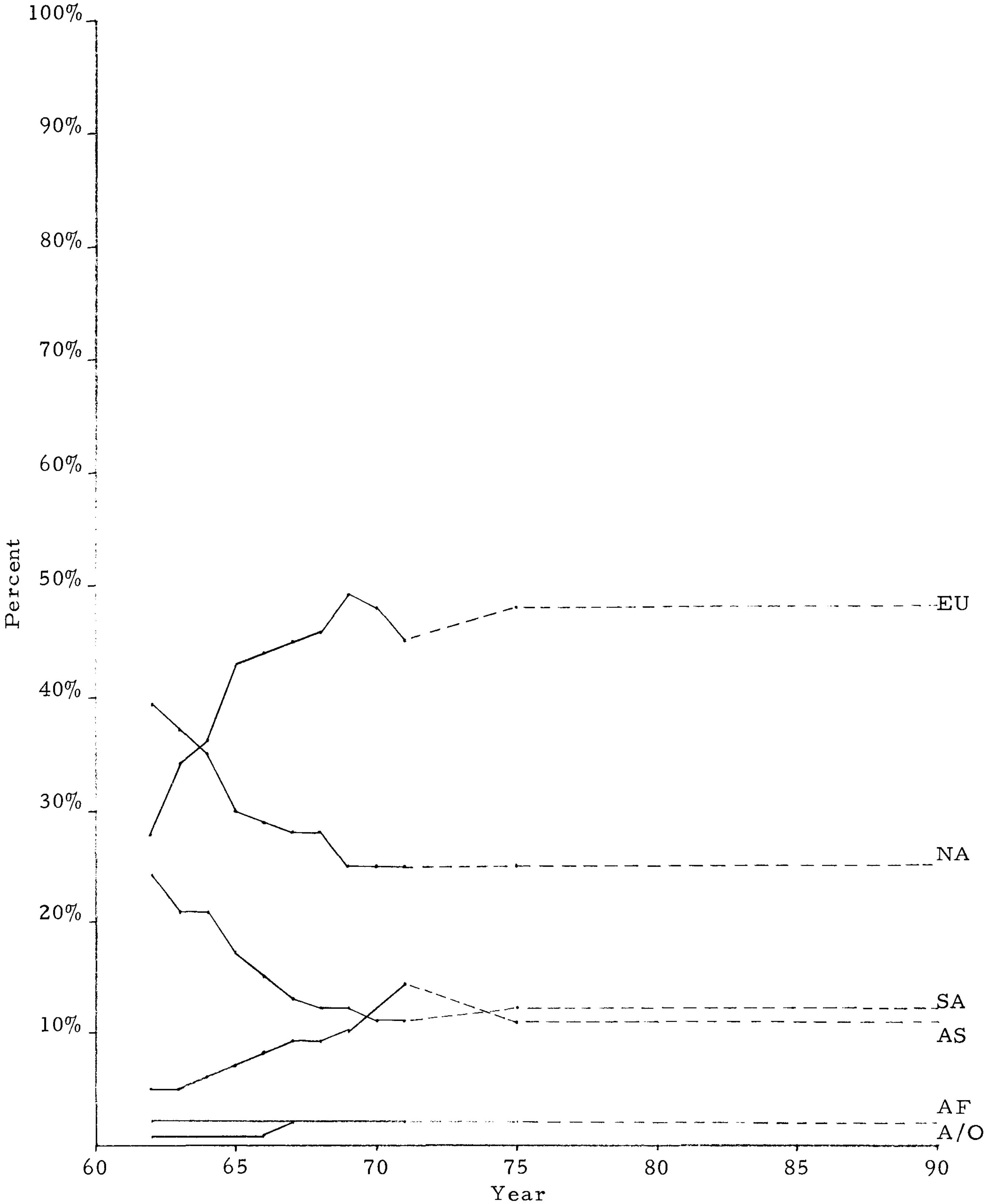

Figure 5-15

AIRBORNE EXPORTS OF UNITED STATES:
CONTINENT DISTRIBUTION, HISTORICAL AND FORECAST
1962-1990

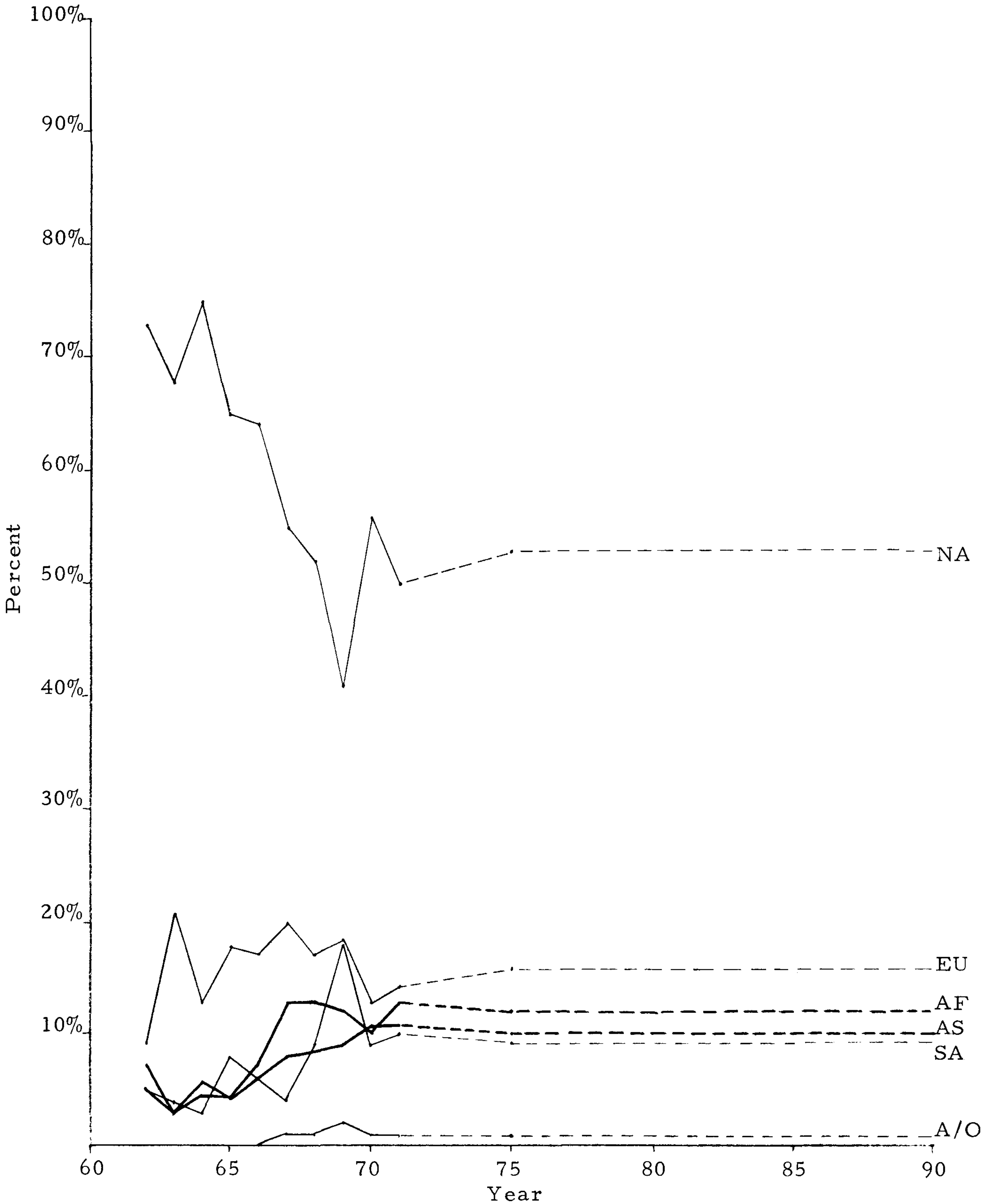

Figure 5-16

AIRBORNE EXPORTS OF TEXAS:
CONTINENT DISTRIBUTION, HISTORICAL
AND FORECAST
1962-1990

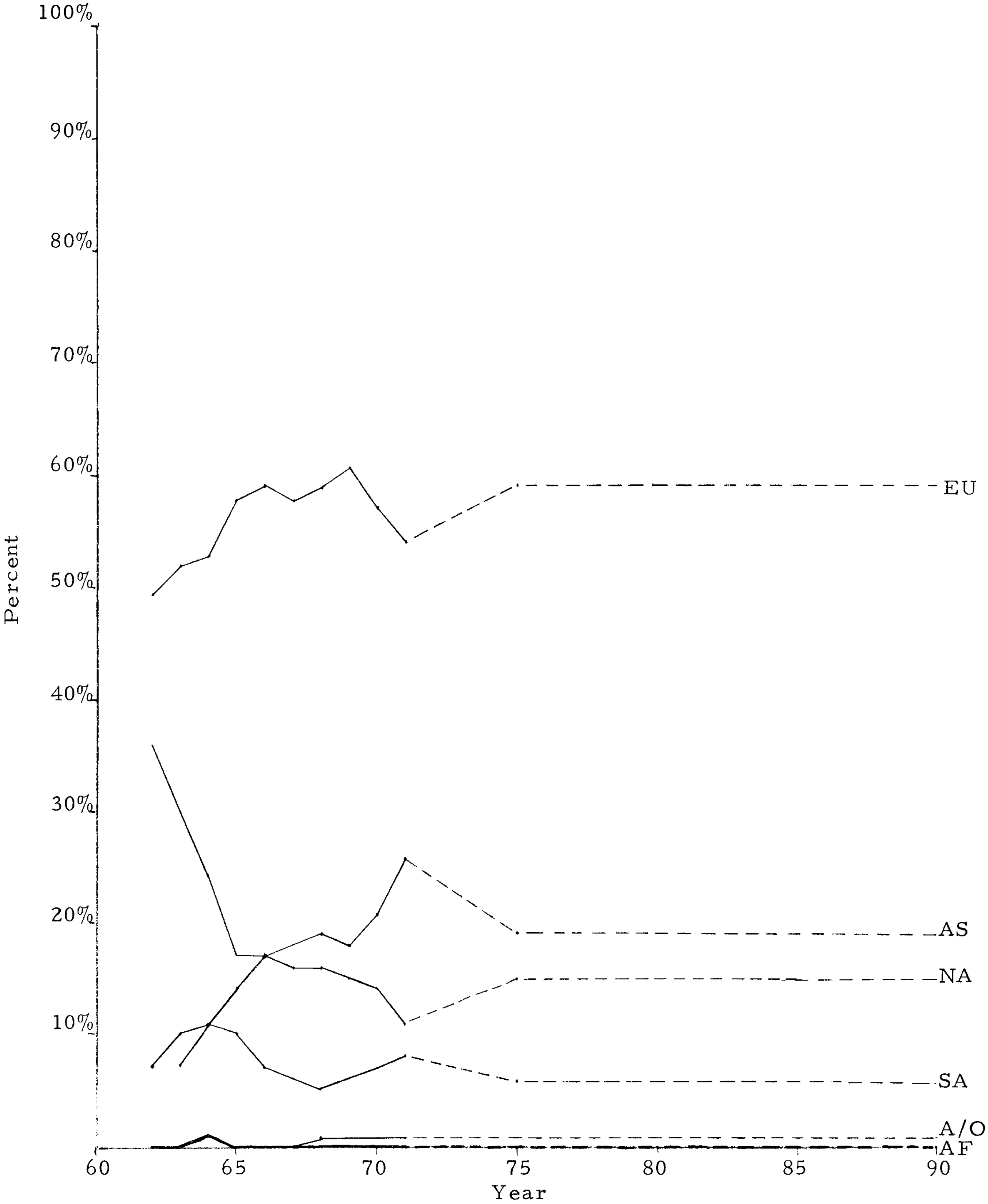

Figure 5-17

AIRBORNE IMPORTS OF UNITED STATES:
CONTINENT DISTRIBUTION, HISTORICAL
AND FORECAST
1962-1990

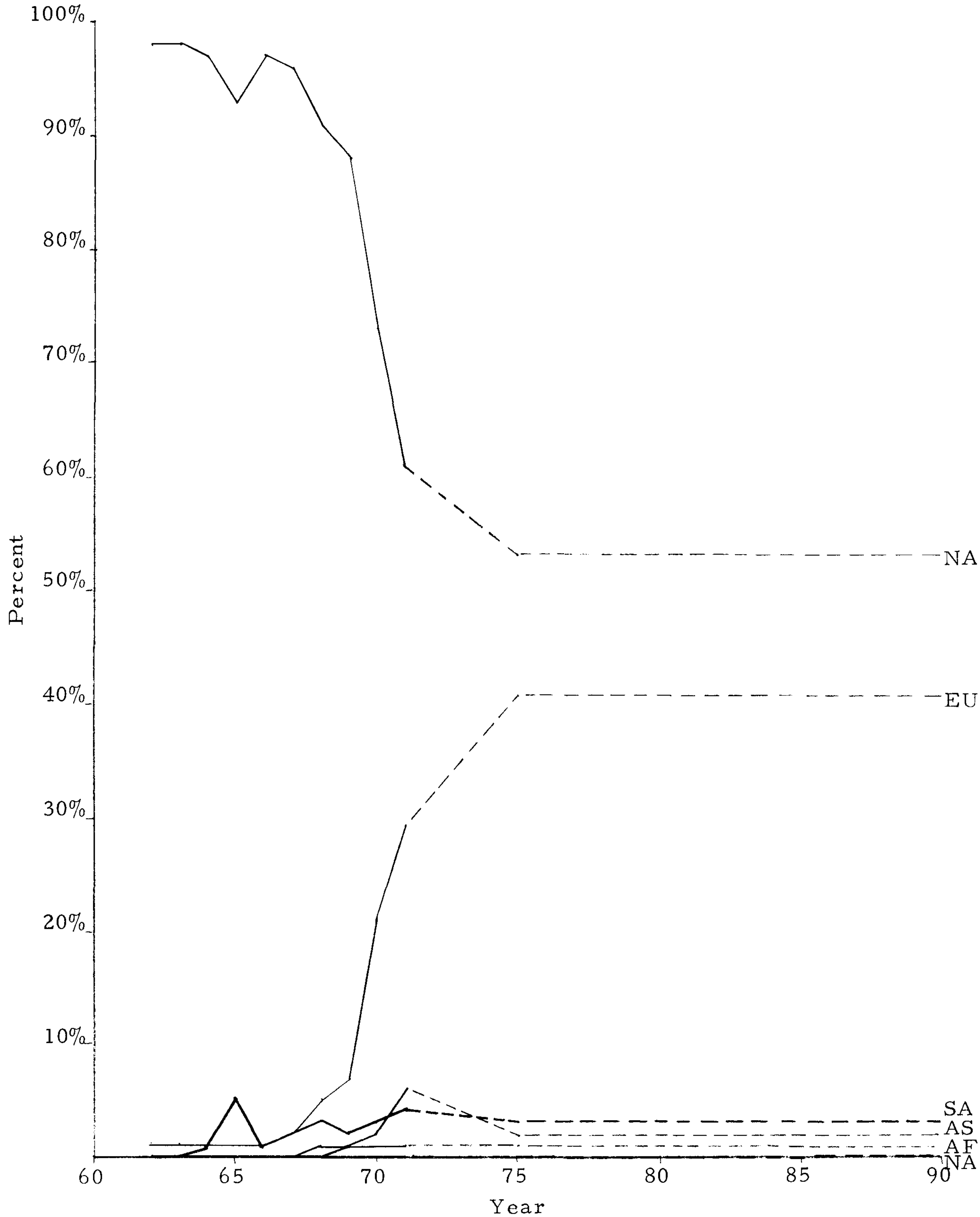

Figure 5-18

AIRBORNE IMPORTS OF TEXAS:
CONTINENT DISTRIBUTION, HISTORICAL
AND FORECAST
1962-1990

INCREMENTS FOR THE TREND-BASED FORECASTS OF TEXAS FREIGHT, EXPRESS AND MAIL, AND CARGO: SOCIOECONOMIC VARIABILITY

The effects of changes in Texas economic/demographic performance, measured in terms of macro - or aggregate - parameters (e.g., income, population, manufacturing), upon the previous share-of-market forecasts for the state will be analyzed here. The median Texas projections for cargo and its components (freight, express, and mail) serve as a base and are defined as the Expected (abbreviation EXP) scenario. Optimistic (OPT) and Pessimistic (PES) scenarios are introduced which reflect varying Texas performance relative to the above macro parameters and derivative air tonnages computed. The results are tabulated in Table 5-29; the format has combined the express and mail categories, and cargo is simply the sum of freight plus express and mail. These variations are graphed, with the solid lines denoting the cargo scenarios, in Figure 5-19. One may note the increasing dominance of freight, which begins at a higher tonnage level and also grows more rapidly (15.5 percent versus about six percent) than express and mail; in the Expected scenario, the ratio of freight to express and mail goes from 2/1 in 1975 to 7/1 in 1990.

The Pessimistic and Optimistic scenario increments - that is, their differences, in terms of tonnage and percentage, vis-à-vis the Expected case - are shown in Table 5-30. These statistics are subsequently charted: the Pessimistic scenario tonnage increments (all negative, of course) in Figure 5-20, the Optimistic scenario tonnage increments (all positive) in Figure 5-21, and both Pessimistic and Optimistic scenario percentage increments in Figure 5-22. Freight increments, for the reasons outlined above, are much larger than the corresponding express and mail variations. The important point is that, while the Pessimistic and Optimistic increments of express and mail are symmetrical and equal, the freight picture has an overall positive potential: its Optimistic increments outpace its Pessimistic ones,

Table 5-29

FORECASTS: PESSIMISTIC, EXPECTED, AND OPTIMISTIC SCENARIOS OF TEXAS FREIGHT, EXPRESS AND MAIL, AND CARGO; 1975, 1980, 1985, 1990

Scenario	Thousands of Tons 1975	1980	1985	1990
Freight				
PES	215	449	909	1,794
EXP	221	475	992	2,018
OPT	238	549	1,221	2,646
Express and Mail				
PES	105	147	203	274
EXP	107	152	214	295
OPT	109	157	225	316
Cargo				
PES	320	596	1,112	2,068
EXP	328	627	1,206	2,313
OPT	347	706	1,446	2,962

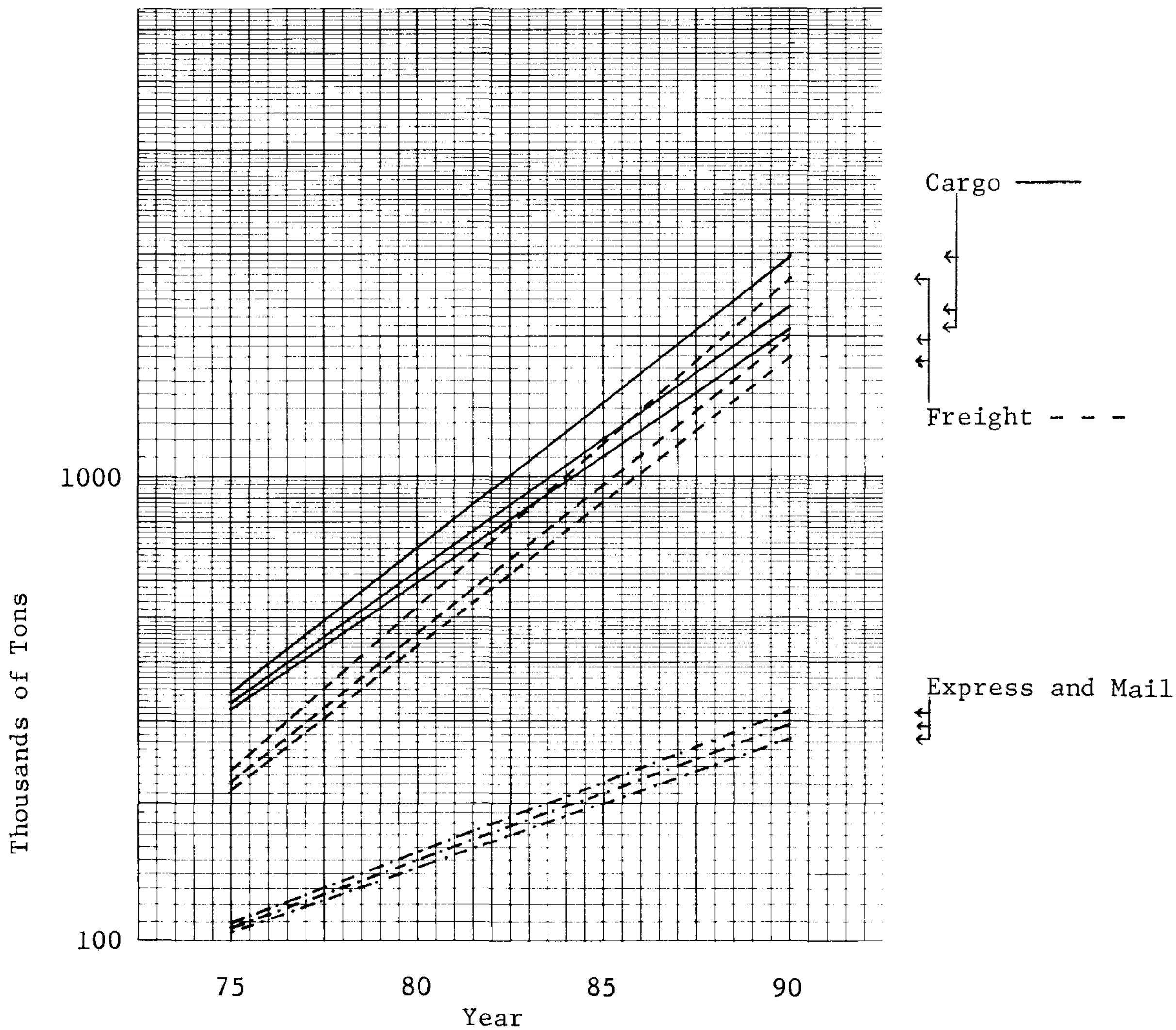

Figure 5-19

FORECASTS: PESSIMISTIC, EXPECTED, AND OPTIMISTIC
SCENARIOS OF TEXAS FREIGHT, EXPRESS AND MAIL, AND CARGO
1975-1990

Table 5-30

INCREMENTS: PESSIMISTIC AND OPTIMISTIC SCENARIOS OF TEXAS FREIGHT, EXPRESS AND MAIL, AND CARGO; 1975, 1980, 1985, 1990

Scenario	Thousands of Tons 1975	1980	1985	1990
Freight				
PES	- 6	- 26	- 83	- 224
OPT	+ 17	+ 74	+ 229	+ 628
Express and Mail				
PES	- 2	- 5	- 11	- 21
OPT	+ 2	+ 5	+ 11	+ 21
Cargo				
PES	- 8	- 31	- 94	- 245
OPT	+ 19	+ 79	+ 240	+ 649

Scenario	Percent 1975	1980	1985	1990
Freight				
PES	- 2.8	- 5.5	- 8.3	-11.1
OPT	+ 7.8	+15.6	+23.4	+31.2
Express and Mail				
PES	- 1.8	- 3.5	- 5.2	- 6.8
OPT	+ 1.8	+ 3.5	+ 5.2	+ 6.8
Cargo				
PES	- 2.4	- 4.9	- 7.8	-10.6
OPT	+ 5.8	+12.6	+19.9	+28.1

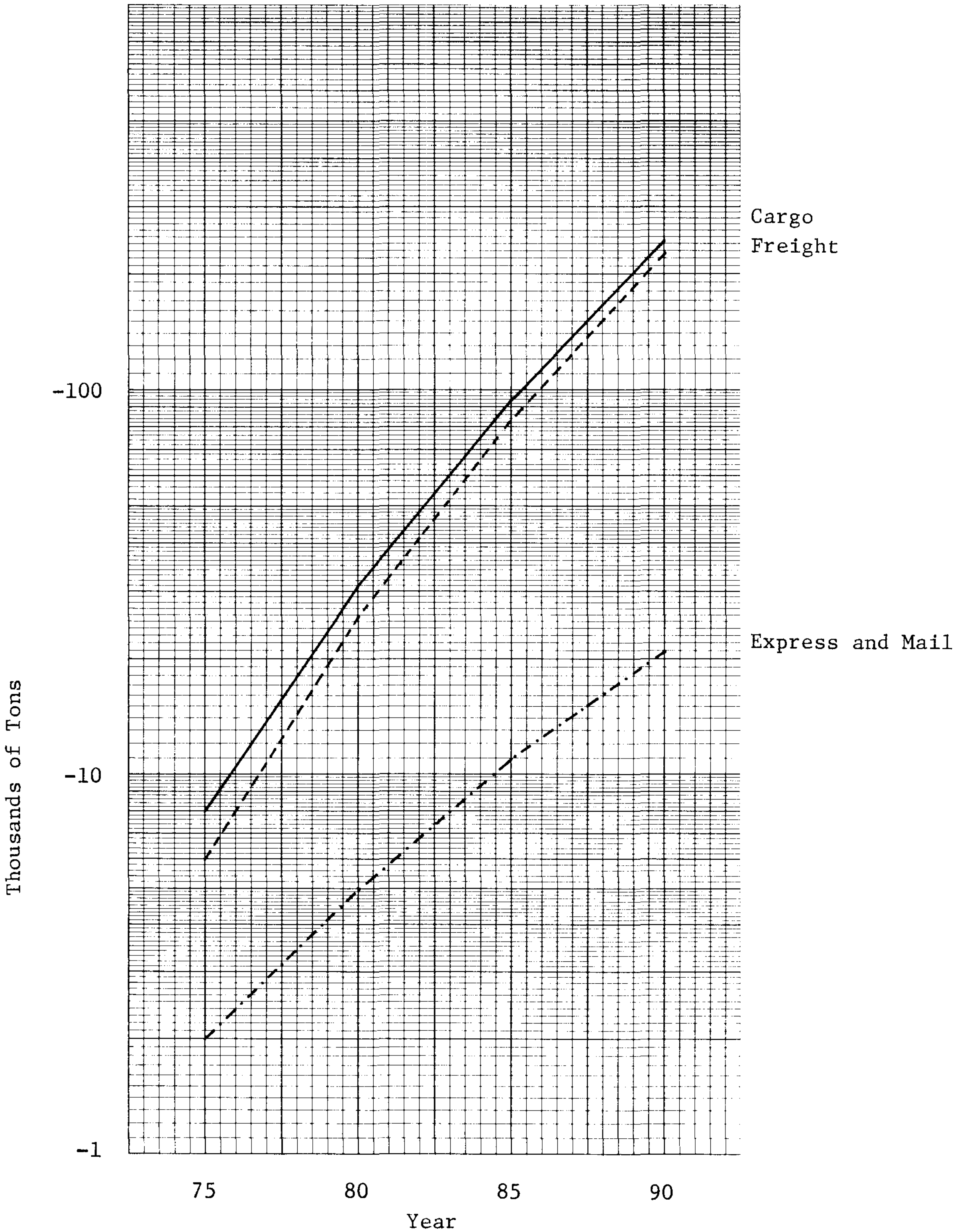

Figure 5-20

TONNAGE INCREMENTS: PESSIMISTIC TEXAS SCENARIOS
1975-1990

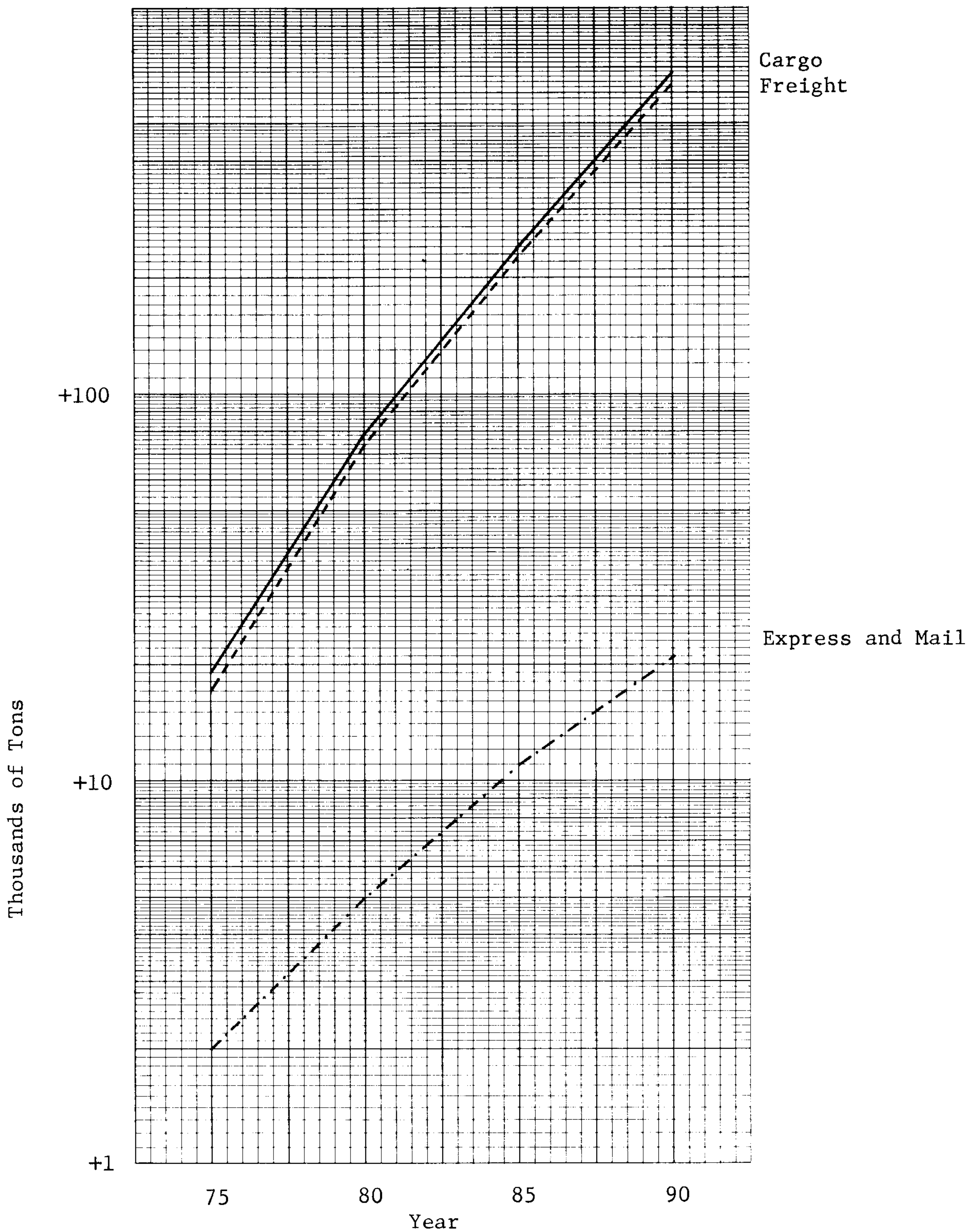

Figure 5-21

TONNAGE INCREMENTS: OPTIMISTIC TEXAS SCENARIOS
1975-1990

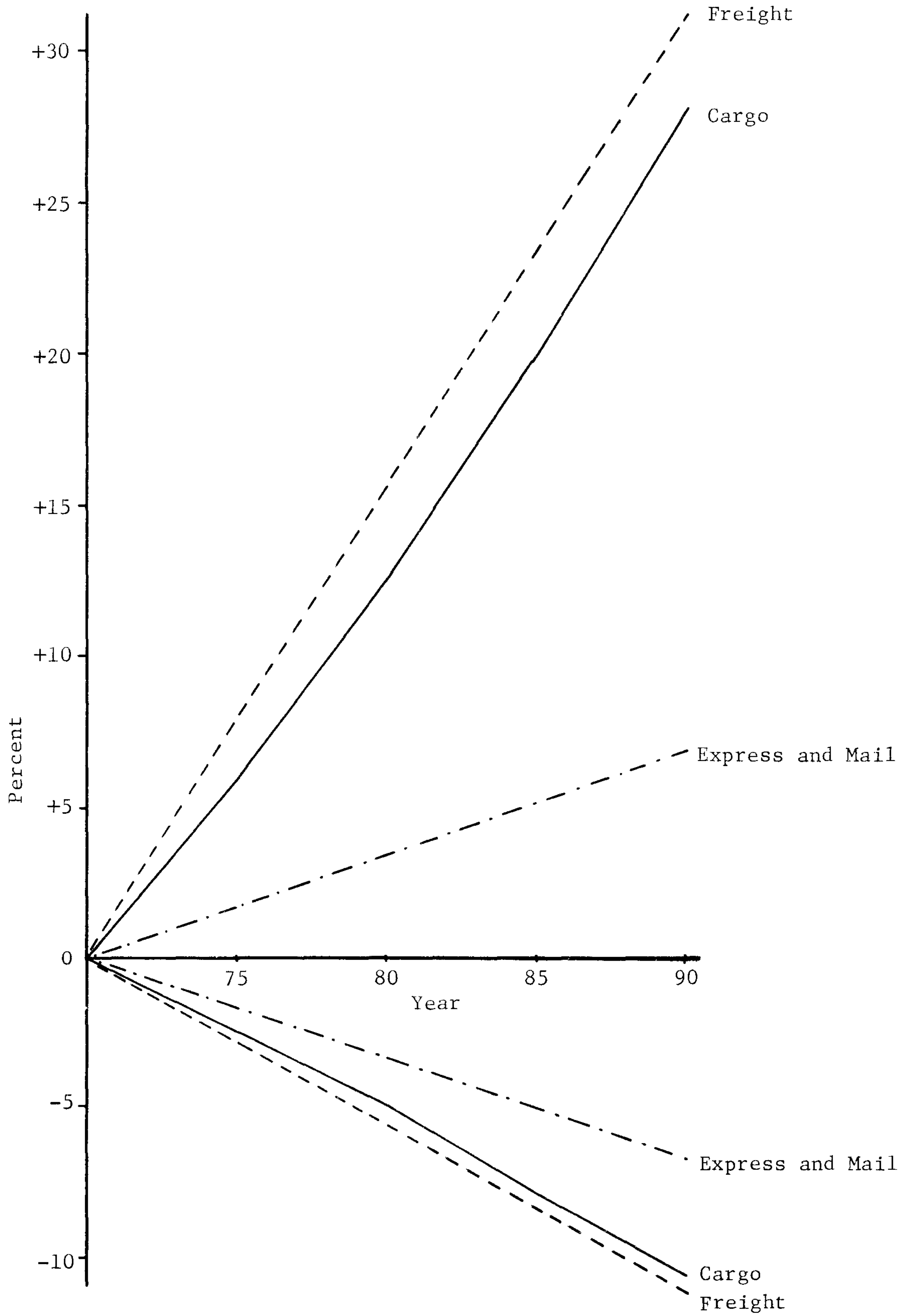

Figure 5-22

PERCENTAGE INCREMENTS:
PESSIMISTIC AND OPTIMISTIC TEXAS SCENARIOS
1970-1990

culminating in 1990 with +628,000 tons (+31.2 percent) versus -224,000 tons (-11.1 percent). This is seen by comparison of Figure 5-20 with Figure 5-21 and/or by contrasting the positive Optimistic line with the negative Pessimistic line of Figure 5-22.

Relevant macro parameters, describing Texas activity in broad economic/demographic terms for 1960-1970, are tabulated and - with the exception of Per Capita Income - graphed, respectively, in Table 5-31 and Figure 5-23. The variety of state trends is interesting. Texas's population role has been steadily increasing. Its share of total personal income was stagnant in 1960-1965 but rose significantly in the second half of the decade. Starting out at a low level - relative to other indicators - the state's manufacturing role has shown the most rapid rate of increase. And, paradoxically, Texas's portion of United States air freight activity actually declined over this same period despite general improvement in the other state economic/demographic parameters. This contradictory situation and its causes will be analyzed in a subsequent discussion; for the present, it is duly noted and will subsequently be considered in the formation of scenarios.

In the above discussions, the Texas share of freight traffic was set at a constant 4.5 percent for the 1970-1980 forecast horizon; by definition, this is the Expected freight scenario. This case and other scenario shares are summarized in Table 5-32 and graphed in accompanying Figure 5-24. The Optimistic case for freight postulates that by 1990 Texas will: (a) exhibit a direct relationship between freight and total personal income, like the United States; (b) account for 5.9 percent of the United States population; and (c) move up to a per capita income equal to the United States - i.e., 100 percent versus the 86 percent to 90 percent range of 1960-1970 (as shown in Table 5-33). Thus, for Texas in 1990:

$$
\begin{aligned}
\text{Air freight activity share} &= \text{Total personal income share} \\
&= \text{Population share x per capita income} \\
&= 5.9 \text{ percent x } 100 \text{ percent} \\
&= 5.9 \text{ percent}
\end{aligned}
$$

Table 5-31

MACRO PARAMETERS: TEXAS AS SHARE OF U.S.
1960-1970

	Percent										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Air Freight: Tonnage	*	*	5.4	5.1	5.0	4.9	5.1	4.6	4.6	4.5	*
Manufacturing: Value Added	*	*	3.6	3.7	3.8	3.8	3.9	4.2	*	*	*
Total Personal Income	4.6	4.6	4.7	4.7	4.7	4.6	4.7	4.8	4.8	4.9	5.0
Population	5.3	*	*	*	*	5.4	*	*	*	*	5.5
Per Capita Income	87	88	86	87	86	87	88	89	89	89	90

*Unavailable or not comparable.

Source: Federal Aviation Administration, U.S. Commerce Department, and U.S. Bureau of the Census.

