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SST

AN ECONOMIC ANALYSIS

Part III. Contractor's Reports

A. Air Travel Demand Analysis

UNITED STATES DEPARTMENT OF COMMERCE

EXPLANATION OF RELEVANCY OF CONCLUSIONS AND DATA CONTAINED IN THE SST ECONOMIC ANALYSIS REPORTS PREPARED BY THE DEPARTMENT OF COMMERCE

In an effort to provide as complete a history as possible of the course of the SST program, materials consisting of Part I, Executive Summary and Supplements, and Part III, Contractor's Reports*, have been made publicly available. However, all persons using these materials should be advised that the data and conclusions pertaining to the SST designs contained therein are not current and have been superseded by the SST designs submitted to the FAA September 6, 1966, which were the basis for the Economic Feasibility Report prepared by the FAA in April 1967 and for the reports of the Economic Research Contractors submitted December 31, 1966. Using the superseded designs and the related economic data for comparisons with economic characteristics of other aircraft, both American and European, could be misleading and not representative of what was achieved with the more recent SST designs.

Because of the changes in development costs and total program costs and because of the provisions of the Phase III contracts with the airframe and engine manufacturers, the financial data and conclusions contained in the Executive Summary relating to the financial capability of the manufacturers do not reflect their financial capability in the context of the current program or their general financial position.

Accordingly, the materials attached hereto should be viewed as predominately historical in character.

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* Part II of the SST Economic Analysis was never issued.

SYSTEMS ANALYSIS AND RESEARCH CORPORATION
BOSTON — WASHINGTON

January 7, 1965

Mr. Abra.
Project Manager
SST Econom: Analysis
Departme: Commerce
Washing . C.

Dear Mr. Katz:

Systems Analy s and Research Corporation submits herewith a study, Air Travel Demand Analysis, in accordance with Contract No. C-8-65.

The basic task of this analysis, one of eight being made for the Supersonic Transport Program, has been to compile, assess, and prepare for simulator use pertinent data from U.S. and International sources related to passenger air travel of 900 nautical miles or more within the Free World during the 1970-1990 time frame.

Within the 90-day limitation of this contract, SARC has explored available source materials, and has conducted numerous interviews with authorities in and out of the Government.

The culmination of this work is the following report, which is divided into two major parts - Part I -- Demand Model, and Part II -- Relative Attractiveness of Aircraft Types. The overall methodology for each of the two tasks is described at the outset of each part.

In essence, the report projects (1) how many passengers will be traveling by air between the specified regions during 1970-1990, and (2) what increase in fares these passengers might be willing to pay for the travel time savings projected for the SST.

Note should be taken, we feel, of the paucity of reliable data in many areas which are of prime significance to a study of this kind. Formidable gaps in such basic information exist, particularly as to true origin and destination of international air travel, and in the crucial area of passenger reaction to changes in quality of air transport service (changes in speed, comfort and fares). Despite such problems with basic data, we feel that the present study attains the objectives sought for our assigned portion of the overall problem of the Study Group.

We wish to take this opportunity to express sincere appreciation for the cooperation of the Study Group and wish to thank, in particular, Mr. Dan Edwards for his frequent and invariably helpful counsel.

Very truly yours,

Sam I. Aldock
President

Attachment

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AIR TRAVEL DEMAND ANALYSIS

Prepared for

SUPERSONIC TRANSPORT STUDY GROUP

U. S. DEPARTMENT OF COMMERCE

Submitted by

SYSTEMS ANALYSIS AND RESEARCH CORPORATION

Cambridge, Massachusetts and Washington, D. C.

October 1964

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INTRODUCTION AND SUMMARY

Introduction

The United States Government and the aviation industry are confronted with a formidable and demanding challenge in deciding whether the nation should pursue the development, production and operation of a supersonic transport program for the 1970-1990 time period, and if so, to choose among various alternatives an SST program which will provide optimum returns in cost effectiveness at minimum possible costs. This objective is, of course, in no way unique. The search for maximum cost effectiveness is applicable everywhere in government and industry.

What is particularly trying, however, in formulating the options and arriving at rational conclusions for the future of the SST is the urgent requirement for long-range analyses and forecasts covering a broad spectrum of study areas in which there are continual and dynamic changes.

A further complication, and one which cannot be ignored, is the lack of comprehensive relevant statistical data on which to base SST decisions which will have great economic consequences.

Anyone who is familiar with the transportation industry knows of the difficulties which persist in making decisions on equipment and scheduling changes on a short-range basis less than a year ahead, even when adequate informational inputs are available. The SST program calls for decisions, based on facts reaching out to the end of this century, and there is wide recognition of great gaps in the pertinent information which is available.

The urgent need to obtain more precise data on which to make rational decisions in implementing the SST program prompted President Lyndon B. Johnson to establish the SST Advisory Committee, headed by Secretary of Defense Robert S. McNamara. A member of that committee, Secretary of Commerce Luther Hodges,

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was directed by the President to conduct systematic economic studies that would relate different types and sizes of aircraft, both supersonic and subsonic, to route structures, possible future fares, and operational conditions under which SST aircraft will be flying.

Working closely with the Civil Aeronautics Board, the Federal Aviation Agency, and other federal agencies, including the Department of Defense, the Department of Commerce established a Supersonic Transport Study Group and named Mr. Abraham Katz as Project Manager for SST Economic Analysis. The "Analytic Approach to SST Economic Analysis", as the project is known officially, was divided into a set of eight tasks.

Systems Analysis and Research Corporation was assigned Task A -- Demand Analysis.

The SARC mission, to be completed within 90 days, had two basic objectives:

I To estimate origin and destination passenger demand between 67 Free World regions during the period 1970-1990 -- Part I.

II To assess the relative attractiveness of different types of aircraft at various assumed fare differentials -- Part II.

<u>Summary</u>

<u>Part I - The Demand Model</u>

In developing the Demand Model, there were two objectives. Briefly described, these were:

1. <u>Identification and Measurement of the Principal Factors Influencing Air Passenger Demand</u>.

The demand for transportation services is affected by a variety of forces which can be classified in two main categories: environmental and transportation. Environmental forces encompass the socio-economic considerations which determine the disposition and means to travel. Population and income are among the most important of the environmental forces. The transportation forces include the various attributes

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of the transportation services which, reacting with environmental forces, further stimulate or depress the total volume of travel demand. The principal transportation forces are price (or cost to user), time, convenience, reliability and safety.

2. Projection of Air Passenger Demand in the Free World Through 1990.

The study projects the significant factors throughout the Free World through 1990 and, based on the projections, forecasts the demand for air transportation, from point of origin to point of destination, among 67 regions.

The analysis utilized was a single equation least squares regression form, sometimes referred to as a "gravity model". This equation, utilizing Gross Domestic Product of each region, distance, and a community of interest factor, established the cross sectional distribution of the traffic among the regions. Projection of the demand through 1990 for each market was based upon growth in the economic factor for each region plus a state of the art factor to reflect the effect upon traffic of such influences as improvement in safety, comfort, reliability and speed.

In detail, the Demand Model as developed contains six major elements. The details of the development are set forth in Chapter I of Part I.

1. An economic variable in the form of the cross products of the Gross Domestic Product of the regions. Projection of this factor, in U. S. dollars, was made for each region through 1990 on the basis of low, medium and high estimated rates of growth. (See Chapter II of Part I)

2. A transportation impedence factor in the form of distance between regions.

3. A "community of interest" factor for each pair of regions to account for the substantial unique variation in traffic of individual markets from the traffic accounted for by gross domestic product and distance. This factor is based upon the observed

variation in 1963 and is assumed to remain constant for each region pair throughout the forecast period.

4. A constant modified to produce traffic growth that follows the projected growth in the world gross product.

5. A "State of the Art" factor to reflect the effect on demand resulting from improvement in speed, safety, comfort and reliability. (See Chapter IV of Part I).

6. A variable term allowing for adjustment in the estimated demand as a function of price elasticity. Through this function, assumptions can be made as to the fare level in the forecast period and the effect upon traffic estimated.

In addition, seasonal and directional variations in air traffic and the distribution of traffic between first class and economy/coach service have been analyzed and factors for each have been projected for use in the Route Simulation (See Chapters VII and VIII of Part I).

In spite of the formidable problems of time constraints and data limitations, the accomplishments of the study are significant. It is believed that principal influences on air passenger demand have been identified and quantified. This includes gross domestic product, distance, community of interest, improvements in the state of the art, such as reliability, comfort, safety and speed, and fares. Projection of Gross Domestic Product and changes in the State of the Art have been made through 1990.

The model developed is a comprehensive and flexible tool for estimating the volume of air passenger demand among the 67 regions of the Free World (a maximum of 2,211 region pairs) through 1990. Different projections of the factors influencing demand or different assumptions as to the overall environment can be used and incorporated into the model and the effect on demand determined.

When a model, such as an Air Traffic Demand

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Model, is developed to make projections into the future, there is no sure method for testing the reliability of the projection prior to the event itself. There are, however, a number of traditional methods that are useful guides to the accuracy of the model for estimating purposes.

One of these is to conduct various statistical tests such as the R^2 which measures the amount of the variability in the dependent variable accounted for by the independent variables.

Another method used for models of this type is to use the model in predicting for past years and comparing the estimated results with the actual data for these years.

A third method for evaluating the accuracy of the model is the consistency of the underlying logic of the build-up of the model.

All of these measures have been applied to the model developed in the study with satisfactory results.

Using the median estimate of Gross Domestic Product through 1990, air passenger demand between each of the 67 regions for each of years 1970, 1980 and 1990 was computed. These are set forth below and compared with 1963.

	No. of Passengers*	Increase Over 1963
1963	78,288,000	-
1970	130,769,000	67%
1980	228,477,000	192%
1990	394,440,000	404%

The average annual rate of growth is as follows:

1963-1970	7.60%
1970-1980	5.75%
1980-1990	5.61%

The traffic projections relate to traffic between the regions and not within a region which excludes a substantial amount of shorter haul traffic.

Part II - Relative Attractiveness of Aircraft Types

The second major task assigned to SARC by the U. S. Department of Commerce was to assess pertinent factors which are likely to influence subsonic vs. supersonic option decisions by airline passengers in

*These traffic projections are based upon constant 1963 fare levels.

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1970-1990. Because of the great expenditures which will be required for development, production and operation of SST aircraft, the possibility of higher fares for this service must be anticipated. Obviously, then, fundamental policy decisions related to the future of SST will be affected greatly by the relative attractiveness of this equipment, particularly in the face of fare differentials 10%, 20% or 30% higher than for aircraft now in the inventory.

Two dominant factors will motivate or deter airline passengers of the future, as in the past, to choose between alternative types of equipment. These are travel time (speed) and fare. Other considerations will affect demand for SST travel, but certainly none will be more important than (1) how long it takes a traveller to move from origin to destination, and (2) how much this costs.

It often has been stated that time is the commodity that air transport operators are selling, but little research has been done on measuring its value. In fact, a search of the literature produced no authoritative studies on this subject.

Three attempts were made in this study to isolate statistically the influence of time saved on the passenger's decision concerning the demand for different types of aircraft. It was thought initially that time and fare could be used as independent or explanatory variables in the Demand Model to explain passenger demand, and that these coefficients could be used to allocate the total demand for air travel among the various types of aircraft, given the fares and times for each market pair. However, due to a high degree of multicollinearity which is discussed in Chapter II of Part I, it was not possible in the general model to quantify the effect of time, fare and distance.

Another attempt to measure statistically the impact of time savings was made through an analysis of the period when jets were introduced into the air transportation system in competition with piston equipment. This period, which began in late 1958, offered the passenger a vastly improved type of equipment with greater speed at a fare which averaged

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about 10% higher than propeller aircraft fares. The jet-piston competition is the closest analogy in air transportation history to the potential SST-jet competition. (The analysis of this transition is discussed in detail in Chapter III of Part II).

Graphic and regression techniques were employed to study the relationship between time saved, fare differentials and the percent of the traffic electing jet service. The graphic analysis indicated a general tendency of passengers to increase their use of jets as the time savings became greater.

Further study of the data strongly suggested, however, that the results were spurious and that basically what was being measured here was supply rather than demand. This conclusion was drawn from the fact that at any given time saving, there were a number of observations that could only be explained by the amount of service offered. In these cases, examination of load factors of pistons and jets did not suggest a strong preference by the passenger.

This conclusion was confirmed through the use of regression analysis with seats, time and fare as independent variables. The results suggested that almost all variation was accounted for by seat availability. The coefficients of time and fare were statistically insignificant.

Although the jet-piston competition did not appear to offer a complete basis for forecasting what might happen in an SST-jet environment, a noteworthy conclusion can be drawn from this empirical evidence. Based on this analysis, it appears that fare differentials of the magnitude of 10% or less are not enough to deter passengers from taking superior equipment if satisfactory schedules are offered.

In addition, a postulation was made that the value placed on a unit of time by an individual would be equal to his income for that time. The basic assumption of this analysis is that there is a given surcharge for each passenger at which this person, based on the value of his time, will be indifferent as to whether he travels by subsonic or supersonic jet. This surcharge is actually equivalent to his earnings for the time saved and represents the maximum surcharge he will pay.

Because time saved has value to individuals, it may be treated as a commodity which is supplied and consumed. Time saved has a price -- the fare differential. To determine the effective demand for SST travel, it is necessary to relate time saved to the fare that differential travellers are willing to pay. The greater an individual's income per hour, the more he is willing to pay to avoid non-productive hours.

In terms of economic theory, the productivity of time may be referred to as the substitution effect, and the tendency to be less concerned with fare as income rises, the income effect. As time becomes more productive, the value of time actually increases relative to money. Individuals then become more concerned over saving time and are thus willing to part with more money than previously for any given time savings. This increases their consumption of the faster modes of travel. The pure income effect considers the increase in consumption of the faster modes of travel due solely to increased income.

Although these two effects are separate concepts, they influence the level of demand simultaneously. For the purposes of this study it is not of particular importance to measure the two effects separately. Indeed, with the available data it is difficult to measure their joint effect. Thus, by assigning income per unit of time as the value of that time, approximation of the relationship of income levels to use of SST vs. subsonic at given fare differentials is possible.

To translate the basic assumption into useable terms, it was necessary to calculate the value of the time saved of the passengers involved.

A fare surcharge of 10, 20 and 30 percent for an SST over a subsonic jet was assumed. This surcharge was expressed in dollars per hour of time saved by an SST over the subsonic at trip lengths of 1500, 2500 and 3500 miles. For this analysis, three different SST's were used - Mach 2.2, 2.7 and 3.0 aircraft.

These surcharges per hour are equivalent to the

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minimum incomes per hour required for payment.

Empirical passenger income distribution data were obtained from Port of New York Authority in-flight surveys giving incomes of air travellers for 1963/64. These distribution figures were then compared to the minimum incomes or surcharges per hour. From these tables the passenger split between certain supersonic aircraft and subsonic jets was calculated.

The figures derived from this analysis indicated that between 75% and 85% of total passengers would be willing to pay a 10% differential for the SST for various time savings. These results are supported by the results suggested by the analysis of the jet/piston transition period presented earlier and are further supported by the results of a Stanford Research Institute Study (See Chapter IV of Part II).

Income Forecast Through 1990

It is clear that with expected future income increased, the value of time will become greater. Thus, it was necessary to forecast what future incomes will be in certain future years. The methodology is discussed in Chapter V of Part II. This forecast indicates a distribution of air travellers as follows:

DISTRIBUTION OF AIR TRAVELLERS
BY INCOME LEVELS
1963 - 1990

Income Category	1963 Percent	1970 Percent	1980 Percent	1990 Percent
$ 0 - 2,999	2.0	1.1	0.5	0.3
3,000 - 5,999	6.0	3.4	1.8	1.1
6,000 - 9,999	15.0	11.0	7.1	4.6
10,000 - 14,000	25.0	25.0	22.2	18.3
15,000 - 19,999	16.0	15.7	17.6	18.8
20,000 - 24,999	9.0	11.1	11.5	12.7
25,000 and Over	27.0	32.7	39.3	44.2
Total	100.0	100.0	100.0	100.0

Based on this forecast the percentage of travellers who would elect an SST at selected assumed fare levels and time savings are shown on the following page.

ESTIMATED PERCENTAGE OF TOTAL AIR PASSENGERS FLYING SST
1963 - 1990

	1500 Mile Trip			2500 Mile Trip			3500 Mile Trip		
	10%	20%	30%	10%	20%	30%	10%	20%	30%
Mach 2.2									
1963	76	32	27	80	35	28	82	36	28
1970	82	40	33	86	42	34	88	44	34
1980	89	45	40	92	49	40	93	51	40
1990	93	55	45	95	55	46	96	57	46
Mach 2.7									
1963	80	37	28	84	39	29	86	42	30
1970	87	43	34	90	48	35	92	51	36
1980	92	50	40	94	56	41	95	58	42
1990	95	56	46	97	61	47	97	65	48
Mach 3.0									
1963	82	36	28	86	41	29	87	44	30
1970	88	44	34	92	50	36	92	52	37
1980	92	51	40	95	57	42	96	60	43
1990	96	57	46	97	64	48	98	67	48

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Our research, as stated, was limited by time and also by the paucity of concrete statistical data. However, based on all evidence available, it is reasonably clear that the relative attractiveness of competing aircraft types to airline passengers of the future will be affected significantly by time and fare differentials, when other factors such as safety and comfort are considered to be relatively constant.

A summation of the three analyses is that an SST fare differential in the magnitude of 10% or less would find a high degree of public acceptance. The likely prospect, all other factors being equal, is that an airline passenger traveling 900 nautical miles or more would choose an SST aircraft over a subsonic jet at a surcharge of 10% or less. Above a 15% differential, however, this acceptance appears to fall off sharply, provided that comparable scheduling is available between subsonic and SST equipment.

The propensity to pay a surcharge measured by the income analysis involved an implicit assumption that scheduling is consistent with the demand. It is not feasible to spell out the impact of all possible combinations of schedules upon demand. However, it is possible to make certain observations which can be used in testing the postulated model for splitting demand in the simulation.

An example is useful at this point to demonstrate the possible effect of scheduling. Assume that in a given market where both type of schedules are available, 25 percent of the air passengers ordinarily would travel by supersonic and 75 percent would go by subsonic. If all subsonic flights were to be terminated, leaving only supersonic flights, the 25 percent who would have gone by supersonic would still go supersonic. The remaining 75 percent now have a choice - to go by supersonic or not to go by air. The choice will be made based on price elasticity of fare. If the fare differential between supersonic and jet had been 10 percent, the elimination of the subsonic flights would be the same as increasing the price to the subsonic passengers by 10 percent. Assuming a price elasticity of -1.0, 7.5% of the total (or 10%

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of the 75%) would drop out and 90 percent of the 75 percent would decide to go by supersonic. In other words, in this given market, with only supersonic schedules, a total of 92.5 percent of all original passengers would now travel supersonic.

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PART I

THE DEMAND MODEL

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PART I

THE DEMAND MODEL

CHAPTER I

ANALYTICAL AND EMPIRICAL DEVELOPMENT

The decision whether or not to develop, produce, and operate SST aircraft will depend in large part on the growth in air passenger demand. For this reason, it is essential to determine Free World airline traffic prospects for the period 1970-1990.

The focus in Part I, herewith, is on the development and formulation of a Demand Model that predicts total air travel of 900 nautical miles or more anywhere in the Free World during the specified time period.

Conceptual Considerations

An ideal approach in accomplishing the first objective of the study, the formulation of a Demand Model, would be to relate statistically the demand for air travel between every region or pair of cities throughout the Free World to the significant variables or demand determinants. These would include socio-economic factors, such as income and population; and transportation factors, such as fares and air travel times, including fares and travel time for competing modes, and distance.

The relationships and estimates of the levels of these variables for the period 1970-1990 was to make it possible to predict demand for air travel between any combination or pairs of points in 1990.

As conceived originally, such a Demand Model would provide a basis for modifications in the demand based on time and price. It would also provide the significant information required for allocating the traffic between various types of equipment (subsonic jets, American SST's, other SST's, etc.) within a prescribed range of fare differentials.

As is explained, however, in Part II, it was not possible to isolate and measure the effect of time and fare in the regression equation derived to estimate total demand. It was ascertained, as the

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problem was studied, that the elasticity of time and fare on total demand was not necessarily identical with the elasticities of time and fare with respect to equipment choices by a traveler who had already decided to go by air.

Therefore, it was concluded that it was not feasible and perhaps conceptually erroneous to build a single general, all-purpose Demand Model which would permit manipulation in such fashion that it could provide a basis for determining influence on demand and the allocation of such demand among equipment types.

Because of these difficulties, it was decided to treat the segment of the problem related to equipment choice as separate and distinct from the general demand model. This report, therefore, is divided into two separate but closely related parts. This part deals with the development of a general model for predicting air passenger demand with appropriate provision for the impact of fare and time on demand; Part II deals with choice of equipment types under assumed fare differentials.

In accomplishing Part I and in order to establish a sound basis for reasonable projections of air passenger travel between the regions of the Free World, the effect of each of the important socio-economic and transportation factors was investigated in the greatest detail possible within the scope and time limitations of the study. Study was made also of the distribution of demand by service distinction - first class and coach - and seasonal and directional imbalance during the year. Detailed discussion is presented in the following chapters:

CHAPTER II - Projected Economic Growth in Free World

CHAPTER III - Free World Origin and Destination Data

CHAPTER IV - "State of the Art" Factor in Assessing Air Travel Growth

CHAPTER V - "Business" and "Personal" Air Travel

CHAPTER VI - Elasticity of Demand with Regard to Fare

CHAPTER VII - Seasonal and Directional Variations in Air Traffic

CHAPTER VIII - Effects of Service Distinctions on Travel Demand

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Study Requirements and Availability of Data

SST Study Group requirements, the lack of data for the Free World on a consistent basis, as well as time limitations on this investigation forced some deviations from the ideal approach.

One important need of the study required that the demand data be compiled and projected in a manner which would allow rearrangement of schedule patterns. This precluded the compilation of traffic flow over those relatively small number of routes which could be designated as prime candidates for SST operation. Because such traffic patterns reflect existing routes and scheduling, they would not offer the flexibility required by the Study Group. To meet the requirements imposed, consideration could only be given, therefore, to passenger origin and destination (O&D) traffic, a unit of traffic that could be accumulated under any assumed set of schedules. While accumulation of such traffic for all city pair combinations accomplished the purpose of affording the desired flexibility, it created another problem. To account for a significant amount of the potential SST traffic, it would be necessary to compile and project the traffic over a very large number of pairs of points. Although the massive volume of data could have been dealt with, the results would have been unwieldy and inconsistent with the objectives of the study.

This problem was solved by compromising flexibility to some extent by classifying the Free World into 67 regions. This approach limited the maximum number of regional pairs or market combinations to slightly over 2,000.

This study requirement presented certain problems in data collection. Data that is usually available on a city, state or county basis had to be cumulated into the appropriate regional divisions of the world.

A practical constraint recognized and adopted from the outset was that the variables selected for inclusion in the model must be available on a reasonably consistent basis, both for the United States and

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for the rest of the Free World. For the independent variable, such as, population and income, the data were needed on both an historical and a forecast basis. The dependent variable, passenger origin and destination data, was required on a historical basis. The problems of data acquisition which are pervasive in all studies of passenger demand were compounded in this study by the constraint of time. Reliance had to be placed entirely on available sources.

A consequence of this data problem is the limitation imposed on the use of the analytical technique. The lack of information on certain economic factors affecting the demand for air transportation on a consistently reliable basis throughout the Free World for either current periods or on a forecast basis into 1990, restricted the numbers of such variables that could be used in the model. Distribution of the population into urban and rural or by employment and delineation of income into discretionary or disposable were not possible.

Of equal importance in influencing the analytical technique was the problem inherent in reconstructing the dependent variable used in construction of the model - origin and destination passenger traffic throughout the Free World.

Such data on such a scope do not exist. A comprehensive body of such information is available only for the domestic United States. However, even those data had to be reassembled, from city to city, into region to region totals. For the rest of the world's markets, it was necessary to construct the data from the available piece-meal O&D data, segment flow data between major areas of the world and information on the distribution of mail, telephone calls and dollars of exports. The development of the O&D passenger volume for the year 1963 among the 67 regions of the Free World is set forth in detail in Chapter III of Part I.

Because of the complexity of the construction and the difficulty of obtaining the data that are

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available, it was not feasible to develop O&D traffic for all the Free World markets for two or more periods of time. It was therefore necessary to employ a cross-sectional analysis for 1963, rather than a time series analysis, in the development of the basic demand model relationships and the distribution of traffic to the individual markets.

Because of this lack of O&D traffic data outside the United States and because of the availability of more comprehensive socio-economic data within the United States, it was decided to develop the basic demand model on the basis of U. S. domestic data and then to apply it with suitable modification to the inter-national markets. This approach would eliminate the indeterminable degree of error involved in the construction of world-wide O&D data.

Selection of Variables

The selection of the dependent variable and the identification and quantification of the influence of socio-economic and transportation factors affecting levels of air passenger traffic in specific markets - and the collection of the necessary data - were the first steps in the study.

The Quantity of Travel Factor

The measure selected as the dependent variable for this analysis was the number of one-way passengers originating in one region and terminating at another point. For each region pair the total traffic is the sum of the traffic in each direction. The basic set of air travel statistics used in formulating the demand model was obtained from the Domestic Origin and Destination Survey published by the Civil Aeronautics Board for the year ended December 31, 1963. These data represent a 10% sample of the passengers originating in a given city and terminating in another city. Although the points included in the survey do, in fact, service geographical areas rather than only the specific airport location, it is extremely difficult to make meaningful estimates of the extent to which the non-airport sections of the respective "service areas"

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contribute to the general volume of air passenger traffic indicated at a specific airport. This situation is of greater significance in regions outside the U. S. where the proportion of total passengers generated at a given airport might well be expected to be more a function of the characteristics of the entire region rather than of the particular location of the airport.

Socio-Economic Factors Considered

The prime determinant of the socio-economic factors selected for evaluation in this study was the availability of data on a consistent and continuing basis, both historically and forecast, throughout the world. Because of the great disparity in the availability, variety, reliability, comparability, and continuity of data between the United States and the rest of the world, many potentially valuable types of U. S. domestic data could not be included in the final model without devoting a large amount of resources to data development.

These included such factors as discretionary income, disposable income and income distribution. However, certain factors that could possibly be developed on a consistent world-wide basis from the resources of this study were evaluated in the preliminary stages to determine the relative sensitivity of air traffic to those variables.

Variables considered for possible inclusion in the model were population, total income and gross product. In addition, population and income were divided into urban and non-urban categories.

An important consideration in the selection of regions to be included in the sample was the matter of availability of meaningful and consistent data describing the region with respect to the basic social and/or economic characteristics. Basic geographic units in the United States for which the socio-economic data were available for all pertinent variables and which reflected an acceptable degree of heterogeneity to quality as a reasonably representative sample were

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the contiguous 48 states. These were combined into 42 basic geographical units for inclusion in the model. See Appendix E for a listing of these units.

For other areas of the world the data was available, generally, for individual countries. However, in some areas, the data, especially projections, were available only for regions encompassing several countries. Descriptions of each of the 67 regions selected for this study are set forth in Appendices D and E.

Transport Factors Considered

In addition to the quantity of travel factor, three other factors closely associated with mode of travel were considered - time, fare and distance.

With respect to time, a reasonable presumption may be made that the total demand for air travel between two points is, in some part, a function of the time required to make the trip. The time necessary to complete a trip - from point of origin to point of destination - consists of several phases. This includes line-haul time, as well as local travel times at the origin and destination, waiting times in the terminals (including, for international travel, customs processing, etc.) and delays due to the fact that common carrier schedules are not always available exactly when desired. In long haul travel, which is of primary importance in this analysis, the portion of the total trip time represented by the line-haul time is greater with an attendant decrease in the relative importance of the local travel time and terminal time.

The time variable examined for use in the demand model is a composite of all of the above factors in an attempt to represent total portal-to-portal elapsed time.

In the absence of local travel data in each market, it was assumed that there was an average of one and one-half hours of non-line-haul time associated with each interstate passenger journey. This included the ground times at each end of the journey.

Variations in fare have often been shown to have a significant influence on the demand for air travel between two points. The weighted average fare (developed as a function of the number of first class and coach passengers, times the respective fares, divided by the total number of passengers) was used here as providing a suitable approximation of the average fare paid. Mid-1963 fares were used in order to be representative of the available passenger data.

Although published fares are available for line-haul travel on all established common carrier segments, the use of more specific average fares per traveler was not warranted, particularly in international markets. There the fares are constructed in such a way as to obscure the relationship of the fare to the true origin and destination. In other words, stopovers at a number of destinations are permitted on a single fare. Also, most airlines have special fares such as round trip discounts, family plan, children's fares, excursion fares, class of service differentials, and many other related variants. The availability of these various fare plans, which results in a rather large range of available fares in some markets, is not uniform.

Another factor generally thought to have an influence on air transportation demand is that of fares, times, or some other measure of availability of other means of commercial transportation such as passenger trains, ships or inter-city buses. This factor was surveyed early in the study but was dropped from further consideration on the basis that very little, if any, of the variation in air passenger demand could be accounted for by use of this variable. This can be explained on the basis that air travel demand considered in this study is for travel between points of 900 nautical miles or more. Other means of transportation become less attractive as substitutes for air travel as distance between points increases.

Still another factor having an influence on the demand for air travel is that of frequency of scheduling. The more flights available between any two points of travel, the more attractive this becomes for potential passengers. Airlines are restricted, however, in the number of flights which can be scheduled between any two points because of cost considerations. Frequency of scheduling, therefore, is believed to be more a function of demand for travel between given points, rather than demand for travel being a function of frequency of flights. This being the case, airlines base their scheduling on demand. Therefore, it can be presumed that schedules currently are in some type of balance in relation to the traffic and will remain so in the future. For this reason, the assumption is made that scheduling will have the same effect on demand in the future as it has had in the past.

In determining distance for use in this analysis the Great Circle distance was used for each observation.

Ideally, it would have been desirable to employ data for a suitable cross-section of regional pairs for a number of time periods, in order that parameters that explain traffic could be estimated directly and that any shifts over time in the values of these parameters might be determined. However, it was necessary to reassemble the reported data from a city to city demand into a region to region demand. Within the time limitation of the study, such traffic data could be developed in the detailed required format only for the period 1962-1963. The 1962 data was discarded because of its close proximity to 1963.

In consideration of the desirability of measuring the relationship of traffic levels and relative socio-economic variables over time, some external time series analyses were conducted of the relationship between traffic and the variables selected for possible inclusion in the demand model. Appropriate secular variations based on these analyses were incorporated in the suggested application of the model.

Formulation of the Model

There are two basic approaches to the development of a statistical demand model. One uses the single equation least squares approach and the other is based on a multiple or simultaneous equation analysis. Investigators agree that there are certain cases where

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the simultaneous equation method must be used in order to prevent the attainment of biased results. Biased results are obtained from the single equation method when the dependent and independent variables are interdetermined; that is, when the value of the dependent variable influences the value of the independent variable. If these interrelationships do not exist, then it is generally agreed that it is possible to obtain "sensible" results with either formulation and that other considerations such as selection of variables and aggregation and adjustments of data often are more important in their effect on the results than the problem of method.

A high degree of interdependency between the dependent and independent variable does not seem to exist in this case. Therefore, it was judged that single equation least squares analysis was the proper approach for the demand model.

Numerous preliminary regression techniques were used to test the importance of certain per capita and aggregate variables and to assist in formulating the final demand model.

The preliminary analysis, as might be expected, showed a high degree of multicollinearity among the variables time, fare, and distance. Thus, the inclusion of more than one of these variables in a given least squares equation is undesirable statistically.

Analysis of the numerous preliminary steps indicated that regional gross product and distance were the two most important *a priori* statistical variables. Regional gross product was considered in two different forms; aggregate and per capita. When per capita gross product was considered, it was also necessary to include population. Examination of the statistical significance of these alternatives showed that application of per capita gross product as compared to using the aggregate figure did not reduce significantly the unexplained variation in passenger traffic. This led to the conclusion that within the overall accuracy of the data there existed no material difference in the

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statistical results of the two alternatives. Therefore, as aggregate gross product precluded the necessity of collecting and forecasting population, total regional gross product was used in the final model.

Urban and non-urban population and income were also analyzed for their effect on traffic. However, the improvement made in the accuracy of the model - a three percentage point increase in the R^2 test, for example - was not considered sufficient to warrant the expenditure of resources that would have been required to develop the data projections throughout the Free World.

The modified power function, sometimes referred to as a "gravity model", was used as the basic statistical least squares equation. The estimated model was of the form

$$Y_{ij} = \frac{b_o (X_{1i} X_{2j})^{b_1}}{{X_{3ij}}^{b_2}}$$

Where Y_{ij} = O&D traffic between markets i and j.

b_o = a constant.

X_{1i} = gross product in region i.

X_{2j} = gross product in region j.

b_1 and b_2 are regression coefficients and may be expressed as the $\frac{\% \; y}{\% \; x_1}$ and are referred to as elasticities.

x_3 = distance between market i and j.

This multiple regression was considered particularly applicable to this problem because of the flexibility of transforming the modified power form to an equation linear in logarithms. The log form is as follows:

$$\text{Log } Y = \log b_o + b_1 \log X_1X_2 - b_2 \log X_3$$

The derived equation with the parameter estimates is as follows:

$$Y_{ij} = \frac{b_o (X_{1i} X_{2j})^{1.0792}}{{X_3}^{.8115}}$$

The values for b_o are set forth in Appendix B, page 4.

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The regression coefficients were significant at the .05 level and the coefficient of correlation (R^2) was .81.

A number of regressions were run on the basic data.[1/] These were made in three basic sets.

1. All region pairs over 1,000 miles apart.
2. All markets paired with Arizona, Florida, and Nevada over 1,000 miles apart.
3. All region pairs over 1,000 miles apart, less all markets paired with D.C., Florida, Arizona, Nevada, and/or New Mexico, less all markets with less than 1,000 passengers per year.

An initial discrimination was made against all market pairs less than 1,000 miles apart on the premise that there are significant dissimilarities between the sensitivities of demand to both transportation and socio-economic variables in long and short haul markets. Since the primary emphasis of this study has been placed on long haul travel markets, this discrimination was deemed desirable to eliminate such spurious influences as might be introduced by including the short haul markets.

Secondary discrimination was introduced after analysis of the residuals produced by the initial regression. The analysis strongly and consistently indicated that market pairs including Arizona, Florida, and Nevada were consistently and significantly underestimated. Since all of these markets can be reasonably classified as predominantly non-business, a materially better "fit", defined in terms of a reduction in the standard error, was achieved by eliminating these deviations.

Extrapolation from the range of the given data is always difficult. The problems associated with this extrapolation are magnified when projections are made for periods as far in the future as 1990. Therefore, when making projections of this type, an *a priori*

1/ The observations included all possible combinations of the 42 domestic regions or 861 separate pairs.

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theoretical frame-work becomes extremely important. This framework with its logical reasoning knowledge often becomes as important per se as the statistical technique derived to carry out this reasoning.

