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Airline Deregulation: An Analysis Under Different Regulatory and Operating Environments

Centre For Transport Studies

Ph.D. Thesis

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Academic Year 1988–9

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July 1989

To my husband Farshad
and my children Nima and Ava

ABSTRACT

Like other transportation modes the airline industry has a long history of government regulation. In recent years however the theoretical and empirical bases for air service regulatory schemes have been questioned by opponents of such policies. In Western Europe there have been pressures for relaxation of regulation of the air transport industry with respect to air fares, service frequency and market access. Because changes in such public policies are likely to have a major impact, there is a considerable interest in their possible implications.

It is the objective of this study to explore the interactions between fare and service frequency in different competitive environments, and to examine the rivalrous behaviour of airlines and their possible equilibrium position under deregulation. The study also considers the effect of a competing mode (rail) on air carriers performance under various competitive conditions. The individual carrier's performance is quantified in terms of fare, service frequency, resulting generalised costs, market share and financial results.

A competition model is developed by which the objectives set above are achieved. The study is divided into three parts. The first part provides a framework within which the competition model can be built. This part also generates the policy questions which must be addressed, should relaxation of regulation take place in Europe.

The second part explains the structure of the competition model and its characteristics. The assumptions upon which the model is built and its limitations are also discussed. The model consists of three sub-models: the market share model, the costing model and the reaction model.

In the third part, with the aid of the model the policy questions generated in the first part are addressed and the general implications for carriers operating under different competitive conditions are discussed. Finally the technical and the policy conclusions are discussed. It is generally concluded that: competition results in lower fares and a more efficient airline industry; the impacts of competition are not evenly distributed amongst markets, routes and carriers; and the competition on equal terms amongst carriers plays an important role in maintaining the effectiveness of deregulation.

ACKNOWLEDGEMENTS

I would like to thank my supervisor Professor M. Cordey-Hayes for his constructive guidance and useful suggestions throughout this work. I also wish to thank Mr. I.G. Black for his useful discussions and suggestions.

My thanks to Dr. and Mrs. Brown for proof reading of this thesis.

Finally I would like to thank my husband for his support at all stages of my study.

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Government regulation of economic activities in terms of prices and conditions of service has grown dramatically in many countries in this century. These regulations are applied to all modes of transport, and in particular to air transport.

In recent years the regulatory reform of the air industry has occupied a distinguished place on the agenda of most western countries' administrations and as a result some important reforms have occurred. But the effects of many of these reforms have remained controversial.

One of the major air transport regulatory reforms took place in the US domestic market in October 1978. The relaxation of air transport regulation in Europe has been a topical subject in recent years. Whilst most of the twelve states involved are in favour of such a reform there are a few countries that are less enthusiastic about the changes. Therefore there is considerable interest in the possible effects of any regulatory reform.

It is the purpose of this study to develop a competition model which is well grounded in economic theory, but which can also simulate carriers' competitive behaviour and the interactions between their fare and service frequency under different conditions.

The model takes into account the interdependent nature of the carriers decision making and considers the effect of a competing mode (rail). It quantifies the effects on individual carrier's performance in terms of fare, service frequency, the resulting generalised costs, market share and financial results. It also identifies the possible equilibrium position of the carriers.

The study is divided into three parts. Figure 1 illustrates its overall structure. Part I analyses the competition in air transport in theory and in practice. This provides a framework for the competition model and identifies the characteristics that the model need to have in order to simulate carriers' competition. This part consists of three chapters. Chapter One discusses the economic theory of competition and the characteristics of airline markets. Chapter Two reviews the US domestic airline industry's performance since deregulation and analyses the effects of such a reform on various aspects of the industry. Such a review raises a number of

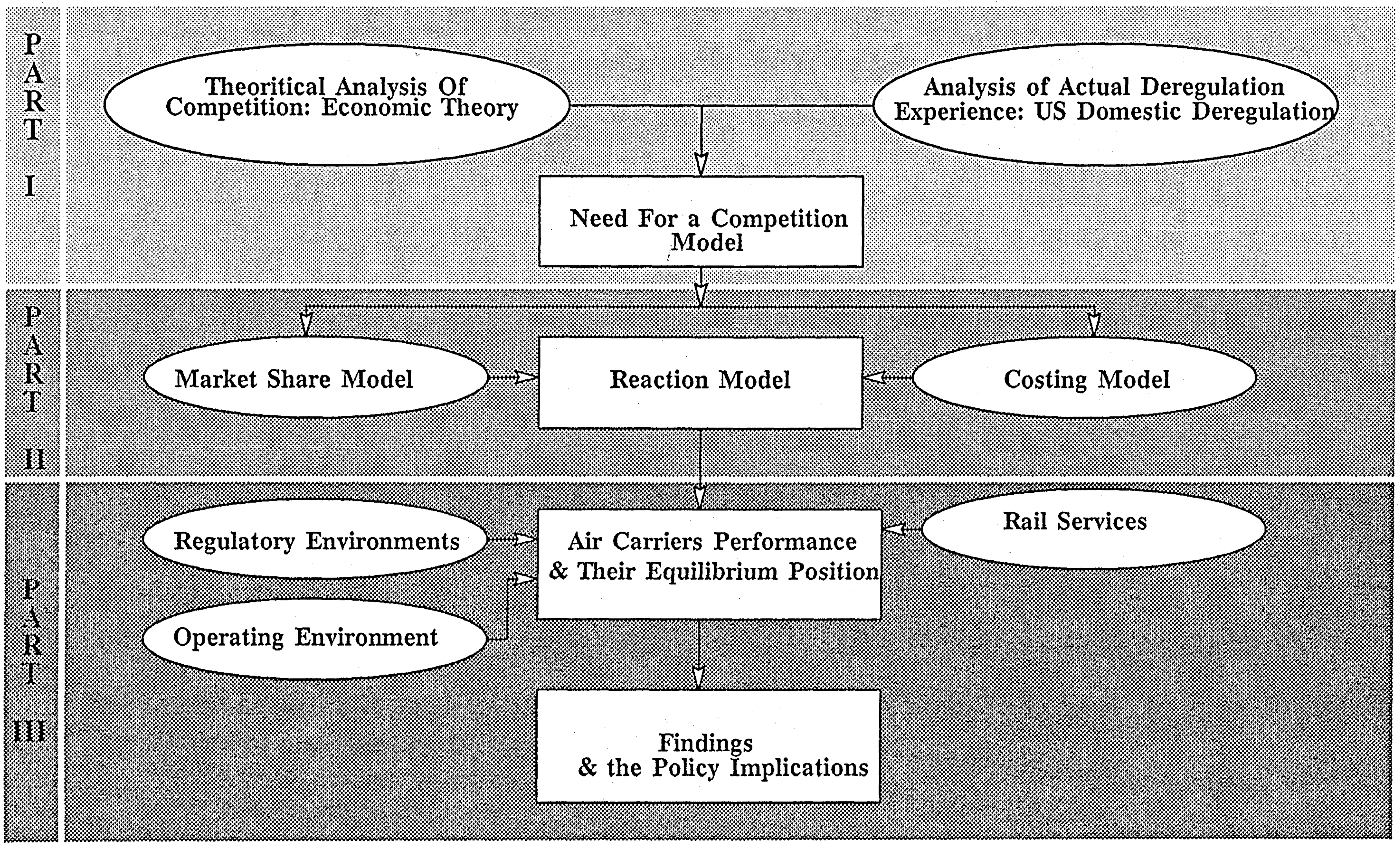


Fig. 1 : Structure of the Study

policy questions in relation to deregulation in Europe. Chapter Three studies the liberalisation movements in Western European airline industry and the way the structure of the European airline market differs from that of the US.

Part II mainly concentrates on the development of the competition model by taking into account certain characteristics of the airline markets which were discussed in Part I. In Chapter Four the overall structure and the components of the competition model are explained, while Chapter Five discusses the market share model. Chapter Six describes the development of the costing model. In Chapter Seven the reaction model, which takes into account the carriers interdependent performance, is developed.

In Part III, the policy questions, which were raised in Part I, are addressed with the aid of the competition model. The model is run to equilibrium for different competitive conditions and the results are analysed. Chapter Eight discusses the carriers' operations under deregulated fare, deregulated frequency and a combination of both. Chapter Nine explores the effect of route characteristics on the carriers' operation under deregulation. Chapter Ten discusses the carriers' operations in different types of market, while Chapter Eleven examines the effect of new entries by airlines with different resource costs. Chapter Twelve quantifies the effect of variation in some of the assumptions and input data on the individual carrier's pattern of operation. Finally, in Chapter Thirteen, the technical and policy conclusions are discussed, the shortcomings of the model and suggestions for the future research are outlined.

PART I

AIRLINE COMPETITION IN THEORY AND IN PRACTICE

INTRODUCTION

It is the purpose of this part of the study to provide a framework within which a model, that simulates air carriers' competition, can be built.

To do so this part is divided into three chapters. In Chapter One different theories of competition are described, and airline market behaviour in a deregulated environment is compared with markets under different types of competition. Such a comparison offers a better understanding of the characteristics of airline markets in the absence of regulations.

Chapter Two reviews deregulation of US domestic air transport and discusses its impacts. Such a study helps to point out the important effects of deregulation and provides the data giving support to the general characteristics of airline markets that were discussed in the previous chapter. This review is also useful in generating policy questions that might be raised in the event of removal of tight regulation in other places such as Europe.

In Chapter Three, Europe's market structure and the move towards a less regulated regime is discussed. The general characteristics of the European market are outlined and its differences with the US airline market are explained. Since the competition model is based on European data, some of these characteristics are taken into account in the development of the model.

CHAPTER ONE

ECONOMIC THEORY OF COMPETITION AND AIRLINE MARKETS CHARACTERISTICS

1.1 INTRODUCTION

It is the purpose of this chapter to identify the general characteristics of airline markets. This provides a framework within which a model can be developed to simulate the competition process in deregulated airline markets.

To do so, first different theories of competition (perfect and imperfect) are described and then compared with the characteristics of airlines' free competition. US domestic airlines operation under deregulation is used as an example of a market operating under free (not regulated) competition. It must be noted that it is not the purpose here to study the effects of US deregulation in detail, as it is dealt with in the next chapter. The comparison of airline competition under deregulation with economic theories of competition offers better understanding of characteristics of airline markets operating under free competition.

1.2 THEORY OF COMPETITION

Here the characteristics of market under perfect competition, perfect contestability and imperfect competition are described.

1.2.1 Perfect Competition Theory

A market is said to operate under perfect competition when it satisfies the following four conditions (Baumol, 1982):

a) Numerous participants: This means there are so many small buyers and sellers that each must accept the price set by market forces (demand and supply). In this market there is no need for individual firms to behave competitively with respect to each other. Since none has any power over the market and one firm's ability to sell its product is uninfluenced by the behaviour of any other single firm.

b) Homogeneity of product: The product offered by any seller is identical to that supplied by any other seller. As a result consumers do not care from whom they buy.

c) Freedom of entry and exit: Any new firm is free to set up production if it so wishes and any existing firm is free to cease production if it is unprofitable. Existing firms cannot bar the entry of new firms and there are no legal prohibitions on entry or exit.

d) Perfect information: Each firm and each customer is well informed about the available products and their prices.

Such conditions imply that there are no economies of scale and scope, no multi-product effects, no sunk costs, prices are related to the costs, there are optimal outputs, inefficient producers are eliminated and low cost producers survive.

A market under perfect competition is one extreme of market structure and the conditions are obviously exacting requirements that are met infrequently. Although this is widely accepted, economists have been searching for a market type which yields the same type of results as does perfect competition. This has led to the development of the contestability theory.

1.2.2 Perfect Contestability Theory

This theory was developed in the late 1970s and finally formulated in the early 1980s by Baumol, Panzar and Willing (1982). According to this theory, benefits of perfect competition can be achieved in a market without a large number of producers, since the threat of entry can provide an effective substitute for actual competition. This means that the effect of potential entrants on incumbents can work the same way as do actual competitors already in the market. Bailey, Graham and Kaplan (1985) in their book define the contestable market as a market into which the threat of entry is sufficiently powerful that firms price competitively regardless of whether the market is structurally competitive or not.

The main conditions for market perfect contestability as emerged from the literature are as follows:

a) There are no sunk costs: This implies that means a firm can enter such a market, earn profit and then exit without incurring any capital or investment losses. This requires that all the factors of production be mobile among markets. In other words, they can be transferred from one market to another, should it become necessary.

b) There is perfect information: Each producer and consumer is aware of available products and its prices. Also customers are willing and able to switch quickly among suppliers.

c) There is equal access to productive techniques: Lack of equal access to certain factors of production creates barriers and protects the existing producers from the effect of new entry. The entrants should be capable of supplying products at the same scale and same quality as the existing producers. Otherwise the existing producers enjoy advantages which reduce the effect of entry and enable them to succeed in possible predatory practices against the new entrants.

1.2.3 Imperfect Competition Theory

Most firms in most markets often engage in rivalrous behaviour and they try to distinguish their product from one another. These types of markets are said to operate under imperfect competition.

Imperfect competition can take two forms:

I) Monopolistic competition

II) Oligopolistic competition

- Monopolistic Competition

A market is said to operate under conditions of monopolistic competition if it satisfies the four following conditions (Baumol, 1982).

a) Many buyers and sellers all of whom are small.

b) Differentiated product which means as far as the buyer is concerned each seller's product is in some way different from all the others.

c) Freedom of entry and exit.

d) Perfect information.

The major difference between monopolistic and perfect competition lies in the assumption of homogeneous and differentiated product. This phenomenon of product differentiation implies that each firm has a degree of local monopoly power over its own product. This is the monopolistic part of the theory. The monopoly power is severely restricted however by the presence of similar products sold by many competing firms which is the competition part of the theory.

- <u>Oligopolistic Competition</u>

In almost all economics text books there is a section describing market characteristics under oligopolistic competition. Here are a few definitions of oligopolistic markets.

- This is a market structure in which there are a few sellers at least several of which are large enough relative to the total market to be able to influence the market price. Product in this market can be identical or quite different in the eyes of consumers.

  The feature distinguishing an oligopolist from other types of competitors is that the oligopolist cares very much about what other firms in the industry do (Lipsey, 1983).

- It is a market with few firms (but more than one firm) on the supply side and a very large number of buyers on the demand side, each of whom makes a negligible contribution to the market demand function. A buyer will take market conditions as given, for he cannot affect them, but a seller will inevitably be preoccupied with guessing the behaviour to be expected from rival sellers. Furthermore, an oligopolist firm will naturally be concerned with how its present actions may influence the behaviour of its rivals in the future. The key distinguishing feature that sets oligopoly apart from other types of market is that oligopolists are strategically linked to one another (Friedman, 1983).

- It is an industry composed of a few firms producing either similar or differentiated products. In addition to having a few sellers, oligopolistic industries generally tend to have several other characteristics such as (Well, 1984):

a) Barriers to entry: These usually take the form of substantial capital requirements, the need for the technical know-how, patent rights, and so forth.

b) Growth through merger: The purpose of most mergers is to gain a substantial increase in market share, greater economies of scale, larger buying power in the purchase of resources, and various other advantages that smaller firms do not possess to the same extent.

c) Price rigidity and non-price competition: In an oligopolistic industry, firms find it more comfortable to maintain constant prices and to engage in various forms of non-price competition. Price reductions are occasional and usually come about only under severe pressure resulting from weakened demand or excessive capacity.

d) Mutual dependence: When there are only a few firms in a market, it matters very much to each firm what its rivals do. This interdependence of decisions makes oligopoly very hard to analyse since there are no simple predictions about how firms react to one another.

Having discussed the various types of market under competition it is important to study the nature of airline competition and demonstrate to which type of competition it approximates.

1.3 AIRLINE COMPETITION

It is the purpose here to explore the characteristics of airline free competition. To do so, air markets operating under free competition are compared with markets under different types of competition (described in the previous section). As mentioned before, the US domestic markets are used as examples of decontrolled markets. The US market behaviour since deregulation is discussed in detail in the next chapter where supporting data is also presented.

However, here the nature of deregulated market behaviour is discussed to examine the characteristics of such markets.

1.3.1 Airline Markets and Perfect Competition

Comparing the structure of airline markets with the condition of perfect competition illustrates that airline markets do not meet such requirements. The first criteria for perfect competition, which is the number of participants, does not exist in airline markets. This is because, even after deregulation, in the US, in many markets only a few airlines have been operating. In 1987 around 65% of markets were served by one carrier and nearly 20% by two (see Table 2.4 in the next chapter). But could this feature be overcome by the contestability theory? Contestability theory assumes that the threat of entry is as effective as the actual competitors in the market, therefore the benefits of perfect competition are achievable (i.e. cost related pricing, production at an optimum level and efficient use of resources).