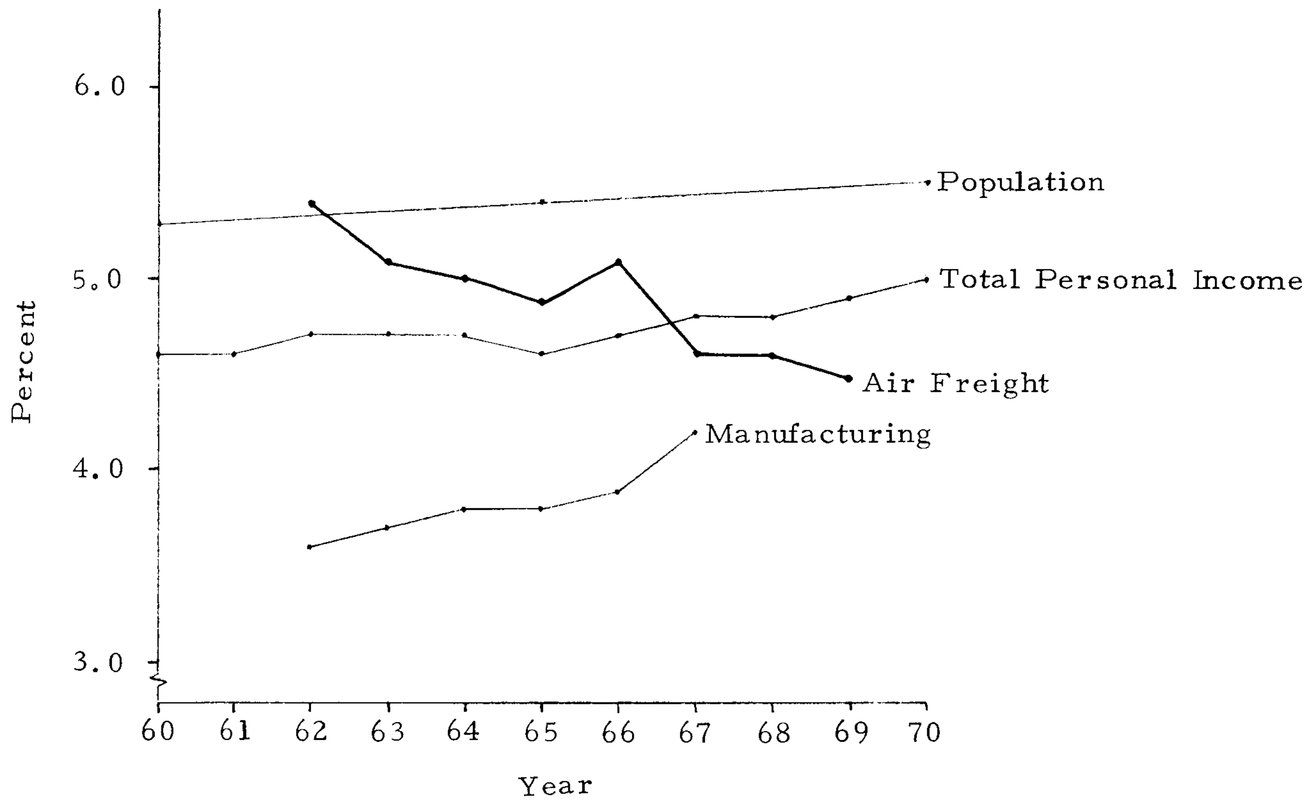

Figure 5-23

MACRO PARAMETERS: TEXAS AS SHARE OF U.S.
1960-1970

Table 5-32

FREIGHT AND EXPRESS AND MAIL: TEXAS AS SHARE OF U.S.; PESSIMISTIC, EXPECTED, AND OPTIMISTIC SCENARIOS; 1975, 1980, 1985, 1990

Scenario	Percent			
	1975	1980	1985	1990
Freight				
PES	4.375	4.25	4.125	4.0
EXP	4.5	4.5	4.5	4.5
OPT	4.85	5.2	5.55	5.9
Express and Mail				
PES	5.5	5.5	5.5	5.5
EXP	5.6	5.7	5.8	5.9
OPT	5.7	5.9	6.1	6.3

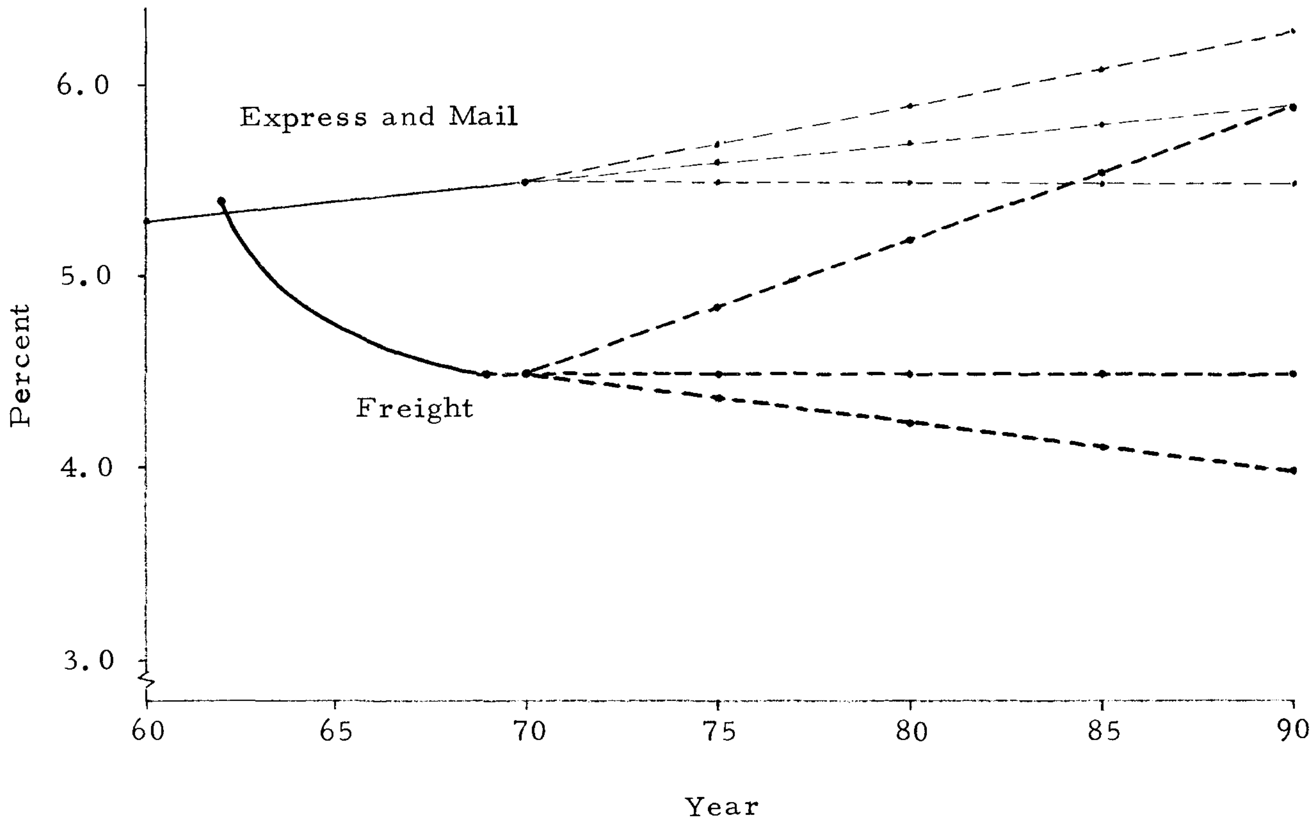

Figure 5-24

FREIGHT AND EXPRESS AND MAIL:
TEXAS AS SHARE OF U.S.; PESSIMISTIC, EXPECTED,
AND OPTIMISTIC SCENARIOS: HISTORY AND FORECASTS
1960-1990

As shown in Figure 5-24, this Optimistic Texas share is linearly increased to the 5.9 percent value from the 1970 share of 4.5 percent. For the Pessimistic freight scenario, lackluster Texas economic/demographic performance - i.e., no further increases in the State's share of total personal income of manufacturing - is assumed; the Texas portion of United States air freight is then projected to decline slowly to 4.0 percent in 1990.

The combined express and mail share - on the basis of previous analysis - is approximately equal to the State share of United States population. The Median projection of that analysis (which, of course, is the Expected scenario in this case) foresaw a linear share increase from the 5.5 percent in 1970 to 5.9 percent in 1990 (see middle express and mail line in Figure 5-24). For an Optimistic scenario, the latest population projections for Texas and the United States - which are tabulated in Table 5-33 - were utilized. The higher of the two State forecasts, i.e., Series I, and the most realistic low United States projection, Series E, were combined. The following Texas shares were then computed (population in millions):

	1975	1980	1985	1990
Texas Population	12.2	13.3	14.4	15.7
United States Population	214.7	225.5	236.9	247.7
Texas Share	5.7%	5.9%	6.1%	6.3%

Interestingly, this pattern shows a 0.2 percent share increase every five years versus the 0.1 percent rate of the Expected express and mail scenario. The Pessimistic scenario will simply postulate that the Texas population share (which, again, is the same as the State's express and mail share) will show no further increases, remaining at the present 5.5 percent through 1990. One may note, in Figure 5-24, the symmetry of the Pessimistic and Optimistic express and mail share lines - i.e., their identical distance from the middle Optimistic one.

Table 5-33

POPULATION PROJECTIONS
1975, 1980, 1985, and 1990

Series	Millions 1975	1980	1985	1990
Texas				
I	12.2	13.3	14.4	15.7
II	11.9	12.6	13.1	14.1
U.S.				
B	219.1	236.8	257.0	277.3
C	217.6	232.4	249.2	266.3
D	215.6	227.5	240.9	254.7
E	214.7	225.5	236.9	247.7
X	*	220.5	*	237.5

*Unavailable.

Source: Texas Bureau of Business Research and U.S. Bureau of the Census.

Freight, express, and mail percentage shares (Table 5-34) were applied to the Median Texas projections given above to obtain the respective Pessimistic, Expected, and Optimistic forecasts of Table 5-31. Finally, an important distinction should be made: while the forecast series (Low, Median, and High) basically projected how large the United States air cargo market will be, the scenarios (Pessimistic, Expected, and Optimistic) predict what portion Texas - based on its economic/demographic performance - will obtain of that market.

Table 5-34

TEXAS AS SHARE OF U.S. ACTIVITY: AIR FREIGHT, MANUFACTURE VALUE ADDED, AND MANUFACTURING EMPLOYMENT FOR 1962-69

	Percent		
	F	VA	EMP
1962	5.4	3.6	3.0
1963	5.1	3.7	3.0
1964	5.0	3.8	3.1
1965	4.9	3.8	3.2
1966	5.1	3.9	3.2
1967	4.6	4.2	3.4
1968	4.5	4.2	3.5
1969	4.5	*	*

* No Texas data available

Note: F = Freight (Air) Tonnage
VA = Value Added by Manufacture
EMP = Employment in Manufacturing

Source: FAA, Airport Activity Statistics, 1962-69 Editions, Bureau of the Census, 1967 Census of Manufactures, Department of Commerce, 1971 U.S. Statistical Abstract.

OUTPUT-PROPENSITY ANALYSIS OF TEXAS MANUFACTURING AND AIR FREIGHT: LONG-RANGE AIR POTENTIAL COMMODITIES

In the preceding section, Texas's share of United States air freight was seen to be declining despite the state's general rise in economic performance, as indicated by macro parameters such as Total Personal Income. This is illustrated, again, in Figure 5-25: state air freight (abbreviated as F) portion falling versus increased manufacturing activity, measured in terms of value added (VA) and employment (EMP). The VA and EMP lines exhibit similar upward rates (the higher VA (versus EMP) share indicates Texas's relatively high amount of capital-intensive versus labor-intensive industries, such as oil and chemical refineries). The F, VA, and EMP percentage share statistics are given in Table 5-35; these were computed from government data (exhibited later, in Table 5-37).

These trends will be analyzed (in fulfillment of proposal paragraph 3.2.1) in an output-propensity framework shown in Figure 5-26. Output refers to state industrial output in important air-prone commodities, which will be operationally defined as Texas's share of United States manufacturing VA or EMP. Propensity means Texas's ability or inclination - in this case, measured against the national standard - to utilize the air freight mode to ship its output. The matrix shows the four possible types of state performance:

1)	$\overline{O}\,\overline{P}$	Low Output:	Low share of air-freighted commodities.
		Low Propensity:	Low general use of air as shipping mode.
2)	$\overline{O}P$	Low Output:	Low share of air-freighted commodities.
		High Propensity:	High general use of air as shipping mode.
3)	$O\overline{P}$	High Output:	High share of air-freighted commodities.
		Low Propensity:	Low general use of air as shipping mode.
4)	OP	High Output:	High share of air-freighted commodities.
		High Propensity:	High general use of air as shipping mode.

As indicated, Texas was found to be $\overline{O}P$; that is, the state's portion of manufacture of air-prone commodities is well below its overall industrial role (e.g., 1968 VA share = 4.2 percent) - but, of that which Texas does produce,

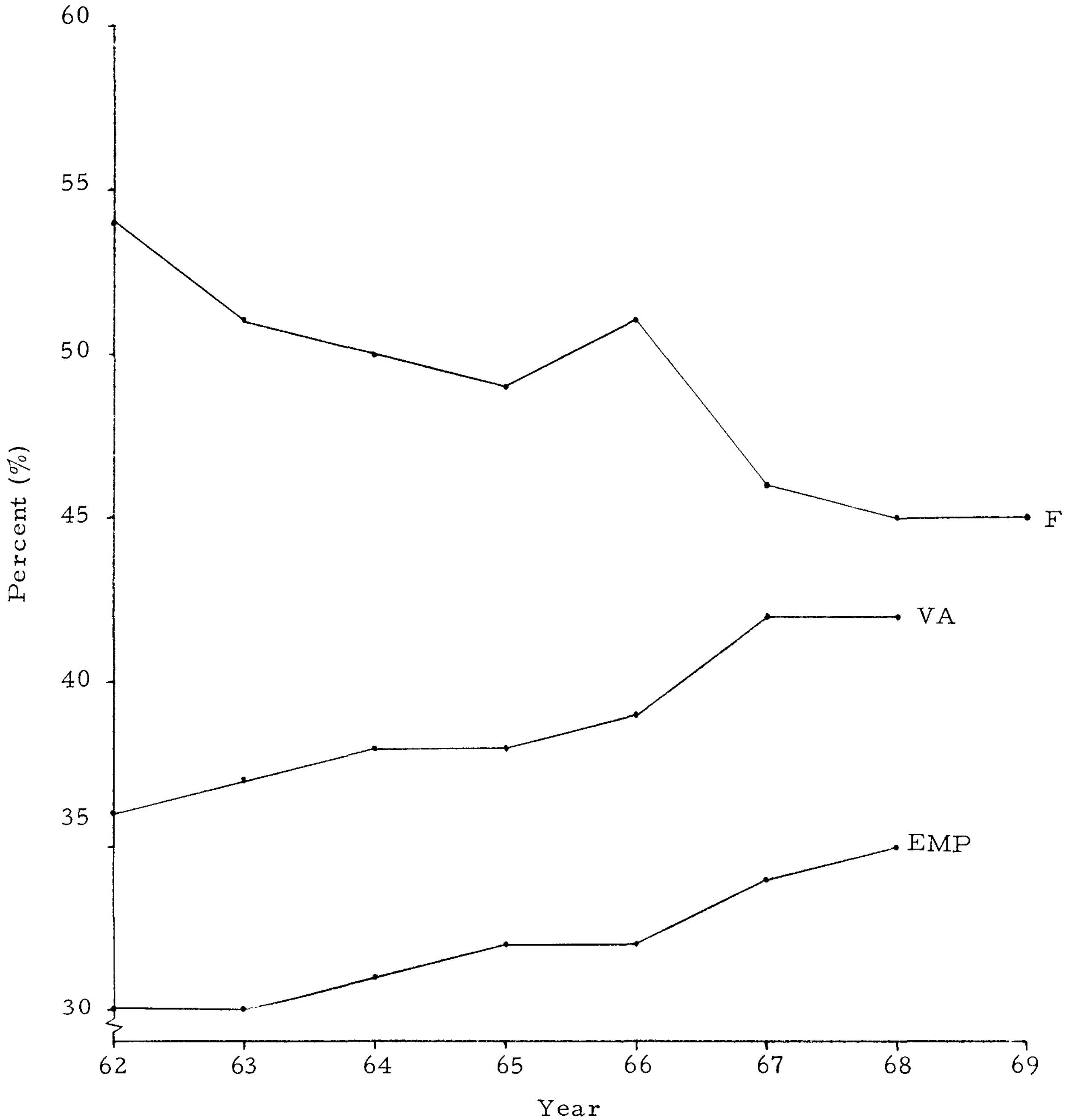

Figure 5-25

TEXAS AS SHARE OF U. S. ACTIVITY: AIR FREIGHT (F), MANUFACTURE VALUE ADDED (VA), AND MANUFACTURING EMPLOYMENT (EMP) FOR 1962-69

Table 5-35

TOP 30 AIR FREIGHT COMMODITIES:
TEXAS AND U.S. VALUE ADDED BY MANUFACTURE
1963 and 1967

	VA: $ x Billion			
	Texas		U.S.	
SIC	1963	1967	1963	1967
2311	.0040	.0125	.832	1.05
2331			.300	.384
2651	.0105	.0083	.477	.563
2831			.0604	.109
2871	.0331	.0420	.288	.434
3061				
3071				
3311				
3429	.0020		1.06	1.44
3431			.140	.141
3452			.695	.979
3461	.0071	.0117	2.28	3.04
3494	.0424	.0814	.943	1.38
3499	.0028	.0064	.299	.522
3541	.0028		.699	1.39
3559	.0210	.0243	.572	1.04
3561	.0307	.0479	.769	1.21
3566	.0080	.0102	.556	.801
3573			1.29	1.93
3599	.0399	.0775	1.37	2.53
3611			.505	.800
3643			.356	.507
3651			.912	1.40
3662	.136		4.33	5.46
3679	.0058		1.46	2.61
3699			.101	.144
3714		.0202	5.00	5.71
3722		.0167	2.21	2.92
3729		.101	2.08	2.96
3811	.0143	.0317	.359	.617
SUM*	.214	.354	8.76	13.2
ALL	7.12	10.9	192	262

*That is, for the eleven SIC that have Texas data for both 1963 and 1967.

Source: Bureau of the Census, 1967 Census of Manufactures.
See Exhibit 5-1 for code definitions.

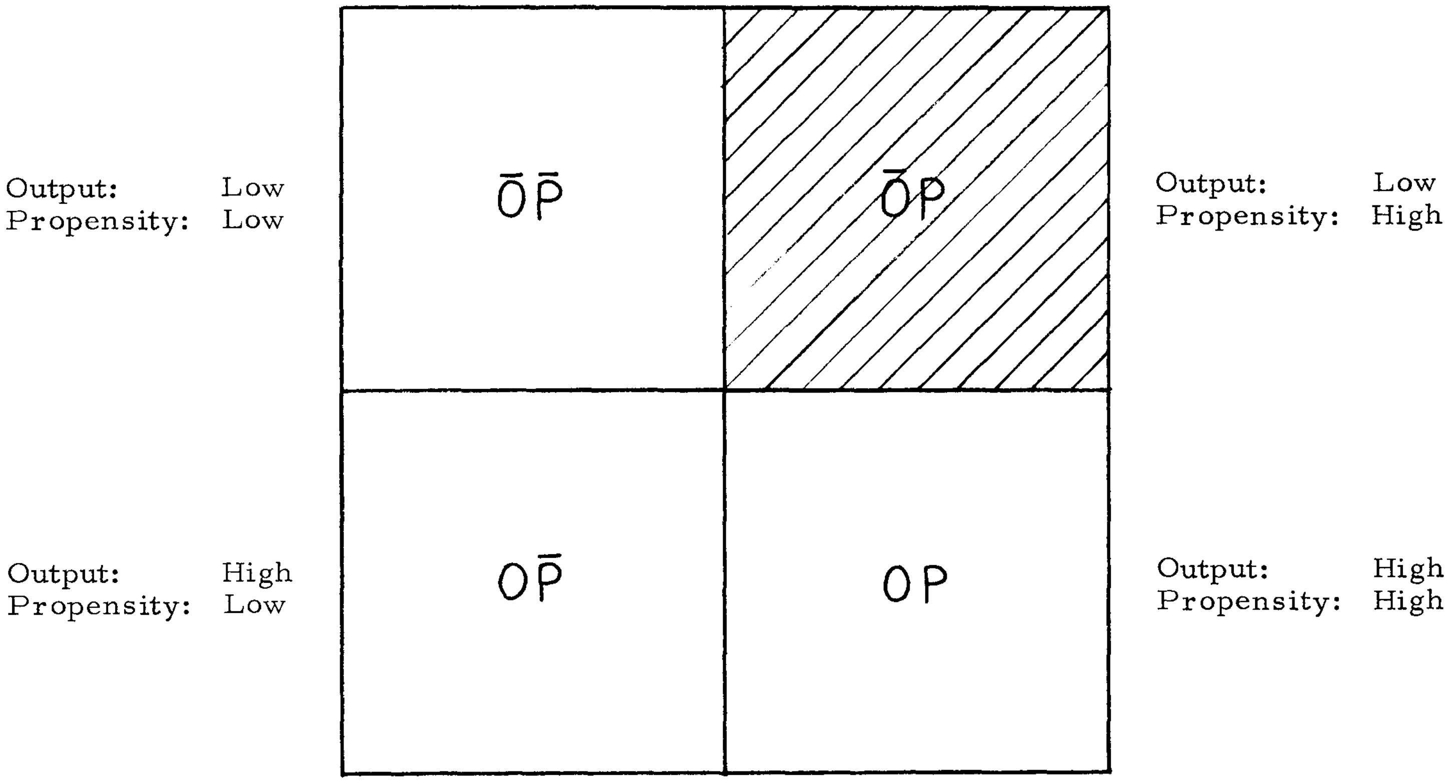

Figure 5-26

OUTPUT-PROPENSITY ANALYSIS MATRIX

it uses air freight more than the nation in general. Thus, the key to greater Texas air shipment activity is production of air-prone goods; correspondingly, state air freight capacity is not a constraining factor. Efforts to increase state air freight should concentrate on increasing capacity in specific air-freighted SIC categories, e.g., "Top Tonnage 30" (Survey Sample Set III) and "Two Percent or More by Air" (Sample Set I). These were delineated in previous discussions; other commodities now at low air usage levels, but with future potential, are discussed - and ranked - later in this report.

The Low Output-High Propensity $\overline{O}P$ findings are graphically summarized in Figures 5-27[1/] and 5-28. The former shows Texas's output in eleven important air-prone SIC categories, with their average denoted by the SUM line; these are compared with Texas's overall manufacturing share, indicated by the ALL line. For most commodities - eight of the 11 in 1967 - Texas activity is low relative to the ALL line standard; consequently, the SUM line in the 2.5 percent (Texas share of United States manufacture value added) range runs well below the ALL line, which is around four percent. Also, one should note that the Texas share increased for only five of the 11 commodities between 1963 and 1967.

The state's relative propensity to utilize air freight is still favorable (see Figure 5-28). With Texas/United States ratios as parameters, the national norm is simply 1.0, as indicated by the dashed line. Despite the decline caused by its low output of air-prone commodities, Texas - in terms of air freight (F) generated as a function of manufacturing activity (VA or EMP) - is still ahead of the United States as a whole.

Tables 5-35 and 5-36[1/] tabulate and analyze, respectively, the manufacturing data (in terms of value added) for the commodities of the "Top Tonnage 30"; this is the basis of Figure 5-27. Blanks in Table 5-35 mean that figures were not available for reasons of disclosure or insignificant output; only 11 of the 30 had Texas data for both years. In Table

1/ See Exhibit 5-1 for SIC code descriptions.

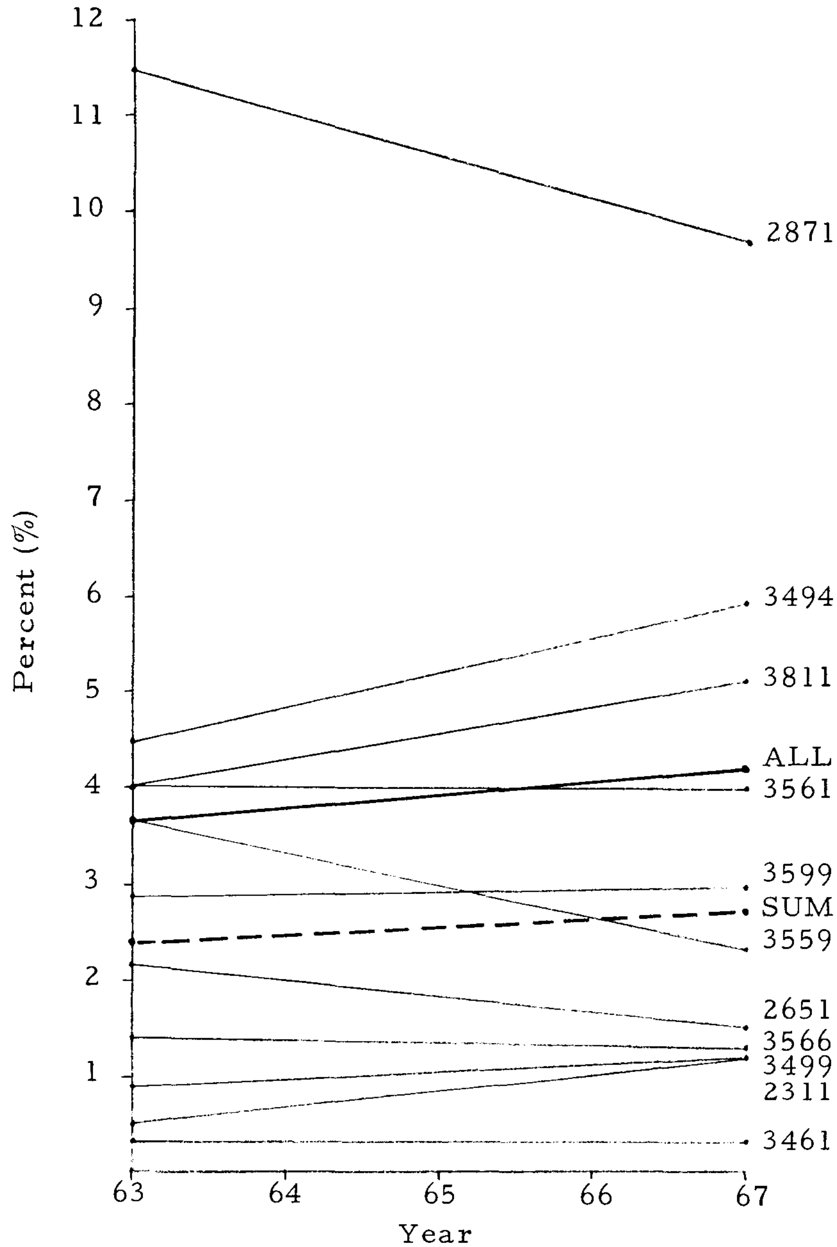

Figure 5-27

TEXAS AS SHARE OF U.S. MANUFACTURE VALUE ADDED: 11 KEY COMMODITIES, THEIR SUM, AND ALL COMMODITIES, 1963-67

See Exhibit 5-1 for code definitions.

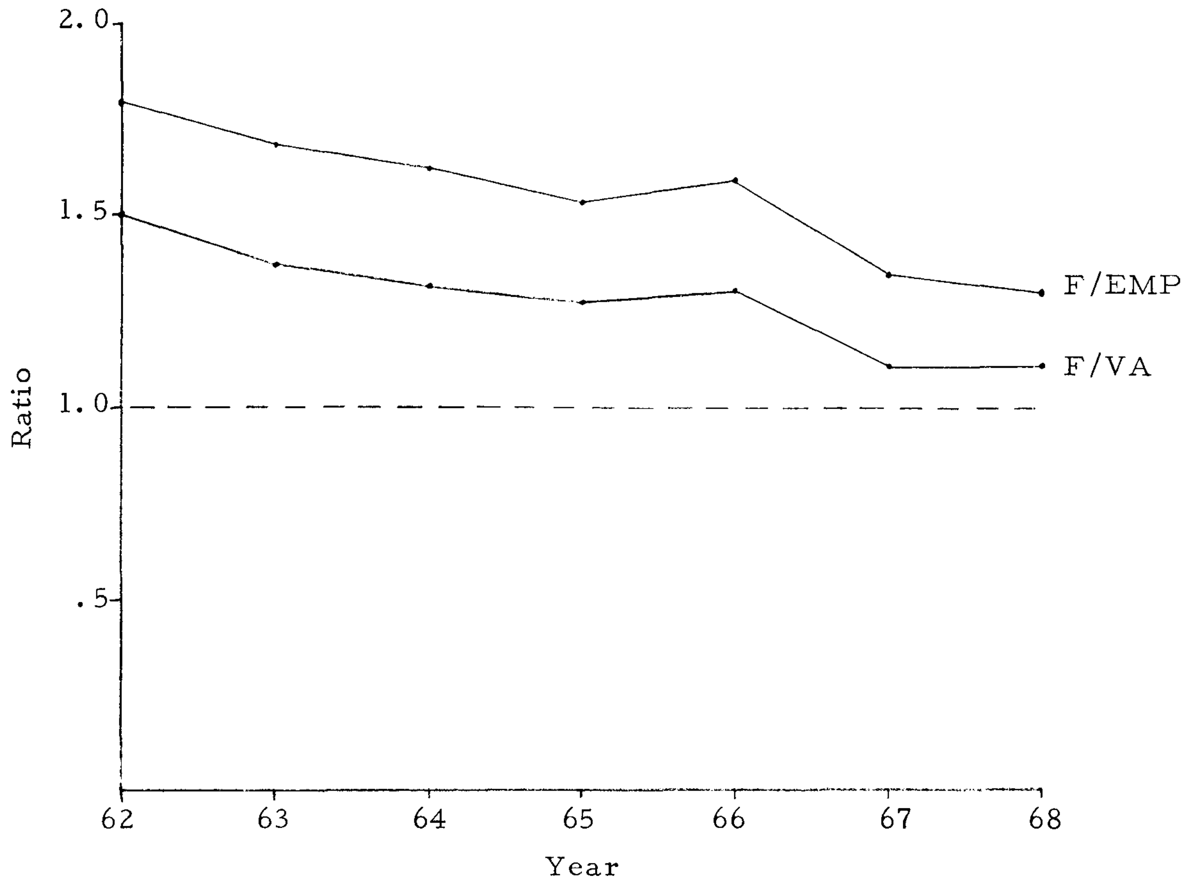

Figure 5-28

AIR FREIGHT AS FUNCTION OF MANUFACTURE VALUE ADDED AND AIR FREIGHT AS FUNCTION OF MANUFACTURING EMPLOYMENT: RATIO OF TEXAS VALUES TO U.S. VALUES 1962-68

Exhibit 5-1

SIC CODE DESCRIPTIONS

2311	Men's/Boys' Suits and Coats
2331	Women's/Girls' Blouses
2651	Folding Paperboard Boxes
2831	Biological Products
2871	Fertilizers
3061	Fabricated Rubber Products
3071	Miscellaneous Plastic Products
3311	Blast Furnace and Basic Steel
3429	Miscellaneous Hardware
3431	Metal Sanitary Ware
3452	Bolts, Nuts, and Washers
3461	Metal Stampings
3494	Valves and Pipe Fittings
3499	Miscellaneous Fabricated Metal Products
3541	Machine Tools: Metal-Cutters
3559	Special Industry Machinery
3561	Pumps and Compressors
3566	Power Transmission Equipment
3573	Electronic Computing Equipment
3599	Miscellaneous Machinery
3611	Electric Measuring Instruments
3643	Current-Carrying Wiring Equipment
3651	Radio/TV Receivers
3662	Phono Records
3679	Miscellaneous Electronic Components
3699	Miscellaneous Elecrrical Equipment
3714	Motor Vehicle Parts
3722	Aircraft Engines and Parts
3729	Miscellaneous Aircraft Equipment
3811	Scientific Instruments

28	Chemical Products
29	Petroleum and Coal Products
34	Fabricated Metal Products
35	Machinery, Except Electrical
36	Electrical Equipment and Supplies
37	Transportation Equipment
38	Instruments, Related Products

Exhibit 5-1

SIC CODE DESCRIPTIONS
(Continued)

2033	Canned Fruits and Vegetables
2036	Fresh or Frozen Packaged Fish
2037	Frozen Fruits and Vegetables
2231	Weaving and Finishing Wool Mills
2391	Curtains and Draperies
2392	Miscellaneous House Furnishings
2393	Textile Bags
2396	Automotive and Apparel Trimmings
2531	Public Building Furniture
2542	Metal Fixtures
2642	Envelopes
2645	Die-Cut Paper and Board
2649	Miscellaneous Paper Products
2654	Sanitary Food Containers
2844	Toilet Preparations
2851	Paints and Allied Products
2899	Miscellaneous Chemical Preparations
3011	Tires and Inner Tubes
3111	Leather Finishing
3141	Shoes, Except Rubber
3142	House Slippers
3161	Luggage
3199	Miscellaneous Leather Goods
3269	Miscellaneous Pottery Products
3292	Asbestos Products
3293	Gaskets and Insulators
3332	Primary Lead
3352	Aluminum Rolling
3357	Nonferrous Insulating
3361	Aluminum Castings
3362	Brass and Copper Castings
3369	Nonferrous Castings
339	Miscellaneous Primary Metal Products
3423	Miscellaneous Hand Tools
3433	Heating Equipment, Except Electrical
3442	Metal Doors
3443	Fabricated Platework
3444	Sheet Metalwork
3481	Miscellaneous Fabricated Wire
3519	Miscellaneous Internal Combustion Engines
3522	Farm Machinery
3531	Construction Machinery

Exhibit 5-1

SIC CODE DESCRIPTIONS
(Continued)

3532	Mining Machinery
3534	Elevators and Escalators
3536	Hoists, Cranes, and Monorails
3537	Industrial Trucks and Tractors
3542	Machine Tools: Metal-Formers
3544	Special Dies and Fixtures
3548	Miscellaneous Metalworking Equipment
3551	Food Products Machinery
3555	Printing Trades Machinery
3564	Blowers and Fans
3569	Miscellaneous Industrial Machinery
3585	Refrigeration Machinery
3589	Miscellaneous Service Machinery
3612	Transformers
3613	Switchgear
3622	Industrial Controls
3623	Welding Apparatus
3634	Electric Housewares
3642	Lighting Fixtures
3644	Non-Current-Carrying Wiring
3694	Engine Electrical Equipment
3732	Boat Building

Table 5-36

TOP 30 AIR FREIGHT COMMODITIES:
TEXAS AS SHARE OF U.S. VALUE ADDED BY MANUFACTURE
1963 and 1967

SIC	Percent (%) 1963	1967	1967 Share/1963 Share
2311	.5	1.2	2.40
2331			
2651	2.2	1.5	.68
2831			
2871	11.5	9.7	.84
3061			
3071			
3311			
3429	.2		
3431			
3452			
3461	.3	.3	1.00
3494	4.5	5.9	1.31
3499	.9	1.2	1.33
3541	.4		
3559	3.7	2.3	.62
3561	4.0	4.0	1.00
3566	1.4	1.3	.93
3573			
3599	2.9	3.0	1.03
3611			
3643			
3651			
3662	3.1		
3679	.4		
3699			
3714		.4	
3722		.6	
3729		3.4	
3811	4.0	5.1	1.28
SUM	2.4	2.7	1.12
ALL	3.7	4.2	1.13

See Exhibit 5-1 for code descriptions.

5-36, whenever possible, the state share (as a percent of the United States total) of specific commodity production was computed; also, in the last column, the ratio of 1967 to 1963 activity was found - here, values above (or below) 1.00 indicate an increase (or decrease) in the Texas share over this period.

Similarly, the data and derivative statistics of, respectively, Tables 5-37 and 5-38 are the basis of Figure 5-28. For the years 1962-1969, air freight data (F), in thousands of tons; manufacture value added (VA), in billions of dollars; and manufacturing employment (EMP), in millions, are tabulated in Table 5-37. In Table 5-38, freight generation functions - specifically, air tonnage per million dollars of value added (F/VA) and air tonnage per thousand employees (F/EMP) - were found for Texas and the United States (for completeness, the functions are graphed in Figure 5-29; note, of course, the higher Texas propensity in both the F/VA and F/EMP cases). The ratios of state to national values are calculated in the last pair of columns in Table 5-38.

The low output (of air-prone commodities) profile of Texas also emerged from analysis of its role in the export of manufactured goods. This is graphically summarized in Figure 5-30[1/], whereas state shares of SIC 28 and 29 (chemicals and oil), two groups that infrequently use air as their transport mode, are greatly above Texas's overall portion - indicated by the "ALL" line - its role in the more air-prone SIC 34-38 is, in all cases, below the line. One should note the similarity to Figure 5-27.

Export data for Texas and the United States are listed in Table 5-39[1/] and the derivative state shares (i.e., the values shown in Figure 6) are then computed in Table 5-40.[1/]

High air freight commodities in terms of present activity were identified for the manufacturers' survey discussed in Part 3 according to the following criteria: Two percent or more of 1967 United States shipments by air, activity of special importance to Texas, and top 30 by total 1967 United States air tonnage. A total of 104 four-digit SIC

1/ See Exhibit 5-1 for SIC code descriptions.

Table 5-37

AIR FREIGHT, MANUFACTURE VALUE ADDED, AND EMPLOYMENT IN MANUFACTURING: TEXAS AND U. S. 1962-1969

	F: Tons x 1000		VA: $ x Billion		EMP: Employees x Million	
	Texas	U. S.	Texas	U. S.	Texas	U. S.
1962	33.7	632	6.36	179	.496	16.7
1963	34.8	685	7.12	192	.514	17.0
1964	42.7	847	7.86	206	.536	17.3
1965	53.0	1085	8.70	227	.567	18.0
1966	63.5	1248	9.73	251	.608	19.0
1967	63.5	1373	10.9	262	.658	19.3
1968	74.8	1628	11.8	285	.689	19.5
1969	82.4	1846	*	306	*	20.0

*Data not yet available.

Sources: FAA, Airport Activity Statistics, 1962-69 Editions; Bureau of the Census, 1967 Census of Manufactures; Department of Commerce, 1971 U.S. Statistical Abstract.

Table 5-38

AIR FREIGHT AS FUNCTION OF MANUFACTURING PARAMETERS (VALUE ADDED, EMPLOYMENT): TEXAS AND U. S. 1962-1969

	F/VA Tons per Million $		F/EMP Tons per 1000 Employees		Texas/U.S. Ratio	
	Texas	U.S.	Texas	U.S.	F/VA	F/EMP
1962	5.3	3.5	68	38	1.50	1.79
1963	4.9	3.6	68	40	1.37	1.68
1964	5.4	4.1	80	49	1.32	1.62
1965	6.1	4.8	93	60	1.27	1.54
1966	6.5	5.0	104	66	1.31	1.59
1967	5.8	5.2	96	71	1.11	1.35
1968	6.3	5.7	109	83	1.11	1.30
1969		6.0		92		

Note: F/VA = Freight (Air) Tonnage ÷ Value Added by Manufacturing
F/EMP = Freight (Air) Tonnage ÷ Employment in Manufacturing

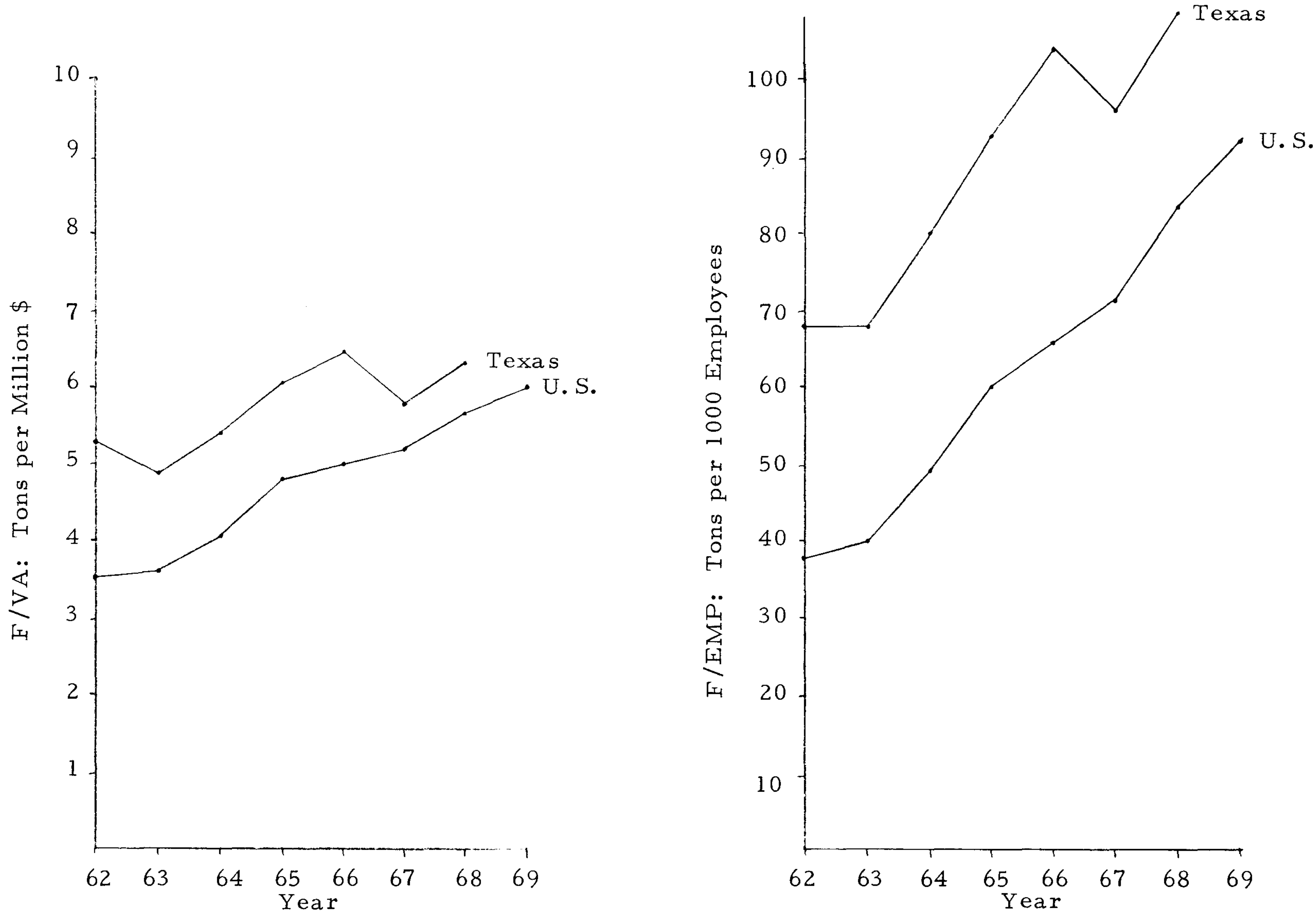

Figure 5-29

AIR FREIGHT AS FUNCTION OF MANUFACTURE VALUE ADDED AND
AIR FREIGHT AS FUNCTION OF MANUFACTURING EMPLOYMENT:
TEXAS FOR 1962-68, U.S. FOR 1962-69

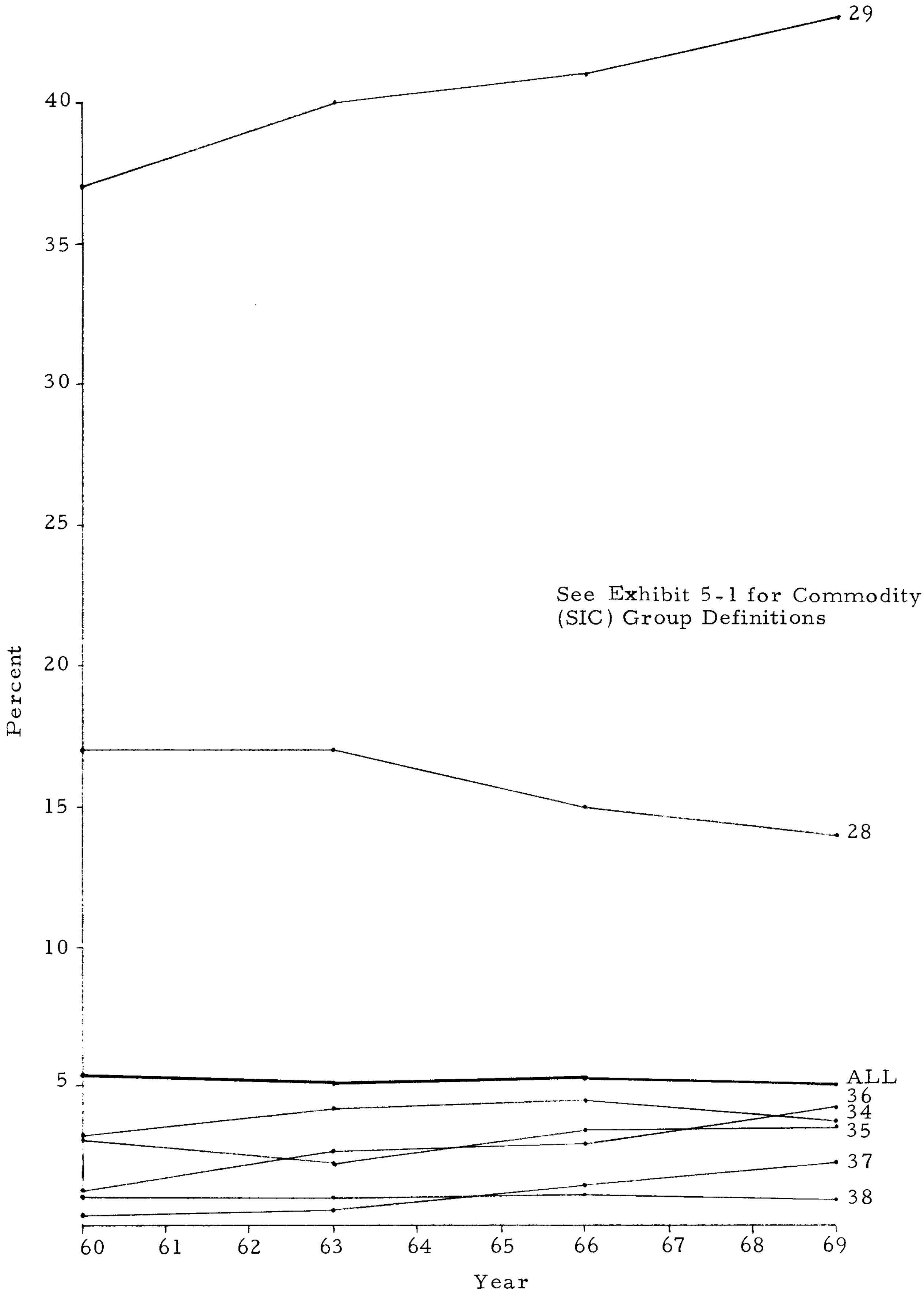

Figure 5-30

TEXAS AS SHARE OF U.S.: EXPORTS OF SELECTED COMMODITY GROUPS
1960-1969

Table 5-39

EXPORTS FOR SELECTED COMMODITY GROUPS: TEXAS AND U.S. 1960, 1963, 1966, 1969

	$ x Billion							
	Texas				U.S.			
SIC	1960	1963	1966	1969	1960	1963	1966	1969
28	.294	.314	.368	.432	1.73	1.87	2.44	3.05
29	.144	.169	.166	.185	.39	.43	.40	.43
34	.013	.023	.042	.044	.41	.55	.95	1.18
35	.085	.078	.159	.217	2.83	3.47	4.72	6.02
36	.012	.031	.047	.105	.92	1.21	1.60	2.48
37	.011	.016	.050	.139	2.55	2.59	3.45	6.17
38	.005	.007	.008	.010	.51	.70	.79	1.09
ALL	.827	.899	1.10	1.47	14.3	16.3	21.3	29.2

See Exhibit 5-1 for SIC definitions.