Since certain information is available from the application of economic theory and the results of other studies to the model, it was possible to obtain better estimates of certain variables outside of the mathematical influence of the regression analysis. In effect, with such constraints imposed on the equation (i.e., a priori prespecification), the same least squares criterion is used; however, the minimization process is subjected to the prescribed constraints. The constraints effectively limit the amount of variability of the estimates that can be used in minimizing the sums of the squares and the model will not fit the data as well. Nonetheless, properly specified constraints that satisfy theoretical and other a priori considerations should result in a more useful model for long run forecasting because of better structural relationships. Therefore, certain refinements were made in the basic statistical modified power function. A brief discussion of these refinements follows.

Refinement of Model

The first refinement of the model was the addition of a community of interest variable.

In addition to the general variations accounted for by the model, substantial unique variations from these general tendencies are encountered on a market by market basis. These variations become more pronounced as the economic and sociological heterogeneity of the markets under study becomes greater. Since this study includes virtually all of the areas of the world, a single formula describing central tendencies of air traffic distribution for all these areas could be expected to suffer from the greatest possible afflictions of this type. However, if a reasonable estimate of the central tendencies has been established, it is not unreasonable to accept the individual variation for exactly what it is - a measure of the extent to which a given market varies from the "norm" due to factors not quantified in the model. To the extent these variations, statistically referred to as "residuals", occur randomly when correlated against other available measures of a type consistent with those included in the model (i.e., descriptions of the individual points in the market) it may be concluded that such variations are functions of factors peculiar, in both character and extent, to the individual market.

If a random distribution of residuals is assumed (i.e., variations above and below the "norm" occurring in no identifiable pattern) then the variations can be interpreted as being uniquely applicable to the individual market pair. No doubt, the variation could be somewhat reduced by the inclusion of more variables in the demand model, but the comparison of the prospective value to the level of effort required to develop and test additional variables was considered unfavorable. Therefore, the residuals computed for the 1963 time period which were random were accepted as measures, in themselves, of the effect of community of interest over and above the "normal" interaction estimated by the demand model. Although it is recognized that these variations, expressed as a multiplier of the estimated value, will experience some change over time, they were considered constant throughout the forecast period in the absence of any predictive knowledge upon which to vary them.

The second refinement was the development of a "state of the art" factor.

In order to permit the reasonable application of the preceding methodology to forecasting as well as cross-sectional distribution of traffic, it was necessary to establish the relationship between the growth of air travel demand and the growth of the factors in the demand equation.

Historical data reveal that the growth in air passenger traffic on both a global and major area basis bears a definite relationship to increases in the gross national product. This relationship is not constant, but varies in a consistent manner which is increasing at a decreasing rate.

This differential between the growth rates of the gross national product and the growth of air passenger demand is assumed to be attributable to a number of factors which exist both in addition to and independent of the growth in the general economic environment. Factors which logically may be included in this group are (1) technological advances in aircraft, such as speed, safety, comfort, and reliability, and (2) improved traffic control and passenger handling techniques.

There is no reason to believe that a continuation of this trend in the relative growth ratio of gross domestic product and air transportation will not continue. Certainly, continued technological advances will be made in the vehicle. All-weather landing systems and improved traffic handling devices are in development.

A factor, therefore, has been provided in the formula to reflect this "State of the Art". This factor is described in more detail in Chapter IV of Part I.

Fare declines have also been a factor in the growth of air transportation. The effect upon traffic of future fare changes can be determined from the next refinement - "Elasticity of Demand With Regard to Fare."

An attempt was made in this study to obtain estimates of elasticities by use of multiple regression analysis on available fare and air passenger data. Results were considered unreliable, however, because coefficients were not statistically significant.

Over the years, particularly during the past decade, many attempts have been made to measure the effect of fares upon the volume of air travel. These studies, done by many investigators and for different reasons, vary in their detail and in specific

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findings of elasticity.[2/] They nevertheless agree in placing the price elasticity of air transportation within a fairly narrow range and concur that business travel is less sensitive to price change than pleasure travel. The degree of sensitivity estimated in these studies varies from a low of -.4 for business travel to a high of -2.0 for personal travel. (See Chapter VI).

Business and personal travel, furthermore, as used in this study and in the other studies on price elasticity, are broad, imprecise categories. There are no comprehensive, reliable, published trend data. The few authoritative statistics that are available suffer from a lack of standardization of definition. Theoretically, business travel is for the purpose of conducting business, attending meetings or conventions, visiting branch offices and similar activities. It is usually tax deductible. Personal travel includes vacations, visits, and trips due to sickness or other emergencies. However, the classification becomes blurred when examining trips such as a wife accompanying her husband on a business trip, a businessman traveling to Florida for a meeting but remaining over the week-end, or a college professor attending the World's Fair in New York and also attending a professional convention there.

The sensitivity to price change will vary within both of these categories depending upon the passengers' need and desire to make the trip. This is treated in more detail in Chapter V.

Therefore, because of the lack of precision in determining price elasticities of demand and in classifying the reasons for travel, and the concurrent

2/ Price elasticity measures the responsiveness of volume of air travel to changes in the level of fares. This can be defined as the percentage change in volume of travel which results from a one percent change in fares. Demand is elastic if a reduction in fares will result in a more than proportionate increase in travel volume and in an increase in total revenue earned. It is inelastic if the fare reduction leads to a less than proportionate increase in volume and a decrease in revenues. Unit elasticity results when the price reduction leads to sufficient increase in volume to maintain a constant total revenue earned.

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absence of comprehensive information by market between business and personal travel it was deemed inappropriate to attempt a detailed breakdown of market by purpose of travel with the application of different elasticities to each. This study has, therefore, classified the Free World markets, on the basis of available information, into markets that are predominantly business and predominantly personal and based on a comprehensive review of all prior estimates, assigned a price elasticity of -1.0 to the first category and -2.0 to the second.

The final refinement was a projected annual modification of the least squares equation constant. This form of the regression equation, containing exponential cross product terms, when used for projections, result in geometric increases (similar to the squares of the geometric mean of the gross products of the market pair) in estimated demand over time. Long term historical trends have shown, however, that total traffic tends to grow in a more linear relationship to gross product. Therefore, while accepting the validity of the demand equation for purposes of a cross-sectional distribution of traffic in any one period of time, the forecasted results of the equation were calibrated to follow the projected growth in the forecasted total world gross product.

This calibration was effected by adjusting the constant term of the equation to result in a percentage reduction in the estimated traffic, while allowing the distribution of the total to remain a function of the variations in the cross products of gross products. In effect, this constraint is closely analagous to varying the coefficient (elasticity) of the cross products over time.

Thus, the final demand model based on the <u>a priori</u> theoretical framework contains six major elements:

1. A socio-economic variable in the form of the cross products of the gross domestic product of the regions.

[redacted]

2. A transportation impedence factor (i.e., distance).
3. A "Community of Interest" factor which represents the unique characteristics of each market pair relative to the "norm".
4. A constant calibrated to, in effect, vary the coefficient of the cross product of the gross domestic product over time.
5. A "State of the Art" factor to reflect the effects upon demand not measured by the gross product, such as improvement in speed, safety and reliability.
6. A variable term allowing for adjustment of the estimated demand as a function of price elasticity.

The symbolic representation of the final demand model format is described below:

$$\ln (Dij) = a \ln (GiGj) - b \ln (D) + \ln K + \ln (Xij) + \ln \frac{(Z)}{100} + E \ln F$$

where

Dij = total origin destination passenger demand between region i and j

Gi and Gj = Gross Domestic Product of region i and j. (Projections for this factor are set forth in Appendix B for the period 1963-1990)

a = coefficient of GDP (b_1 = 1.0792)

D = Distance in nautical miles

b = coefficient of distance (b_2 = .8115)

K = annual constant applicable to each forecast year. (These are presented in Appendix B for the period 1963-1990).

Xij = community of interest factor for market ij. (These have been provided on computer tape for each market).

Z = "State of the Art" factor applicable to all markets but changing for each forecast year (see Appendix B for values applicable to each forecast year).

E = price elasticity of demand (negative)

F = Fare expressed as a ratio $\frac{Fo}{Fn}$ where Fo is the

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existing fare and Fn the assumed fare in the forecast year.

Reliability of Model

When a model, such as an Air Traffic Demand Model, is developed to make projections into the future, there is no sure method for testing the reliability of the projection prior to the event itself. There are, however, a number of traditional methods that are useful guides to the accuracy of the model for estimating purposes.

One of these is to conduct various statistical tests such as the R^2 which measures the amount of the variability in the dependent variable accounted for by the independent variables. This is applicable when the model is derived from regression analysis as is the case here.

Another method used for models of this type is to use the model in predicting for past years and comparing the estimated results with the actual data for these years.

This latter method has limited application in this case. As indicated in a later section, in calibrating the model to fit individual pairs of points, it has been assumed that, except for the socio-economic factor used to predict traffic growth, all other factors in any given market would not change relative to each other. This assumption was made for two reasons:

1. On a market by market basis the myriad of possibilities for change could not be anticipated.
2. A forecast which excludes changes of the kind involved, such as fares, is the proper base point for evaluating and measuring the impact of proposed changes such as the introduction of the SST.

A third method for evaluating the accuracy of the model is the underlying logic of the buildup of the model which, of course, includes the meticulous refinements derived from a study of air transportation growth over a period of time.

All of these measures have been applied to the model developed in the study with satisfactory results.

The R^2 test indicated a value of .81, which is satisfactory for models of this type.

Because of its limited value as a check but primarily because of time and data limitations indicated earlier, all markets were not tested historically. A test was performed for a selected number of pairs in 1959 ranging in traffic between 2,000 and 1,300,000 passengers. Although 1959 was just the beginning of the jet age, whereas in 1963 most of the transition had taken place, average deviation in the estimated from the actual O&D passenger traffic for all markets tested was less than 12%.

With respect to the logic of the model development, much care was taken to refine the model both by individual market and in total to reflect all facts currently available.

In using the model for projection, gross domestic product was estimated through 1990 on the basis of the medium estimates for each of the 67 regions of the Free World. Air passenger demand between each of the 67 regions for each of the years 1970, 1980 and 1990 was computed. These are set forth below and compared with 1963.

	No. of Passengers*	Increase Over 1963
1963	78,288,000	
1970	130,769,000	67.0%
1980	228,477,000	192.0%
1990	394,440,000	404.0%

The average annual estimates of growth are as follows:

1963-1970	7.60%
1970-1980	5.75%
1980-1990	5.61%

*These traffic projections are based upon constant 1963 fare levels.

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PART I

CHAPTER II

PROJECTED ECONOMIC GROWTH IN FREE WORLD

The object of this chapter is to assess the level of economic growth in 1963 and predict the comparative range of prospective progress for 1970, 1980, and 1990 that would be applicable to the 67 simulation SST regions of the Free World. The following chapters (III and IV) analyze origin and destination of 1963 air passenger travel, and project future travel potential. This chapter seeks to expand this analysis, and thereby strengthen the global perspective of the study.

In this effort, SARC has examined closely the action of the U. N. General Assembly in designating the 1960's as the United Nations Development Decade. The goal of attaining an annual national income growth rate of at least 5% by the end of the decade is discussed at length in a special report prepared for the United Nation's Conference on Trade and Development held in Geneva in the spring of 1964.[1/]

1/ <u>A Review of World Trends in Gross Domestic Product</u> E/CONF 46/67, United Nations.

Economic growth and related air travel patterns, particularly in a world that is marked by dramatic achievements of emerging nations, are dynamic phenomena, and must be kept under constant surveillance. Perhaps the best information available on economic growth, both in the Free World and in the Soviet-Sino nations, which are not covered in this study, comes from United Nations sources. This SST study is indebted to U. N. studies, most particularly, and to the cooperation of U. N. staff.

In recent research for government and private clients, SARC has prepared economic development projections for areas within the United States and for foreign areas. These studies were designed to assist responsible officials in making decisions which would affect future transportation.[2/] It was, therefore,

2/ Demand for Intercity Passenger Travel in the Washington-Boston Corridor for the U.S. Department of Commerce, 1963, Feasibility and Cost of Expanded Intercity Air Service in The Washington-Boston Corridor for the U. S. Department of Commerce, 1963; Exhibits in Supplemental Air Service Proceeding before the Civil Aeronautics Board, Docket 13795 et al. of American Flyers Airline Corporation, Capitol Airways, Inc. and others, 1963.

possible, early in the SS1 study, to select several sources of compatible and uniform data, which portrayed trends that could be used to prepare long-range forecasts. These were discussed earlier in Chapter II. At the same time, however, it was necessary to reject considerable data because of the lack of uniformity and, most importantly, because of formidable gaps in basic data among Free World nations.

A noteworthy "exclusion" example is illustrative of the problem. It has been a frequent practice in studies which forecast the future of various aspects of the aviation industry, particularly in the United States, to employ tested data that reflect income distribution by family, per capita disposable income, standard of living indexes, distribution and growth of population within nations, and the growth and changes in occupational characteristics. Such data are available only for a handful of countries; the general absence and incomparability of such data on a global basis, confirmed by new research in Washington and at the United Nations, precluded their use.

It was decided, therefore, to develop for the simulation model growth projections related exclusively to gross domestic product. Information concerning per capita income and population expansion was surveyed, and repeatedly was used for research controls and confirmation. But in the final analysis, the model that was developed is built on gross domestic product, rather than on alternative trends in population growth and changes in per capita gross domestic product.

The use of GDP (Gross Domestic Product) rather than GNP (Gross National Product) or GPO (Gross Product Originated) was dictated by several considerations. First of all, it was available on a consistent worldwide basis. In addition, it is considered an appropriate measure of a country's total production of goods and services.

International economic studies increasingly have relied on United Nations estimates of gross domestic product in order to assure the effectiveness and validity of comparative analyses. Also, it eliminates the danger of double counting net factor income from abroad, and excludes the excess of indirect taxes over subsidies.

An example of such GDP use occurred in a joint study of Air Transport in Africa, by the International Civil Aviation Organization (ICAO) and the Economic Commission for Africa. This report established the close relationship of the world distribution of air transport capacity and air traffic to the world distribution of the gross domestic product. This ICAO-ECA study also traced the comparative relationship of air transport capacity to the gross domestic product for Africa and the United States from 1958 to 1963. These analyses demonstrated the usefulness of the GDP as an economic indicator for the establishment of regional benchmarks and forecasts.

Another example of the GDP approach occurred at the United Nations Conference on Trade and Development, Geneva, March 23 to June 15, 1964. A paper prepared by the Bureau of General Economic Research and Policies of the United Nations Secretariat covering "A Review of World Trends in Gross Domestic Product" was presented. This paper and related research[3/] by this U.N. Bureau has been used extensively in developing and evaluating the reasonableness of the SARC forecasts presented herewith.

Because the economic projections of the United States were related to forecasts in the growth of the GNP, and because the concept of GDP varies from the GNP, it was necessary to relate the U. S. GNP to the UN GDP data. In addition, GPO was used to allocate the total U. S. GNP to the various states and regions.

The following are the definitions of these terms as used in this study.[4/]

"GNP (gross national product) at current or market prices is the market value of the product, before deduction of provisions for the consumption of fixed capital,

3/ Proposal for Computer Work Regarding Long-Term Economic Projections of the Trade Needs of the Developing Countries, United Nations Secretariat manuscript November 25, 1963. Bureau of General Economic Research, United Nations, "A Review of World Trends in Gross Domestic Product," New York, March 3, 1964, E/Conf. 46/67

4/ United Nations, The Growth of World Industry, 1938-1961.

attributable to the factors of production supplied by normal residents of the given country. It is identically equal to the sum of consumption expenditure and gross domestic capital formation, public and private, and the net exports of goods and services plus the net factor incomes received from abroad."

The GPO (gross product originating), sometimes referred to as the gross private output, is a term developed and used by the National Planning Association. Simply stated the estimates and forecasts of GPO (gross private output) allocate the total GNP (gross national product) to various U. S. regions and states (sub areas) and the NPA methods in effect forecast the distribution of the GNP by state.

"The GDP (gross domestic product) at factor cost is the value at factor cost of the product, before deduction of provisions for the consumption of fixed capital, attributable to factor services rendered to resident producers of the given country. It differs from the gross domestic product at market prices by the exclusion of the excess of indirect taxes over subsidies."

Source Data

The gross domestic product (GDP) approach was buttressed by the availability of data from the bibliography, which will be found at the conclusion of this report. Supplementing these published resources, SARC researchers held conferences and contacts with experts in the Division of National Accounts, Economic Projections and Programme Center and Population Branch at the United Nations; Office of Program Coordinator, USAID, U.S. State Department; European Common Market in Washington; Regional Economics Division, Office of Business Economics, and Balance of Payments Division, U. S. Department of Commerce; U. S. Council of Economic Advisors; Immigration and Naturalization Service; U.S. Post Office Department; and the International Bank for Reconstruction.

The principal selected source data came from the Regional Economic Projection Series prepared by the National Planning Association of Washington, D. C. and the national account statistics, population projections and related research prepared by the Social and Economic Council of the United Nations. In addition related data and research statistics compiled by the International Monetary Fund, Washington, D.C.; the International Postal Union, Berne; the European Economic Community Commission, Brussels; and by private and public organizations such as the Twentieth Century Fund, the U. S. Department of State and the U. S. Department of Commerce were examined.

This work confirmed the availability of a few satisfactorily uniform and consistent bodies of data suitable for use on a long-range basis to portray world development. One such body of data was the preliminary draft of United Nations quintennial population projections for each nation from 1960 to 2000. These U. N. forecasts give a medium projection and a high and low variant. Another body of research data centered around the core concept of the gross domestic product used by the United Nations for countries of the Free World to facilitate international comparisons. Also helpful was the Regional Projection Series of the National Planning Association.[5/]

Estimates of GDP in Simulated SST Areas

The United Nations developed in 1964 an improved GDP for various countries based on the use of calculated parity rates of exchange rather than par values. A discussion of the improved method for calculating the 1953, 1958 and 1962 base data follows.

All U. N. estimates of the GDP are expressed in current U. S. dollars and are designed to facilitate international comparisons of levels of economic activity. A special effort was made to present a complete set of estimates for the year 1958 in order to make possible the compilation of comparable regional and global figures.

For most of the countries for which a GDP was prepared, the estimates are based on the official GDP figures in national currency shown in International

5/ United Nations, Provisional Report on World Population Prospects as Assessed in 1963, ST/SOA/SER/R-7 New York, 1964; United Nations Yearbook on National Account Statistics 1963. New York 1964; National Planning Association Regional Economic Projection Series, Vols. 1, 2 & 3, Washington.

Table 1 of the Yearbook of National Account Statistics 1963 United Nations. The national data were converted into U. S. dollars by means of the calculated parity rates. In general, parity rates for 1953, 1958 and 1962 were estimated by adjusting the official or free market exchange rates in 1938 for each country by the relative change in the level of prices from 1938 to the year in question, between the United States and the country concerned. The relative change in prices was measured by means of implicit price indexes of the gross domestic product where the data needed to compute these index numbers were available for the country concerned.

The required data consisted of estimates in current and constant national prices of the GDP or similar aggregate for 1938 and the particular year in question. Otherwise, recourse was had to implicit price indexes of value added in manufacturing, index numbers of producer prices. In some instances, analysis of the official or free rates for 1938 in the light of other available rates of conversion and prevailing economic and political conditions, indicated that they were too unrealistic to be utilized as the starting point for calculating the parity rates. In these instances, the starting point for the calculations was the official rate of exchange in 1929 or the purchasing power equivalent for 1950 and the publication, An International Comparison of National Products and the Purchasing Power of Currencies, by Milton Gilbert and Irving B. Kravis, OEEC, Paris.6/

These estimates of the GDP at parity rates should be considered as indicators of the total and also the per capita production of goods and services of the countries represented and not as measures of the standard of living of their inhabitants.

An estimated 1963 GDP for 30 simulated SST world areas and for the United States and Canada was extrapolated from the annual average compound rate of growth

6/ For further details concerning the methods and sources of data employed in calculating the parity rates, see Appendix II of the publication, The Growth of World Industry, 1938-1961: International Analyses and Tables, United Nations, New York.

[redacted]

for each country from 1958 to 1962.[7] In instances where only 1958 data existed and where a growth trend for a country was not available, a regional observed rate of growth from 1950-1960[8] was substituted and the probable 1963 GDP for such a country or group of countries was obtained. The estimates for each country were then aggregated into regional totals. These findings and the 1963 estimates of GDP for each of the 67 simulated SST regions and for the United States and Canada appear in Table 1.

Variant GDP Forecasts

In arriving at variant GDP forecasts for 1970, 1980, and 1990, the projected annual rates of growth for the 30 regions of the Free World outside of the U.S. and Canada and for the United States and Canada were calculated separately. This was done prior to the calculations of expected growth of the 37 regions within the latter two countries.

Since no long range projections of the Gross Domestic Product exist for the specific SST regions under consideration, the global data and projections for the Free World as developed in the United Nations Secretariat paper on GDP trends were used as parameters for the SARC forecasts. The medium, high and low variant for the GDP of each foreign simulated SST region was calculated on a judgment basis. This involved weighing the merits of three observed rates of growth for each area. The principal sources on which these judgments were based are: (1) the annual average rate of growth of the GDP between 1958 and 1963 as shown in Table 1, deflated to compensate for adjustments in the value of the dollar;[9] (2) the observed average annual rates of growth of the real gross domestic product between 1953 and 1961 as indicated in Table 2A of the United Nations Yearbook of National Account Statistics, 1963; and (3) the observed trends in world regional GDP growth as set forth in the cited

7/ United Nations Yearbook of National Account Statistics, 1963, Table III.

8/ United Nations Conference on Trade and Development. A Review of World Trends in Gross Domestic E/CONF 46/67, March 3, 1964.

9/ Implicit Price Deflater for the GNP - 1954 = 100.0; 1958 = 110.8; 1963 = 118.5; U. S. Department of Commerce Survey of Current Business, 1964.

[redacted]

United Nations review.[10/]

Reports and studies by the Twentieth Century Fund, the European Economic Community, the Government of Japan, the Office of Business Economics, U. S. Department of Commerce, the regional offices of organizations affiliated with the United Nations and international treaty organizations were evaluated.[11/] This latter research provided helpful guidelines in preparing the parameters for local area forecasts.

Most "long range" forecasts of economic growth extended only to 1970, and most were linear in logarithms with a high and low variant. An exception was a manuscript prepared in the U. N. Economic Projection and Programme Centre, where the problems relating to 20-year projections are analyzed.[12/] This research explored the expected impact of the population "explosion" on GDP growth. The paper makes two alternative assumptions. One is that the long range annual GDP growth will be constant and, in effect, linear from 1960 to 1980. The other assumption explores the impact of population growth - with a high projection that an annual variance of .1 of a percentage point in the annual rate of growth of the GDP could occur as early as 1965 in developing countries. If such assumptions proved true, then an upward swing in the annual rates of growth might be expected at the rate of .5 of a percentage point each five years. However, this assumption is based on both a substantial increase in world population and the fulfillment of high U.N. target rates of growth.

The National Planning Association in several studies has projected a tapering rate of growth in the GNP for the U.S.[13/] After testing, it was decided in this study to present linear projections to 1990 with a high, medium and low variant.

Again, it should be stressed that the SARC pro-

10/ Ibid. - [illegible] 1/.

11/ See bibliography.

12/ See bibliography.

13/ National Planning Association, Economic Projections to 1976 and 1985, Tech. Sup. No. 10, Washington, and Outdoor Recreation Resource Review Commission Report No. 23, to 1976 and 2000. (see bibliography) jections are judgment observations. On a worldwide basis the medium increase would be 200% or a 4.1% annual average rate of growth in the GDP to 1990, with a high of 4.8% and a low of 3.4% as the variant annual average rates of Free World GDP growth by 1990. The major rates of growth for particular regions likely will deviate from these projections due to short term cyclical effects or for political-economic reasons. Table 2 presents the 1963 estimated gross domestic product for the 30 extra-U.S./Canada regions, the U.S. and Canada, together with the projected high, medium and low variant annual rates of growth.

Variant GDP Forecasts for U.S. and Canada and for SST Regions Within These Countries

The variant projected GDP for the U.S. was determined separately. The medium annual average rate of growth for the U.S. was established at 3.6%. This figure was used for several reasons. The annual rate of growth between "1948 and 1962" would be 3.6% if the real GNP for 1947-1949 were averaged and then compared with the average for 1961-1963. It so happens that the rate of growth in the U.S. gross domestic product derived from U.N. data as shown in Table 2 is also 3.6% on a real dollar basis. The National Planning Association long range projections for the U.S. forecast a 4.2% growth rate to 1976 and a lower rate for the following years. When extrapolated to 1990, this indicates a 187.1% increase in the GNP, or the equivalent of a 3.6% growth rate from 1960 to 1990.

Using these cross-checked forecasts as a base, SARC took steps to allocate these variants to the 35 simulated regions of the U.S. An examination of the sources for U.S. regional economic projections disclosed that the National Planning Association's Center for Economic Projections had prepared the only presently recognized and reasonably consistent body of data suitable to forecast economic growth to 1976 by state.[14/] SARC has relied on these regional economic projections to establish the average annual rate of GPO (gross private output) growth for each of the 48 continental states. It has also been assumed in this study that

14/ See bibliography.

the ratio of distribution of the GDP (gross domestic product) by state if such data were available would be equivalent to the distribution of GPO.

The National Planning Association GPO forecasts by state are based on economic and other demographic trends observed between 1947 and 1957 or 1950 and 1960, respectively. More recent research and data shortly will supplement these observations, but the development of forecasts from these contemporary studies still awaits final release.[15/] The NPA plans to make available revised regional forecast data in late 1964 or 1965. The SST regional structure developed for this study has been contrived so that these new findings and any other authoritative data which become available may be easily substituted for data used herein.

significant shifts or changes in forecasts may occur, we believe, will be a more coherent projection of U.S. growth by regions.

The NPA forecasted gross private output annual rates of growth. The GPO for each state as of 1957 was used to prepare by interpolation a 1963 benchmark GPO and a 1970 estimated GPO, and subsequently, by extrapolation the 1980 and 1990, GPO for each of the 48 continental states. The GPO estimates for Hawaii and Alaska in 1963-1970, 1980 and 1990 were obtained by estimating the total U.S. GPO for these years and arriving at the Hawaii and Alaska estimates as a direct function of the U.S. growth.

Once the GPO estimates for the 50 states were established, they were aggregated to obtain the estimated and forecasted GPO for each of the 35 U. S. regions. Where these regions were composed of parts of states, the statewide shifts in population between 1930 and 1960 and the reported personal income in 1959 were used to determine the probable GPO originated in each sub-state area as of 1963. The forecasted growth of these sub-state areas, however, has been held constant in the SARC projections.

Assuming that the distribution of the estimated GDP by state would be the same as the distribution

15/ U.S. Department of Commerce, Regional Change in a National Setting. Staff Working Paper in Economics and Statistics, No. 7. April 1964 by Dr. Lowell D. Ashby.

of the U.S. GPO among the 35 U.S. regions, a ratio method of distribution was used to allocate the estimated medium U.S. GDP for the 1963 base year and for each forecast period 1970, 1980 and 1990 to each of the 35 regions. Once these estimates were prepared, the average annual rates of growth of the medium projection for each region were calculated.

The high variant for each region was established at the projected average annual rates of GPO used by the National Planning Association for the 48 states. The low variant was set at .6 of a percentage point below the medium growth rate variant for each region. This low variant growth rate, when aggregated for the U.S. approximates the average annual rate of GDP growth for the U.S. as observed by the U.N. between 1953 and 1962.

Since National Planning Association projections of the GPO were prepared for the forty-eight states, excluding Hawaii and Alaska, the estimate of the GDP for these two states was arrived at separately. The Hawaiian and Alaskan GDP were established by the following method. First a U.S. 1963 per capita GDP was estimated. Then, the percentage difference from the national average of both states' per capita personal income was used to calculate the assumed per capita GDP for the respective states. Finally, the cross products of these per capita gross domestic products and the states' 1963 population yielded the region's 1963 GDP. Forecasts of the regions' GDP growth were assumed to be the same as the growth for the U.S. as a whole.

The distribution of GDP for the two Canadian SST regions was made on the basis of the estimated percentage of 1963 population living in each region.[16/] Though the percentage of disposable personal income is presently somewhat higher in the Western Canadian region than in Eastern Canada, the thirty-year trend of population growth and projected growth of population and industry in Eastern Canada could offset this differential. However, due to lack of research comparable to National Planning Association Regional Studies

16/ Survey of Buying Power, Sales Management, 1964.

[redacted]

mentioned previously, it was assumed that Canadian GDP would be split best by the method mentioned above.

Table 3 presents the estimated 1963 Gross Domestic Product and the high, medium and low variant of the projected annual average rate of growth to 1990 for each of the 35 United States regions and for the two Canadian regions.

TABLE 1

ESTIMATED GROSS DOMESTIC PRODUCT AND GROWTH RATE
FOR
THE UNITED STATES AND CANADA
THIRTY SIMULATED SST WORLD REGIONS
1958 - 1963
(Millions of Constant U.S. Dollars)

Region Number	Simulated SST Regions	Gross Domestic Product 1958	Gross Domestic Product 1963	Average Annual Rate of Growth
1-35	United States	$406,474	$525,755	4.7
36-37	Canada	29,972	36,955	5.4
38	Caribbean	4,886	5,914	9.4
39	South America	13,649	15,453	2.5
40	South America	9,530	15,585	9.0
41	South America	8,035	11,281	7.0
42	South America	2,495	3,450	6.7
43	Central America	13,276	18,108	6.4
44	Pacific	13,907	18,296	6.3
45	Pacific	3,685	4,805	6.1
46	Asia	33,252	61,700	13.1
47	Asia	4,530	6,439	7.3
48	Asia	12,264	15,349	4.7
49	Asia	37,133	45,655	4.2
50	Eurasia	6,326	8,920	6.9
51	Eurasia	12,127	16,940	6.8
52	Europe	23,920	32,243	6.2
53	Europe	65,282	81,569	4.5
54	Europe	1,643	2,216	3.9
55	Europe	11,609	15,749	6.8
56	Europe	9,803	12,383	4.7
57	Europe	52,335	72,281	7.0
58	Europe	13,070	18,789	7.5
59	Europe	59,679	87,265	7.9
60	Europe	33,779	49,526	7.7
61	Europe	17 278	22,362	5.3
62	Africa	5 309	6,376	3.7
63	Africa	5 355	6,511	4.0
64	Africa	2 493	2,754	2.0
65	Africa	1,329	1,590	3.7
66	Africa	5,227	5,754	1.9
67	Africa	8,320	11,373	5.3
		$925,974	$1,239,256	6.0

SOURCE: See Text and United Nations Yearbook of National Account Statistics, 1963, Table 3-B.

Average annual rate of growth in constant dollars.

TABLE 2

ESTIMATED HIGH,
MEDIUM AND LOW ANNUAL RATES OF GROWTH
BY SST WORLD SIMULATION REGIONS

1963 - 1990

Region Number	SST Regions	Estimated Annual Growth Rates High %	Medium %	Low %
1-35	United States	4.2	3.6	3.0
36-37	Canada	4.2	3.6	3.0
38	Caribbean	8.4	5.2	4.5
39	South America	5.6	5.0	4.5
40	South America	5.6	5.0	4.5
41	South America	5.6	5.0	4.5
42	South America	5.6	5.0	4.5
43	Central America	5.6	5.0	4.5
44	Pacific	4.5	4.1	3.7
45	Pacific	4.7	4.1	3.7
46	Asia	7.5	6.0	4.5
47	Asia	5.9	5.1	4.2
48	Asia	5.6	4.9	4.2
49	Asia	5.6	5.0	4.4
50	Eurasia	6.0	5.2	4.4
51	Eurasia	5.6	5.0	4.2
52	Europe	4.8	4.2	3.6
53	Europe	3.8	3.4	3.0
54	Europe	4.8	4.2	3.6
55	Europe	5.0	4.3	3.6
56	Europe	4.8	3.6	3.2
57	Europe	5.0	4.4	3.6
58	Europe	5.0	4.4	3.6
59	Europe	5.0	4.4	3.6
60	Europe	5.0	4.2	3.6
61	Europe	5.0	4.1	3.0
62	Africa	5.0	4.1	3.2
63	Africa	5.0	4.1	3.2
64	Africa	5.0	4.1	3.2
65	Africa	5.0	4.1	3.2
66	Africa	5.0	4.1	3.2
67	Africa	5.0	4.2	3.4

Rate of Growth in constant dollars.

Gross Domestic Product in Millions of U.S. Dollars.

TABLE 3

ESTIMATED GROSS DOMESTIC PRODUCT AND
HIGH, MEDIUM AND LOW ANNUAL RATES OF GROWTH
BY SST WORLD SIMULATION REGIONS

1963 - 1990

SST Regions	Estimated Gross Domestic Product 1963	Estimated Annual Growth Rates High %	Medium %	Low %
US-1	$ 22,294	4.1	3.5	2.9
US-2	64,534	4.1	3.5	2.9
US-3	17,455	3.8	3.2	2.6
US-4	8,697	4.1	3.5	2.9
US-5	23,089	3.9	3.3	2.7
US-6	16,677	3.7	3.1	2.5
US-7	22,227	4.4	3.8	3.2
US-8	18,734	3.8	3.2	2.6
US-9	19,021	4.1	3.5	2.9
US-10	13,613	3.9	3.3	2.7
US-11	10,213	4.3	3.7	3.1
US-12	14,642	4.4	3.8	3.2
US-13	11,849	5.8	5.2	4.6
US-14	11,721	4.3	3.7	3.1
US-15	14,141	4.0	3.4	2.8
US-16	36,835	3.7	3.1	2.5
US-17	24,575	3.6	3.0	2.4
US-18	10,916	4.1	3.5	2.9
US-19	4,592	3.6	3.0	2.4
US-20	13,579	3.8	3.2	2.6
US-21	10,777	3.4	2.8	2.2
US-22	12,457	3.9	3.3	2.7
US-23	18,576	4.5	3.9	3.3
US-24	14,641	4.6	4.0	3.4
US-25	3,625	5.4	4.8	4.2
US-26	6,240	4.6	4.0	3.4
US-27	3,897	4.1	3.5	2.9
US-28	10,063	3.8	3.2	2.6
US-29	4,648	4.0	3.4	2.8
US-30	20,999	4.8	4.2	3.6
US-31	33,290	4.8	4.2	3.6
US-32	1,113	5.5	4.9	4.3
US-33	3,193	5.3	4.7	4.1
US-34	2,022	4.2	3.6	3.0
US-35	840	4.2	3.6	3.0
Total USA	$525,785			
C-1	27,147	4.2	3.6	3.0
C-2	9,838	4.2	3.6	3.0
Total Canada	$ 36,985			

Rate of Growth in constant dollars.

Gross Domestic Product in Millions of U. S. Dollars.