1.3.2 Contestability of Airline Markets

The US air transport market behaviour since deregulation has provided a ground for testing such an hypothesis. The supporters of airline market contestability believe that if an incumbent on a route charges above marginal cost, because the major factors of airline production (i.e. aircraft) are mobile and airport facilities are rentable, another airline can easily enter the market, undercut the existing fares and gain some profit. If the older carrier reacts effectively it can exit without incurring losses.

Therefore if airline markets are contestable, the entrant should be able to acquire gates and slots at the relevant airport, and in order to operate competitively should be capable of offering services at the same scale and scope of the incumbents (later in this section the economies of such operations are discussed). Also it should be able to convey information about its services to the customers. If the incumbents react by employing policies such as undercutting the entrant's prices, it should be able to leave the market without absorbing any sunk costs. These hypotheses are tested by comparing the nature of air carriers' competition after deregulation in the US with criteria set for contestable markets.

a) Sunk costs : It is not realistic to assume that because aircraft are transferrable from one route to the other, if the existing air carriers counter the entries by undercutting fares or overproduction, the entrants can exit without absorbing any sunk costs. This is because entrants need to acquire gates and landing slots at airports , have to advertise their services, pay commission to travel agents and so on. All these activities incur costs. Therefore if the entrants have to leave the market as a result of predatory policies of the incumbents, all these costs will be absorbed. As Morrisson and Winston (1987) have pointed out, entry into the airline market requires that a carrier already has some presence in the market by serving at least one of the relevant airports. Otherwise carriers require time and must absorb sunk costs to obtain gate space and established patronage.

The main incentive for an airline to enter a market is to operate a profitable operation and certainly not a loss making one. This requires that the incumbents do not get involved in predatory activities resulting in loss making operation of all the carriers in the market. This is because if the older carriers react to the new entrant by fare cutting or overproduction at a level that the profitable operation cannot be continued, the entrant has to leave the market and absorb costs associated with its entry into the market and operation. An example of successful predatory practices is the People Express entry into the Newark - Minneapolis market which was countered by Northwest's lower fares. Muse air received a similar reaction from Southwest when it entered to the Love Field markets which led to the exit of the entrant from the markets. Under such circumstances the older carriers have a better chance of surviving (despite the higher unit cost of their operation) due to the economies of scale and scope of their operation (this point is discussed later in this section) and better ability to support themselves in times of difficulty by selling their other assets or using the capital that they accrued during regulation. If such incidents occur on international routes the major or flag carrier airlines can also receive the support of their governments. A very good example of such a situation was Laker Airways competition with the three large airlines TWA, Pan Am and British Airways over North Atlantic routes. The large airlines, despite their very poor financial position in 1981, brought their minimum fare down to 249 dollars in response to Laker's low prices. Such a price matching resulted in the reduction of Laker's Transatlantic traffic by 51% of his projection, driving Laker Airways out of business. BA alone, lost 144 million pounds in the year 1981-82 partly due to the fight against Laker but received a major loan from its government (Simpson, 1984).

Such predatory activities discourage entry to larger carriers' markets, because the exit of the entrants is not costless due to non-recoverable expenses associated with their operations, such as marketing activities.

b) Perfect information: An entrant should be able to inform the customers of its services through advertising and travel agents' computer reservation system (CRS). Otherwise, even if it offers a very competitive service, the passengers would not be able to switch to the new carrier in the market due to the lack of perfect information. The operation of CRS and the type of contracts between the owners of the system and the travel agents in the US have proved that perfect information in the airline markets is not achievable. The next chapter discusses how the CRS owners limited the effect of competition by either not including the competitors' flight information or listing their own service information first. Even if this type of predatory practice can be overcome, for perfect information, passengers should be provided with details of all the different types of services with their conditions and prices. This is a time consuming task for passengers in particular. This may lead to a situation where passengers choose the airline which has name recognition due to the large scale and scope of its operation. This is not to say that the cheaper and smaller entrants have no chance to be chosen, but that the larger established incumbents have a greater chance to be selected.

c) Equal access to the productive techniques: Difficulties associated with acquiring access to slots and gates at congested airports can create barriers for new airlines to enter the markets. This clearly puts the incumbents who are already present in the market in an advantageous position. Levine (1987, p.464) refers to this problem in his study of airline competition noting that "it seems intuitively obvious that airlines serving airports where the factors of production are in particularly short supply, enjoy some protection from entry". He criticises the airport facilities arrangements in force which have created a situation where larger carriers can hold onto excess airport facilities (e.g. landing slots which are time periods during which airlines have landing or takeoff rights, gates, ticket counters and so on) which would make the new entry difficult. It is not the purpose here to discuss the problems related to airport access, but to emphasise that the threat of new entry cannot be powerful unless airlines can have equal access to the airports or to the more convenient airports (convenient from the passenger's point of view). This requires the expansion of the existing airport or construction of the new ones so that airport capacity can meet the requirement of carriers in terms of provision of gates, landing slots and other airport facilities. This is a difficult task financially, environmentally and politically.

Even if the problem of airport access is solved, the entry to a market cannot be effective unless the entrant can offer services at the same scale (size of operating network) and scope (number of cities and customers sub-markets served) as that of the incumbents. They should also have equal access to CRS. The disadvantages with the inability of entrants to offer competitive services is enhanced in hub cities. Although hub and spoke operations do provide efficiency and cost saving for hubbing carriers and benefit passengers through an increase in number of connections and flight frequency (effects of such operations are discussed in the next chapter), the system puts the new entrants in a weaker position to compete effectively. "Hub and spoke operation seem to provide some protection from new entry and hence some market power at the hub city, power which is enhanced when the hubbing airline also operates the dominant computer reservation system at the hub" Levine (1987). The reasons for hubbing carriers having advantages over the new entrant which discourage entry are:

-Passengers prefer to travel by airlines that give them choice of departure and airport. As stated earlier, the advantage of hub and spoke operation for passengers is higher service frequency and higher number of destinations. Therefore unless the new entrant offers the same level of service, it cannot compete with the incumbents operating hub and spoke operation.

- Passengers prefer to travel by one airline rather than changing. Therefore the carrier capable of transporting passengers from different cities to the hub and providing service from the hub to their final destinations is in a better position to attract patronage.

- The carrier already present in the market who serves a larger number of cities and operates over a large and dense network enjoys economies of scale, scope and density. These include: name recognition and better acceptance by passengers; ability to offer different types of services at different fares; having better experience in meeting the passenger requirements; ability to influence travel agents; lower unit cost of generating information about and promotion. These are the types of carriers capable of offering policies such as the frequent flyers program: the more passengers fly, mileage based, the higher the reward for additional travel; reduced hotel rates and car rental rates. Such policies increase the loyalty of passengers. It must be mentioned that in airline industry there are no significant economies of scale as measured by the unit cost (Caves, Christensen and Tretheway, 1984) but the gross size of an airline in terms of the size of network or number of flights or any other measure results in other advantages which are pointed out above.

Therefore even if entrants offer lower fares than those of the existing carriers, they cannot necessarily attract all or a large proportion of the market due to the advantages that larger carriers enjoy. Unless an entrant can offer services at the same scale and scope as those of the hubbing airlines, it would not compete effectively in those markets. If an entrant can offer such services it should also be able to survive the possible reaction of the incumbent (i.e. undercutting prices or increase in capacity). Otherwise it has to exit and bear losses due to the costs of acquiring gate and landing slots at airport, advertising and so on. The question then is how many airlines can have such characteristics? Out of the twenty five cities being used as a hub in the US in 1987 only six are served by two airlines and the rest by only one (Levine, 1987). It must be mentioned that considering all the markets in the US, since deregulation the number of markets previously served by one carrier has decreased (see Table 2.4 in the next chapter).

Therefore the inapplicability of perfect contestability to airline markets does not mean that regulation is better than deregulation. Under regulation the major carriers were protected by the certificate issuing system of Civil Aeronautics Board (CAB) whereas under deregulation they try to protect themselves from the effects of competition which may make them more efficient and innovative. Mergers are one of the obvious examples of policies designed for protection.

It is mainly the advantages associated with the capability to offer a large number of flights, serving a large number of cities or customers that have persuaded carriers towards mergers or marketing alliance activities. From 1978 to 1987 over eighteen mergers have been approved by CAB. This illustrates that mergers or buyouts must enable the merged carriers to protect themselves from new entrants competition and survive the competition with larger carriers. Otherwise the carriers would not get involved in such activities which shield them from the effects of competition.

The above factors (entrants absorbing sunk costs after exit, lack of perfect information and unequal access to the productive techniques) have limited the effectiveness or the power of threats of smaller carriers' entry despite their lower unit costs of operation. As discussed before an entry can be effective if the entrants can have equal access to the economies that are available to the larger incumbents carriers due to the scale, scope and density of their operations. As in American domestic markets, there are only a few carriers that have such characteristics (the big seven airlines Texas, American, United, Northwest, Delta, TWA and PanAm). All these suggest that the perfect contestability theory is not applicable to airline markets and perfect results are not achievable.

The contestability of airline markets has been studied by several other economists, with the majority concluding that the theory of perfect contestability is not applicable to airline markets.

Sinha (1986) has reviewed the literature on contestability of airline markets and has revealed diverse opinions among economists on the subject. Bailey and Panzar (1981) at first, strongly argued that City-pair markets were perfectly contestable but later they supported the theory only partially. There are studies that demonstrate doubt about the applicability of this theory to airline markets.

Graham, Kaplan and Sibley's (1983) findings illustrated that there is a positive relationship between fare and market concentration which is inconsistent with the theory of contestability. Also Moore (1986) and Call and Keeler (1985) in their empirical studies of the airline industry have shown that various measures of efficiency (e.g. price-cost ratio) depend on the number of actual competitors. Since such an exercise of market power is inconsistent with the perfect contestability hypothesis, each of these authors concluded that airline markets are not perfectly contestable. Baumol and Willing (1986) and Morrison and Winston (1987) support the contestability theory partially. In the latter study it is found that the actual competition had a greater influence on the behaviour of the incumbents than the potential competition.

The inapplicability of the perfect contestability theory to airline markets does not mean that regulation would benefit passengers or new entrants more than deregulation. As Levine (1987) states, there are some imperfections present in airline markets but one should be careful to find cures which are not worse than the disease.

1.3.3 Airline Markets and Imperfect Competition

As mentioned before there are two types of imperfect competition, monopolistic and oligopolistic.

Monopolistic competition theory is not applicable to airline markets, since apart from the differentiated product condition which is applicable to airlines, the rest of the requirements (many producers, no barriers to entry and exit and perfect information) are already discussed as being inconsistent with airline market structure. In terms of product differentiation, although the airlines basic product (seat miles) is the same, each tries, by employing different policies, to distinguish its product from others. This enables each of the carriers to deal slightly separately from the others and to cater for a set of customers who vary in their loyalty to its services. Therefore if a carrier increases its prices, it may lose some but not all of its customers or if it lowers its fare, it may attract some of the passengers from its rivals but not all. An example of product differentiation is the operation of frequent programmes by the US carriers (basically the more the passengers fly, the higher the rewards for additional travel). This enables the larger carriers to offer something that the smaller airlines with their limited network cannot (see Section 2.5.8). Because of airlines' product differentiation, each carrier spends more and more on advertising to convince the customers that its services meet their requirements in better ways than the rival's. In the US, since deregulation, there has been more emphasis on advertising as the advertising sale ratio did increase from 1.7% in 1978 to 2.2% in 1984 (Boyer, 1985).

The comparison of airline markets with markets under oligopolistic competition illustrates that there are some general characteristics of oligopolies that pertain to airline industry such as:

a) Number of sellers. The airline industry certainly meets the first criteria in terms of fewness of firms. In the United States the big seven operators can be regarded as an oligopoly.

b) Barriers to effective entry. It was discussed before that problems associated with access to a convenient airport and acquiring landing slots and gates , the inability of the entrants to offer competitive services, the lack of perfect information in the market and successful predatory reaction of the incumbents which all stem from economies of scale, scope and density discourage or create barriers to entry.

c) Price rigidity: The recent policies employed by larger carriers, that cannot be followed by the smaller carriers such as the frequent flier programmes, illustrate the reluctance of the carriers to get involved in price wars. Therefore instead of competing on fares which would not improve their financial position, the larger carriers try to adopt policies that cannot be matched by their competitors.

d) Growth through merger. This is a clear characteristic of oligopolies in general and the airline industry in particular. The purchase of Republic airline by Northwest, the acquisition of Eastern Airlines by Texas Air, the merger of

Ozark into TWA (Flight International 3 May 1986) and the acquisition of Western by Delta (Air Transport World May 1987) are examples of recent mergers (see also Table 2.3 in the next chapter).

e) Mutual dependence. This characteristic has been clearly demonstrated by the airline industry, in that no carrier will dare to alter its price policy or service features without attempting to calculate the most likely reaction of its rivals.

It is the mutual dependence of airlines that make it difficult to explore and predict the outcome of the rivalry behaviour of carriers in decontrolled markets. This is because there are no simple answers to how they react to one another. This illustrates the need for a model which takes into account the characteristics of the airline market and simulate the competition process. A model which enables the quantitative analyses of carriers operation in competitive environments.

The comparison of a deregulated airline market with a market under different types of competition provides a better understanding of airline free market characteristics and suggests that airline competition does not meet the criteria of perfect contestability but rather is a close approximation to an oligopolistic market which is partially contestable. The general characteristics of the competitive airline markets are as follows:

- In the majority of markets, only a few carriers operate.

- Due to rivalrous behaviour amongst airlines, carriers do not alter their policy without taking into account the possible reaction of their rivals.

-Carriers try to differentiate their products. This is to ensure that a certain number of passengers always use their services. Otherwise a slight increase in their prices might drive all the passengers to the rivals. However with the differentiated product such a carrier may lose some of its customers but not all.

-As result of imperfect information, passengers cannot always travel with the cheapest carrier in the market. Therefore the expensive carriers have still the chance of being selected by the travellers.

-Carriers do not compete on equal terms due to factors such as differences in their unit cost, the scale and scope of operation, unequal access to airports , inability to own a CRS or offering programs that attract the loyalty of customers.

-There is a strong tendency towards mergers and hub and spoke operations. As such activities increase the ability of airline to compete effectively.

The study of the characteristics of airline markets provides a framework within which a model can be built. A model that can quantitatively analyse carriers' competition at a disaggregated level in terms of fare, flight frequency, carriers' market share and financial performance. It must be mentioned that the model takes into account a number of airline market characteristics but not all of them. The characteristics and operational sequence of this model is discussed in Part Two of this study. But first the US domestic airline deregulation is reviewed in the next chapter. Such a review raises certain policy questions such as those concerning the deregulation of air industry in Europe.

CHAPTER TWO

AIRLINE DEREGULATION: THE US EXPERIENCE

2.1 INTRODUCTION

In this chapter deregulation of the US air transport industry is reviewed and its impacts are discussed. Such a review is useful as it illustrates the main effects of deregulation and generates the policy questions that need to be addressed if deregulation of air transport industry takes place in Europe. It also provides the data that gives support to the characteristics of the airline market discussed in the previous chapter.

Before studying the US domestic air transport deregulation, the air carriers' operation under the regulatory regime is discussed in brief.

2.2 US AIR TRANSPORT INDUSTRY UNDER REGULATION

In the USA, regulation of airline passenger's service formally began with the passage of US Civil Aeronautics Act in 1938 establishing the Civil Aeronautics Authority (CAA) which was reorganized to become the Civil Aeronautics Board (CAB) in 1946. In terms of economic regulation the CAB was given the power to:

a) Control entry into the industry as well as into markets. The Board not only restricted entry by new firms but also restricted the number of existing carriers competing in a given market. It also controlled exit by requiring approval before cessation of service to a point on a route.

b) Control and generally set fares based on a rate-making procedure adopted from the Interstate Commerce Act.

c) Award direct subsidies to airlines.

d) Approve or prevent mergers and inter-carrier agreements.

e) Investigate deceptive trade practices and unfair methods of competition.

Although the CAB initially was given the authority over technical and operational aspects of the industry, the Federal Aviation Act of 1958, the successor to the 1938 Act, gave the control over aspects of air transportation such as safety matters to the Federal Aviation Administration (FAA).