Source: Department of Commerce, Current Industrial Reports: Survey of the Origin of Exports by Manufacturing Establishments.

Table 5-40

EXPORTS FOR SELECTED COMMODITY GROUPS:
TEXAS AS SHARE OF U.S.
1960, 1963, 1966, 1969

	Percent			
SIC	1960	1963	1966	1969
28	17	17	15	14
29	37	40	41	43
34	3.2	4.2	4.4	3.7
35	3.0	2.2	3.4	3.6
36	1.3	2.6	2.9	4.2
37	.4	.6	1.4	2.3
38	1.0	1.0	1.1	.9
ALL	5.4	5.1	5.2	5.0

See Exhibit 5-1 for SIC definitions.

commodities were found to generate significant air shipments. Texas manufacturing activity in 50 of these was found to be minimal,[1/] leaving 64 long-range air-potential commodities for the state.

As a measure of potential, the 1967 Texas value added by manufacture (VA) was tabulated for each of the 64 (see Table 5-41). In about half of the cases, 31, it was necessary to estimate VA because disclosure provisions precluded publication of such data. Whenever possible, Texas VA was estimated on the basis of its share of United States employment:

$$\text{Texas VA/United States VA} = \text{Texas Employment/United States Employment}$$

e.g., for SIC 2036, Fresh or Frozen Packaged Fish:

$$\text{Texas VA}/165 - 2856/22029$$
$$\text{Texas VA} = 21.4(\$ \text{ x Million})$$

If employment data were also withheld, number of firms was the parameter of estimation:

$$\text{Texas VA/United States VA} = \text{Texas Number of Firms/United States Number of Firms}$$

e.g., for SIC 2231:

$$\text{Texas VA}/429 = 2/310$$
$$\text{Texas VA} = 2.8 \ (\$ \text{ x Million})$$

In Table 5-42, the long-range air-potential commodities are ranked in order of VA.

1/ I.e., no state listing (because total SIC employment was below 150) in the Bureau of the Census' 1967 Census of Manufactures: Texas.

Table 5-41

LONG-RANGE AIR-POTENTIAL COMMODITIES:
TEXAS VALUE ADDED BY MANUFACTURE
1967

	Texas		U.S.		Texas	
SIC	VA: $ x Million	SIC	Employees or Firms	VA: $ x Million	Employees or Firms	VA:* $ x Million
2033	29.2	2036	22029	165	2856	21.4
2037	16.7	2231	310	429	2	2.8
2391	5.8	2393	9809	78.0	691	5.5
2392	6.6	2396	780	91.5	12	1.4
2531	19.8	2649	33041	376	789	9.0
2542	4.7	2654	36159	506	721	10.1
2642	9.5	3111	519	319	7	4.3
2645	5.7	3141	951	1526	23	36.9
2844	2.5	3142	132	94.2	2	1.4
2851	71.7	3161	333	186	8	4.5
2899	31.4	3269	434	63.4	17	2.5
3011	59.4	3292	19777	308	999	15.5
3199	2.1	3332	19	48.3	1	2.5
3293	13.8	3352	53594	939	1194	20.9
3361	5.0	3357	66050	1330	814	16.4
339	84.5	3362	17821	227	372	4.7
3442	23.4	3369	35069	324	911	11.8
3443	97.2	3423	667	509	12	9.1
3444	28.0	3433	533	548	20	20.6
3481	17.6	3519	155	1016	8	52.4
3522	16.7	3532	22272	308	240	3.3
3531	34.5	3534	144	196	3	4.1
3536	3.9	3542	28566	437	130	2.0
3537	6.9	3548	45399	693	656	10.0
3544	11.2	3564	21736	302	172	2.4
3551	7.3	3612	47064	679	263	3.8
3555	11.8	3613	68610	1030	1212	18.2
3569	9.1	3623	147	265	2	3.6
3585	115.7	3634	290	590	8	16.3
3589	7.1	3644	21517	345	202	3.2
3622	8.2	3732	36202	275	2680	20.4
3642	12.1					
3694	1.4					

*Estimate

SIC's are defined in Exhibit 5-1.

Source: Bureau of the Census, 1967 Census of Manufactures and 1967 County Business Patterns

Table 5-42

LONG-RANGE AIR-POTENTIAL COMMODITIES:
RANKING BY TEXAS MANUFACTURING ACTIVTY
1967

Rank	SIC	VA: $ x Million	Rank	SIC	VA: $ x Million
1	3585	115.7	33	3569	9.1
2	3443	97.2	33	3423	9.1
3	339	84.5	35	2649	9.0
4	2851	71.7	36	3622	8.2
5	3011	59.4	37	3551	7.3
6	3519	52.4	38	3589	7.1
7	3141	36.9	39	3537	6.9
8	3531	34.5	40	2392	6.6
9	2899	31.4	41	2391	5.8
10	2033	29.2	42	2645	5.7
11	3444	28.0	43	2393	5.5
12	3442	23.4	44	3361	5.0
13	2036	21.4	45	3362	4.7
14	3352	20.9	45	2542	4.7
15	3433	20.6	47	3161	4.5
16	3732	20.4	48	3111	4.3
17	2531	19.8	49	3534	4.1
18	3613	18.2	50	3536	3.9
19	3481	17.6	51	3612	3.8
20	2037	16.7	52	3623	3.6
20	3522	16.7	53	3532	3.3
22	3357	16.4	54	3644	3.2
23	3634	16.3	55	2231	2.8
24	3292	15.5	56	2844	2.5
25	3293	13.8	56	3269	2.5
26	3642	12.1	56	3332	2.5
27	3555	11.8	59	3564	2.4
27	3369	11.8	60	3199	2.1
29	3544	11.2	61	3542	2.0
30	2654	10.1	62	3694	1.4
31	3548	10.0	62	2396	1.4
32	2642	9.5	62	3142	1.4

See Exhibit 5-1 for code definitions.

Source: Ibid.

It is interesting to compare the results of the manufacturing output propensity air freight analysis of Texas industries with the results of the Air Cargo Study's survey of manufacturers.

The conclusions from that survey were: Texas manufacturers view air cargo primarily as an emergency means of transportation and not as part of their normal distribution system. As such, air cargo provides an extremely valuable service. At the same time there are no indications that this view of air cargo will change in the near future. Shippers foresee a relatively slower growth in air cargo shipments than to total shipment growth, as shown in Table 5-43. There are indications that shippers expect air rates to decline relative to motor carrier rates, and if such occurs, they will increase their use of air cargo. There are shipper complaints of air cargo service particularly at the smaller airports, but these complaints are very similar to those frequently levied against common carrier motor transportation. Overall, the survey results support a conclusion of no dramatic growth in air cargo as a result of the manufacturing sector, rather, they indicate continued growth at a level equal to or less than recent growth patterns.

These conclusions are very much in agreement with the results of a survey conducted by Distribution Worldwide, January 1972. This survey concluded that "despite considerable effort on the part of airline cargo management in marketing the concept, shipper attitude really hasn't changed materially in the past five years."

The forecasts herein imply compensatory contributions to air cargo usage from the long-range air-potential manufactured commodities and from non-manufacturing to make up for decreased usage rates by present high potential manufactured commodities.

Table 5-43

ESTIMATED ANNUAL GROWTH RATE IN AIR SHIPMENTS
RELATIVE TO ESTIMATED ANNUAL GROWTH RATE
IN TOTAL SHIPMENTS

SIC	Responses	Air Less Than Total	Air Same As Total	Air Greater Than Total
2311-2399	2	1	1	0
2651	1	1	0	0
2721-2789	5	2	2	1
28151-28216	14	8	4	2
2834	2	1	1	0
3461-3499	12	8	2	2
3531-3533	17	8	7	2
3545-3599	7	5	0	2
36112-36795	21	12	7	2
3714-3729	6	4	1	1
3811-3842	11	6	4	1
Total	98	56	29	13

Source: Manufacturers Survey, Texas Air Cargo Study, May 1972.

TEXAS PARTICIPATION IN INDUSTRIES EXPORTING SIGNIFICANTLY BY AIR

Exports represent a special case of long-range potential for air freight shipment. Complementary, air transport offers a greater potential for marketing Texas products abroad than it does at home. In many trades (specific commodity - usually shipped in small quantities - foreign city) air freight - particularly with direct connections - offers economies in inland line-haul, transfer, time costs (transit inventory interest, spoilage), packaging[1/], and insurance. Increasing scheduled passenger demand places pressures for more United States city-foreign city direct route authority, and this pressure will impinge on Texas hubs. Significant additions to direct route bulk cargo capacity are almost certain to become available to Texas industry.

Because of these considerations, the Texas air Cargo Study included a special analysis of air export of commodities from the viewpoint of industrial source. This complements the domestic manufacturing industry output potential analysis above.

The purpose of this section is to compare Texas's role as an exporter of commodities by air with the rest of the United States. In this comparison, it is desirable to see if Texas deviates from the national trend of air export and to identify classes of Texas industry which demonstrate high activity in air exports.

Table 5-44 gives United States and Texas manufacturing employment plus the value of exports of manufactured goods for the United States and Texas. From this table, it is seen that Texas accounted for 3.72 and 3.86 percent of the manufacturing employment for 1969 and 1970, respectively, and that Texas has accounted for approximately five percent of the value for exported manufactured goods.

1/ Though containerized ocean carriage has equated air advantages here.

No statistics are readily available which relate air exports to states or which relate air exports to the Standard Industrial Classification (SIC) code. To compensate for the deficiency of data, the top four-digit Schedule B commodities of exports by shipping weight were delineated to the seven-digit level by use of the United States Bureau of the Census Computer Printouts of EA 622, "U.S. Exports of Domestic and Foreign Merchandise - Schedule B Section by Division, by Group, by Number, by Country of Destination, by Customs District of Exportation, and Method of Transportation for 1970." The seven-digit code was translated into the seven-digit SIC base code (for which there is a direct correspondence) and aggregated to the four-digit SIC code and sorted by shipping weight. The result is a printout of United States exports by air for 1970 by SIC code ordered by shipping weight.

For each of the four digit-SIC groupings which accounted for one million pounds of air exports in 1970, the number of employees for the United States and Texas were recorded, and the percentage of the Texas employment in that industry was recorded. These are shown in Table 5-45. This percentage was applied to the total air shipping weight of that grouping to derive a shipping weight for Texas for air exports. Description of the four-digit SIC code is found in Exhibit 5-2 at the end of this section.

A few points should be made about the formulation of this table:

1. SIC code 3xxx is defined as "miscellaneous manufacturers, not elsewhere classified." This group contains mostly "general merchandise valued at less than $100 - estimated." Obviously, no employment figure could be derived for this code and, hence, Texas's share of this commodity was assumed as five percent which is Texas's share of value of manufacturers' exports (Table 5-44).

Table 5-44

TEXAS AND U.S. EMPLOYMENT IN MANUFACTURING:
TEXAS AND U.S. VALUE OF MANUFACTURING EXPORTS

Employment (000)	1960	1963	1966	1969	1970
U.S.	16,337	17,035	19,323	20,121	19,761
Texas	489	515	657	749	764
Ratio (percent)	2.99	3.02	3.40	3.72	3.86
Exports/Value (billions)					
U.S.	14.3	16.3	21.3	29.2	
Texas	.827	.899	1.10	1.47	
Ratio (percent)	5.4	5.1	5.2	5.0	

Source: U.S. Bureau of the Census and Economics Research Associates.

Table 5-45

1970 U.S. AIR EXPORTS

SIC Code	Shipping Weight (thousand pounds)	Employment U.S. 1970	Employment Texas 1970	Percent Texas	Texas's Share of Shipping Weight	Percent
3xxx	114,347	--	--	5.80	5,717.0	21.2
3573	52,530	158,461	2,689	1.69	887.7	3.3
3679	31,970	240,996	0	.37	118.3	.4
3729	23,517	147,852	6,594	4.45	1,046.5	3.87
3531	20,402	130,368	2,183	1.67	340.7	1.2
3714	17,373	364,900	1,800	.49	85.1	.3
3494	16,180	93,199	6,825	7.32	1,184.4	4.4
3821	13,992	69,333	1,271	1.83	256.0	.9
723	13,255	65,124	4,229	6.49	860.0	3.2
3559	13,054	66,820	2,445	3.65	476.5	1.7
3861	10,879	96,342	200	.20	21.7	.08
3561	10,790	80,048	3,311	4.13	445.6	1.65
2821	10,782	77,228	3,543	4.57	492.7	1.82
3519	10,054	13,330	1,410	1.92	193.0	.7
3662	9,819	362,932	19,803	5.45	535.1	1.9
3585	8,821	114,070	7,296	6.39	563.6	2.0
2752	8,493	157,535	5,741	3.64	309.1	1.1
3611	7,945	67,579	3,557	5.26	417.9	1.5
3533	7,942	37,081	21,177	57.1	4,535.7	16.81
3674	7,749	100,720	D	.1	7.7	.02
3722	7,747	175,024	1,562	.89	68.9	.25
3079	7,615	282,853	6,791	2.4	182.7	.67
3574	7,575	42,262	--	--	--	--
2818	7,249	103,605	22,223	21.4	1,554.0	5.7
3312	7,168	523,592	9,246	1.76	126.1	.4
3566	6,709	51,992	985	1.89	126.8	.4
2824	6,421	68,558	--	--	--	--
2221	6,250	119,801	D	1.00	62.5	.2
3651	6,078	99,466	854	.85	51.6	.2
123	5,710	--	--	6.3	360.0	1.3
122	5,469	--	--	6.3	344.0	1.3
3643	5,420	50,847	531	1.04	56.3	.2
3357	5,347	70,533	1,160	1.64	87.7	.3
2256	5,093	42,723	--	--	--	--
3621	5,089	110,083	110	.09	4.58	.0
3843	5,040	11,085	--	--	--	--
3644	4,862	26,332	192	.72	35.0	.1
3572	4,462	19,149	1,590	8.3	370.3	1.37
3069	4,461	144,054	D	.98	43.7	.1

Table 5-45
(Continued)

SIC Code	Shipping Weight (thousand pounds)	Employment U.S. 1970	Employment Texas 1970	Percent Texas	Texas' Share of Shipping Weight	Percent
135	4,267	--	--	6.3	268.8	.99
2834	4,049	111,242	1,100	.98	39.7	.1
3841	4,035	29,359	108	.36	14.5	.05
3999	3,925	58,581	1,182	2.01	78.9	.3
2621	3,892	143,132	13,000	.9	35.0	.1
3811	3,681	50,979	2,826	5.5	203.9	.7
9200	3,593	--	--	--	--	--
3579	3,561	23,120	--	--	--	--
3634	3,526	44,982	877	1.94	68.4	.2
3452	3,360	62,938	677	1.07	35.9	.1
3569	3,324	45,748	914	1.99	66.1	.2
3555	3,301	30,394	914	3.0	99.0	.4
3211	3,290	22,887	--	--	--	--
3552	3,275	36,752	--	--	--	--
3522	3,228	126,958	1,952	1.53	49.38	.18
3481	3,201	63,848	2,494	5.47	175.00	.6
193	3,119	--	--	6.3	196.4	.7
3352	3,104	54,202	1,068	1.9	60.0	.2
3231	3,051	27,104	423	1.56	47.5	.1
2911	3,030	101,336	28,101	27.7	840.2	3.11
3661	3,019	138,773	161	.11	3.3	.0
2851	2,998	65,601	3,366	5.13	153.7	.5
3011	2,994	102,450	3,588	3.5	104.7	.38
2721	2,973	75,354	1,562	2.0	61.5	.2
2011	2,941	169,850	10,622	6.25	183.8	.7
3541	2,928	75,209	1,567	2.08	60.9	.2
3652	2,892	18,333	104	.56	16.2	.0
2731	2,884	52,322	2,801	5.35	154.3	.5
2741	2,879	33,229	1,021	3.07	88.38	.3
3499	2,875	42,228	1,159	2.74	78.77	.3
3537	2,870	30,546	348	1.13	32.4	.1
2819	2,777	82,675	3,883	4.69	130.2	.5
3297	2,724	9,000	--	--	--	--
2891	2,711	10,701	134	1.25	33.88	.1
3551	2,701	34,549	907	2.62	70.7	.3
3532	2,639	23,020	260	1.12	29.55	.1
3589	2,622	24,619	925	3.75	98.3	.4
3822	2,617	30,956	--	--	--	--
2899	2,489	36,467	2,246	6.15	153.0	.5

Table 5-45
(Continued)

SIC Code	Shipping Weight (thousand pounds)	Employment U.S. 1970	Employment Texas 1970	Percent Texas	Texas' Share of Shipping Weight	Percent
2111	2,370	39,817	--	--	--	--
3548	2,357	47,548	602	1.26	29.6	.1
3562	2,277	57,477	--	--	--	--
1493	2,247	287	--	--	--	--
3941	2,226	52,927	495	.9	20.7	.07
2833	2,163	6,062	490	8.0	174.7	.6
3423	2,095	38,918	265	.68	14.24	.05
2631	2,053	75,585	1,740	2.3	47.2	.2
3632	2,006	49,790	--	--	--	--
2844	2,002	43,222	324	.74	14.8	.05
3949	1,992	50,835	1,679	3.3	65.7	.2
9900	1,988	--	--	5.0	99.4	.36
3542	1,944	27,393	137	.5	9.72	.0
3613	1,927	72,157	1,081	1.49	28.7	.1
2815	1,864	30,105	2,333	7.74	144.2	.5
3356	1,846	23,628	D	--	--	--
3429	1,846	100,214	383	.38	7.0	.02
3694	1,805	51,964	376	.72	12.8	.04
2392	1,794	14,613	984	6.73	120.7	.44
2295	1,788	14,690	--	--	--	--
3461	1,757	208,776	1,109	.53	9.31	.03
2369	1,737	32,135	666	2.07	35.9	.13
3264	1,706	12,204	--	--	--	--
3111	1,697	27,317	311	.8	14.0	.05
2335	1,680	227,316	10,179	4.47	75.0	.27
3622	1,645	54,560	880	1.61	26.4	.09
2831	1,632	4,967	--	--	--	--
2647	1,589	23,426	--	--	--	--
3545	1,542	55,554	306	.55	8.48	.03
192	1,513	--	--	6.3	95.0	.35
3642	1,503	68,224	1,404	2.05	30.8	.11
2211	1,472	179,363	2,581	1.43	21.0	.07
3255	1,450	13,597	300	2.2	31.9	.11
2649	1,443	37,761	865	2.3	33.0	.12
3553	1,435	13,935	148	1.06	15.2	.05
2641	1,400	38,040	200	.52	7.28	.06
3699	1,381	16,471	711	4.3	59.5	.22
3631	1,295	21,526	--	--	--	--

Table 5-45
(Concluded)

SIC Code	Shipping Weight (thousand pounds)	Employment U.S. 1970	Employment Texas 1970	Percent Texas	Texas' Share of Shipping Weight	Percent
3691	1,288	21,610	1,051	4.86	64.0	.22
3554	1,262	21,262	--	--	--	--
2321	1,243	110,002	552	.5	6.21	.02
3951	1,234	10,609	--	--	--	--
3636	1,222	3,350	--	--	--	--
3612	1,219	51,796	357	.68	8.28	.03
3693	1,210	9,713	200	2.05	24.8	.09
3842	1,193	38,740	1,662	4.29	82.9	.30
3629	1,119	21,495	--	--	--	--
3831	1,108	20,433	1,193	5.83	64.5	.23
3334	1,097	30,435	3,650	11.99	131.5	.48
3544	1,080	121,093	1,048	.86	9.3	.03
3673	1,062	15,961	200	1.25	13.3	.04
3321	1,026	138,388	5,315	4.56	46.8	.17
3564	1,011	24,817	563	2.2	22.8	.08
Sub-total	719,296	8,629,957	275,648	3.2	26,973.0	
Total	881,781	19,761,548	764,534	3.86		
Percent of Total	81.5%	43.6%	36.0%		3.75%	

Source: U.S. Bureau of the Census and Economics Research Associates.

2. No employment figures were available for SIC codes 123 (Vegetables), 122 (Fruits and Tree Nuts), 135 (Beef Cattle), 193 (Animal Specialties), and 192 (Horticultural Specialties). Texas's share of farm income (6.3 percent) for 1970 was used.
3. Where employment figures were not available for the four-digit SIC Texas industry, that industry's share of Value Added for 1967 was used.
4. SIC code 9200 is "Miscellaneous Commodities, NEC." As for SIC code 3xxx, five percent was used as Texas's share of the market.

General statements about Table 5-45 are:

1. Employment for the high air export SIC industries listed accounted for 43.6 percent of their United States employment and 36.0 percent of their Texas employment.
2. Shipping weight for these SIC industries listed accounted for 81.5 percent of total United States exports by air.
3. Texas's shipping weight by air as calculated using Texas's share of United States employment accounted for 3.75 percent of the air export shipments. Average of total shipping weight through Texas customs districts has been 1.9 percent over the last 10 years.

The conclusions of this analysis are:

- Texas's share of employment in those industries which have a high propensity to export by air is a little below its share for all industries (i.e., 3.2 to 3.8 percent). Texas's share of the market of air exports is most likely consistent with its share of industrial and agricultural activities.

- The following industries are shown to be significant in Texas air exports. They are listed in order of shipping weight as calculated in Table 5-45.

SIC	Description	Shipping Weight (1000 lbs.)
3xxx	Miscellaneous manufacturer, n.e.c.	5717
3533	Oil field machinery and equipment	4535
2818	Industrial organic chemical. n.e.c.	1554
3494	Valves and pipe fittings, except plumbers' brass goods	1184
3729	Aircraft parts and auxiliary equipment, n.e.c.	1046
3573	Electronic computing equipment	887
0723	Poultry hatcheries	860
2911	Petroleum refining	840
3662	Radio and television transmitting, signaling, and detection equipment and apparatus	535
2821	Plastics materials, synthetic ruins and nonvulcanizable electronics	493
3561	Pumps, air and gas compressors, and pumping equipment	477
3611	Electric measuring instruments and test equipment	418

This list not only identifies commodities peculiar to Texas air exports but also those commodities which are known to have a high propensity toward air transport.

Exhibit 5-2

SIC CODE DEFINITIONS

TABLE 1B. United States, by Industry: 1970

(Excludes government employees, railroad employees, self-employed persons, etc.—see "General Explanation." Size class 1 to 3 includes reporting units having payroll during 1st quarter but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual reporting units)

SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES											
	TOTAL	57 265 292	94 282 043	3 520 930	1 762 340	723 019	593 038	272 635	90 103	51 566	16 597	11 632
...	AGRICULTURAL SERVICES, FORESTRY, FISHERIES	189 026	212 998	31 078	18 481	6 794	4 167	1 260	275	87	12	2
07	AGRICULTURE SERVICES AND HUNTING	168 110	182 643	27 811	16 565	6 130	3 662	1 119	243	79	12	1
071	MISC. AGRICULTURAL SERVICES	38 776	35 821	4 293	2 166	889	784	342	84	24	4	-
072	ANIMAL HUSBANDRY SERVICES	65 124	72 347	12 790	7 900	2 957	1 521	315	68	26	2	1
073	HORTICULTURAL SERVICES	62 859	72 405	10 621	6 442	2 263	1 341	453	90	27	5	-
074	HUNTING, TRAPPING, GAME PROPAGATION	467	496	78	52	11	10	4	-	1	-	-
08	FORESTRY	5 642	6 289	537	270	92	108	44	18	5	-	-
09	FISHERIES	15 274	24 066	2 730	1 646	572	397	97	14	3	-	1
...	MINING	600 715	1 282 939	23 802	9 070	4 120	5 101	3 314	1 158	668	232	139
10	METAL MINING	82 738	176 359	896	319	163	147	92	51	53	32	39
101	IRON ORES	22 144	49 156	101	24	10	18	8	8	12	9	12
102	COPPER ORES	30 558	67 250	95	29	18	10	8	3	4	6	17
103	LEAD AND ZINC ORES	10 215	19 668	116	39	13	9	12	13	18	9	3
104	GOLD AND SILVER ORES	4 445	7 964	127	64	28	19	5	5	3	1	2
1042	LODE GOLD	2 691	4 847	40	21	8	4	1	3	2	-	1
1044	SILVER ORES	1 669	2 988	72	33	18	13	3	2	1	1	1
105	BAUXITE AND OTHER ALUMINUM ORES	570	1 215	16	3	5	-	6	1	1	-	-
106	FERROALLOY ORES EXCEPT VANADIUM	3 751	8 399	37	15	2	11	3	2	1	1	2
1062	MANGANESE ORES	129	227	12	6	-	3	3	-	-	-	-
1064	TUNGSTEN ORES	(D)	(D)	12	5	1	5	-	-	-	1	-
1069	FERROALLOY ORES, N.E.C.	(D)	(D)	11	4	1	2	-	1	1	-	2
108	METAL MINING SERVICES	2 206	4 304	184	74	43	37	21	7	2	-	-
109	MISCELLANEOUS METAL ORES	8 771	18 312	196	55	38	41	29	12	12	6	3
1092	MERCURY ORES	1 011	1 953	43	14	10	5	10	3	-	1	-
1093	TITANIUM ORES	773	1 499	7	-	1	1	1	1	2	1	-
1094	URANIUM-RADIUM-VANADIUM ORES	6 235	13 317	121	33	22	28	17	7	7	4	3
1099	METAL ORES, N.E.C	747	1 541	24	8	4	7	1	1	3	-	-
11	ANTHRACITE MINING	5 494	9 466	263	91	61	52	39	11	4	5	-
1111	ANTHRACITE	5 436	9 374	261	90	61	52	39	10	4	5	-
12	BITUMINOUS COAL AND LIGNITE MINING	125 501	281 216	2 640	597	536	710	412	140	119	77	49
1211	BITUMINOUS COAL	125 467	281 189	2 632	591	536	708	412	140	119	77	49
13	OIL AND GAS EXTRACTION	222 455	460 684	14 275	6 669	2 349	2 614	1 709	575	292	51	16
131	CRUDE PETROLEUM AND NATURAL GAS	93 643	206 496	7 517	4 316	1 239	1 031	577	197	121	27	9
132	NATURAL GAS LIQUIDS	9 336	22 673	335	69	46	82	93	28	13	4	-
138	OIL AND GAS FIELD SERVICES	119 418	231 441	6 412	2 277	1 063	1 499	1 037	351	158	20	7
1381	DRILLING OIL AND GAS WELLS	47 126	98 614	1 978	612	293	480	350	147	82	11	3
1382	OIL AND GAS EXPLORATION SERVICES	12 387	24 743	753	369	122	133	78	28	17	4	2
1389	OIL AND GAS FIELD SERVICES, N.E.C.	59 843	108 048	3 678	1 294	648	886	609	175	59	5	2
14	NONMETALLIC MINERALS, EXCEPT FUELS	106 025	194 994	4 826	1 221	869	1 391	882	300	121	32	10
141	DIMENSION STONE	3 026	4 060	196	51	42	61	30	8	4	-	-
142	CRUSHED AND BROKEN STONE	39 196	69 631	1 493	205	197	470	433	134	46	7	1
1422	CRUSHED AND BROKEN LIMESTONE	26 654	45 928	1 017	140	131	334	290	85	30	6	1
1423	CRUSHED AND BROKEN GRANITE	4 357	7 450	135	8	11	36	57	16	7	-	-
1429	CRUSHED AND BROKEN STONE, N.E.C	4 647	8 538	208	25	41	63	58	17	3	1	-
144	SAND AND GRAVEL	32 992	59 932	2 377	755	514	682	310	82	29	4	1
1442	CONSTRUCTION SAND AND GRAVEL	27 572	49 461	2 071	655	460	602	263	66	21	3	1
1446	INDUSTRIAL SAND	451	901	28	5	6	10	5	2	-	-	-
145	CLAY AND RELATED MINERALS	9 319	16 966	252	56	33	60	54	32	9	6	2
1452	BENTONITE	769	1 373	28	4	1	9	8	5	1	-	-
1453	FIRE CLAY	748	1 254	59	21	17	10	6	5	-	-	-
1454	FULLER'S EARTH	883	1 460	11	-	1	3	2	2	2	1	-
1455	KAOLIN AND BALL CLAY	3 781	7 084	39	4	1	6	10	10	3	3	2
1456	FELDSPAR	472	761	11	1	-	2	4	3	1	-	-
1459	CLAY AND RELATED MINERALS, N.E.C.	2 663	5 033	103	25	13	30	24	7	2	2	-
147	CHEMICAL AND FERTILIZER MINERALS	14 980	32 810	170	40	22	28	15	23	23	13	6
1472	BARITE	637	981	20	6	2	4	3	3	2	-	-
1473	FLUORSPAR	586	1 337	24	9	6	3	2	1	3	-	-
1474	POTASH, SODA, AND BORATE MINERALS	5 641	13 209	25	3	2	3	1	4	3	5	4
1475	PHOSPHATE ROCK	3 160	6 186	42	5	5	13	5	6	4	3	1
1476	ROCK SALT	2 201	4 864	23	4	2	1	2	6	5	3	-
1477	SULFUR	2 577	5 944	27	10	2	3	1	2	6	2	1
1479	CHEMICAL & FERTILIZER MINING, NEC	171	267	8	3	2	1	1	1	-	-	-
148	NONMETALLIC MINERALS SERVICES	737	1 489	89	37	23	19	10	-	-	-	-
149	MISCELLANEOUS NONMETALLIC MINERALS	5 559	9 792	228	67	36	64	29	20	10	2	-
1492	GYPSUM	423	947	18	4	5	5	3	-	-	1	-
1493	MICA	287	425	13	5	1	2	3	2	-	-	-
1494	NATIVE ASPHALT AND BITUMENS	420	769	14	2	1	6	1	3	1	-	-
1495	PUMICE AND PUMICITE	174	279	17	4	4	7	2	-	-	-	-
1496	TALC, SOAPSTONE, AND PYROPHYLLITE	998	1 613	28	5	4	5	8	4	2	-	-
1497	NATURAL ABRASIVES, EXCEPT SAND	225	455	9	3	2	1	1	1	1	-	-
1498	PEAT	776	903	48	17	8	16	3	3	1	-	-
1499	NONMETALLIC MINERALS, N.E.C.	2 256	4 401	81	27	11	22	8	7	5	1	-
--	ADMINISTRATIVE AND AUXILIARY	58 502	160 220	902	173	142	187	180	81	79	35	25

TABLE 1B. United States, by Industry: 1970—Continued

(Excludes government employees, railroad employees, self-employed persons, etc.—see "General Explanation." Size class 1 to 3 includes reporting units having payroll during 1st quarter but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual reporting units)

SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
...	CONTRACT CONSTRUCTION	3 197 382	6 437 179	298 595	152 417	62 578	49 993	22 834	6 796	3 148	612	217
15	GENERAL BUILDING CONTRACTORS	916 805	1 773 660	80 507	41 470	17 265	12 699	5 829	1 944	965	252	83
16	HEAVY CONSTRUCTION CONTRACTORS	608 476	1 266 514	29 069	11 383	5 529	5 936	3 650	1 458	841	191	81
161	HIGHWAY AND STREET CONSTRUCTION	208 821	378 603	11 058	3 761	2 368	2 533	1 449	543	340	52	12
162	HEAVY CONSTRUCTION, N.E.C.	398 882	886 584	17 962	7 605	3 148	3 392	2 197	913	499	139	69
17	SPECIAL TRADE CONTRACTORS	1 645 096	3 318 539	188 382	99 460	39 690	31 185	13 209	3 323	1 308	162	45
171	PLUMBING, HEATING, AIR CONDITIONING	403 580	913 978	43 440	21 641	9 386	8 004	3 225	782	344	47	11
172	PAINTING, PAPER HANGING, DECORATING	116 830	192 078	22 149	14 566	4 123	2 384	851	173	50	2	-
173	ELECTRICAL WORK	290 243	712 360	25 568	11 887	5 395	5 011	2 307	610	303	42	13
174	MASONRY, STONEWORK, AND PLASTERING	215 427	348 020	25 664	13 470	5 585	4 216	1 779	444	146	19	5
1741	MASONRY AND OTHER STONEWORK	138 603	202 484	17 378	9 258	3 909	2 757	1 070	281	89	10	4
1742	PLASTERING AND LATHING	49 716	97 214	4 537	2 160	921	841	437	119	50	9	-
1743	TERRAZZO, TILE, MARBLE, MOSAIC WORK	27 040	48 229	3 730	2 039	753	614	272	44	7	-	1
175	CARPENTERING AND FLOORING	105 593	170 169	21 077	13 992	4 070	2 145	692	137	37	3	1
1751	CARPENTERING	68 463	105 393	14 189	9 632	2 760	1 297	374	95	27	3	1
1752	FLOOR LAYING & FLOORWORK, N.E.C.	37 087	64 693	6 882	4 357	1 308	848	317	42	10	-	-
176	ROOFING AND SHEET METAL WORK	115 142	202 506	11 977	5 510	2 656	2 331	1 135	272	67	6	-
177	CONCRETE WORK	76 788	121 763	8 259	3 996	1 984	1 507	552	141	64	13	2
178	WATER WELL DRILLING	13 256	19 237	3 178	2 200	589	301	72	13	3	-	-
179	MISC. SPECIAL TRADE CONTRACTORS	300 570	627 512	25 652	11 338	5 602	5 090	2 545	744	290	30	13
1791	STRUCTURAL STEEL ERECTION	62 035	149 794	2 472	517	457	702	510	191	78	10	7
1792	ORNAMENTAL METAL WORK	3 475	6 469	388	188	82	80	25	10	3	-	-
1793	GLASS AND GLAZING WORK	12 928	26 770	1 666	684	466	398	96	16	6	-	-
1794	EXCAVATING AND FOUNDATION WORK	49 305	89 008	6 725	3 671	1 458	1 064	411	97	21	2	1
1795	WRECKING AND DEMOLITION WORK	8 127	13 438	781	307	203	164	83	16	8	-	-
1796	INSTALLING BLDG. EQUIP., N.E.C.	15 787	42 434	660	198	114	170	106	42	24	4	2
1799	SPECIAL TRADE CONTRACTORS, N.E.C.	148 394	298 532	12 917	5 759	2 814	2 502	1 304	371	150	14	3
--	ADMINISTRATIVE AND AUXILIARY	27 005	78 466	637	104	94	173	146	71	34	7	8
...	MANUFACTURING	19 761 548	37 979 790	297 770	68 921	47 435	66 043	52 207	26 839	21 486	8 574	6 265
19	ORDNANCE AND ACCESSORIES	343 232	803 383	467	73	32	46	59	44	45	54	114
20	FOOD AND KINDRED PRODUCTS	1 595 472	2 736 106	28 579	5 195	4 020	6 399	5 917	3 223	2 518	899	408
201	MEAT PRODUCTS	312 078	552 100	4 354	896	609	881	792	450	416	206	104
2011	MEAT PACKING PLANTS	169 850	350 194	2 311	535	358	470	410	205	178	87	68
2013	SAUSAGES AND OTHER PREPARED MEATS	53 104	104 424	1 256	245	174	294	271	142	92	30	8
2015	POULTRY DRESSING PLANTS	88 666	96 747	772	111	74	112	110	103	146	88	28
202	DAIRY PRODUCTS	202 650	365 078	5 043	889	714	1 153	1 107	651	432	86	11
2021	CREAMERY BUTTER	7 197	10 889	408	78	114	116	66	25	9	-	-
2022	CHEESE, NATURAL AND PROCESSED	21 090	31 532	846	223	150	225	158	51	28	9	2
2023	CONDENSED AND EVAPORATED MILK	10 725	20 019	257	27	21	66	73	48	18	4	-
2024	ICE CREAM AND FROZEN DESSERTS	22 416	38 505	689	128	87	182	164	79	42	7	-
2026	FLUID MILK	140 678	262 852	2 824	427	338	561	643	447	333	66	9
203	CANNED, CURED, AND FROZEN FOODS	232 232	318 309	3 208	512	406	645	686	407	332	148	72
2031	CANNED AND CURED SEA FOODS	13 724	17 552	267	56	44	56	50	31	21	5	4
2032	CANNED SPECIALTIES	28 202	47 799	190	36	28	37	22	13	21	25	8
2033	CANNED FRUITS AND VEGETABLES	67 947	95 320	1 079	146	120	233	244	161	123	37	15
2034	DEHYDRATED FOOD PRODUCTS	11 723	17 269	172	39	17	24	36	20	24	9	3
2035	PICKLES, SAUCES & SALAD DRESSINGS	17 501	27 789	454	114	74	101	82	38	30	12	3
2036	FRESH OR FROZEN PACKAGED FISH	24 375	24 031	462	55	46	90	148	68	36	16	3
2037	FROZEN FRUITS AND VEGETABLES	68 622	88 445	573	64	73	103	100	76	77	44	36
204	GRAIN MILL PRODUCTS	112 766	210 945	2 898	584	495	763	574	266	147	42	27
2041	FLOUR AND OTHER GRAIN MILL PRODUCTS	19 688	38 544	490	123	74	84	92	66	40	7	4
2042	PREPARED FEED FOR ANIMALS AND FOWLS	57 619	98 868	2 117	407	386	630	427	165	76	21	5
2043	CEREAL PREPARATIONS	11 945	25 261	38	5	2	3	7	6	3	6	6
2044	RICE MILLING	3 995	6 268	64	9	6	8	19	12	7	2	1
2045	BLENDED AND PREPARED FLOUR	5 756	11 169	122	25	22	25	20	13	13	3	1
2046	WET CORN MILLING	13 662	30 765	61	13	5	10	9	3	8	3	10
205	BAKERY PRODUCTS	260 836	452 610	3 901	688	580	838	667	378	496	180	74
2051	BREAD, CAKE, AND RELATED PRODUCTS	216 070	379 717	3 580	664	541	783	603	327	449	167	46
2052	COOKIES AND CRACKERS	44 701	72 825	319	24	39	55	62	51	47	13	28
206	SUGAR	31 075	60 866	181	8	10	10	36	21	51	32	13
2061	RAW CANE SUGAR	7 182	12 766	75	4	3	6	31	6	16	8	1
2062	CANE SUGAR REFINING	10 894	23 700	30	2	1	-	2	3	5	5	12
2063	BEET SUGAR	12 999	24 400	76	2	6	4	3	12	30	19	-
207	CONFECTIONERY AND RELATED PRODUCTS	83 448	121 710	1 052	209	153	231	176	121	80	46	36
2071	CONFECTIONERY PRODUCTS	68 558	96 272	983	204	149	216	167	109	72	37	29
2072	CHOCOLATE AND COCOA PRODUCTS	8 879	15 489	44	1	2	11	7	9	6	5	3
2073	CHEWING GUM	6 003	9 933	22	2	1	4	2	3	2	4	4
208	BEVERAGES	220 388	414 358	3 932	512	367	895	1 142	541	327	94	54
2082	MALT LIQUORS	56 271	133 904	186	15	5	9	25	25	42	36	29
2083	MALT	2 070	4 959	44	5	2	9	14	7	7	-	-
2084	WINES, BRANDY, AND BRANDY SPIRITS	7 861	14 881	190	44	28	43	38	20	12	3	2
2085	DISTILLED LIQUOR EXCEPT BRANDY	18 980	37 398	125	6	5	15	27	24	26	12	10
2086	BOTTLED AND CANNED SOFT DRINKS	124 646	201 370	3 001	338	253	731	964	440	226	38	11
2087	FLAVORING EXTRACTS AND SIRUPS, NEC.	10 554	21 835	385	104	73	88	74	25	14	5	2