PART I

CHAPTER III

FREE WORLD ORIGIN AND DESTINATION DATA

In the development of a flexible Free World Demand Model that would be applicable to the 1970-1990 time period (Chapter I), it was essential to obtain the latest and most authoritative information available on passenger traffic origin and destination (O&D). Thus, a fundamental requirement of this study was to ascertain where the 135 million Free World air passengers during 1963 began and terminated their trips.

Once this basic task was accomplished, it would be necessary also to the validity of the SST economic analysis to examine this total passenger flow in terms of business vs. personal traffic, first class vs. economy, and winter vs. summer. These factors, and others which can be expected to impinge on SST origin and destination, are discussed in detail in later sections of this report.

Complete documentation on world O&D traffic is not possible. This is particularly so in overseas travel, where more precise data are needed. However, available information has permitted distribution of 1963 air travel, first, among 10 Free World areas, and then among 67 regions and more than 2,000 "regional pairs" in accordance with procedures necessary for integration into the total SST economic study. Inter-area and inter-regional passenger flows were determined through review and analysis of published data, such as statistics from ICAO, IATA, CAB, and the U.N. Important also were the inputs from unpublished data, such as international mail flow, international export movements, and global telephone traffic patterns.

The review and analysis of such indices as communications and commerce have helped fill the gaps in the documentation of Free World air passenger traffic, but these "gap fillers" must be recognized for what they are. Hopefully, in the years immediately ahead, steps will be taken to eliminate deficiencies in the world-wide O&D data.

<u>Worldwide Air Passenger Volumes 1963</u>

Passenger traffic statistics compiled by ICAO

[redacted]

for 1963 show that of the total 135 million Free World air passengers, 102 million flights were made within the national boundaries of 82 nations. The remaining 33 million passengers were on international flights. ICAO receives air carrier reports from each nation in which total passenger loads are divided into domestic and international categories. The ICAO data do not provide details as to air travel O&D, but this remains the single most authoritative source of total Free World air passenger travel now available. Supplementing the ICAO reports are a recent study of the Stanford Research Institute, and several studies made by the Boeing Airplane Company. These and other studies referred to in this Chapter are listed in the bibliography.

ICAO summary data for 1963, shown in Table 4, present a breakdown of principal passenger distributions into particular countries for domestic travel, and into principal inter-area movements for international travel. Because ICAO data on domestic sub-totals by nations were not yet available for 1963, this was derived from analysis of trends through 1962.

It was necessary also to make parallel projections in international travel, as is explained in footnotes to Table 4. International passenger volumes between the listed countries and/or areas were determined through use of IATA and European Research Bureau data, and from studies made by the Stanford Research Institute, Boeing Airplane Company, and Systems Analysis and Research Corporation.

The 33 million international air passengers during 1963, as shown in Table 4, are divided among 16 classifications, of which three are sharply dominant: Intra-Europe; U.S. and Canada-Europe; and U.S. and Canada-Central America and Caribbean.

The purposes of this SST economic analysis required (1) a more precise definition than hitherto available of air passenger volume for the United States, (2) the determination of air passenger volumes within Canada between the two regions selected for that country, and (3) a more informative sub-division of the "other international" total, shown as

5,190,000 passengers on the last line of Table 4. The following tables and text in this section set forth the results achieved and the methodology used.

(1) United States Domestic Passengers

Fortunately, accurate records covering true passenger origin and destination within the 48 contiguous United States are available. In addition, authoritative O&D data are available for air passenger traffic between these 48 states and Hawaii and Alaska and also within the islands of Hawaii.

These statistics provide the basis for derivation of the true origin/destination domestic travel of passengers in all 50 states. As shown in Table 5, there were 50,750,000 United States air passengers during 1963.

It is to be noted that this total of 50,750,000 differs from the 65,660,000 reported by ICAO (Table 4) for total U.S. domestic passenger traffic. The ICAO figure is based upon passenger origins as reported by each airline. Individual carrier passenger figures then are summed to produce the ICAO total. Obviously, this results in a considerable duplication of passenger count. This duplication is probably more widespread for the U.S. than in any foreign country, because of the relatively large number of carriers (a minimum of 11 trunklines and 13 local service lines within the 48 contiguous states). The great bulk of the 15,000,000 passenger difference is accounted for by this duplication. Any remaining difference between the ICAO tabulation and the true 50-state O&D passenger total is attributable to a difference in definition as to domestic vs. territorial and international traffic. One example is the inclusion of Puerto Rican traffic within the domestic U.S. total by ICAO, and its exclusion from the domestic U.S. for purposes of this study.

(2) Canadian Air Travel

Table 5 also sets forth total domestic passengers for Canada and explains the derivation of the so-called "inter-regional" total of 570,000 passengers. The 570,000 passenger figure represents that portion of total air passenger volume moving entirely within the

[redacted]

boundaries of Canada from origin to destination which could conceivably be regarded as part of the demand within that country for long-haul air travel. This is travel in excess of 900 l miles.

It should be noted that stic passengers for only Canada and the United States are so regarded in this study. In the cases of all other countries, domestic air passenger travel has been eliminated from consideration as a potential source of demand for long-haul jet or supersonic transports.

(3) Distribution Between Areas of "Other International Passengers"

It will be recalled in Table 4 that 5,190,000 of the total international passengers recorded by ICAO were lumped together in a miscellaneous classification, and remained to be distributed in terms of inter-area passenger flow volumes. Table 6 which follows, lists the distribution of these "other" international passengers. The distribution was accomplished as follows:

1. Wherever origin and destination passenger traffic data were available, particularly to and from the U.S., distributions were based upon such traffic.

2. Where such data were felt not to be reliable, mail flow volumes between areas, telephone call summaries between areas and/or exports in terms of U.S. dollars were used as means of distributing passenger traffic.

Before these data were utilized, control comparisons were made in terms of these various indices of community of interest and actual documented air travel volume. Such analyses revealed, particularly in the cases of inter-area mail flow and export volume that there was a meaningful correlation with actual passenger travel.

As shown in Table 6, of the 5,190,000 total, the greatest passenger flow volumes so allocated were between Asia and Europe and between Asia and Africa.

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Travel between Central America and the Caribbean and between Central America and South America followed in order of importance.

TABLE 4

DISTRIBUTION OF FREE WORLD AIR PASSENGERS

1963

	Passengers (000,000)
Grand Total	135.00 11/
Domestic Total	102.00 11/
United States	65.66 1/
Europe	11.07 2/
South America	8.44 3/
Asia	6.08 3/
Canada	3.31 3/
Other Domestic	7.44 3/
International Total	33.00 11/
Intra-Europe	13.10 4/
U.S. and Canada-Europe	3.20 5/
Europe-Eurasia	1.31 6/
Europe-Africa	1.06 6/
Asia-Eurasia	.47 6/
U.S. and Canada-Central America and Caribbean	3.91 6/
U.S. and Canada-South America	.63 6/
Europe-Central America, Caribbean and South America	1.06 7/
U.S.-Canada	.63 8/
U.S. and Canada-Pacific	.16 9/
U.S. and Canada-Asia	.61 6/
Pacific-Asia	.15 9/
Pacific-Europe	.08 9/
Intra-Asia	.50 9/
Intra-Africa	.37 10/
Intra-South America	.57 10/
Other International	5.19*

*For distribution of this total among remaining areas, see Table 7.

Footnotes are opposite.

TABLE 4

Footnotes -

1/ By applying 1962-1963 percentage increases of trunk and local air carrier totals to 1962 ICAO figure for USA total domestic passengers.

2/ By applying 1962-1963 percentage increases of EARB member carriers to 1962 ICAO figure for European domestic passengers.

3/ By increasing 1962 ICAO figures for these areas sufficiently to equal Total Domestic less U.S. and Europe. "Other Domestic" includes Eurasia, Africa, Pacific and Central America domestic passengers.

4/ Traffic and operating data EARB Carriers, June 1964.

5/ IATA carrier total of 2.72 million divided by 89.5% (proportion of total ICAO traffic accounted for by these 17 carriers).

6/ Boeing Airplane Company's 1963 passenger estimates, for IATA carriers ÷ 89.5% to reflect total passengers of all carriers.

7/ Estimated, consistent with SRI study, at one-third North Atlantic volume.

8/ Based on U.S. Flag O&D total expanded to include foreign flag passengers at 35% of all carrier total, consistent with a SARC 1961 study of international air travel.

9/ SRI and Boeing estimates combined to determine distribution.

10/ Derived from ICAO data and estimates of total international passengers within these two continents.

11/ ICAO, 1963.

[redacted]

TABLE 5

DERIVATION OF UNITED STATES AND CANADA
PASSENGER TOTALS

1963

United States		
Total Origin-Destination Passengers		
48 State Total	49,047,000 1/	
Intra-Hawaii Total	788,000 1/	
Hawaii and Alaska to and from Other States	691,000 1/	
Intra-Alaska Total	224,000 2/	
Total U.S.-50 States		50,750,000
Canada		
Inter-Regional Passengers		
1962 Inter-Regional Passengers Among Canada's 21 Principal Air Passenger Cities	379,915 3/	
Total Canadian Passengers Generated by These 21 Cities (Intra and Inter-Regional)	2,210,390 3/	
Percent, Inter-Regional of Total		17.2%
Canada's Total Domestic Air Passengers, 1963		3,310,000 4/
Canada's Total 1963 Inter-Regional Passengers (3,310,000 x 17.2%)		570,000

1/ From CAB Passenger O&D Surveys, 1963.

2/ From Intra-Alaskan Carrier's passenger origination reports, 1963.

3/ Domestic Passenger Origin and Destination Statistics, Air Transport Board, Ottawa, Canada.

4/ From Table 4.

TABLE 6

ALLOCATION OF "OTHER INTERNATIONAL PASSENGERS"

1963

	Passengers (000,000)
Total - All "Other" Inter-Area Passengers	5.19
Inter-Area Allocation	
U.S.-Eurasia	.28 1/
U.S.-Africa	.21 1/
Canada-Eurasia	.03 1/
Intra-Central America & Caribbean	.19 2/
Central America & Caribbean-South America	.63 4/
Central America & Caribbean-Pacific	.03 5/
Central America & Caribbean-Asia	.20 4/
Central America & Caribbean-Eurasia	.01 4/
Central America & Caribbean-Africa	.10 4/
South America-Pacific	.02 5/
South America-Asia	.10 4/
South America-Eurasia	.04 4/
South America-Africa	.02 4/
Intra-Pacific	.19 2/
Pacific-Eurasia	.07 5/
Pacific-Africa	.14 5/
Asia-Europe	1.30 3/
Asia-Africa	.91 4/
Intra-Eurasia	.36 2/
Eurasia-Africa	.35 4/

Footnotes on following page.

[redacted]

TABLE 6

Footnotes -

1/ Based upon distribution of mail to U.S. and Canada from Eurasia and Africa relative to that of mail to U.S. and Canada from four other areas.

2/ Based upon ratios of estimated intra-area international passengers (four areas shown in Table 4) to total international passengers of those areas (from ICAO data).

3/ Based upon ratios of estimated passengers between Europe and two other areas to mail flow between Europe and these other areas - applied to Europe - Asia mail flow.

4/ After the allocations described in 1/, 2/, and 3/ above, 2.62 million passengers remained to be allocated. Mail flow and export flow data showed that some 10% of this total should be allocated to inter-area passengers to and from the Pacific (between the Pacific and Africa, Eurasia, South America and Central America and the Caribbean), while 90%, or 2.36 million passengers should be allocated to the remaining nine inter-area categories. This 2.36 million passenger total was allocated among these nine categories on the basis of each category's percent of total pieces of mail flowing between each pair of areas making up the nine categories.

5/ In the absence of detailed mail flow data to and from the Pacific area, the remaining 260,000 passengers were allocated to the four area pairs involving the Pacific on the assumption that passengers between the Pacific and these four areas would be distributed as were passengers between Asia and these same four areas.

Total Inter-Area Distribution of 1963 Passengers

The summary shown in Table 7 indicates the results of the foregoing distributions of total Free World passenger volumes among the principal areas of concern in this study. As shown in the table there are 36 totals which describe passenger volumes flowing between these areas and an additional nine totals which show other passenger flows within the nine areas studied.1/

1/ A total of 10 areas rather than nine were selected for study in this report. Tables 7 and 8 show only nine areas - combining the Central American area, with the Caribbean area. This was done for technical reasons, particularly because most sources presented data only for the one "Latin American" area. Shown separately in Table 9 is the individual breakdown for these two areas.

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[redacted]

TABLE 7

SUMMARY OF INTRA-AND INTER-AREA DISTRIBUTION OF 1963 PASSENGERS
(Millions)
(Passengers are International Passengers Except for Intra-U.S. and Intra-Canada)

Between: And	U.S.	Canada	Central America & Caribbean	South America	Pacific	Asia	Eurasia	Europe	Africa
	Passengers (000,000)								
United States	50.75 1/	.63 2/	3.31 3/	.53 3/	.14 3/	.52 3/	.28 5/	2.71 3/	.21 5/
Canada		.57 1/	.60 3/	.10 3/	.02 3/	.09 3/	.03 5/	.49 4/	.01 5/
Central America and Caribbean			.19 5/	.63 5/	.03 5/	.20 5/	.01 5/	.25 4/	.10 5/
South America				.57 2/	.02 5/	.10 /	.04 5/	.81 4/	.02 5/
Pacific					.19 5/	.15 2/	.07 5/	.08 2/	.14 5/
Asia						.50 2/	.47 2/	1.30 5/	.91 5/
Eurasia							.36 5/	1.31 2/	.35 2/
Europe								13.10 2/	1.06 2/
Africa									.37 2/

Total Passengers Distributed above 84.32 million

1/ From Table 5.

2/ From Table 4.

3/ U.S. and Canada totals from Table 4 split on basis of each country's share in North Atlantic passenger traffic in 1963 - 84.75% for U.S. and 15.25% for Canada.

4/ Europe - Central and South American passengers from Table 4 split between Central America and Caribbean on one hand and South America on the other on basis of ratios of total international passengers (23.5% and 76.5%, respectively).

5/ From Table 6.

[redacted]

[redacted]

Inter-Regional Distribution of 1963 Passengers

For purposes of this study, the Free World was divided into 10 areas and each of these, in turn, was divided into regions. For the entire Free World, there were 67 regions, 33 within the 48 United States, 2 more for Alaska and Hawaii, 10 within the area of Europe and lesser numbers for other areas. This section of the report explains the methods used to determine passenger flows within each pair of the 67 regions selected - 2,211 pairs or combinations in all, and thus to describe the means by which the intra-area and inter-area passenger flows, as summarized in Tables 7 and 9, were distributed in further detail into inter-regional categories.

For four of the areas shown in Table 7, each with only two regions, (Canada, Central America and Caribbean, Pacific, and Eurasia) the previous totals shown in Table 7 for intra-area passengers provided the required detail in terms of inter-regional breakdown. This is because there was only one pair of regions and therefore one inter-regional total for such areas.

The detailed and comprehensive CAB origin and destination data for passenger movement in the United States permitted a direct derivation of the required inter-regional detail. Such detailed O&D data, applied to the total of 50.75 million U. S. passengers in the 50 states (Tables 6 and 7) reduced this total to 45.64 million passengers moving inter-regionally between the 35 selected regions of the U.S. This reduction of 5.11 million passengers represents passengers who move intra-regionally only, and consequently are not the concern of this study.

As to the remaining 40 selected passenger flows throughout the world, three basic methods were employed in order to accomplish the necessary inter-regional distributions. Wherever possible, origin and destination passenger data from CAB surveys for the months of March and September 1963 were utilized. As shown in Table 8, this approach was used for the inter-regional distribution of passengers in the U.S. and Canada, and in 30 foreign regions.

[redacted]

Unfortunately, similarly reliable data as to actual passenger origin and destination are not available in determining inter-regional flows between foreign areas. This gap required reliance on other data indicating probable inter-regional passenger movements, such as movement of mail inter-regionally, and flow of exports between regions. As shown by Table 8, mail distributions were utilized in some of the more significant inter-regional combinations, particularly intra-Europe, intra-Asia, Europe to Asia, and between Central America and the Caribbean, and Asia and Europe.

Mail flow statistics were not available for the Pacific area and were incomplete also as between specific regions in several of the other areas. In such cases, export data were utilized, as shown by Table 8. This methodology resulted in the complete inter-regional distribution of the Free World 1963 passenger total of 78.29 million passengers. (84.32 million shown in Table 7 less 6.03 million U.S. intra-regional passengers).

As noted earlier, summary Tables 7 and 8 include only 9 of the 10 areas selected for analysis. Two of the selected areas - Central America and the Caribbean - were combined. In Table 9, the individual figures for each of the two areas are summarized. CAB international origin and destination data for passengers were utilized to derive the passenger flows between each of these two areas to and from both Canada and the United States. Mail and export flow data provided the basis for distribution between each of these areas and the other foreign areas.

The same statistical bases were used to provide the more detailed inter-regional distribution, that between each of the two regions Central America and the Caribbean and the other 65 regions.

In summary, inter-regional passenger flows were derived for a total of 2,211 pairs of regions. The results of this distribution, too voluminous to be included in tabular form in this section, are reproduced in a machine run supplement to this report.

TABLE 8

DISTRIBUTION OF 1963 TOTAL INTER AND INTRA-AREA PASSENGERS ON AN INTER-REGIONAL BASIS

Region - - - - - - - - -		1-35	36,37	38,43	39-42	44,45	46-49	50,51	52-61	62-67
	Area - - - - - - -	U.S.	Canada	Central America & Caribbean	South America	Pacific	Asia	Eurasia	Europe	Africa
1-35	United States	1/	3/	4/	4/	4/	4/	4/	4/	4/
36,37	Canada		2/	5/	5/	5/	5/	5/	5/	5/
38,43	Cen.Am. & Caribbean			2/	7/	7/	6/	7/	6/	7/
39-42	South America				7/	7/	7/	7/	7/	7/
44,45	Pacific					2/	7/	7/	7/	7/
46-49	Asia						6/	7/	6/	7/
50-51	Eurasia							2/	7/	7/
52-61	Europe								6/	7/
62-67	Africa									7/

1/ CAB origin-destination data permitted the direction elimination of intra-regional passengers, resulting in a reduction from 50.75 million total O&D to 45.64 million inter-regional passengers for the 50 United States.

2/ Inter-regional total identical to Table 5 figure for Canada and Table 6 figures for Central America and Caribbean, Pacific and Eurasia (each having only 2 regions).

3/ Distributed between the two Canadian regions on one hand, and the 35 U.S. regions on the other hand, on basis of 1963 O&D passenger distribution.

4/ Distributed between each U.S. region on one hand, and each region of each foreign country, on the other hand in same proportions as U.S. foreign passengers in 1963 were distributed.

5/ Canada region 36 passengers distributed in same proportions among foreign regions as U.S. region 3 passengers were distributed; Canada region 37 distribution same as U.S. region 28.

6/ Distributed inter-regionally in same proportions as inter-regional distribution of mail.

7/ Distributed inter-regionally in same proportions as inter-regional distribution of exports.

[redacted]

TABLE 9

DISTRIBUTION OF TOTAL CENTRAL AMERICA AND CARIBBEAN PASSENGERS

Between: And-	Passengers (000,000) Total Central America & Caribbean 1/	Central America	Caribbean
United States	3.31	.843	2.467
Canada	.60	.150	.450
South America	.63	.052	.578
Pacific	.03	.015	.015
Asia	.20	.115	.085
Eurasia	.01	.0004	.0096
Europe	.25	.096	.154
Africa	.10	.014	.086

1/ From Table 7

Non-Scheduled Passengers

Consideration was given by SARC investigators to the inclusion of non-scheduled air passenger traffic in this study, both in the forecast and in the Free World distributions of passengers. In view of the lack of a reliable basis upon which either to forecast or distribute such traffic, however, these passengers have been excluded. Non-scheduled air passenger volumes have thus far been of minor importance in all Free World areas except across the Atlantic and within Europe. Even though there may be some basis for inclusion of such traffic in these areas within this study, the period of experience is very short - three to five years - and little or no basis for inter-area or inter-regional distribution exists. No data whatsoever are available as to non-scheduled actual or potential passenger volumes in other world areas or regions, including the United States of America. In addition, the volume of non-scheduled traffic will vary widely with changing policies on scheduled air fare levels.

[redacted]

The recently introduced group fares provide one example of changed policy in the North Atlantic area. The unpredictability of future policy changes is another reason for not attempting a forecast of non-scheduled air passengers.

The net effect of the exclusion of all such passengers for these reasons, will, of course, tend to be an understatement of total available air passengers for current or future periods.

PART I

CHAPTER IV

"STATE OF THE ART" FACTOR IN ASSESSING AIR TRAVEL GROWTH

The analysis of the origin and destination travel of 135 million Free World passengers during 1963 and the division of this travel into areas and regions in Chapter III provide a foundation for discussing in this chapter the crucial relationship between the growth of air travel and the rise in gross national product. Because the SST study deals with the 1970-1990 period, it is vital to project air travel potential as accurately as available data, admittedly deficient, will permit on a global basis. In such a projection, no single factor is more important than the interplay of gross national product growth on air travel flows.

It is estimated, as detailed and documented in this chapter, that by 1975, the domestic passenger traffic originated in the United States alone will surpass the contemporary total Free World air travel. By 1990, it may be anticipated that 283 million airline passengers will be originated in the United States.

The prospects are that air travel, will continue to increase annually in the United States, through 1990, but at a steadily declining rate. At the same time, however, air travel will continue to grow at a greater rate than the growth in gross national product for the next 27 years.

Forecasting air travel with a formula based, essentially, upon future gross products will therefore produce an understatement of future volumes of air travel. A means of correcting such gross product formula results is required and is developed in this chapter. The correction is called the "State of the Art" factor, since the greater growth rates of air travel are felt to be attributable, in substantial part, to continuing improvements in air services provided, particularly increased safety, comfort, and reliability of air travel and increasing technological advances in aircraft equipment.

The assumptions and background for the air passenger forecast made in this chapter should be clearly understood at the outset. In light of thorough analyses of the changing nature of the airline product since 1950, of the vacillations in airline prices and of the growth of the United States economy during this same period, a basic assumption has been made that future air fare levels will remain constant in real dollar terms, at approximately 1963 levels. While it is true that, primarily as a result of the expansion of air coach passenger traffic, airline fares declined some 12% from 1951 to 1963, this decline was not a steady one and, in fact, air fare levels within the United States increased more than 8% from 1957 through 1962. Air coach passenger traffic increased as a percent of total from 13% in 1950 to 68% in 1963 so that this source of continued reductions in airlines prices has been exhausted.

Moreover, costs for both labor and materials required by airline operation will continue to climb as they have in the past. In addition, increasing user charges to be levied by the government upon the airline industry for use of the airports and airways will add to operating costs. This increasing cost trend will probably not be offset, as it was to a large degree in the past, by increased productivity, since the quantum jump in productivity which long haul jet operation began to bring in the late 1950s have by now been largely exploited.

No one, even in the airline industry, can accurately foresee what will be the future trends in airline prices. Despite the relatively prosperous years of 1963 and 1964, however, one major United States airline already has proposed a fundamental change in airline pricing policy calling for substantil increases in all short haul fares with some reduction in longer haul fares. The net effect of this proposal can not be precisely determined but it will probably increase the average price per passenger mile and will almost certainly increase the average fare paid per passenger.

The final consideration which prompted the assumption of constant fare level in the future in this study was the study requirement for a forecast which would ultimately be applied on an inter-regional basis -- 2,211 pairs of regions. Obviously, there will be many fare changes in the future in many of these regional pairs -- both upward and downward during the forecast period. The impossibility of predicting specific fare changes in this great variety of situations should be apparent.

In light of the foregoing, the air passenger forecast developed in this chapter assumes a stable air fare level in constant dollars at the 1963 level for the forecast period. This, we believe, to be a reasonable assumption not only for the foregoing reasons but, further, because of the use to which the forecast in this study is to be put, i.e., as a level of indicated air travel demand at various times in the future, within which the effects of various mixes of subsonic and supersonic equipment and schedules may be examined.

However, if for purposes of the simulation analysis, changes in fare levels are assumed,

[redacted]

provision has been made in the Demand Model for estimating the effect of fare changes on demand.

Past U.S. Traffic Growth

The chart and the table which follow summarize U.S. domestic air passenger traffic growth since 1930. This includes traffic generated by the domestic operations of the trunklines and local service carriers, helicopter operators and intra-Hawaii and intra-Alaska traffic. The figures recorded are those appearing in official CAB publications for revenue passengers originated by these carriers in domestic operations only.1/ The passenger miles shown also

1/ It will be recalled from the previous chapter that true origin and destination passengers from CAB surveys were used to determine inter-regional passenger volume. The use of revenue passengers originated in the present chapter, rather than true origin and destination of passengers may raise some question of consistency. Were true origin and destination passenger data available for a ten-year or longer period these data would be utilized here. Unfortunately, such data are available only as far back as 1959, and for that reason passenger originations are used here. The forecast is, nevertheless, not felt to be inconsistent, in view of the fact that the ratios between true O&D passenger volumes and passengers originated since 1959 have been constant, varying very narrowly between 77% and 78%. Annual rates

are those reported by the CAB for the same periods for such operations. The analysis covers the period from 1930 through 1964 - the latter year estimated on the basis of the first eight months' recorded figures.

As shown by Chart 1 and Table 10, annual growth rates in terms of either passengers or passenger miles have been declining since 1935, although for individual years, growth rates have varied widely, a pattern typical of relatively young growth industries. From 1935 to 1940, four of the five years registered growths of more than 20% over the previous year, ranging from 22% to 62%.

Lower growth rates took place after World War II. From 1949 to 1954, four of the five years grew from 11% to 15% over the previous year, with one year showing a rate of 30%. In the next five years, there was one year of decline, two years with growths of 8% and

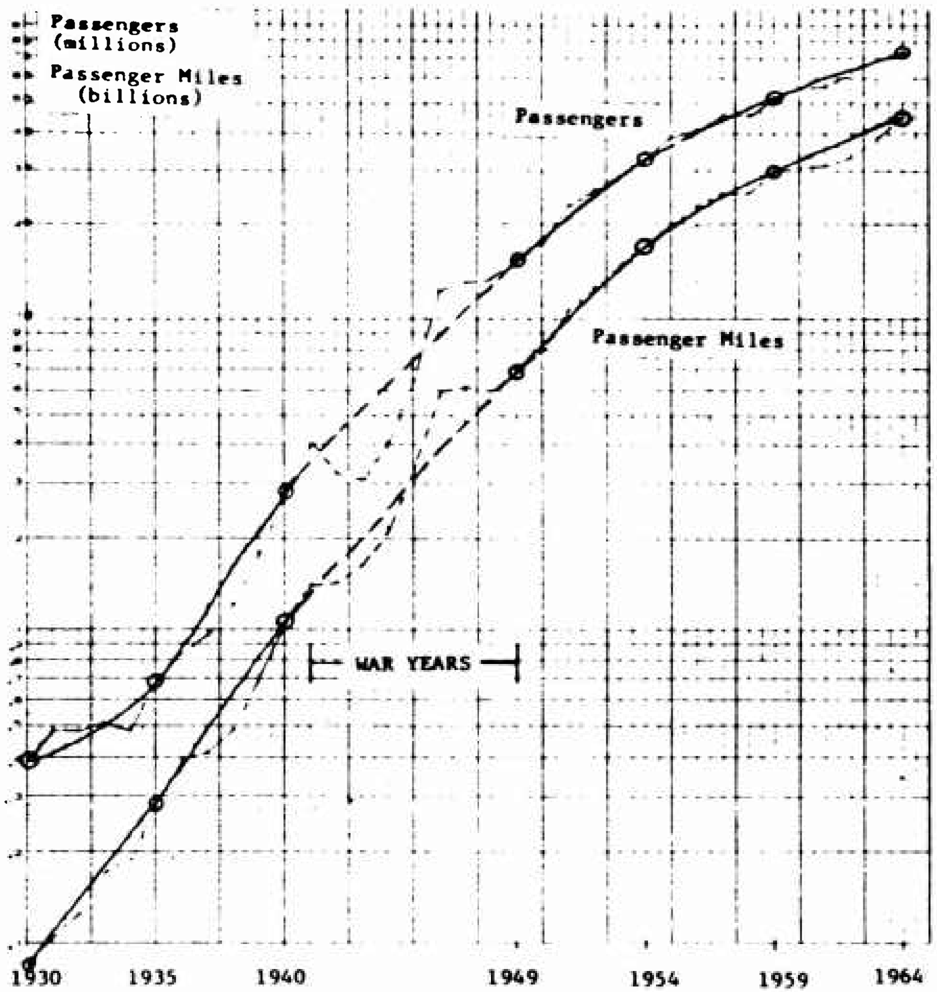
1/--continued.
of past growth and the forecast for the future, therefore, in terms of passengers originated should apply just as accurately to true O&D passenger totals as they do to passengers originated.

[redacted]

[redacted]

CHART 1

GROWTH IN DOMESTIC U. S. AIR PASSENGER TRAFFIC VOLUME
1930 - 1964



Source: CAB Handbook of Airline Statistics. Domestic traffic of trunks, local carriers, helicopter, intra-Hawaiian and intra-Alaskan carriers are included.

TABLE 10

GROWTH IN DOMESTIC U.S. AIR PASSENGER VOLUME
1930-1964

Calendar Year	Passenger Miles (Billions) [1]	Passengers [1] (Millions)	Annual Growth Rates During Each Five-Year Period: Passenger Miles	Annual Growth Rates During Each Five-Year Period: Passengers
1930	.085	.385		
1935	.281	.679	27.0%	12.0%
1940	1.052	2.803	30.2%	32.8%
(War Years)				
1949	6.77	15.12		
1954	16.80	32.53	19.9%	16.6%
1959	29.31	51.00	11.8%	9.4%
1964	44.40 [2]	73.30 [2]	8.6%	7.6%

1/ Revenue passenger originations and revenue passenger miles in scheduled domestic operations of U.S. certificated route air carriers.

2/ Estimated on basis of first 8 months of 1964, which reflected a 14.66% growth over the same 1963 period in terms of passengers and a 15.45% growth in terms of passenger miles.

[redacted]

[redacted]

9% and two with 14% and 17% growth rates. And in the most recent period, 1959-1964, the first three years grew 6% or less over the preceding year with 1963 and 1964 showing rates of 14% and 15% over previous years.

Air Passenger Volume Forecast, 1965-1990

The forecast developed for this study recognizes the generally declining rates of past domestic air travel growth, but is based upon the relationship of air travel volume - at constant prices or level of air fares - to the U.S economy. Particular study was made of the air fare level and air passenger growth in the past - World War II period when four-engine aircraft were first used, initially the piston aircraft in the early 1950's and, beginning in late 1958, the subsonic jet equipment. The forecast was then developed, based upon a continuation in the future of the trend in relationship existing in the 1950-1963 period between air passenger volumes at constant fare levels and U.S. Gross Domestic Product in constant dollars.

An analysis of domestic U.S. airline fares - as reflected in passenger revenues per passenger mile (called passenger mile "yield" in airline parlance) - demonstrates a steady decline in prices from 1950 through 1957, a steady increase for the next five years through 1962, and another decline in 1963. If unit elasticity is assumed, and passenger volumes originated each year are adjusted to reflect the effect of constant passenger mile yields at 1963 levels, adjusted passenger volume totals result which are shown in Table 11.

The adjusted passenger volume column in this table reflects, of course, elimination of effect of price changes (assuming unit elasticity). The uneven rates of annual growth still remaining are in significant degree due to uneven growth rates in the national economy -- clearly depressed in the 1957-1958 and 1960-1961 periods, for example. Table 12 presents ratios of passenger volumes (adjusted for constant yield) to gross national product in 1963 dollars.

[redacted]

[redacted]

TABLE 11

ACTUAL AIR PASSENGER VOLUMES ADJUSTED FOR CONSTANT FARE LEVELS

1950 - 1963

Calendar Year	Actual Passengers Originated (000,000)	Passenger Mile Yield Dollars (Cents)	Percent Yield of 1963 Level	Adjusted Passengers Originated (000,000) (2) x (4)
(1)	(2)	(3)	(4)	(5)
1950	17.5	7.36¢	119.3	20.9
1951	22.7	6.91	112.0	25.4
1952	25.2	6.73	109.1	27.5
1953	28.9	6.54	106.0	30.6
1954	32.5	6.41	103.9	33.8
1955	38.2	6.28	101.8	38.9
1956	41.9	6.04	97.9	41.0
1957	45.2	5.80	94.0	42.5
1958	44.7	6.03	97.7	43.7
1959	51.0	6.19	100.3	51.2
1960	52.4	6.32	102.4	53.7
1961	52.7	6.43	104.2	54.9
1962	55.9	6.55	106.2	59.4
1963	63.9	6.17	100.0	63.9

TABLE 12

RATIOS OF ADJUSTED AIR PASSENGERS TO GROSS NATIONAL PRODUCT

1950 - 1963

Calendar Year	GNP 1963 Dollars (Billions)	Passengers Adjusted for Constant Yield (Millions)	Passengers per $1,000,000 of GNP (3) ÷ (2)
(1)	(2)	(3)	(4)
1950	$376.8	20.9	55.31
1951	405.3	25.4	62.75
1952	419.2	27.5	65.54
1953	437.4	30.6	70.03
1954	430.3	33.8	78.55
1955	463.1	38.9	84.02
1956	474.9	41.0	86.46
1957	484.0	42.5	87.71
1958	475.4	43.7	91.95
1959	508.0	51.2	100.69
1960	521.5	53.7	102.85
1961	530.8	54.9	103.45
1962	564.8	59.4	105.11
1963	583.9	63.9	109.49

C[redacted]

[redacted]

These past ratios of passengers to GNP provide the principal basis for the forecast of air passengers in the period 1965-1990. As explained elsewhere in this study, United States GNP is forecast to average an annual growth rate of 3.6% (in constant dollars) during the 27 year future period, 1963-1990. Such a growth indicates a GNP of $1.517 billion by 1990, approximately 2.6 times the 1963 level. In light of the past trends in U.S. air travel growth, such travel, at the 1963 air fare level - in constant dollars - may be expected substantially the GNP average growth rate, but should, toward the end of the forecast period, grow at rates closer to the GNP rate than has been true in the past.

The projection of past experience into a specific forecast of air travel growth in the future was based upon a continuation of the past trends in ratio of air passenger volumes to GNP and checked against the results obtained by other forecasts of air travel growth for a particular future year. Attempts were made to develop a reasonable forecast on a strictly mathematical basis but these attempts were not successful. A second degree parabolic equation, for example provided what appeared to be a very good fit with past experience but yielded unacceptable results for future growth trends. The conclusion was reached that a purely mathematical approach was less desirable than the approach actually used.[2/]

2/ That a purely mathematical approach to the present problem is of doubtful validity is indicated by the basic changes from 1950-1957 operations which have taken place in air transportation in the last five years of experience (1958-1963), viz., the introduction of subsonic jet aircraft, fluctuations in price levels, etc. As F. C. Mills put it:

> "The fact should be clearly recognized that projection, or *extrapolation*, represents a guess, justified only on the assumption that a proper line of trend has been fitted and that the same conditions that affected the series in the past will prevail in the future. A change in conditions, the introduction of new elements, renders the projection invalid.
>
> * * * * * *
>
> "When a projection is to be made, a simple curve with few constants is to be preferred to a more complicated one. A third or fourth degree parabola may give an excellent fit to the data in a given case, but the projection of such curves is inadvisable. It is well to remember, as Perrin has pointed out, that a curve suitable for interpolation may not be at all adapted to extrapolation."