These regulations were argued to be in the public interest and their main objectives were to ensure safety and the sound development of the air transport industry. (For the history and the objectives of the US government in the regulation of the air transport industry see Levine, 1965 and 1981).

The general aim of the 1938 Act was to provide a complete network of scheduled services with the minimum of federal subsidy. This was not possible unless carriers could make sufficient profit in denser markets to subsidise thinner ones which could not cover the costs of provided services. To ensure such cross subsidisations the CAB developed a policy of restricting entry to monopoly markets. As a result the right of operation on the trunk routes (the most profitable routes) was given to the majors while the regional airlines could operate in feeder and local routes. Such a system restricted the entry of new carriers to such markets. During the forty years of regulation (from 1938 to 1978) none of the new carriers' applications to enter the trunk routes were approved (Button, 1989). At the same time it was also difficult for the existing airlines to enter each others' routes due to the cost and time involved to get certificates for operation. Such a system let the major carriers, based on a rate-making formula charge fares which were above marginal costs. This was also to ensure a profitable operation by carriers in trunk routes. It must be noted that the CAB, despite its power to control different aspects of the carriers' operation could not influence the capacity offered by the airlines. As a result of non-price competition, carriers competed on the basis of service frequency and service features leading to excess capacity and lower load factor. This in turn resulted in an increase in the operators' costs over that which the demand could justify (Douglas and Miller, 1974).

The regulations limited competition and resulted in higher fares and excess capacity. Such a system of control continued to operate for forty years during which a number of factors combined for a successful push towards deregulation.

2.3 FACTORS THAT AFFECTED THE DEREGULATION MOVEMENT IN THE US

The theoretical and empirical bases for the regulatory scheme were questioned as early as the 1960s in a series of economic studies. There were even earlier studies that threw doubt upon the benefits of regulations; such as the work by Keyes (1951) which could find no available evidence of any need for federal control over entry in aviation. Similar arguments were put forward regarding the disadvantages of regulation of the air transport industry by Cave (1962), Levine (1965), Jordan (1970), Douglas and Miller (1974), Eads (1975) and Keeler (1978).

Despite criticisms of the benefits of regulation in early years, it was not until 1975 that certain factors began combining to form a strong ground for the Civil Aeronautics Board regulatory policy reform. These factors were as follows:

a) Large increase in capacity, resulting from the advent of wide bodied jet aircraft in 1970.

b) Serious economic recession which influenced demand.

c) Massive rise in fuel costs in 1973 which resulted in a series of rises in fares but with increases in costs exceeding increases in yield.

d) The performance of several intra-state carriers (not regulated by the CAB) in California and Texas, which charged a lower fare per mile for comparable distances than CAB regulated airlines and operated more profitably. The activities of these carriers were studied by Keeler (1972) and Well (1984). They concluded that the intra-state carriers operated more efficiently than the CAB regulated airlines. (The responding arguments noted that factors such as good weather, dense traffic, freedom from interlining costs, etc., accounted for the lower costs of these intra-state carriers).

The combination of all these factors made the arguments for regulatory reform strong.

As a result of the anti-regulation atmosphere in the

US, the move towards deregulation began in 1976, when airlines were permitted to offer discount fares. The actual regulatory reform took place when the Airline Deregulation Act (ADA) was signed on October 28, 1978. For a more detailed background to deregulation see Sampson (1984).

2.4 THE AIRLINE DEREGULATION ACT

The Act proposed a gradual relaxation of the CAB's regulation of the industry. In the Act Congress created a schedule for phasing out CAB regulation of entry, rates and mergers, and for ending the CAB itself and transferring its authority to the Department of Transport (DOT). Included in the package were also a labour protection and a new 10 year subsidy programme for maintaining essential air services to certain communities faced with a total loss of air service. The main schedule of major provisions of the ADA is illustrated in Table 2.1.

Table 2.1: Time Phasing of Major Provisions of the ADA of 1978

Subsidy:	October 24 1979 :	Eligibility for essential air service determined
Route :	December 31 1981:	Most of CAB's domestic route authority expired
Fare :	January 1 1983 :	Domestic fare authority expired
CAB :	January 1 1985 :	Final sunset of CAB and transfer of its residual functions mainly to DOT

2.5 THE US AIRLINE INDUSTRY'S PERFORMANCE SINCE DEREGULATION

The analysis of the effects of deregulation on the airline industry's performance is complicated by a number of factors and it is difficult to measure their influences on the industry particularly in the early years of deregulation. These are:

- The rise in the price of aviation fuel. The cost of fuel rose by approximately 237% between November 1978 and March 1981.

- General economic recession. From 1979 to the end of the third quarter of 1982 real gross national product increased by only 4% and the volume of air travel was adversely affected.

- The Air Traffic Controllers' strike. In August 1981 the disruption of the air traffic control system controlling traffic level prevented entry into the most attractive markets (long and dense routes).

In the following sections the US airline industry's performance in the post-deregulation era is compared with that of pre-deregulation. Such a comparison is carried out in terms of volume of air traffic, number of airlines and mergers, service levels, fares, operating costs, financial performance, development of hub and spoke network, use of computer reservation systems and frequent flyer programmes, and airport access. The changes occurred in different aspects of the air transportation industry cannot be solely attributed to the impacts of deregulation. This is because there are some other external factors such as fluctuation in the input prices or the general economy that have affected the industry simultaneously. In the following sections, the causes for the changes are explained and the role deregulation played in the overall air industry result is discussed.

2.5.1 <u>Air Traffic</u>:

The level of demand for air transport is affected by a number of factors such as the quality of air service, fare levels and general economic climate in terms of people's real income.

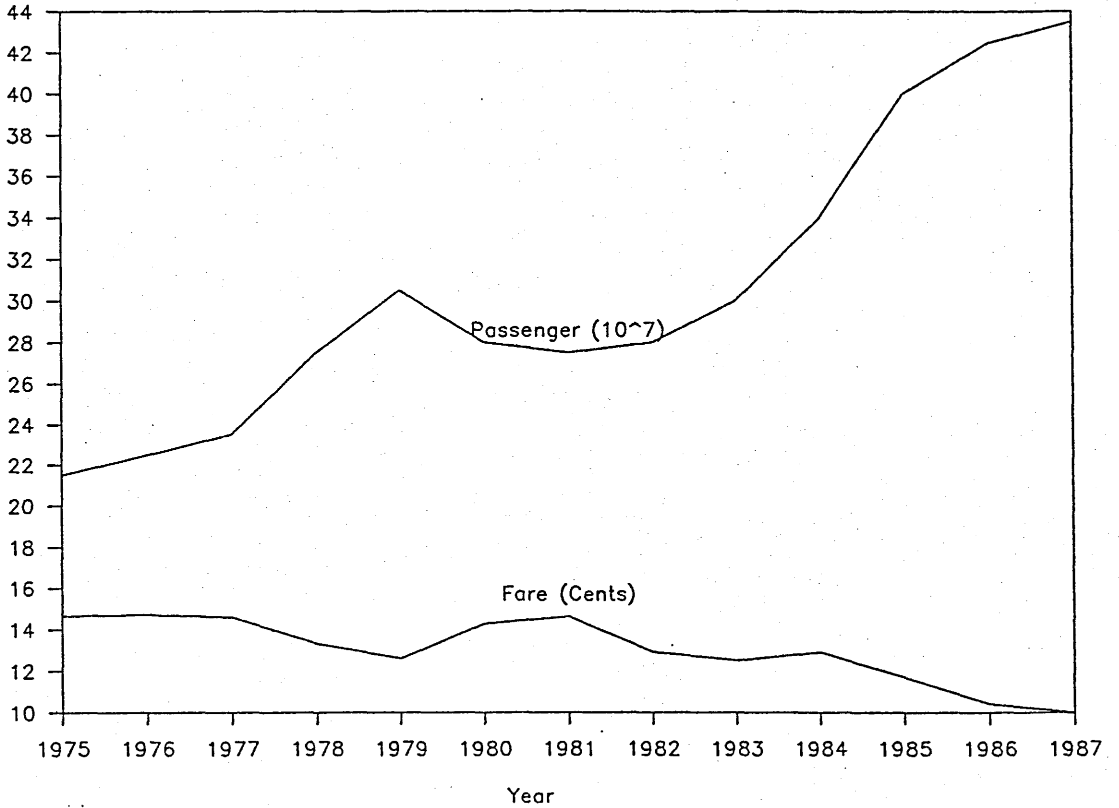
Demand for air transport, which had a rising trend throughout the late 1970s, experienced a decline in the post deregulation period. As can be seen from Figure 2.1 the domestic level of passengers carried dropped from 295 million in 1979 to 275 million in 1980 and continued to be lower than 1979 levels until 1983. It can be seen that in the same period of time, fare levels increased while flight departures declined. The fall in passenger demand is mainly attributed to the 1979-82 recession. As the economic situation improved in 1983 traffic volume returned to the 1979 level and continued to rise. Passenger levels were up by 55% in 1987 compared to 1978. The extent to which the economic climate in the US and deregulation influenced the pattern of passenger demand is unclear. But it appears that the general recession is the main cause of the decline in passenger levels in the period of 1979-83. The impact of deregulation on quality of service and fare which in turn have affected passenger demand is discussed in the following sections.

2.5.2 Number of Airlines and Mergers

The removal of entry controls in 1978 led to the entry of many of the existing carriers to new markets and to their exit from out of markets that they no longer wished to serve. It also provided opportunities for many new airlines to have access to the industry. Figure 2.2 illustrates the number of US scheduled airlines from 1978 to 1987. Although many air carriers entered the industry, some had to leave. It is reported by James (1988) that in the period following deregulation until July 1987, some 210 airlines entered the markets and 168 exited mainly due to mergers or bankruptcies. Despite the exit or merger of many airlines, the absolute number of scheduled carriers was more than doubled by 1987, an increase from 36 airlines to 78. Such an expansion appears to be mainly due to the decontrol of market access. During the forty years of CAB regulation none of the new carriers' applications to enter trunk routes were approved and from 1965 until deregulation in 1978 fewer than 10% of all applications by existing airlines to serve new routes were granted (Breyer, 1982).

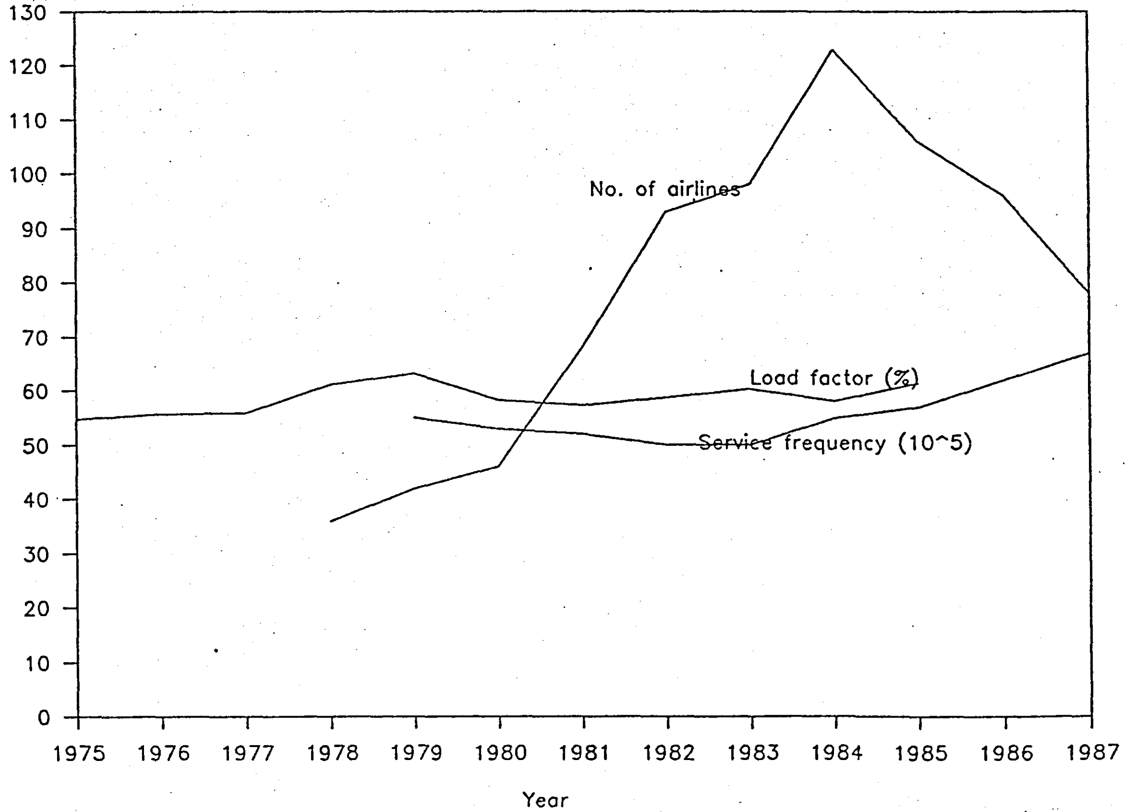
Table 2.2 illustrates the change in the number of carriers in relation to route density and length. For example, in 1983 out of 37 long haul dense routes 59% gained more carriers, 11% lost carriers and the rest had the same number. It can be seen that the largest increase in the number of carriers happened on long dense routes which were the routes of financial appeal. In these types of routes carriers could operate larger aircraft at higher load factor leading to lower unit cost of operation than in short or sparse routes.

Fig. 2.1: US Domestic Scheduled Passengers Carried and Fare/Passenger Mile



Sources: US ATA and Sawers (1987)

Fig. 2.2: No. of US Scheduled Airlines, Scheduled Service Frequency and Average Load Factor



Sources: Button (1989), Gialloreto (1988) and Sawers (1987)

Table 2.2 : Changes in the Number of the US Carriers and the Service Level (1976-1983)

Market	Number of Markets			
	Carriers		Departures	
	Gaining	Losing	Gaining	Losing
Long-haul major (s^* = 37)	22 (59%)	4 (11%)	NA	NA
Large-metropoltian /big cities				
- medium haul (s = 27)	14 (52%)	1 (0.03%)	16 (59%)	10 (37%)
- short haul (s = 25)	13 (52%)	4 (16%)	14 (56%)	11 (44%)
Small cities / big cities				
- medium haul (s = 23)	8 (35%)	6 (26%)	8 (35%)	11 (48%)
- short haul (s = 30)	13 (34%)	3 (10%)	17 (57%)	11 (37%)

source: Moore (1986)
s = sample
NA = Not Available

As Figure 2.2 illustrates it was not until 1985 that the reduction in the absolute number of airlines occurred and concentration increased as the less successful airlines (companies with high costs, large debts or uncompetitive services) merged with or were acquired by more successful carriers. From the mid-1980s to 1987 some 24 mergers and acquisitions were approved by the Department of Transport (Button, 1989). Table 2.3 illustrates the consolidation of major US airlines. The mergers and agreements were between either directly competing major carriers or major and smaller regional carriers operating on feeder routes. By 1988, some 52 regional airlines had been linked to major carriers (Shepherd, 1988). The reason for carriers to merge was to gain economies of scale (not in terms of lowering the unit costs) and of scope such as name recognition, ability to offer a different range of services at different prices, operation at higher load factors and better ability to influence travel agents. The mergers and acquisitions have also enabled the airlines to gain access to airport facilities and as a result to new markets which would not have been possible due to the shortage of airport capacity.

It must be noted that the changes in the Anti-trust law have made it easier for airlines to merge. The mergers were permitted with the view that they result in a better co-ordination of services, size-related cost savings and that the perfect contestability of airline markets prevents any monopoly practices. But as discussed in the previous chapter, the conditions for perfect contestability are not present in the aviation market and mergers have created market concentration which may enable the larger carriers to eliminate or reduce the effects of competition. But it must be noted that despite these mergers the level of competition as measured by the number of airlines serving each market has increased since the passage of Airline Deregulation Act (see Table 2.4). This illustrates that although the level of competition in terms of number of airlines operating in each market compared with the pre-deregulation period has increased, there are still monopoly operations in 65% of markets.