TABLE 1B. United States, by Industry: 1970—Continued

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SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
209	MISC. FOODS AND KINDRED PRODUCTS	139 344	239 503	3 936	873	671	962	725	386	237	64	18
2091	COTTONSEED OIL MILLS	5 786	8 429	138	17	6	21	48	37	8	1	-
2092	SOYBEAN OIL MILLS	8 104	16 119	102	12	6	14	16	28	20	5	1
2093	VEGETABLE OIL MILLS, N.E.C.	1 358	2 413	29	6	3	4	6	4	6	-	-
2094	ANIMAL AND MARINE FATS AND OILS	13 630	25 969	519	70	80	146	155	48	17	3	-
2095	ROASTED COFFEE	15 553	31 827	220	31	37	48	45	27	19	7	6
2096	SHORTENING AND COOKING OILS	14 313	29 880	129	12	5	13	23	33	28	12	3
2097	MANUFACTURED ICE	8 665	11 813	800	281	198	216	79	21	4	1	-
2098	MACARONI AND SPAGHETTI	7 035	11 808	182	40	27	44	29	20	17	5	-
2099	FOOD PREPARATIONS, N.E.C.	64 757	101 018	1 816	404	309	456	324	168	117	30	8
21	TOBACCO MANUFACTURES	70 925	104 789	362	67	32	57	67	40	48	26	25
211	CIGARETTES	39 817	66 199	33	4	2	2	3	2	6	2	12
212	CIGARS	16 677	17 379	141	32	17	25	23	10	12	12	10
213	CHEWING AND SMOKING TOBACCO	3 903	6 189	55	18	4	11	3	7	7	4	1
214	TOBACCO STEMMING AND REDRYING	10 497	14 986	127	9	8	18	38	21	23	8	2
22	TEXTILE MILL PRODUCTS	947 734	1 267 429	7 009	691	556	1 212	1 408	978	1 103	621	440
221	WEAVING MILLS, COTTON	179 363	236 729	453	26	27	32	56	24	69	98	121
222	WEAVING MILLS, SYNTHETICS	119 801	158 787	385	24	9	39	47	56	68	71	71
223	WEAVING AND FINISHING MILLS, WOOL	36 912	54 234	284	31	21	37	52	41	54	32	16
224	NARROW FABRIC MILLS	27 982	37 568	394	36	44	75	88	70	60	[illegible]	5
225	KNITTING MILLS	248 490	304 744	2 615	260	199	536	633	376	359	166	86
2251	WOMEN'S HOSIERY, EXCEPT SOCKS	69 074	77 218	384	32	15	52	69	54	80	46	36
2252	HOSIERY, N.E.C.	34 389	35 490	420	32	39	72	99	73	67	34	4
2253	KNIT OUTERWEAR MILLS	68 083	88 166	1 045	115	87	252	291	145	104	33	18
2254	KNIT UNDERWEAR MILLS	29 249	32 397	116	6	5	8	16	20	30	17	14
2256	KNIT FABRIC MILLS	42 723	65 480	542	55	36	133	124	77	71	33	13
2259	KNITTING MILLS, N.E.C.	4 070	5 174	62	9	9	9	20	5	6	3	1
226	TEXTILE FINISHING, EXCEPT WOOL	75 072	117 993	599	53	42	98	131	89	104	46	36
2261	FINISHING PLANTS, COTTON	34 146	51 136	195	23	15	31	37	27	25	13	24
2262	FINISHING PLANTS, SYNTHETICS	27 757	47 777	232	13	9	32	53	43	53	20	9
2269	FINISHING PLANTS, N.E.C.	13 093	18 980	167	17	17	32	40	19	26	13	3
227	FLOOR COVERING MILLS	53 076	76 867	431	63	47	78	67	53	67	26	30
2271	WOVEN CARPETS AND RUGS	14 011	20 498	91	18	13	11	12	8	11	10	8
2272	TUFTED CARPETS AND RUGS	35 812	51 579	244	21	16	48	33	39	51	15	21
2279	CARPETS AND RUGS, N.E.C	2 998	4 503	72	16	10	13	21	6	4	1	1
228	YARN AND THREAD MILLS	134 481	166 006	789	45	51	72	101	125	223	117	55
2281	YARN MILLS, EXCEPT WOOL	84 804	103 153	399	16	14	20	35	48	157	75	34
2282	THROWING AND WINDING MILLS	24 230	30 090	177	6	14	24	30	44	26	23	10
2283	WOOL YARN MILLS	14 071	18 985	132	12	11	14	25	27	28	10	5
2284	THREAD MILLS	11 166	13 662	75	11	10	12	10	6	11	9	6
229	MISCELLANEOUS TEXTILE GOODS	71 155	112 418	1 010	141	106	230	227	140	98	49	19
2291	FELT GOODS, N.E.C.	4 350	6 995	36	2	1	10	4	6	5	8	-
2292	LACE GOODS	4 897	7 007	124	27	15	35	18	12	12	5	-
2293	PADDINGS AND UPHOLSTERY FILLING	7 721	13 035	150	11	16	39	45	23	8	8	-
2294	PROCESSED TEXTILE WASTE	5 540	8 186	142	22	16	40	37	15	9	2	1
2295	COATED FABRIC, NOT RUBBERIZED	14 690	28 499	157	12	18	30	33	31	19	8	6
2296	TIRE CORD AND FABRIC	10 994	15 942	24	-	-	-	4	-	9	4	7
2297	SCOURING AND COMBING PLANTS	4 468	6 176	57	10	4	5	20	9	5	3	1
2298	CORDAGE AND TWINE	9 840	13 245	150	24	17	31	31	19	21	4	3
2299	TEXTILE GOODS, N.E.C.	8 655	13 328	170	33	19	40	35	25	10	7	1
23	APPAREL AND OTHER TEXTILE PRODUCTS	1 376 356	1 603 887	24 319	3 828	2 795	4 857	5 931	3 430	2 398	825	255
231	MEN'S AND BOYS' SUITS AND COATS	129 098	170 643	914	87	68	159	151	135	171	93	50
232	MEN'S AND BOYS' FURNISHINGS	352 702	363 567	2 758	242	188	339	459	441	639	355	95
2321	MEN'S & BOYS' SHIRTS AND NIGHTWEAR	110 002	109 600	706	57	43	80	94	80	199	118	35
2322	MEN'S & BOYS' UNDERWEAR	14 614	14 557	85	8	4	6	13	19	13	17	5
2323	MEN'S & BOYS' NECKWEAR	9 947	13 049	275	62	28	54	75	40	11	3	2
2327	MEN'S & BOYS' SEPARATE TROUSERS	94 221	98 799	654	52	57	78	98	82	162	101	24
2328	MEN'S & BOYS' WORK CLOTHING	78 107	77 159	463	20	18	41	45	83	148	85	23
2329	MEN'S AND BOYS' CLOTHING, N.E.C.	44 882	49 822	560	39	36	77	134	133	104	31	6
233	WOMEN'S AND MISSES' OUTERWEAR	426 020	512 191	8 694	613	609	1 720	3 118	1 700	767	131	36
2331	WOMEN'S & MISSES' BLOUSES & WAISTS	55 344	58 756	850	40	50	158	282	170	118	23	9
2335	WOMEN'S AND MISSES' DRESSES	227 316	272 851	4 849	301	284	961	1 912	927	392	55	17
2337	WOMEN'S AND MISSES' SUITS AND COATS	77 162	105 931	1 788	144	169	383	608	355	104	18	7
2339	WOMEN'S AND MISSES' OUTERWEAR, NEC.	63 687	72 261	1 111	112	99	187	284	243	149	34	3
234	WOMEN'S AND CHILDREN'S UNDERGARMENTS	114 549	130 344	1 151	95	98	177	245	197	216	87	36
2341	WOMEN'S AND CHILDREN'S UNDERWEAR	80 493	88 665	846	67	80	140	174	145	147	71	22
2342	CORSETS AND ALLIED GARMENTS	34 056	41 673	305	28	18	37	71	52	69	16	14
235	HATS, CAPS, AND MILLINERY	20 146	23 485	605	112	108	166	130	44	34	7	4
2351	MILLINERY	5 374	7 208	298	64	56	97	65	11	4	1	-
2352	HATS AND CAPS, EXCEPT MILLINERY	14 702	16 189	304	48	51	68	64	33	30	6	4
236	CHILDREN'S OUTERWEAR	76 093	84 898	1 204	100	77	226	362	236	148	46	9
2361	CHILDREN'S DRESSES AND BLOUSES	35 353	39 292	569	36	23	97	192	126	75	16	4
2363	CHILDREN'S COATS AND SUITS	8 042	10 389	187	21	17	42	52	35	18	2	-
2369	CHILDREN'S OUTERWEAR, N.E.C.	32 135	34 687	431	40	36	83	113	72	54	28	5
237	FUR GOODS	5 984	12 800	980	553	206	163	48	7	3	-	-

TABLE 1B. United States, by Industry: 1970—Continued

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	UNITED STATES--CON.											
238	MISCELLANEOUS APPAREL AND ACCESSORIES	69 434	77 691	1 324	160	153	263	352	210	144	36	6
2381	FABRIC DRESS AND WORK GLOVES. . . .	14 659	14 234	162	10	14	20	33	39	33	9	4
2384	ROBES AND DRESSING GOWNS.	11 796	12 733	223	24	19	34	74	37	30	5	-
2385	WATERPROOF OUTER GARMENTS	20 969	25 295	313	21	23	52	95	63	43	15	1
2386	LEATHER AND SHEEP LINED CLOTHING. .	5 538	6 409	156	22	23	42	40	18	8	3	-
2387	APPAREL BELTS	8 403	10 231	248	39	40	67	60	29	10	2	1
2389	APPAREL AND ACCESSORIES, N.E.C. . .	8 069	8 795	222	44	34	48	50	24	20	2	-
239	MISC. FABRICATED TEXTILE PRODUCTS . .	171 955	219 839	6 211	1 791	1 222	1 484	931	427	267	70	19
2391	CURTAINS AND DRAPERIES.	26 464	29 148	1 348	475	277	303	166	73	40	13	1
2392	HOUSEFURNISHINGS, N.E.C..	45 938	54 610	1 106	256	168	246	210	114	82	24	6
2393	TEXTILE BAGS.	8 759	11 035	191	26	23	40	43	33	24	2	-
2394	CANVAS PRODUCTS	14 613	19 071	768	254	167	200	76	41	24	6	-
2395	PLEATING AND STITCHING.	14 332	16 378	953	324	201	222	145	45	14	2	-
2396	AUTOMOTIVE AND APPAREL TRIMMINGS. .	28 941	49 001	651	104	127	191	140	54	24	3	8
2397	SCHIFFLI MACHINE EMBROIDERIES . . .	4 723	7 239	484	182	135	114	40	10	2	1	-
2399	FABRICATED TEXTILE PRODUCTS, N.E.C.	27 932	32 954	694	165	120	165	108	56	57	19	4
24	LUMBER AND WOOD PRODUCTS.	554 835	783 654	28 942	11 139	6 066	6 119	3 194	1 356	821	192	55
241	LOGGING CAMPS AND LOGGING CONTRACTORS	73 811	88 370	11 646	6 471	2 917	1 756	368	79	46	8	1
242	SAWMILLS AND PLANING MILLS.	202 479	276 812	8 949	2 722	1 760	2 254	1 301	552	284	49	27
2421	SAWMILLS AND PLANING MILLS, GENERAL	169 597	237 762	7 910	2 524	1 596	1 974	1 083	441	225	43	24
2426	HARDWOOD DIMENSION AND FLOORING . .	26 618	31 898	582	80	70	133	140	94	56	6	3
2429	SPECIAL PRODUCT SAWMILLS, N.E.C.. .	6 264	7 163	457	118	94	147	78	17	3	-	-
243	MILLWORK, PLYWOOD & RELATED PRODUCTS.	160 609	262 408	4 085	909	647	1 028	730	367	285	98	21
2431	MILLWORK.	67 586	110 670	2 858	791	522	785	455	174	102	24	5
2432	VENEER AND PLYWOOD.	69 623	114 840	628	43	20	78	131	135	151	58	12
2433	PREFABRICATED WOOD STRUCTURES . . .	23 371	36 873	596	74	104	165	143	58	32	16	4
244	WOODEN CONTAINERS	30 196	38 162	791	184	121	179	149	65	76	17	-
2441	NAILED WOODEN BOXES AND SHOOK . . .	14 457	19 324	489	117	81	117	97	42	31	4	-
2442	WIREBOUND BOXES AND CRATES.	9 957	11 100	141	26	18	22	21	12	33	9	-
2443	VENEER AND PLYWOOD CONTAINERS . . .	2 720	2 928	62	11	5	15	16	9	4	2	-
2445	COOPERAGE	2 732	4 322	84	26	12	23	12	2	7	2	-
249	MISCELLANEOUS WOOD PRODUCTS	87 438	116 898	3 445	846	615	895	642	292	129	20	6
2491	WOOD PRESERVING	12 523	17 357	423	82	58	107	96	56	22	2	-
2499	WOOD PRODUCTS, N.E.C.	74 915	99 549	3 022	764	557	788	546	236	107	18	6
25	FURNITURE AND FIXTURES.	445 756	660 954	9 414	2 201	1 523	2 099	1 704	832	675	257	123
251	HOUSEHOLD FURNITURE	308 710	421 322	5 862	1 339	870	1 233	1 110	566	467	186	91
2511	WOOD HOUSEHOLD FURNITURE.	153 723	202 766	2 797	796	454	534	424	219	219	96	55
2512	UPHOLSTERED HOUSEHOLD FURNITURE . .	81 632	113 446	1 529	236	209	337	370	180	133	44	20
2514	METAL HOUSEHOLD FURNITURE	37 748	50 410	470	68	48	97	94	55	65	32	11
2515	MATTRESSES AND BEDSPRINGS	31 849	49 501	965	219	142	239	209	99	39	13	5
2519	HOUSEHOLD FURNITURE, N.E.C.	3 586	4 964	77	13	9	17	13	13	11	1	-
252	OFFICE FURNITURE.	36 680	65 964	361	43	40	74	71	48	46	25	14
2521	WOOD OFFICE FURNITURE	9 351	14 206	165	21	22	40	41	16	17	5	3
2522	METAL OFFICE FURNITURE.	27 311	51 734	192	19	18	33	30	32	29	20	11
253	PUBLIC BUILDING FURNITURE	23 618	38 815	410	71	56	93	91	45	32	17	5
254	PARTITIONS AND FIXTURES	53 352	97 985	1 778	396	329	487	305	131	103	21	6
2541	WOOD PARTITIONS AND FIXTURES. . . .	28 197	53 043	1 298	321	258	364	222	73	54	6	-
2542	METAL PARTITIONS AND FIXTURES . . .	24 859	44 486	472	73	69	121	82	58	48	15	6
259	MISCELLANEOUS FURNITURE AND FIXTURES.	21 099	33 971	785	266	172	167	100	39	26	8	7
2591	VENETIAN BLINDS AND SHADES.	11 891	18 315	510	217	126	100	39	9	10	3	6
2599	FURNITURE AND FIXTURES, N.E.C.. . .	9 208	15 664	275	49	46	67	61	30	16	5	1
26	PAPER AND ALLIED PRODUCTS	668 087	1 301 464	6 032	443	460	1 000	1 321	1 014	1 200	373	221
261	PULP MILLS.	11 341	27 340	47	1	2	5	7	8	8	8	8
262	PAPER MILLS, EXCEPT BUILDING PAPER. .	143 132	321 120	410	17	9	25	49	56	100	62	92
263	PAPERBOARD MILLS.	75 585	168 027	297	11	5	14	44	59	87	43	34
264	MISC. CONVERTED PAPER PRODUCTS. . . .	200 714	366 332	2 434	270	281	498	498	332	374	122	59
2641	PAPER COATING AND GLAZING	38 040	76 303	409	42	47	87	79	58	54	27	15
2642	ENVELOPES	23 709	41 594	229	16	10	27	43	43	70	15	5
2643	BAGS, EXCEPT TEXTILE BAGS	51 528	90 436	563	62	65	94	118	70	101	40	13
2644	WALLPAPER	3 099	5 686	77	11	9	23	16	10	7	1	-
2645	DIE CUT PAPER AND BOARD	17 288	31 120	410	53	52	126	92	43	33	8	3
2646	PRESSED AND MOLDED PULP GOODS . . .	5 860	11 100	50	2	5	2	13	9	14	4	1
2647	SANITARY PAPER PRODUCTS	23 426	48 323	117	10	6	16	19	16	25	12	13
2649	CONVERTED PAPER PRODUCTS, N.E.C . .	37 761	61 752	578	73	87	123	118	83	70	15	9
265	PAPERBOARD CONTAINERS AND BOXES . . .	224 977	393 846	2 745	133	159	446	706	536	609	133	23
2651	FOLDING PAPERBOARD BOXES.	50 333	90 230	582	31	37	88	139	126	119	38	4
2652	SET-UP PAPERBOARD BOXES	19 570	25 875	396	24	27	83	126	91	39	6	-
2653	CORRUGATED AND SOLID FIBER BOXES. .	104 198	195 131	1 219	51	57	173	305	208	358	62	5
2654	SANITARY FOOD CONTAINERS.	34 569	56 310	246	11	7	35	57	51	51	20	14
2655	FIBER CANS, DRUMS, RELATED MATERIAL	15 972	25 883	289	14	29	64	75	59	41	7	-
266	BUILDING PAPER AND BOARD MILLS. . . .	11 374	22 204	85	6	2	10	17	21	20	4	5

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	UNITED STATES--CON.											
27	PRINTING AND PUBLISHING	1 082 353	2 057 990	36 310	11 673	7 470	8 492	4 906	1 897	1 207	397	268
271	NEWSPAPERS	355 299	632 314	7 675	2 079	1 615	1 853	1 063	475	340	133	117
272	PERIODICALS	75 354	165 252	2 424	883	497	513	303	97	76	33	22
273	BOOKS	98 582	194 674	1 684	437	225	385	303	127	120	49	38
2731	BOOK PUBLISHING	52 322	102 703	1 027	344	170	195	135	63	74	26	20
2732	BOOK PRINTING	46 260	91 966	657	93	55	190	168	64	46	23	18
274	MISCELLANEOUS PUBLISHING	33 229	54 875	1 408	610	279	265	131	62	36	17	8
275	COMMERCIAL PRINTING	350 478	696 300	17 728	6 218	3 827	4 164	2 227	750	389	98	55
2751	COMM. PRINTING, EXCEPT LITHOGRAPHIC	180 369	343 782	10 102	3 923	2 332	2 296	977	330	164	47	33
2752	COMMERCIAL PRINTING, LITHOGRAPHIC	157 535	329 921	6 790	1 988	1 330	1 657	1 143	392	210	49	21
2753	ENGRAVING AND PLATE PRINTING	10 834	20 094	537	132	106	159	96	27	14	2	1
276	MANIFOLD BUSINESS FORMS	35 543	69 438	538	52	54	118	148	70	64	25	7
277	GREETING CARD PUBLISHING	24 597	39 022	193	40	26	38	44	11	15	9	10
278	BLANKBOOKS AND BOOKBINDING	57 868	91 223	1 397	267	225	364	254	148	104	25	10
2782	BLANKBOOKS AND LOOSE LEAF BINDERS	25 537	41 369	414	69	44	96	80	53	53	13	6
2789	BOOKBINDING AND RELATED WORK	32 331	49 856	983	198	181	268	174	95	51	12	4
279	PRINTING TRADE SERVICES	43 621	102 451	2 305	541	513	648	395	149	52	7	-
2791	TYPESETTING	27 753	62 412	1 520	403	349	391	244	95	32	6	-
2793	PHOTOENGRAVING	13 203	33 988	674	118	148	224	121	47	15	1	-
2794	ELECTROTYPING AND STEREOTYPING	2 637	6 010	107	18	15	32	30	7	5	-	-
28	CHEMICALS AND ALLIED PRODUCTS	881 275	1 940 537	11 389	2 386	1 817	2 472	2 057	1 090	880	350	337
281	INDUSTRIAL CHEMICALS	261 901	636 352	2 174	311	291	435	411	248	243	120	115
2812	ALKALIES AND CHLORINE	17 677	42 771	68	8	10	1	11	9	13	3	13
2813	INDUSTRIAL GASES	14 677	32 959	568	97	101	178	136	41	11	2	2
2815	CYCLIC INTERMEDIATES AND CRUDES	30 105	69 857	200	15	22	35	36	23	34	24	11
2816	INORGANIC PIGMENTS	12 331	27 731	100	7	11	18	19	17	15	9	4
2818	INDUSTRIAL ORGANIC CHEMICALS, NEC	103 605	269 022	517	71	60	77	75	68	74	38	54
2819	INDUSTRIAL INORGANIC CHEMICALS, NEC	82 675	192 271	711	110	86	125	131	89	96	44	30
282	PLASTICS MATERIALS AND SYNTHETICS	186 364	395 722	900	103	79	175	175	112	112	53	91
2821	PLASTICS MATERIALS AND RESINS	77 228	176 019	763	94	73	161	166	102	97	40	30
2822	SYNTHETIC RUBBER	11 156	28 569	43	3	4	5	5	3	7	6	10
2823	CELLULOSIC MAN-MADE FIBERS	29 422	45 838	25	1	-	3	1	1	2	2	15
2824	ORGANIC FIBERS, NONCELLULOSIC	68 558	145 291	69	5	2	6	3	6	6	5	36
283	DRUGS	122 271	290 462	1 041	271	156	185	163	96	78	41	51
2831	BIOLOGICAL PRODUCTS	4 967	11 189	128	36	30	19	22	11	6	2	2
2833	MEDICINALS AND BOTANICALS	6 062	14 486	108	20	18	29	15	10	12	3	1
2834	PHARMACEUTICAL PREPARATIONS	111 242	264 790	805	215	108	137	126	75	60	36	48
284	SOAP, CLEANERS, AND TOILET GOODS	102 190	201 335	2 261	663	423	471	332	171	106	54	41
2841	SOAP AND OTHER DETERGENTS	30 169	69 775	568	146	98	113	103	51	30	12	15
2842	POLISHES AND SANITATION GOODS	22 756	41 989	946	316	194	212	117	63	29	11	4
2843	SURFACE ACTIVE AGENTS	6 036	13 663	156	20	29	34	42	20	8	2	1
2844	TOILET PREPARATIONS	43 222	75 899	589	180	101	112	70	37	39	29	21
285	PAINTS AND ALLIED PRODUCTS	65 601	135 690	1 597	242	248	400	376	177	113	36	5
286	GUM AND WOOD CHEMICALS	6 194	11 318	148	50	36	16	18	15	9	1	3
287	AGRICULTURAL CHEMICALS	51 095	92 252	1 088	211	155	256	238	120	78	19	11
2871	FERTILIZERS	19 408	32 375	251	35	32	41	37	47	39	16	4
2872	FERTILIZERS, MIXING ONLY	13 135	19 777	539	122	87	134	130	45	19	1	1
2879	AGRICULTURAL CHEMICALS, N.E.C.	18 411	39 925	287	49	34	79	70	27	20	2	6
289	MISCELLANEOUS CHEMICAL PRODUCTS	84 997	176 063	2 111	506	410	519	340	150	140	26	20
2891	ADHESIVES AND GELATIN	10 701	22 659	320	60	56	85	63	32	19	4	1
2892	EXPLOSIVES	23 488	48 076	104	12	20	16	10	9	20	7	10
2893	PRINTING INK	10 642	23 384	348	36	63	107	89	26	23	4	-
2895	CARBON BLACK	3 683	8 438	48	7	5	1	8	11	15	1	-
2899	CHEMICAL PREPARATIONS, N.E.C.	36 467	73 464	1 290	391	266	309	170	72	63	10	9
29	PETROLEUM AND COAL PRODUCTS	136 170	337 417	1 858	407	288	406	327	159	160	53	58
291	PETROLEUM REFINING	101 336	269 229	595	108	48	93	91	61	96	43	55
295	PAVING AND ROOFING MATERIALS	24 905	48 297	902	202	188	237	163	58	43	8	3
2951	PAVING MIXTURES AND BLOCKS	10 572	22 643	681	178	173	188	111	21	7	2	1
2952	ASPHALT FELTS AND COATINGS	14 329	25 650	220	24	14	49	52	37	36	6	2
299	MISC. PETROLEUM AND COAL PRODUCTS	9 845	19 717	355	96	51	74	71	40	21	2	-
2992	LUBRICATING OILS AND GREASES	8 258	16 951	297	84	40	57	61	38	15	2	-
2999	PETROLEUM & COAL PRODUCTS, N.E.C.	1 578	2 760	55	10	10	17	10	2	6	-	-
30	RUBBER AND PLASTICS PRODUCTS, N.E.C.	558 186	995 370	6 840	1 109	814	1 410	1 485	858	722	247	195
301	TIRES AND INNER TUBES	102 450	244 283	193	27	12	30	21	17	20	16	50
302	RUBBER FOOTWEAR	25 725	32 998	72	4	2	4	6	9	14	16	17
303	RECLAIMED RUBBER	1 624	3 349	22	2	1	7	3	3	5	1	-
306	FABRICATED RUBBER PRODUCTS, N.E.C.	144 054	262 976	1 175	161	104	215	237	176	148	67	67
307	MISCELLANEOUS PLASTICS PRODUCTS	282 853	449 687	5 367	911	693	1 154	1 216	653	534	147	59
31	LEATHER AND LEATHER PRODUCTS	304 367	387 845	3 430	507	381	632	607	425	483	327	68
311	LEATHER TANNING AND FINISHING	27 317	44 614	496	87	54	116	89	73	56	17	4
312	INDUSTRIAL LEATHER BELTING	2 531	4 306	67	18	7	18	15	4	3	1	1
313	FOOTWEAR CUT STOCK	12 942	16 930	323	44	40	64	87	59	29	-	-

TABLE 1B. United States, by Industry: 1970—Continued

(Excludes government employees, railroad employees, self-employed persons, etc.—see "General Explanation." Size class 1 to 3 includes reporting units having payroll during 1st quarter but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual reporting units)

SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
314	FOOTWEAR, EXCEPT RUBBER	196 451	242 905	1 072	83	63	108	107	114	259	283	55
3141	SHOES, EXCEPT RUBBER.	184 806	229 808	956	74	52	89	92	90	236	269	54
3142	HOUSE SLIPPERS.	11 534	12 951	115	9	11	19	15	24	22	14	1
315	LEATHER GLOVES AND MITTENS.	5 036	4 964	111	16	11	19	26	23	15	1	-
316	LUGGAGE	19 047	24 016	296	45	34	71	66	39	30	6	5
317	HANDBAGS AND PERSONAL LEATHER GOODS .	34 241	42 209	716	115	108	152	154	85	81	18	3
3171	WOMEN'S HANDBAGS AND PURSES	22 706	27 882	444	60	55	93	107	59	57	12	1
3172	PERSONAL LEATHER GOODS.	11 519	14 315	270	54	53	58	47	26	24	6	2
319	LEATHER GOODS, N.E.C.	6 746	7 855	345	97	64	83	62	28	10	1	-
32	STONE, CLAY, AND GLASS PRODUCTS	592 150	1 093 075	14 162	3 047	2 538	3 792	2 530	1 036	782	268	169
321	FLAT GLASS.	22 887	55 563	72	6	6	12	10	5	6	10	17
322	GLASS AND GLASSWARE, PRESSED OR BLOWN	114 612	210 782	359	49	25	38	25	26	46	69	81
3221	GLASS CONTAINERS.	68 948	128 680	128	1	2	2	4	4	17	45	53
3229	PRESSED AND BLOWN GLASS, N.E.C. . .	45 663	82 097	230	47	23	36	21	22	29	24	28
323	PRODUCTS OF PURCHASED GLASS	27 104	50 238	783	244	143	166	114	52	43	14	7
324	CEMENT, HYDRAULIC	27 854	65 749	213	13	7	12	14	36	116	14	1
325	STRUCTURAL CLAY PRODUCTS.	54 521	90 581	803	76	65	118	210	186	118	26	4
3251	BRICK AND STRUCTURAL CLAY TILE. . .	22 830	34 004	437	38	30	72	128	120	42	7	-
3253	CERAMIC WALL AND FLOOR TILE	9 565	15 133	85	12	6	11	16	9	23	6	2
3255	CLAY REFRACTORIES	13 597	26 731	152	14	14	19	36	30	28	9	2
3259	STRUCTURAL CLAY PRODUCTS, N.E.C.. .	8 488	14 650	126	12	15	14	29	27	25	4	-
326	POTTERY AND RELATED PRODUCTS.	42 897	66 823	558	163	87	99	67	46	40	34	22
3261	VITREOUS PLUMBING FIXTURES.	8 790	16 110	58	3	4	13	5	5	12	13	3
3262	VITREOUS CHINA FOOD UTENSILS. . . .	6 736	10 011	35	7	4	3	5	5	2	5	4
3263	FINE EARTHENWARE FOOD UTENSILS. . .	6 163	6 824	20	2	-	2	4	-	5	2	5
3264	PORCELAIN ELECTRICAL SUPPLIES . . .	12 204	22 485	66	5	4	11	10	9	11	7	9
3269	POTTERY PRODUCTS, N.E.C..	8 995	11 382	377	145	74	70	43	27	10	7	1
327	CONCRETE, GYPSUM, & PLASTER PRODUCTS.	177 766	317 337	8 814	1 940	1 764	2 715	1 617	501	237	36	4
3271	CONCRETE BLOCK AND BRICK.	21 362	35 619	1 332	270	250	485	264	48	14	1	-
3272	CONCRETE PRODUCTS N.E.C..	64 194	111 497	3 083	838	627	791	505	213	93	14	2
3273	READY-MIXED CONCRETE.	75 472	138 157	4 167	803	866	1 415	808	191	68	15	1
3274	LIME.	5 897	11 510	101	12	12	11	25	22	16	-	1
3275	GYPSUM PRODUCTS	10 710	20 442	123	16	5	13	13	26	44	6	-
328	CUT STONE AND STONE PRODUCTS.	14 350	21 010	761	227	145	202	123	39	22	3	-
329	MISC. NONMETALLIC MINERAL PRODUCTS. .	109 748	214 406	1 775	320	293	423	347	144	153	62	33
3291	ABRASIVE PRODUCTS	29 645	61 315	346	50	52	77	78	36	32	11	10
3292	ASBESTOS PRODUCTS	19 468	35 675	133	10	8	26	13	22	31	16	7
3293	GASKETS AND INSULATIONS	18 798	34 159	303	41	48	73	62	26	34	14	5
3295	MINERALS, GROUND OR TREATED	9 903	19 192	462	95	83	131	111	25	15	2	-
3296	MINERAL WOOL.	17 589	36 850	104	5	6	17	25	14	20	10	7
3297	NONCLAY REFRACTORIES.	9 000	18 700	83	5	8	15	20	9	15	7	4
3299	NONMETALLIC MINERAL PRODUCTS, NEC .	5 345	8 524	344	114	88	84	38	12	6	2	-
33	PRIMARY METAL INDUSTRIES.	1 268 342	2 737 371	6 833	689	662	1 294	1 438	876	953	459	462
331	BLAST FURNACE & BASIC STEEL PRODUCTS.	602 282	1 377 161	942	68	59	94	145	110	171	112	183
3312	BLAST FURNACES AND STEEL MILLS. . .	523 592	1 211 535	418	31	30	29	48	28	49	54	149
3313	ELECTROMETALLURGICAL PRODUCTS . . .	11 507	25 416	35	2	-	1	4	2	9	10	7
3315	STEEL WIRE AND RELATED PRODUCTS . .	27 195	54 701	215	14	13	32	41	37	50	20	8
3316	COLD FINISHING OF STEEL SHAPES. . .	17 684	37 769	120	10	7	15	24	20	24	11	9
3317	STEEL PIPE AND TUBES.	22 302	47 739	153	10	9	17	28	23	39	17	10
332	IRON AND STEEL FOUNDRIES.	229 241	453 615	1 397	68	61	175	311	269	284	137	92
3321	GRAY IRON FOUNDRIES	138 388	274 273	987	53	44	133	242	219	182	68	46
3322	MALLEABLE IRON FOUNDRIES.	22 234	45 436	84	2	2	4	14	7	27	20	8
3323	STEEL FOUNDRIES	68 385	133 488	316	11	13	36	52	43	74	49	38
[illegible]	PRIMARY NONFERROUS METALS	70 672	156 296	185	15	13	13	24	18	28	21	53
[illegible]	PRIMARY COPPER.	19 214	40 380	38	-	2	1	2	3	6	8	16
[illegible]	PRIMARY LEAD.	3 974	7 658	23	1	-	-	7	1	8	5	1
[illegible]	PRIMARY ZINC.	8 301	17 138	17	1	-	1	2	-	2	2	9
[illegible]	PRIMARY ALUMINUM.	30 435	71 378	42	2	3	2	3	3	3	4	22
[illegible]	PRIMARY NONFERROUS METALS, N.E.C. .	8 748	19 740	65	11	8	9	10	11	9	2	5
[illegible]	SECONDARY NONFERROUS METALS	16 121	32 683	374	72	61	73	79	48	28	12	1
[illegible]	NONFERROUS ROLLING AND DRAWING. . . .	186 933	390 973	881	66	52	106	150	119	190	103	95
[illegible]	COPPER ROLLING AND DRAWING.	38 570	82 033	140	8	4	13	19	17	34	22	23
[illegible]	ALUMINUM ROLLING AND DRAWING. . . .	54 202	115 637	246	21	21	34	36	32	53	21	28
[illegible]	NONFERROUS ROLLING AND DRAWING, NEC	23 628	53 274	152	13	10	31	37	17	19	15	10
[illegible]	NONFERROUS WIRE DRAWING, ETC. . . .	70 533	140 035	343	24	17	28	58	53	84	45	34
[illegible]	NONFERROUS FOUNDRIES.	89 760	165 077	1 807	253	244	479	432	185	151	42	21
[illegible]	ALUMINUM CASTINGS	48 114	90 428	962	145	133	239	232	98	81	22	12
[illegible]	BRASS, BRONZE AND COPPER CASTINGS .	18 614	32 564	487	57	72	150	128	43	26	7	4
[illegible]	NONFERROUS CASTINGS, N.E.C.	22 731	41 651	347	49	38	85	72	42	43	13	5
[illegible]	MISCELLANEOUS PRIMARY METAL PRODUCTS.	72 612	160 638	1 209	130	166	345	294	127	98	32	17
[illegible]	IRON AND STEEL FORGINGS	39 384	91 816	274	21	23	40	48	43	61	25	13
[illegible]	NONFERROUS FORGINGS	9 518	21 488	42	2	1	10	7	9	7	2	4
[illegible]	PRIMARY METAL PRODUCTS, N.E.C . . .	23 710	47 333	893	107	142	295	239	75	30	5	-