<u>Statistical Methods Applied to Economics and Business</u>, by Frederick Cecil Mills, 1938.

[redacted]

It is apparent from Tables 11 and 12 that air passenger growth in the early 1950's substantially exceeded that during the 1955-1960 period; and on this basis alone it might be predicted that in the decade 1960-1970 substantially lower growth rates would exist, reflecting a continuation of the sharp drop in growth rates of the 1960's. Such a prediction, however, overlooks the slow rate of growth in GNP during the 1955-1960 period (2.5% per year) and the further fact that as subsonic jet equipment was introduced in 1958 and 1959, air fares were raised in those years as well as in 1960, 1961 and 1962. (Table 11). These factors, together with the air traffic upsurge in 1963 and 1964, suggested that a level of annual air passenger growth approximating that in 1955-1960 and definitely higher than that in 1961 and 1962 could be forecast for the 1960-1970 period.

The average annual rate of air passenger growth (at constant 1963 fare levels) was therefore forecast for the decade of the 1960's at 6.5% per year (approximately that of 1955-1960). The resulting curve was extended to 1975 and later periods on the basis of gradually declining growth rates. For the year 1975 this method indicated an air passenger volume of approximately 2.5 times the 1960 level. This growth was checked against that determined by two other relatively recent forecasts and was found to be in close agreement with them.[3/] Those forecasts called for a growth rate of just under 2.5 times during these fifteen years in terms of passenger miles which should be adjusted slightly upward to the 2.5 level for passenger growth if allowance is made for slight increases of average length of passenger trip from 1959 to 1961.

3/ The two forecasts selected were "An Economic Analysis of the Supersonic Transport," Stanford Research Institute, August 1963, a study for the FAA; and "Feasibility and Cost of Expanded Inter-city Air Service in the Washington-Boston Corridor," a study prepared by SARC for the Department of Commerce in 1963. Neither of these forecasts predicted significant changes in the level of real air fares in the 1960-1975 time period.

Tables 13 and Charts 2 and 3 show the forecast of air passengers in total and as related to GNP. Comparative rates of growth for the 1960-1990 period are as follows:

Period	GNP	Air Passengers	Air Passengers for $1,000,000 of GNP
1960-1990	3.6%	6.5%	2.7%
1970-1980	3.6	5.7	2.2
1980-1990	3.6	4.9	1.3

In comparison to the forecast for GNP growth of 160% (2.60 times) from 1963 to 1990, air passenger growth for this period (at 1963 constant prices) is forecast to increase 343% (4.43 times). The assumed constant annual GNP growth rate of 3.6% compares with the forecast 5.66% average annual air passenger growth rate from 1963 to 1990.

"State of the Art" Factor

The relationship between air passenger traffic volumes and GNP during the 1963-1990 period provides a method by which estimates, for any particular year in the future, of air passenger traffic based upon GNP growth alone, may be adjusted upward to reflect the effect of the non-GNP traffic generating factors referred to at the beginning of this chapter. If the ratio of 1963 air passenger traffic volume to GNP is taken as a base of 100, then the air passenger volume/GNP ratio for each future year will indicate the extent of the required increase. Such a "State of the Art" factor is shown in both tabular and chart form in Chart 4.

TABLE 13

FORECAST OF U.S. AIR PASSENGERS
AND GROSS NATIONAL PRODUCT
1963 - 1990

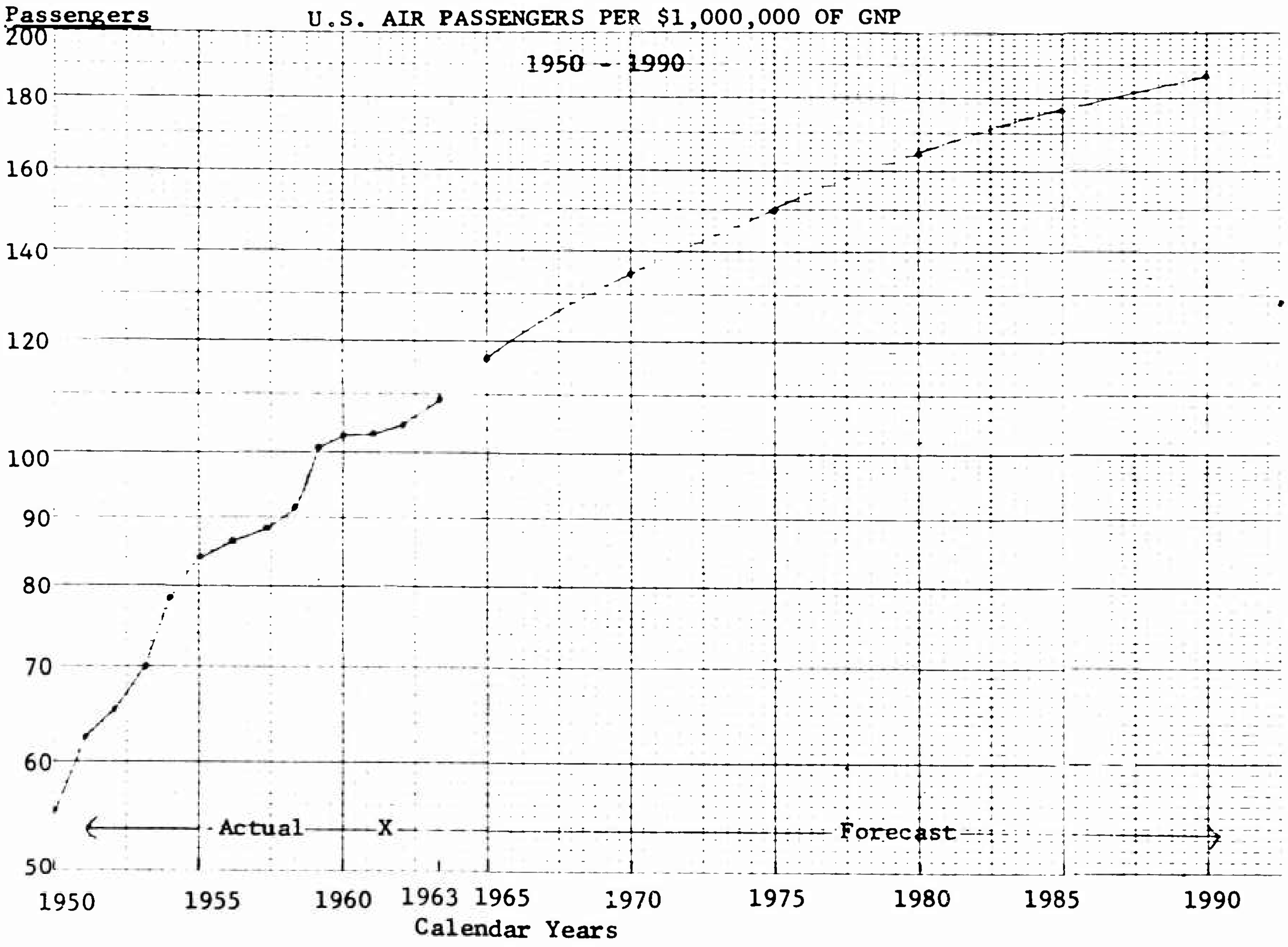
Calendar Year	GNP 1963 Dollars (Billions)	Air Passengers (1963 Yield) (Millions)	Air Passengers per $1,000,000 of GNP
1963	583.9	63.9	109.5
1965	626.7	73.5	117.3
1970	747.9	101.0	135.0
1975	892.5	134.3	150.4
1980	1,065.1	175.5	164.8
1985	1,271.1	225.1	177.1
1990	1,517.0	283.2	186.7

CHART 2 [redacted]

ACTUAL AND FORECAST

U.S. AIR PASSENGERS PER $1,000,000 OF GNP

1950 - 1990



NOTE: GNP in constant 1963 dollars; air passengers at 1963 fare level in constant dollars.

[redacted]

[redacted]

CHART 3

ACTUAL AND FORECAST
DOMESTIC UNITED STATES AIR PASSENGERS
(At 1963 Fare Level - Constant Dollars)

1950 - 1990

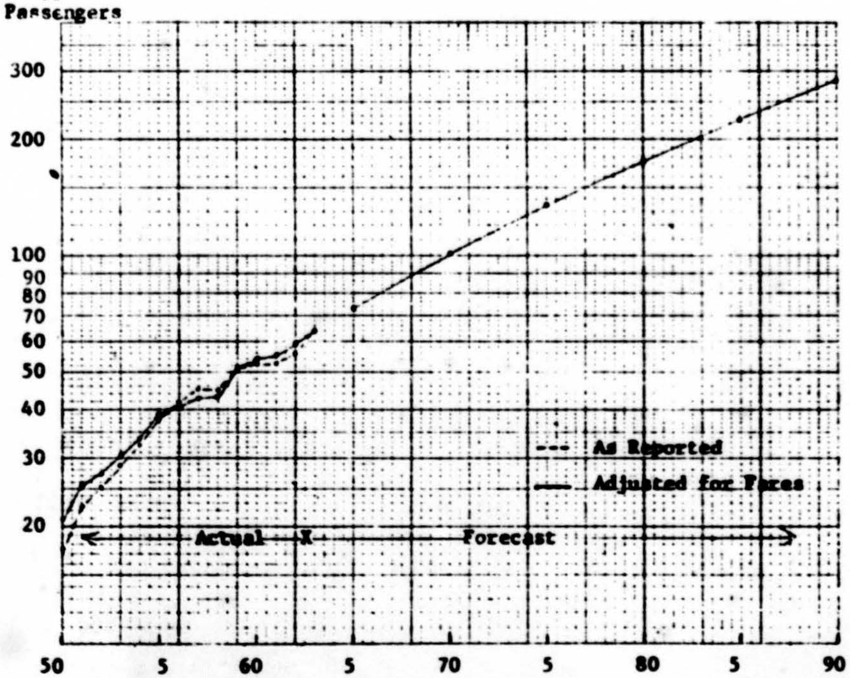
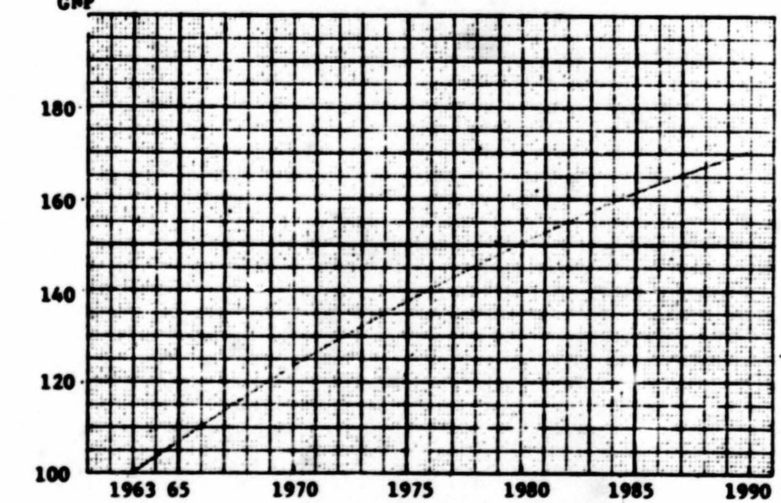


CHART 4

STATE OF THE ART ADJUSTMENT FACTOR



1963	100.0	1977	142.8
1964	103.9	1978	145.4
1965	107.2	1979	148.0
1966	110.7	1980	150.6
1967	114.0	1981	153.1
1968	117.2	1982	155.5
1969	120.3	1983	157.7
1970	123.4	1984	159.8
1971	126.4	1985	161.9
1972	129.3	1986	163.8
1973	132.1	1987	165.7
1974	134.9	1988	167.5
1975	137.5	1989	169.2
1976	140.2	1990	170.7

[redacted]

World Wide Applicability of "State of the Art" Factor

This section relates to the applicability of the United States "State of the Art" adjustment to other Free World areas. Analysis of growth rates of both air travel and gross national products of other Free World areas revealed generally higher increases in both categories than those for the United States. This is forecast to be particularly true between 1960 and 1970, when both travel and economy growth in the developing countries (Latin America, Africa and Asia) will reach levels of growth perhaps 20% higher than those for the United States.[4/]

In view of these findings, a test was made, for the decade 1950-1960, comparing air travel to gross product ratios for the United States and the balance of the Free World (Table 14). The U.S. ratio compared closely to that of the rest of the Free World, both in terms of the absolute ratios and of the change in ratio over the ten-year period.

4/ U.N. Yearbook of National Accounts Statistics, 1963 and forecasts from United Nations Conference on Trade and Development papers E/CONF 46/67 and 46/58.

Unfortunately, a similar test of comparative ratios for future periods is not practicable. This is because Free World air travel forecasts of the kind required are not available. Those forecasts which are available envisage air fare reductions which are not necessarily related to air fare trends in either U.S. or other Free World areas in the 1950-1960 period.

In the absence of such a future period test, and in view of the results shown in Table 14, it is assumed in this study that the U.S. "State of the Art" factor is properly applicable to the remainder of the Free World. Since a principal purpose of the index is to adjust for aircraft technological and related improvements, and recognizing that U.S. aircraft will be operated in increasing numbers throughout the world, at least through the 1970's, this assumption appears reasonable. The assumption finds further support in the fact that the major portion of Free World air travel is generated by the United States itself.

[redacted]

[redacted]

TABLE 14

AIR TRAVEL TO DOMESTIC PRODUCT RATIOS
UNITED STATES AND REST OF FREE WORLD

1950 and 1960

Area	Year	Gross Domestic Product 1/ (Billions)	Passenger Miles (Billions)	Passenger Miles per $1,000 of GDP
United States	1950	$376.8 2/	8.0	21.2
	1960	521.5 2/	30.4	58.1
Rest of Free World	1950	448.1	8.6	19.2
	1960	588.4	34.2	58.3

1/ In constant dollars.

2/ Gross National Product in 1963 dollars.

PART I

CHAPTER V

"BUSINESS" AND "PERSONAL" AIR TRAVEL

Any discussion of future trends in commercial air travel throughout the Free World -- with or without an SST -- must take into account that there are two distinct passenger markets: business and non-business. As is reported and analyzed in Chapters VII and VIII, business and non-business travelers do not react identically, in fact quite differently, to such factors as seasonality and service class distinctions.

Looking to the future, with focus on the prospect of SST travel, it may well be that the increasing lure of long distance travel for vacationers, the elimination of travel barriers, the combination of airline promotional fares, improved credit plans for airline passengers and increased promotional and advertising budgets will spur further increases in non-business travel.

[redacted]

More importantly, the ability to classify routes by a business vs. non-business factor will help refine the analysis of the price elasticity of demand. (Chapter VI)

Therefore, the purpose of this chapter is to discuss the characteristics and background of the two markets, and to demonstrate by pertinent examples how different world routings and even some city pairs can be allocated between the two markets. The discussion which follows supports the identification of the following markets as predominantly personal or pleasure travel markets, having an assumed price elasticity of two.

All markets involving Region

13	Florida
32	Nevada
33	Arizona
34	Hawaii
38	Caribbean

All markets between Regions 1 through 37 (the United States and Canada) and Regions

46	Japan
47	Hong Kong
51	Greece, Turkey, Israel
52 through 61	Europe

All other markets are considered predominantly business travel markets with a price elasticity of one. The next chapter in this report - Chapter VI - is a detailed discussion of price elasticity, including its effect in the business and pleasure markets.

One obvious problem which handicaps the investigator is the lack of reliable, published, trend

[redacted]

data on business vs. non-business travel. Even the statistics which are available suffer from a lack of standardized definition. However, it has been possible to locate certain studies which do shed light on the problem. These studies, however limited, cover the great preponderance of long haul passengers, who for this study are those travelling 900 nautical miles and more.

Among the more important studies which have been surveyed are:

1) the port of New York Authority "in-flight surveys" of domestic and international passengers, conducted in 1956 and again in 1963-64;

2) the annual surveys of the Hawaii Visitors Bureau;

3) studies made by the Caribbean Tourist Association (1960) and the Department of Commerce, U.S. Virgin Islands (1963);

4) Confidential studies of individual airlines.

(Additional sources are listed in the bibliography)

Business vs. Personal Travel

It would be helpful if there were a universally recognized distinction between business and personal travel. Unfortunately, this does not exist.

Business travel theoretically is travel whose primary purpose is to conduct business (including government and military business), attend meetings or conventions, visit branch offices, and for similar purposes. Non-business travel includes vacation trips, visits to friends or relatives, trips due to a sickness or other emergencies, and for other privately oriented purposes.

Some trips are a little of each. The wife who accompanies a husband on his business trip is herself traveling primarily for pleasure. Yet her trip was taken only because of her husband's business needs. And what about the business man who travels to Florida in January for a Friday meeting, and who then elects stay for the week-end? How also to classify the California professor who goes to New York primarily to see the World's Fair (personal), and while there

[redacted]

attends a professional convention session (business)? The complications are endless.

The distinction is also blurred because the classification in published reports usually is based on an individual air traveler's answer to a single question included in a survey questionnaire distributed on board the airplane or at some other focal point where the individual's reaction to or assessment of what the survey question is really getting at might affect his answers differently at different times. The California professor might answer "business" if he spent three days at the convention and three at the Fair and might answer "pleasure" if he spent five days at the Fair and only one day at the convention.

Needless to say, income tax regulations also might affect how an individual responds to such a questionnaire.

Granting the fact that there is something less than an exact science in classification and that these may restrict the ability to assess precise trend characteristics, certain relevant and wide divergencies can be found in the percentage distribution of trips for different purposes between different countries and different city pairs.

It is generally accepted fact in the domestic airline industry that the user market is: (a) relatively small in terms of the <u>number</u> of individuals who fly annually -- somewhere in the neighborhood of 10 to 12% of American adults accounting for all domestic air trips (Source: Bureau of Traffic Analysis, American Air Lines); (b) an even smaller number of business passengers traveling for business purposes account for the majority of all the trips (the most commonly accepted figure is that about 15% of all domestic air travelers account for about two-thirds of all domestic trips), and (c) that about two-thirds of <u>all</u> the domestic airline trips are for business.

There is a wide range around this average as shown in the following figures for major long haul city pairs extracted from the recent PNYA survey and a confidential airline study:

[redacted]

Segments	Percent Business
Los Angeles-Washington/Baltimore	85
New York-Atlanta	77
New York-Chicago	73
New York-St. Louis	71
Los Angeles-Philadelphia	71
Boston-Chicago	71
New York-Dallas	70
Chicago-San Francisco	67
Chicago-Los Angeles	60
Boston-Los Angeles	58
New York-Los Angeles	55
New York-San Francisco	55
New York-Tampa	41
New York-Miami	27

Another long haul market is the North Atlantic. Here the situation is quite different, with non-business passengers predominating. The following PNYA statistics indicate the reversal:

Percent Business Travel	Foreign Residents	U. S. Residents
New York - London	41%	27%
New York - Paris	29	22
New York - Rome	22	15
New York - Madrid	28	21
New York - West Germany	31	25

These figures are similar in magnitude to those developed by one of the airlines flying the North Atlantic. Their survey of eastbound passengers who are residents of the U. S. shows the following long term trend:

Percent Business Travel In Survey Made In:	Winter	Summer
1957	40%	17%
1961	28	17
1963-64	36	16

Investigating further the business-personal dichotomy on other main routes, we find data available from the PNYA survey for airline travelers on certain U.S.-Caribbean segments as follows:

[redacted]

[redacted]

Percent Business	Foreign Residents	U. S. Residents
New York - Bahamas	42%	9%
New York - Jamaica	19	7

The Department of Commerce of the Virgin Islands, in a study made in the summer of 1963, estimated that 15% of all parties traveling by air to that section were on business. Additionally, confidential figures supplied by an airline indicate that approximately 20 to 25% of air traffic between New York and Puerto Rico is for "business" or business related purposes. Thus, on balance, the U.S.-Caribbean market is more similar to the North Atlantic than it is to the U.S. domestic in terms of business air travel.

The best source of data for travelers to Honolulu is the Hawaii Visitors Bureau. In its annual Research Report for 1963, the Bureau states that only 6% of the westward Hawaii-bound travelers in 1963 were traveling for business reasons (another 17% were on "business and pleasure" trips -- with 14% on combined business and pleasure trips. (See Table 21).

These figures require broad interpretation. Actually about 90% of the Hawaii westward visitors travel by air; however only about 80% are from the other states. Thus, although the absolute levels of the mainland -- Honolulu air-business travelers may be somewhat different than the figures shown above (because 10% do not go by air and 20% are not from the other states, exclusive of Alaska), it is not likely that the orders of magnitude would change materially.

Confidential figures supplied by one of the airlines indicated that of the total traffic between U.S. and Japan, approximately 25% was for business purposes with another 17% for combination business and pleasure.

The sixth long haul world route is Europe-Middle East. We have been unable to locate any reliable data concerning the business-non-business division on that route.

The seventh route is U.S. West Coast-Europe, where again there is an absence of data. However, it may be speculated that U.S. West Coast-Europe

[redacted]

does not materially differ from the North Atlantic.

In summary, a classification of these long-haul routes, would be as follows:

	Percent Business
U.S. Domestic	60 - 70
North Atlantic	20 - 30
U.S. - Caribbean, Latin America	10 - 20
U.S. - Honolulu	20 - 30
U.S. - Japan	25 - 40
Europe - Middle East	----
U.S. West Coast - Europe	20 - 30

The remainder of this chapter presents the seven detailed tables upon which the preceding summary was based.

TABLE 15

TRAVEL PURPOSE OF U.S. DOMESTIC AIR PASSENGERS TO AND FROM NEW YORK

(Percent of Total)

	Winter		Summer		Estimated Average
New York To/From	Pleasure Personal	Business	Pleasure Personal	Business	Business
Cincinnati	13	87	16	84	85
Washington	18	82	23	77	80
Cleveland	20	80	23	77	78
Atlanta	19	81	27	73	77
Minneapolis	21	79	27	73	76
Chicago	29	71	25	75	73
Pittsburgh	27	73	29	71	72
St. Louis	27	73	31	69	71
Dallas	26	74	33	67	70
Syracuse	33	67	28	72	70
Detroit	39	61	31	69	65
Buffalo	34	66	35	65	65
Rochester	35	65	34	66	65
Providence	31	69	40	60	65
Boston	33	67	43	57	62
Los Angeles	42	58	48	52	55
San Francisco	48	52	42	58	55
Tampa	69	31	49	51	41
Miami	76	24	70	30	27

SOURCE: New York Port Authority - Domestic In-Flight Survey, 1963-1964.

TABLE 16

TRAVEL PURPOSE OF U.S. DOMESTIC AIR PASSENGERS

Selected Routes

Route Segment	Percent Business
Los Angeles-Washington/Baltimore	85
New York-St. Louis	81
New York-Chicago	75
Los Angeles-Philadelphia	71
Boston-Chicago	71
Chicago-San Francisco	67
New York-San Francisco	62
Chicago-Los Angeles	60
New York-Los Angeles	59
Boston-Los Angeles	58

SOURCE: Domestic Airline Confidential Survey.

TABLE 17

TRAVEL PURPOSE OF U.S. DOMESTIC AIR PASSENGERS

Transcontinental Routes

	(May) 1960	(October) 1961	(October) 1962	(May) 1964
Pleasure/Personal	55	42	35	38
Business	45	58	62	62

between Boston, New York, Baltimore and Dallas (1964 only) on East and San Francisco and Los Angeles on West

SOURCE: Domestic Airline Confidential Survey.

[redacted]

TABLE 18

TRAVEL PURPOSE OF INTERNATIONAL AIR PASSENGERS
TO AND FROM NEW YORK

New York To/From	Foreign Residents: Pleasure Personal	Foreign Residents: Business	American Residents: Pleasure Personal	American Residents: Business
London	59%	41%	73%	27%
Paris	71	29	78	22
Rome	78	22	85	15
Madrid	72	28	79	21
West Germany	69	31	75	25
Frankfurt	75	25	64	36
Hamburg	72	28	75	25
Bonn	43	57	69	31
West Berlin	24	16	83	17
Jamaica	31	19	93	7
Bahamas	58	42	91	9

SOURCE: New York Port Authority, International In-Flight Survey, October 1963 - March 1964.

TABLE 19

TRAVEL PURPOSE OF INTERNATIONAL AIR PASSENGERS

Eastbound Transatlantic Flights

U.S. Residents Only

(Percent of Total)

Summer Surveys

	1952	1954	1955	1956	1957	1958	1961	1962	1963
Pleasure*	74%	66%	74%	85%	72%	71%	73%	67%	73%
Business	16	18	12	9	17	13	17	23	16
Other	10	16	14	6	11	16	10	10	11

Winter Surveys

	'52	'54	'55	'56	'57	'58	'60	'61	'62	'63	'64
Pleasure*	---	54%	55%	62%	51%	---	43%	61%	55%	57%	5[illegible]%
Business	---	35	29	27	40	---	44	28	35	35	36
Other	---	11	16	11	9	---	13	11	10	8	11

*Includes Business/Pleasure combined

Source: Confidential Airline Survey

[redacted]

[redacted]

TABLE 20

TRAVEL PURPOSE OF AIR TRAVELERS FROM THE VIRGIN ISLANDS

Purpose Of Trip	Percent of Parties
Recreation	76
Business	15
Family Affairs	1
Other*	7
Combination	1
	100%

*Mainly students

Source: Survey of passengers departing from airports on St. Thomas and t. Croix, June 15 to August 15, 1963, reported in "A Study of the Tourist Industry in the Virgin Islands," prepared by the Division of Trade and Industry, Department of Commerce, U.S. Virgin Islands, for the Small Business Administration, Washington, February, 1964.

TABLE 21

TRAVEL PURPOSE OF PASSENGERS TO AND FROM HAWAII

Westbound

Mode of Travel of All Westbound Travelers - 1963

	Air	Ship	Total
Visitors to Hawaii	233,370	20,395	258,765
Visitors Beyond Hawaii	90,705	22,070	112,775
	329,075	42,465	371,540
Total from U.S.			
To Hawaii	249,675		
Beyond Hawaii	53,570		

Percent Distribution of Westbound Total Visitors

	1962	1963
Visitors to Hawaii (258,765)		
Pleasure	75%	68 %
Business & Pleasure	10	17
Business	8	6
All Other	7	9
Visitors Beyond Hawaii (112,775)		
Pleasure	44%	47 %
Business & Pleasure	10	14
Business	35	30
All Other	11	9

SOURCE: Hawaii Visitors Bureau.

PART I

CHAPTER VI

ELASTICITY OF DEMAND WITH REGARD TO FARE

It was necessary to include in the final Demand Model a fare factor which would account for the effect of changes in fare on total number of passengers flying between any two regions at any point in time.

To measure the effect of fare changes requires a knowledge of the composition of the travel market and of the reaction of each component to price changes.

Although there is better information available in certain markets than in others, the available data will permit, on a world-wide basis, the classification of markets into only two categories - those that are predominantly business and those composed mostly of non-business travelers.

As discussed in the preceding chapter, more precise measures of the relative proportions of each type of travel are not available. There is a lack of reliable, published trend data and the information that is available suffers from the indistinct definition between the two types of travel.

In this chapter the price elasticity component of the fare factor is examined. It is this elasticity which would relate total demand to fare changes. It is quite evident that increases in fares would decrease the number of passengers willing to fly. The problem arises when an attempt is made to determine just how much a given fare change will change the number of passengers willing to travel by air.

Although for most demand schedules, the elasticity will vary for each point on the curve, it is often possible to develop an average elasticity over a range of fares. Consideration was given to estimating an average price elasticity for a demand curve in any given point of time as compared to a demand curve derived from a series of equilibrium points resulting from shifts in the supply and demand curve over an extended time period.

Three main methods of attack were considered for developing elasticity coefficients. These were:

1. Survey a sample of the population to measure reaction to price.
2. Use multiple regression analysis on available fare and air passenger traffic data.
3. Analyze historical traffic trends and the various factors that have affected the trends to determine the significance of price.

The first approach was not feasible in this study, though it has been employed in other studies.

An attempt was made in this study to utilize the second approach but results were considered unreliable because coefficients were not statistically significant. A complete discussion of this approach is covered in Chapter II, Part I, of this report.

The third approach has been used by a number of investigators in recent years in making estimates of elasticity with regard to fare. Although there is disagreement on some points among these studies, they do not represent the best efforts put forward to measure elasticity.

Due to the absence of any significant improvements in the data on which the previous studies were based, it was concluded that, in the time available for this study, further attempts to estimate elasticity using the third approach would merely be retracing the effort of others without adding to the significance or accuracy of the results. Furthermore, it was decided that the areas of agreement in these previous studies were broad enough for purposes of the present study. This is true especially in view of the lack of comprehensive data in individual markets as to the nature of the traffic with respect to being business or pleasure motivated.

Based on a review of previous studies it can be concluded that there is a consensus concerning some aspects of price elasticity and little concerning others. There is general agreement that:

1. Pleasure travel is more price elastic than business travel with price elasticity for the two falling between -0.4 and -2.
   Business travel is generally considered

[redacted]

to be less than -1 and pleasure travel more than -1.

2. The effect of any fare reduction takes approximately three years to be felt fully.

There is little agreement as to whether:

1. Elasticities are rising or falling with time.
2. Elasticities are higher or lower internationally than in the U.S.
3. Elasticities are higher or lower at high fare levels than at low fare levels.

It is evident, therefore, that the degree of preciseness available as to price elasticities is comparable to that of the market composition. The effect upon business and personal travel has been determined to be different but the magnitude can only be determined to fall within a range.

In actual fact, of course, the effect of fare changes will differ in each market and vary during the year depending upon the composition of the traffic between business and non-business. However, as indicated, the available information will not justify such a precise treatment.

Therefore, considering all available evidence, price elasticity for use in the study in markets where the traffic is predominantly business motivated has been estimated to be -1.0 and in the predominantly pleasure motivated markets to be -2.0.

This elasticity coefficient was developed to fit average weighted fare, that is, number of first class passengers times first class fare, plus number of tourist class passengers times tourist class fare, all divided by the total number of passengers. Such a weighted average is considered to give the best single estimate for what is actually two separate markets.

The attached table and the remainder of this chapter summarizes the results of previous studies on price elasticity for air travel.

[redacted]

TABLE 22

SUMMARY OF AIRLINE PRICE ELASTICITY STUDIES

Source	Conclusions Concerning Elasticity: Business Travel	Conclusions Concerning Elasticity: Pleasure Travel	Remarks
Wheatcroft-1955	Low (<-1)	Higher (>-1)	Seasonal (Europe) Takes time to have effect (Worldwide)
ICAO - 1958	Low	High	Pleasure more elastic in off-peak (U.S. Domestic)
URI - 1958	-1.23		
Caves - 1962	<-1		(U.S.Domestic) Implies time to take effect. Rising, possibly to near unity
SRI - 1959	approximately -1< E <-2		(U.S. Overseas) Takes time to take effect (High fare Pacific market)
ICAO - 1960	<-1		(Worldwide) Falling
Seaboard - 1961	-1.8		(Transatlantic) Takes time to take effect
Wallace - 1962	-2+		(3 Pacific-Northwest short-haul markets) Less elastic for air than surface
American Airlines-1963	Lower <-1	Higher	(U.S. Domestic long-haul markets) Markets analyzed were 2/3 non-business
Wallace - 1964	-2+		(Domestic and International) Lower for U.S., higher transatlantic
Wheatcroft - 1964	-0.4 to -1	-2.0	(Transatlantic) Elasticities higher in summer than winter Elasticities higher with Canada than U.S.

Price Elasticity of Demand

(1) Wheatcroft, S., <u>The Economics of European Air Transport</u>, 1956.

In this book Wheatcroft gives broad and thorough treatment to the subject of airline economics. In his chapter on "The Economic Consequences of Tourist Fares" he discusses the behavior of BEA's traffic over a long period up to 1953 and 1954 when fares were abruptly reduced by about twice the average annual reduction of previous years. In the period from 1947 to 1953, fares, in real terms, had dropped at about 6% per year, equipment had improved, unduplicated route miles were increased roughly 50%, other factors also changed for the better and over all, the traffic increased at roughly 25% per year. In 1953 fares were abruptly reduced 13%. All other factors were at least as favorable toward a traffic increase as before: BEA's equipment was especially competitive, the actual British foreign travel allowance was increased from £ 30 to £ 50 per person and advertising was especially heavy.

Traffic increased 29%. The inference might be drawn that the market was moderately inelastic to price change, since the extra fare reduction was coupled with such a small increase in traffic over that which might otherwise have been expected. Wheatcroft suggests that two added factors be considered. First, though the average increase in traffic was 29%, the increase by quarters (1953/54 over 1952/53) was:

Period	RPM Increase
2nd Quarter	32%
3rd Quarter	34%
4th Quarter	20%
1st Quarter	24%
Total	29%

indicating that the summer holiday travelers were much more highly influenced by the fare reduction than had been the winter travelers, who tend more toward being businessmen. This indicates that while the elasticity of the latter is low, considerably less than -1, the elasticity of the former, the pleasure travelers, is considerably higher probably, in the vicinity of -1 or a bit greater (based on the presumption that were all business passengers removed from the 2nd and 3rd quarters their increases would have been above the levels shown, say roughly 35%, which compared with the trend of 25% with 6% fare increase leaves the extra 10% increase in traffic to be compared with the extra 7% decrease in fares).

The second point Mr. Wheatcroft makes concerning the overall relatively low apparent elasticity is that it may be, as is held by a fair number of industry observers, that the full impact of a fare reduction such as this one is not felt in the first season, but rather takes two or three years to show up.

(2) ICAO, The Economic Implications of the Introduction to Service of Long-Range Jet Aircraft, June 1958.

This study does not present specific, quantitative, study results concerning elasticity of demand. It does however address itself to the question in its discussion of fares:

> "Passenger traffic falls broadly into two categories: business and pleasure. To individuals travelling on business, whether public or private, reasonable levels of speed, comfort and prestige are of more concern than cost. If necessary for business reasons, they will travel by air with relatively little regard to the fare, and they will generally be permitted, or will permit themselves, to travel first-class if not in the more expensive luxury class. Probably it is safe to conclude, therefore, that this category of traffic will be relatively little affected by changes in fares.
>
> "If there is to be any large increase in passenger traffic it must probably be sought in the pleasure category. More tourists or pleasure travellers can be attracted to air travel by the appeal of new aircraft and shorter time spent on the journey, and also by effective advertising and sales techniques, but the basic fact is that to the pleasure traveller cost is the most important consideration. This category of traffic will certainly be susceptible to any well advertised reduction in fares, therefore, whether it be in the form of a straight cut or special arrangements such as excursion or off-season rates or family plans. As the air transport industry comes to depend more and more on the pleasure traveller, however, the problem of "peak" demand periods will be accentuated, and it may be that some of the older aircraft will be stored in serviceable condition for use at such times."