The entry and exit from different markets of many of the incumbents, the emergence of new entrants and the mergers have affected the carriers' market shares. Following deregulation, while all of the trunk carriers were gainers of new opportunities, they were losers as other carriers moved into their own routes. The local carriers had far more to gain by access to denser routes (which were previously served by the

Table 2.3: Consolidation of US airlines

Year	Airline: Surviving	Airline: Acquired
1979	North Central	Southern
1980	Pan Am	National
	Republic	Hughes Airwest
	Flying Tigers	Seaboard World
1982	Texas AirCorp.	Continental
1984	Midway	Air Florida
1985	Air Wisconsin	Mississippi Valley
	Southwest	Muse Air
	People Express	Frontier
1986	Piedmont	Empire
	United	Pan Am-Pacific Division
	People Express	Britt
	People Express	Provincetown-Boston
	Presidential	Key/Coligan
	Northwest	Republic
	TWA	Ozark
	Texas AirCorp.	Rocky Mountain
	Texas AirCorp.	Frontier
	Texas AirCorp.	Eastern
	Delta	Western
	Alaska	Jet America
	Alaska	Horizon Air
	Texas AirCorp.	People Express
1987	Continental	New YorkAir/ People Express
	American	Aircal
	World	Key
	Midway	Fischer Bros Aviation
	USAir	PSA
	USAir	Piedmont

Source: Jordan (1987)

trunk carriers) than to lose from new competition. The new entrant clearly had a net gain. Table 2.5 illustrates carrier's market share between 1978 and 1984. It can be seen that the trunk carrier's share of markets kept declining while the local carrier and intra-state airlines' market share increased. The trunk carriers lost market share because they were generally inefficient and had excessively high cost structure. They also possessed too many wide bodied aircraft. Therefore they found it difficult to compete on short or medium haul routes which favoured smaller aircraft enabling higher frequencies to be offered without incurring undue penalties. But despite these, the trunks continued to dominate the market. In 1985 the trend in the major carriers' market share was reversed as airlines started to merge, or larger airlines absorbed smaller ones, or in some cases large carriers absorbed even larger carriers, as in the case of Continental and Eastern. Such practices have led to market concentration and it is reported that in 1987 nine airlines controlled 94% of the airline market in the USA (Flight International, 18 April 1987). This illustrates that the trunk carriers not only regained the market share that they had lost but became more dominant than before deregulation.

2.5.3 Service Level

The changes in the level of service as measured in terms of available seat miles is a function of variations in flight frequency, number of markets or points served, route length and aircraft size.

As can be seen from Figure 2.2, following deregulation there was a rise in flight departure which did not last very long. Between 1979 and 1983 the US domestic market experienced a fall in the service frequency offered by the carriers after which it started to rise. This follows the pattern of demand which was suppressed due to the recession. Other factors that contributed to the reduction in flight departure in that time period were the increase in the carriers' load factor to utilise the excess capacity into which the regulatory system resulted, increase in price of aviation fuel and the air controllers' strike in 1981. The level of load factor has fluctuated with the fare yield and the level of GNP, but has generally been above the pre-deregulation levels. By 1987 the flight frequency rose by 26% compared with pre-deregulation level (Button, 1989).

Table 2.4: The Number of Scheduled Carriers in Each Market

Number of Carriers	Number of Markets			
	February 1978	+%	February 1987	+%
1	3839	77.0	3458	65.0
2	802	93.0	1027	84.0
3	205	98.0	419	92.0
4	66	99.0	191	96.0
5	26	99.5	87	98.0
6	13	99.7	52	99.0
7	7	99.8	27	99.5
8	4	99.9	14	99.8
9	1	99.9	8	99.9
10 or more	2	100	9	100
Total	4965		5292	

+% is cumulative per cent
Source as reported in Button (1989)

Table 2.5 : The US Carriers' Market Share as Groups

Year	Carriers		
	Trunk	Local	Intrastate
1978	90.1	7.9	2.0
1979	89.2	8.4	2.4
1980	86.9	9.3	3.8
1981	83.3	10.5	6.2
1982	80.8	11.4	7.8
1983	79.8	11.1	9.1
1984	77.0	10.9	12.1

Source : Jordan (1986)

There has been an increase in the total number of markets served from 4965 in 1978 to 5292 in 1987, an increase of 6%. The available seat miles which reflect the total output of the industry has increased by 65% within the same time period (Button, 1989).

The changes in the total level of service since deregulation do not provide a full picture of the effects. This is because markets were affected differently depending on their characteristics, such as the size of the markets and length of routes.

Table 2.2 illustrates the service changes in selected markets. As can be seen, the increase in the number of departures occurred more on denser routes due to the entry of trunk and local service airlines. It also seems that the small cities short-haul markets have received an increased number of departures. For example in the sample of 30 sparse short-haul routes, 57% gained departures and 37% lost.

After deregulation larger carriers were permitted to withdraw from services they no longer wished to provide. As a result many larger operators left thinner routes that they had to serve under regulation. But they were replaced by smaller airlines. Consequently it has appeared that most small communities had experienced fewer seat departures per week since deregulation but more flight departures due to operation of smaller and more suitable aircraft size (Vellenga, 1986).

It must be mentioned that it is not only the level of service which has been affected since deregulation, but also its structure. Following deregulation the industry has witnessed the gradual replacement of long trips by shorter trips connected by hubs (hub and spoke operation is discussed in Section 2.5.7).

In summary, comparing the level of service which was offered in 1987 with the pre- deregulation level, the industry output in terms of available seat miles has increased by 65%. Such a growth was due to a higher service frequency (26%), an increase in number of points served (6%) and must be mainly due to an increase in total mileage covered by the carriers. The total mileage must have increased as a result of the higher number of cities served and hub and spoke operation. The aircraft size also affected the number of seats offered. Soon after deregulation there was a tendency towards operation of smaller aircraft because of the flexibility that they could offer. However in recent years, due to airport capacity limitation, operation of larger aircraft seems to be more favourable.

Although since deregulation, (with the exception in the period from 1979 to 1983), the number of flight departures has risen, this cannot be attributed solely to deregulation. This is because demand for air travel has a rising trend and therefore the increase in service frequency seems to be necessary to meet such increases in demand. The main effect of deregulation in relation to airline level of operation seems to be on the structure of the services provided by air carriers rather than its level.

At disaggregated level it seems that there has been a decline in the number of seats offered in some sparse markets, or short routes, due to the exit from these types of market of trunk carriers which owned wide bodied aircraft. However most sparse markets or short routes received additional service frequency as result of operation of smaller aircraft by local airlines. It can be seen that the freedom to choose which route to operate has led airlines to organise their services in a manner that matches the characteristics of different types of routes or markets.

It must be mentioned that part of the Deregulation Act dealt with the guarantee of essential services to small communities for 10 years, therefore the true effect of deregulation can only be tested on such communities after the temporary subsidy program cancellation which was due in 1988.

2.5.4 Costs

The costs of the airline industry have been affected by changes in the prices of inputs, by technological advances and by the efficiency with which the equipment is used and the business is run. Since deregulation, despite the fluctuation in the prices of aviation fuel, the use of more fuel-efficient aircraft, the competitive stimulation of lower cost entrants and the increasing use of hub and spoke operation have led to the reduction in the operating costs. It is estimated that airline operating costs per seat mile declined by 20% between 1981 and 1985 , after allowing for a 19% inflationary increase in other prices (Weathcroft and Lipman, 1986). It is difficult to quantify the effect of deregulation on such a reduction in costs. But deregulation must have contributed in bringing the costs down. This is because following removal of entry controls, the low cost entrants could enter the airline markets and offer fares which were considerably below those of the incumbents. Therefore the existing carriers had to reduce their costs, in order to offer competitive prices in the markets. The new entrants' cost level was estimated to be one third that of older airlines in 1983 (Bailey, 1985). Such cost advantages arose from offering low cost air travel while requiring passengers to pay for all additional services, low labour costs by employing non-unionised labour and starting at entry level wage rate, and operation of second hand and more suitable aircraft. Lower labour costs were the most important source of cost advantages. A very good example of a low cost carrier was People Express. In any market that this carrier entered, it offered fares which were one third of the incumbent airlines' levels.

All these cost advantages of the new entrant put pressure on the established carriers to bring their operating costs down by changing work role, wage cut, reduction in the number of employees. American Airlines was the first carrier to cut labour costs by introducing two-tier wage contracts. Braniff and Continental are examples of airlines which ceased operation for sometime and started with sharply changed operation rules under new management which led to lower operating costs. As Levine (1987) pointed out, although the major carriers reduced their unit costs (average of 7.2 cents), it is not as low as the new entrant levels (average of 6.2 cents).

The new entrants had major cost advantages over the established carriers but as was predicted (Meyer, 1984) these advantages were lessened over time as the established airlines brought their costs under better control. Furthermore the new entrants cost advantages have withered as their work force became older and acquired seniority. Another source of cost savings has come from the carriers restructuring of their networks by developing hub and spoke operation leading to operation of larger aircraft at higher load factor. This has led to cost savings for the hubbing carriers which are mainly the older and established airlines (hub operation is discussed in Section 2.5.7).

The established airlines in recent years not only reduced their unit costs, but also pursued revenue-earning activities such as hub domination, and frequent flyer programmes that could not be copied by the lower cost new entrants (see Levine, 1987). These types of activities have enabled the major carriers to exercise their power while the new entrants are losing their lower cost advantage.

In summary, it appears that deregulation has accelerated the reduction in the industry unit cost of operation. The sources of cost savings due to deregulation are the labour costs, the changes in the airlines' staff work role and the increasing move of airlines towards hub and spoke operations. Although the incumbent carriers have reduced their unit cost of operation, it is still higher than the entrant's. Such cost differences have led to the engagement of the older and more established airlines in activities that generate revenue but cannot be followed by lower costs and smaller carriers.

2.5.5 Fares

The underlaying influences on prices in the airline industry are the cost and quality of supply, the strength of demand and the intensity of competition. As discussed in the previous section airline operating costs have already been declining due to technical advances in the aircraft technology. Therefore the fare levels also have tended to fall. In the late 1970s the rise in input costs due to the second increase in oil prices and the decline in the level of demand as a result of the recession led to the rise in fare levels (see Figure 2.1). But the intense competition in the industry produced a rapid reversal of this increase. The deregulation of fares allowed the airlines to introduce discount fares to fill the empty seats. As a result the load factor increased while the average fare fell. Pryke (1987) reported that the average fare fell by 14%, in real terms, between 1977 and 1983. This seems to be due to open competition among the existing carriers and entry of the new low cost airlines which emphasised discount services. Since deregulation there has been an increasing trend in both the number of passengers flying on discount fares and the amount of discount offered (see Figure 2.3). It is reported that in 1986, some 90% of all passengers travelled on discount tickets at an average 61% below coach fare (ATA, 1987). It is mainly due to the increasing use of these types of fares that the average yield per mile dropped in real terms by 28.5% between 1976 and 1986 (Kahn, 1988).

The average fare, in real terms, since deregulation has generally been lower than the regulated fare but the nature of price competition has changed from mid-1980s. In the period following deregulation the major carriers, with market share expansion in mind felt the need to be competitive on prices. The fare war between the incumbents and the low cost entrants became very expensive for the large and high cost carriers. Therefore the larger companies had to find other ways of competing rather than principally on fares. It was not until 1985 that they started to employ policies such as the frequent flyer programmes (the more passengers fly, mileage based, the higher the reward for additional travel; see Section 2.5.8 for more details) which has enabled them to increase their market share in a way that could not be followed by the smaller airlines. Such schemes tie passengers to a particular firm and cannot be copied by other airlines unless they offer regular services on a large network or serve many markets. This illustrates that passengers would not always travel on the cheapest fare in the markets. This is because if a passenger is about to be rewarded as a result of reaching a certain accumulated amount of mileage flown, he or she would not switch to another airline for the next trip, even at a cheaper fare. It must be borne in mind that if a customer decided to do so the overall benefit from travelling by larger carriers must have been greater than those offered by smaller and cheaper airlines. The adverse effects of such schemes are mainly felt by the smaller firms which could no longer compete effectively and attract a large proportion of market based just on their ability to offer lower fares. There are these types of economies of scale and scope that have encouraged carriers to merge or share codes in order to be competitive in all the aspects of airline operation.

Although the average fare in the deregulated era has generally been lower than during the regulatory period, there has been a variation in the level of changes in prices by route or market type. Such a consideration illustrates that the decline in fares has mainly taken place in high density and long haul markets, whereas they seem to have increased in most small city markets (see Table 2.6). The differential effects of deregulation on fares is supported by other studies which find that in all but the shortest routes and the least dense markets, deregulated air fares were actually lower than the levels set under regulation (see Kaplan, 1985 and Morrison and Winston, 1986).

Costs of providing services and the level of competition have played an important role in determining prices. Under regulation the existing carriers were protected from the effects of new entry by CAB, and based on the regulatory fares formula, they could charge above marginal costs in dense markets and long routes. This enabled the subsidisation of thinner

Table 2.6 : Variation in Average Fare on Routes of Different Characteristics (1976 - 1983)

	Major large areas			Small cities	
Route length	Long	Medium	Short	Medium	Short
Changes in average fare	- 8.7	- 12.1	- 14.5	53.1	13.2

Source: Moore, 1986.

routes by the existing carriers. But following deregulation carriers could no longer acquire excessive profits on long routes or dense markets, due to the removal of entry and exit barriers and the fact that these types of markets attracted more carriers than any other markets, leading to more intense competition. In terms of costs of services, it is a fact that the unit cost of serving long and dense routes are lower due to the operation of larger aircraft at higher load factors, and in long routes also due to the lower proportion of costs associated with landing and take-off (the most expensive parts of a flight). Following the freedom of pricing, fares started to reflect the costs of providing services and in some cases they were set below cost as a result of intense competition between low cost base entrants and the incumbents. By contrast, in thinner routes there have been some increases in fare levels due to higher costs of services and lower level of competition.

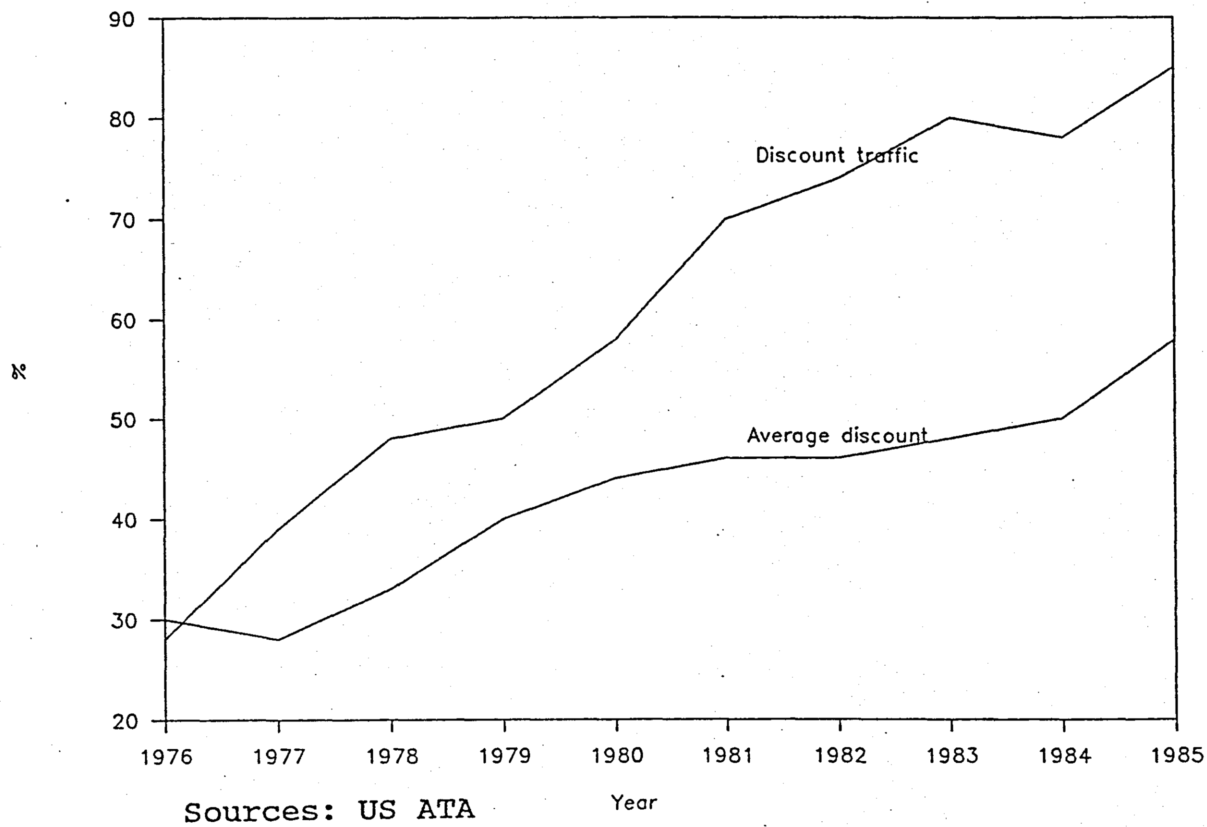
In summary, although the average fare had a declining trend prior to deregulation, it appears that the removal of control from pricing has accelerated the reduction in the industry average fare. This has been due to both the increasing use of discount fares and the level of discount itself as a result of competition amongst airlines. Considering individual markets or routes, it appears that fares in all markets have been reduced, in real terms, except in the shortest and least dense ones. This is because these types of routes could no longer be subsidised by the denser routes, and fares reflect the true costs of the operation. On these routes also the level of competition is less than on dense or long routes. This illustrates that deregulation has had differential impacts on routes and markets with different characteristics. It has also become apparent that passengers would not necessarily travel with the cheapest carriers. This was due to the use of loyalty payments by larger airlines, passengers' lack of perfect information about the full details of different airline services or due to certain service features that one airline offers which may attract some passengers even if its fare is higher than the rival's.