TABLE 1B. United States, by Industry: 1970—Continued

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	UNITED STATES--CON.											
34	FABRICATED METAL PRODUCTS	1 353 513	2 609 493	26 224	4 887	3 850	6 466	5 464	2 672	1 875	633	377
341	METAL CANS.	65 878	141 772	360	25	24	44	62	64	68	34	39
342	CUTLERY, HAND TOOLS AND HARDWARE. . .	159 739	300 435	1 813	345	219	361	332	228	180	88	60
3421	CUTLERY	13 627	23 683	129	20	18	23	21	15	21	6	5
3423	HAND AND EDGE TOOLS, N.E.C.	38 918	70 107	603	148	67	127	109	64	45	29	14
3425	HAND SAWS AND SAW BLADES.	6 505	12 059	80	6	9	18	18	11	12	4	2
3429	HARDWARE, N.E.C..	100 214	194 013	999	171	125	193	184	137	102	48	39
343	PLUMBING AND HEATING, EXCEPT ELECTRIC	79 456	141 671	826	137	87	149	161	87	118	53	34
3431	METAL SANITARY WARE	14 090	25 714	102	12	6	14	26	13	17	5	9
3432	PLUMBING FITTINGS AND BRASS GOODS .	18 196	31 065	203	35	26	32	35	25	34	9	7
3433	HEATING EQUIPMENT, EXCEPT ELECTRIC.	47 150	84 874	520	90	55	103	99	49	67	39	18
344	FABRICATED STRUCTURAL METAL PRODUCTS.	393 635	765 695	9 635	1 916	1 497	2 361	2 039	987	573	181	81
3441	FABRICATED STRUCTURAL STEEL	105 302	208 743	1 955	177	217	498	533	283	163	66	18
3442	METAL DOORS, SASH, AND TRIM	62 743	105 372	1 511	283	261	375	277	170	102	27	16
3443	FABRICATED PLATE WORK(BOILER SHOPS)	100 915	208 689	1 442	164	148	335	394	197	134	38	32
3444	SHEET METAL WORK.	72 584	148 329	2 882	711	514	766	556	215	87	25	8
3446	ARCHITECTURAL METAL WORK.	20 445	35 752	1 259	474	278	271	156	47	27	4	2
3449	MISCELLANEOUS METAL WORK.	31 555	58 652	582	105	79	115	123	74	60	21	5
345	SCREW MACHINE PRODUCTS, BOLTS, ETC. .	108 250	215 368	2 409	366	349	687	524	255	159	39	30
3451	SCREW MACHINE PRODUCTS.	45 312	86 274	1 779	311	278	568	386	163	62	10	1
3452	BOLTS, NUTS, RIVETS, AND WASHERS. .	62 938	129 095	630	55	71	119	138	92	97	29	29
346	METAL STAMPINGS	208 776	434 683	2 667	325	311	674	613	337	274	77	56
347	METAL SERVICES, N.E.C	87 652	143 816	4 456	1 087	826	1 291	874	249	109	19	1
3471	PLATING AND POLISHING	59 675	97 303	3 094	706	588	915	636	170	69	10	-
3479	METAL COATING AND ALLIED SERVICES .	27 949	46 467	1 360	381	238	374	238	79	40	9	1
348	MISC. FABRICATED WIRE PRODUCTS. . . .	63 848	105 475	1 470	259	227	348	304	163	125	35	9
349	MISC. FABRICATED METAL PRODUCTS . . .	186 026	360 109	2 565	418	302	548	555	301	268	106	67
3491	METAL BARRELS, DRUMS, AND PAILS . .	11 335	22 765	151	13	9	25	40	26	30	7	1
3492	SAFES AND VAULTS.	5 174	10 285	41	10	5	9	3	7	2	3	2
3493	STEEL SPRINGS	6 837	13 230	111	22	13	22	23	12	11	7	1
3494	VALVES AND PIPE FITTINGS.	93 199	188 395	674	74	55	116	131	79	117	58	44
3496	COLLAPSIBLE TUBES	4 958	7 231	18	-	-	-	-	3	9	2	4
3497	METAL FOIL AND LEAF	6 565	12 832	58	2	4	10	16	7	12	3	4
3498	FABRICATED PIPE AND FITTINGS. . . .	15 730	30 446	373	54	39	94	96	49	32	9	-
3499	FABRICATED METAL PRODUCTS, N.E.C. .	42 228	74 920	1 139	243	177	272	246	118	55	17	11
35	MACHINERY, EXCEPT ELECTRICAL.	1 996 070	4 292 400	37 839	9 770	7 061	9 702	5 883	2 334	1 649	737	703
351	ENGINES AND TURBINES.	122 356	269 967	209	26	19	21	31	30	21	16	45
3511	STEAM ENGINES AND TURBINES.	48 949	107 176	46	4	6	3	5	6	5	3	14
3519	INTERNAL COMBUSTION ENGINES, N.E.C.	73 330	162 600	162	22	13	18	26	23	16	13	31
352	FARM MACHINERY.	126 958	249 710	1 513	298	206	335	290	172	119	38	55
353	CONSTRUCTION AND RELATED MACHINERY. .	284 654	616 388	2 353	351	283	491	458	285	242	116	127
3531	CONSTRUCTION MACHINERY.	130 368	290 551	628	97	76	107	107	67	74	46	54
3532	MINING MACHINERY.	23 020	47 296	222	27	29	44	44	31	25	10	12
3533	OIL FIELD MACHINERY	37 081	78 035	346	49	43	60	63	51	40	24	16
3534	ELEVATORS AND MOVING STAIRWAYS. . .	14 059	30 478	140	18	15	32	27	21	14	5	8
3535	CONVEYORS AND CONVEYING EQUIPMENT .	29 151	62 683	455	65	43	115	101	59	44	15	13
3536	HOISTS, CRANES & MONORAILS.	20 388	44 408	160	23	18	38	31	17	14	7	12
3537	INDUSTRIAL TRUCKS AND TRACTORS. . .	30 546	62 860	397	69	59	94	84	39	31	9	12
354	METALWORKING MACHINERY.	329 845	772 772	9 309	2 042	1 763	2 744	1 652	558	322	136	92
3541	MACHINE TOOLS, METAL CUTTING TYPES.	75 209	182 520	840	142	151	221	142	64	53	32	35
3542	MACHINE TOOLS, METAL FORMING TYPES.	27 393	64 659	354	54	43	84	71	42	35	15	10
3544	SPEC. DIES, TOOLS, JIGS & FIXTURES.	124 093	309 249	6 518	1 538	1 333	2 058	1 132	297	122	28	10
3545	MACHINE TOOL ACCESSORIES.	55 554	119 888	1 130	212	194	279	228	96	74	31	16
3548	METALWORKING MACHINERY, N.E.C.. . .	47 548	96 380	457	89	42	99	79	59	38	30	21
355	SPECIAL INDUSTRY MACHINERY.	204 506	429 055	3 163	564	446	755	659	296	245	123	75
3551	FOOD PRODUCTS MACHINERY	34 599	72 619	638	113	100	141	135	56	66	18	9
3552	TEXTILE MACHINERY	36 752	66 433	501	90	70	119	115	45	30	20	12
3553	WOODWORKING MACHINERY	13 935	26 479	234	41	38	57	50	14	19	10	5
3554	PAPER INDUSTRIES MACHINERY.	21 262	48 318	209	20	17	57	38	34	19	15	9
3555	PRINTING TRADES MACHINERY	30 394	68 639	539	119	84	144	93	37	29	17	16
3559	SPECIAL INDUSTRY MACHINERY, N.E.C..	66 820	145 178	1 039	180	137	237	228	110	82	41	24
356	GENERAL INDUSTRIAL MACHINERY.	289 293	617 484	3 622	731	586	828	617	302	300	140	118
3561	PUMPS AND COMPRESSORS	80 048	168 485	623	97	79	128	101	67	70	42	39
3562	BALL AND ROLLER BEARINGS.	57 477	120 733	146	12	7	17	14	16	35	18	27
3564	BLOWERS AND FANS.	24 817	47 483	328	55	43	72	72	31	27	17	11
3565	INDUSTRIAL PATTERNS	11 191	28 274	1 036	343	262	304	97	19	11	-	-
3566	POWER TRANSMISSION EQUIPMENT. . . .	51 992	112 102	475	51	55	75	118	66	62	26	22
3567	INDUSTRIAL FURNACES AND OVENS . . .	17 993	38 870	283	54	35	56	65	24	30	14	5
3569	GENERAL INDUSTRIAL MACHINERY, NEC .	45 748	101 491	730	119	105	176	149	79	65	23	14
357	OFFICE AND COMPUTING MACHINES	253 996	597 241	923	136	97	138	183	112	102	64	91
3572	TYPEWRITERS	19 149	40 593	26	2	1	2	3	2	4	3	9
3573	ELECTRONIC COMPUTING EQUIPMENT. . .	158 461	393 868	485	56	46	79	101	66	49	33	55
3574	CALCULATING AND ACCOUNTING MACHINES	42 262	92 099	116	19	5	17	26	15	14	8	12
3576	SCALES AND BALANCES	6 543	13 065	73	17	10	9	15	3	13	3	3
3579	OFFICE MACHINES, N.E.C.	23 120	48 015	190	39	32	25	31	24	16	13	10

TABLE 1B. United States, by Industry: 1970–Continued

(Excludes government employees, railroad employees, self-employed persons, etc.—see "General Explanation." Size class 1 to 3 includes reporting units having payroll during 1st quarter but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual reporting units)

SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
358	SERVICE INDUSTRY MACHINES	165 116	310 475	1 580	286	228	313	287	175	146	68	77
3581	AUTOMATIC MERCHANDISING MACHINES. .	11 704	20 667	134	27	24	28	19	11	10	6	9
3582	COMMERCIAL LAUNDRY EQUIPMENT. . . .	7 173	13 606	127	26	20	25	28	10	10	6	2
3585	REFRIGERATION MACHINERY	114 070	212 684	684	96	73	118	128	97	78	41	53
3586	MEASURING AND DISPENSING PUMPS. . .	7 550	14 515	44	5	6	10	8	1	5	2	7
3589	SERVICE INDUSTRY MACHINES, N.E.C. .	24 619	48 996	591	132	105	132	104	56	43	13	6
359	MISC. MACHINERY, EXCEPT ELECTRICAL. .	218 911	428 433	15 137	5 325	3 426	4 071	1 701	404	151	36	23
36	ELECTRICAL EQUIPMENT AND SUPPLIES . . .	1 881 082	3 648 150	11 342	1 801	1 366	2 064	2 073	1 313	1 277	684	764
361	ELECTRIC TEST & DISTRIBUTING EQUIP. .	193 730	364 391	1 322	173	149	255	268	158	162	77	80
3611	ELECTRIC MEASURING INSTRUMENTS. . .	67 579	136 208	603	96	87	113	122	63	68	29	25
3612	TRANSFORMERS.	51 796	87 516	207	16	15	35	43	34	28	13	23
3613	SWITCHGEAR & SWITCHBOARD APPARATUS.	72 157	135 877	505	59	45	106	103	61	65	35	31
362	ELECTRICAL INDUSTRIAL APPARATUS . . .	213 387	403 339	1 311	183	152	234	240	145	167	84	106
3621	MOTORS AND GENERATORS	110 083	200 955	400	44	25	47	58	48	68	48	62
3622	INDUSTRIAL CONTROLS	54 560	106 801	521	93	88	127	94	41	42	14	22
3623	WELDING APPARATUS	14 844	32 129	136	14	10	22	34	22	22	7	5
3624	CARBON AND GRAPHITE PRODUCTS. . . .	12 405	24 647	68	7	7	12	9	8	13	3	9
3629	ELECTRIC INDUSTRIAL APPARATUS, NEC.	21 495	38 800	186	25	22	26	45	26	22	12	8
363	HOUSEHOLD APPLIANCES.	165 862	287 589	622	105	75	89	77	62	71	61	82
3631	HOUSEHOLD COOKING EQUIPMENT	21 526	35 660	67	8	5	8	8	4	9	10	15
3632	HOUSEHOLD REFRIGERATORS & FREEZERS.	49 790	96 381	40	8	2	1	4	6	3	3	13
3633	HOUSEHOLD LAUNDRY EQUIPMENT	23 639	45 258	38	3	1	1	5	3	7	7	11
3634	ELECTRIC HOUSEWARES AND FANS. . . .	44 982	63 828	272	47	36	42	26	30	31	33	27
3635	HOUSEHOLD VACUUM CLEANERS	8 350	14 517	32	2	4	7	7	3	1	3	5
3636	SEWING MACHINES	3 350	7 042	85	30	18	13	11	7	3	1	2
3639	HOUSEHOLD APPLIANCES, N.E.C.. . . .	14 225	24 903	88	7	9	17	16	9	17	4	9
364	ELECTRIC AND WIRING EQUIPMENT	179 936	298 607	1 868	290	244	359	375	237	182	111	70
3641	ELECTRIC LAMPS.	34 533	52 881	123	16	10	12	19	10	9	20	27
3642	LIGHTING FIXTURES	68 224	115 988	1 144	202	168	241	236	143	99	41	14
3643	CURRENT-CARRYING WIRING DEVICES . .	50 847	80 938	414	59	49	67	88	57	46	29	19
3644	NONCURRENT-CARRYING WIRING DEVICES.	26 332	48 793	187	13	17	39	32	27	28	21	10
365	RADIO AND TV RECEIVING EQUIPMENT. . .	117 799	192 177	715	194	88	118	114	50	61	41	49
3651	RADIO AND TV RECEIVING SETS	99 466	162 300	375	56	41	66	65	30	42	33	42
3652	PHONOGRAPH RECORDS.	18 333	29 876	340	138	47	52	49	20	19	8	7
366	COMMUNICATION EQUIPMENT	501 260	1 166 834	1 575	216	177	272	280	195	167	90	178
3661	TELEPHONE AND TELEGRAPH APPARATUS .	138 773	281 215	136	22	9	25	18	11	11	8	32
3662	RADIO, TV COMMUNICATION EQUIPMENT .	362 932	886 396	1 436	193	167	246	262	184	156	82	146
367	ELECTRONIC COMPONENTS & ACCESSORIES .	396 490	722 371	2 655	345	288	498	521	355	331	152	165
3671	ELECTRON TUBES, RECEIVING TYPE. . .	18 545	30 810	29	5	2	4	2	1	2	3	10
3672	CATHODE RAY PICTURE TUBES	19 774	36 419	73	28	12	13	6	1	2	1	10
3673	ELECTRON TUBES, TRANSMITTING. . . .	15 961	38 342	54	3	5	4	6	10	9	7	10
3674	SEMICONDUCTORS.	100 720	184 577	291	28	29	58	51	31	39	19	36
3679	ELECTRONIC COMPONENTS, N.E.C. . . .	240 996	431 441	2 204	280	240	419	455	311	279	121	99
369	MISC. ELECTRICAL EQUIP. & SUPPLIES. .	109 862	208 597	1 039	204	139	184	169	109	132	68	34
3691	STORAGE BATTERIES	21 610	43 208	224	31	31	38	29	27	44	18	6
3692	PRIMARY BATTERIES, DRY AND WET. . .	10 094	16 566	48	5	3	3	8	5	5	14	5
3693	X-RAY APPARATUS AND TUBES	9 713	19 978	96	24	10	12	14	12	16	3	5
3694	ENGINE ELECTRICAL EQUIPMENT	51 963	103 687	288	47	24	62	47	34	37	22	15
3699	ELECTRICAL EQUIPMENT, N.E.C.. . . .	16 471	25 146	380	95	70	69	71	31	30	11	3
37	TRANSPORTATION EQUIPMENT.	1 817 492	4 177 387	7 813	1 438	1 077	1 450	1 289	898	814	341	506
371	MOTOR VEHICLES AND EQUIPMENT.	774 021	1 763 064	2 739	435	360	541	465	274	243	158	263
3713	TRUCK AND BUS BODIES.	34 106	58 661	642	93	86	181	132	68	55	15	12
3715	TRUCK TRAILERS.	25 279	46 927	200	29	18	33	35	32	18	23	12
3717	MOTOR VEHICLES AND PARTS.	714 226	1 656 823	1 870	299	256	322	292	172	170	120	239
372	AIRCRAFT AND PARTS.	696 941	1 777 955	1 165	138	117	177	185	149	164	82	153
3721	AIRCRAFT.	373 265	973 801	163	23	18	15	13	14	18	14	48
3722	AIRCRAFT ENGINES AND ENGINE PARTS .	175 024	432 194	247	13	16	27	41	32	42	27	49
3723	AIRCRAFT PROPELLERS AND PARTS . . .	(D)	(D)	7	2	-	2	1	-	1	-	1
3729	AIRCRAFT EQUIPMENT, N.E.C	(D)	(D)	745	99	83	132	130	102	103	41	55
373	SHIP AND BOAT BUILDING AND REPAIRING.	183 505	361 200	1 894	549	350	378	262	137	118	46	54
3731	SHIP BUILDING AND REPAIRING	143 579	301 967	391	32	43	72	82	48	38	27	49
3732	BOAT BUILDING AND REPAIRING	39 866	59 163	1 499	516	307	304	179	89	80	19	5
374	RAILROAD EQUIPMENT.	57 941	118 381	140	7	16	19	18	24	18	11	27
3741	LOCOMOTIVES AND PARTS	17 901	38 749	28	3	4	5	6	4	2	1	3
3742	RAILROAD AND STREET CARS.	40 016	79 603	111	4	12	14	11	20	16	10	24
375	MOTORCYCLES, BICYCLES, AND PARTS. . .	12 167	19 811	129	31	22	26	24	7	8	5	6
379	MISC. TRANSPORTATION EQUIPMENT. . . .	92 701	136 127	1 731	271	208	308	333	307	262	39	3
3791	TRAILER COACHES	77 993	113 724	1 303	184	139	202	234	278	229	35	2
3799	TRANSPORTATION EQUIPMENT, N.E.C.. .	14 706	22 406	427	86	69	106	99	29	33	4	1
38	INSTRUMENTS AND RELATED PRODUCTS. . . .	404 518	846 771	4 471	1 040	710	970	710	378	344	167	152
381	ENGINEERING & SCIENTIFIC INSTRUMENTS.	50 979	109 682	656	114	98	148	138	60	57	23	18
382	MECHANICAL MEASURING, CONTROL DEVICES	100 289	203 081	770	155	97	154	122	70	85	36	51
3821	MECHANICAL MEASURING DEVICES. . . .	69 333	144 012	646	136	82	135	106	59	70	27	31
3822	AUTOMATIC TEMPERATURE CONTROLS. . .	30 956	59 075	124	19	15	19	16	11	15	9	20
383	OPTICAL INSTRUMENTS AND LENSES. . . .	20 433	46 779	349	87	53	87	50	35	21	10	6

TABLE 1B. United States, by Industry: 1970 – Continued

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	UNITED STATES--CON.											
384	MEDICAL INSTRUMENTS AND SUPPLIES. . .	79 236	135 691	1 468	389	274	325	208	106	86	44	36
3841	SURGICAL AND MEDICAL INSTRUMENTS. .	29 359	49 360	367	64	64	78	65	31	33	16	16
3842	SURGICAL APPLIANCES AND SUPPLIES. .	38 740	65 596	769	215	139	183	103	54	37	20	18
3843	DENTAL EQUIPMENT AND SUPPLIES . . .	11 085	20 662	332	110	71	64	40	20	16	8	3
385	OPHTHALMIC GOODS.	27 675	41 423	487	128	83	112	78	31	36	14	5
386	PHOTOGRAPHIC EQUIPMENT AND SUPPLIES .	96 342	261 115	550	130	81	113	84	53	44	24	21
387	WATCHES, CLOCKS, AND WATCHCASES . . .	29 563	49 000	190	36	24	31	30	23	15	16	15
3871	WATCHES AND CLOCKS.	26 480	44 229	152	31	17	27	23	14	12	14	14
3872	WATCHCASES.	3 083	4 770	38	5	7	4	7	9	3	2	1
39	MISCELLANEOUS MANUFACTURING INDUSTRIES.	422 329	634 508	13 132	3 760	2 388	3 095	2 092	946	568	187	96
391	JEWELRY, SILVERWARE, AND PLATED WARE.	52 711	87 604	2 158	757	452	472	275	109	60	23	10
3911	JEWELRY, PRECIOUS METAL	32 242	53 868	1 460	491	307	348	183	74	36	17	4
3912	JEWELERS' FINDINGS AND MATERIALS. .	5 137	7 486	225	56	47	52	40	22	6	1	1
3913	LAPIDARY WORK	1 954	3 455	291	169	71	31	14	5	1	-	-
3914	SILVERWARE AND PLATED WARE.	13 378	22 788	182	41	27	41	38	8	17	5	5
393	MUSICAL INSTRUMENTS AND PARTS	21 241	34 833	333	97	52	57	45	23	35	16	8
394	TOYS AND SPORTING GOODS	116 580	158 377	2 194	542	335	471	398	192	157	63	36
3941	GAMES AND TOYS.	52 927	72 587	619	130	85	118	109	71	61	25	20
3942	DOLLS	8 799	9 965	257	50	32	63	61	33	15	3	-
3943	CHILDREN'S VEHICLES, EXC. BICYCLES.	4 018	6 156	37	6	2	8	5	2	8	5	1
3949	SPORTING AND ATHLETIC GOODS, N.E.C.	50 835	69 670	1 280	355	216	282	223	86	73	30	15
395	PENS, PENCILS, OFFICE & ART SUPPLIES.	33 255	53 943	913	219	167	228	152	80	46	10	11
3951	PENS AND MECHANICAL PENCILS	10 609	15 791	107	17	14	19	17	16	14	4	6
3952	LEAD PENCILS AND ART GOODS.	7 671	11 379	124	20	19	30	23	16	9	2	5
3953	MARKING DEVICES	9 223	16 246	584	172	125	159	94	24	9	1	-
3955	CARBON PAPER AND INKED RIBBONS. . .	5 752	10 530	98	10	9	20	18	24	14	3	-
396	COSTUME JEWELRY AND NOTIONS	50 081	66 239	1 435	335	275	375	235	113	66	22	14
3961	COSTUME JEWELRY	19 583	25 898	689	173	145	185	100	50	23	8	5
3962	ARTIFICIAL FLOWERS.	4 181	4 788	248	75	43	73	39	14	4	-	-
3963	BUTTONS	5 479	8 182	216	44	48	56	38	19	10	1	-
3964	NEEDLES, PINS, AND FASTENERS. . . .	20 838	27 366	282	43	39	61	58	30	29	13	9
399	MISCELLANEOUS MANUFACTURES.	147 762	232 573	5 993	1 758	1 085	1 468	980	429	203	53	17
3991	BROOMS AND BRUSHES.	15 747	22 004	449	103	81	102	84	44	25	8	2
3993	SIGNS AND ADVERTISING DISPLAYS. . .	51 912	90 532	2 929	970	578	733	407	159	67	15	-
3994	MORTICIANS' GOODS	15 338	24 006	535	94	81	150	130	55	19	5	1
3996	HARD SURFACE FLOOR COVERINGS. . . .	2 707	5 046	16	1	3	3	2	1	1	2	3
3999	MANUFACTURES, N.E.C	58 581	84 154	2 051	590	342	479	354	169	85	22	10
--	ADMINISTRATIVE AND AUXILIARY.	1 061 304	2 959 810	11 003	2 770	1 529	2 009	1 745	1 040	964	476	470
...	TRANSPORTATION AND OTHER PUBLIC UTILITIES	3 837 876	7 750 576	127 363	51 893	23 841	25 800	14 990	5 601	3 329	1 042	867
41	LOCAL AND INTERURBAN PASSENGER TRANSIT.	374 245	542 818	12 915	5 056	2 371	2 688	1 673	620	328	114	65
411	LOCAL AND SUBURBAN TRANSPORTATION . .	163 314	311 931	2 501	670	508	629	396	149	76	39	34
4111	LOCAL AND SUBURBAN TRANSIT.	142 287	288 449	903	186	133	174	171	106	65	34	34
4119	LOCAL PASSENGER TRANSPORTATION, NEC	21 004	23 446	1 594	482	375	453	225	43	11	5	-
412	TAXICABS.	115 108	105 616	5 536	2 439	966	1 117	625	218	106	43	22
413	INTERCITY HIGHWAY TRANSPORTATION. . .	39 312	80 274	798	130	109	179	173	104	75	22	6
4131	INTERCITY BUS LINES	39 211	80 118	784	122	107	177	171	104	75	22	6
4132	INTERCITY TRANSPORTATION, N.E.C.. .	98	155	13	7	2	2	2	-	-	-	-
414	TRANSPORTATION CHARTER SERVICE. . . .	3 404	3 538	159	37	36	45	26	10	4	-	1
4141	LOCAL PASSENGER CHARTER SERVICE . .	2 416	2 527	89	19	19	23	17	7	3	-	1
4142	CHARTER SERVICE, EXCEPT LOCAL . . .	868	931	56	14	12	18	8	3	1	-	-
415	SCHOOL BUSSES	47 609	35 343	3 497	1 603	642	636	421	126	57	10	2
417	BUS TERMINAL AND SERVICE FACILITIES .	3 322	4 073	297	132	74	61	15	7	8	-	-
4171	BUS TERMINAL FACILITIES	2 520	2 854	278	126	72	57	13	6	4	-	-
4172	BUS SERVICE FACILITIES.	747	1 115	18	6	2	4	2	-	4	-	-
42	TRUCKING AND WAREHOUSING.	1 049 737	1 997 279	71 073	33 101	13 141	13 194	7 432	2 533	1 304	273	95
421	TRUCKING, LOCAL AND LONG DISTANCE . .	967 993	1 870 628	64 756	30 437	11 824	11 958	6 646	2 319	1 213	265	94
4211	TRUCKING WITHOUT STORAGE.	890 443	1 752 639	60 322	29 633	10 885	10 416	5 759	2 119	1 163	254	93
4214	LOCAL TRUCKING AND STORAGE.	71 992	106 851	4 316	793	929	1 516	842	188	40	7	1
422	PUBLIC WAREHOUSING.	78 818	121 688	6 034	2 528	1 248	1 194	760	209	86	8	1
4221	FARM PRODUCT WAREHOUSING & STORAGE.	11 949	15 179	974	396	210	190	142	25	11	-	-
4222	REFRIGERATED WAREHOUSING, N.E.C . .	12 395	21 082	537	109	87	148	144	31	14	4	-
4223	FOOD LOCKERS.	6 421	5 961	1 477	897	386	170	20	3	1	-	-
4224	HOUSEHOLD GOODS WAREHOUSING	3 090	5 054	196	77	29	36	41	9	4	-	-
4225	GENERAL WAREHOUSING AND STORAGE . .	37 528	62 442	2 281	851	404	505	351	115	51	3	1
4226	SPECIAL WAREHOUSING & STORAGE, NEC.	6 297	10 364	449	149	98	124	50	22	5	1	-
423	TRUCKING TERMINAL FACILITIES.	2 259	4 130	160	66	36	29	20	4	5	-	-
44	WATER TRANSPORTATION.	188 358	331 516	4 814	1 927	932	912	543	190	163	80	67
441	DEEP SEA FOREIGN TRANSPORTATION . . .	23 218	54 278	212	58	32	34	31	22	16	9	10
442	DEEP SEA DOMESTIC TRANSPORTATION. . .	8 070	19 632	82	18	15	12	11	8	12	2	4
4421	NONCONTIGUOUS AREA TRANSPORTATION .	1 087	3 007	20	6	3	3	3	2	2	-	1
4422	COASTWISE TRANSPORTATION.	6 317	15 214	48	7	11	7	6	4	8	2	3
4423	INTERCOASTAL TRANSPORTATION	663	1 399	13	4	1	2	2	2	2	-	-
443	GREAT LAKES TRANSPORTATION.	3 187	8 855	43	7	5	10	9	3	5	3	1
444	TRANSPORTATION ON RIVERS AND CANALS .	8 780	19 658	227	60	25	48	49	19	20	5	1
445	LOCAL WATER TRANSPORTATION.	25 788	50 018	1 505	537	312	359	210	47	27	10	3

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	UNITED STATES--CON.											
446	WATER TRANSPORTATION SERVICES	118 782	176 595	2 716	1 235	536	443	230	91	83	50	48
4463	MARINE CARGO HANDLING	103 679	153 882	707	159	87	106	119	69	70	49	48
4469	WATER TRANSPORTATION SERVICES, NEC.	14 780	22 064	1 980	1 064	444	328	110	20	13	1	-
45	TRANSPORTATION BY AIR	346 501	921 588	4 567	1 547	876	957	602	209	178	86	112
453	AIR TRANSPORTATION.	312 096	860 546	2 804	859	510	562	394	159	139	75	106
458	AIR TRANSPORTATION SERVICES	33 747	60 473	1 615	631	334	360	189	47	37	11	6
46	PIPE LINE TRANSPORTATION.	15 035	40 061	744	245	114	169	150	41	20	5	-
47	TRANSPORTATION SERVICES	107 222	184 747	9 349	4 030	2 431	1 759	758	229	122	13	7
471	FREIGHT FORWARDING.	35 014	66 041	1 789	516	416	432	267	94	55	7	2
472	ARRANGEMENT OF TRANSPORTATION	57 397	96 546	6 654	3 181	1 862	1 107	359	90	46	5	4
473	STOCKYARDS.	2 788	3 825	75	17	7	16	17	11	6	1	-
474	RENTAL OF RAILROAD CARS	1 151	1 622	129	67	22	24	13	2	1	-	-
478	MISCELLANEOUS TRANSPORTATION SERVICES	10 148	15 487	653	234	117	165	92	31	13	-	1
4781	TRANSPORTATION SERVICES, N.E.C. . . .	9 163	13 672	558	188	99	145	87	26	12	-	1
4782	INSPECTION AND WEIGHING SERVICES. .	632	1 370	79	42	15	16	4	1	1	-	-
48	COMMUNICATION	1 079 053	2 155 399	12 599	2 482	2 380	3 981	1 769	850	610	239	288
481	TELEPHONE COMMUNICATION	884 890	1 738 327	5 431	1 226	973	1 122	742	495	424	192	257
482	TELEGRAPH COMMUNICATION	33 457	68 874	905	480	162	119	62	38	21	12	11
483	RADIO AND TELEVISION BROADCASTING . .	136 662	300 936	4 766	294	791	2 363	833	294	147	28	16
489	COMMUNICATION SERVICES, N.E.C.. . . .	23 778	46 536	1 491	479	453	376	132	23	17	7	4
49	ELECTRIC, GAS AND SANITARY SERVICE. . .	633 441	1 466 352	10 614	3 370	1 508	2 011	1 923	844	526	214	218
491	ELECTRIC COMPANIES AND SYSTEMS. . . .	249 996	596 593	2 699	250	243	581	836	383	231	95	80
492	GAS COMPANIES AND SYSTEMS	145 136	317 155	2 509	461	392	618	568	231	137	51	51
493	COMBINATION COMPANIES AND SYSTEMS . .	195 650	481 218	1 020	147	107	168	187	142	126	59	84
4931	ELECTRIC & OTHER SERVICES COMBINED.	189 706	466 714	992	142	104	163	180	140	124	57	82
4932	GAS AND OTHER SERVICES COMBINED . .	4 886	11 552	19	4	1	4	4	2	1	2	1
4939	COMBINATION COMPANIES & SYSTEMS NEC	1 058	2 954	9	1	2	1	3	-	1	-	1
494	WATER SUPPLY.	17 025	27 781	2 188	1 466	339	220	107	34	17	5	-
495	SANITARY SERVICES	20 472	34 499	1 849	865	357	362	199	49	14	2	1
496	STEAM SUPPLY.	1 332	2 864	51	11	14	12	9	2	1	2	-
497	IRRIGATION SYSTEMS.	2 251	2 979	270	154	51	47	14	3	-	-	1
--	ADMINISTRATIVE AND AUXILIARY.	44 284	110 816	688	135	88	129	140	85	78	18	15
...	WHOLESALE TRADE	4 035 995	8 190 533	297 211	110 993	66 962	71 391	34 450	8 981	3 522	656	256
501	MOTOR VEHICLES & AUTOMOTIVE EQUIPMENT	362 367	679 128	28 715	9 525	7 347	7 531	3 295	701	251	43	22
5012	AUTOMOBILES & OTHER MOTOR VEHICLES.	96 751	207 503	4 332	1 247	729	1 010	943	267	104	22	10
5013	AUTOMOTIVE EQUIPMENT.	225 458	396 093	21 327	7 332	5 923	5 635	1 959	335	114	17	12
5014	TIRES AND TUBES	40 111	75 402	3 044	938	693	884	393	99	33	4	-
502	DRUGS, CHEMICALS, AND ALLIED PRODUCTS	217 237	485 431	14 942	6 256	2 961	3 087	1 747	613	226	37	15
5022	DRUGS, PROPRIETARIES, AND SUNDRIES.	104 199	222 453	5 292	2 096	884	1 055	726	359	139	22	11
5028	PAINTS AND VARNISHES.	19 249	40 069	1 855	725	486	437	153	38	13	3	-
5029	CHEMICALS AND ALLIED PRODUCTS, NEC.	93 323	221 895	7 740	3 408	1 582	1 581	865	214	74	12	4
503	DRY GOODS AND APPAREL	136 373	293 986	11 603	5 052	2 615	2 420	1 067	281	139	21	8
5033	PIECE GOODS	37 269	91 379	3 091	1 207	759	736	288	62	28	9	2
5034	NOTIONS AND OTHER DRY GOODS	15 036	30 669	1 231	500	302	274	113	24	14	3	1
5036	MEN'S CLOTHING AND FURNISHINGS. . .	19 520	39 868	1 761	759	412	365	163	40	18	2	2
5037	WOMEN'S AND CHILDREN'S CLOTHING . .	35 245	69 711	3 203	1 535	646	635	277	65	38	5	2
5039	FOOTWEAR.	11 977	26 398	955	397	222	205	83	31	15	1	1
504	GROCERIES AND RELATED PRODUCTS. . . .	560 274	986 827	37 107	13 710	7 120	8 979	5 135	1 465	577	101	20
5041	GROCERIES, GENERAL LINE	87 813	162 803	2 647	581	387	747	516	216	150	39	11
5042	FROZEN FOODS.	39 289	71 557	1 723	504	310	443	301	99	46	17	3
5043	DAIRY PRODUCTS.	52 163	100 160	3 702	1 452	689	869	498	124	63	7	-
5044	POULTRY AND POULTRY PRODUCTS. . . .	29 436	39 248	2 373	987	433	576	270	80	24	2	1
5045	CONFECTIONERY	19 583	32 229	2 369	1 127	533	476	184	40	9	-	-
5046	FISH AND SEA FOODS.	16 304	20 222	1 447	521	352	377	145	43	5	4	-
5047	MEATS AND MEAT PRODUCTS	76 767	147 499	5 317	1 762	995	1 440	837	214	60	9	-
5048	FRESH FRUITS AND VEGETABLES	92 733	125 261	6 182	2 324	1 223	1 405	822	287	110	9	2
5049	GROCERIES & RELATED PRODUCTS, NEC .	144 728	284 933	11 233	4 390	2 176	2 632	1 551	360	107	14	3
505	FARM PRODUCT RAW MATERIALS.	110 275	135 783	11 663	4 639	2 998	2 687	1 084	196	53	6	-
5052	COTTON.	3 173	5 380	484	299	88	66	25	4	2	-	-
5053	GRAIN	44 646	68 037	5 944	2 234	1 973	1 363	310	46	17	1	-
5054	LIVESTOCK	31 029	22 689	2 808	1 046	490	751	467	50	4	-	-
5059	FARM PRODUCT RAW MATERIALS, N.E.C .	20 334	26 752	1 593	722	299	310	168	69	22	3	-
506	ELECTRICAL GOODS.	265 541	590 666	17 270	5 949	4 132	4 335	1 987	509	265	61	32
5063	ELECTRICAL APPARATUS AND EQUIPMENT.	138 342	315 174	8 239	2 733	1 890	2 147	1 066	236	108	31	28
5064	ELECTRICAL APPLIANCES, TV & RADIOS.	61 887	135 204	2 959	934	609	722	424	144	102	21	3
5065	ELECTRONIC PARTS AND EQUIPMENT. . .	65 107	139 881	6 053	2 273	1 630	1 462	494	129	55	9	1
507	HARDWARE, PLUMBING & HEATING EQUIP. .	165 711	338 498	13 214	4 257	3 161	3 726	1 589	331	131	16	3
5072	HARDWARE.	66 869	126 867	4 321	1 468	957	1 111	548	141	77	16	3
5074	PLUMBING AND HEATING EQUIPMENT. . .	71 714	148 653	6 389	1 915	1 564	1 970	766	143	31	-	-
5077	AIR CONDITIONING AND REFRIGERATION.	27 019	62 803	2 495	868	640	644	273	47	23	-	-
508	MACHINERY, EQUIPMENT, AND SUPPLIES. .	726 096	1 641 005	52 863	18 468	12 344	13 387	6 294	1 616	596	118	40
5081	COMMERCIAL MACHINES AND EQUIPMENT .	200 602	513 443	9 591	3 067	2 347	2 253	1 192	426	207	66	33
5082	CONSTRUCTION AND MINING MACHINERY .	111 134	253 074	6 361	2 106	1 137	1 499	1 130	343	127	16	3
5083	FARM MACHINERY AND EQUIPMENT. . . .	26 726	54 895	1 788	586	347	491	258	75	29	2	-
5084	INDUSTRIAL MACHINERY & EQUIPMENT. .	130 508	300 942	13 126	5 168	3 313	3 074	1 231	263	68	9	-
5085	INDUSTRIAL SUPPLIES	97 931	210 899	8 185	2 414	1 975	2 544	1 023	165	54	8	2
5086	PROFESSIONAL EQUIPMENT AND SUPPLIES	77 725	150 568	5 811	1 917	1 305	1 577	744	201	58	8	1
5087	SERVICE ESTABLISHMENT EQUIPMENT . .	53 325	96 053	5 708	2 246	1 393	1 482	478	83	23	3	-
5088	TRANSPORTATION EQUIPMENT & SUPPLIES	24 866	53 679	2 012	820	468	423	218	51	26	5	1
5089	MACHINERY AND EQUIPMENT, N.E.C. . .	2 221	4 831	226	117	49	38	13	6	3	-	-

TABLE 1B. United States, by Industry: 1970—Continued

(Excludes government employees, railroad employees, self-employed persons, etc.—see "General Explanation." Size class 1 to 3 includes reporting units having payroll during 1st quarter but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual reporting units)

SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
509	MISCELLANEOUS WHOLESALERS	1 284 484	2 529 213	105 922	41 968	23 650	24 367	11 664	3 006	1 072	154	41
5091	METALS & MINERALS, EXCEPT PETROLEUM	141 701	324 226	8 230	2 928	1 724	1 820	1 153	393	177	27	8
5092	PETROLEUM AND PETROLEUM PRODUCTS	199 581	387 116	20 627	9 344	5 013	4 243	1 472	363	161	21	10
5093	SCRAP AND WASTE MATERIALS	79 646	124 284	7 025	2 832	1 582	1 575	744	227	60	4	1
5094	TOBACCO AND ITS PRODUCTS	34 870	56 622	2 475	691	478	763	439	84	20	-	-
5095	BEER, WINE, AND DISTILLED BEVERAGES	101 897	217 164	6 863	2 124	1 536	1 777	1 038	291	84	12	1
5096	PAPER AND ITS PRODUCTS	139 791	293 760	10 245	3 647	2 091	2 636	1 391	348	111	18	3
5097	FURNITURE AND HOME FURNISHINGS	90 118	177 979	7 976	3 174	1 785	1 854	884	210	58	10	1
5098	LUMBER AND CONSTRUCTION MATERIALS	165 207	332 915	12 996	4 036	2 964	3 749	1 742	381	113	11	-
5099	WHOLESALERS, N.E.C.	331 355	614 663	29 440	13 168	6 467	5 940	2 801	709	287	51	17
--	ADMINISTRATIVE AND AUXILIARY	207 588	509 887	3 903	1 162	634	872	586	263	212	99	75
...	RETAIL TRADE	11 071 289	12 035 185	1 034 857	490 713	249 599	194 288	72 093	17 676	7 260	1 939	1 289
52	BUILDING MATERIALS & FARM EQUIPMENT	448 638	631 562	62 447	27 287	17 020	14 293	3 309	411	108	15	4
521	LUMBER AND OTHER BUILDING MATERIALS	206 378	312 760	21 903	7 215	6 199	6 302	1 842	259	73	10	3
522	PLUMBING & HEATING EQUIPMENT DEALERS	16 545	26 394	2 652	1 336	681	495	121	15	4	-	-
523	PAINT, GLASS, AND WALLPAPER STORES	38 292	56 884	7 135	4 065	1 863	945	220	30	9	3	-
524	ELECTRICAL SUPPLY STORES	5 946	9 165	857	433	211	155	47	7	4	-	-
525	HARDWARE AND FARM EQUIPMENT	181 353	226 210	29 879	14 224	8 063	6 394	1 077	100	18	2	1
5251	HARDWARE STORES	90 127	100 155	17 312	9 887	4 326	2 525	491	68	12	2	1
5252	FARM EQUIPMENT DEALERS	91 173	125 954	12 560	4 334	3 736	3 866	586	32	6	-	-
53	GENERAL MERCHANDISE	2 129 954	2 172 963	59 752	23 762	11 463	11 740	6 314	2 845	2 167	797	664
531	DEPARTMENT STORES	1 308 917	1 332 997	4 636	-	-	-	875	1 253	1 353	591	564
532	MAIL ORDER HOUSES	136 044	184 685	4 239	1 703	853	1 046	433	89	52	24	39
533	VARIETY STORES	322 524	265 381	14 439	4 106	3 083	3 903	2 083	679	437	100	48
534	MERCHANDISING MACHINE OPERATORS	66 912	94 963	4 207	1 676	851	878	497	184	104	14	3
535	DIRECT SELLING ORGANIZATIONS	60 275	77 774	7 151	3 772	1 439	1 273	475	135	55	2	-
539	MISC. GENERAL MERCHANDISE STORES	235 132	217 034	25 032	12 502	5 236	4 640	1 950	504	166	24	10
54	FOOD STORES	1 636 080	1 776 749	125 172	63 271	26 003	21 412	9 731	2 727	1 334	390	304
541	GROCERY STORES	1 401 571	1 571 454	92 451	47 395	17 733	14 853	8 054	2 501	1 244	376	295
542	MEAT AND FISH (SEA FOOD) MARKETS	40 736	48 362	9 367	5 931	2 135	1 092	189	15	5	-	-
543	FRUIT STORES AND VEGETABLE MARKETS	9 416	8 431	2 226	1 525	435	201	54	8	3	-	-
544	CANDY, NUT, AND CONFECTIONERY STORES	21 818	14 837	3 444	1 925	818	529	129	29	11	2	1
545	DAIRY PRODUCTS STORES	38 844	30 071	3 292	1 260	976	710	229	62	45	5	5
546	RETAIL BAKERIES	113 448	93 151	12 402	3 995	3 496	3 762	1 015	103	21	7	3
549	MISCELLANEOUS FOOD STORES	9 283	9 646	1 742	1 065	368	239	56	9	5	-	-
55	AUTOMOTIVE DEALERS & SERVICE STATIONS	1 620 600	2 280 354	218 374	112 509	55 592	33 560	12 455	3 418	779	49	12
551	NEW AND USED CAR DEALERS	708 647	1 319 520	31 067	3 499	4 292	11 064	8 877	2 765	559	10	1
552	USED CAR DEALERS	37 981	51 802	9 934	6 860	1 956	930	168	19	1	-	-
553	TIRE, BATTERY, AND ACCESSORY DEALERS	151 056	221 853	20 020	8 948	5 608	4 197	985	203	67	9	3
554	GASOLINE SERVICE STATIONS	657 952	594 741	146 616	87 945	40 773	15 297	2 052	376	136	29	8
559	MISCELLANEOUS AUTOMOTIVE DEALERS	63 130	89 846	10 405	5 052	2 911	2 016	357	53	15	1	-
5591	BOAT DEALERS	14 446	19 953	2 558	1 268	705	497	82	4	2	-	-
5592	HOUSEHOLD TRAILER DEALERS	20 920	30 368	3 490	1 662	994	709	107	13	5	-	-
5599	AUTOMOTIVE DEALERS, N.E.C	20 750	29 396	3 122	1 537	815	596	136	30	7	1	-
56	APPAREL AND ACCESSORY STORES	770 935	782 920	84 867	36 355	23 008	17 947	5 877	1 093	457	98	32
561	MEN'S & BOYS' CLOTHING & FURNISHINGS	138 294	177 064	15 669	6 392	4 217	3 717	1 073	195	56	16	3
562	WOMEN'S READY-TO-WEAR STORES	276 153	249 240	26 601	11 354	6 752	5 647	2 139	437	207	51	14
563	WOMEN'S ACCESSORY & SPECIALTY STORES	45 249	39 574	6 333	3 162	1 660	1 098	317	70	24	1	1
564	CHILDREN'S AND INFANTS' WEAR STORES	17 254	13 712	3 231	1 853	775	484	97	17	5	-	-
565	FAMILY CLOTHING STORES	131 694	122 257	9 442	3 112	2 283	2 459	1 224	225	104	22	13
566	SHOE STORES	145 476	160 527	20 262	8 407	6 648	4 092	912	137	58	7	1
567	CUSTOM TAILORS	5 087	6 356	1 126	747	207	132	34	6	-	-	-
568	FURRIERS AND FUR SHOPS	5 797	9 091	1 132	694	235	166	32	4	-	1	-
569	MISCELLANEOUS APPAREL AND ACCESSORIES	3 627	3 264	650	383	138	103	22	1	3	-	-
57	FURNITURE AND HOME FURNISHINGS STORES	446 179	643 207	63 566	30 566	16 738	12 496	3 098	472	159	33	4
571	FURNITURE AND HOME FURNISHINGS	271 156	402 615	37 905	17 540	10 174	7 935	1 850	288	96	22	-
5712	FURNITURE STORES	200 701	300 835	25 459	10 815	7 008	5 896	1 402	238	79	21	-
5713	FLOOR COVERING STORES	40 303	67 229	6 806	3 460	1 799	1 248	265	29	5	-	-
5714	DRAPERY AND UPHOLSTERY STORES	13 917	15 826	3 034	1 874	709	361	78	10	2	-	-
5715	CHINA, GLASSWARE & METALWARE STORES	7 221	7 927	894	414	220	188	59	7	5	1	-
5719	MISC. HOME FURNISHINGS STORES	8 821	10 475	1 665	946	428	237	45	4	5	-	-
572	HOUSEHOLD APPLIANCE STORES	89 528	123 642	11 454	5 482	2 870	2 218	717	114	45	5	3
573	RADIO, TELEVISION, AND MUSIC STORES	85 315	116 734	14 184	7 528	3 689	2 343	531	68	18	6	1
5732	RADIO AND TELEVISION STORES	51 241	73 791	8 650	4 498	2 371	1 440	297	31	9	3	1
5733	MUSIC STORES	34 071	42 911	5 532	3 028	1 318	903	234	37	9	3	-
58	EATING AND DRINKING PLACES	2 438 137	1 696 290	233 048	103 006	51 961	48 149	23 100	5 076	1 424	248	84
59	MISCELLANEOUS RETAIL STORES	1 214 784	1 371 348	183 228	93 017	47 149	33 808	7 484	1 227	431	85	27
591	DRUG STORES AND PROPRIETARY STORES	436 745	466 772	41 521	11 496	12 920	13 308	3 075	447	200	52	23
592	LIQUOR STORES	93 749	95 563	23 973	15 800	5 791	2 027	304	40	8	3	-
593	ANTIQUE STORES AND SECONDHAND STORES	46 544	45 460	9 008	6 128	1 720	838	215	77	21	7	2
594	BOOK AND STATIONERY STORES	46 583	46 130	6 298	3 225	1 530	1 134	308	67	26	8	-
5942	BOOK STORES	26 297	23 980	2 884	1 430	684	512	183	47	20	8	-
5943	STATIONERY STORES	20 275	22 142	3 409	1 791	845	622	125	20	6	-	-

TABLE 1B. United States, by Industry: 1970—Continued

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SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
595	SPORTING GOODS STORES & BICYCLE SHOPS	39 827	44 653	7 358	4 543	1 578	961	205	46	22	3	-
5952	SPORTING GOODS STORES	37 227	42 167	6 482	3 892	1 419	898	202	46	22	3	-
5953	BICYCLE SHOPS	2 598	2 487	874	649	159	63	3	-	-	-	-
596	FARM AND GARDEN SUPPLY STORES	127 301	154 670	18 025	8 158	5 065	3 753	850	145	51	2	1
597	JEWELRY STORES	84 336	104 876	13 968	7 453	3 557	2 336	496	91	33	1	1
598	FUEL AND ICE DEALERS	104 604	174 584	14 222	5 807	4 016	3 471	811	92	23	2	-
5982	FUEL AND ICE DEALERS, N.E.C	10 966	14 658	2 048	1 241	421	299	74	10	3	-	-
5983	FUEL OIL DEALERS	55 044	101 614	6 892	2 871	1 759	1 698	484	61	17	2	-
5984	LIQUIFIED PETROLEUM GAS DEALERS	38 533	58 198	5 273	1 691	1 834	1 472	252	21	3	-	-
599	RETAIL STORES, N.E.C.	234 588	238 136	48 780	30 362	10 959	5 966	1 219	221	46	7	-
5992	FLORISTS	67 033	58 938	13 865	8 031	3 533	1 932	322	40	6	1	-
5993	CIGAR STORES AND STANDS	9 289	9 039	1 882	1 262	376	183	42	13	5	1	-
5994	NEWS DEALERS AND NEWSSTANDS	11 172	10 053	2 400	1 593	472	264	54	13	3	1	-
5995	HOBBY, TOY, AND GAME SHOPS	12 765	11 637	2 222	1 285	513	317	91	11	3	2	-
5996	CAMERA & PHOTOGRAPHIC SUPPLY STORES	15 295	19 785	2 334	1 193	602	411	97	27	4	-	-
5997	GIFT, NOVELTY, AND SOUVENIR SHOPS	31 818	24 505	7 531	4 923	1 655	775	155	18	5	-	-
5999	MISCELLANEOUS RETAIL STORES, N.E.C.	85 926	102 412	18 433	12 009	3 791	2 075	444	93	19	2	-
--	ADMINISTRATIVE AND AUXILIARY	365 982	679 792	4 403	940	665	883	725	407	401	224	158
...	FINANCE, INSURANCE, AND REAL ESTATE	3 674 899	6 282 479	326 779	205 980	53 962	38 385	17 887	5 815	3 178	926	646
60	BANKING	1 017 920	1 694 114	16 822	1 248	2 557	5 745	4 208	1 590	879	308	287
601	FEDERAL RESERVE BANKS	20 622	37 155	45	5	2	1	2	3	13	6	13
602	COMMERCIAL AND STOCK SAVINGS BANKS	944 541	1 561 887	15 097	445	2 283	5 499	4 032	1 500	800	276	262
603	MUTUAL SAVINGS BANKS	30 343	53 080	403	5	24	121	114	71	48	13	7
604	TRUST COMPANIES, NONDEPOSIT	1 867	3 582	18	6	2	4	2	1	1	1	1
605	FUNCTIONS CLOSELY RELATED TO BANKING	20 393	38 114	1 243	783	243	112	57	15	17	12	4
61	CREDIT AGENCIES OTHER THAN BANKS	361 534	574 178	43 635	21 527	12 092	6 774	2 239	638	301	49	15
611	REDISCOUNT AND FINANCING INSTITUTIONS	1 922	3 904	161	48	36	59	14	2	1	1	-
612	SAVINGS AND LOAN ASSOCIATIONS	101 095	171 550	5 482	1 154	1 312	1 737	882	256	123	15	3
613	AGRICULTURAL CREDIT INSTITUTIONS	6 467	11 171	822	300	228	235	53	6	-	-	-
614	PERSONAL CREDIT INSTITUTIONS	192 866	278 898	31 792	17 516	9 227	3 743	920	260	93	23	10
615	BUSINESS CREDIT INSTITUTIONS	45 718	85 427	3 587	1 613	820	711	263	92	78	8	2
616	LOAN CORRESPONDENTS AND BROKERS	5 962	11 648	669	347	168	97	39	10	6	2	-
62	SECURITY, COMMODITY BROKERS & SERVICES	211 561	542 917	7 935	3 355	1 323	1 478	1 023	371	258	79	48
621	SECURITY BROKERS AND DEALERS	191 093	494 969	6 509	2 559	1 055	1 286	924	333	233	75	44
622	COMMODITY CONTRACTS BROKERS, DEALERS	2 167	4 905	209	112	52	24	11	8	-	2	-
623	SECURITY AND COMMODITY EXCHANGES	4 330	9 807	61	21	13	9	8	3	5	-	2
628	SECURITY AND COMMODITY SERVICES	13 833	33 081	1 141	655	200	157	79	26	20	2	2
63	INSURANCE CARRIERS	1 002 035	1 904 685	29 207	10 193	4 865	5 914	4 811	1 716	1 099	353	256
631	LIFE INSURANCE	515 248	1 011 742	15 519	4 858	2 207	3 569	3 232	880	520	154	99
632	ACCIDENT AND HEALTH INSURANCE	73 922	123 214	1 126	447	197	234	94	40	45	27	42
633	FIRE, MARINE, AND CASUALTY INSURANCE	368 531	688 008	9 363	3 270	1 847	1 652	1 159	681	479	165	110
635	SURETY INSURANCE	3 674	7 078	278	125	68	44	24	11	5	1	-
6351	SURETY COMPANIES	(D)	(D)	273	124	65	44	24	11	4	1	-
6352	BANK DEPOSIT INSURANCE	(D)	(D)	5	1	3	-	-	-	1	-	-
636	TITLE INSURANCE	22 445	40 184	858	184	171	216	183	71	28	3	2
639	INSURANCE CARRIERS, N.E.C.	16 564	30 830	2 021	1 293	365	193	112	33	20	3	2
64	INSURANCE AGENTS, BROKERS, & SERVICE	272 512	463 813	60 124	41 806	11 041	5 572	1 276	290	110	23	6
65	REAL ESTATE	691 936	889 170	153 256	116 952	19 453	11 552	3 782	1 001	416	77	23
651	REAL ESTATE OPERATORS AND LESSORS	401 956	438 509	108 087	86 725	11 642	6 830	2 167	504	180	33	6
653	AGENTS, BROKERS, AND MANAGERS	119 909	181 359	23 953	17 653	3 497	1 839	665	189	92	15	3
654	TITLE ABSTRACT COMPANIES	15 834	23 161	2 304	1 320	545	311	93	24	10	-	1
655	SUBDIVIDERS AND DEVELOPERS	85 991	134 512	8 700	4 808	1 772	1 333	514	165	77	20	11
656	OPERATIVE BUILDERS	58 562	99 347	7 439	4 252	1 666	1 052	294	111	53	9	2
66	COMBINED REAL ESTATE, INSURANCE, ETC.	34 559	52 210	8 465	6 034	1 605	629	147	34	14	2	-
67	HOLDING AND OTHER INVESTMENT COMPANIES	64 676	124 015	7 095	4 818	998	673	359	146	71	24	6
671	HOLDING COMPANIES	19 065	43 111	1 316	752	209	163	90	56	38	8	-
672	INVESTMENT COMPANIES	9 698	20 678	784	467	136	94	57	16	8	4	2
673	TRUSTS	18 555	30 466	2 375	1 688	314	218	91	41	12	9	2
6732	EDUCATIONAL, RELIGIOUS, ETC. TRUSTS	10 104	14 399	1 120	697	188	134	67	21	8	4	1
6733	TRUSTS, N.E.C.	8 428	16 030	1 251	989	126	82	24	20	4	5	1
679	MISCELLANEOUS INVESTING INSTITUTIONS	17 028	29 307	2 577	1 883	331	196	117	32	13	3	2
6791	OIL ROYALTY AND COMMODITY TRADERS	1 820	3 294	585	491	55	26	11	2	-	-	-
6794	PATENT OWNERS AND LESSORS	11 636	18 847	778	352	161	131	93	25	11	3	2
6799	INVESTING INSTITUTIONS, N.E.C.	3 567	7 159	1 212	1 039	114	39	13	5	2	-	-
--	ADMINISTRATIVE AND AUXILIARY	18 166	37 377	240	47	28	48	42	29	30	11	5
...	SERVICES	10 461 468	13 584 179	984 579	589 225	188 899	125 795	50 257	16 960	8 888	2 604	1 951
70	HOTELS AND OTHER LODGING PLACES	787 347	684 462	51 403	27 224	8 947	7 682	4 327	1 898	964	231	130
701	HOTELS, TOURIST COURTS, AND MOTELS	649 793	569 130	34 674	16 393	6 096	6 072	3 446	1 540	794	204	129
702	ROOMING AND BOARDING HOUSES	96 289	77 812	6 898	3 661	975	1 064	723	308	145	22	-
703	TRAILER PARKS AND CAMPS	26 714	25 682	6 419	4 854	991	407	110	36	18	3	-
7031	TRAILER PARKS	11 849	11 750	4 144	3 284	640	189	21	8	2	-	-
7032	SPORTING AND RECREATIONAL CAMPS	14 865	13 928	2 275	1 570	351	218	89	28	16	3	-
704	MEMBERSHIP-BASIS ORGANIZATION HOTELS	14 294	11 665	3 345	2 266	877	132	46	14	7	2	1

TABLE 1B. United States, by Industry: 1970—Continued

(Excludes government employees, railroad employees, self-employed persons, etc.—see "General Explanation." Size class 1 to 3 includes reporting units having payroll during 1st quarter but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual reporting units)

SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
72	PERSONAL SERVICES	1 002 453	1 017 196	178 537	113 213	37 048	20 472	5 681	1 416	609	92	6
721	LAUNDRIES AND DRY CLEANING PLANTS	497 283	505 844	46 460	21 315	10 921	8 769	3 676	1 151	537	85	6
7211	POWER LAUNDRIES, FAMILY & COMMERCIAL	116 828	117 259	4 660	1 348	654	941	1 090	424	175	26	2
7212	LAUNDRIES, EXCEPT POWER	3 533	3 053	919	656	150	85	26	2	-	-	-
7213	LINEN SUPPLY	71 633	94 272	1 456	199	175	322	324	213	188	31	4
7214	DIAPER SERVICE	5 170	6 913	274	73	48	64	67	17	5	-	-
7215	COIN-OPERATED LAUNDRIES & CLEANING	36 984	25 111	11 710	8 767	2 081	756	81	23	2	-	-
7216	DRY CLEANING PLANTS, EXCEPT RUG	224 842	207 460	25 824	9 727	7 490	6 291	1 883	327	91	15	-
7217	RUG CLEANING AND REPAIRING PLANTS	5 808	7 434	816	378	221	163	45	7	2	-	-
7218	INDUSTRIAL LAUNDERERS	31 372	43 103	652	87	69	123	151	135	74	13	-
722	PHOTOGRAPHIC STUDIOS	34 520	45 711	6 853	4 428	1 426	723	223	38	13	2	-
723	BEAUTY SHOPS	279 725	253 323	70 967	46 757	16 106	6 954	1 021	108	19	2	-
724	BARBER SHOPS	52 816	56 334	24 577	21 671	2 318	510	65	11	2	-	-
725	SHOE REPAIR AND HAT CLEANING SHOPS	10 271	9 321	3 890	3 230	463	160	31	5	1	-	-
726	FUNERAL SERVICE AND CREMATORIES	66 968	91 356	13 171	7 247	3 463	2 099	325	34	2	1	-
727	GARMENT PRESSING, ALTERATION, REPAIR	19 134	17 244	5 933	4 574	945	334	66	8	5	1	-
729	MISCELLANEOUS PERSONAL SERVICES	34 353	32 095	4 985	2 884	1 050	732	233	56	29	1	-
73	MISCELLANEOUS BUSINESS SERVICES	1 631 633	2 417 617	93 195	41 254	19 411	17 620	8 759	3 355	1 956	580	260
731	ADVERTISING	115 198	278 653	8 118	3 562	1 880	1 669	629	215	115	27	21
7311	ADVERTISING AGENCIES	81 809	220 900	5 861	2 636	1 392	1 178	406	139	72	20	18
7312	OUTDOOR ADVERTISING SERVICES	11 607	22 324	1 013	436	198	249	89	28	11	2	-
7313	RADIO, TV, PUBLISHER REPS	9 984	20 969	566	205	153	117	61	14	12	2	2
7319	MISCELLANEOUS ADVERTISING	11 724	14 343	672	283	134	125	73	33	20	3	1
732	CREDIT REPORTING AND COLLECTION	64 531	81 966	5 531	2 462	1 277	1 167	434	108	63	15	5
733	DUPLICATING, MAILING, STENOGRAPHIC	64 214	87 109	5 059	2 377	982	971	468	171	72	15	3
7331	DIRECT MAIL ADVERTISING	36 682	48 450	1 680	559	317	391	239	105	52	14	3
7332	BLUEPRINTING AND PHOTOCOPYING	14 412	21 994	1 130	409	247	278	140	41	14	1	-
7339	STENOGRAPHIC AND DUPLICATING N.E.C.	13 117	16 660	2 246	1 406	418	302	89	25	6	-	-
734	SERVICES TO BUILDINGS	288 569	251 857	15 597	7 109	3 248	2 838	1 329	535	366	122	50
7341	WINDOW CLEANING	12 943	12 371	1 217	663	236	188	87	24	14	4	1
7342	DISINFECTING AND EXTERMINATING	31 634	41 929	3 498	1 632	766	741	293	48	14	3	1
7349	MISCELLANEOUS SERVICES TO BUILDINGS	243 973	197 555	10 875	4 808	2 246	1 908	949	463	338	115	48
735	NEWS SYNDICATES	3 714	17 923	387	149	76	85	48	22	5	-	2
736	PRIVATE EMPLOYMENT AGENCIES	50 456	62 791	5 597	2 503	1 470	1 101	373	101	45	4	-
739	MISCELLANEOUS BUSINESS SERVICES	1 040 414	1 634 976	52 651	22 934	10 420	9 761	5 471	2 202	1 287	397	179
7391	RESEARCH & DEVELOPMENT LABORATORIES	81 223	226 511	2 021	759	373	430	243	95	71	27	23
7392	BUSINESS CONSULTING SERVICES	288 099	603 410	18 828	8 949	3 821	3 233	1 751	612	334	90	38
7393	DETECTIVE AND PROTECTIVE SERVICES	151 637	144 323	3 389	899	561	687	562	323	228	89	40
7394	EQUIPMENT RENTAL AND LEASING	63 216	121 947	7 301	3 661	1 612	1 340	506	135	43	3	1
7395	PHOTOFINISHING LABORATORIES	40 263	60 854	1 647	565	317	339	222	122	63	15	4
7396	TRADING STAMP SERVICES	5 841	8 100	548	272	132	83	45	11	4	-	1
7397	COMMERCIAL TESTING LABORATORIES	15 499	28 133	1 046	315	247	293	144	26	17	4	-
7398	TEMPORARY HELP SUPPLY SERVICE	184 391	136 852	2 185	325	160	342	463	411	312	120	52
7399	BUSINESS SERVICES, N.E.C.	209 922	304 214	15 663	7 182	3 194	3 006	1 531	466	215	49	20
75	AUTO REPAIR, SERVICES & GARAGES	384 143	521 155	70 336	43 514	14 816	9 027	2 357	460	140	18	4
751	AUTOMOBILE RENTALS, WITHOUT DRIVERS	65 333	110 259	5 229	2 383	1 147	967	492	148	79	9	4
7512	PASSENGER CAR RENTAL AND LEASING	38 745	60 725	2 556	1 090	622	457	236	84	55	8	4
7513	TRUCK RENTAL AND LEASING	19 251	36 284	1 849	841	375	379	192	43	19	-	-
7519	UTILITY AND HOUSE TRAILER RENTAL	1 643	3 549	289	193	46	32	15	2	1	-	-
752	AUTOMOBILE PARKING	37 934	40 918	3 779	1 767	826	753	311	87	29	6	-
7523	PARKING LOTS	20 589	20 502	2 239	1 235	428	359	148	45	19	5	-
7525	PARKING STRUCTURES	11 680	14 111	964	273	270	274	111	28	8	-	-
753	AUTOMOBILE REPAIR SHOPS	217 253	324 327	54 249	36 033	11 431	5 835	837	95	16	2	-
7531	TOP AND BODY REPAIR SHOPS	53 180	86 362	12 630	7 731	3 042	1 673	177	7	-	-	-
7534	TIRE RETREADING AND REPAIR SHOPS	16 993	25 138	2 301	1 087	558	476	145	32	3	-	-
7535	PAINT SHOPS	12 092	18 055	2 477	1 360	676	394	42	3	2	-	-
7538	GENERAL AUTOMOBILE REPAIR SHOPS	92 398	127 739	26 524	19 418	4 651	2 087	313	44	9	2	-
7539	AUTOMOBILE REPAIR SHOPS, N.E.C.	42 512	66 941	10 297	6 425	2 498	1 203	160	9	2	-	-
754	AUTOMOBILE SERVICES, EXCEPT REPAIR	63 434	45 438	7 042	3 305	1 409	1 467	714	130	16	1	-
7542	AUTOMOBILE LAUNDRIES	48 042	29 938	4 624	1 930	866	1 122	585	111	9	1	-
7549	AUTOMOBILE SERVICES, N.E.C.	8 697	10 399	1 811	1 076	440	237	55	2	1	-	-
76	MISCELLANEOUS REPAIR SERVICES	202 616	325 118	38 139	24 779	7 423	4 442	1 167	206	107	10	5
762	ELECTRICAL REPAIR SHOPS	61 222	94 672	13 047	8 821	2 445	1 367	324	60	26	3	1
7622	RADIO AND TELEVISION REPAIR	35 140	51 510	7 953	5 606	1 408	722	161	37	16	2	1
7623	REFRIGERATOR SERVICE AND REPAIR	6 020	10 034	1 479	1 018	284	144	28	4	1	-	-
7629	ELECTRICAL REPAIR SHOPS, N.E.C.	17 114	27 840	3 118	1 864	673	448	108	18	7	-	-
763	WATCH, CLOCK, AND JEWELRY REPAIR	4 644	5 983	1 351	1 015	210	102	21	1	2	-	-
764	REUPHOLSTERY AND FURNITURE REPAIR	19 242	22 647	5 815	4 295	1 031	416	64	7	2	-	-
769	MISCELLANEOUS REPAIR SHOPS	117 277	201 535	17 910	10 639	3 734	2 554	758	138	76	7	4
7692	WELDING REPAIR	15 793	25 572	3 011	1 805	685	417	89	12	2	1	-
7694	ARMATURE REWINDING SHOPS	23 164	42 394	2 309	1 066	561	442	175	37	24	3	1
7699	REPAIR SERVICES, N.E.C.	76 830	130 846	12 372	7 644	2 437	1 670	479	88	48	3	3

TABLE 1B. United States, by Industry: 1970—Continued

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SIC code	Industry	Number of employees, mid-March pay period	Taxable payrolls, Jan.-Mar. ($1,000)	Total reporting units	Number of reporting units, by employment-size class: 1 to 3	4 to 7	8 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 or more
	UNITED STATES--CON.											
78	MOTION PICTURES	183 408	239 471	11 090	3 176	2 092	3 732	1 565	355	119	30	21
781	MOTION PICTURE FILMING & DISTRIBUTING	51 200	125 288	2 922	1 424	572	542	229	97	38	11	9
7813	MOTION PICTURE PRODUCTION, EXC. TV.	19 737	50 669	854	479	157	134	43	25	9	3	4
7814	MOTION PICTURE PRODUCTION FOR TV. .	10 279	27 744	706	343	149	110	54	35	12	2	1
7815	PRODUCTION OF STILL, SLIDE FILMS. .	1 572	3 316	107	53	27	21	2	1	2	-	1
7816	MOTION PICTURE FILM EXCHANGES . . .	6 282	12 495	537	204	118	140	55	14	4	2	-
7817	FILM OR TAPE DISTRIBUTION FOR TV. .	3 369	8 572	104	37	22	23	15	3	2	1	1
7818	MOTION PICTURE DISTR. SERVICES. . .	2 219	3 813	221	111	39	50	16	2	2	1	-
782	MOTION PICTURE PRODUCTION SERVICES. .	12 481	30 619	460	160	98	106	56	19	11	4	6
783	MOTION PICTURE THEATERS	119 675	83 538	7 702	1 590	1 421	3 082	1 279	239	70	15	6
7832	THEATERS, EXCEPT DRIVE-IN	89 640	63 795	5 419	1 090	954	2 159	936	205	57	14	4
7833	DRIVE-IN THEATERS	18 526	11 414	1 567	342	346	675	178	16	9	-	1
79	AMUSEMENT AND RECREATION SERVICES, NEC.	430 734	462 859	37 982	18 539	7 491	6 990	3 617	958	289	57	41
791	DANCE HALLS, STUDIOS, AND SCHOOLS . .	11 642	7 375	2 260	1 438	412	304	96	8	2	-	-
792	PRODUCERS, ORCHESTRAS, ENTERTAINERS .	57 806	82 718	6 179	3 168	1 540	960	329	109	65	2	6
7922	THEATRICAL PRODUCERS AND SERVICES .	20 589	37 023	1 736	876	357	272	141	60	28	-	2
7929	ENTERTAINERS & ENTERTAINMENT GROUPS	28 494	32 453	3 791	1 928	1 069	592	142	31	25	1	3
793	BOWLING AND BILLIARD ESTABLISHMENTS .	93 501	74 200	9 215	3 786	1 707	2 295	1 242	169	15	1	-
7932	BILLIARD AND POOL ESTABLISHMENTS. .	7 451	4 864	2 499	2 002	340	129	21	7	-	-	-
7933	BOWLING ALLEYS.	78 862	63 522	6 111	1 509	1 282	2 050	1 116	140	13	1	-
794	MISC. AMUSEMENT, RECREATION SERVICES.	267 324	298 157	20 299	10 131	3 826	3 428	1 948	671	206	54	35
7941	SPORTS PROMOTERS, ATHLETIC FIELDS .	12 315	24 884	448	158	78	72	85	30	16	7	2
7942	PUBLIC GOLF COURSES	8 929	8 694	1 188	580	264	244	80	18	2	-	-
7943	COIN-OPERATED AMUSEMENT DEVICES . .	9 037	13 101	1 734	955	426	302	45	6	-	-	-
7945	SKATING RINKS	6 664	4 512	958	459	232	191	70	5	1	-	-
7946	AMUSEMENT PARKS	5 067	4 629	362	160	75	71	32	15	8	1	-
7947	GOLF CLUBS AND COUNTRY CLUBS. . . .	87 477	88 262	4 638	1 418	771	992	991	396	68	2	-
7948	RACE TRACKS AND STABLES	33 104	36 027	1 387	702	270	232	98	26	25	20	14
7949	AMUSEMENT AND RECREATION, N.E.C.. .	104 495	117 687	9 562	5 684	1 707	1 322	546	175	85	24	19
80	MEDICAL AND OTHER HEALTH SERVICES . . .	2 902 447	3 565 873	214 767	150 967	35 272	13 968	6 597	3 689	2 198	925	1 151
801	OFFICES OF PHYSICIANS AND SURGEONS. .	374 296	505 597	104 402	75 697	20 260	7 228	949	186	66	7	9
802	OFFICES OF DENTISTS, DENTAL SURGEONS.	158 418	162 010	63 817	52 572	9 751	1 365	113	9	7	-	-
803	OFFICES OF OSTEOPATHIC PHYSICIANS . .	12 173	13 884	4 266	3 358	723	164	17	2	2	-	-
804	OFFICES OF CHIROPRACTORS.	6 596	4 497	3 984	3 768	184	24	8	-	-	-	-
806	HOSPITALS	1 743 799	2 274 677	5 137	177	122	182	634	824	1 230	836	1 132
807	MEDICAL AND DENTAL LABORATORIES . . .	51 870	83 891	6 951	3 861	1 489	1 092	384	93	26	5	1
8071	MEDICAL LABORATORIES.	27 851	45 471	2 800	1 350	634	539	192	60	19	5	1
8072	DENTAL LABORATORIES	23 988	38 374	4 147	2 509	855	551	192	33	7	-	-
809	HEALTH AND ALLIED SERVICES, N.E.C.. .	554 695	522 564	26 130	11 486	2 726	3 904	4 488	2 574	866	77	9
8092	SANATORIA CONVALESCENT & REST HOMES	438 384	362 955	11 162	1 106	859	2 367	3 758	2 287	723	56	6
8099	HEALTH & ALLIED SERVICES, N.E.C.. .	95 334	138 798	13 921	10 011	1 698	1 313	555	209	117	16	2
81	LEGAL SERVICES.	237 464	369 509	68 500	53 832	9 219	4 212	904	223	89	20	1
82	EDUCATIONAL SERVICES.	890 493	1 332 383	32 951	11 475	6 595	8 240	4 200	1 230	787	249	175
821	ELEMENTARY AND SECONDARY SCHOOLS. . .	306 252	344 759	23 503	8 249	4 818	6 328	3 118	722	234	28	6
822	COLLEGES AND UNIVERSITIES	467 335	838 877	1 855	177	128	243	275	248	435	191	158
823	LIBRARIES AND INFORMATION CENTERS . .	15 229	17 362	1 188	598	299	189	72	14	11	1	4
824	CORRESPONDENCE AND VOCATIONAL SCHOOLS	53 707	79 512	3 382	1 182	768	879	396	98	36	16	7
8241	CORRESPONDENCE SCHOOLS.	7 361	12 507	385	174	84	71	35	10	5	3	3
8242	VOCATIONAL SCHOOLS.	46 324	66 987	2 995	1 008	683	807	361	88	31	13	4
829	SCHOOLS & EDUCATIONAL SERVICES, NEC .	46 655	50 434	2 881	1 197	555	571	329	146	71	12	-
84	MUSEUMS, BOTANICAL, ZOOLOGICAL GARDENS.	18 446	25 058	798	346	144	150	83	40	22	7	6
841	MUSEUMS AND ART GALLERIES	14 299	18 966	682	296	127	133	70	31	16	5	4
842	BOTANICAL AND ZOOLOGICAL GARDENS. . .	4 099	6 050	100	37	15	16	13	9	6	2	2
86	NONPROFIT MEMBERSHIP ORGANIZATIONS. . .	1 142 363	1 213 526	124 246	66 624	27 354	19 739	7 204	1 993	1 026	227	79
861	BUSINESS ASSOCIATIONS	73 641	136 204	12 027	7 813	2 324	1 310	409	105	55	9	2
862	PROFESSIONAL ORGANIZATIONS.	20 565	38 455	2 135	1 202	404	320	134	46	25	4	-
863	LABOR ORGANIZATIONS	138 895	161 082	20 376	10 329	5 096	3 723	1 009	163	48	6	2
864	CIVIC AND SOCIAL ASSOCIATIONS	244 693	223 156	28 422	17 327	4 758	3 840	1 713	505	221	44	14
865	POLITICAL ORGANIZATIONS	4 890	6 187	928	623	170	94	30	9	2	-	-
866	RELIGIOUS ORGANIZATIONS	297 898	246 424	44 638	22 481	12 061	7 727	1 970	271	101	19	8
867	CHARITABLE ORGANIZATIONS.	144 440	173 257	6 562	2 296	1 051	1 477	1 057	398	230	42	11
869	NONPROFIT MEMBER ORGANIZATIONS, NEC .	217 176	228 593	9 143	4 546	1 489	1 245	878	496	344	103	42
89	MISCELLANEOUS SERVICES.	590 452	1 304 224	60 182	33 418	12 454	9 040	3 547	1 013	519	134	57
891	ENGINEERING & ARCHITECTURAL SERVICES.	261 012	627 542	22 227	9 828	5 134	4 530	1 886	515	257	61	16
892	NONPROFIT RESEARCH AGENCIES	101 608	217 775	3 562	1 547	694	670	378	122	87	38	26
893	ACCOUNTING, AUDITING, AND BOOKKEEPING	200 053	401 194	29 465	18 848	5 757	3 234	1 085	327	167	32	15
899	SERVICES, N.E.C..	27 280	57 097	4 898	3 184	862	602	192	47	8	3	-
--	ADMINISTRATIVE AND AUXILIARY.	57 469	105 728	2 453	864	633	481	249	124	63	24	15
...	UNCLASSIFIED ESTABLISHMENTS	435 094	526 185	98 896	64 647	18 829	12 075	3 343	2	-	-	-

Part 6

DEMAND CAPACITY ANALYSIS

INTRODUCTION

In this part of the study the demand for airport and aircraft services will be linked to the capacity to provide those services. The demand considerations begin with a look at air cargo peaking by time of day, day of week, and month of year. The patterns of air cargo handling operations are generally uniform throughout the State with a scale difference between the three large hubs and the other airports in the State due to volume, scheduling, and equipment differences. A discussion of the air carrier share of the market by Texas airports and their performance histories aids in understanding the present and anticipated capacity of individual airports. The type of carrier, route structure, and service provided have an important effect on the demand for air cargo service. Finally, a discussion of present and forecast air cargo operations is provided.

PEAK PERIOD ANALYSIS

The information in this section comes primarily from a number of interviews conducted with air carriers including corporate office personnel, station managers, air cargo managers, and sales representatives.

Airport demand/capacity analysis and space planning must take place with cognizance of the relationship of peak demand to average demand. A discussion of daily, weekly, and monthly peaking is provided in this section. In response to the question, "Is peaking a problem?", the air carriers responded without exception that peaking was not a problem. It may be inferred from this that Texas air carrier airports are capable of handling present peak loads.

Daily Peaking

Daily peaking for air freight is closely tied to the shipping patterns of manufacturers and other commercial establishments. These firms expect deliveries at their plants between 8:00 a.m. and 10:00 a.m. and pickup of outbound freight between 3:30 p.m. and 5:00 p.m. The outbound freight is assembled by airline by an ACI contractor or air freight forwarder and delivered to the airlines beginning at about 4:00 p.m. and continuing until 8:00 p.m. The freight is sorted by flight by the respective airline and prepared for loading. One should notice that the air freight peak is arriving at the airline cargo terminal right at or just after the 4:30 p.m. to 6:30 p.m. passenger peak. By the time the freight has been sorted and prepared for loading, the passenger peak is passed. The airlines have until morning to fly the freight to the destination city, sort the freight by consignee, and turn it over to an ACI contractor or to an air freight forwarder for morning delivery.

Some air freight is, of course, moving all day long; however, in general it moves according to the above pattern. As a result, there is a great deal of unused freight capacity in the belly compartments of passenger aircraft during the day when passenger traffic is highest and freight volume is lowest. American Airlines is presently offering reduced daytime freight rates as an incentive to shippers to utilize this capacity.

Carrier responses to daily peaking questions were consistent and reflect periods of greatest activity at the air cargo terminal. Results are summarized below:

Station	Peak Hours		
Dallas	7:30 a.m. to 9:30 a.m.	6:00 p.m. to 8:00 p.m.	late evening & early morning
Houston	7:00 a.m. to 9:00 a.m.	6:00 p.m. to 8:00 p.m.	late evening
San Antonio	7:00 a.m. to 9:00 a.m.	4:00 p.m. to 6:00 p.m.	late evening
El Paso	6:00 a.m. to 8:00 a.m.	4:30 p.m. to 6:00 p.m.	late evening

Responses from the manufacturers' survey confirm the daily peaking for outbound shipments. Timing of pickup of shipments was 14 percent pre-noon, 51 percent noon to 4:00 p.m., and 35 percent after 4:00 p.m. Considering the fact that most shipments picked up during the noon to 4:00 p.m. period will not be at the airport ready to load prior to 5:00 p.m., 86 percent of the outbound traffic is moving from the airport after 5:00 p.m. These responses also indicate that fundamental changes in the daily shipping patterns of manufacturers will have to be made before air cargo becomes a 24-hours a day activity instead of primarily an early evening and nighttime activity.

Weekly Peaking

Air carrier responses to weekly peaking questions were also very consistent. Sunday and Monday are light; volume picks up on Tuesday, Wednesday, Thursday, and Friday, and is slow again on Saturday. Saturday deliveries are made on a reduced basis in the South and Southwest. Saturday deliveries are not made in the North and Northeast.

American Airlines furnished the following breakdown of air freight weight by day of week.

	Outbound	Inbound
Sunday	3%	3%
Monday	13%	8%
Tuesday	18%	18%
Wednesday	20%	20%
Thursday	20%	20%
Friday	18%	18%
Saturday	8%	13%

These figures are typical of most Texas airports; a fairly uniform volume Tuesday - Friday and slow Saturday - Monday.

Monthly Peaking

Information on monthly peaking was obtained from the air carrier interviews, manufacturers' survey, and an examination of monthly import-export data through Texas Customs Districts. Monthly peaking is to some extent a function of the arrangement of days in a month, i.e., the number of Mondays, Tuesdays, etc. The occurrence of holidays such as the shift of

Easter, between March and April, also is important for explaining monthly variations. Short-term monthly airline forecasting is done using a day-over-day procedure to compensate for these effects. The monthly data discussed here have not been adjusted for these daily effects.

Air carrier responses to the question, "Which months of the year are the busiest? Slowest?" were not always consistent. The busiest month for one airline might be the slowest month for another airline. Generally, January, February, and November are slow months. July, August, September, October, and December are busy months, with December mentioned most frequently as busiest. The December peak was attributed to late restocking of fast moving items during the Christmas buying season. The January-February decline was also attributed to slower retail sales during this period. From this, it can be inferred that retail sales demand has a noticeable effect on air freight volume.

Table 6-1 shows, for selected airlines, the distribution of annual traffic volume by month for enplaned and deplaned air freight at Dallas and Houston. One will notice that, although the monthly variation is not consistent between carriers, the high month peak is about twice the low month volume. Tables 3-5 and 3-6 provided an analysis of monthly deplaning and enplaning cargo and total cargo for Braniff Airlines. The highest total monthly peak was for Amarillo in December 1971 when traffic volume was 1.41 times the average monthly traffic volume. The Dallas peaks for total cargo were 1.24 in 1969, 1.17 in 1970, and 1.23 in 1971 times the average monthly volume which occurred in March, April, and December, respectively. The Houston peaks for total cargo were 1.15 in 1969, 1.10 in 1970, and 1.14 in 1971 and occurred in December, April, and December, respectively. Dallas and Houston appear to be very stable over time with regard to peak to average ratios.