The conclusion the reader must draw from this is that ICAO feels that business travel is inelastic while pleasure travel is elastic, at least during off-peak periods.

(3) URI, <u>A Method for Determining the Economic Value of Air Traffic Control Improvements and Application to All-Weather Landing Systems</u>, prepared for the FAA, 1958.

In this study a vigorous multi-variate regression analysis was performed, which took into account variables of price, GNP, and seasonality. Speed was found to be so highly correlated with GNP that it could not be separated as an independent factor. No separate study was made of first class and coach or of the variation of the coefficient of price with changes in the seasons. Thus a single elasticity of demand figure was derived which was -1.23 or moderately elastic.

(4) Caves, R.E., <u>Air Transport and Its Regulation</u>, Harvard University Press, 1962.

Caves makes the points that, usually, when any fares have changed, other important factors have changed simultaneously, that the price of air travel has been shifting relative to other modes, that fewer and fewer travelers fear flying as the years go by, that more and more travelers are exposed to flying, [redacted] quality of service has improved for air travel while it has deteriorated for rail, all making statistical measures difficult to interpret.

He does cite testimony offered by American Airlines before the CAB in 1957, labeling it of doubtful validity, to the effect that study (by multiple regression) of the years 1949-1956 yielded an elasticity of -0.2. He also mentions a CAB study which produced very high elasticities but suffered so seriously from intercorrelation between the independent variables, as to be completely untrustworthy (recognized so by its authors).

He concludes with the statement (already referred to) that he believes "...an elaborate cross-sectional study of fares and travel in particular city pairs markets might yield acceptable evidence on elasticity of demand for air travel....", and that for small changes in the fares of all classes of service in particular markets the usual response would be such as to indicate less than unit elasticity within a year.

(5) <u>SRI, Influence of Jet Service and Economy on Air Travel Between North America and the Orient</u>, 1959.

This report, prepared by SRI for Pan American was filed by them as PA-200, an exhibit in Docket 7723, a Pacific fare investigation before the CAB. The report was based on an examination of historical trends in the Pacific; on experience in the North Atlantic market with the introduction of Economy fares; on an examination of some other markets; and on an extensive survey of passengers on board Pan American flights. Though the title does not make it clear, the study was not based on actual experience with Pacific fare reduction but was rather to make an estimate of the probable effect of the introduction of both jet aircraft and economy fares on the demand for air travel across the Pacific. The study concluded that the roughly 40% reduction in time which the jet would make possible and a 20 to 25% reduction in fares would result in an increase in traffic over the base year of 65 to 80%, after roughly three years. The effects of time and fare reduction were not individually reported and the inference which may be drawn is that the authors felt that at least half the increase in traffic would come from the fare reduction. This would imply a price elasticity of between -1 and -2. This study was largely qualitative in the nature of its analysis.

(6) ICAO, The Technical, Economic and Social Consequences of The Introduction into Commercial Service of Supersonic Aircraft, A Preliminary Study, August 1960.

In this study ICAO authors mention again their belief that fare reductions strongly stimulate traffic. A direct indication of elasticity is not given. However, charts are given indicating estimates of future traffic with and without a future fare decrease of an estimated 20% by 1967. It would not be proper to impute to the authors any statement they were unwilling to make, but the only inference one can draw from their projections is that they would expect the elasticity to be equal to or slightly less than unity, overall, world-wide. The shape of the curves presented implies also a tendency for the elasticity to decrease as the market matures with time and its growth rate falls off. This is somewhat in conflict with their expressed opinion that:

> "If...the supersonic aircraft were forced to charge fares substantially higher than competing aircraft, the market would be very greatly reduced, since the mass demand for air transport lies in the cheaper-fare field."

(7) Seaboard World Airlines, Exhibits, Docket No. 12752, 1961.

In this exhibit Seaboard presented its case to the Civil Aeronautics Board for authority to carry passengers on a more-or-less standby basis on cargo aircraft at an exceptionally low fare. As part of the support for the contention that the low fare would generate significant traffic volumes, an analysis was made of the years 1958, 1959 and 1960 for economy traffic across the North Atlantic. It was concluded that the market did appear elastic: that, on the average, a 1% decrease in fare (revenue per passenger) produced, not constant revenues, but a 0.8% increase in revenues, indicating an elasticity of approximately -1.8. Since this analysis is for the transatlantic market, this elasticity might reasonably be expected to reflect the influence of the high percentage of pleasure travel in this market.

(8) Wallace, W. M., Price Elasticity of Demand for Air Travel (Pilot Study), The Boeing Company, March 14, 1962.

In this brief monograph Wallace examines three markets, Seattle to and from Portland, Spokane and Vancouver. He makes the point in his discussion that each market has in fact its own demand curve. He bases his analysis on a total trip cost including value of time (at a low American Association of Highway Officials estimate of $1.55 per hour), and concludes that these markets are highly elastic to price (ranging from roughly -2 to -3.5 for air, calculated on fares*) but more elastic to changes in price at auto, rail and bus fare levels than to changes in price of air travel at its fare levels.

(9) Stewart, W. P., Jr., American Airlines, Docket 13939, 1963.

In his testimony Stewart presented the results of a number of analyses. A series of surveys of Chicago-Los Angeles passengers was conducted, the objective of which was to determine the effects of reduced fares. Based on the application of these survey results to American traffic it was concluded that the market was inelastic (an estimated 14% reduced revenue from a 20% fare reduction). The past experience in the same markets was also analyzed with a similar conclusion. The survey indicated that elasticity was higher for non-business than for business passengers.

* * * *

It should be noted that United and TWA agreed in general with American's stand in this case, while Continental disagreed.

*SARC calculation based on Wallace's curves.

[redacted]

(10) Wallace, W. M., The Demand for Airline Travel, the Boeing Company, April 1964.

Based on multiple correlation studies, comparative price vs. traffic trends, aggregate price vs. traffic and revenue trends, analysis of the North Atlantic traffic and individual city pairs, and studies of ability to buy, Wallace concludes that air traffic is price elastic. Various curves given indicate an approximate estimate of U.S. domestic price elasticity of -1.6 and an international traffic elasticity perhaps slightly higher, in the vicinity of -2. The North Atlantic elasticity estimate would be in the region of -2 or slightly above. Again these elasticities have been calculated from curves of the author's. The author's conclusion was limited to the simple statement that demand appeared elastic.

(11) Wheatcroft, S., Elasticity of Demand for North Atlantic Travel, prepared for IATA, July 1964.

Wheatcroft attempted to establish price elasticities by means of multiple regression anaylses and, as have most other reliable investigators, he learned a great deal but concluded "these analyses produced interesting (and plausible) figures for the price elasticity coefficients of summer travel and winter travel. There were, however, peculiarities in the significances attributed to some of the other variables and I do not think that, at this stage, any reliance can be placed upon the price elasticity conclusions. For this reason I have not included any of the results of the multiple regression analyses in this report."

Wheatcroft was forced to resort to other more qualitative means of analysis, but his analysis is unusually thorough. He took into account changes in income levels (highly important), political and other special factors, changes in the quality of air service (also important) and finally changes in fares. His conclusions may be summarized best in the form in which he himself put them:

COEFFICIENTS OF PRICE ELASTICITY

Market	Summer	Winter
U.S.-Europe	-1.6	-1.5
Canada-Europe	-2.0	-1.8

[redacted]

[redacted]

COEFFICIENTS OF PRICE ELASTICITY

Purpose of Travel	Coefficient
Business	-0.4 to -1.0
Visiting Friend or Relatives	-2.1
Vacation Trips	-2.0

(12) European Travel Commission, Study of Characteristics of Returning U.S. Travellers, in preparation, October 1964.

This study does not investigate elasticity directly. It does, however, present a great deal of up-to-date data about the characteristics of the travellers which make inferences concerning elasticity possible. It shows that incomes in the traveller category of people have been rising rapidly.

The survey concludes:*

> "...the strongest single determinant of traffic growth" has been price, and that "the traffic increases in recent years would seem to owe more to increase the buying power of the American people, and to prices, especially fare reductions, than to better marketing."

*New York Times, Sunday October 11, 1964, page 1, Section 10.

PART I

CHAPTER VII

SEASONAL AND DIRECTIONAL VARIATIONS IN AIR TRAFFIC

A long-range forecast of air travel, notably as related to the possibility of a choice between conventional jet and SST aircraft, must take into account the turbulence in passenger flows because of sharp seasonal and directional variations.

The basic reason for seasonal variations in air passenger traffic flow is the preference for travel during vacations and holidays. This is the so-called tourist traffic. Business travel is more constant on a year around basis. It is the tourist with his camera and not the businessman with his attache case who accounts for the glaring peaks and valleys in seasonal air travel.

In addition to seasonal variations, consideration must be given also to directional variations, or directionality -- also largely influenced by tourist traffic. Concurrently with the seasonal variation in travel activity, there is the related

[redacted]

and aggravating complication of peaks in traffic flow moving in only one direction, with no increase in the opposite direction. At the end of the holiday season, the situation is reversed. Usually the directional characteristics are such as to cancel out. Thus, the increase in one direction later is balanced by an equal increase in the opposite direction. If, at the end of a twelve-month period, traffic statistics show an annual directionality, this is because of migration in one direction, or because travellers choose another route for their return.

Because available data on recreational patterns show a steadily burgeoning vacation travel by air, it must be anticipated that seasonal and directional variations, on a global basis, will present formidable challenges in attaining maximum efficiency with available aircraft equipment in the 1970-1990 period. This will be the case whether this travel is performed at speeds of 600 miles an hour or 2000 miles an hour. If there were difficulties in adjusting airline operations to these factors in the transition from piston aircraft to jets, it may well be assumed that these difficulties will be compounded in the prospective shift to SST aircraft.

A prominent example of both seasonal and directional imbalance is the North Atlantic. Seasonal variations are such that about 50% of the annual traffic is carried during the four summer months. This peak traffic is almost four times as high as the off-peak traffic; it is twice the average annual level. Directionally, there is a tremendous upsurge in traffic to Europe in June, followed by a fairly balanced traffic in July and then a wave of traffic back to U.S. in August, and September.

In the Northern Hemisphere, the increase in traffic activity comes in most markets during the months of June to September. In the Southern Hemisphere, the peak loads occur between December and March. Traffic between the two hemispheres, as would be expected, shows insignificant seasonal fluctuations.

[redacted]

For the purpose of this study, analysis is made only of seasonal variations which are regular and permanent. This excluded the impact of such phenomena as a World's Fair, Olympic Games, and other special events.

Methods and Definitions

The total purpose of this Demand Analysis study is to develop a method for estimating the potential air traffic between all major areas in the Free World. This potential is expressed as the average annual passenger flow over each route. From this information, it is possible to calculate the required seat capacity, assuming normal load factors, and taking into account seasonal and directional variations.

To make these calculations as flexible and adaptable as possible, quantitative expressions have been developed to express the variations. These formulations can be applied directly to the average flow as multiplicating factors.

We have chosen the following definitions:

Peak Season = the quarter year which shows the highest traffic in either direction

Seasonal Factor = Monthly average traffic during peak season. Annual Traffic Average per Month

$$\text{or } K_1 = \frac{T\ max}{T\ m}$$

By specifying the maximum traffic in either direction, the seasonal factor combines the effects of seasonal and directional variations and represents the increased capacity which is required to handle the peak season traffic. It can be applied directly to the average annual traffic flow information which is supplied elsewhere in this study.

While the traffic flow during the three peak months is $T\ max = K_1 \times T\ m$, the traffic factor for the "low" season is:

$$K_2 = \frac{12 - 3K_1}{9}$$ and average traffic during the low season is: $T\ low = K_2 \times T\ m$.

The two factors K_1 and K_2 are connected through

[redacted]

the formula, as follows:

When K_1 = 1.10 1.20 1.30 1.40 1.50 1.60 1.70

K_2 = 0.97 0.93 0.90 0.87 0.83 0.80 0.77

If it is desired to isolate the directional factor this can be done as follows:

$$\text{Directional Factor} \quad D = \frac{2 \times F_1}{F_1 + F_2}$$

where F_1 and F_2 are the traffic flows in opposite directions during the <u>same</u> month.

Sometimes it may be preferred to express directionality as the percent X of total traffic which goes in the next flow direction. The relationship between X% and the directional factor D are as follows:

$$X + \frac{100\ D\%}{2}$$

The directional factor on an annual basis is an expression for the migration or one-way imbalance which may be temporary or a permanent phenomenon.

<u>Information Available on Season and Directional Variations</u>

A study of traffic flow variations requires statistics on a <u>monthly</u> basis in <u>each direction</u>.

IATA in their "World Air Transport Statistics" publishes such details for North and South Atlantic traffic from which information a summary has been made (See Table 23).

ICAO in their Traffic Statistics presents data by country and airline, annual and monthly. However, no directional information is provided.

ICAO Traffic Flow Statistics present traffic flow by airline but only for the months of March and September each year. This deficiency makes them useless for study of seasonal fluctuations.

CAB Domestic Origin-Destination Surveys on a quarterly and annual basis can be used to study seasonal fluctuations. From the quarterly variations, it is possible to make approximate estimates of the monthly variations and we have included data on the seasonal factor for some of the more important domestic markets in U.S.A. (Table 24).

CAB also publishes monthly statistics of passenger traffic for each U.S. carrier which in some cases can be used to study the seasonal fluctuations. UAL's territorial traffic, for example, concerns only the Hawaiian Route. We have made use of this information wherever possible.

For other areas of the world, however, there is no readily available information on seasonal or directional traffic characteristics.

Discussion

As stated at the outset of this chapter, the most important example of seasonal and directional variations is the North Atlantic. It is interesting to note that the two classes of traffic, first and economy, behave differently in this respect.

Economy class (Tourist-travel) accounts for 91% of the total and therefore dominates the picture with a seasonal factor of $K_1 = 1.80$. First-class traffic (= business travel) is much more evenly spread with a seasonal factor of $K_1 = 1.33$.

Analysis of the directional aspect shows that the peak month eastbound occurs in June, and the peak in the westerly direction comes in August and September.

This traffic flow imbalance reaches a maximum in August when the directional factor is D = 1.28 W. This means that out of the total traffic both ways across the North Atlantic, 64% goes west and 36% east. South Atlantic traffic shows a similar directionality, with D = 1.30 N.

The directional characteristics of a route have such an important bearing on the achievable load factor and therefore on the operating economics of a route that they cannot be overlooked. The fact that enough seating capacity must be provided to at least allow for the maximum flow of passengers in one direction means that the return load factor during the same period is correspondingly lower.

Assuming that the carriers had been flexible enough (in 1962) to make available exactly the number of seats required to carry the passengers in the high flow direction each month, the theoretical maximum load factor on the North Atlantic would have been 88%.

Such flexibility is, of course, not possible in

[redacted]

practical operations. The load factor of 51.6% actually achieved in 1962 corresponds to 58.6%, had there not been any directional imbalance on the route.

This is true about any route with similar characteristics and must be taken into account when judging the economics of such routes. The maximum achievable load factor as defined above is a convenient measure of this condition. As already mentioned, the seasonal factor we have chosen includes this effect of directionality.

For other areas of the Free World, detailed statistics are not readily available for analysis. Some general conclusions, therefore, have been drawn from the data presented in Tables 23 and 24, that can be applied in those areas:

(1) The seasonal factor is generally higher for economy class than for first-class travel, with some exceptions such as the Mexican and Latin American market.

(2) If we further assume that economy class is largely represented by tourist type travel and first-class by business travel, then we can conclude that the seasonal factor for:

Business travel	S = 1.10 - 1.20
Business/tourist mixed	S = 1.20 - 1.40
Tourist travel	S = 1.40 - 1.80

and these factors can then be applied to those areas for which no statistical information is available.

(3) Directional variations are peculiar to each route and no general conclusions are possible. In lieu of precise information a directional factor of D = 1.0 must be assumed.

[redacted]

TABLE 23. SEASONAL AND DIRECTIONAL CHARACTERISTICS OF INTERNATIONAL AIR TRAFFIC - 1962-63

Route or Market (1)	Carrier (2)	Travel Class (3)	Unit	Peak Quarter Traffic (4)	Qtr. (5)	Direction (6)	Total Traffic per Year (7)	Total Traffic per % (8)	Peak Flow per Month (9)	Average Flow per Year (10)	Seasonal-Directional Factor K_1 (11)	Seasonal-Directional Factor K_2 (12)
A. North												
Atlantic	All	F	Pass.	34,475	3	W	208	9.0	11,491	8,674	1.33	0.89
	IATA	E	Pass.	462,942	3	W	2,063	91.0	154,314	85,999	1.80	0.73
Total			Pass.	497,417	3	W	2,272	100	165,805	94,673	1.75	0.75
B. South	All	F	Pass.	3,203	2	N	19	18.1	1,067	794	1.34	0.89
Atlantic	IATA	E	Pass.	14,515	2	N	86	81.9	4,871	3,610	1.35	0.89
Total			Pass.	17,718	2	N	105	100	5,906	4,400	1.34	0.89
C. Pacific		F	P.M.	63,383	2	Both	246	12.7	21,127	26,553	1.03	0.99
	PAA	E		506,659	3	Both	1,704	87.3	168,886	142,041	1.19	0.94
Total				569,140	3	Both	1,941	100	189,713	162,595	1.17	0.955
		F	P.M.	18,890	2	Both	65	11.9	6,300	5,490	1.15	0.95
	NWA	E		147,978	3	Both	487	88.1	49,400	40,600	1.22	0.93
Total				163,602	3	Both	553	100	54,300	46,100	1.18	0.94
D. Hawaii		F	P.M.	23,672	3	Both	79	12.0	7,891	6,650	1.19	0.94
	UAL	E		199,611	3	Both	588	88.0	66,537	49,000	1.36	0.88
Total				223,283	3	Both	668	100	74,428	55,600	1.34	0.89
E. Central-												
America		F	P.M.	9,890	1	Both	28	23.1	3,297	2,347	1.41	0.86
(Mexico)	AAL	E		27,968	1	Both	93	76.9	9,123	7,800	1.17	0.945
Total				37,858	1	Both	121	100	12,420	10,147	1.22	0.93
(Bermuda) (Puerto Rico)		F	P.M.	23,907	1	Both	81	9.3	7,969	6,780	1.18	0.94
(Mexico)	EAL	E		257,774	3	Both	793	90.7	85,925	66,127	1.30	0.90
Total				277,442	3	Both	874	100	93,894	72,877	1.29	0.905
F. Latin		F	P.M.	6,773	1	Both	24	16.6	2,257	2,033	1.12	0.96
America	BNF	E		34,675	3	Both	122	83.4	11,558	10,233	1.13	0.96
Total				40,577	3	Both	147	100	13,525	12,266	1.11	0.96
		F	P.M.	16,049	1	Both	33	14.2	5,349	2,803	1.91	0.75
	Panagra	E		56,665	3	Both	204	85.8	18,888	17,017	1.11	0.96
Total				69,737	1	Both	237	100	23,248	19,820	1.17	0.945
G. U.S. Int'l.	All	F	P.M.	523,000	4	Both	1,350	11.4	174,000	112,000	1.55	0.975
& Territ.	U.S.	E		3,438,000	3	Both	10,555	88.6	1,146,000	879,000	1.30	0.97
Total				3,787,000	3	Both	11,905	100	1,262,000	992,000	1.27	0.97

SOURCE: IATA, ICAO, CAB.

[redacted]

TABLE 24. SEASONAL AND DIRECTIONAL CHARACTERISTICS OF U.S. DOMESTIC AIR TRAFFIC - 1963

Route or Market (1)	Carrier (2)	Travel Class (3)	Peak Quarter Traffic (4)	Quarter (5)	Direction (6)	Total Traffic per Year (7)	Total Traffic per % (8)	Peak Flow per Month (9)	Average Flow per Month (10)	Seasonal-Directional Factor K 1 (11)	Seasonal-Directional Factor K 2 (12)
CHI-NYC	All	Both	13,710	2	E	100,569	-	4,580	4,170	1.10	0.97
NYC-DCA	All	Both	17,537	2	N	120,802	-	5,860	5,033	1.16	0.95
LA-NY	All	Both	7,547	3	E	51,033	-	2,515	2,130	1.18	0.94
NY-SF	All	Both	5,221	3	W	34,040	-	1,740	1,420	1.23	0.925
CHI-SF	All	Both	2,927	3	E	19,558	-	976	815	1.20	0.933
CHI-LA	All	Both	5,549	3	E	36,557	-	1,849	1,525	1.22	0.93
LA-SF	All	Both	14,921	3	N	91,877	-	4,973	3,825	1.30	0.90
NYC-MIA	All	Both	15,143	1	N	94,508	-	5,047	3,940	1.28	0.905
U.S.Domestic	All	F	523	3	-	11,788	32.5	1,065	982	1.08	0.975
(Billion Psgr.Miles	All	C	3,438	3	-	24,596	67.5	2,231	2,049	1.09	0.97
	All	Tot.	3,787	3	-	36,384	100	3,297	3,031	1.09	0.97

SOURCE: CAB.

[redacted]

PART I

CHAPTER VIII

EFFECTS OF SERVICE DISTINCTIONS ON TRAVEL DEMAND

In the preceding chapter, the impact of seasonal and directional flow on airline travel was assessed, and it was pointed out that the peaks and valleys in passenger flows are most pronounced for the lower fare traffic. With this background, it is possible now to explore in greater depth the effects of different classes of service on travel of all types, but most particularly air travel.

On the basis of historical data of the past two decades, it can be safely forecast that in the two decades between 1970 and 1990, air travel will be marked by a continuing rise in the importance of economy coach class travel, whenever the passenger has a choice. And there is strong new evidence that passengers will continue to be given such a choice.

During 1964, one U.S. carrier (United Air Lines), which had been promoting a single fare, single service concept, found it necessary to reverse directions, and promote three-class air travel instead. This shift reflected the fact that passengers, accustomed to a choice, will continue to demand availability of options in their mode of air travel.

Notwithstanding the compressed flying time that will characterize SST travel, it can be assumed, as was the case in the switch from pistons to jets, that although economy travel will continue to grow much more rapidly than first class service, travellers will insist on a choice.

Background

Every mode of public transportation, including buses, offers different classes of service to accommodate the requirements and tastes of their customers. Even in taxi service, there is often a choice, where a taxicab rider may take advantage of a group (or economy) rate if he is willing to share the company of other riders, or pay the full rate (first class) and travel without such new-found companions.

The taxicab example aside, differences in classes of service with consequent differences in fares usually are distinguished by comfort factor variables, such as seat width, distance between seat rows, and such extra frills as free drinks, meals, entertainment, and priority in embarking and debarking.

The railroads traditionally have provided "first class" (Pullman) and "coach" classes. On ships, there are a great number of classes, depending on the location and size of the accommodations -- forward or aft, upper or lower deck -- and on the degree of privacy, ranging from individual cabins to dormitory.

Inter-city bus travel, on the other hand, is predominantly a single class operation, but in recent years there has been an increasing trend toward so-called luxury service at premium fares.

In the early days of aviation, single class service was the rule -- the single class being first class.

During the early 1950's, the air travel pattern changed. The advent of larger aircraft and the mounting demand permitted and forced the introduction of a cheaper service. This was called "tourist class" on international routes, and "coach class" in domestic U.S. travel. The reaction to this option was immediate and spectacular, particularly on the international routes and most especially on the North Atlantic.

Despite this reception by the public, airline operators were divided in their opinions as to the wisdom of introducing and promoting a cheaper class. Many airlines resisted the change, and held fast to an exclusive "first" or "regular" class policy. These holdouts argued that reduced fares only deprived the airlines of revenue they would otherwise receive. But ultimately, the recalcitrants were forced to abandon their positions.

In 1958 there was a feeling in the aviation industry that the introduction of tourist class was only a first step in the right direction, which ought to be followed by the addition of a third option called "economy" class.

The effect was to shift the tourist passengers into economy class. After two years, the demand for tourist accommodations had dwindled so much that this class was discontinued. From 1961 to 1964, only first and economy (coach) remained on most routes.

First class travel, aside from temporary fluctuations, remained by and large at the same level. Traffic growth took place only in the economy or coach class.

This history of service classes in air transportation has been somewhat similar on all routes in the Free World, although in some cases the proportions between first and coach class are more balanced than in others. Tables 25 and 26 show the deterioration of first class traffic as a percentage of total traffic in some of the most important markets in the World. First class travel in 1963 comprised about a third of the total in the United States, while for other Free World markets, such travel accounted for some 10% or less of the air travel total.

Service Classes and Fares

The split between first and economy class traffic has a direct relationship with the fare levels in each class.

This may be exemplified by a comparison between two important markets in terms of fare and traffic ratios:

Ratio	U.S. Domestic			North Atlantic		
Year	1961	1962	1963	1961	1962	1963
1st Class Fare to Economy Fare	1.33	1.30	1.25	1.63	1.65	1.65
1st Class Traffic to Total Traffic	.42	.34	.30	.17	.12	.09

The comparison shows that although there has been no appreciable change in fare ratios, the traffic ratio has kept moving and does not seem to have reached an equilibrium in 1963. It is apparent from these figures that the higher the fare ratio, the lower the traffic ratio, a conclusion which appears reasonable. It cannot be concluded, however, that such relationships alone provide a sound basis for conclusions as to future travel volume distributions between first class and economy passengers. Such predictions cannot be made without some knowledge of future air fare policies, and that knowledge is necessarily lacking at present.

<u>The Fluidity of Air Fare Policy</u>

That air fares are still in the process of change is clearly evident. Any air traveller is perhaps painfully aware of the great variety of air fares existing in most all markets today. There has been an "open rate" situation in the Pacific area for more than two years. The Civil Aeronautics Board has called for fare reductions in the Pacific of some 25%, and has indicated its concern as to the fare level there by permitting a supplemental carrier to offer reduced rates in the area through a special exemption from the usual fare regulations. Authoritative studies are predicting air fare reductions across the North Atlantic and in other major air travel markets. Eastern Air Lines has announced a system-wide fare change which will increase substantially the "taper" in unit air fares to be charged within the United States.

This generally fluid fare situation is exemplified further by the changing policy of United Air Lines, the largest airline in the world. This carrier's management for many years opposed the expansion of coach service and high density seating, but just recently has reversed this policy. United is now actively competing in its major short-haul market, Los Angeles-San Francisco, for the lowest fare air passengers, offering these customers competitive fares on high density 727 aircraft.

Another basic change for United has taken place regarding its "business" or single class air services. For a time, these seemed to work out successfully. However, when Continental and other airlines introduced a three-class system, UAL lost passengers and made a 180° turn to a three-class system.

Even though the UAL initiative to simplify to one class was seen by many as a laudable effort, it is equally obvious that as the travelling public grows and encompasses more layers of the population, three classes or even more may be required to cater to everyone's taste and pocketbook.

In any event, stability in air fares or fare policy is not yet in sight, and the precise future characteristics of air fares are simply not predict-able. Air travellers have made it plain that reduced fares are to their liking, and that in the future, first class air travel will be confined to a relatively small portion of the total. No more definitive prediction appears possible at this time.

Tables 25 and 26, in addition to the historic trends, also show projections through the year 1990. Those projections are based on the past trends and the considerations set forth above. As to four of the principal markets shown in the tables, first class air travel is projected to level out at about 5% of the total, while in the South Atlantic, the future level appears to be at some 9%. Past trends indicate a slightly higher percentage for this class of travel within the United States.

TABLE 25

HISTORIC AND PROJECTED U.S. FLAG CARRIER AIR TRAFFIC BY CLASS OF SERVICE

Passenger Miles (Millions)

Year	U.S. Domestic First Class	U.S. Domestic Total	U.S. Domestic % First Class	U.S.-South America First Class	U.S.-South America Total	U.S.-South America % First Class	U.S.-Pacific First Class	U.S.-Pacific Total	U.S.-Pacific % First Class
1951	8,933	10,211	87.5	717	1,069	67.1	481	520	92.5
1952	9,766	12,121	80.6	773	1,205	64.1	558	608	91.8
1953	10,579	14,298	74.0	769	1,328	57.9	502	711	70.6
1954	10,913	16,235	67.2	643	1,385	46.4	371	847	43.8
1955	12,489	19,206	65.0	661	1,559	42.4	395	1,031	38.3
1956	13,577	21,643	62.7	684	1,793	38.1	436	1,282	34.0
1957	15,012	24,500	61.3	778	2,062	37.7	470	1,414	33.2
1958	14,391	24,436	58.9	775	2,166	35.8	437	1,351	32.3
1959	15,853	28,127	56.4	794	2,573	30.9	493	1,665	29.6
1960	14,846	29,233	50.8	616	2,692	22.9	542	2,133	25.4
1961	12,453	29,535	42.2	447	2,880	15.5	500	2,375	21.1
1962	10,954	31,828	34.4	401	3,186	12.6	462	2,733	16.9
1963	11,787	36,384	32.4	364	3,626	10.0	393	3,172	12.4
Projection									
1970	14,000	58,000	24.2	560	5,570	9.7	580	6,000	9.7
1980	15,500	90,000	17.2	700	9,600	7.3	630	10,000	6.3
1990	17,000	125,000	13.6	800	14,400	5.5	700	15,000	4.7

Source: CAB, Handbook of Airline Statistics.

TABLE 26

HISTORIC AND PROJECTED INTERNATIONAL CARRIERS AIR TRAFFIC BY CLASS OF SERVICE

Passengers Carried (Thousands)

Year	North Atlantic First Class	North Atlantic Total	North Atlantic % First Class	South Atlantic First Class	South Atlantic Total	South Atlantic % First Class	Intra-Europe First Class	Intra-Europe Total	Intra-Europe % First Class
1951	330	330	100						
1952	244	432	56.3						
1953	186	507	36.7						
1954	170	550	30.9						
1955	190	652	29.1						
1956	209	785	26.6						
1957	229	968	23.6						
1958	256	1,193	21.4						
1959	294	1,367	21.5	16.0	48.1	33.2	480	8,467	5.7
1960	306	1,761	17.4	17.5	70.2	24.9	760	10,349	7.3
1961	245	1,919	12.8	21.1	86.6	24.4	915	11,334	8.1
1962	208	2,272	9.2	19.1	105.7	18.1	960	12,585	7.6
1963	192	2,422	8.0	-	-	-	927	14,495	6.4
Projection									
1970	320	4,050	7.9	26	190	13.7	1,500	29,000	5.2
1980	350	7,000	5.0	34	320	10.6	2,400	48,000	5.0
1990	440	10,000	4.4	43	480	9.0	3,500	70,000	5.0

Source: IATA, World Air Transport Statistics.