2.5.6 Financial Performance

The air carriers' financial performance as measured by net profit deteriorated in the years after deregulation and started to pick-up by 1984 (see Figure 2.4). The factors that contributed to the loss-making operation of the airlines, were the price wars among the carriers immediately after deregulation, the prolonged economic slump of 1980-1983, the rises in fuel prices in 1979 and 1981 and the air traffic controllers' strike. It is difficult or may be impossible to arrive at any precise mathematical breakdown of the degree of contribution of each element to the overall airline result. But it can be concluded that the external factors played their part along with deregulation. At the very least, deregulation led to certain response (e.g. fare wars) to the external factors, that have prolonged the financial stress. The economic recovery in 1984 and falling oil prices helped the industry to return to profit. But the continuing intense competition reduced the fares of trunk airlines and profitability fell in 1985. In terms of return on capital invested, the industry carried on a positive return. But the rate of return kept declining from 13% in 1979 to 2.7 percent in 1983 after which it started to rise. This is illustrated in Figure 2.4.

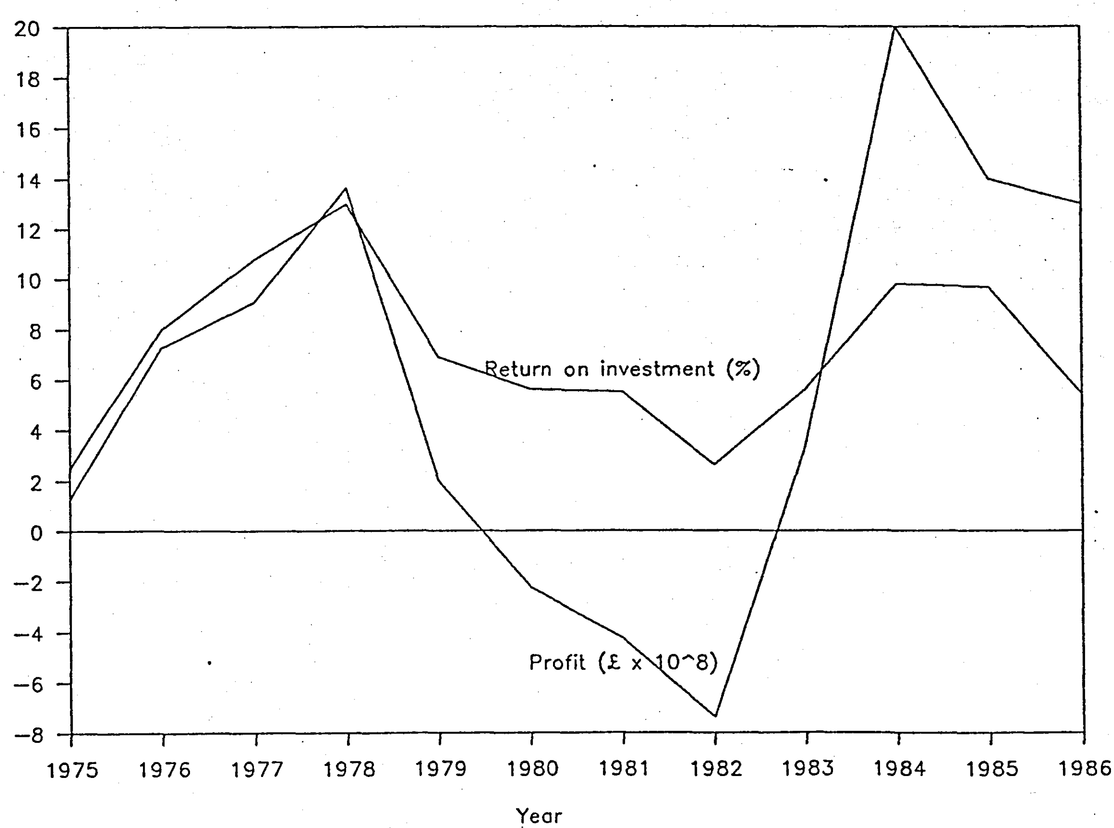
Following deregulation, the way firms responded to the new competitive environments, and their management strategies contributed to their success or failure. For example, American Airlines, which is number one in profit category with a $280 million net for 1986 (Air Transport World, May 1987), was one of the first airlines to employ one of the toughest and most effective business strategies to cope with the changes that were taking place. It was the first airline to cut labour costs by employing staff who accepted a significantly lower level of pay than employees of other airlines, by strengthening its hub and spoke system, acquiring suitable aircraft and introducing the "frequent flier" discount programme. By contrast, there were other airlines that suffered a major loss, such as Braniff which went into bank-

Fig. 2.3: Discount Traffic (% of Revenue Passenger Mile) and Average Discount (% off Full Fare)



Sources: US ATA

Fig. 2.4: US Domestic Airlines' Financial Performance



Sources: Brenner (1985), Button (1989) and US ATA ruptcy in 1982 and ceased operation for nearly two years. The main reason for such a situation occurring appears to have been from a too rapid expansion of this carrier. Braniff pursued new routes actively soon after deregulation took place in the belief that deregulation might be temporary and regulation may occur again. This illustrates that in a competitive environment, where airlines have the freedom to respond to the changes, the differences between the air companies in terms of employed strategies have an important effect on their success. Although the pressure on costs also contributes to a better financial performance, access to economies of scale and scope (benefits associated with the operation of regular and frequent services on a large network and to different places) plays an important role in the success of carriers. It is because of such economies that the older carriers, despite having higher unit costs, have been able to continue their operation while so many lower cost new entrants ceased their operation.

2.5.7 Hub and Spoke Network

Almost all carriers since deregulation emphasised connecting services by developing hub and spoke operations. Flights from various origins arrive at an intermediate point where passengers change planes to proceed to their ultimate destination. It must be noted that deregulation did not lead to development of such operations but has accelerated their use.

Such operations have led to an increase in hub traffic since deregulation. Some 15.6% of passengers departed from hubs in 1977 compared with 24.5% in 1984 (Weathcroft and Lipman, 1986).

Airline hub and spoke operation provides an enormous multiplier effect to the number of city pairs by offering a wider range of destinations from all originating points, it also offers a better utilization of larger aircraft at higher load factor, leading to better productivity and lowering costs of hubbing airlines. It should be mentioned that although the consumers have access to a larger number of destinations, their journey time does increase as a result of such operations.

The hub and spoke system has provided advantages for the hubbing airlines compared with the smaller carriers that provide point to point services. Carlton, Landes and Posner (1980) have shown that where there is no convenient non-stop flight, passengers prefer single-carrier service to having to change airlines in mid-journey. This is because the connecting flight is more likely to be conveniently timed and there is felt to be less risk of baggage going astray. Therefore large airlines with well devised hub and spoke systems tend to carry more traffic over any particular route via a hub than small airlines that provide services only on the spoke. The greater the amount of traffic the more flights can be offered and the more attractive the service will become. It appears that passengers and travel agents tend to book with the airline which provides the greatest number of flights. If an airline controls a high proportion of the flights from the hub, it can charge even higher fares than an airline with a smaller proportion of departures from that airport. It is estimated by Bailey (1985) that an airline with 50% of departures from an airport charged fares 7% higher than those charged by an airline with 25% of the departures. Airlines with a large share of departures are also able to maintain their position against potential competitors because an entrant cannot usually obtain the terminal facilities and landing slots to match the frequencies offered by the dominant airline. It seems that airlines which have inherited or developed a dominant position at a hub airport therefore have some control over the local market for air transport. Such systems coupled with mergers have provided a dominant position for major carriers at their hubs (see Table 2.7).

Table 2.7: Dominance at Major Hubs in the US, 1987

Airport	Dominant Carrier	Market Share	Secondary Carrier	Market Share
Atlanta Hartsfield	Delta	53	Eastern	42
Chicago O'Hare	United	49	American	27
Dallas/Forth Worth	American	63	Delta	24
Denver Stapleton	United	44	Continental	41
Detroit Metro	North West	65	American	6
Houston Intercont	Continental	72	Eastern	6
Memphis Internat	Northwest	87	Delta	7
Miami Internat	Eastern	49	Pan Am	17
Pittsburgh Internat	USAir	83	Eastern	4
St.Louis Internat	TWA	82	American	2

Source : Shepherd, 1988

2.5.8 Computer Reservation Systems (CRSs) and Frequent Flyer Programmes

Computer reservation systems (CRSs) and frequent flyer programmes are the most powerful marketing tools of the American airline industry.

The development of CRS has been one of the most important events in the US airline industry over the last 10 years. Since deregulation, these systems have gone through a lot of changes and improvements. Carriers have used CRS to control sales in the travel agents. With the event of deregulation, which gave the freedom to carriers to introduce new fares and schedules, more passengers were dealing with travel agencies, because they felt they would get a fuller knowledge of the options, which were changing all the time. Before deregulation (1978) 45% of airline business came through travel agents whereas in 1987 the percentage had nearly doubled (Longman seminars, 1987). As a result 95% of travel agents are equipped with CRS. Such a situation has led to airlines competing furiously to link travel agencies to their computer networks and selling their CRS to travel agents. There are five principal CRS vendors in the USA, as shown in Table 2.8. Of these, the two most important ones are American Airlines with Saber and United with Apollo which together account for some 74% of the market share through out the US (Feldman, 1988).

Table 2.8: The US CRS Vendors' Market Share as Percentage of Travel Agent Revenue in 1985

US CRS Vendor	Market Share
Sabre (American Airlines)	46
Apollo (United)	28
Pars (TWA/Northwest)	10
SystemOne (Texas Air)	10
Datas II (Delta)	5
Mars Plus (not operating)	1

Source: Feldman (1988)

As travel agencies automation progressed it became apparent that manipulating screen displays results in incremental booking for one carrier, in particular for the CRS owners, at the expense of another. It is reported that between 70% and 90% of airline flights booked by travel agents are reserved from the first CRS availability screen displayed (ELU, 1987). Such practices gave the opportunity to certain CRS vendors to have more flights booked, as their names always appeared first on the screen. These have also led to a situation where airlines try to influence the travel agents. As a result the commission costs paid to the agents by the major carrier in 1986 were double the level in 1977. This illustrates that offering the lowest fare in the market is not the only key to attract passengers, as there are other factors that influence the choice of the customers. It is reported that CRS in the USA are closely controlled by the Department of Transport mandatory regulation for flight booking and ticket selling purposes, and they are about as close to neutrality as a system could reasonably be expected to get (Flight International, 10 October 1987).

Frequent flyer programmes are the latest marketing tool in the US airline industry. They were initially introduced by American Airlines in 1980 but recently, with a few exceptions, every large domestic airline operates or participates in frequent flyer programmes. Basically, airlines encourage individuals to join their programmes by charging no membership fee and crediting up to 5,000 miles to their accounts as enrolment bonuses. Thereafter, members accumulate credits by flying on the airline's routes. Credits also can be earned by renting cars from, and staying at hotels belonging to, designated affiliates. Members can cash in their earned mileage credits for certificates of upgrades on free travel. These credits are generally transferable, especially to family members. Thomas (1987) estimated that approximately 12 million people are frequent flyer members in 1987.

As Toh and Hu (1988) have pointed out there are three motives for operating frequent flyer programmes which are as follows:

- To generate brand loyalty and repeat business for an airline. Such programmes tie passengers to a particular airline irrespective of that carrier's efficiency.

- To achieve product differentiation. The awards allow the larger airlines with comprehensive interconnected routes to offer the travelling public something that the smaller, newer, low-cost airlines with limited route networks cannot.

- To compile demographic profiles and travel characteristics of their members. The sign-up procedure provides useful demographic data and information on travel patterns.

It can be seen that such programmes enable the larger carriers to reduce both actual competition and potential competition.

Another development in marketing strategies since deregulation has been the emergence of niche marketing. The smaller airlines who have recognised that they cannot compete directly with the major airlines have sought a niche where they can offer service specially tailored to the needs of a identified segment of the market, and make that their own. This is another example of product differentiation in airline marketing. By employment of such a policy the airline practising this strategy creates a quasi-monopoly protection for its own product. The niche marketing usually can be successful if the airline concerned accepts a limited share of a particular market otherwise the major airlines may retaliate and produce a competitive product which, by its price or service quality, destroys the niche.

The differences in the carriers' marketing strategies, in their products and the way information about airline service is distributed have affected the passengers' choice of airlines.

2.5.9 Airport Access

Following deregulation the increase in passenger demand, in the number of airlines and in the use of hub and spoke operation have led to the increase in demand for airport gates and landing slots. The airport scheduling committees which consist of various interested airlines and airport authorities have been responsible for allocating the slots. Before deregulation, these committees faced no demand for slots from new entrants. This was because the CAB effectively prevented new entry to the industry. It also restricted the increase in the demand for slots from existing carriers. However after removal of entry control, the requirement for slots increased due to the new entry and expansion of existing carriers' operation. In order to meet the increasing demand for airport capacity, the airports would either have to expand, or access to them be restricted. The expansion is not always possible due to the lack of space or environmental restrictions. The restricted access to airports puts the carriers already present in the market in a better position to compete. This is the reason for acquiring more airport facilities than required by larger airlines to impose access constraints at some airports (Levine, 1987). This illustrates that in a deregulated operating environment, there are factors such as unequal access to airports which limit the effect of competition.

2.6 SUMMARY OF THE US AIRLINE INDUSTRY'S PERFORMANCE SINCE DEREGULATION AND POLICY QUESTIONS

The analysis of the US airline operation since deregulation illustrates the role of removal of regulations in the way the industry has performed, and generates the policy questions that should be addressed, if relaxation of regulation takes place elsewhere (e.g. in Europe).

Since 1978 the US airline industry has been affected by the change in the regulatory regime as well as other external factors such as fluctuation in the price of fuel and economic climate. In summary, the performance of the US airline industry since deregulation between 1978 and 1987, has been as follows:

- The volume of traffic which had a rising trend, started to decline in the post-deregulation period (1979-1983). This appears to be mainly due to the general recession in the same period of time. From 1983 passenger levels rose and in 1987 they were 55% higher than the 1978 levels. Deregulation must have contributed to such increases in passenger demand through accelerating the decline in the average fare and enabling passengers to have access to wider range of destinations via hubs.

- The number of airlines has more than doubled since deregulation, a net increase of 42 carriers. Although there have been new entries to the industry some have exited due to bankruptcy or mergers. Most markets have experienced more carriers, in particular long haul major markets, while there have been no changes in some markets and some have lost carriers. The increase in the number of airlines could be attributed to the effect of removal of control from entry and exit. This is because during the forty years of CAB regulation, none of the new air carriers applications to enter the trunk routes were approved and therefore there were no new entries to such markets.

In recent years as a result of airline mergers and buy outs, the industry has become more concentrated and the trunk carriers market share has increased, as nine airlines controlled 94% of the air market in the US in 1987. It seems that the intense competition due to deregulation encouraged the unsuccessful carriers with high costs, large debts or uncompetitive services to consolidate with the stronger carriers in order to survive. Such a situation has led to an increase in the market concentration as compared with the pre-deregulation period. It must be noted that the level of competition as measured by the number of airlines in each market has increased which seems to be due to ease of access to markets by air carriers.

fittest survive

-The total industry output as measured in terms of available seat miles increased by 65% in 1987 compared with the level in 1978. There has been some increase in service frequency (26%) and number of cities served (6%). Carriers' average load factor has been slightly higher than the pre-deregulation period. The increase in service frequency and load factor compared with the increase in passenger demand suggests that the average aircraft size has increased too. Following deregulation smaller aircraft were more popular because of their flexibility, however in recent years there is a tendency towards operation of bigger aircraft due to limitation in the airport capacity. Another factor that affected the rise in total available seat miles is the length of routes which must have increased greatly as a result of hub and spoke operation. The comparison of pre and post-deregulation average number of flights does not reveal the role of deregulation in the changes that have taken place in flight frequency. This is because there has been a rising trend in service frequency prior to deregulation, and if it was not because of the recession and the other external factors that were mentioned before, it would not have declined in the period between 1979 and 1983. It must also be borne in mind that capacity was not regulated by CAB prior to deregulation. The effect of deregulation in relation to airline services is more noticeable on the structure of services offered by airlines than on its level. It appears

· frequency
· load factor
· aircraft size

that deregulation of entry and exit has led to increase in flight departure on more profitable routes (i.e. dense and long routes). However some shortest or least dense routes have experienced reduction in the flight departure. Also, by adopting hub and spoke operations airlines have been able to serve more cities.