Peak months for air shipment of manufactured products, Table 6-2, are May, June, July, October, and November, in terms of number of shippers, and February, May, June, October, and December in terms

Table 6-1

MONTHLY PERCENT DISTRIBUTION OF AIR FREIGHT
FOR DALLAS AND HOUSTON, SELECTED CARRIERS

	AA 1969		AA 1970		BN 1969		BN 1970		OZ 1970	
	Enp.	Dep.	Enp.	Dep.	Enp.	Dep.	Enp.	Dep.	Enp.	Dep.
Dallas										
J	9.4	9.1	6.4	7.1	8.5	7.8	8.5	8.4	5.4	5.7
F	7.3	7.5	7.1	7.0	8.2	7.4	7.8	8.1	4.4	5.6
M	3.0	3.1	7.8	7.8	11.8	9.8	8.0	7.8	4.8	6.1
A	9.2	8.9	10.5	9.9	8.5	8.0	9.9	10.2	8.6	9.2
M	9.5	8.3	11.3	10.4	8.3	7.7	10.5	9.9	16.7	12.9
J	9.8	8.5	10.1	9.1	7.8	7.2	9.8	9.0	12.6	10.9
J	9.2	8.1	7.6	8.2	7.8	7.6	7.3	8.1	8.9	9.7
A	8.7	9.2	7.3	7.8	7.7	8.0	7.7	7.6	7.2	8.8
S	9.0	8.9	7.5	8.2	7.8	7.7	7.3	7.2	8.6	9.2
O	9.1	10.4	8.3	8.2	8.7	8.6	8.2	8.3	8.7	9.4
N	7.9	8.8	8.1	7.9	7.3	6.9	6.9	5.3	5.3	5.3
D	7.9	9.0	8.1	8.4	7.5	7.2	8.0	8.2	8.6	6.9

	AA 1970		BN 1969		BN 1970		DL 1969		DL 1970	
	Enp.	Dep.	Enp.	Dep.	Enp.	Dep.	Enp.	Dep.	Enp.	Dep.
Houston										
J	6.6	6.8	8.8	8.1	9.6	7.8	6.9	7.0	6.2	6.6
F	9.0	8.8	8.6	8.7	10.3	8.1	5.9	7.6	7.0	6.6
M	7.9	10.3	10.7	8.4	6.9	7.4	10.3	11.5	8.4	8.1
A	8.9	9.2	8.0	8.4	8.0	9.7	8.0	8.5	10.0	9.5
M	10.2	10.8	9.8	8.6	8.8	10.4	9.1	9.7	10.0	9.8
J	9.6	7.6	3.0	7.7	9.0	8.8	7.4	8.2	7.8	8.9
J	7.5	7.2	9.3	8.2	7.0	8.3	7.7	7.3	9.0	7.5
A	6.8	7.6	8.5	8.4	8.0	8.6	8.7	8.5	7.8	8.4
S	8.4	7.6	8.8	8.3	7.4	7.3	8.4	8.8	8.3	8.4
O	10.0	8.1	9.2	10.3	8.9	8.5	8.4	9.2	8.9	8.8
N	7.5	7.4	8.0	7.6	7.8	7.4	6.3	8.5	7.4	7.7
D	7.4	8.6	7.2	7.4	8.2	7.6	13.0	5.0	9.3	9.8

Source: TTI Air Carrier Survey

Table 6-2

ANALYSIS OF PEAK MONTH BY RESPONSES, DISTRIBUTION OF RESPONSES, RATIO PEAK TO TOTAL SHIPMENTS AND DISTRIBUTION OF SHIPMENTS MANUFACTURERS SURVEY

	Responses	Distribution of Responses	Ratio Peak to Total 1/	Distribution of Shipments
January	4	5.19%	10.82%	8.26%
February	3	3.90	10.69	10.37
March	4	5.19	9.21	8.41
April	5	6.49	9.79	2.39
May	10	12.99	11.96	17.47
June	10	12.99	13.64	12.94
July	8	10.39	12.93	5.57
August	5	6.49	10.69	4.39
September	4	5.19	53.00 2/	2.27 3/
October	10	12.99	10.23	14.65
November	8	10.39	29.48	1.33
December	6	7.79	9.58	11.90

1/ Peak month shipments divided by total shipments per year.
2/ This figure is heavily weighted by one respondent in the electronics industry with 100,000 shipments per year and 30,000 of them in September.
3/ Electronics shipper not included.

of number of shipments. If shipments moved with the same frequency throughout the year, 8.33 percent would move each month. May, the peak month, had 17.47 percent of the shipments, or slightly more than twice the average month.

Airport domestic capacity should be planned for in terms of peak May-December activity. Peak month activity is not expected to exceed twice the average monthly activity (yearly total volume + 12 x 2).

AIR CARGO SHARE OF MARKET AT TEXAS AIRPORT AND PERFORMANCE OF CERTIFICATED CARRIERS SERVING TEXAS AIR CARRIER AIRPORTS

The survey of air carriers serving Texas cities is a key element in the Texas Air Cargo Study. Publicly available statistics by carrier are both useful directly and as a background for interpreting the survey results. This discussion exploits those statistics and makes selected inferences from them. In the following paragraphs, the certificated, scheduled air carrier's share of the competitive markets in Texas is described and analyzed; the air cargo performance of these carriers is explored; and interpretations about carrier's performance at particular stations are assayed.

Share of the Market

Each carrier's share of the cargo market and the change in that share at each station form the basis for the survey design. Table 6-3 shows Fiscal Year 1970 tonnages of freight, express, mail, and total cargo in domestic operations, by carrier, for Texas stations served by more than one certificated scheduled carrier. The shares for FY 1970, as well as for 1965, are shown. Braniff is definitely the leader in the cargo-rich Dallas/Fort Worth market, followed by American. Together they account for 70 percent of this hub. In the dynamic and important Houston cargo market, Eastern has a slight edge on Braniff as leader in total cargo (together they account for 43 percent), but Braniff's rate of growth is more spectacular. Braniff is the clear leader in the San

Table 6-3

CERTIFICATED AIR CARRIERS DOMESTIC TONNAGE
OF ORIGINATED FREIGHT EXPRESS AND MAIL,
FY 1970 AND SHARE OF MARKET FY 1970 AND FY 1965
AT EACH STATION
SERVED BY TWO OR MORE CARRIERS, AND TEXAS TOTALS

		Air Freight			Air Express			Air Mail		
		Tons	Market Share (percent)		Tons	Market Share (percent)		Tons	Market Share (percent)	
Community	Carrier	1970	1970	1965	1970	1970	1965	1970	1970	1965
Dallas/Ft. Worth	--	47,500	100.0%	100.0%	6,694	100.0%	100.0%	28,181	100.0%	100.0%
	AA	15,826	33.3	48.9	1,671	24.9	27.3	5,539	19.6	37.6
	BN	18,920	39.8	31.2	2,195	39.8	33.8	13,365	47.4	34.3
	CO	1,753	3.7	1.4	405	6.0	3.8	1,036	3.7	3.1
	DL	3,631	7.6	6.6	1,097	16.4	20.1	4,792	17.0	14.5
	EA	951	2.0	1.1	180	2.7	7.6	1,030	3.6	.9
	FL	1,300	2.7	(CN) .9	164	2.4	(CN)2.6	616	2.2	(CN)7.7
	OZ	365	.8	0	16	.2	0	66	.2	0
	RD	256	.5	(SI) 3.6	1	--	(SI) .3	80	.3	(SI) .6
	TT	4,497	9.5	6.3	964	14.4	10.5	1,657	5.9	7.9
Houston	--	19,634	100.0	100.0	1,836	100.0	100.0	9,325	100.0	100.0
	AA	1,061	5.4	1.4	76	4.1	.5	247	2.6	.8
	BN	4,186	21.3	14.5	371	20.2	25.9	1,984	21.3	15.8
	CO	2,815	14.3	8.0	276	15.0	14.2	1,172	12.6	12.3
	DL	2,144	10.9	16.8	361	19.7	14.9	2,582	27.7	21.7
	EA	4,597	23.4	27.6	172	9.4	21.9	1,757	18.8	28.8
	NA	1,241	6.3	15.3	137	7.5	8.2	961	10.3	13.3
	RD	1,459	7.4	(SI)11.3	5	(SI) .3	.5	148	1.6	(SI) .2
	TT	2,130	10.8	5.1	438	23.8	13.9	474	3.1	7.1
San Antonio	--	6,817	100.0	100.0	439	100.0	100.0	5,293	100.0	100.0
	AA	1,550	22.7	9.2	21	4.8	.5	620	11.7	.8
	BN	2,347	34.4	54.5	142	32.3	26.7	2,164	40.9	29.1
	CO	1,133	16.6	11.7	96	21.7	21.4	1,135	21.4	30.3
	EA	1,415	20.7	20.5	86	19.6	25.2	1,230	23.2	32.4
	TT	371	5.4	4.1	94	21.4	25.7	143	2.7	7.4
El Paso	--	2,137	100.0	100.0	192	100.0	100.0	1,223	100.0	100.0
	AA	1,180	55.2	59.1	55	28.6	38.6	578	47.3	52.5
	CO	834	39.0	24.4	117	60.9	27.7	605	49.5	32.3
	FL	93	4.3	11.2	17	8.9	17.8	35	2.9	10.6
	TT	29	1.4	5.3	2	1.0	14.9	5	.4	4.6
Amarillo	--	561	100.0	100.0	73	100.0	100.0	547	100.0	100.0
	BN	114	20.3	62.7	7	9.6	30.3	116	21.2	69.1
	CO	76	13.5	5.2	22	30.1	42.4	185	33.8	9.8
	FL	25	4.5	(CN)10.7	5	6.8	(CN)18.2	2	.4	(CN)11.4
	TT	44	7.8	4.3	5	6.8	3.0	34	6.2	.8
	TW	302	54.0	16.7	34	46.6	9.1	210	38.4	8.1
Austin	--	626	100.0	100.0	215	100.0	100.0	1,179	100.0	100.0
	BN	352	56.0	77.0	63	29.3	44.1	995	84.4	46.1
	CO	72	11.5	0	1	.4	0	17	1.4	0
	TT	202	32.3	23.0	151	70.2	55.9	166	14.2	53.9
Beaumont/ Port Arthur	--	312	100.0	100.0	49	100.0	100.0	157	100.0	100.0
	DL	76	24.3	4.1	0	0	4.2	2	1.3	4.1
	TT	236	75.7	34.0	49	100.0	16.7	155	98.7	43.9
	EA	0	0	61.9	0	0	79.2	0	0	52.0
Brownsville/ Harlingen	--	261	100.0	100.0	37	100.0	100.0	96	100.0	100.0
	BN	134	51.3	21.9	7	18.9	1.2	39	40.6	6.1
	TT	127	48.7	38.3	30	81.1	95.3	57	59.4	86.4
	EA	0	0	39.1	0	0	3.1	0	0	7.6

Table 6-3
(Continued)

Community	Carrier	Air Freight Tons 1970	Air Freight Market Share (percent) 1970	Air Freight Market Share (percent) 1965	Air Express Tons 1970	Air Express Market Share (percent) 1970	Air Express Market Share (percent) 1965	Air Mail Tons 1970	Air Mail Market Share (percent) 1970	Air Mail Market Share (percent) 1965
Corpus Christi	--	555	100.0%	100.0%	70	100.0%	100.0%	778	100.0%	100.0%
	BN	329	59.3	58.9	39	55.7	40.7	483	62.0	45.4
	EA	133	24.0	31.1	7	10.0	22.2	107	13.7	35.0
	TT	93	16.7	10.0	24	34.3	37.1	187	24.0	19.6
Lubbock	--	339	100.0	100.0	70	100.0	100.0	385	100.0	100.0
	BN	122	36.0	49.7	36	51.4	35.7	74	19.2	37.0
	CO	187	55.2	24.9	29	41.4	26.2	297	77.1	34.4
	TT	30	8.8	26.0	5	7.1	38.1	14	3.6	27.6
Midland/Odessa	--	639	100.0	100.0	44	100.0	100.0	346	100.0	100.0
	CO	469	74.5	69.9	31	70.4	43.0	328	94.8	85.1
	TT	164	25.5	30.1	13	29.6	57.0	18	5.2	14.9
Wichita Falls	--	209	100.0	100.0	85	100.0	100.0	155	100.0	100.0
	BN	3	1.4	94.5	0	0	76.9	0	0	75.0
	CO	42	20.1	5.5	3	3.5	23.1	9	5.8	25.0
	TT	164	78.5	0	82	96.5	0	146	94.2	0
Texas, Total	Total	--	80,996	44,252	--	10,145	6,308	--	48,200	16,049
Domestic	--	Total	Cargo	(F+E+M)						
Big Four (x 3/4)	AA	28,424	20.4	30.0						
	EA	11,418	8.2	8.9						
	TW	546	.4	.1						
Other Trunks	BN	48,587	34.9	28.6						
	CO	13,145	9.4	6.0						
	DL	14,685	10.5	9.8						
	NA	2,339	1.7	2.9						
Local Service	CN		--	.9						
	FL	2,306	1.6	--						
	OZ	447	.3	0						
	TT	14,992	10.8	9.5						
All Cargo Carriers	SI		--	3.2						
	RD	1,949	1.4	--						
Total Tons			139,341	66,609						

* Abbreviations and carrier names are matched in Exhibit 6-1.

Exhibit 6-1

AIRLINE CODES AND CARRIERS PROVIDING CARGO SERVICE IN TEXAS

Code	Carrier
TT	Texas International Airlines
WY	Aztec Airway, Inc.
BN	Braniff
CO	Continental
FL	Frontier
TW	TWA
RI	Tricon International
XO	Rio Airlines
DL	Delta
HY	Houston
ZK	Davis Airlines
EA	Eastern
AA	American
KG	King
MJ	SMB Stage Lines
OZ	Ozark
RD	Airlift International
AF	Air France
AM	Aeronaves
KL	KLM
NA	National
PA	Pan Am
MX	Mexicana
AT	Royal Air
SI	Slick
CN	Central

Antonio market in cargo originated; it operates the only all-cargo operation into that hub. (If American's service via truck from Dallas could be accounted for, the dominance would be less pronounced.) American is the clear leader in El Paso, although Continental dominates express shipments. Evaluation of the relative importance of individual air carriers in the top markets is facilitated by the data in Table 6-3.

The Texas summary at the end of Table 6-3 presents share of the overall Texas market for cargo as a whole (freight, plus express, plus mail). Braniff is the definite leader in cargo originations as of 1970 and has increased its share at a healthy rate. American dropped from first in 1965 to second in 1970. Texas International, Delta, Continental, and Eastern were all fairly close at between eight and eleven percent of the market. Their shares did not change much over the 1964-1970 period. The all-cargo carriers (Slick in 1965 and Airlift International in 1970) carried a quite small share of Texas cargo. The rather sharp drop 1965-1970 might be partly attributable to the increase in all-cargo operations of the combination carriers.

A total of 13 stations are served by only one airline (Brownwood, Big Spring, Abilene, College Station/Bryan, Galveston, Laredo, Longview/Kilgore/Gladewater, Lufkin, San Angelo, Temple, Tyler, and Victoria by Texas International, and Paris and Borger by Frontier). In addition, Texarkana, Texas, and Hobbs and Carlsbad, New Mexico (airports which serve Texans) are provided scheduled service by Texas International solely.

The level of international cargo originations at Texas gateway hubs is relatively small compared to their total originations. Table 6-4 shows the United States carriers' tonnage and share for FY 1965 and FY 1970 in a manner parallel to Table 6-3. Foreign carriers serving Texas air hubs are KLM and Air France at Houston Intercontinental Airport, and Mexicana at San Antonio International Airport.

Table 6-4

U.S. CERTIFICATED AIR CARRIER INTERNATIONAL TONNAGE
OF ORIGINATED FREIGHT, EXPRESS, AND MAIL, FY 1970 AND FY 1965
AND SHARE OF MARKET AT TEXAS INTERNATIONAL HUBS

Community	Carrier	Freight (tons)	Percent Share of Market	Express (tons)	Percent Share of Market	Mail (tons)	Percent Share of Market
Fiscal Year 1970							
Dallas/Fort Worth	AA	638	100%	10.4	100%	233.3	100%
Houston	BN	301	--	--	--	231.0	--
	PA	944	--	--	--	243.0	--
Total		1,245	--	--	--	474.0	--
San Antonio	AA	585	45	2.4	100	136.0	81
	BN	721	55	--	--	32.0	19
Total		1,306	100%	2.4	100%	168.0	100%
Fiscal Year 1965							
Dallas/Fort Worth	AA	583	100%	17.0	100%	149.0	100%
Houston	BN	150	12	0.0	--	2.0	1
	PA	1,145	88	0.0	--	201.0	99
Total		1,295	100%	0.0	--	203.0	100%

National Performance of Carriers Serving Texas

Selected national air cargo performance measures for Texas market carriers in domestic operations are shown in Table 6-5 along with some Texas comparisons. The ratio of passenger ton-miles to cargo ton-miles (column 5) provides a measure of the relative place of cargo revenues and cargo service in the carriers' operations. The smaller the number, the more important air cargo is; the larger, the less important. This may reflect management priorities but it also, in the case of high values, represents a potential for increasing cargo service. The ratio would reflect fleet mix and route structure also. American displayed the lowest ratio, with Braniff second. Braniff's dominance in the Texas market, together with Texas forming a high proportion of Braniff's market, bodes well for cargo service in Texas.

Only two carriers showed a marked increase in the PTM/CTM factor: Continental and Texas International. In Continental's case, this reflects the relatively higher priority in marketing passenger service which was conveyed in the carrier survey. Because of Continental's importance in the Texas market, the potential for increasing service is worth noting. Eastern showed an 18 percent decrease from 1965 to 1970 but remains the highest of the trunks. The local service carriers show higher ratios than the trunks in all cases; the higher costs per ton-mile and fleet mix and route structure indicate that this difference will prevail for some time.

Each carrier's cargo originations in Texas as a percentage of domestic cargo originations are shown in column 6. Texas International, as would be expected, is most strongly dependent on the Texas market. Its significant decrease from 1965 to 1970 reflects a growing network and a capability of broader service to Texas. As stated above, Braniff shows a strong dependence which has grown over the five-year period. Continental is significantly dependent and growing.

Table 6-5

SELECTED DOMESTIC AIR CARGO PERFORMANCE MEASURES OF CERTIFICATED SCHEDULED AIR CARRIERS SERVING TEXAS STATIONS IN 1970, WITH SOME TEXAS COMPARISONS

Code	Airline	Year	Passenger Ton Miles (millions)	Cargo Ton Miles (millions)	PTM/CTM	Texas as Percent of Carriers Market	Load Factor: Revenue Passenger	Load Factor: Overall Revenue	ORLF/RPLF	Total Air Cargo Tons in Texas	Tons Cargo per Thousand Passengers: Nationally	Tons Cargo per Thousand Passengers: Texas
AA	American	1965	859.3	304.9	2.8	8.4%	58.8	49.0	.83	19,971	22.5	21.3
		1970	1,623.3	565.5	2.9	6.7	50.9	41.4	.81	28,424	21.7	14.6
EA	Eastern	1965	638.0	82.1	7.8	5.6	56.2	46.7	.83	5,910	8.3	17.0
		1970	1,164.9	182.1	6.4	4.9	53.0	44.6	.80	11,418	11.7	22.8
TW	TWA	1965	721.2	193.1	3.7	*	53.7	42.5	.79	52	17.7	1.8
		1970	1,239.6	350.8	3.5	.1	45.7	37.4	.82	546	24.0	11.5
BN	Braniff	1965	150.2	31.1	4.8	27.3	54.7	48.7	.89	19,081	15.0	11.6
		1970	337.6	85.8	3.9	32.0	46.4	41.5	.91	48,587	22.5	16.0
CO	Continental	1965	131.7	29.2	4.6	14.5	52.2	41.4	.79	4,013	14.2	6.6
		1970	443.4	80.3	5.5	19.7	51.2	40.6	.79	13,145	14.0	9.2
DL	Delta	1965	400.9	77.6	5.1	8.0	58.6	50.2	.86	6,541	9.9	10.7
		1970	958.0	209.1	4.6	6.8	49.2	44.3	.90	14,685	13.8	11.1
NA	National	1965	253.0	36.6	6.8	5.2	52.5	41.1	.78	1,931	11.3	13.3
		1970	254.9	46.7	5.4	5.4	37.4	33.3	.89	2,339	11.9	12.7
FL	Frontier	1965	20.6	2.5	8.2	11.7	39.9	38.3	.99	584*	9.6	
		1970	102.3	12.3	8.3	7.4	43.8	38.8	.89	2,306	9.3	13.6
OZ	Ozark	1965	21.8	2.4	9.1	0	53.6	56.1	1.05	0	11.2	-
		1970	65.3	9.6	6.8	1.9	43.4	46.9	1.08	447	14.5	9.5
TT	Texas International	1965	19.9	2.0	10.0	77.3	41.1	41.3	1.00	6,359	9.8	9.9
		1970	66.0	6.0	11.0	65.5	43.0	36.2	.84	14,992	10.5	9.8
SI	Slick International	1965	--	--	--	11.1	--	57.8	--	2,133		
RD	Airlift International	1970	--	28.4	--	5.9	--	39.5	--	1,949		

*Central

Source: Civil Aeronautics Board, Handbook of Airline Statistics, 1969 edition, Washington, D.C., February 1970.
______________, Air Carrier Traffic Statistics, December 1971.
______________, and Federal Aviation Administration, Airport Activity Statistics.

The official statistics do not publish a cargo specific load factor except for all-cargo operations (revenue ton-miles carried to available ton-miles). They do publish revenue passenger load factors (as in column 7) and overall load factors (column 8). The ratio between these (column 9) is intended to show whether cargo load factors exceed passenger (greater than one) or vice versa (less than one). For all the trunks, the value was less than one, indicating a greater potential to expand cargo service than passenger service with present flow. For Braniff and Delta, the ratio is about 90 percent, compared to approximately 80 percent for the other trunks. American's ratio would have been higher if not for its all-cargo load factor which dropped from 58 to 45 percent in 1970.[1/] Again, this indicates a favorable cargo performance by Braniff and Delta (in a survey interview in Houston, Mr. Wells indicated Delta's relatively high importance placed on cargo revenues). The local service carriers show high ratios but in 1970 have low passenger load factors.

Tons of cargo per thousand passengers give insights at a gross level of the reserve capacity for cargo carriage. The factor is parallel to the PTM/CTM factor, but state and station comparisons are possible with the former. National (column 11) and Texas (column 12) cargo per thousand passengers are shown for each of the carriers. TWA displays the highest value nationally, yet their overall load factor is the second lowest of the trunks. This would indicate that values as high as 50 tons per thousand passengers would be feasible. Of course, this would depend on fleet mix with particular focus on the proportion of all-cargo capacity. Braniff again shows as a good cargo performer with the largest increase in tons per passenger (followed closely by TWA in gain). Of the trunks, only Continental showed a decline nationally (reflecting their relatively higher passenger priority weighting); however, Continental showed a respectable increase in Texas. Eastern displays the lowest ratio nationally but remarkably, has the highest in Texas. The two lowest ratios in 1970 were generated by local carriers, but Ozark was on a par with Continental.

1/ Civil Aeronautics Board source.

In fiscal year 1970, Texas generated 13.9 tons of cargo per thousand enplaned passengers, compared to 17.4 for the United States as a whole. As alluded to above, only Eastern carried in excess of the national average, and only Eastern, National, and Ozark carried at higher cargo per passenger ratios in Texas than they did nationally. This indicates that, in the aggregate, Texas is not capacity limited, and its potential "reserve capacity" is greater than that nationally. However, the rate of growth in this factor (1965-1970) is higher (seven percent in five years) compared to the United States (five percent).

Calculations were made on cargo to passenger ratios by carrier and in total at each Texas station for fiscal years 1965 and 1970. The stations showing 1970 ratios of cargo to passengers in excess of Texas's 1970 ratio are:

	1970	1965	Percent Change 1965-1970
Texarkana	32.2	21.8	48%
Longview/Kilgore/Gladewater	20.9	10.5	99%
Laredo	19.3	15.2	27%
Temple	16.8	5.3	217%
College Station	16.2	5.8	180%
San Antonio	16.1	14.6	10%
Dallas/Fort Worth	15.8	16.5	-4%
Lufkin	15.0	15.5	-3%
Houston	14.2	11.6	23%

Of course, the small amount of either cargo or passenger traffic in the smaller stations can yield wide swings in this ratio. Nonetheless, the Texarkana value is unusually high. The top three are all higher than the United States average. Temple and College Station show similar performance as well as growth (the two fastest, in this regard) and, in both cases, the growth in the ratio seems to be due almost entirely to low growth in passengers, and, hence, poor passenger load factor. The top three air cargo producers are all above Texas's average in cargo production per passenger, with San Antonio highest in 1970. Houston increased over the five-year period at a strong rate, whereas Dallas declined. Eastern's cargo per thousand passengers was 28.3 in Houston which accounts for its high ratio in the State. This was due to a 10 percent decline in passengers from 1965 to 1970.

Austin (340 percent), Wichita Falls (285 percent), and Amarillo (200 percent) topped the five-year growth rate in cargo from 1965 to 1970, at a time when the State was growing by 110 percent. All three display low (seven-eight) cargo tons per thousand passengers. Austin's growth appears to have been from electronics and government factors and from Braniff's promotions (they showed a 480 percent growth there). Introduction of Texas International service into Wichita Falls seems to have been the stimulating factor there. In Amarillo, where TWA's cargo production was very low (1962-1966), running at around two tons per thousand passengers, it appears that TWA (showing over a 2,000 percent cargo growth) may have stimulated cargo production with rates and service.

ALL-CARGO OPERATIONS AT TEXAS HUBS AND THEIR FORECASTS

One way in which air cargo growth influences airport operations and planning is to generate all-cargo aircraft operations at critical thresholds. Separate cargo operations call for rational planning of land use, terminal area configuration, and specialized cargo access. Because of the different timing of all-cargo operations, the airport management and the community must come to grips with noise intrusion on adjacent communities. Complementarily, all-cargo operations are off-peak, and knowledge of that component of total operations aids peak period planning. Longer range considerations of the feasibility of all-cargo airports will depend on some critical level of all-cargo operations.

This section provides a forecast of the number of all-cargo operations at Texas large and medium hubs. This is based on the development of methodology which relates all-cargo operations to cargo and passenger histories, and is described below.

Methodology

At present, three Texas hubs have scheduled all-cargo service. Tables 6-6 and 6-7 show the services as of June 1971, December 1970, and May 1972. San Antonio and Houston's cargo service is supplemented by American Airlines' "expedited" truck delivery from Dallas for early morning workday delivery.

Figure 6-1 shows the curve derived from the joint analysis of cargo originations to passenger enplanements (in domestic service, fiscal year 1970) on the one hand and the ratio of scheduled all-cargo operations to total departures performed (also domestic service, fiscal year 1970) on the other hand.

The horizontal axis shows the ratio of all-cargo flights to passenger enplanements; the vertical axis the ratio of scheduled operations to total scheduled departures. The observations are selected major hubs plus San Antonio. The curve was fitted (with a banded area)

Table 6-6

ALL-CARGO SERVICE TO DALLAS-FT. WORTH, HOUSTON, AND SAN ANTONIO
BY CARRIER AND BY AIRCRAFT TYPE
June 1971 and December 1970

	June 1971			December 1970		
Hub/Carrier	A/C Type	Flights per Week	Direct Service With:	A/C Type	Flights per Week	Direct Service With:
Dallas-Fort Worth						
American	B-707300C	37	CHI, DET, NYC, CLE CINCI, MEMPH, LAK, SF/O, OK CITY	B-707300C	27	BOS, NYC, CLE, CINC, MEMPH, MILW
Braniff	B727QC	25	CHI, HOU, NYC, SAT	B727QC/100C	50	HOU, CHI, WICHITA, KC, NYC, CHI
Delta	L-100	10	NEW ORL, ATL, CHARLOTTE, NYC, LAX, SFO	L382	16	N. O., ATL, CHAR, NYC, LAX, SFO
Airlift International			LAX, SFO	B707300C	5	HOU, LAX, MIAMI
Houston						
Eastern	727QC	10	PHI, NYC, BOS, NEW ORLEANS, ATL	B727QC/	5	PHILA, ATL, N. O., NYC
Airlift International				B700/300C	5	LAX, D/FW, MIAMI
Braniff	727QC	5	CHI, D/FW	B727QC	5	D/FW, CHI, KC, WICHITA, NYC
San Antonio						
Braniff	727QC	5	CHI, D/FW	B727QC	5	CHI, D/FW

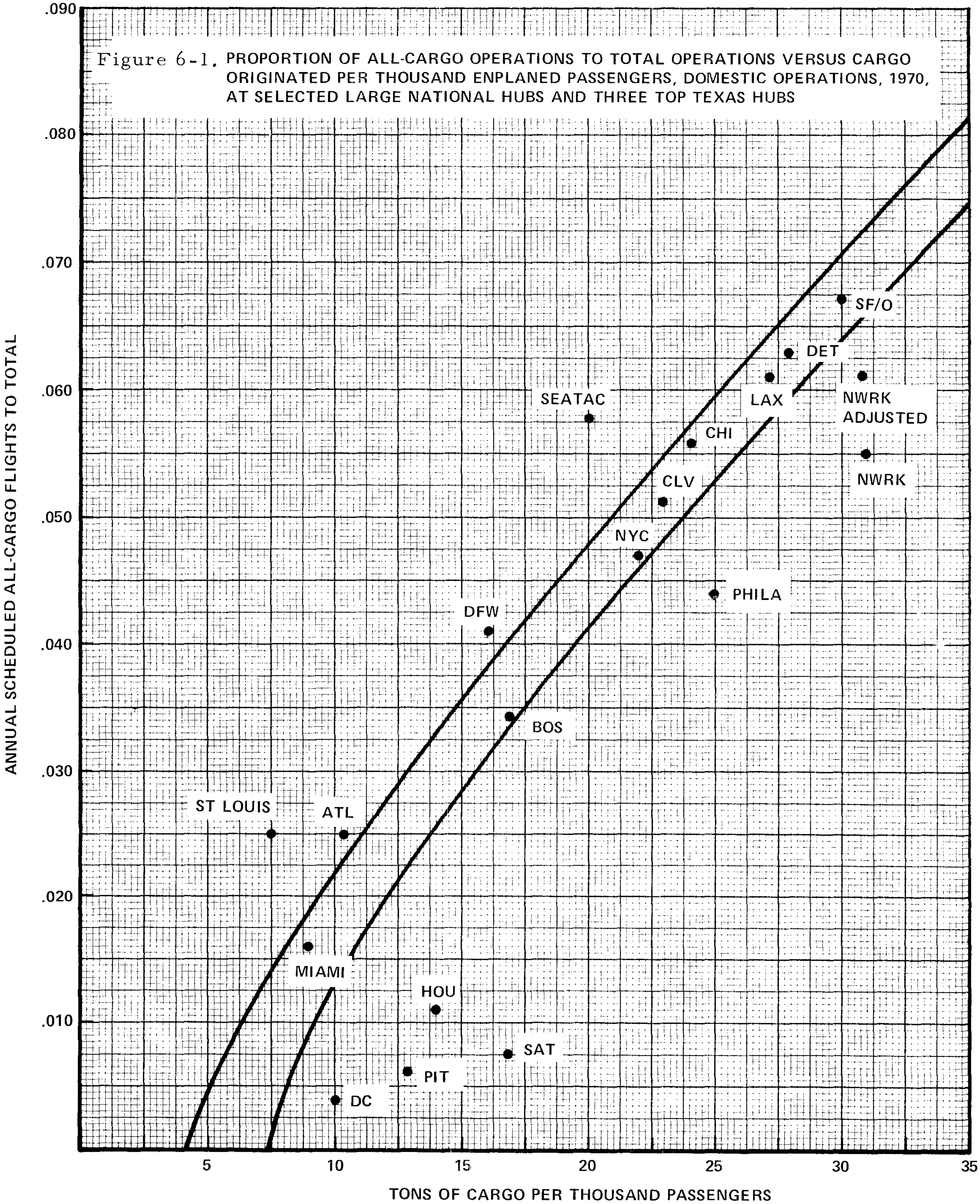
Source: Reuben H. Donnelley Corp., Air Cargo Guide, June 1971; and Air Cargo, January 1970.

Table 6-7

ALL CARGO SERVICE FROM DALLAS-FT. WORTH, HOUSTON, AND SAN ANTONIO
BY CARRIER AND BY AIRCRAFT TYPE
May 1972

Airline	Origin	Destinations	Equipment	Frequency of Service
Braniff	Dallas	New York	B727	Tuesday - Saturday
		New York	B727	Monday - Friday
		San Antonio	B727	Tuesday - Saturday
		Chicago	B727	Monday - Friday
		Houston	B727	Tuesday - Saturday
American	Dallas	Nashville, New York	B707F	Saturday
		Cleveland, New York	B707F	Monday - Friday
		Los Angeles, San Fran.	B707F	Saturday, Sunday
		Los Angeles, San Fran.	B707F	Tuesday - Saturday
		Chicago, Los Angeles	B707F	Monday - Friday
Delta	Dallas	Atlanta	L-100	Tuesday - Saturday
		San Francisco	L-100	Tuesday - Saturday
Braniff	Houston	Dallas, Chicago	B727	Monday - Friday
Eastern	Houston	New Orleans, Atlanta, New York, Boston	B727	Monday - Friday
		New York, Boston	B727	Monday - Friday
Airlift International	Houston	New York	B727	Tuesday - Saturday
		Miami, New York	DC8S	Monday - Friday
Braniff	San Antonio	Dallas, New York	B727	Tuesday - Saturday

Source: Reuben H. Donnelley Corp., Air Cargo Guide, May 1972.



SOURCES: AIRPORT ACTIVITY STATISTICS, FY 1970 AIR CARGO, AND AIR CARGO GUIDE.

visually and without statistical sophistication. Most observers would ascribe, intuitively, an excellent correlation between the two factors. Indeed this relationship might be expected, a priori, since the ratio contains cargo on passenger aircraft and cargo on all-cargo craft in the numerator but only passengers on passenger aircraft in the denominator. In a real world sense, the relationship is a functional one, since critical cargo densities in passenger craft cargo compartments require augmentation by all-cargo operations. The forecasts of the proportion of operations at the top four Texas hubs rest on the validity of this functional relationship.

Forecasts

Forecasts unadjusted for the growing population of wide bodied jets are given in Table 6-8. They are based on the forecasts of cargo to passenger ratios that were based on interim share-of-market forecasts. (The forecast herein should be adjusted for final passenger forecasts.) The functional relationship described by the banded curve in Figure 6-1 implies that, on the approximate average a gain of one percent in cargo tons per thousand passengers, at hubs above some critical cargo traffic thresholds, results in a 1.08 percent gain in the ratio of all-cargo to total operations.

One of the most significant observations from Figure 6-1 vis-à-vis Texas hubs is that both Houston and San Antonio appear to have lower levels of all-cargo service than would be warranted by the experience of the selected major hubs. Also, Dallas/Fort Worth appears to have a somewhat higher level of service. San Antonio's relative departure from the functional path is in part due to the truck service mentioned above. That is, they have an implicit cargo service not reflected in the all-cargo scheduled flights. Total volume of traffic may also weigh in the factor.

Houston, on the other hand, appears to be underscheduled as of 1970. Around 2.5 percent of departures in all-cargo operations would have been warranted by the major hub experience. Actually, only about one percent were in such service. Service in June 1971 (Air Cargo Guide)

Table 6-8

UNADJUSTED FORECASTS OF PERCENT
OF SCHEDULED CERTIFICATED OPERATIONS
THAT ARE ALL-CARGO OPERATIONS
AT TOP FOUR TEXAS HUBS
1975-1990

	Percent All-Cargo Operations to Total Departures			
Year	Dallas-Fort Worth	Houston	San Antonio	El Paso
1975	4.5%	5.2%	4.8%	*
1980	5.5	6.7	6.2	1.0%
1985	6.2	7.3	7.1	1.7
1990	7.5	9.3	8.9	2.5

* Probably insufficient cargo volume to warrant all-cargo service.

showed 15 flights weekly, no change from December 1970. American has an "expedited truck service" to Houston as well as San Antonio which may explain a part of the deviation. Currently, Airlift International is serving Houston with five flights per week (DC8F). It has dropped its Dallas service. This brings the two cities more in line and confirms the hypothesis.

Dallas/Fort Worth lies slightly above the curve indicating a seemingly relative excess of service. The position of Dallas/Fort Worth may be influenced by Braniff scheduling which is influenced by headquarters location. More importantly, however, is that the deplaning cargo at Dallas/Fort Worth exceeds enplaning by a significant margin. Love Field is also a connecting point (See also note above on Airlift International).

The excess of deplaning over enplaning cargo is also evident at other Texas hubs. If the curve had been calibrated on total cargo or cargo in the dominant direction, Houston and San Antonio probably would have appeared even more underserviced.

Export-Import Seasonality

Seasonality, i.e., variations in export-import weight (millions of pounds) and value (dollars per pound), was also studied. Figures 6-2 and 6-3 examine variations in weight of airborne trade for, respectively, Texas exports and imports. Monthly (along the horizontal scale, J = January, F = February, etc.) data for three years - 1964, 1967, and 1970 - are connected to give year profiles. There is no definite export pattern: high and low points are mixed throughout the year. Regarding imports, there are - to some extent - peaks in summer (July) and winter (October or November) with a valley in between (August).

Figures 6-4 and 6-5 show seasonality for average values of exports and imports of Texas. For exports, the high is observed in summer (June or July) with the rest of the year at a lower, steady level, with the exception of March 1970. The import picture is marred by 1970, when any seasonal trend was overshadowed by marked month-to-month changes; the 1964 and 1967 lines provide no definite highs and/or lows.