CHART 5

FIRST CLASS TRAFFIC IN RELATION TO TOTAL TRAFFIC
1950-1990

U.S. DOMESTIC TRUNKS

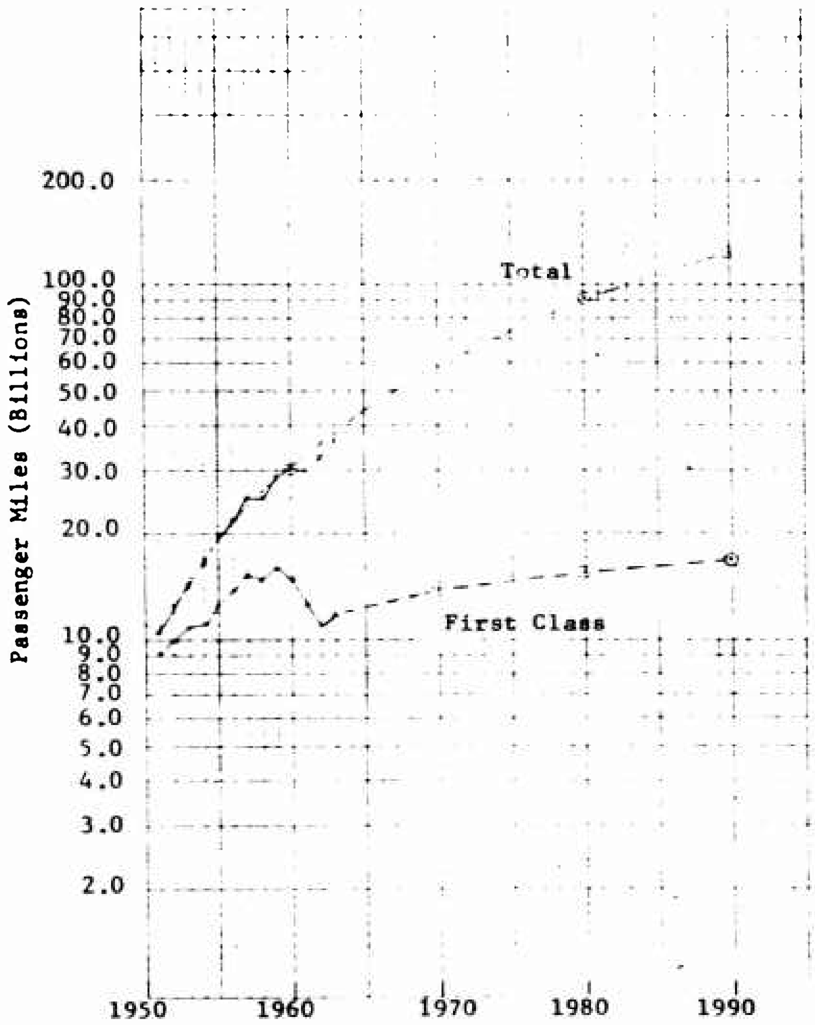


CHART 6

FIRST CLASS TRAFFIC IN RELATION TO TOTAL TRAFFIC
1950-1990

INTRA-EUROPE

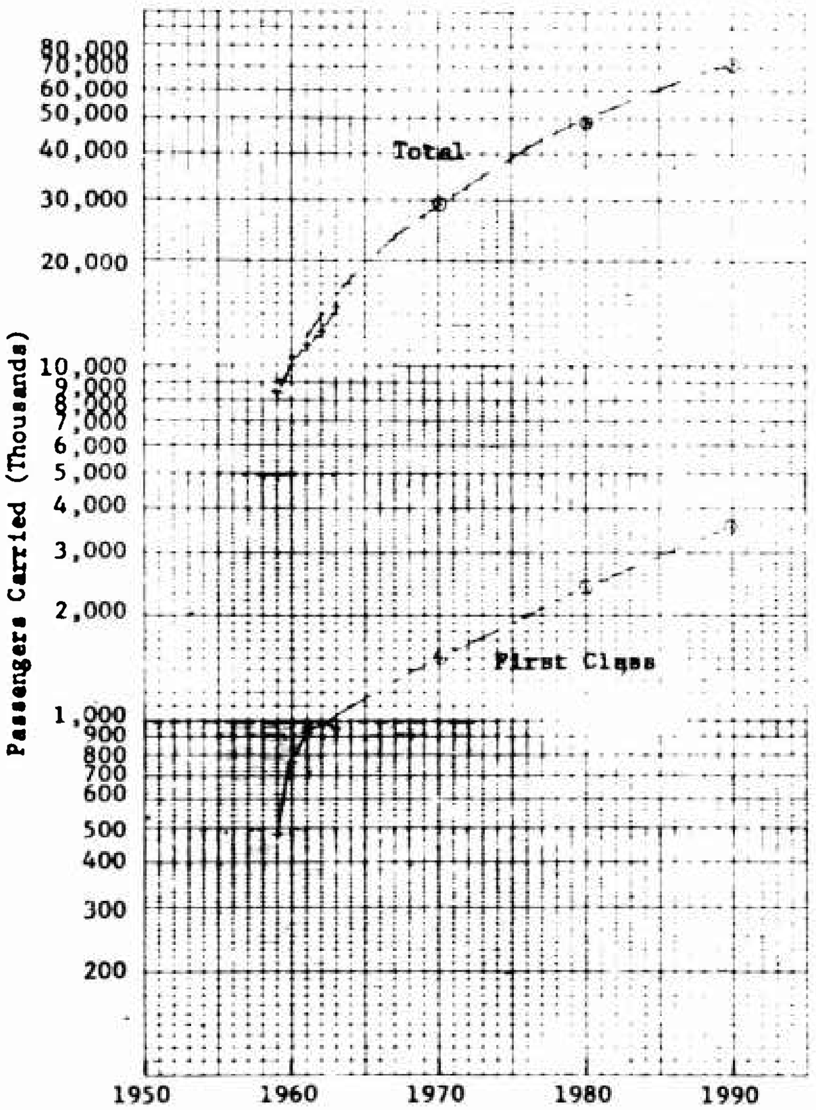


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CHART 7

FIRST CLASS TRAFFIC IN RELATION TO TOTAL TRAFFIC
1950-1990

U.S. - SOUTH AMERICA

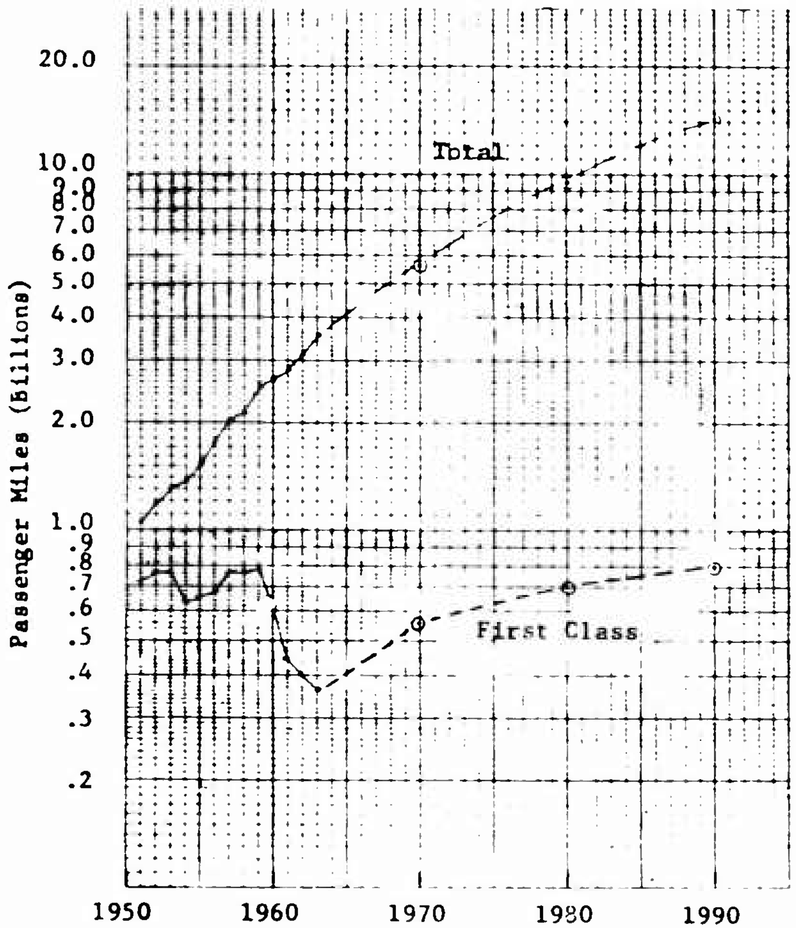

CHART 8

FIRST CLASS TRAFFIC IN RELATION TO TOTAL TRAFFIC
1950-1990

U.S. - PACIFIC

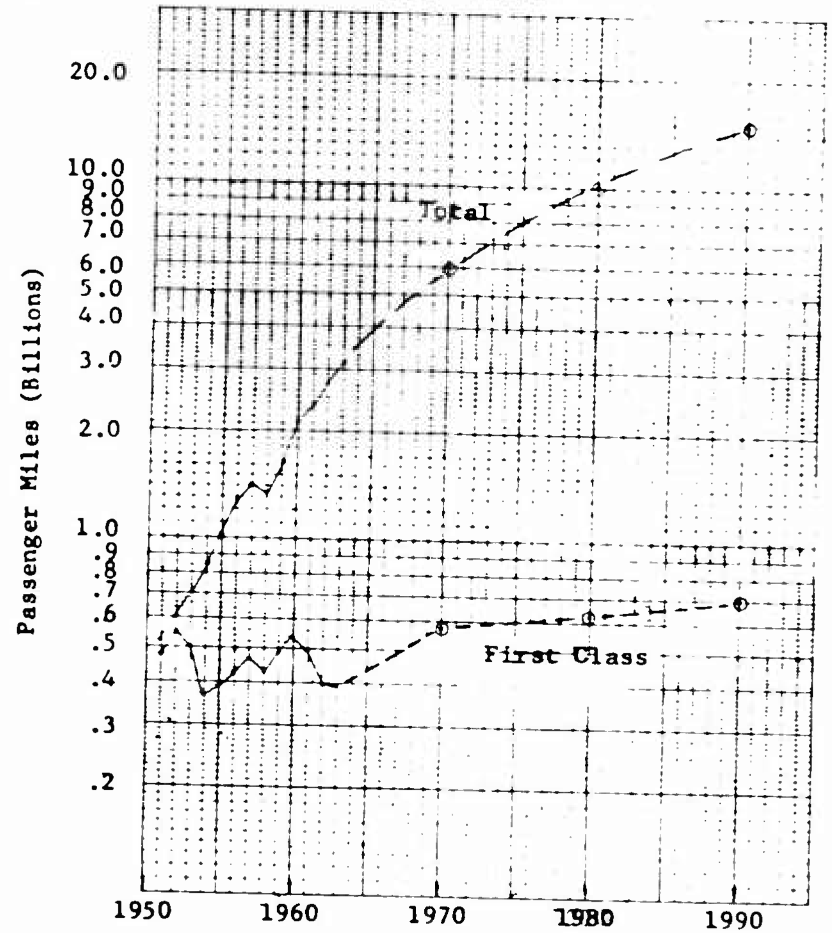

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CHART 9

FIRST CLASS TRAFFIC IN RELATION TO TOTAL TRAFFIC
1950-1990

NORTH ATLANTIC

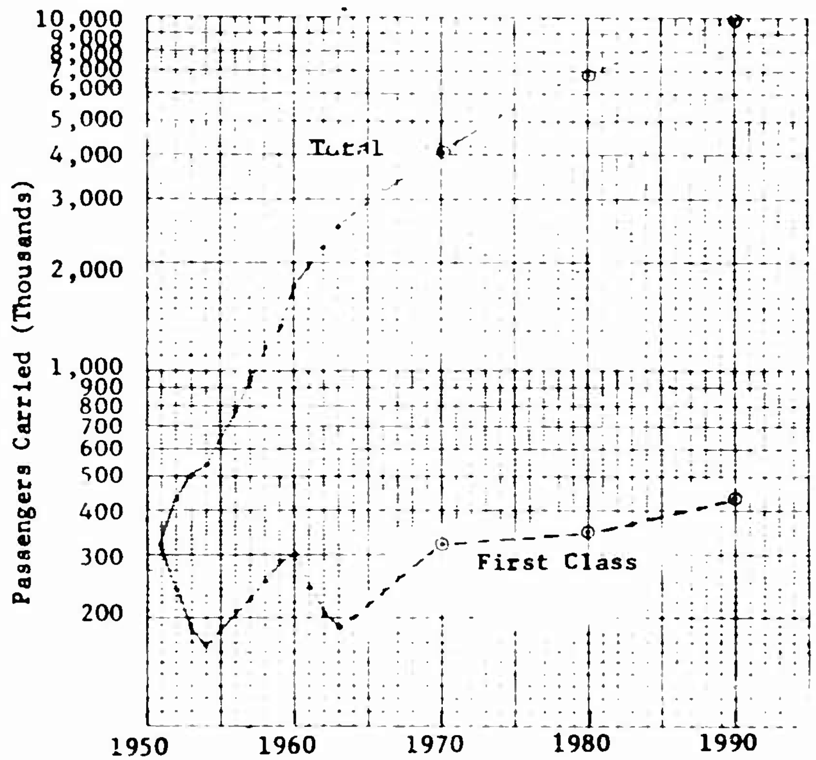
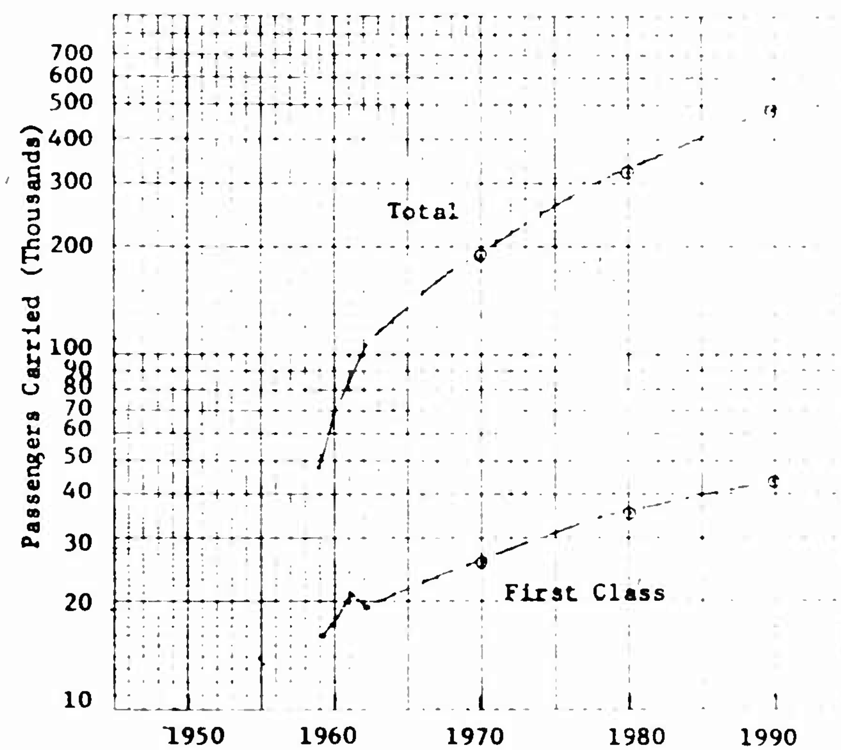


CHART 10

FIRST CLASS TRAFFIC IN RELATION TO TOTAL TRAFFIC
1950-1990

EUROPE - SOUTH AMERICA



PART II

CHAPTER 1

INTRODUCTION

The development of a flexible Demand Model for air travel of 900 nautical miles or more between 67 Free World regions and more than 2,000 city pairs during 1970-1990 was the first of two basic tasks assigned to SARC in the SST economic analysis studies. In Part I of this report (THE DEMAND MODEL), the total air travel between Free World regions and cities was analyzed, projected and formulated for simulation. This Demand Model reflects the steadily increasing rate of global air travel, but it does not reflect how this traffic might be expected to divide between subsonic and supersonic aircraft.

The second major task assigned to SARC by the U. S. Department of Commerce was to assess pertinent factors which would be likely to influence subsonic vs. supersonic option decisions by airline passengers in 1970-1990. Because of the great expenditures which will be required for development, production and operation of SST aircraft, the possibility of higher fares for this service must be anticipated. Obviously, then, fundamental policy decisions related to the future of the SST will be affected greatly by the relative attractiveness of this equipment, particularly in the face of fare differentials 10%, 20% or 30% higher than for aircraft now in the inventory.

Two overwhelming factors will motivate or deter airline passengers of the future, as in the past, to choose between alternative types of equipment. These are travel time (speed) and fare. Other considerations will affect demand for SST travel, but certainly none will be more important than (1) how long it takes a traveller to move from origin to destination, and (2) how much this costs.

It is desirable, however, to discuss briefly some of the other major supplemental considerations that influence air travel decisions. One of these is safety. Another is scheduling. A third is comfort.

Still other passenger choice factors include carrier preference, monetary restrictions, government travel policies, and the exhilaration of participation in economic progress and expansion.

For the most part, it has been essential in this study to assume a status quo approach in assessing the foregoing ancillary choice factors. It must be anticipated, for example, that SST will be as safe as existing equipment; otherwise, they will not be certified. If new operational restrictions are imposed on SST's, such as might result from sonic boom effects, this will be reflected in higher operating costs, and consequently in higher fares.

Flight scheduling will continue to have a formidable impact on passenger flows. There are abundant data to show that convenient flight schedules often can make an inferior type of equipment attractive to the traveller, especially the business traveller. A noteworthy example is the shuttle service instituted by Eastern Air Lines on the New York-Boston and New York-Washington routes. When the shuttle service was introduced, Eastern's share of these markets was 20%; it zoomed quickly to almost 80%, notwithstanding the fact that the shuttle service employs obsolete piston engine equipment. Although scheduling will be of considerable importance to the future of SST, it is beyond the scope of this study to estimate and evaluate Free World airline schedule patterns for the 1970-1990 period.

Similarly, passengers will be influenced by in-flight comfort in making their choice between rival equipment and rival carriers. Passengers will react to such enticements as smooth flight above the weather, air conditioning, improved pressurization, and lack of vibration. For this study, it must be assumed, however, that these factors will be relatively constant. Other comfort measures, such as cabin service and seating, are not related to competing equipment types as such; as with the sonic boom problem, these accommodations are reflected in fare differentials.

A study of the Allocation of Demand cannot ignore passenger motivation as a result of carrier preference. This is similar to "brand" preference of other consumer items, such as automobile gas, cigarettes, and detergents. This motivation is sensitive to such stimuli as advertising and promotion, availability of movies, television or high-fidelity music -- even quiet -- while in flight, and by a host of other subjective considerations. In the long run, however, it has been demonstrated repeatedly that carrier preference largely is offset by competition. A survey by a national magazine revealed, for example, that only 8% of passengers chose the airline on which they were flying because they "liked that particular airline."

On the international scene, passenger preference may be influenced ntry of residence, place of birth, and citizenship. Available evidence indicates, however, that while carrier preference has some notable effects in particular markets at particular times when competing carriers were operating comparable aircraft, this preference historically has not been great enough to offset a marked equipment disadvantage. For this reason, all carriers, both foreign and domestic, have been forced quickly to acquire competitive equipment to maintain their market share.

The elimination or easing of monetary restrictions since the end of World War II and the liberalization of foreign travel allowances by numerous governments have contributed to the growth of air travel, and this trend may be expected to continue. But specific year-to-year forecasts of these economic phenomena are not possible, certainly for the 1970-1990 period. Regulations and restrictions on air travel as a result of balance of payments factors also are worthy of note, but are impossible of firm, long-range assessment.

If airline travel history provides any insights into the future, then certainly great numbers of passengers can be expected to demonstrate an enthusiastic initial response to SST flight. At the same time, however, others will be chary of trying something new. Economists have recognized that innovations and technological advances provide a source of great interest and personal power and accomplishment and early SST passengers will share this feeling. The relevant exhilaration thesis of Terborgh emphasizes that innovations and technological advances are sufficient to take up additional savings, and stimulate great interest on the part of investors as well as patrons.

Full and comprehensive data on the changing moods and preferences of consumers are, however, a study unto themselves, requiring the skills of the psychologist and sociologist, among others. For the present and for the purposes of its effect on the SST, it is safe to conclude that "carrier preference" will exist to a significant degree only when there is a major equipment differential between airlines. This could be either SST versus regular jet, or faster SST versus slower SST.

When all is said and done, what will overwhelm all other considerations in allocation of demand for Free World air travel between 1970 and 1990 are factors of time and cost, and their interplay.

An illustrative case in point is the success of Icelandic Airlines on the North Atlantic route. By means of reduced fares, it has demonstrated a capability to attract passengers from airlines using superior equipment and flying at faster speeds.

It may be taken for granted that in airline travel, as in virtually all other forms of travel (shipboard travel may be cited as a possible exception), passengers will prefer the fastest type equipment available, all other considerations being equal. This preference is certainly true for the traveller who has decided to make his trip by air.

One of the key factors which complicates the SST policy making decision process is the widely accepted possibility that technological problems resulting from operations at Mach 2 and Mach 3 will result in higher costs, and consequently in increased fares. This phenomenon would differ from past experience with new aircraft equipment. In past aviation history, as a new equipment type was developed, manufactured, and introduced into service, it has provided an improvement in reliability, comfort, and speed, and also, most importantly, a reduction in unit costs of operation. Consequently, economic justification for the new aircraft in the past was clear.

Because the SST may cost more to operate than present generation aircraft, it is essential to the effectiveness of an SST economic analysis to assume that possibility and to estimate the degree of public acceptance of higher fares over a range of fare differentials. As has been developed in this study, primary value to be offered by the SST in comparison to contemporary aircraft will be speed, or time saving. It follows that the basic question to be explored is: **What is the value of time?**

This crucial question is surveyed in Chapter II of Part II, which concludes with an evaluation of the findings. Chapter II is followed by three related chapters as follows:

CHAPTER III -- **Evaluation of the Piston-Subsonic Jet Transition Period**

CHAPTER IV -- **Development of the Income Equivalence Approach**

CHAPTER V -- **Income Equivalence Forecast**

PART II

CHAPTER II

VALUE OF TIME

Aircraft innovations in the past have given the traveling public improved speed, range, and comfort. Almost without exception, these important improvements have been made available at little or no increase in passenger fare. And certainly these improvements in the vehicle have been largely responsible for the long-term decline in the cost of air transportation.

Although the cost of manufacturing and operating SST aircraft is not known at this time, there are indications that the SST may have higher initial and operating costs than subsonic aircraft. If the SST can be built to operate at the same or lower costs than the future generation of subsonic jets, the financial success of the SST is clearly assured. However, if present thinking is correct, and if it does cost more to build and operate the SST, the additional cost burden may have to be borne by higher passenger fares. Thus, the economic feasibility of the SST, in the final analysis, may be dependent on the ability of the SST to attract a sufficient segment of the air passenger market at a higher fare.

Current Knowledge

It often has been stated that time is the commodity that air transport operators are selling, but little research has been done on measuring its value. In fact, a search of the literature produced no authoritative studies on this subject.

The reason for this is not hard to discover. The commercial air transportation industry is relatively young. Technical advancement in this industry has been rapid, and many improvements have taken place simultaneously. Although the speeds of aircraft have increased constantly, these gains have been achieved concurrently with dramatically improved comfort and safety. At the same time, due to growth and improved technology the cost of such improved air transportation relative to other prices has not risen.

In light of this situation, it is not difficult to understand that the need to isolate and measure the impact of time on demand has been limited. Notwithstanding the inherent difficulties, an attempt has been made in this study to isolate statistically the influence of time saved on the passenger's decision concerning the demand for different types of aircraft.

Statistical Approaches

As indicated in earlier sections of this report, it was thought initially that time and fare could be used as independent or explanatory variables in the Demand Model to explain passenger demand, and that these coefficients could be used to allocate the total demand for air travel among the various types of aircraft, given the fares and times for each market pair.

Regression analyses were conducted using a number of variables in various forms and levels of aggregation in an attempt to explain or estimate total demand in such a manner that results would be statistically sound and acceptable to a priori reasoning. Variables describing population, gross product per capita, urban and non urban population, income and time, fare and distance were used.

However, in the initial regressions, variables exogenous to the air transportation system seemed to explain most of the variations in demand. When all three of the variables - time, fare and distance were included as independent variables, at least two of the coefficients invariably would test statistically insignificant at the .05 percent level. When used alone, these variables were significant. This would tend to indicate the high degree of multicollinearity which was discussed in Chapter II of Part I. As a result of these problems, it was not possible in the general model to quantify the effect of time, fare and distance relationships in such a manner as to be useful in allocating total d mand among the various types of aircraft.

To allow for the fact that increased speed or time saving influences total passenger demand, a factor representing the effect of the improvements in the "state of the art" was introduced in the aggregate Demand Model in Part I.

Another attempt to measure statistically the impact of time savings was made through an analysis of the period when jets were introduced into the air transportation system in competition with piston equipment. This period, which began in late 1958, offered the passenger a vastly improved type of equipment with greater speed at a fare which averaged only about 10% higher than propeller aircraft fares. Although jet planes provided substantial improvement in comfort over piston aircraft, there is no reason at this time to believe that the SST will offer similar improvement in comfort other than that associated with time saved in flight. In spite of this difference, the jet-piston competition is the closest analogy in air transportation history to the potential SST-jet competition. (The analysis of this transition is discussed in detail in Chapter III, which follows).

It should be noted also that the jet-piston experience had many of the advantages of a laboratory experiment. The CAB collected and compiled special monthly reports on this experience for all major markets in the country.

After examining these data from May 1959 through early 1964, it was decided to analyze carefully the data for the year 1961. In the early stages of the piston-to-jet transition when jets were novel and in short supply, they attained abnormally high load factors. This indicated that some passengers who wanted to go by jet could not do so because of the unavailability of seats. During the latter years of the period, jets became more numerous and actually took over many of the markets completely. This was especially true of the longer hauls. Here also the passenger could express no choice. During 1961, on the other hand, there appeared to be a balance between jets and piston types in terms of scheduling, seats offered, passenger division and load factors.

Graphic and regression techniques were employed to study the relationship between time saved, fare differentials and the percent of the traffic electing jet service. This graphic analysis of the cross-sectional data, which were examined for four separate months, indicated a general tendency of passengers to increase their use of jets as the time savings became greater. Although the variation about this central tendency was great, a least squares regression line was fitted to data for one of the months.

The results indicated that time saved was statistically significant in explaining the passenger split between jet and prop aircraft.

Further study of the data strongly suggested, however, that the results were spurious and that basically what was being measured here was supply rather than demand. This conclusion was drawn from the fact that at any given time saving, there were a number of observations that could only be explained by the amount of service offered. In these cases, examination of load factors of pistons and jets did not suggest a strong preference by the passenger.

This conclusion was confirmed through the use of regression analysis with seats, time and fare as independent variables. The results suggested that almost all variation was accounted for by seat availability. The coefficients of time and fare were statistically insignificant.

Although the jet-piston competition did not appear to offer a complete basis for forecasting what might happen in an SST-jet environment, a noteworthy conclusion can be drawn from this empirical evidence. Based on this analysis, it appears that fare differentials of the magnitude of 10% or less are not enough to deter passengers from taking superior equipment if satisfactory schedules are offered. As is explained in greater detail in Chapter III, this is the only definitive conclusion to be drawn from the CAB data.

In addition, a postulation was made that the value placed on a unit of time by an individual would be equal to his income for that time. The basic assumption of this analysis is that there is a given surcharge for each passenger at which this person, based on the value of his time, will be indifferent as to whether he travels by subsonic or supersonic jet. This surcharge is actually equivalent to his earnings for the time saved and represents the maximum surcharge he will pay. There follows a discussion of this concept.

Utility of Time Saved

Comfort and convenience have been cited already as reasons why there is a desire to minimize travel time -- particularly on transcontinental and trans-oceanic flights. Two other reasons, perhaps even more important, require examination. They are associated with the motive of business or personal profit.

The first is represented by the businessman, whose time means money to him or to his organization. The second, closely related reason for the desire of passengers to reduce air travel to a minimum time, is represented by the individual who measures his time either in dollars or some other consideration. Thus, a scholar with limited time for research studies during a university vacation period would place a value on trav[illegible] time savings, and so would a ski enthusiast hurrying from the U.S. to Switzerland for a brief vacation.

No matter what the reason for the desire to save time, it is clear that time saved has utility for all individuals traveling by air, whether this motivation is monetary, career advancement, recreation, or any other type of valued accomplishment.

Because time saved has value to individuals, it may be treated as a commodity which is supplied and consumed. Time saved has a price -- the fare differential. To determine the effective demand for SST travel, it is necessary to relate time saved to the fare differential travelers are willing to pay. The greater an individual's income per hour, the more he is willing to pay to avoid non-productive hours.

In terms of economic theory, the productivity of time may be referred to as the substitution effect, and the tendency to be less concerned with fare as income rises as the income effect. As time becomes more productive, the value of time actually increases relative to money. Individuals then become more concerned over saving time and are thus willing to part with more money than previously for any given time savings. This increases their consumption of the faster modes of travel. The pure income effect considers the increase in consumption of the faster modes of travel due solely to increased income.

Although these two effects are separate concepts, they influence the level of demand simultaneously. For the purposes of this study it is not of particular importance to measure the two effects separately. Indeed, with the available data it is difficult to measure the two effects separately. Indeed, with the available data it is difficult to measure their joint effect. Thus, by assigning income per unit of time as the value of that time, approximation of the relationship of income levels to use of SST vs. subsonic at given fare differentials is possible.

To translate the basic assumption into useable terms, it was necessary to calculate the value of the time saves of the passengers involved.

A fare surcharge of 10, 20 and 30 percent for an SST over a subsonic jet was assumed. This surcharge was expressed in dollars per hour of time saved by an SST over the subsonic at trip lengths of 1500, 2500 and 3500 miles. For this analysis, three different SST's were used - Mach 2.2., 2.7 and 3.0 aircraft. These surcharges per hour are equivalent to the minimum incomes per hour required for payment.

Empirical passenger income distribution data were obtained from Port of New York Authority in-flight surveys giving incomes of air travellers for 1963/64. These distribution figures were then compared to the minimum incomes or surcharges per hour. From these tables the passenger split between supersonic aircraft and subsonic jets was calculated. (Table 27).

TABLE 27

SST SHARE OF DOMESTIC MARKET PERCENT

Fare Differential Percent	Trip Miles 1500	2500	3500
U. S. Domestic Mach 2.2			
10	75	81	81
20	32	35	36
30	27	28	28
U. S. Domestic Mach 2.7			
10	81	85	87
20	35	39	42
30	28	29	29
U. S. Domestic Mach 3.0			
10	82	87	88
20	36	41	44
30	28	29	30

[redacted]

The figures derived from this analysis indicated that between 75% and 85% of total passengers would be willing to pay a 10% differential for the SST for various time savings. These results are supported by the results suggested by the analysis of the jet/piston transition period presented earlier and are further supported by the results of a Stanford Research Institute Study.

The percentages indicating willingness to pay 20% or higher, on the other hand could not be tested by any empirical data. A full discussion of this technique is set forth in Chapter IV.

<u>Income Forecast Through 1990</u>

It is clear that with expected future income increases, the value of time will become greater. Thus, it was necessary to forecast what future incomes will be in certain future years. The methodology is discussed in Chapter V. This forecast indicates a distribution of air travellers as follows:

PROJECTED DISTRIBUTION OF AIR TRAVELLERS
BY INCOME LEVELS
1970 - 1990

Income Category	1970 Percent	1975 Percent	1980 Percent	1985 Percent	1990 Percent
$ 0 - 2,999	1.1	0.7	0.5	0.4	0.3
3,000 - 5,999	3.4	2.4	1.8	1.4	1.1
6,000 - 9,999	11.0	8.9	7.1	5.7	4.6
10,000 - 14,999	25.0	23.7	22.2	20.4	13.3
15,000 - 19,999	15.7	16.7	17.6	18.2	18.8
20,000 - 24,999	11.1	10.8	11.5	12.3	12.7
25,000 and Over	32.7	36.8	39.3	41.6	44.2
	100.0	100.0	100.0	100.0	100.0

Based on this forecast and the above-discussed minimum incomes or surcharges, the percentage of travellers who would elect an SST at selected assumed fare levels and time savings are shown in Table 28 on the following page.

TABLE 28

ESTIMATED PERCENTAGE OF TOTAL AIR PASSENGERS FLYING SST

	1500 Mile Trip			2500 Mile Trip			3500 Mile Trip		
Surcharge	10%	20%	30%	10%	20%	30%	10%	20%	30%
Mach 2.2									
1963	76	32	27	80	35	28	82	36	28
1970	82	40	33	86	42	34	88	44	34
1980	89	45	40	92	49	40	93	51	40
1990	93	55	45	95	55	46	96	57	46
Mach 2.7									
1963	80	37	28	84	39	29	86	42	30
1970	87	43	34	90	48	35	92	51	36
1980	92	50	40	94	56	41	95	58	42
1990	95	56	46	97	61	47	97	65	48
Mach 3.0									
1963	82	36	28	86	41	29	87	44	30
1970	88	44	34	92	50	36	92	52	37
1980	92	51	40	95	57	42	96	60	43
1990	96	57	46	97	64	48	98	67	48

Scheduling Considerations

Scheduling exercises a great influence on equipment selection by passengers. This was evidenced by the evaluation of the jet/piston transition period.

The propensity to pay a surcharge measured by the income analysis involved an implicit assumption that scheduling is consistent with the demand. It is not feasible to spell out the impact of all possible combinations of schedules upon demand. However, it is possible to make certain observations which can be used in testing the postulated model for splitting demand in the simulation.

An example is useful at this point to demonstrate the possible effect of scheduling. Assume that in a given market where both type of schedules are available 25 percent of the air passengers ordinarily would travel by supersonic and 75 percent would go by subsonic. If all subsonic flights were to be terminated, leaving only supersonic flights, the 25 percent who would have gone by supersonic would still go supersonic. The remaining 75 percent now have a choice - to go by supersonic or not to go by air. The choice will be made based on price elasticity of fare. If the fare differential between supersonic and jet had been 10 percent, the elimination of the subsonic flights would be the same as increasing the price to the subsonic passengers by 10 percent. Assuming a price elasticity of -1.0, 7.5% of the total (or 10% of the 75%) would drop out and 90 percent of the 75 percent would decide to go by supersonic. In other words, in this given market, with only supersonic schedules, a total of 92.5 percent of all original passengers would now travel supersonic.

Evaluation of Findings

A fundamental point of view in Part II of this study, in accordance with objectives sought by the SST Study Group, takes into account the fact that the economic feasibility of the SST in the 1970-1990 time period may be dependent in great measure on the ability of the SST to attract a sufficient segment of the air passenger market at higher fares than imposed for subsonic aircraft. In light of this, it is extremely important to evaluate and determine correctly the attractiveness of the SST relative to potential competition.

Our research was limited by time and also by the paucity of concrete statistical data. However, based on all the evidence available, it is reasonably clear that the relative attractiveness of competing aircraft types to airline passengers of the future will be affected significantly by time and fare differentials, particularly the latter, when other factors such as safety and comfort are considered to be relatively constant.

In the time available, we attempted several statistical approaches in analyzing the attractiveness problem. The seemingly analagous situation which obtained during the piston-subsonic jet transition was examined in detail. The results of a questionnaire study conducted by Stanford Research were surveyed. A third area of examination was based on income equivalence, which then was checked against the limited empirical evidence available.

A summation of these analyses is that an SST fare differential in the magnitude of 10% or less would find a high degree of public acceptance. The likely prospect, all other factors being equal, is that an airline passenger traveling 900 nautical miles or more would choose an SST aircraft over a subsonic jet at a surcharge of 10% or less. Above a 15% differential, however, this acceptance appears to fall off sharply, provided that comparable scheduling is available between subsonic and SST equipment.

PART II

CHAPTER III

EVALUATION OF THE PISTON-SUBSONIC JET TRANSITION

As has been noted briefly in Chapter II, the introduction of jet transports in the United States in late 1958 presented a unique situation in air transportation history. Coincidentally with the introduction of the jets and the related surcharges, the Civil Aeronautics Board began assembling from the domestic trunk carriers information as to the relative volume of capacity offered and traffic carried in jet and non-jet aircraft in selected domestic markets.

The basic conditions for an analysis of the related effect of both time and fare seemed to exist. The passenger was offered a choice, at least for a time, of a faster aircraft at a higher fare, or a slower aircraft at a lower fare and information was available, market by market, as to the number choosing each alternative.

A major effort, therefore, was devoted to investigation and analysis of these data. A description of the data, a discussion of how they were compiled and analyzed, and the conclusions drawn from this analysis follow.

<u>Description and Compilation of the Data</u>

The data were collected monthly beginning with May 1959 and continuing into early 1964. Each of the twelve trunklines conducting any scheduled nonstop flights over major city pair route segments - approximately 100 markets -- made reports to the CAB.

For each of the segments, the carriers reported for all non-stop service the number of revenue flights performed, the number of passenger seats available, and the number of revenue passengers carried. Statistics were obtained on the total passengers carried between the stations without regard to origin or destination. These statistics were grouped into three categories based on type of engine power, i.e., piston, turbo-prop, and turbo-jet, and classified by type of service (first-class or coach). Data were reported in terms of the total volume over the route segment in both directions - not for each direction.

For the purpose of this SST study, a first requirement was to select the periods of the piston-to-jet transition to be analyzed. The jets first entered service in limited supply in only a few markets and at a very high load factor. At that time, passenger choice was restricted by the supply. At a later stage in the transition, the jets had preempted all or nearly all of the service in a great many markets, especially the long haul traffic with the more significant time savings. Then, as early in the changeover, choice was restricted. The trend of the load factors and relative participation in the traffic of the jets and non-jets during the period is set forth in Table 29. As is apparent from the table, 1961 was the first year in which jet load factors approached levels of less than 70%. In that year also the volume of piston aircraft service was still large enough to offer the passenger a choice between the two equipment types.

With these considerations in mind, 1961 was selected as the year for analysis. The months of March, June, September and December, being the last month in each calendar quarter, were selected to permit identification of any seasonal effect on the passengers' choice.

In addition to compiling each carrier's data in each market into a total for each market, and calculating the percentage of the total passengers flying on the jets, it was necessary also to determine (1) the scheduled flight time and time saving and (2) the jet and non-jet coach and first-class fares for each market.

For this purpose, the Quick Reference Editions of the Official Airline Guide were used. In all cases, only non-stop flight times, averaged in both directions, were used. In markets where piston and turbo-prop operated, the average flight time of both, weighted by the number of seats available, was used.

With the data thus assembled a screening was made of all the markets to eliminate those where daily service or a minimum of 1,000 seats per month in both jet and non-jet aircraft was provided.

The number of markets remaining in each class of service in each month were as follows:

	First Class	Coach
March	34	39
June	52	52
September	67	64
December	68	65

A final compilation of the remaining data was made by selecting only those markets that appeared in each of the four quarters - 27 first class and 25 coach markets meeting this requirement. The monthly data were then expanded to an annual total.

Analysis of the Data

With the data thus compiled, graphic and regression techniques were used to analyze the data. Using simple graphic regression, the percent jet of total passenger traffic was plotted as a dependent variable against the time saved in minutes between jet and non-jet service. These are plotted for those markets appearing in all four months in Charts 11 and 12.