- The average unit cost of airline operation declined by 20% in real terms (between 1981 and 1985). This appears to be partly due to the competitive stimulation of low cost new entrants, the increasing use of hub and spoke operation and technical progress in aircraft technology. The main burden of the reduction in airline operating expenses since deregulation, has fallen upon the pay of employees. Although the older carriers have reduced their unit cost of production, their costs are still higher than those of the new entrants.

- The overall industry average fare per mile declined by 28.5% (between 1976 and 1986). This has been due to decline in the costs associated with aircraft operation (operation of more efficient aircraft) and deregulation through intense competition among the air carriers. Under regulation fares were set higher than competitive levels in most markets. Therefore with the removal of regulation, fares were set by market forces leading to lower average fares. There has also been a change in fare structure. The increase in the use of discount fares and level of discounts has played an important role in bringing the average fare down. While fare level had a declining trend, deregulation accelerated the reduction in the industry average fare. However, the reductions in fares have not been distributed evenly amongst the different markets. While dense markets, in particular long routes, have experienced great reductions, thinner markets have experienced a rise in fares.

- The carrier's net profit declined in the years following deregulation due to recession, increases in the price of aviation fuel as well as the price war among the airlines as a result of deregulation of fare levels. In 1984 the industry returned to profit but the intense competition reduced the trunk carriers' fare and profit. The air carriers' return on capital invested continued to be positive following deregulation but has been generally lower than the 1978 level which was 13%. There have been differences in the financial performance of individual carriers. The ability to lower the unit costs to a competitive level and the access to economies of scale, density and scope have had some important effects on the financial performance of carriers.

- Since deregulation, the freedom to choose which route to operate has led airlines to restructure their networks into effective hub and spoke systems. Although deregulation did not lead to development of such operations, it substantially accelerated their use. Such a system is advantageous to passengers; smaller cities can have more frequent services and can have access to a wider range of destinations. It is advantageous to airlines as it provides a better utilisation of aircraft at higher load factor leading to better productivity and lower costs. This system has also provided a dominant position at hubs where major airlines have a large share of flight departures.

- Since deregulation there has been an increasing use of Computer Reservation Systems (CRS) and loyalty payments systems. These are the most powerful marketing tools of American airlines. The owners of these systems have been able to reduce the effects of competition in their own favour.

- There has been an increasing demand for airport capacity since deregulation. The removal of regulation of access to the markets and the increasing movements towards hub and spoke operations have contributed to the increase in demand for landing slots and gates at major airports.

The study of the performance of the US airline industry since deregulation suggests that generally the industry is more competitive and that removal of regulation from airline operations has contributed to changes that have taken place since then. It appears that deregulation has accelerated the reduction in airlines' operating costs and fares. It has made it easier for airlines to restructure their services so that they can operate more efficiently. But it has also contributed to market concentration as the intense competition has encouraged the carriers with uncompetitive services to consolidate with the stronger airlines who have access to economies of technology (e.g. CRS), density (operation in dense routes), scale (operation of frequent services on a large network) and scope (serving different cities and customer sub-markets).

At disaggregated level, it can be seen that the effects of deregulation have not been distributed evenly amongst markets, amongst routes and carriers. This suggests that the study of effects of deregulation should consider the characteristics of market, route and operators.

The analysis of the effects of the US domestic air transport deregulation raises some broad policy questions, if liberalisation of air transport operation takes place in other places such as in Europe. In this study a number of policy questions concerning fare, service frequency and cost issues are raised and addressed. These are:

I) What are the impacts of partial deregulation? In other words what are the effects of deregulating one aspect of the airlines' operation (e.g. fare) compared with the effects of removing controls from other aspects (e.g. service frequency) or deregulating both (fare and service frequency)?

II) Do the effects of deregulation depend on the characteristics of the routes (length and density), markets (business or leisure) and the carriers (cost level)? In other words, would free competition lead to:

- fares of smaller cities being set higher than air fares of larger cities and would the length of route affect such a pattern?

- loss of services to sparse markets?

- market segmentation, where tourists oriented markets will be served differently compared with business oriented markets?

- lower fares and higher service frequency where a new carrier enter the market, and what are the impacts on the incumbents carriers operation?

- a situation where the cheapest carrier attracts all the passengers, or would other advantages such as the access to the economies of scale, scope and density enables the larger and more expensive carrier to attract most passengers?

To address these policy questions, in the next part of the study a model which simulates the competitive behaviour of airlines is developed. This model takes into account some of the general characteristics of airlines' competitive markets which were outlined in the previous chapter. It analyses the comparative effects of partial deregulation; compare the effects of deregulating fare with frequency and combination of fare and frequency. It also explores the impacts of complete deregulation in terms of fare and service frequency interactions in different markets and routes and on carriers with different level of costs which do not have equal access to the economies of scope and density. These economies were discussed in Section 1.3.2.

Although US deregulation has affected different aspects of the air industry, the competition model developed in this study focuses on the effects on individual carrier's fare and frequency interactions and their resulting market share, operating costs and profit. It also determines the possible equilibrium position of carriers under different conditions. A detailed characteristic of this model is discussed in the second part of the study.

The competition model developed in this study is based on European airline data. Therefore in the next chapter the underlying structure of the European air transport market is discussed and its differences compared with US markets and their possible effects on the competitive outcome in Europe are studied.

CHAPTER THREE

EUROPEAN AIR TRANSPORT LIBERALISATION

3.1 INTRODUCTION

In this chapter the structure of the European air transport market is discussed and its differences with the US market and their possible effects on the outcome of regulatory changes are analysed. This is relevant to the competition model developed in the next part which is based on European data. Some characteristics of the European air market are incorporated in the development of the model.

3.2 EUROPEAN AIRLINES' MARKET STRUCTURE

In Europe more than 130 airlines of various sizes operate and they fall basically into three main groups:

- The scheduled airlines: These carriers are typically government owned, have high costs and provide a full service to the passengers. They operate on trunk routes between highly industrialised countries of western Europe as well as offering inter-continental and domestic services. These carriers tend to serve most other European centres from their own national airport hubs.

- The charter airlines: These carriers operate in almost all European countries and have a dominant position. The intra-European market share of charter carriers has traditionally been around 60% of the total passenger kilometres carried. These carriers normally have low costs and provide a low level of service. They tend not to operate on a regular basis nor routes that are dominated by business traffic which are typically served by the large scheduled airlines. The charters in Europe operate mainly between the industrialised northern countries and the holiday resort countries of the Mediterranean. The charter airlines in turn are divided into two categories: affiliated charter airlines that are owned by a parent scheduled carrier and independent charters some of which are linked to, or owned by, tour operators.

- The regional airlines: These are small airlines operating commuter type aircraft on thinner domestic and transborder routes. They are essentially independent but the majors have increasing interest in this type of operation.

As a result of these carriers offering different types of services, airline operations are clearly divided into non-scheduled and scheduled. Non-scheduled services are charter operations which as stated before carry leisure traffic to holiday destinations. Scheduled services by contrast carry a lower proportion of leisure traffic and their main concern are business traffic though by offering many types of promotional fares try to attract some leisure travellers. It is estimated that over 50% of traffic between industrial countries of western Europe are business passengers (Weathcroft and Lipman, 1986).

3.3 REGULATION OF AIR TRANSPORT IN EUROPE

In 1944 the pattern for the development of international civil aviation was set by the Chicago Convention. This recognised that each state has exclusive and complete sovereignty in the air space over its territory and has the full right to determine the conditions on which airlines of other states may use that air space. As a result of this agreement the direct intervention of governments in air transport became inevitable.

The fact that much of the intra-European flights (around 80%) are cross-border and the majority of air carriers are state owned has made the intervention of the governments in airline activities stronger. Governments want their domestic, and in particular their international services, to reflect their political, economic and social norms. They impose regulations on the basis of such criteria as: safety, economics, prestige and culture, military, tourism, employment, protection of consumer interests and so on. A list of objectives of European governments' regulation in relation to the airline services is given in Appendix A.

Because all states are interested in the aviation trade affecting their markets and since they have different abilities to compete, bilateral agreements have been used to control the degree of competition through the regulation of market entry, price and capacity. The attitudes of states to bilateral negotiations are very much influenced by their approach to public service and competition. Those states that consider air transport as a public utility (there is a great tendency toward monopolistic operation in such industries) are in favour of control and regulation of airline operations to protect public interests against any monopolistic behaviour. The stronger their view on this matter the tighter is their control. Also those states (e.g. Spain or Greece) that recognise the inability of their airline/s to compete with stronger airlines of other countries, advocate regulation. By contrast, the governments (e.g. British or Dutch) whose air carriers are in a better position in terms of finance or geographical location of their operation are supporters of relaxation or removal of regulation.

In Europe all scheduled airlines' activities are determined by bilateral agreements in which the degree of control exercised varies. It must be noted that a large proportion of charter operation (inclusive tour operations) do not fall under bilateral agreements and they are subject to unilateral approval. The regulations are typically applied to tariffs and their conditions, capacity and frequency on city pair routes, route entry and exit, airlines' designations, landing rights, revenue and cost pooling on single routes and so on. These applications are discussed below.

1- Control over fare: Regulation of scheduled pricing in Europe was traditionally exercised at three levels: proposal by airlines; mutual approval by governments; and enforcement by a combination of IATA (International Air Transport Association) and government regulation , inspection and fines. In the late 1970s, due to carriers' initiatives, market pressure and unenforced regulation, some changes in the structure and level of prices took place. Although most governments and airlines welcomed the reduced multilateral controls, they felt the strong need to maintain adequate control at bilateral levels. As a result competition on price has been constrained. The degree of control on tariffs in bilateral agreements between states has varied from double approval (both states should agree) to automatic approval (without any state involvements). In between there have been the rules of origin (approved if the state where traffic originates agree), home state approval (approved if the state of registry of the airline agree) and double disapproval (approved unless both states agree to reject). In Europe double disapproval and automatic approval are not often exercised (Weathcroft and Lipman, 1986).

-Control over capacity: The regulators control the capacity offered by air carriers to make sure the airline of their country gets an adequate share of the traffic on the route where they operate. Bilateral agreements typically included a 50/50 division of traffic. It is reported in ECAC (European Civil Aviation Conference, 1982) that in 1980 some 90% of European bilaterals had capacity controls of which 60% had an ex-post facto review and almost 30% predetermined level. Such bilateral agreements illustrate the rigidity of regulation in Europe and the extent to which air carriers in Europe have been protected.

-Pooling agreements: Usually these agreements involve a coordination of schedules, selling tickets and a sharing of traffic revenue according to pre-determined market quotas. The quotas may or may not be periodically reviewed. These pools clearly do not encourage competitive incentives and eliminate capacity competition between airlines. Pooling of services is mainly in the interests of airlines as they are able to schedule flights at off-peak times, improve load factor and facilitate interlining by accepting each others (pool partners) tickets. It is estimated that more than 75% of ton-kilometres flown on intra-European international services in 1980 were subject to pooling agreements (ECAC, 1982).

-Control over market entry: in Europe access to scheduled routes has been controlled which like regulation of other aspects of the industry, has limited the competitiveness of air transport. In the same report by ECAC it is estimated that in practice 23% of country pairs under bilateral agreements are not served by the airline of the responding country, 17% are served by one air carrier per state and only 6% by two or more. On city pair bases only 2% of the routes operated had more than one airline per state.

Such tight controls over different aspects of air transport operation have been criticised by the opponents of regulation, on the basis that free competition leads to an efficient industry that serves the need of its customer at lower price and higher standard. These are discussed in the next section where the factors that have contributed to the movements towards a more liberal air transport industry in Europe, are studied.

3.4 PRESSURE FOR CHANGE

There has been an increasing pressure in Europe for relaxation of regulation in the air transport industry. There are a number of factors such as the European Community's initiatives for change, new liberal bilateral agreements between governments who advocate free competition, consumer organisation's reports and US deregulation effects that have contributed to pressures for a liberalised regime in European air transportation.

The European Community policy for creating more flexibility in the current regulatory system of air transport is reflected in its activities and modest proposals over the last few years. These include:

- In the mid-1970s the Council began to show a greater interest in aviation. This was mainly promoted by the decision of the European Court suggesting that the general rules of the Treaty of Rome, including the competition rules, are applicable to air transport.

- In June 1978 the Council issued a nine point list of priorities in the air transport sector. The main features were the provisions regarding aids and competition, possible improvements to inter-regional services and the right of establishments.

- In July 1979 the Commission of European Communities issued its first official memorandum. The underlying theme of the memorandum is that the highly regulated air transport sector in Europe has lagged behind developments elsewhere, notably in America. The Commission proposed an evolutionary process of development aimed at increasing competition to improve flexibility and innovation in European air transport.

- In 1980 the Commission proposed a draft regulation on scheduled inter-regional air services. The objective of such a proposal was to give freedom to airlines to operate inter-regional services subject to certain conditions. The Directive was issued by the Council of Ministers in June 1983. The conditions included restrictions on the type of routes such as authorisation to operate between second major provincial airports (category 2 airports) and other smaller airports with facilities for international flights (category 3 airports), size of aircraft (maximum of

70 seats or maximum take-off weight of not more than 30 tons), minimum stage length (400 kilometres, shorter when over mountains or sea). Despite these limitations, it supersedes the bilateral system, and the agreement was a remarkable development in creation of a common air transport market. The Directive, subject to the restrictions noted above, allowed for capacity freedom and for a liberal tariff regime under which tariffs or inter-regional services had to be approved by both states if they "are in reasonable proportion to the costs of the air carrier's operation" (Kaze, 1987). In July 1986, the Commission proposed a series of amendments to the 1983 directive, which would extend its application.

-In 1981 the Commission issued a report on the level of scheduled air fares which suggested that there was a need for tariff development. This led to a draft Directive on Scheduled air fares (EC, 1981). The key items included were the introduction of country of origin fares approval, settlements of disputes between states by a Commission arbitration process and provision for Commission observers to attend IATA traffic conferences.

- In 1984 the Commission issued its second Memorandum which was more liberal and more oriented towards the establishment of a community air transport policy than the previous proposals. The Commission while recognising that American-style deregulation is unlikely to work in the present European context, not only because of the difference in constitutional structure, but also because in the US approximately 20 large airlines operate commercially as a consequence of which governmental concern is very little, proposed some changes in the European regulatory regime. Elimination of regulation has not been the Commission's aim, but rather to introduce sufficient flexibility to allow efficiency and innovation in the air transport industry. The Memorandum covers issues such as capacity, revenue and tariff.

In terms of capacity and revenue, it proposed that pooling agreements between air carriers are not to be considered as a binding condition in bilaterals and 50/50 market sharing should not be insisted upon. Instead it suggests a zone for free capacity with a safety net of 25% of markets.

With respect to tariffs, the Memorandum was a revised version of the 1981 Tariff Directive, introducing the concept of zones of non-intervention or approval by one state only.

In respect of subsidy it proposed that aids should be transparent. The Community action aims at the elimination of support except in certain circumstances such as part of a general restructuring or to cover public service requirements.

The Memorandum dealt cautiously with market entry and suggests that it should be possible for charter carriers to offer up to 15% of their space on a seat-only basis (this is when the inclusive tour, IT, operators sell seats from their main holiday programmes to passengers going to their own or friend's holiday accommodation). It is generally believed that seat-only sales have been a large part of the non-scheduled market as in 1984, when 25% of the IT market was sold on a seat only basis unofficially (Weathcroft, 1986). It therefore appeared that such a provision has made the IT operators activities official rather than changing the actual situation. The Memorandum also proposed that any new entrant should be able to operate unused routes which had been agreed in bilateral agreements.