Figure 6-2

EXPORTS - WEIGHT:
TEXAS SEASONALITY

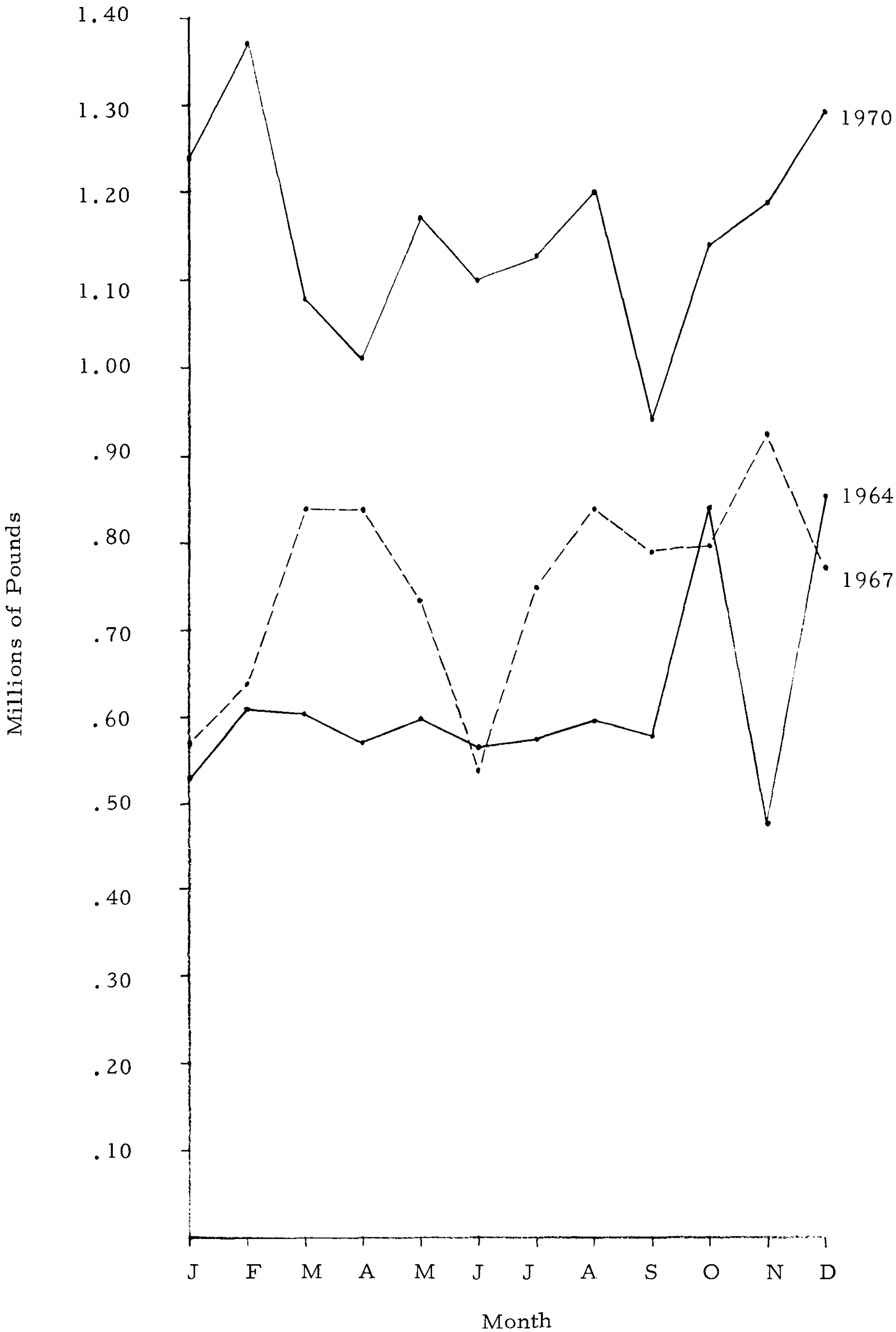


Figure 6-3

IMPORTS - WEIGHT:
TEXAS SEASONALITY

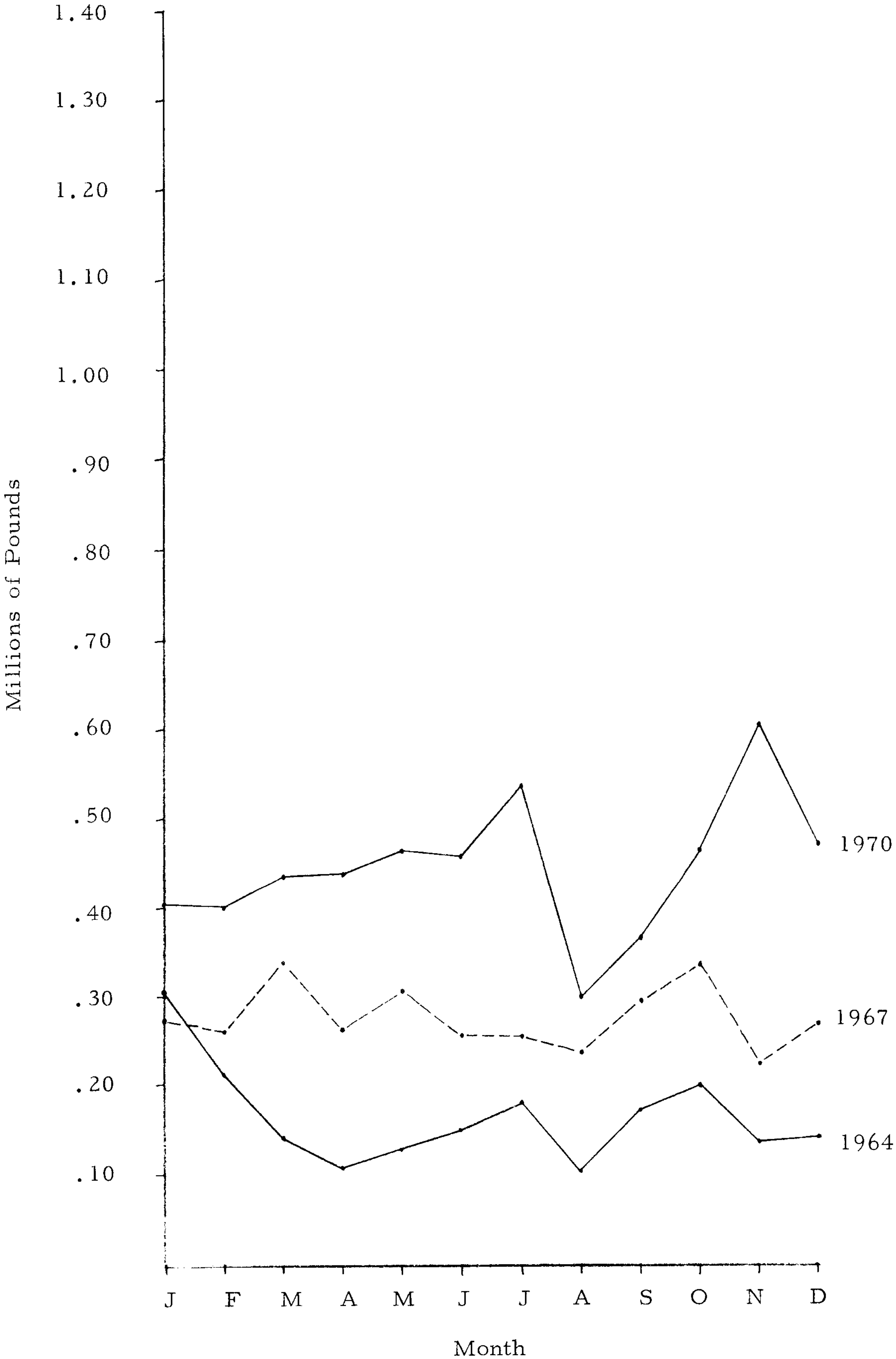


Figure 6-4

EXPORTS - VALUE:
TEXAS SEASONALITY

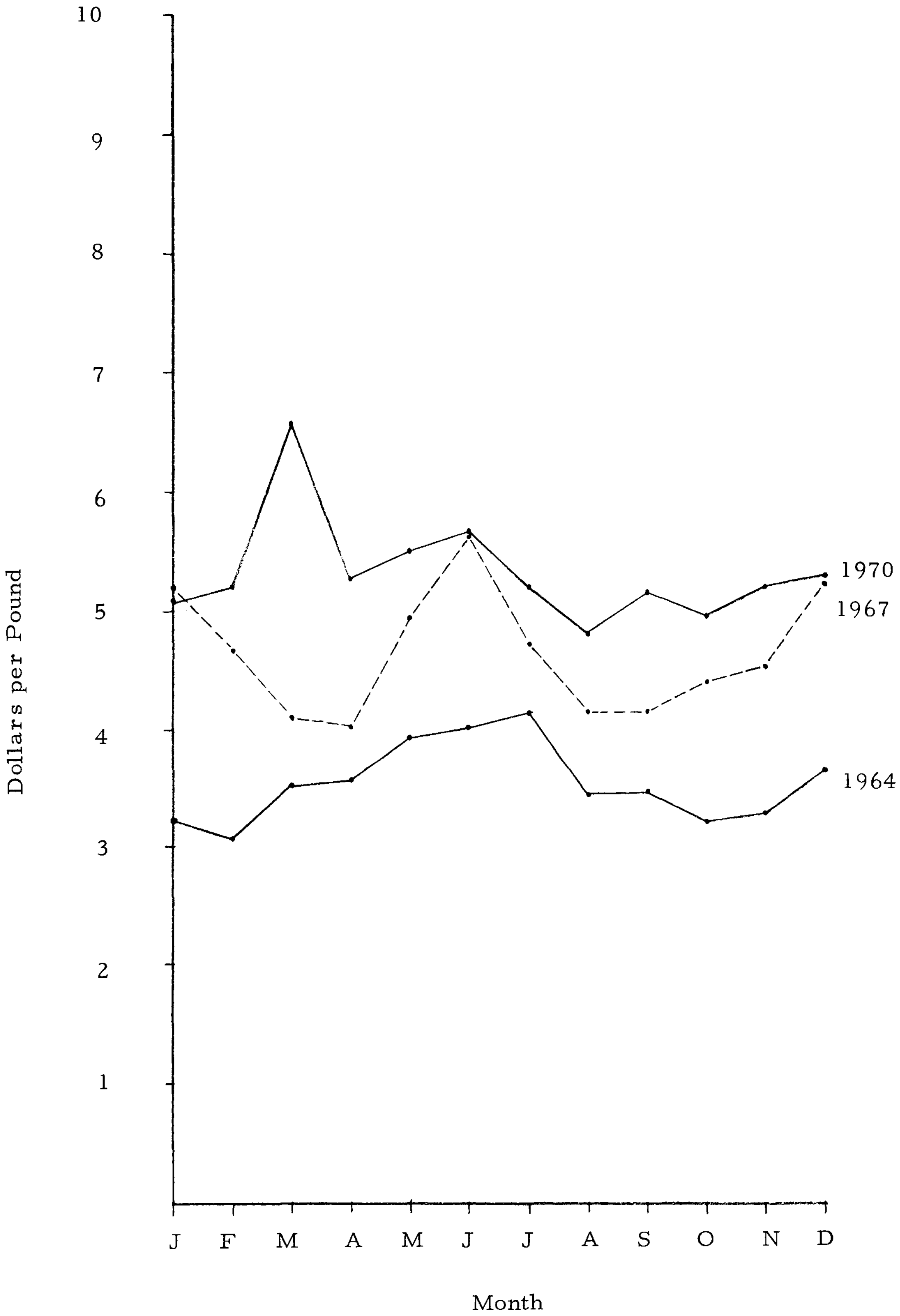
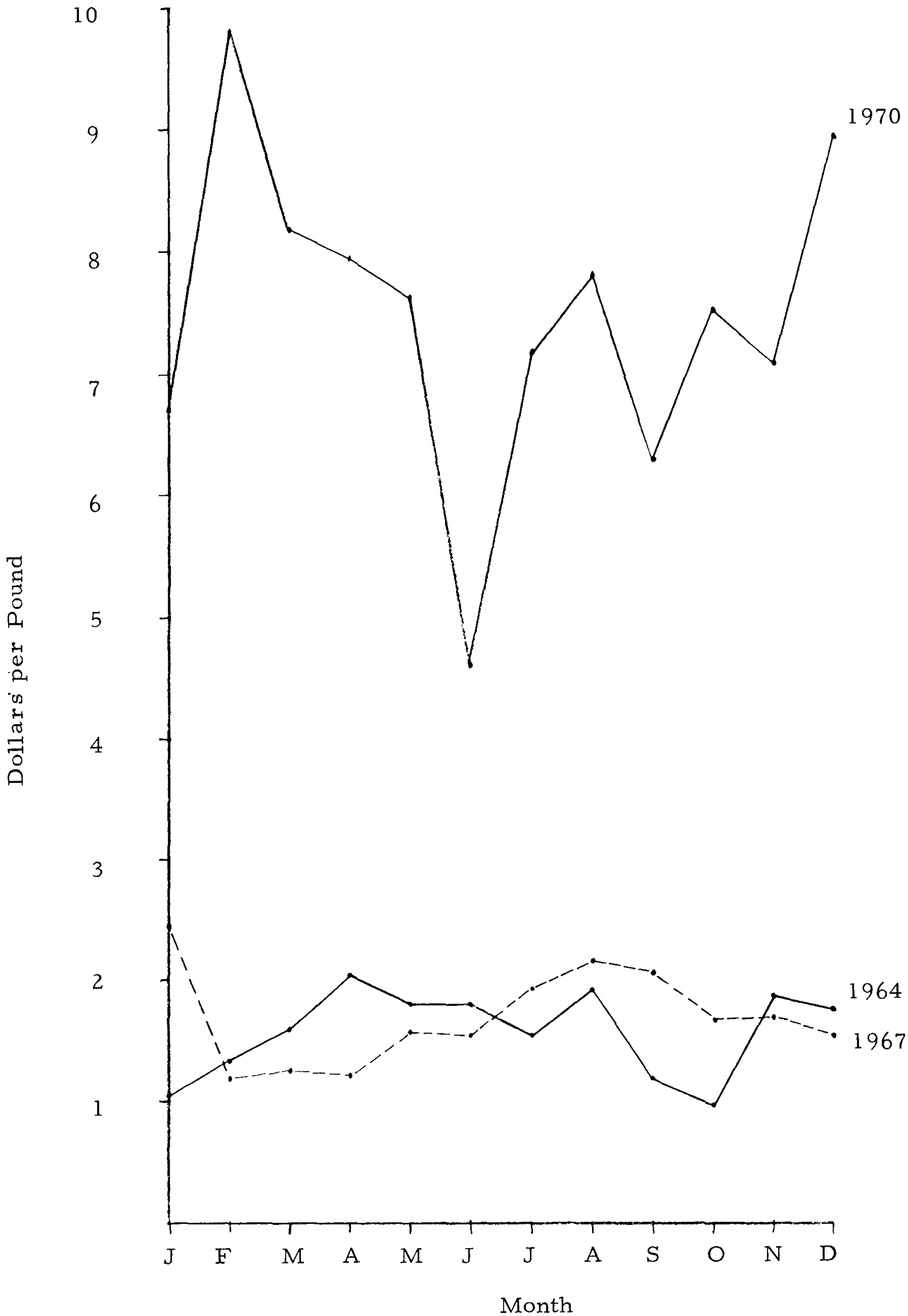


Figure 6-5

IMPORTS - VALUE:
TEXAS SEASONALITY



Given the inconclusive results of the seasonality graphs (Figures 6-2 - 6-5), more extensive analysis was undertaken. Before covering that final phase, the variations in average import value recorded at the Houston Customs District since 1969 will be examined. In Figure 6-6, the solid line connects actual monthly values, whereas the dashed line is the series of three-month moving averages (e.g., the July 1969 value = average of June, July, and August 1969). While the moving average modulates the month-to-month jumps, such changes are still quite significant. There is no apparent seasonal variation here, either; example: in 1969 summer import values were the highest of the year; in 1970 they were the lowest. Finally, it is seen that the value line is gradually increasing, with less drastic random (month-to-month) variation as time goes by.

To derive the more comprehensive profile of Texas seasonality, all monthly data since 1964 - with the exception of aforementioned import value figures since 1969 - for the four basic parameters of Figures 6-2 - 6-5 (i.e., export weight, import weight; export value, import value) were utilized. For each month of a year, a ratio of its activity to the yearly average was taken (e.g., May 1968 export value of \$5.92 versus year 1968 average of \$5.20 yields ratio = 5.92/5.20 = 1.14). Then, the set of ratios over the 1964-1970 period were averaged to give an overall monthly figure (e.g., for May, export value ratios of 1.02, 1.08, 1.04, 0.98, 1.14, 1.07, 1.09 for years 1964 through 1970 give an average of 1.06). The results, for weight and value, respectively, are seen in Figure 6-7. For clarity, in Figure 6-7, corresponding three-month moving averages were computed and graphed.

One may notice first, from Figure 6-8, that export (solid line) variations, both in terms of weight and value, are less erratic than those of imports. Looking at the weight lines (top graph), export activity in the six months between November-April is definitely higher than in the other six months between May-October. Import weight fluctuates more, with four-month cycles: low activity in January-April, average activity in May-August, and high activity in September-December. With regard to value (bottom graph), exports are fairly constant, though

Figure 6-6

IMPORTS - VALUE:
HOUSTON SEASONALITY

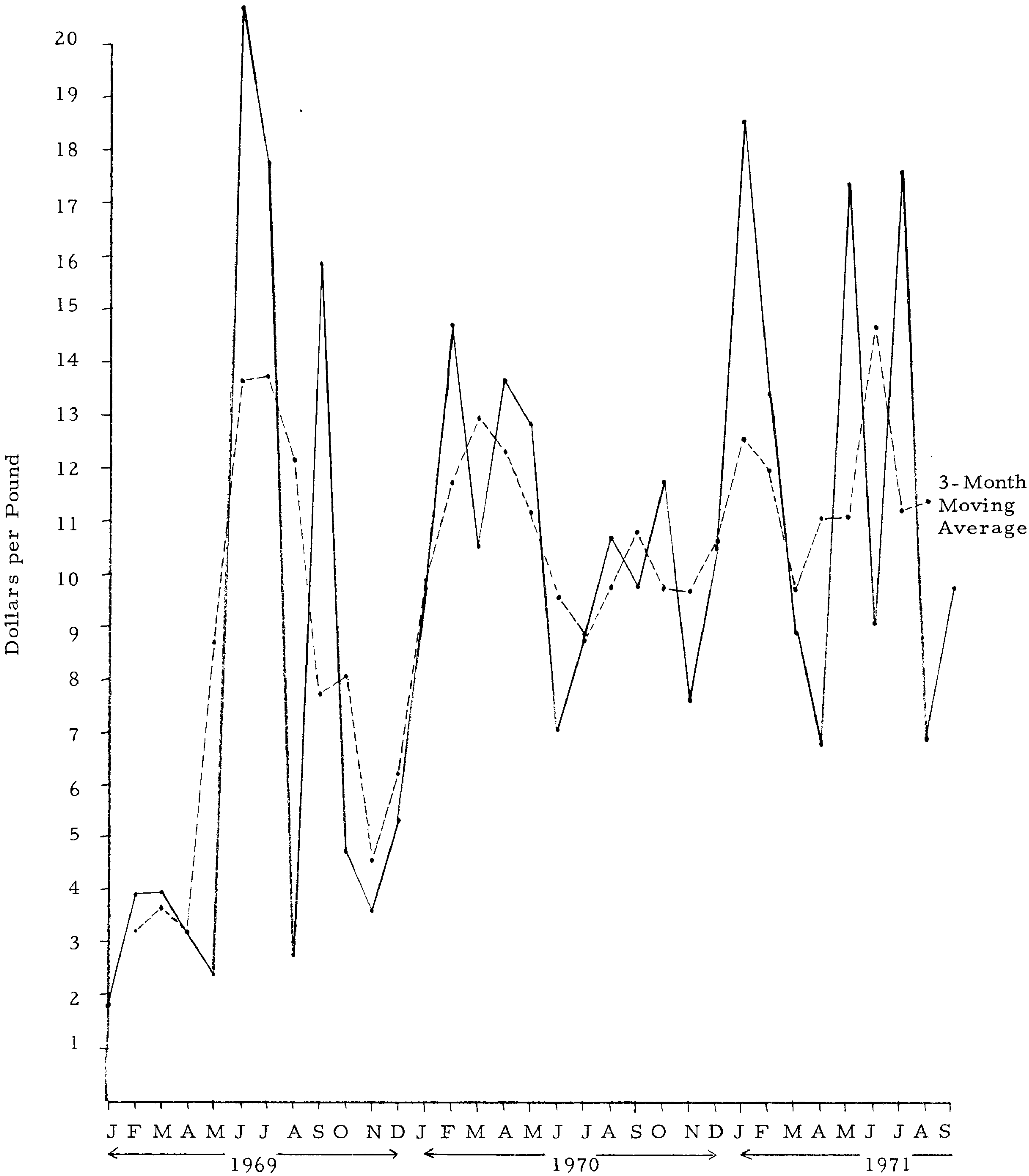


Figure 6-7

WEIGHT AND VALUE:
TEXAS SEASONALITY

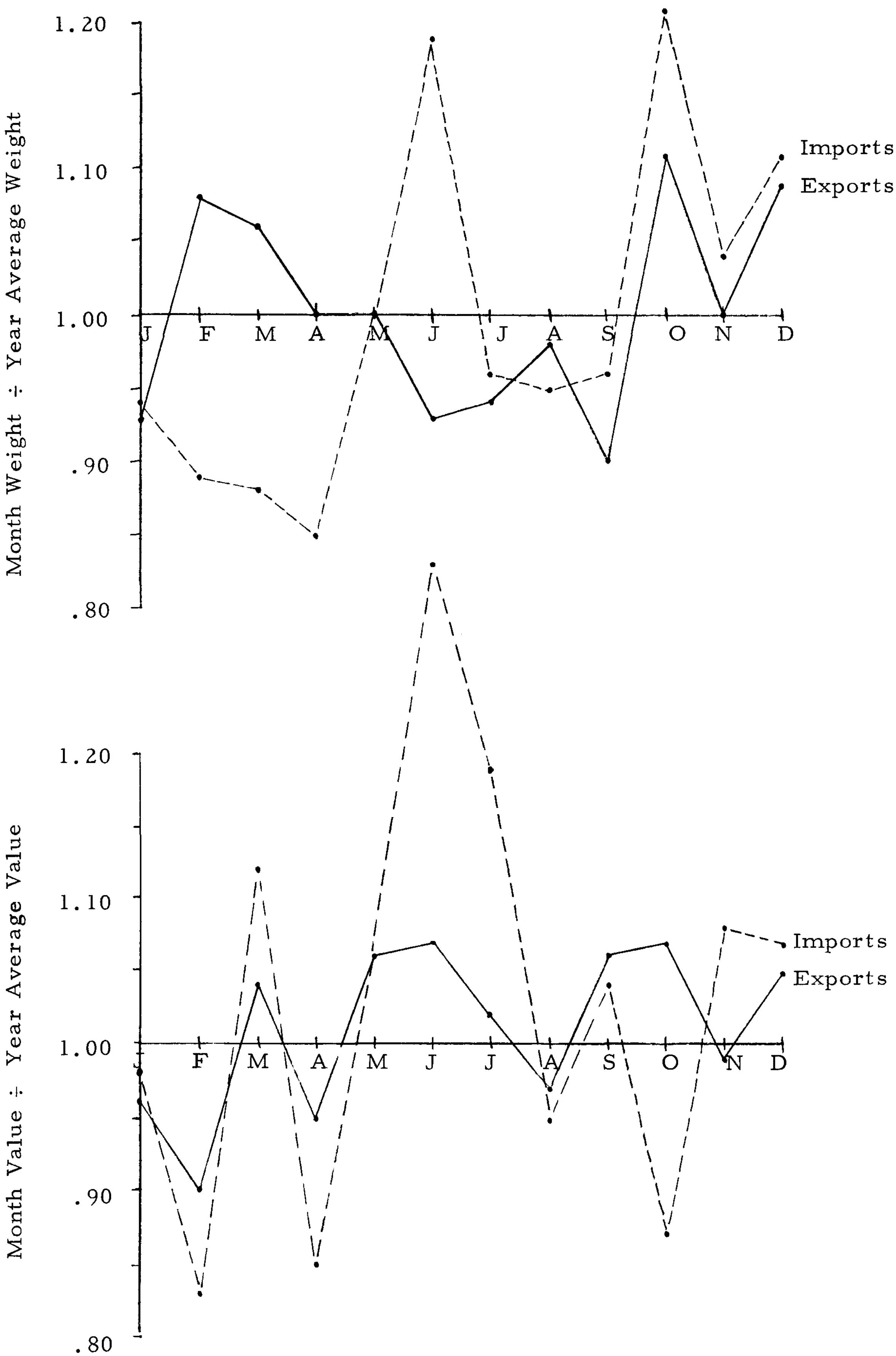
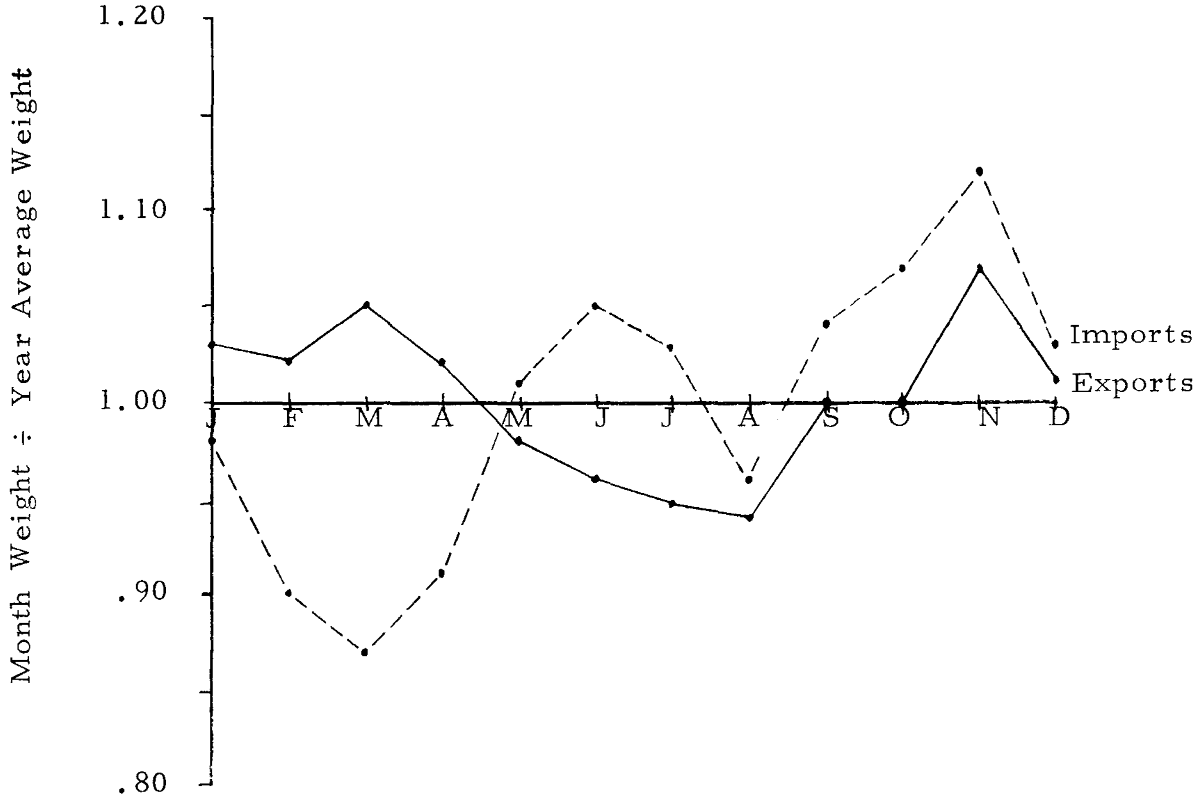
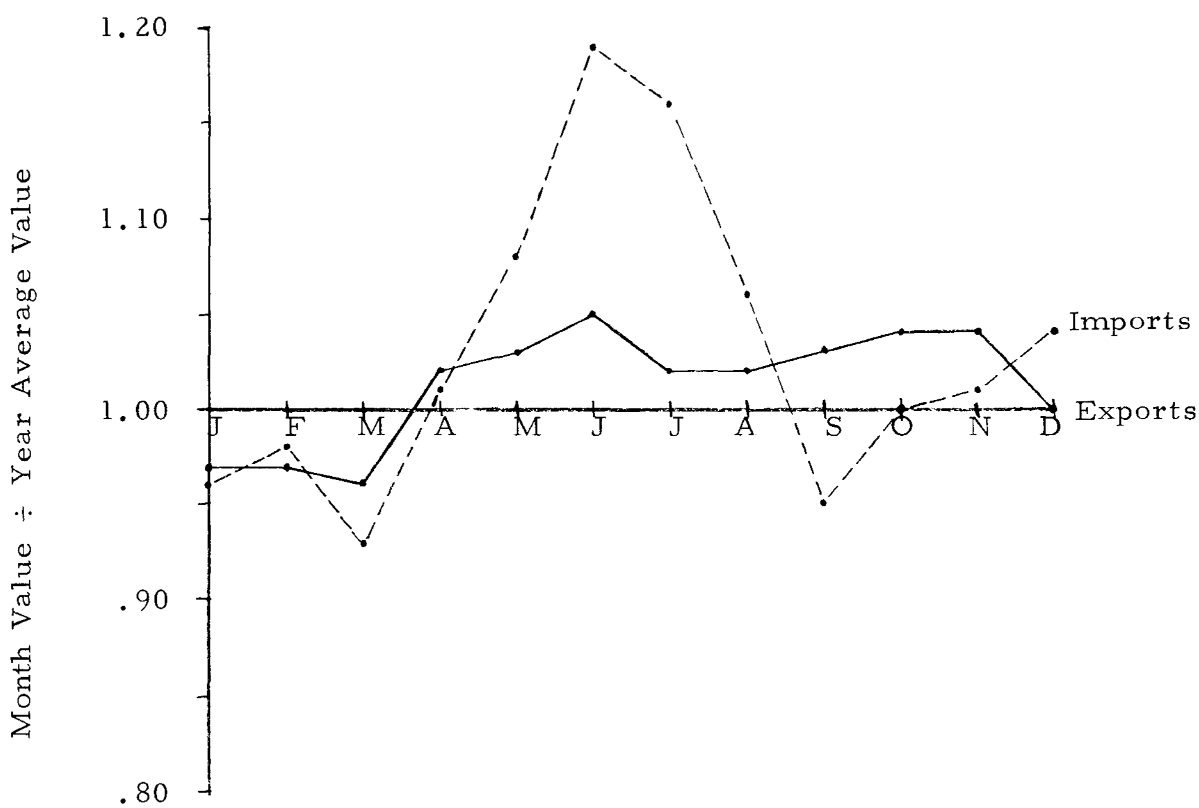


Figure 6-8

WEIGHT AND VALUE:
TEXAS SEASONALITY - 3 MONTH MOVING AVERAGES





December-March is lower than the remainder of the year. The import value line exhibits another four-month cycle: very high May-August figures preceded and followed by periods of low-to-average valuation.

Profiles such as Figure 6-8 and their underlying cycles are of use for forecasting air cargo-handling needs as well as general economic fluctuations. Examples: total export-import capacity should be planned for in terms of peak October-December activity, and security must be especially effective in May-August when the highest value imports (and exports) are being shipped.

Seasonality Induced Peaking

No general peaking problems were encountered. However, in isolated cases peaking is a major problem to some shippers. The shipment of live blue crabs through Houston Intercontinental Airport is a prime example of seasonality-induced peaking.

Delta Airlines expects to handle approximately 9,000 pounds of live and 2,000 pounds of processed crab per day, or about a quarter million pounds per month, to Baltimore during the May-September peak.[1/] Shipments of live crabs have increased to the extent that cargo space is a major constraint to air shipments Delta currently must allocate space to Houston area shippers.

Live crabs are an extremely perishable item and air cargo provides the opportunity to penetrate distant markets. Prior to enplaning, the crabs are cooled to 45 degrees to reduce death losses. This process also makes the crabs easier to handle. Crabs cannot survive when the temperature reaches 80 degrees. These critical factors make air cargo the only alternative for long distance shipments.

When moving live crabs by air, time is of the essence. The success of the operation entails cooperation and coordination of both the pickup and delivery aspects of the shipment. A minimum amount of surface transportation time will add to the success of the venture. Live crabs should be transferred immediately to refrigerated trucks for distribution after arrival at the destination airport.

1/ Jet Cargo News, May 11, 1972.

In 1970, 5.5 million pounds of crabs were landed on the Texas coast with a value of more than $500,000. Figure 6-9 shows the monthly average landing at Texas points. Although crabs are harvested monthly, the period between May and September represents the peak of activity. Crabs are caught from the Sabine Lake area to Baffin Bay, but more than one-third the total catch is from Trinity and Galveston Bays. Approximately 63 percent of the blue crab catch is within 125 miles of Houston Intercontinental Airport.

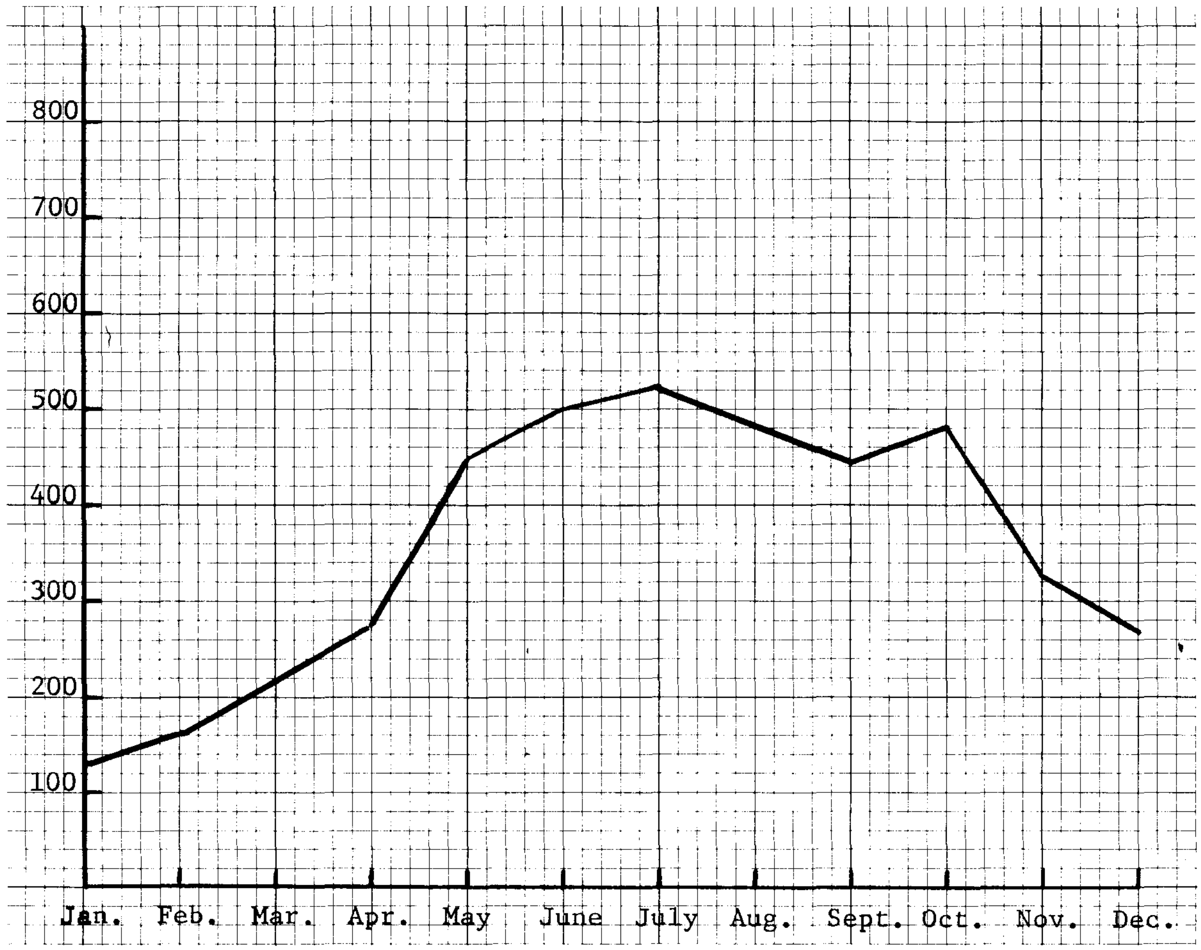
Peaking and Service Considerations

Uniformly, peaking is not a problem; however, underutilization of present freight capacity was mentioned by several cargo managers as a problem. This situation is expected to continue and, with the continued introduction of wide bodied jets, a large "chunk" of additional capacity will be introduced. One airline in Dallas mentioned that inbound capacity from the Northeast occasionally results in shipment delay. Another airline in Houston mentioned that seasonal outbound shipments of seafood and decorative greens occasionally caused minor delays. Based on the airline interviews, there is no shortage of outbound capacity at any Texas airport. There may, on occasion, be under capacity for inbound freight out of the Northeast. This is a balance of traffic situation that can be economically corrected only by increasing outbound cargo relative to inbound cargo.

There are indications of service, equipment, and scheduling deficiencies at some Texas airports that may well be caused by meeting a peaking problem at another location. Comments received as part of the manufacturers' survey indicate that service to the smaller airports is not always adequate from the shipper's point of view. The volume of traffic available at these airports (see next section) does not support service levels comparable to the major hubs. Specific comments relating to peaking and peak induced service deficiencies were:

Figure 6-9

TEXAS CRAB LANDINGS BY MONTHS
(5-Year Average, 1966-1970)



Source: The Coastal Fisheries of Texas, Page 9.

- Inadequate service at Big Spring due to schedules and aircraft size limit shipments by air.
- Use of air freight has been disappointing as it is always more expensive and no faster than other means of shipping. All gain in speed is lost trying to get a shipment from Houston or Dallas to Bryan.
- Most shipping damage and delay due to transfer to other airlines required on approximately 75 percent of destinations of our equipment other than southwest region.
- General air cargo service in the Dallas area is good. It is likely that costs will increase and door-to-door service decline slightly when airlines begin scheduling flights into Dallas/Fort Worth Regional Airport. Transit times and expense to and from Dallas/Fort Worth will be a concern to our company. While no diversion of traffic would be anticipated, this move will be reflected in overall transportation efficiency.
- Shipments delayed at terminal due to size, lack of space, etc., and shipments "bumped" along route for same reasons.
- During 1970, Brownsville was served for the majority of the year with only one commercial airline flight which left Brownsville in the early afternoon. This meant that the majority of our air shipments were held at the airport from 15 to 20 hours.
- Principal complaint: Air cargo bumped due to higher priority of mail.
- We have had to employ an Air Contract Hauler because:
    1. Limited destinations of Air Cargo Service.
    2. Lack of dependability of scheduled airlines to load freight the first available departing flight.
    3. Scheduled airlines do not service all of the locations to which we deliver.

- Airlines should adopt a policy of confirming available space for air freight when given sufficient time and specifications.
- Domestic air shipments delivered to the airline on a "space available" basis are usually delayed at origin from 24 to 48 hours. The "reserved air space" and "package express" innovations of recent origin alleviate this problem, but, not many shippers have the personnel to utilize these services as they require time and some training of shipper employees to be effective.

Load Factors

Eastern Airlines was the only carrier able to furnish load factors from Texas airports by route (Exhibit 6-2). System cargo load factors were between 30 and 40 percent for outbound combination aircraft. Pan American estimated an outbound load factor from Houston of 90 percent. These estimates are in agreement with the previous conclusion that there is substantial underutilized outbound freight capacity from Texas airports.

All cargo service to and from Texas airports is shown in Tables 6-6 and 6-7. All cargo configuration aircraft are used primarily for freight which, because of size, shape, commodity, or weight, cannot be moved on combination aircraft. Freighters also tend to be used during the late evening and night hours when the daily freight peak occurs. The airlines did not foresee any major increase in all cargo configurations or all freighter service. The introduction of the wide bodied jets will greatly increase the cargo capacity of combination aircraft. All cargo configuration load factors were reported by American as 75-80 percent inbound to Texas and 30-35 percent outbound. Braniff reported cargo load factors of 85-90 percent inbound and 20-25 percent outbound.

Interlining

Interline measure is a significant criterion in cargo facility planning. The higher the percentage of cargo interlined, the greater the attention which must be paid to the co-location of airline cargo

Exhibit 6-2

EASTERN AIRLINE CARGO LOAD FACTORS BY ROUTE

(August, 1971)

	Combination Aircraft	Freighter
Dallas-Atlanta	24.2%	
-Miami	9.2	
-Tampa	6.1	
Corpus Christi-Houston	6.0	
Houston-Atlanta	38.9	
-Baltimore	29.5	
-Boston	7.7	
-Corpus Christi	6.4	
-Newark	4.5	
-Dulles	15.4	
-Kennedy	6.9	97.0%
-LaGuardia	4.0	
-New Orleans	2.8	66.0
-Philadelphia	7.0	
-San Antonio	21.7	
San Antonio-Atlanta	24.2	
-Houston	30.3	
-Kennedy	22.7	
-Miami	3.5	
-New Orleans	14.3	

terminals. The air carriers were asked for estimates of percentages interlined and percentages on line traffic. Responses were incomplete, and estimates at best were very rough.

Interlining occurs between airlines and also between planes of the same airline. For example, American Airlines in Dallas estimated that 40 percent of their freight was interline, with 25 percent transferred between American airplanes and 15 percent between American and other airlines in Dallas. Delta commented that a very large percentage of freight enplaned or deplaned in Dallas was interlined between Delta airplanes in Atlanta. Interline between airplanes of the same airline is primarily a function of route structure, scheduling, and available capacity. Occasionally, freight will move on a very circuitous route between origin and destination due to capacity availability.

Interline between carriers was not identified as a problem by any of the airlines. Significant interlining does occur at Amarillo, Dallas, El Paso, Houston, and San Antonio, with El Paso interlining the highest percentage of freight and Dallas interlining the largest volume of freight.

Peak Period Analysis Summary

1. Daily peak periods for outbound shipments at the airport are 5:00 p.m. to 8:00 p.m. when approximately 86 percent of the shipments are moving from the airport.

2. Weekly peak periods are Tuesday - Friday when traffic volume is about 12 percent above the Saturday - Monday average.

3.. Although subject to considerable variability, the volume months are May - December for domestic shipments and October - December for international shipments. Volume during the peak month may be as high as twice that of the low month for domestic shipments.

4. Seasonality-induced peaking occurs in Houston for the shipment of live blue crabs to Baltimore.

5. Peaking is not presently a problem at any Texas airport. On the contrary, the problem appears to be underutilization of capacity, particularly outbound capacity, but also daytime capacity both inbound and outbound.

Part 7

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