An examination was made to determine what effect variation in the jet surcharge may have had on the distribution of the observations plotted. The fare differentials were generally stated in even dollars, applying to both first class and coach and varying in approximate relation to distance. They ranged from 6% to 14% of the piston fare in first class and from 6% to 20% in coach with an average of 8% and 14% respectively. Preliminary investigation showed that there was little relationship between the fare differential and the percent of traffic using jet. It was concluded, therefore, that no improvement in the graphic regression would be accomplished by adjusting the time differential data for fare.

A final examination of the data was made to determine if there were any consistent bias, upward or downward, in the load factor of either the jet or non-jet service. Although there were some load factors above 70%, these were in the minority and were distributed randomly for both services.

In addition to the graphic analysis, a multiple regression analysis was made of the observations for the month of June 1961, using the number of passengers as the dependent variable and seats, time and fare as independent variables. The results were statistically significant with an R^2 of .95. However, the seats accounted for 96% of the variation. The coefficient derived for time and fare were insignificant and unreliable.

Findings and Conclusions

As stated at the outset of this chapter, the piston-jet transition period and the data collected by the CAB relating to it seemed at first look to offer a unique "laboratory" opportunity to determine the effect of higher fares and greater speeds. However, after a detailed examination and analysis of the data, it was concluded that the evidence, although indicating a general tendency of passengers to increase their use of jets as the time saving became greater, was too inconclusive to make specific measurements. Two factors obscured the time-fare relationship:

1. The significant improvement in comfort of the jet over the piston.
2. The relatively small surcharge attached to the jet that enabled schedule convenience to override the fare factor.

In addition to speed, the jet carried the passenger over the weather enroute, thus avoiding much turbulence. The jets also eliminated the unpleasant vibration and noise associated with the reciprocating piston engine. Undoubtedly, many of the passengers would have paid a surcharge for these features alone, exclusive of time savings.

When the jets were introduced into service by the airlines, they were scheduled first into the longer haul markets, where, as indicated, they had immediate public acceptance and operated at very high load factors. Thus the economics of the jets almost immediately forced the non-jet aircraft out of the market.

The available observations, therefore, that offered a choice to the passengers were in the range where the time savings were smaller. Only two of the coach markets and none of the first class markets had time savings in excess of one hour. These two markets had time savings of about 90 minutes. The average time savings for all markets was approximately 30 minutes.

At time savings of such magnitude and fare differentials approximating $3.00, it is therefore reasonable to assume that in many cases, an overriding consideration of the passenger in selecting a flight would be the most convenient departure time rather than the elapsed time or fare differential.

TABLE 29

AIR TRAFFIC SHARES OF DOMESTIC OPERATIONS OF TRUNK CARRIERS SCHEDULED SERVICE

1958 - 1962

		Percent Share Revenue Passenger Miles			Load Factor (%)		
		Jet	Prop Jet	Piston	Jet	Prop Jet	Piston
1958	4th Quarter	0.1	4.9	95.0	84.7	64.9	62.4
1959	1st Quarter	1.7	8.4	89.8	92.0	60.8	59.1
	2nd Quarter	6.9	10.6	82.5	92.7	60.6	61.6
	3rd Quarter	14.1	11.9	74.0	84.5	58.7	63.1
	4th Quarter	19.8	16.3	63.9	72.3	57.5	55.1
1960	1st Quarter	24.3	18.2	56.8	70.1	56.5	53.1
	2nd Quarter	31.3	14.9	53.8	73.8	56.9	58.5
	3rd Quarter	37.8	13.6	48.6	72.5	55.0	57.3
	4th Quarter	42.4	13.3	44.3	63.7	50.8	52.4
1961	1st Quarter	47.3	12.0	40.7	62.5	54.5	53.0
	2nd Quarter	49.9	13.3	36.8	61.7	47.7	54.2
	3rd Quarter	55.7	13.6	30.7	60.1	51.9	51.7
	4th Quarter	58.2	14.2	27.6	55.2	52.7	51.2
1962	1st Quarter	60.6	13.5	25.9	54.0	52.4	51.0
	2nd Quarter	63.3	13.3	[illegible]	55.3	55.9	51.9
	3rd Quarter	68.7	12.3	18.9	55.8	59.8	54.5
	4th Quarter	67.9	13.0	19.1	49.7	52.0	48.3

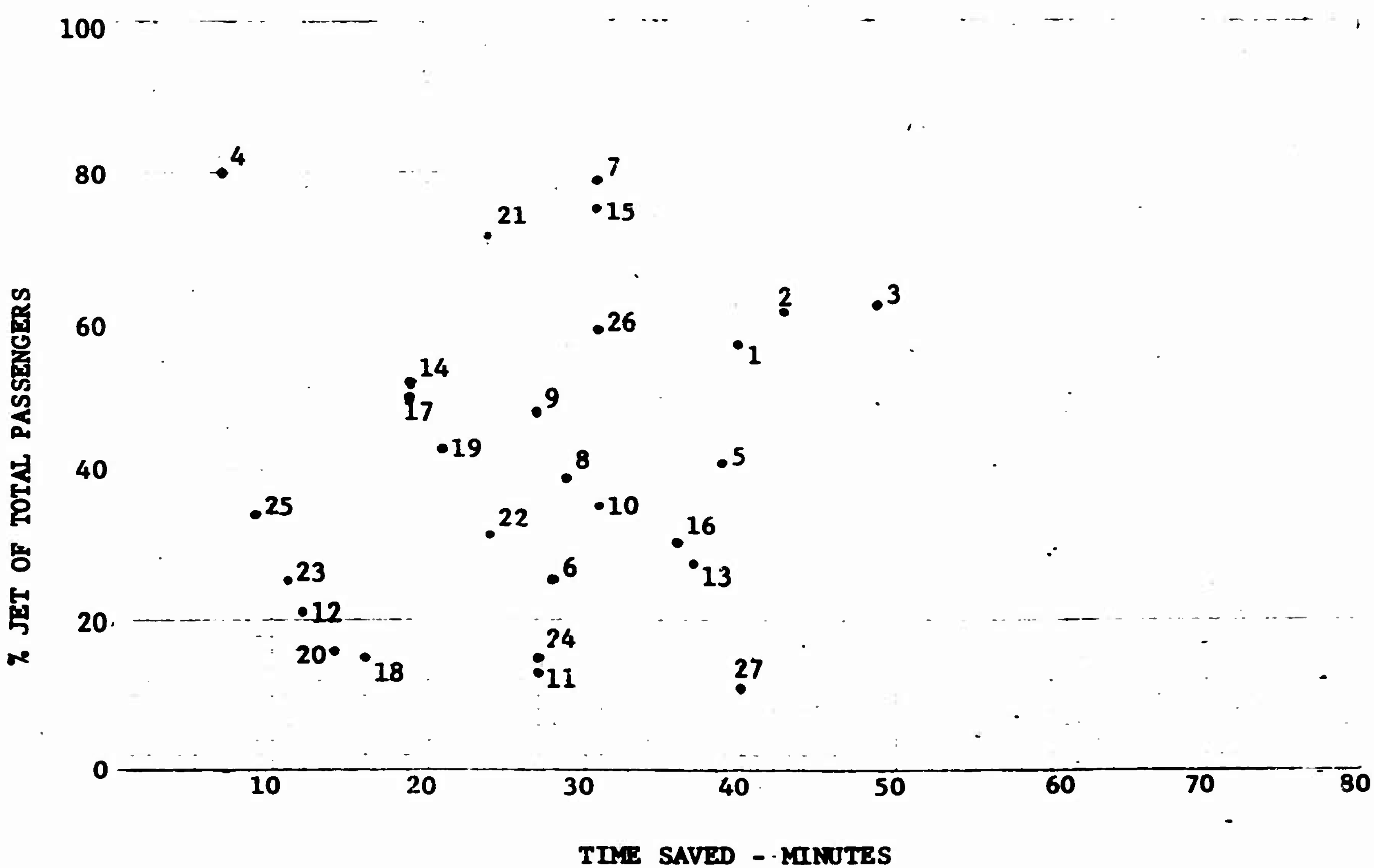
SOURCE: CAB Handbook of Airline Statistics, 1963 Edition, Table 9b.

[redacted]

CHART 11

PROPORTION OF FIRST CLASS PASSENGERS FLYING ON JET AIRCRAFT AT VARIOUS TIME SAVINGS OVER NON-JET AIRCRAFT

Year 1961



[redacted]

[redacted]

CHART 12

PROPORTION OF COACH PASSENGERS FLYING ON JET AIRCRAFT AT VARIOUS TIME SAVINGS OVER NON-JET AIRCRAFT

Year 1961

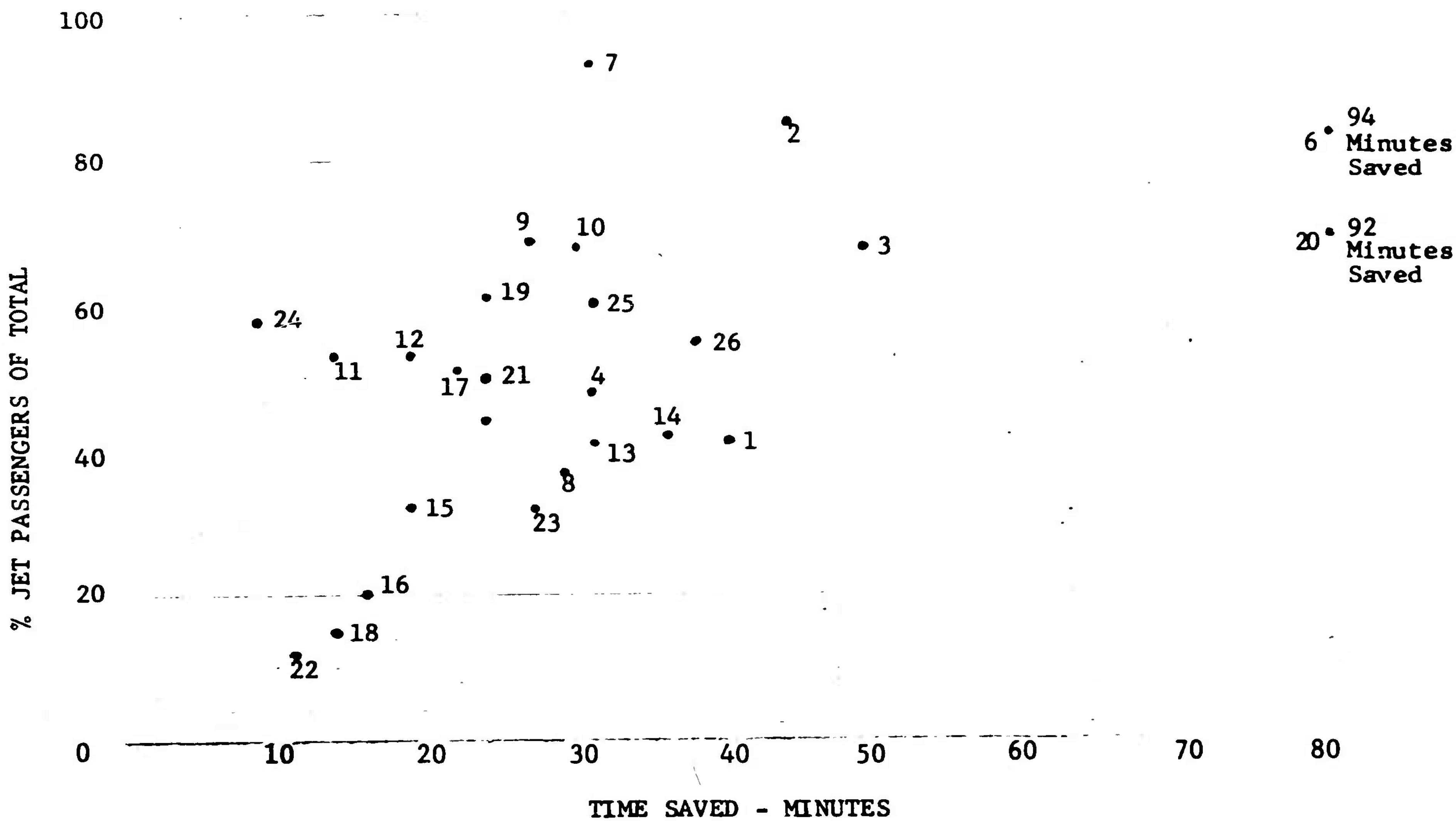


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TABLE 30

PROPORTION OF FIRST CLASS PASSENGERS FLYING ON JET AIRCRAFT AT VARIOUS TIME SAVINGS OVER NON-JET AIRCRAFT

Year 1961

		Percent Jet of Total Passengers	Jet Time Saving (Min.)
1	Atlanta-Chicago	57	40
2	Atlanta-New York	61	43
3	Atlanta-Miami	62	49
4	Baltimore-Philadelphia	80	7
5	Hartford-Cleveland	41	39
6	Boston-Philadelphia	25	28
7	Chicago-New York	79	31
8	Chicago-Kansas City	39	29
9	Chicago-Omaha	48	27
10	Chicago-Pittsburgh	35	31
11	Chicago-St. Louis	13	27
12	Chicago-Detroit	21	12
13	Dallas-New Orleans	[illegible]	37
14	Dallas-San Antonio	52	19
15	Denver-Omaha	75	31
16	Denver-Salt Lake City	30	36
17	Houston-New Orleans	50	19
18	Las Vegas-Los Angeles	15	16
19	Los Angeles-Phoenix	43	21
20	Los Angeles-San Diego	16	14
21	Los Angeles-San Francisco	71	24
22	New York-Detroit	31	24
23	Miami-Tampa	25	11
24	Kansas City-St. Louis	15	27
25	Portland-Seattle	34	9
26	Portland-San Fransciso	[illegible]	31
27	Philadelphia-Detroit	11	40

SOURCE: CAB Form 2789.

TABLE 31

PROPORTION OF COACH PASSENGERS FLYING IN JET AIRCRAFT AT VARIOUS TIME SAVINGS OVER NON-JET AIRCRAFT

Year 1961

		Percent Jet of Total Passengers	Jet Time Saving (Min.)
1	Atlanta-Chicago	41	40
2	Atlanta-New York	85	45
3	Atlanta-Miami	68	49
4	Boston-Philadelphia	48	31
5	Chicago-Dayton	44	24
6	Chicago-Denver	83	94
7	Chicago-New York	93	31
8	Chicago-Kansas City	37	29
9	Chicago-Omaha	69	27
10	Chicago-Pittsburgh	68	30
11	Chicago-Detroit	53	14
12	Dallas-San Antonio	53	19
13	Denver-Omaha	41	31
14	Denver-Salt Lake City	42	36
15	Houston-New Orleans	32	19
16	Las Vegas-Los Angeles	20	16
17	Los Angeles-Phoenix	51	22
18	Los Angeles-San Diego	15	14
19	Los Angeles-San Francisco	61	24
20	New York-Miami	69	92
21	New York-Detroit	50	24
22	Miami-Tampa	12	11
23	Kansas City-St. Louis	32	27
24	Potland-Seattle	58	9
25	Portland-San Francisco	60	31
26	Philadelphia-Detroit	55	38

SOURCE: CAB Form 2789.

[redacted]

PART II

CHAPTER IV

DEVELOPMENT OF THE INCOME EQUIVALENCE APPROACH

The pitfalls in drawing definitive conclusions concerning factors which influence passenger choice of airline equipment from detailed empirical data associated with the piston to jet transition were surveyed in the preceding chapter. It is the purpose of this chapter to develop and describe a relevant income equivalence approach to the problem of traveler options. This is followed in Chapter V by a forecast of passenger distribution based upon this approach.

The basic assumption in the income equivalence analysis is that there is a given surcharge for each passenger at which this traveler, based on the value of his time, will be indifferent as to whether he travels by subsonic jet or pays the surcharge and travels by SST. This surcharge, for the purpose of this analysis, is assumed to be equivalent to an individual's earnings for the time saved and represents the maximum surcharge he will pay. In this study, calculations and forecasts are based on 2,000 hours of employment per year.

The feasibility of determining the split in traffic between subsonic and supersonic aircraft thus depends on an ability to calculate (1) the amount of time saved by the faster equipment, and (2) the additional fare charged for each hour of time saved. Then it becomes possible to relate the surcharge per hour to the earnings per hour distribution of airline passengers, and thereby determine the minimum required income level and the proportion of those passengers earning this amount or more.

Time Saved

The time required for any given flight is a function of the speed of the aircraft and distance traveled. Likewise, the time saved by one aircraft over another is a function of the speed of each aircraft and distance. Time saved is actually the block time of the slower minus the block time of the faster aircraft.

Therefore, a formula for block time for each basic aircraft type was derived. These follow the

[redacted]

form $t_i = a + bD$ where:

t_i = is time required for aircraft type i

D = distance in statute miles

a = constant parameter

b = the regression coefficient reflecting the average time necessary to travel one mile

These formulae are based on achieving 95% of the specified cruise speeds in practical operations and assume non-stop operations. The derived formulae are as follows:

$$ts = .00190D + .40$$

$$tss_1 = .00074D + .65$$

$$tss_2 = .00060D + .70$$

$$tss_3 = .00054D + .75$$

where:

ts = time required in hours for the subsonic aircraft

tss_1 = time required in hours for the Mach 2.2 aircraft

tss_2 = time required in hours for the Mach 2.7 aircraft

tss_3 = time required in hours for the Mach 3.0 aircraft

The time saved by each supersonic type over the subsonic aircraft is $ts - tss_1$ or:

$$ts - tss_1 = .00116D - 0.25$$

$$ts - tss_2 = .00130D - 0.30$$

$$ts - tss_3 = .00136D - 0.35$$

Amount of the Surcharge

The primary determinant of fare for a given aircraft type is distance. Although the fare structure changes over time and differs by geographical areas, an analysis of U.S. domestic air fares in 1963 gives some general relationships. The analysis was made for traffic markets ranging in length from 200 to 2,500 miles

The derived relationships are as follows:

$$F_f = 7.50 + .063D$$

$$F_c = 5.00 + .057D$$

where:

F_f = first class fare in dollars

F_c = coach class fare in dollars

D = trip distance of markets in statute miles

In order to take into account both first class and coach class travel in one equation, the following function, based on a weighted average of the first class and coach class equations, was derived:

$$F = 6.00 + .060D$$

Any percent surcharge or fare differential for a given fare can be expressed in dollars as

$$S = \frac{X}{100} F = \frac{X(6.00 = .060D)}{100}$$

Here,

S = the surcharge in dollars

X = percent fare differential

F = fare derived from weighted average equation above.

Determination of Surcharge per Hour Saved

The maximum surcharge any passenger will be willing to pay can be expressed by $Sm = (ts - tss_i)\ Vt$. In this equation, Sm represents the maximum surcharge individuals at different income levels will be willing to pay for a given flight; $ts - tss_i$ is time saved in hours by the faster plane over the slower plane; Vt is the value of the passenger's time in dollars per hour or in other words, his income per hour.

The maximum surcharge per hour saved can be found by

$$\frac{Sm}{(ts - tss_i)}$$

It follows that the maximum surcharge per hour of time saved which any given passenger will pay, based on time saved and income is:

$$\frac{Sm}{(ts - tss_i)} = Vt.$$

Thus, Vt or income per hour can be used to determine the minimum income per hour required by passengers before they will pay a given surcharge.

The following equation can be written for SS_1,

SS_2, and SS_3 respectively:

$$(SS_1) \quad \frac{X}{100} (6.00 + 0.06D) = (0.00116D - 0.25)\ Vt$$

$$(SS_2) \quad \frac{X}{100} (6.00 + 0.06D) = (0.00130D - 0.30)\ Vt$$

$$(SS_3) \quad \frac{X}{100} (6.00 + 0.06D) = (0.00136D - 0.35)\ Vt$$

SS_1, SS_2 and SS_3 are Mach 2.2, Mach 2.7 and 3.0 aircraft respectively.

These can be rearranged in order to solve for Vt = Sm per hour saved:

$$(SS_1) \quad V_t = \frac{6\ X\ (100 + D)}{11.6D - 2500}$$

$$(SS_2) \quad V_t = \frac{6\ X\ (100 + D)}{13D - 3000}$$

$$(SS_3) \quad V_t = \frac{6\ X\ (100 + D)}{13.6D - 3500}$$

The equation should be interpreted as follows (assuming a market as a pair of regions 1,500 miles apart and a 20 percent fare differential between S and SS_2)

$$V_t = \frac{Sm}{ts - tss_2} = \frac{6\ (20)(100 + 1500)}{13(1500) - 3000} = 11.60$$

Thus, under the basic assumption guiding this analysis, only passengers earning more than $11.60 per hour would be willing to pay the 20% surcharge for the Mach 2.7 supersonic jet. Various minimum income levels calculated in this manner are presented in Table 32.

Proportion of Passengers Who Would Pay Surcharge

The final step in determining the proportion of the passengers is to relate the surcharge per hour saved to an hourly income distribution of air travelers.

In order to test the effect of this splitting technique on an empirical basis, it was applied to 1963 data. The New York Port Authority 1963/64 in-flight survey of the income distribution of air passengers arriving at or leaving New York airports is the most comprehensive, consistent, and up-to-date survey conducted on U.S. domestic travellers. Thus, these data were used for the analysis (See Table 33). The distribution of per hour incomes from this table is shown in Chart 13. The use of this graph along with the surcharge per hour saved in Table 32 gives the cumulative percent of U.S. domestic passengers with per hour income above given fare differentials. The cumulative percent figures read from Chart 13 actually give the percent of total passengers that will travel by certain supersonic aircraft types at assumed fare differentials.

These are presented in Table 34.

Validity of Results

As discussed in earlier chapters of this part of the report, there is sound support in economic theory for the use of productivity of time to measure a person's willingness to part with money for a particular type of air travel. However, to the extent permitted by available data, the figures derived from this analysis were also tested against empirical data.

The figures derived from the analysis (Table 34) indicate that 75-88% of all passengers would be willing to pay a 10% surcharge. The conclusions derived from analysis of the piston-jet transition experience (Chapter III), despite some lack of comparability in the two situations and the deficiencies in those data, support such results.

Another source of empirical data on this subject is a survey of transcontinental passengers conducted by Stanford Research Institute for the Federal Aviation Agency in a report entitled "An Economic Analysis of the Supersonic Transport", September 1962.

This study was conducted to attempt to assess the probable reaction of the traveling public to surcharges for supersonic air travel. This study concluded that there was only slight resistance to an SST fare on the order of 10 percent above present transcontinental fares.

There is very little empirical evidence as to the effect of surcharges of 20 or 30%. The responses to the Stanford Survey, while indicating no corroboration of the income approach for coach passengers, does produce very similar results for first class passengers. That study shows that 56% of the first class passengers would pay a 20% surcharge and 43% a 30% surcharge. This compares with 55% and 41% of the passengers who would pay those surcharges as indicated by the income equivalence analysis.

TABLE 32
MINIMUM INCOMES PER HOUR REQUIRED BEFORE PASSENGERS WILL PAY 10%, 20%, or 30% SURCHARGES FOR SUPERSONIC TRAVEL

Aircraft	Surcharge	Trip Miles 1500	2500	3500
Mach 2.2	10%	$ 6.44	$ 5.89	$ 5.67
	20%	12.88	11.78	11.34
	30%	19.32	17.67	17.01
Mach 2.7	10%	$ 5.80	$ 5.30	$ 5.07
	20%	11.60	10.60	10.14
	30%	17.40	15.90	15.20
Mach 3.0	10%	$ 5.68	$ 5.11	$ 4.90
	20%	11.36	10.22	9.80
	30%	17.04	15.33	14.70

TABLE 33

INCOME DISTRIBUTION OF U.S DOMESTIC PASSENGERS 1963/64

Income Bracket	Average Income $ Per Year	Average Income Per Hour	First Class Percent	First Class Cum. Percent	Coach Class Percent	Coach Class Cum. Percent	Total Percent	Total Cum. Percent
$ 0 - 2,999	1,500	.75	2	100	2	100	2	100
3,000 - 4,999	4,000	2.00	2	98	3	98	3	98
5,000 - 5,999	5,500	2.25	2	96	4	95	3	95
6,000 - 6,999	6,500	3.25	2	94	5	91	4	92
7,000 - 9,999	8,500	4.25	9	92	13	86	11	88
10,000 - 14,999	12,500	6.25	23	83	25	73	25	77
15,000 - 19,999	17,500	8.75	16	60	17	48	16	52
20,000 - 25,999	22,500	11.25	10	44	9	31	9	36
25,000 and Over	45,000	22.50	34	34	22	22	27	27
Total			100	-	100	-	100	-

SOURCE: Port of New York Authority, Domestic Inflight Survey, 1963-64.

CHART 13

INCOME DISTRIBUTION OF AIR TRAVELERS

1963

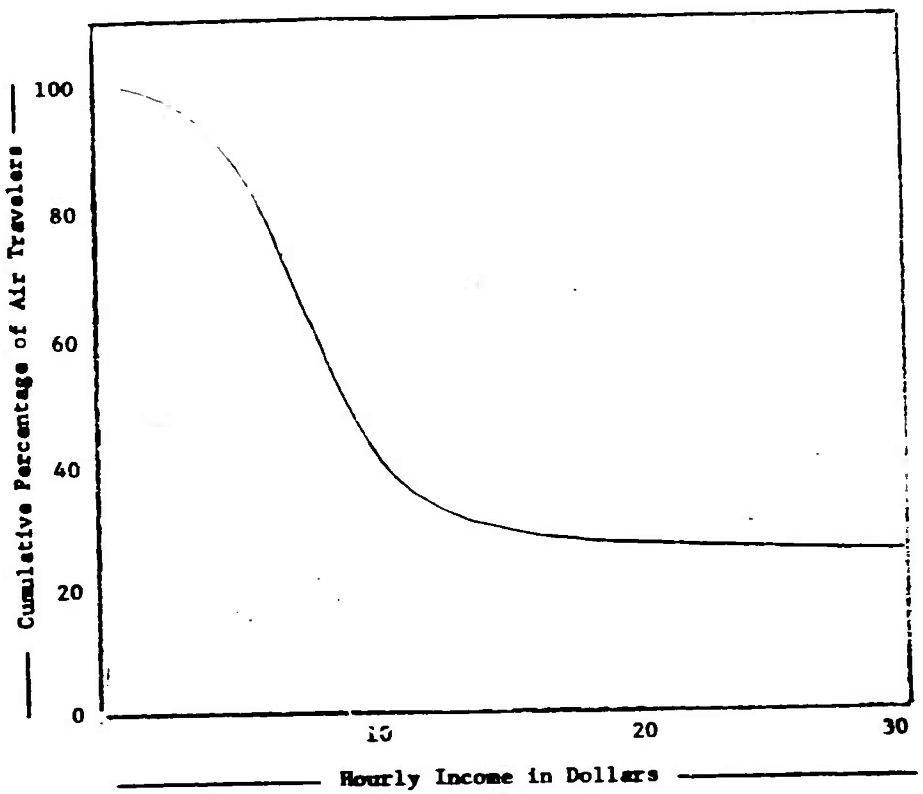


TABLE 34

ESTIMATED PERCENTAGE OF TOTAL AIR PASSENGERS FLYING SST

1963

Surcharge 1/	1500 Mile Trip	2500 Mile Trip	3500 Mile Trip
		Mach 2.2 Aircraft	
10%	75%	81%	81%
20	32	35	36
30	27	28	28
		Mach 2.7 Aircraft	
10%	81%	85%	87%
20	35	39	42
30	28	29	29
		Mach 3.0 Aircraft	
10%	82%	87%	88%
20	36	41	44
30	28	29	30

1/ As percent of lower fare.

PART II

CHAPTER V

INCOME EQUIVALENCE FORECAST

The development and evaluation of the income equivalence approach as applied to 1963 was discussed in Chapter IV. In order to estimate the proportion of passengers who would be willing to pay surcharges in the period 1970-1990, it is necessary to determine what the distribution of the hourly income of the air passengers will be in that period.

Past trends and future projections show that income has risen steadily, and will continue to do so. Therefore, more passengers will be willing and able to pay any given surcharge in the 1970-1990 period than at present.

<u>Income Distribution of Air Passengers</u>

The only information available on income distribution among air passengers is historic and from in-flight surveys. The most comprehensive and up-to-date survey was made by the New York Port Authority in 1963/64, both on U.S. Domestic and Overseas Routes. This information covered many of the major markets and is assumed to be representative of the U.S. air passenger characteristics. These findings agree essentially with the results of the other surveys examined. The domestic distribution is presented in Table 35.

Because there were no current forecasts of income distribution of air passengers available, it was decided to relate passenger income distribution to other income distributions for which there were reliable forecasts. For that purpose the income distribution of consumer units was selected.1/ This is a standard definition and is used by the National Planning Association and the Outdoor Recreation Resources Review Commission in making projections.

The income distribution of air passengers for 1963/64 was related to the percentage of consumer units

1/ A consumer unit income level as used herein is the same definition as the income levels for families and unattached individuals as used by the U.S. Department of Commerce, <u>Survey of Current Business</u>, April, 1964, p. 3-11.

in each income category. Then, the relative weight of 1963/64 air passengers demand for air travel was generated for each consumer unit income category. Table 36 presents the data for domestic U.S. air passengers. The Weighted Demand Index was applied to the projection of consumer unit income distribution to obtain a forecast of air passenger income distribution. It was assumed that the demand for air travel within each income level group will remain constant in the future and that any shift in the weighted demand for air travel will be accounted for by individual consumer units shifting from one income level to another.

Projection of Consumer Unit Income Distribution

The distribution of U.S. consumer unit income level has followed certain definite trends. Table 37 presents time series data showing the percentage of consumer units having incomes over each minimum income bracket.

The National Planning Association has projected comparable data for the years 1968 and 1973, and the Outdoor Recreation Resource Review Commission in its Report No. 23 made similar forecasts for 1976 and the year 2000. These independent forecasts were used for the SARC extrapolation. The income projections are shown in Chart 14.

Using these data as a base, the projected percentage distribution of consumer unit income level has been prepared. Table 38 presents this information by incomes over a given level and Table 39 shows the projected percentage in each income level category.

Projection of Air Traffic Split for U. S. Markets

Table 39 shows the projected distribution of consumer units by income level. These percentages were multiplied by the corresponding constant Weighted Demand Index. The product becomes a projected air travel index, which was then converted to show the projected percentage distribution of air travellers by income levels (Table 40).

The income categories were expressed as average hourly incomes and the percentage distributions of passengers were shown as a percent having income in excess of the indicated amount per hour (Table 41). These percentages are plotted as curves on Chart 15.

The minimum per hour income figures attached to Chapter IV as Table 32 were used in conjunction with Chart 15 of this chapter to estimate the percentage of air passengers that will travel by each supersonic aircraft type. These predictions were made for 1970, 1980 and 1990 and compared with 1963 (Table 42).

Following the forecast increase in incomes, the estimated proportion of the passengers who will fly the SST shows a continued increase. On a flight, for example, from San Francisco to Dallas (1,477 miles) the number who would pay a 10% surcharge to fly a Mach 3 SST over a subsonic jet increase from 82% in 1963 to 96% in 1990. At a 30% surcharge, 46% would take the Mach 3 - an increase from 28% in 1963.

Projection of Traffic Split for World Markets

The foregoing discussion and projection, as indicated, is based on U.S. domestic information. Since the scope of the Demand Study is the Free World, a search was made for comparable information on economy for the rest of the World. This search disclosed that world-wide estimates of the percentage distribution of consumer units by income levels for various countries are virtually non-existent. The few estimates which do exist are not comparable because of inconsistent means of measurement.

Careful examination was made of current research and studies in the possession of the United Nations, and the International Labour Office. Data available from the UN and ILO have not been used in this study because of their incomparability, and lack of uniformity in sampling methods.

The incompleteness of the data was confirmed in a joint study by the United Nations, the International Labour Office, the Food and Agricultural Organization, The World Health Organization and UNESCO, which established international definitions of the levels of living. This study concluded that "it is not considered possible to recommend wide-scale international comparison of levels of per capita income", in spite of the considerable work which has been done on the methodology of comparison of purchasing power between pairs of countries and small groups of countries with similar economic and social backgrounds.[2] It further recommended that data on income and expenditure should be considered as basic information rather than as an indicator of levels of living.

Also considered was the possibility of estimating foreign income distributions by the projections developed from the distribution of U.S. consumer income as presented in Tables 37, 38 and 39 of this chapter. This would have involved (1) the establishment of a relationship of the percentage distribution of consumer unit income levels to per capita gross domestic product and (2) the extrapolation of these relationships of percentage distribution of consumer unit and relating the extrapolation levels so as to fit varying per capita GDP levels. Such per capita GDP levels could be projected for the Free World SST regions both as to income level and time.

2/ International Definition and Measurement of Levels of Living. An Interim Guide, United Nations, 1961, paragraphs 54-60.

However, in view of the above cited UN recommendations and the paucity of information from foreign countries with which to confirm the assumptions, such estimates were not considered to be useful.

Examination of other international data such as those collected by the airline industry also showed the lack of information on the income distribution of the air travellers in foreign countries. The only useful data found related to United States overseas travellers. The Port of New York Authority survey was the most current and comprehensive. These data showed that the average income of the U.S. overseas passengers was slightly higher than the domestic passengers. In addition, the percentage distribution of air travellers with family incomes of $15,000 and over was comparable to income distribution of U.S. domestic air travellers with similar incomes.

In view of the lack of data reflecting either world-wide consumer unit, or air travellers income level distribution, and since the Port of New York

Authority showed a comparability of the percentage distribution of income levels over $15,000 for domestic and overseas air travellers, consideration was then given to a determination of the error involved in applying the U.S. domestic distributions to world-wide air traffic.

In a previous chapter in Part I of this study (Determination of Free World Origin and Destination Statistics, Chapter III, Table 4, showing the 1963 ICAO distribution of a Free World air passengers) U.S. domestic air passengers accounted for 48.6% or 65.66 million of the estimated 135 million air passengers. When air passengers having an origin or destination in the United States are included, the percentage rises to 55.8% or 75.29 million of the 135 million world air passenger total.

In a separate study of the world air trips over 1,000 statute miles, the U.S. domestic revenue passenger miles in 1958 were estimated to be 61% of the Free World total, and trips showing the U.S. as an origin or a destination accounted for 90% of all revenue passenger miles flown.

This same study projected the U.S. domestic share of trips exceeding 1,000 statute miles to be 48% of the Free World share in 1975, and total U.S. origin and destination trips would account for 82% of air passenger miles for air trips over 1,000 miles by 1975.[3/]

The SARC demand model forecast of future Free World air traffic also shows that the U.S. air travel market is and will dominate the Free World market for years to come.

While those passengers showing an origin and/or destination in the U.S. are not all U.S. citizens, the majority are. Immigration and Naturalization Serice data show that U.S. citizens comprise more than 60% of air travel between the U.S. and foreign countries. Therefore, for a majority of the passengers the U.S. income data would be applicable.

3/ Journal of Air Law and Commerce, text of paper presènted at IATA Symposium on Supersonic Air Transport, Montreal, April 1961 from Supersonic Transport Market Analysis - General Dynamics Corporation, 1960.