The reaction to Memorandum Number 2 varied among the European countries depending on their geographical position, market size and control, level of government protection, air transport and tourism structures, strength of the national airline and so on. While the UK (which is a large supplier of air transport services) and the Netherlands (which has the central geographical position) are supporters of greater competition, countries like West Germany and France hold the middle ground and states with weaker economies and airlines such as Greece, Portugal and Spain see any increase in competition as a threat to their national interest.

These proposals illustrate that the European Commission is taking steps towards creating a more liberal air transport environment.

In 1987, all 12 nations in the European Community were about to reach an agreement on liberalisation of the air transport system when Spain vetoed the package at the last minute, and insisted that Gibraltar should be excluded from the deal (Flight International, 11 July 1987). The package had the following main characteristics (for more detail see Official Journal of the European Communities, 1987):

- on capacity sharing: It allows any capacity increase by third and fourth freedom carriers provided that the resulting capacity shares are not outside 55%-45% for the first two years after notification of the decision and 60%-40% for the third year. Multiple designation by the approval of one state on routes that carry more than 250,000 passengers a year in the first year, 200,000 passengers in the second year and 180,000 passengers in the third year.

- on fares: It allows fares to be automatically approved between Member States provided that they remain within the zones of flexibility, that is a discount zone from 90% to more than 65% of the reference fare and a deep discount zone from 65% to 45% of the reference fare.

-on fifth-freedom services: The package allows fifth- freedom services if they are an extension of present third and forth freedom routes. A major airport (category 1 airport) could only be used once on any route involving fifth-freedom rights (except in the case of Ireland and Portugal who were granted limited fifth- freedom rights through major hubs for their airlines), and only 30% of an airline's total capacity for the preceding year could be carried on fifth freedom services (see Appendix B for the list of traffic rights).

This package was finally adopted by the Council on 14 December 1987. The advocates of liberalisations such as the UK government believes that the package is not liberal enough and has asked for greater liberalisation in the air transportation market.

Meanwhile, as a result of countries' differing views on liberalisation of European air transport, negotiating liberal bilaterals has been used as an instrument by some governments to speed up the movement towards relaxation of regulations. The UK government has taken the lead and made the first liberal agreement with the Netherlands in June 1984. Since then it has concluded agreements with West Germany (December 1984), Luxemburg (March 1985), Belgium (October 1985) Switzerland (December 1985) and some loosening up of agreement with France (September 1985). Table 3.1 illustrates the main features of the agreements between the UK and other countries. The UK agreements with the Netherlands, Luxembourg and Belgium are more liberal than with others. These bilateral agreements, in terms of route access, aim to provide the opportunity for airlines to operate scheduled services on any route between the two countries and combine services to more than one airport in either country. However it is accepted that there would be no cabotage rights (that a foreign airline cannot carry domestic passengers). On capacity issues, the airline can decide on required capacity without any control from their governments. There are a few limitations to this freedom, such as it allows each country to call for consultations if it is considered that any of its own airlines are seriously damaged, due to services being mounted by airlines of another country. With respect to tariffs, there is no need for airlines to consult their governments before filing tariffs. But it allows a double disapproval system and matching of fares on routes to a third country. A country can call for consultation if tariffs filed by one of its own airlines are considered to be predatory or excessive in relation to airline costs. Scheduling or any other aspect of pooling are not considered in the new bilaterals with the exception of the first Netherlands agreements.

Table 3.1 : Nature of Agreements Between UK and Number of Other European Countries

Country	Liberalisation of Route Access	Liberalisation of Capacity Constraint	Liberalisation of Tariff Constraint
Netherlands (I)	YES	YES	NO
Netherlands (II)	YES	YES	YES
West Germany	YES	YES	LIMITED
Luxembourg	YES	YES	YES
Belgium	YES	YES	YES
Switzerland	YES	YES	LIMITED
France	LIMITED	LIMITED	NO

It can be seen that, although the nature and contents of the new bilaterals are less restrictive than the old ones, there are still some restrictions and qualifications attached to any freedom proposed. This is because the air carriers of the negotiating governments have differing abilities to compete and the governments do not want to see that their airlines are driven out of business by airlines of other countries. Therefore they include some safeguards in their agreements.

Consumer organisations criticisms of the European regulatory system of air transport have also put pressure on the introduction of flexibility in the control of economic aspects of the industry.

One of the major but not the only complaint in Europe has been the high fares. It is argued that this is due to the lack of competition among airlines which prevents them from operating efficiently and therefore from providing better and cheaper services to consumers. In March 1986 the UK National Consumer Council provided a report on the European air transport regulations. Its 30 conclusions and recommendations cover a wide range of issues. In the part relevant to liberalisation of European air transport, the operation of national airlines is criticised as being protected by the roles of regulators and that Europe's air fares are higher than they would be under a more competitive scheme. It then refers to non-scheduled airlines as an operation that demonstrates the merits of a less regulated environment. The report recommends that the Commission should use its own powers to end anti-competitive aspects of air service arrangements and support a regime without capacity controls, pooling and a real price competition. Other consumer organisation reports such as those of the Bureau of European Consumers Unions and the International Users' organisations attack the regulatory system in Europe and report that the market is dominated by state airlines which are inefficient particularly in comparison with the US carriers. Furthermore, they offer low fares only where they are in competition with charter airlines.

Some economic studies such as that by Barret (1985 and 1987) also strongly attack European fares and call for competition between airlines, travel agents and airports. It is reported that European fares in each category in June 1986 were on average three times those charged on comparable flights in the United states mainly due to lack of competition among airlines in Europe which has led to European airline inefficiency. In the study by Sawers (1987), the European airline's fares, costs and profits were compared with the equivalent airlines in the US. It was demonstrated that European air carrier's costs are higher as are their fares and profit, but the difference between fares was higher than that between costs. It was therefore concluded that the European airlines appeared to be less efficient than the equivalent air carriers in the US, yet able to charge high enough fares to earn larger profits. It is this type of economic analysis that have created pressure for the movement towards a liberalised regime in European air transportation.

Another factor which has contributed to the pressure for the liberalisation is the impact of US airline deregulation. Although none of the European states support US-style deregulation in Europe, the advocates of liberalisation have pointed to the air carriers increased air carriers efficiency, cost reduction, pricing innovations, increase in number of airlines, expansion of feeder services and increase in consumer choice, as benefits of US deregulation.

Although the move towards the relaxation of regulation is gradual, it is working its way through, as many carriers have already changed their strategies to become more efficient and are getting ready for the changes. These are illustrated in their following activities in recent years:

- Development of Computer Reservation Systems (CRS). Two major CRSs are being developed, Galileo by BA, KLM, Swissair, Airlingus, TAP Air and Alitalia. This system is linked with Covia's Apollo CRS (United Airline's US-based system) and is reported to be going live on September 1, 1989 (Flight International 27 May 1989). The other system is Amadeus which is being developed by Air France, Lufthansa, Iberia and SAS.

- Cost cutting by reducing numbers of staff and route restructuring. For example British Airways reduced its number of staff by one third between 1980 and 1983.

- Airline mergers and takeovers are emerging as a key part in the survival strategies of many carriers in a less regulated environment. The buy-out of British Caledonian by British Airways, the KLM takeover of the short haul "commuter" airline Netherline and its purchase of 40% holding in the charter/short haul scheduled carrier Transavia, illustrate that European airlines, after observing the US airline experience since deregulation, would like to adopt a strategy of absorption of smaller airlines, as seems to have helped the giant airlines in the US to survive (Gauldie, 1988).

- Movement of charters to scheduled airline markets. The recent route awards to Air Europe shows the emergence of charters into scheduled services. The charters have also been able to sell "seat only" tickets and compete directly with the major airlines.

- Increasing use of discount fares and the increasing ability of charter carriers to compete directly with the major carriers has already put some pressure on the average fare levels. The £85 fare offered by Air Europe on the London-Paris which included a £25 in-flight cash rebate could be the sign of a greater increase in use of discount fares. Around 70% of passengers have already travelled on discount fares (Gialloreto, 1988).

3.5 DIFFERENCES BETWEEN EUROPEAN AND US MARKETS

A comparison of US and European Community air transport also helps to point out the differences that exist between the two markets. These differences are as follows:

- Market type: The routes between European states are obviously international unlike in the US which are domestic. The American market is subject to a single regulatory body whereas in Europe there are 22 sovereign countries who are the member of ECAC (European Civil Aviation Conference) and 12 countries are member of EEC, each affected by narrow national interests. Therefore their collective agreements are required for implementing any changes. These states have different political, social and economic objectives, and their airlines have different abilities to compete. Such differences have obviously slowed down the movements towards any liberalisation and have created an environment where all the aspects of airline operations are controlled by bilaterals, allowing in most cases one carrier from each partner country to operate on the inter-state routes. The US market is a single market whereas Europe is to become a single market by 1992 when most the internal barriers between the EEC member states are probably to be removed. This has some implications for the aviation industry such as the removal of intracommunity duty-free sales, which is likely to lead to a substantial reduction in airport revenues (Orrell, 1988). This in turn may put pressure on airports to increase charges to airlines in an attempt to recoup earnings. This, coupled with the decrease in inflight sales affecting the airlines own revenue, may lead to fare increases. The single market also demands the harmonisation of indirect taxation policies. Therefore there is the possibility of imposing something like an average of current EEC VAT rates on fares, which would result in a further increase in the cost of air travel.

- Market size: The US market is a larger market. The volume of traffic carried by the US airlines is 8 times higher than that carried by the airlines of European countries which are members of ECAC. In Europe, the average route length is 750 kilometres whereas in the US it is 1300 kilometres. Among the top 75 routes in Europe, which account for the great bulk of all traffic, there are only 17 where the flight time is two hours or more (Pryke, 1989). Due to the shorter flight time in Europe, passengers are likely to be more sensitive to the time wasted as a result of airline delays or making a stop en-route. This is because any time wasted would represent a larger proportion of the total flight time for short flights compared with the longer flights. European routes have lower traffic density compared with US routes of the same length. These two factors, route length and density, determine the aircraft size and as a result the unit costs. The longer and denser the route the lower is the unit cost.

- Market structure: Although the type of airlines operating in US and European markets are the same, their relative strengths are quite different. The charter carriers in the US were carrying a small proportion of passengers; however in Europe, as stated before, charters carry around 60% of intra-European passenger kilometres. Many of these charter carriers have newer aircraft, good distribution networks and name recognition. In Europe the new entrants to the scheduled markets would be these charter carriers which already have experience of running the airlines. Also Inclusive Tour Charters which are a large proportion of the charter market do not fall under bilateral agreements and are subject to unilateral approval. Charter carriers in

Europe have stronger positions compared with those in the US. The ability of charters to offer lower fares, has put some pressure on scheduled carriers operating in the same markets to offer discount fares. The discount fares offered by scheduled carriers usually have restricted conditions. The degree of discount and their restrictions varies, depending on the type of market and seasons. It is reported that in 1981, 70% of all passengers and 81% of passenger kilometres were flown on reduced fares (Gialloreto, 1988). Therefore it appears that there is not going to be a large increase in passenger demand in Europe due lower fares, because the majority of passengers are already travelling on discount fares.

- Modal competition: In Europe the majority of routes are shorter than those in the US, therefore airlines face far more competition from railways in Europe than they do in the US. In Europe train fares are cheaper than air and there is a dense rail network which makes connections easier. Therefore rail transport (in particular the high speed trains) competition with air transport is much stronger in Europe. The opening of the Channel Tunnel in 1993 will introduce directly competing high-speed railway services between London and other European cities, affecting airline markets such as London-Paris and London-Brussels. In Europe there is the possibility that interline passengers may be attracted to the cheaper road and rail links for the final stage of their journeys. In such a case airlines will have to retain competitive frequencies which leads to the operation of smaller aircraft with higher seat costs. This is counter to the need for larger aircraft to avoid hub congestion. The alternative is to establish more direct inter-regional services, avoiding the hubs (Flight International 20 May 1989).

- Production costs: Costs on international services within Europe are about 65% more than those on comparable services in the US (Sawers, 1987). This appears to be partly due to the higher cost of factors of production such as fuel and labour costs and European airline route structure, and partly caused by inefficiency in the use of resources. As said before, the average stage length is shorter in Europe with one third more landings. Since costs associated with aircraft landings and take-off are the most expensive part of a flight, the airline unit cost of operation is higher in Europe. Also the aircraft are typically smaller in Europe due to operation on shorter routes than those in the US. This in turn leads to higher costs per seat kilometre. European carriers can bring their costs down through acquiring more suitable aircraft, pruning of routes or cutting labour costs, as they have already started to do. But it must be borne in mind that they cannot reduce labour costs in the same way as American airlines. This is because the labour unions in Europe are much stronger than in the US. Thus in Europe the air carriers would probably reduce costs by acquiring more suitable aircraft, route restructuring or changes in management strategies.

- Product differentiation: In the US there were already many scheduled carriers prior to deregulation with small differences between them in terms of service quality. In Europe, on the other hand, various scheduled carriers do display a marked difference in brand quality. They have gone much further in branding themselves and their product than US carriers prior to deregulation. This has led to a situation where certain carriers have achieved a higher share of high yield business traffic than others. In Europe, because carriers are coming from different countries, the nationality of the airlines and their traits as well as level and price of their services affect the passengers' choice. This supports the general characteristics of airline markets that carriers level of service or fares are not the only factors that determine the choice of passengers. There are other factors such as passenger taste, and in flight services, and in Europe nationality of carriers also affects travellers' choice of airline.

- Regulatory environment: It was discussed in the previous chapter that, CAB prior to deregulation did not have any control over the capacity offered by airlines, unlike Europe where the capacity provided by scheduled carriers is determined by negotiating bilateral agreements between countries. This illustrates that European airlines are more protected than those in the US. The fact that the majority of European carriers are state owned makes it hard to believe such protections will be removed totally. This is because if a smaller carrier is driven out of business by a larger carrier of another country , this would have some national implications for the government of the country of the smaller airline. Therefore bankruptcies or acquisitions that lead to a country losing its carrier would probably not take place in Europe.

- Speed of regulatory reform: In Europe the movements are towards a gradual liberalisation unlike in the US where the movements were towards a deregulated market. The slower speed in liberalisation of regulation in Europe has given the opportunity to the air carriers to prepare or adapt their operation to a less restricted competition in terms of acquiring suitable aircraft, lowering unit costs, and so on. In the US carriers' route structure and aircraft were not adapted to the need of customer free choice. European carriers also have had the chance to learn lessons from US airline deregulation and many of the marketing innovations, such as CRS and frequent flier programmes, have already been followed in Europe. Therefore European airlines can better plan their way through in a less restricted operating environment.

3.6 CONCLUSIONS

From this brief study of the European air transport market, certain characteristics, in addition to the general characteristics of airline markets which were pointed out in the first chapter, can be outlined. Following liberalisation of regulation of air transport industry in Europe,

- the airlines would be less vulnerable to the changes compared with the air carriers of the US. Thus there would be fewer ups and downs in carriers operation as they have had enough time to prepare themselves for the changes that occur in a less regulated environment, and they have learnt lessons from the American experience of deregulation.

- the new entrants to scheduled markets would be mainly the charter carriers who have better experience in airline operation and have name recognition. This puts them in a better position to compete with major carriers than the new entrants with large carriers in the US.

- a great increase in passenger demand due to lower fares following the liberalisation of air transport is not expected . This is because a high proportion of passengers (i.e. 60%) has already been travelling on discount fares.

- passengers do not necessarily travel with the cheapest carrier in the market. This, as said before, is one of the general characteristics of airline markets, but in Europe it is more enhanced. This is due to the fact that the carriers nationality is also different as well as other differences that exist between airlines' products.

- labour costs are unlikely to be the major sources of cost reduction due to the strong labour unions in Europe. Therefore carriers would probably reduce expenses by acquiring more suitable aircraft, route restructuring or changes in management strategies.

- there would be more commercial alliances between carriers of different countries than buy-outs or mergers. This is because buy-out of a carrier by another foreign airline may have some national implications for the government of the taken over airline.

- there is a strong competition from surface modes, in particular from rail services, with air transport on shorter routes.

- the home state carriers would probably continue to be supported by their governments. It is very unlikely to see that such supports will be removed following liberalisation of air transport in Europe.

Some of the above characteristics of the European market, in addition to certain general characteristics of airline markets which were discussed in the first chapter, are incorporated in the development of the competition model. The structure of the competition model and its limitations are discussed in the second part of the study. The model monitors the competitive behaviour of air carriers and quantifies the effects of different operating environments on individual carrier's fare and flight frequency and resulting passengers generalised costs of travel, carrier's market share and financial performance. It also identifies air carriers' operation at equilibrium position.