As indicated earlier, no data are available as to the income distributions of foreign air travellers. The average incomes in foreign countries are below those of the U.S. but this gap is expected to narrow in the future due to higher growth rates for these countries. Furthermore, since the average income of air travellers is higher than that of the national average, and since the income distribution of foreign countries tends to be skewed toward the very high and very low incomes, the income of the foreign air passenger may not be as different from the U.S. air passenger as might be indicated by the difference in the incomes of the total population.

In conclusion, it is believed that the use of U.S. air passenger income data for estimating the proportion of passengers who will fly the SST will produce meaningful results. For many of the major long haul routes where the justification for the SST will be determined, the U.S. passenger will be the deciding influence. In other parts of the world where the U.S. passenger may not be in the majority, the SST estimated portion of the traffic may be high but present information is too inadequate to measure the possible error.

[redacted]

TABLE 35

INCOME DISTRIBUTION OF U.S DOMESTIC PASSENGERS 1963/64

	Average Income $		First Class		Coach Class		Total	
Income Bracket	Per Year	Per Hour	Percent	Cum. Percent	Percent	Cum. Percent	Percent	Cum. Percent
$ 0 - 2,999	1,500	.75	2	100	2	100	2	100
3,000 - 4,999	4,000	2.00	2	98	3	98	3	98
5,000 - 5,999	5,500	2.25	2	96	4	95	3	95
6,000 - 6,999	6,500	3.25	2	94	5	91	4	92
7,000 - 9,999	8,500	4.25	9	92	13	86	11	88
10,000 - 14,999	12,500	6.25	23	83	25	73	25	77
15,000 - 19,999	17,500	8.75	16	60	17	48	16	52
20,000 - 25,999	22,500	11.25	10	44	9	31	9	36
25,000 and Over	45,000	22.50	34	34	22	22	27	22
Total			100	-	100	-	100	-

SOURCE: Port of New York Authority, Domestic Inflight Survey, 1963-64.

[redacted]

[redacted]

TABLE 46

PERCENTAGE DISTRIBUTION OF U.S. AIR TRAVELLERS AND CONSUMER UNIT INCOME LEVEL AND RELATED DEMAND FOR AIR TRAVEL BY INCOME LEVEL

1963

Income Bracket	U.S. Air Traveller 1/ %	U.S. Consumer Unit 2/ %	Weighted Demand Index 3/ %
0 - 2,999	2.0	20.0	.38
3,000 - 5,999	6.0	29.5	.78
6,000 - 10,000	15.0	29.5	1.94
10,000 - 14,999	25.0	13.5	7.08
15,000 - 19,999	16.0	4.0	15.93
20,000 - 24,999	9.0	1.5	22.93
25,000 and Over	27.0	2.0	51.60

1/ Port of New York Authority, 1963/64 Inflight Survey data.

2/ Survey of Current Business, U.S. Department of Commerce, April 1964.

3/ Weighted demand index = $\frac{a}{\sum \frac{b}{a}}$ where:

a = U.S. consumer units in each income bracket

b = U.S. air traveller in each income bracket

TABLE 37

PERCENT DISTRIBUTION OF CONSUMER UNITS BY INCOME LEVEL

Selected Years

Year	$3,000 or More	$6,000 or More	$10,000 or More	$15,000 or More	$20,000 or More	$25,000 or More
1944	48.1	11.9	3.0	1.3	.7	.4
1946	53.3	14.0	4.1	1.6	.8	.5
1947	56.2	16.3	4.5	1.8	1.0	.6
1950	60.2	18.6	5.1	2.0	1.2	.8
1951	66.8	23.9	6.4	2.6	1.5	.9
1952	69.2	26.7	6.9	2.8	1.6	1.0
1953	70.5	30.2	8.2	3.0	1.6	1.0
1954	69.8	29.8	8.3	3.1	1.6	1.0
1955	72.9	32.7	9.4	3.5	1.8	1.1
1956	75.2	36.5	11.3	4.1	2.0	1.2
1957	75.8	39.4	12.7	4.7	2.3	1.4
1958	75.8	39.8	13.3	4.8	2.3	1.4
1959	76.8	43.4	15.3	5.7	2.6	1.5
1960	77.7	45.4	16.8	6.2	2.7	1.5
1961	78.0	46.4	17.6	6.5	2.8	1.6
1962	79.5	49.3	19.5	7.2	N.A.	N.A.
1968	82.9	58.0	26.0	10.0	5.0	3.0
1973	86.0	65.0	34.0	14.0	7.0	4.0
1976	87.2	68.7	39.6	16.7	8.5	4.7
2000	92.4	80.4	60.5	35.0	19.1	11.1

SOURCE: 1929-1962 - Survey of Current Business, April 1964, p. 5, Table 4.
1968-1973 - NPA National Economic Projection, p. 1-17, Table 1-11.
1976-2000 - ORRRC Study Report #23, p. 22, Table D-31.

[redacted]

TABLE 38

DISTRIBUTION OF CONSUMER UNITS BY INCOME LEVELS

1970 - 1990

Projected Income Distribution	1970 %	1975 %	1980 %	1985 %	1990 %
$ 3,000 or More	84.5	87.2	89.0	90.0	91.0
6,000 or More	61.0	67.2	71.2	74.5	77.0
10,000 or More	30.5	37.0	43.0	48.4	53.1
15,000 or More	11.5	15.0	18.7	22.6	26.8
20,000 or More	6.0	7.8	9.8	12.0	14.3
25,000 or More	3.4	4.7	5.9	7.2	8.7

SOURCE: See Chart 13.

CHART 14

PERCENT DISTRIBUTION OF INCOME PER CONSUMER SPENDING UNIT

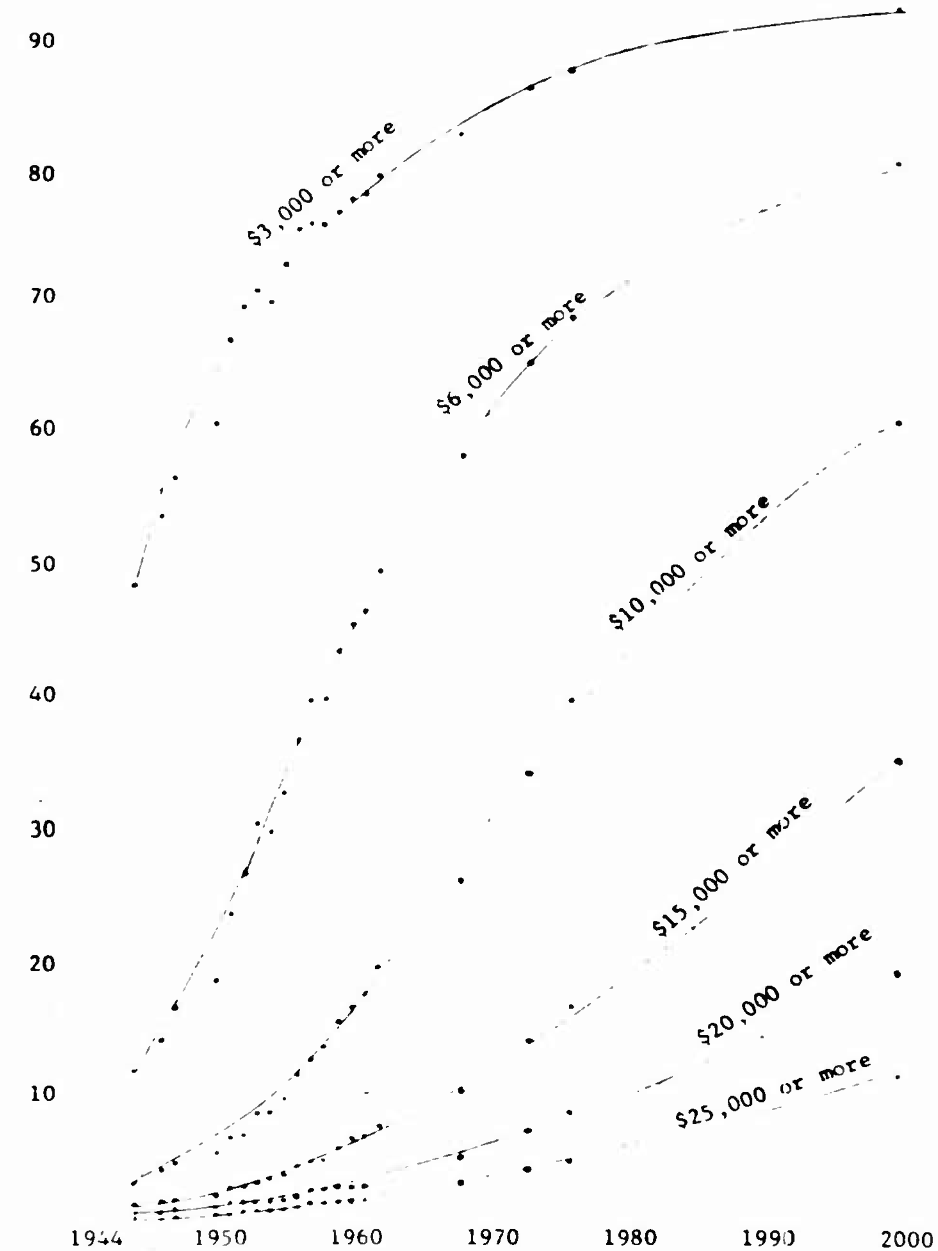


TABLE 39

DISTRIBUTION OF CONSUMER UNITS BY INCOME LEVELS

1970 - 1990

Income Category	1970 %	1975 %	1980 %	1985 %	1990 %
$ 0 - 2,999	15.5	12.8	11.0	10.0	9.0
3,000 - 5,999	23.5	20.0	17.8	15.5	14.0
6,000 - 9,999	30.5	30.2	28.2	26.1	23.9
10,000 - 14,999	19.0	22.0	24.3	25.8	26.3
15,000 - 19,999	5.5	7.2	8.9	10.6	12.5
20,000 - 24,999	2.6	3.1	3.9	4.8	5.6
25,000 and Over	3.4	4.7	5.9	7.2	8.7
	100.0	100.0	100.0	100.0	100.0

SOURCE: See Chart 14.

TABLE 40

PROJECTED DISTRIBUTION OF AIR TRAVELLERS BY INCOME LEVELS

1970 - 1990

Income Category	1970 %	1975 %	1980 %	1985 %	1990 %
$ 0 - 2,999	1.1	0.7	0.5	0.4	0.3
3,000 - 5,999	3.4	2.4	1.8	1.4	1.1
6,000 - 9,999	11.0	8.9	7.1	5.7	4.6
10,000 - 14,999	25.0	23.7	22.2	20.4	18.3
15,000 - 19,999	15.7	16.7	17.6	18.2	18.8
20,000 - 24,999	11.1	10.8	11.5	12.3	12.7
25,000 and Over	32.7	36.8	39.3	41.6	44.2
	100.0	100.0	100.0	100.0	100.0

[redacted]

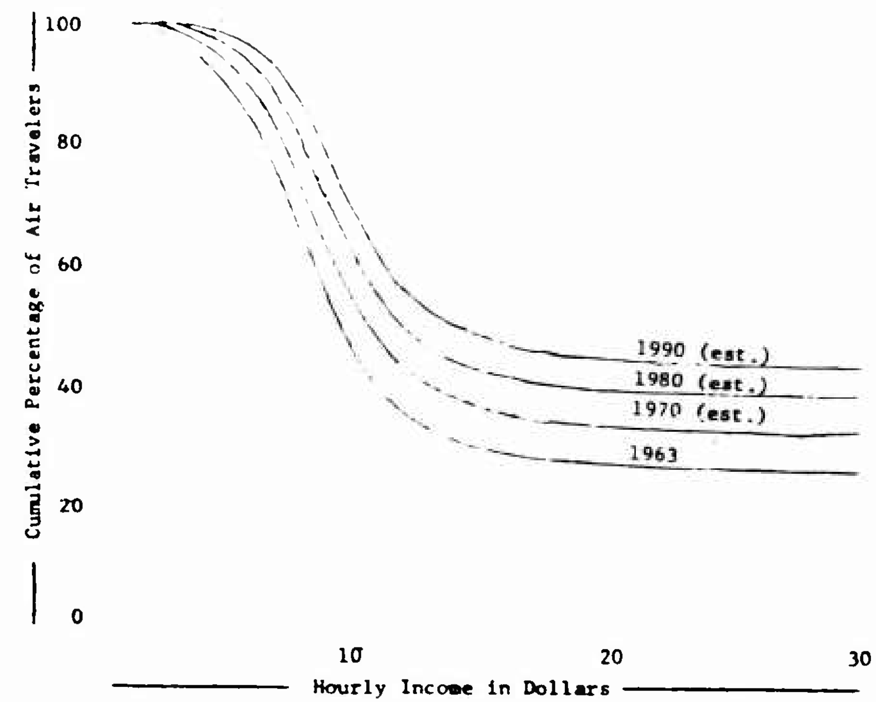
TABLE 41

DISTRIBUTION OF AIR TRAVELERS AVERAGE INCOME PER HOUR

Average Income Per Hour	1963	1970	1980	1990
0.75	100	100	100	100
2.25	90	99	99	10C
4.00	92	96	98	99
6.25	77	85	91	94
8.75	52	60	69	76
11.25	36	44	51	57
22.50	27	33	39	44

CHART 15

INCOME DISTRIBUTION OF AIR TRAVELERS
1963-1970-1980-1990



[redacted]

[redacted]

TABLE 42

ESTIMATED PERCENTAGE OF TOTAL AIR PASSENGERS FLYING THE SST

	1500 Mile Trip			2500 Mile Trip			3500 Mile Trip		
Surcharge	10%	20%	30%	10%	20%	30%	10%	20%	30%
Mach 2.2									
1963	76	32	27	80	35	28	82	36	28
1970	82	40	33	86	42	34	88	44	34
1980	89	45	40	92	49	40	93	51	40
1990	93	55	45	95	55	46	96	57	46
Mach 2.7									
1963	80	37	28	84	39	29	86	42	30
1970	87	43	34	90	48	35	92	51	36
1980	92	50	40	94	56	41	95	58	42
1990	95	56	46	97	61	47	97	65	48
Mach 3.0									
1963	82	36	28	86	41	29	87	44	30
1970	88	44	34	92	50	36	92	52	37
1980	92	51	40	95	57	42	96	60	43
1990	96	57	46	97	64	48	98	67	48

SOURCE: Values estimated from Table 32 and Chart 15.

[redacted]

[redacted]

TOTAL ESTIMATED AIR PASSENGER DEMAND
1963
(in Thousands)

	Canada	Caribbean	South America	Central America	Pacific	Asia	Eurasia	Europe	Africa
U.S.	631	2,466	530	842	140	520	279	2,717	210
Canada	-	450	100	150	20	90	30	490	10
Caribbean	-	-	578	190	15	85	9	154	86
South America	-	-	-	51	20	100	40	810	20
Central America	-	-	-	-	14	114	1	95	13
Pacific	-	-	-	-	-	150	70	80	140
Asia	-	-	-	-	-	-	44	1,300	910
Eurasia	-	-	-	-	-	-	-	1,310	350
Europe	-	-	-	-	-	-	-	-	1,053

[redacted]

TOTAL ESTIMATED AIR PASSENGER DEMAND 1/
1970
(in Thousands)

	Canada	Caribbean	South America	Central America	Pacific	Asia	Eurasia	Europe	Africa
U.S.	1,009	4,469	948	1,505	234	949	491	4,466	347
Canada	-	813	178	267	32	157	51	819	17
Caribbean	-	-	1,138	374	28	176	19	276	159
South America	-	-	-	100	36	205	78	1,469	36
Central America	-	-	-	-	26	232	1	174	25
Pacific	-	-	-	-	-	283	128	131	236
Asia	-	-	-	-	-	-	91	2,330	1,725
Eurasia	-	-	-	-	-	-	-	2,392	645
Europe	-	-	-	-	-	-	-	-	1,777

TOTAL ESTIMATED AIR PASSENGER DEMAND1/

1980

(in Thousands)

	Canada	Caribbean	South America	Central America	Pacific	Asia	Eurasia	Europe	Africa
U.S.	1,649	8,724	1,818	2,876	407	1,870	914	7,565	590
Canada	-	1,538	329	495	54	307	95	1,391	28
Caribbean	-	-	2,490	818	56	412	43	531	317
South America	-	-	-	215	70	474	171	2,864	71
Central America	-	-	-	-	52	528	2	342	50
Pacific	-	-	-	-	-	589	255	225	422
Asia	-	-	-	-	-	-	212	4,481	3,587
Eurasia	-	-	-	-	-	-	-	4,711	1,284
Europe	-	-	-	-	-	-	-	-	3,127

TOTAL ESTIMATED AIR PASSENGER DEMAND 1/

1990

(in Thousands)

	Canada	Caribbean	South America	Central America	Pacific	Asia	Eurasia	Europe	Africa
U.S.	2,659	16,886	3,447	5,420	697	3,347	1,676	12,652	990
Canada	-	2,875	603	907	89	541	174	2,337	47
Caribbean	-	-	5,380	1,768	111	841	94	1,009	624
South America	-	-	-	455	136	942	368	5,523	138
Central America	-	-	-	-	100	1,068	4	661	96
Pacific	-	-	-	-	-	1,078	501	381	743
Asia	-	-	-	-	-	-	433	8,277	6,604
Eurasia	-	-	-	-	-	-	-	9,177	2,527
Europe	-	-	-	-	-	-	-	-	5,448

1/ Based on median projection of Gross Domestic Product.

[redacted]

DEMAND MODEL FACTORS

ESTIMATED GROSS DOMESTIC PRODUCT AND HIGH, MEDIUM AND LOW ANNUAL RATES OF GROWTH BY SST WORLD SIMULATION REGIONS

1963 - 1990

SST Regions	Estimated Gross Domestic Product 1963	Estimated Annual Growth Rates High %	Medium %	Low %
US-1	$ 22,294	4.1	3.5	2.9
US-2	64,534	4.1	3.5	2.9
US-3	17,455	3.8	3.2	2.6
US-4	8,697	4.1	3.5	2.9
US-5	23,089	3.9	3.3	2.7
US-6	16,677	3.7	3.1	2.5
US-7	22,227	4.4	3.8	3.2
US-8	18,734	3.8	3.2	2.6
US-9	19,021	4.1	3.5	2.9
US-10	13,613	3.9	3.3	2.7
US-11	10,213	4.3	3.7	3.1
US-12	14,642	4.4	3.8	3.2
US-13	11,849	5.8	5.2	4.6
US-14	11,721	4.3	3.7	3.1
US-15	14,141	4.0	3.4	2.8
US-16	36,835	3.7	3.1	2.5
US-17	24,575	3.6	3.0	2.4
US-18	10,916	4.1	3.5	2.9
US-19	4,592	3.6	3.0	2.4
US-20	13,579	3.8	3.2	2.6
US-21	10,777	3.4	2.8	2.2
US-22	12,457	3.9	3.3	2.7
US-23	18,576	4.5	3.9	3.3
US-24	14,641	4.6	4.0	3.4
US-25	3,625	5.4	4.8	4.2
US-26	6,240	4.6	4.0	3.4
US-27	3,897	4.1	3.5	2.9
US-28	10,063	3.8	3.2	2.6
US-29	4,648	4.0	3.4	2.8
US-30	20,999	4.8	4.2	3.6
US-31	33,290	4.8	4.2	3.6
US-32	1,113	5.5	4.9	4.3
US-33	3,193	5.3	4.7	4.1
US-34	2,022	4.2	3.6	3.0
US-35	840	4.2	3.6	3.0
Total USA	$525,785			
C-1	27,147	4.2	3.6	3.0
C-2	9,838	4.2	3.6	3.0
Total Canada	$ 36,985			

Rate of Growth in constant dollars.

Gross Domestic Product in Millions of U.S. Dollars.

DEMAND MODEL FACTORS

ESTIMATED GROSS DOMESTIC PRODUCT AND HIGH, MEDIUM AND LOW ANNUAL RATES OF GROWTH BY SST WORLD SIMULATION REGIONS

1963 - 1990

Region Number	SST Regions	Estimated Gross Domestic Product 1963	Estimated Annual Growth Rates High %	Medium %	Low %
1-35	United States	$525,785	4.2	3.6	3.0
36-37	Canada	36,985	4.2	3.6	3.0
38	Caribbean	5,814	8.4	5.2	4.5
39	South America	15,453	5.6	5.0	4.5
40	South America	15,585	5.6	5.0	4.5
41	South America	11,281	5.6	5.0	4.5
42	South America	3,450	5.6	5.0	4.5
43	Central America	18,108	5.6	5.0	4.5
44	Pacific	18,296	4.5	4.1	3.7
45	Pacific	4,805	4.7	4.1	3.7
46	Asia	61,700	7.5	6.0	4.5
47	Asia	6,439	5.9	5.1	4.2
48	Asia	15,399	5.6	4.9	4.2
49	Asia	45,655	5.6	5.0	4.4
50	Eurasia	8,820	6.0	4.2	4.4
51	Eurasia	16,840	5.6	5.0	4.2
52	Europe	32,243	4.8	4.2	3.6
53	Europe	81,569	3.8	3.4	3.0
54	Europe	2,216	4.8	4.2	3.6
55	Europe	15,749	5.0	4.3	3.6
56	Europe	12,383	4.8	3.6	3.2
57	Europe	72,281	5.0	4.4	3.6
58	Europe	18,789	4.0	4.4	3.6
59	Europe	87,265	5.0	4.4	3.6
60	Europe	49,526	5.0	4.2	3.6
61	Europe	22,362	5.0	4.1	3.0
62	Africa	6,376	5.0	4.1	3.2
63	Africa	6,511	5.0	4.1	3.2
64	Africa	2,754	5.0	4.1	3.2
65	Africa	1,590	5.0	4.1	3.2
66	Africa	5,754	5.0	4.1	3.2
67	Africa	11,373	5.0	4.2	3.4

Rate of Growth in constant dollars.

Gross Domestic Product in Millions of U.S. Dollars.

[redacted]

DEMAND MODEL FACTOR

Community of Interest Factors

A factor to reflect individual market differences in demand that cannot be accounted for by the total market variables.

A tape containing the necessary information has been supplied to the Study Group.

DEMAND MODEL FACTOR

K Values*

A calibration to bring the projected traffic growth into relationship with the forecasted total world gross product

1963	-4.6293
1964	-4.6686
1965	-4.7064
1966	-4.7516
1967	-4.7864
1968	-4.8283
1969	-4.8763
1970	-4.9146
1971	-4.9587
1972	-5.0078
1973	-5.0547
1974	-5.1056
1975	-5.1600
1976	-5.2060
1977	-5.2500
1978	-5.3023
1979	-5.3521
1980	-5.4041
1981	-5.4492
1982	-5.5007
1983	-5.5497
1984	-5.5964
1985	-5.6410
1986	-5.6837
1987	-5.7247
1988	-5.7363
1989	-5.8081
1990	-5.8324

*In terms of natural logarithms (base $_e$).

DEMAND MODEL FACTOR

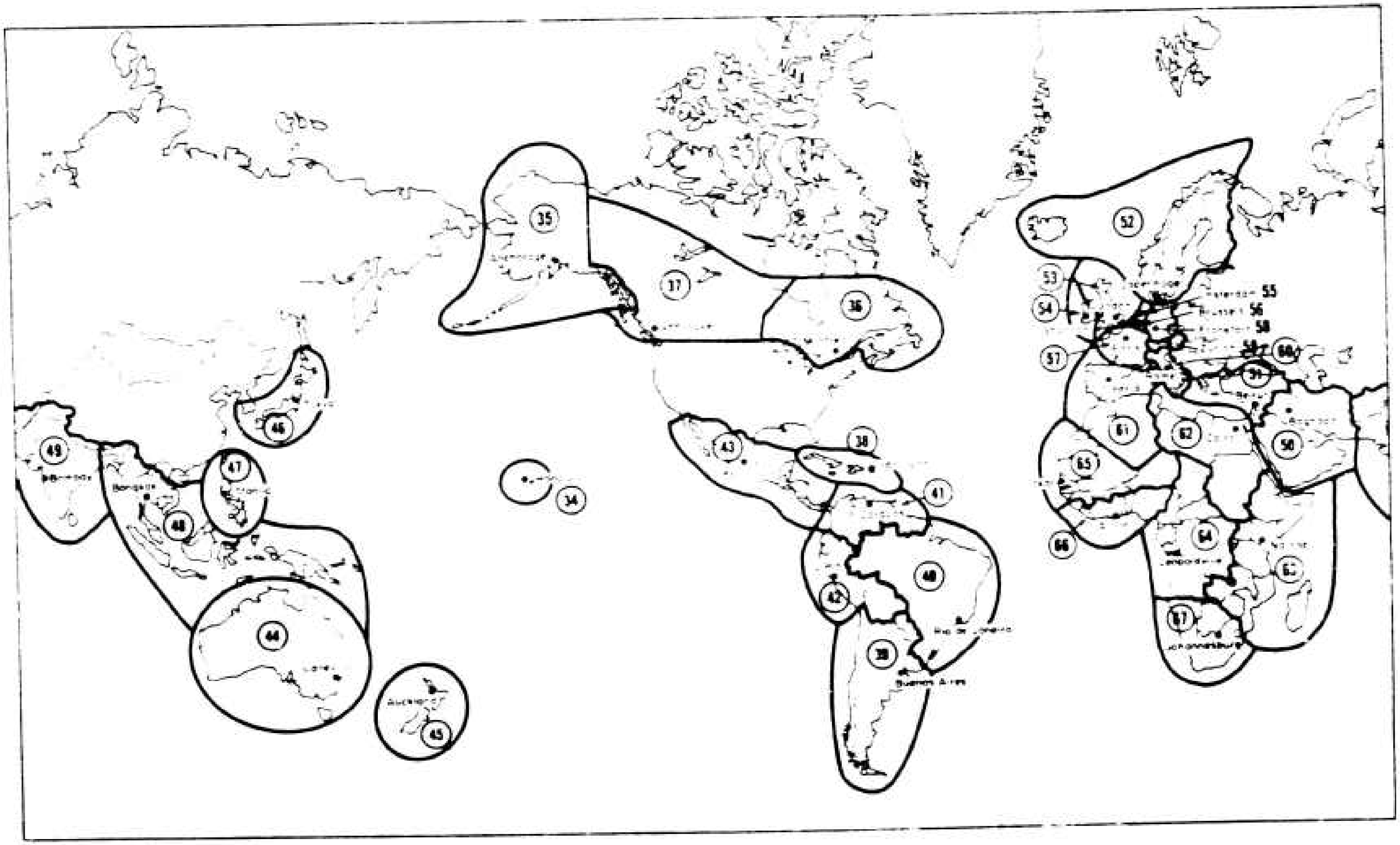
State of The Art Factor

A factor to reflect the effect on air passenger demand of such advances in the state of the art as increased safety, reliability, comfort and speed.

1963 - 100.0	1977 - 142.8
1964 - 103.9	1978 - 145.4
1965 - 107.4	1979 - 148.0
1966 - 110.7	1980 - 150.6
1967 - 114.0	1981 - 153.1
1968 - 117.2	1982 - 155.5
1969 - 120.3	1983 - 157.7
1970 - 123.4	1984 - 159.8
1971 - 126.4	1985 - 161.9
1972 - 129.3	1986 - 163.8
1973 - 132.1	1987 - 165.7
1974 - 134.9	1988 - 167.5
1975 - 137.5	1989 - 169.2
1976 - 140.2	1990 - 170.7

SST WORLD SIMULATION REGIONS

SST WORLD SIMULATION REGIONS



SST WORLD SIMULATION REGIONS

Region Code	United States	
1	US-1	Maine, Vermont, New Hampshire, Massachusetts, Rhode Island (Boston)
2	US-2[1/]	New York City, New Jersey (New York City)
3	US-3[1/]	Upstate New York (Rochester)
4	US-4	Connecticut (Hartford)
5	US-5[2/]	East Pennsylvania, Delaware (Philadelphia)
6	US-6[2/]	West Pennsylvania, West Virginia (Pittsburgh)
7	US-7	Maryland, Virginia, Washington (Washington)
8	US-8[3/]	North Ohio (Cleveland)
9	US-9[3/]	South Ohio, Kentucky (Cincinnati)
10	US-10	North Carolina, South Carolina (Charlotte)
11	US-11	Tennessee, Arkansas (Memphis)
12	US-12	Alabama, Georgia (Atlanta)
13	US-13	Florida (Miami)
14	US-14	Mississippi, Louisiana (New Orleans)
15	US-15	Indiana (Indianapolis)
16	US-16	Illinois (Chicago)
17	US-17	Michigan (Detroit)
18	US-18	Wisconsin (Milwaukee)

Approximate Division Lines:

1/ NYC---------S. of 42° Parallel
Upstate NY--N. of 42° Parallel

2/ E. Penna.---E. of 78° Parallel
W. Penna.---W. of 78° Parallel

3/ N. Ohio-----N. of 40° Parallel
S. Ohio-----S. of 40° Parallel

Region Code		
19	US-19[4/]	East Missouri (St. Louis)
20	US-20[4/]	West Missouri, Kansas (Kansas City)
21	US-21	Iowa, Nebraska (Des Moines)
22	US-22	North Dakota, South Dakota, Minnesota (Minneapolis)
23	US-23[5/]	North Texas, Oklahoma (Dallas)
24	US-24[5/]	South Texas (Houston)
25	US-25[5/]	West Texas, New Mexico (Albuquerque)
26	US-26	Colorado, Wyoming (Denver)
27	US-27	Utah, Idaho (Salt Lake City)
28	US-28	Montana, Washington (Seattle)
29	US-29	Oregon (Portland)
30	US-30[6/]	North California (San Francisco)
31	US-31[6/]	South California (Los Angeles)
32	US-32	Nevada (Las Vegas)
33	US-33	Arizona (Phoenix)
34	US-34	Hawaii (Honolulu)
35	US-35	Alaska (Anchorage)

4/ E. Missouri----E. of 93° Parallel
W. Missouri----W. of 93° Parallel

5/ N. Texas-------N. of 31° Parallel
S. Texas-------S. of 31° Parallel
W. Texas-------W. of 103° Parallel

6/ N. Calif.------N. of 36° Parallel
S. Calif.------S. of 36° Parallel

[redacted]

Region Code		
	Canada 7/	
36	C-1	Newfoundland, Ontario, Quebec (Montreal)
37	C-2	Manitcba, Saskatchewan, Alberta, British Columbia, Yukon (Vancouver)
	Caribbean	
38	CB-1	Cuba, Haiti, the Dominican Republic, Puerto Rico, Jamaica, Trinidad and Tobago, the Windward Islands, Martinique, Guadeloupe, Barbados, the Netherlands, Antilles, the Leeward Islands, the Bahama Islands, the Virgin Islands (United States administration), the Cayman Islands, the Turks and Caicos Islands (San Juan, Puerto Rico)
	South America	
39	SA-1	Argentina, Chile, Uruguay, Paraguay and Falkland Islands (Buenos Aires)
40	SA-2	Brazil (Rio de Janeiro)
41	SA-3	Venezuela, Columbia, British Guiana, Surinam, French Guiana (Caracas)
42	SA-4	Bolivia, Peru, Ecuador (Lima)
	Central America	
43	CA-1	Mexico,Guatamala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, British Honduras, Canal Zone (Mexico City)
	Pacific	
44	P-1	Australia (Sidney)
45	P-2	New Zealand (Auckland)

7/ Northern territories not included.

Region Code		
	Asia	
46	A-1	Japan, South Korea (Tokyo)
47	A-2	Hong Kong, Philippines, Taiwan, Ryukyu Islands, Macao (Manila)
48	A-3	Indonesia, Viet Nam, Thailand, Burma, Malaysia, New Guinea, Cambodia, Laos, Portuguese Timor, Brunei (Bangkok)
49	A-4	India, Pakistan, Afghanistan, Ceylon, Nepal, Bhutan, Sikkim, Maldive Islands (Bombay)
	Eurasia	
50	EA-1	Iraq, Saudi Arabia, Yemen, the Protectorate of Southern Arabia, Muscat and Oman, Palestine (Gaza Strip), Kuwait, Aden, Bahrain, Trucial Oman, Qatar, Iran (Baghdad)
51	EA-2	Greece, Turkey, Syria, Lebanon, Israel, Jordan, Cyprus (Beirut)
	Europe	
52	E-1	Sweden, Denmark, Norway, Finland, Iceland (Copenhagen)
53	E-2	The United Kingdom, Channel Islands (London)
54	E-3	Ireland (Shannon)
55	E-4	The Netherlands (Amsterdam)
56	E-5	Belgium, Luxembourg (Brussels)
57	E-6	France (Paris)
58	E-7	Switzerland, Austria (Zurich)
59	E-8	West Germany, Berlin (Frankfort)
60	E-9	Italy (Rome)
61	E-10	Spain, Portugal, Morocco, Algeria (Madrid)

Region Code		
	Africa	
62	AF-1	The United Arab Republic, Sudan, Libya, Tunisia (Cairo)
63	AF-2	Ethiopia, Tanganyika, Kenya, Ugunda, Mozambique, Madagascar, Southern Rhodesia, Northern Rhodesia, Nyasaland, Rwanda, Burumdi, Somalia, Mauritius, Reunion, Zanzibar, Comoro Islands, Seychelles, French Somaliland (Nairobi)
64	AF-3	Congo, Angola, Central African Republic, Republic of the Congo, Gabon, Cameroon, Rio Muni, Chad (Leopoldville)
65	AF-4	Mauritania, Senegal, Guinea, Niger, Mali, Upper Volta, Portuguese Guinea, Gambia, Sao Tome, Principe, Cape Verde Islands (Dakar)
66	AF-5	Nigeria, Ghana, Liberia, Sierra Leone, Dahomey, Togo, Ivory Coast (Accra)
67	AF-6	South Africa, Basutoland, South West Africa, Bechuanaland, Swaziland (Johannesburg)

[redacted]

BASIC GEOGRAPHIC UNITS INCLUDED IN DOMESTIC DEMAND MODEL FORMULATION

1. New York, New Jersey, Connecticut[1/]
2. Illinois
3. California
4. D.C., Maryland, Virginia[1/]
5. Florida
6. Texas
7. Pennsylvania, Delaware[1/]
8. Ohio
9. Washington
10. Minnesota
11. Missouri
12. Colorado
13. Massachusetts, Rhode Island[1/]
14. Michigan
15. Georgia
16. Kentucky
17. Louisiana
18. Maine
19. Alabama
20. Arizona
21. Arkansas
22. Mississippi
23. Idaho
24. Montana
25. Nebraska
26. Nevada
27. New Hampshire, Vermont[1/]
28. New Mexico
29. North Carolina
30. North Dakota
31. Indiana
32. Oklahoma
33. Oregon
34. South Carolina
35. South Dakota
36. Tennessee
37. Iowa
38. Utah
39. Kansas
40. West Virginia
41. Wisconsin
42. Wyoming

1/ Some combining of states was deemed advisable in some instances because of service availability and/or statistical reporting.

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