PART II

THE COMPETITION MODEL

INTRODUCTION

In this part of the study the competition model structure and its relation to the previous studies are discussed. The components of the competition model are also studied. In the development of this model many of the airline market characteristics which were explained in the previous parts are incorporated.

As was discussed in Part I, in order to simulate the competitive behaviour of the carriers, there is a need for a competition model. To structure such a model, three sub-models are required. These are as follows:

- a market share model which can determine passenger choice (i.e. which carrier to choose) and therefore can estimate each carrier's market share as a function of its service attributes as well as those of other operators in the market.

- a costing model that can quantify the operating costs associated with serving the amount of patronage that each carrier attracts to its service.

- a reaction model that can simulate the competitive behaviour of the rival carriers and also can determine their possible equilibrium position.

In order to develop these sub-models this part of the study is organised as follows: Chapter Four discusses the general structure of the competition model and its relation to previous works in this field. In Chapter Five the choice theories are reviewed and the most appropriate choice model which corresponds to airline market characteristics is adopted to calculate individual carriers' market share. In Chapter Six the costing model is developed while Chapter Seven explains the reaction model.

CHAPTER FOUR

OVERALL STRUCTURE OF THE COMPETITION MODEL AND ITS RELATION TO THE PREVIOUS STUDIES

4.1 INTRODUCTION

The prime purpose of this chapter is to discuss the overall structure of the competition model, but before doing so, the previous works in this field are briefly reviewed and the ways in which the present study differs from them are considered. Then the assumptions upon which the model is built, and finally the type and source of data which is incorporated in the model, are explained.

4.2 PREVIOUS WORKS

The purpose of reviewing the previous works in relation to the competition model is to illustrate that although there are some studies that have developed models similar to the components of the competition model (i.e. the market share model), none have considered the competition model as a means of exploring the effects of deregulation on individual carriers in routes and markets of different characteristics.

Over the past 25 years an enormous body of theoretical and empirical research has focused on the airline market, in particular on economic regulation and its consequences. Much of this general literature has been considered in Chapter Three when assessing the US experience.

In this section various analytical studies in relation to airline industry performance are considered. They are grouped as pre-deregulation and the post-deregulation economic studies.

4.2.1 Pre-deregulation Economic Studies

Among all the studies of the air transport market, several important ones concerning the regulation of the air industry appeared in the years preceding deregulation in the US (1978). These are studies undertaken by Keeler (1972), Fruhan (1972), Douglas and Miller (1974), Eads (1975), Devany (1975) and Schmalensee (1977). Douglas and Miller were one of the first groups of economists to argue that any analysis of airline performance must consider the total costs of travel to the consumers, both out-of-pocket costs and the implicit costs of travel. This alternative framework (which takes into account total travel cost and not just out-of-pocket cost) requires that service level be explicitly considered in order to measure travel time and delay experienced by travellers. Douglas and Miller assumed that a travellers objective is to minimise costs and inconvenience. These models of the regulated airline market were very useful in demonstrating that regulators faced a combination of possible price/service/ quality options. Douglas and Miller determine the optimal combination by minimising the sum of the fare and the valuation of scheduled delay time.

The most important application of this alternative methodology was the evaluation of the effect of the Civil Aeronautic Board (CAB) regulations, which was considered as a major contribution to the deregulation policy debate.

In general, studies done prior to deregulation in the main modelled the market for air travel in city-pair markets under the assumption that price and entry were exogenous and that the carriers competed in service quality only.

4.2.2 Post-deregulation Economic Studies

After the US air transport deregulation, there are still studies that analyse the air industry, mainly during the regulatory period, and use the results to provide some indication of relative effects of deregulation. Such a study was done by Abraham (1983), in which the multiple regression technique is used to develop an econometric model of air passenger demand. This model is based on the concept of service quality competition. The estimation was done for domestic American city-pairs during the 1973-1977 regulatory period and a series of conclusions on the sensitivity of demand to fare, service quality, income and so on are drawn.

Another example is Spiller's work (1983). In this study a theoretical framework is used mainly to analyse the effect of changes in CAB regulatory pricing policy during the 1959-1978 period on the individual American trunk carriers. By demonstrating how each trunk carrier was affected differently by CAB regulatory pricing policy, he concluded that regulators did not set rules to maximise the joint carriers' profits. Therefore any theory of regulation should look at different firms as having different interests in the regulatory outcome.

After deregulation of the air industry in the US many studies concentrated on the effect of deregulation, by comparing the industry performance in the period before deregulation with the post deregulation period. Besides these types of studies there are many articles on the subject of deregulation to which some references were made in Chapter Two.

Only a few of these studies have modelled the unregulated airline market. The work by Dorman (1983) is an example of such studies where the conventional economic models are considered not to be particularly relevant to the nature of price and service quality competition in the airline industry, and which do not adequately stress the importance of new entry as a competitive force. In this unregulated model the relationship of fare and frequency with firms' profit, passenger welfare and demand is discussed. The firms profit (Π_j) has the following form:

$$\Pi_j = P_j X_j - a X_j - b F_j \qquad (4.1)$$

Where:

P	is price,
F	is service frequency,
X	is number of passengers and
a,b	are the coefficients of passenger cost and flight cost respectively.

Then the passenger utility function (U) is presented as:

$$U = U (x, g ,z) \qquad (4.2)$$

where:

g	is schedule delay
x	is consumption of airline trips
z	is consumption of other things

In Dorman's study it is assumed that each passenger maximises his/her utility subject to the budget constraint. Furthermore the social welfare and passenger demand as a function of airline service is discussed in the same way.

It is not intended to discuss this model in detail but to demonstrate the form of the model and the variables considered. Although Dorman discusses profit, passenger utility and passenger demand as function of a number of variables, he does not actually model any of these functions and therefore effects of variables on carriers profit or on passenger demand cannot be quantified.

The study by Morrison and Winston (1986), quantifies the economic effects of deregulation by comparing the actual welfare for travellers and carriers in 1983 with the welfare levels that would have been achieved had deregulation been in effect in 1983. The passengers welfare is measured through a development of a demand model which took into account the competition between air carriers and rail. This work advances the previous studies as it does not compare the pre-deregulation situation with the post-deregulation. In this case the effects of external factors on key variables such as fare and service frequency are limited. In this study it is concluded that the travellers have benefited $6 billion annually through lower fares and better service. But in fact according to the calculations in this work, the greatest benefits are achieved by business travellers from increased flight frequency. The reason for such large benefits is the high value of time that is attached to business travellers' time which is 1.5 times their wages. Also to arrive at $6 billion, the estimated average welfare change per traveller is multiplied by the estimated number of intercity passenger trips during 1977. However the average welfare changes should have been multiplied by the number of air passengers, otherwise it leads to an overestimation of the benefits.

The present study advances earlier works in several important ways:

a) considers the fact that air carriers, as discussed in the Chapter One, are strategically linked and therefore react to each other's policies. Thus the competition model simulates the competitive behaviour of carriers and identifies their possible market equilibrium.

b) it was discussed in Chapter Two that

deregulation, depending on carriers' characteristics, has affected airlines differently. This study explores the interaction between fare and service frequency in a deregulated environment and quantifies the effects on individual carriers rather than on the industry alone.

c) it compares the effects of partial deregulation (e.g. deregulated fare effects compared with deregulated flight frequency) as well as a complete deregulation. It was discussed in Chapter Two that deregulation impacts have not been spread evenly among different markets and routes. Thus this study, in a deregulated environment, explores the interaction between fare and service frequency in different markets (tourist and business) and routes (length and density) while carriers have different characteristics (different resource cost and unequal access to economies of scale, scope and technology).

d) it quantifies the effects on passengers in terms of the total costs of a trip and on individual airlines in terms of fare, service frequency, resulting aircraft size, carrier's market share and their financial performance.

e) the majority of the previous studies have concentrated mainly on the US airline industry. However this study takes into account the differences between the US airline market and Europe which were discussed in the Chapter Three, and focuses on the European context.

4.3 STRUCTURE OF THE COMPETITION MODEL

To develop the competition model, a series of economic assumptions are made which affect the nature of the competition and are mostly derived from economic theory. On the nature of competition it is assumed that:

a) The major carriers (belonging to the country of origin and destination) compete with one another, and they are also in competition with rail and foreign air carriers that use the fifth traffic right (see Appendix B for the list of traffic rights). These types of carriers are considered as one carrier and in this study are called "foreign airlines". The major carriers on a given route react to each other's policies but in the model it is assumed that there is no reaction from rail operators and the foreign airlines towards the major carriers.

b) The air carriers objective is profit maximisation. Although in practice profit is not the only factor that influences the airlines, it is believed that profit is an important consideration under free competition.

c) Carriers' competition is a noncooperative one, in other words it is supposed that they would not collude.

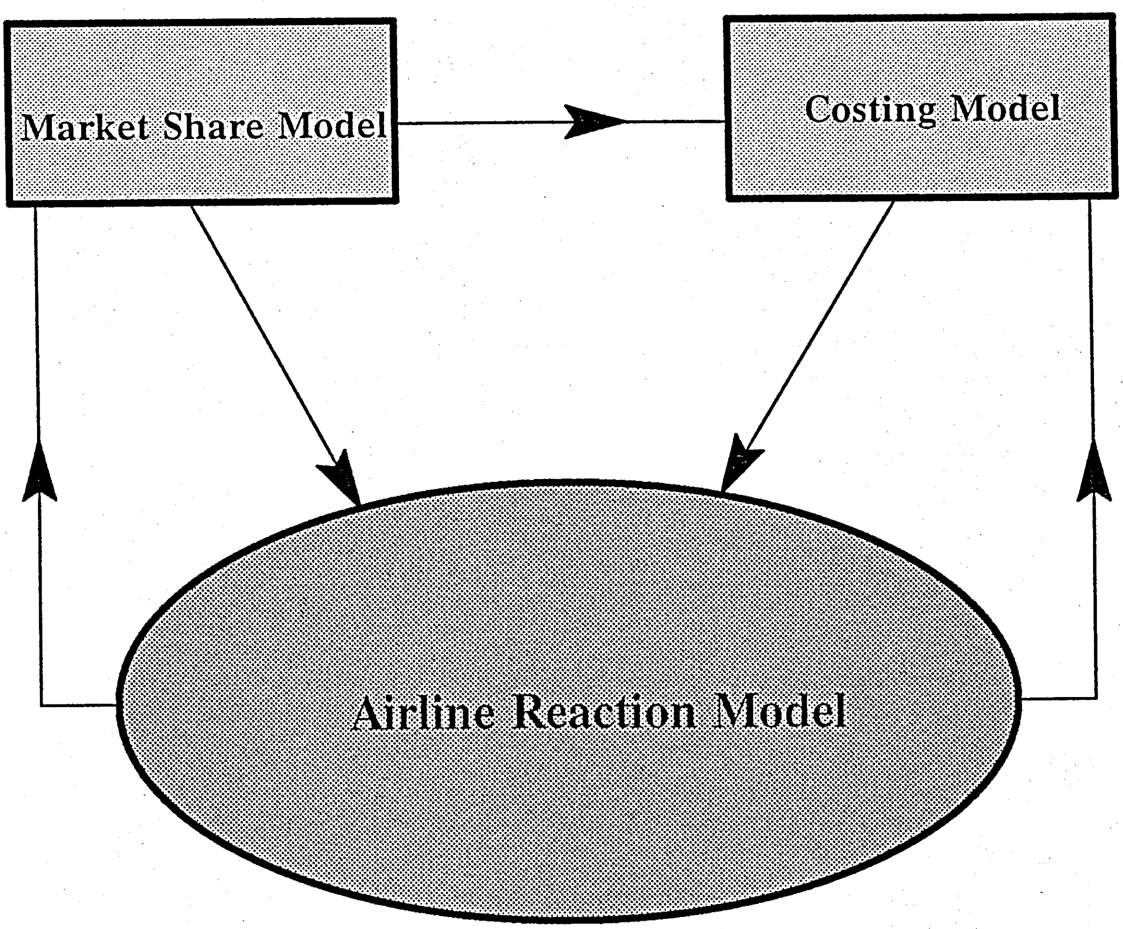
The structure of the competition model is illustrated in Figure 4.1. In order to develop this model there is a need for three sub-models. These are the market share model, the operating cost model and the reaction model.

- The market share model: It was discussed in Chapter One that airline competition is a close approximation to oligopolistic competition. Therefore carriers do react to their rivals' policies. Such reactions can take different forms such as altering fare levels and service frequency or improving in-flight services and so on. Thus in order to quantify the impact of such changes in carriers' service on their market share, there is a need for a market share model. This model should be capable of taking into account the characteristics of the airline markets and can also quantify the effects of changes in carries' service attributes on the traveller's choice.

- The costing model : After determining the individual carrier's market share, the costs associated with serving them for each carrier should be obtained. This would enable airlines to identify the optimum level of service at which they can maximise their operating objective. The costing model calculates the carrier's total variable and fixed costs taking into account the effect of aircraft size on the operating costs.

- The reaction model: Once the individual carrier's market share and the costs of serving that level of demand are defined, a reaction model is required to simulate the rivalrous behaviour of the airlines (e.g. adjusting fare levels or service frequency in response to changes in the rival's service levels) and also to determine the possible equilibrium position of the

Fig. 4.1: Airline Competition Model in an Aggregate Form



competing carriers. The reaction model uses the output of the market share and the cost model to determine each carrier's optimum fare, service frequency and the resulting passenger generalised costs, market share and profit. This model takes into account the carrier's interdependent nature of decision making process.

The objectives of the competition model are:

a) to explore the competitive interactions of carriers under different regulatory environments (i.e. deregulated fare, deregulated service frequency, flight frequency and market access).

b) to analyse the interaction between fare and service frequency under different competitive environments and to determine the effects on the carriers' operation in terms of fare, service frequency, the resulting passengers' generalised costs, carriers' market share and financial performance. As discussed in Chapter Two, deregulation has differential impacts on air carriers. The competition model therefore aims to quantify the effects on individual airlines rather than treating them as one homogeneous industry. The competition model also considers the differences in carriers' characteristics in terms of their resource costs and access to the economies of scale, scope and density which affects the level of passengers' loyalty to the carriers.

c) to explore and quantify the effects of different operating environments (market and route characteristics) on individual carrier's operation. This is because, as illustrated in Chapter Two, the effects of deregulation varied according to the characteristics of markets and routes.

d) to demonstrate the effects of ground competition on air carriers, under various operating conditions. As discussed in Chapter Three, in Europe there is strong competition from ground transportation, in particular from rail, due to the shorter average route length in Europe compared with the US.

e) to determine carrier's possible equilibrium position under different competitive conditions. Chapter One, showed how carriers react to each other's policies in different ways. The competition model takes into account such characteristics of the airline market and simulates rivalry behaviour of carriers until they reach a possible equilibrium.

f) and finally to provide an operational tool for strategic management.

In order to demonstrate the performance of the competition model European air route carrying passengers between two points is considered (i.e. London - Amsterdam). The demand level is defined as a daily flow of passengers in each direction. The fact that air transport comprises a complex network in which individual airline markets are interdependent is not considered in the model's development and it is assumed that the aircraft operating on this route are dedicated to it and not utilised on any other routes. Furthermore it is assumed that the total flow of passengers (air plus rail) is constant and there is no variation in the level of demand across days or weeks. It must be mentioned that although the total flow of passengers is assumed to be constant the air market size is not fixed, since any improvement in air service level or fare cut generates new air trips which are attracted from the rail's and the foreign airlines' market. The sources of the data are discussed in the following section.

4.4 DATA COLLECTION

Data on air carriers and rail operating on the London - Amsterdam route during 1976 to 1981 was collected (see Table 4.1 for the model input data). The major scheduled air carriers which belonged to countries of origin or destination were British Airways (BA), British Caledonian (BCal) and KLM. There were other air carriers that used the fifth air traffic right and carried passengers between these two points. These carriers were considered as one in the model.

Data on air carriers included passenger seats available, load factor and flight frequency for each airline. This data was extracted from International Civil Aviation Organisation (ICAO, Traffic by Stage, 1976-1981). Information on air carriers' fares was collected from ABC travel guide (1976-1981). The coach economy class was used in this study. Data on airlines' indirect operating costs was collected from ICAO, Financial Data (1979-1984). Aircraft costs were obtained from US Quarterly Aircraft Operating Costs and Statistics (December 1984). This data included the size of the aircraft and its related oil, fuel,

Table 4.1: The Model Input Data

Carrier	F	FQ	LD	JT	RC
BA	*	*	0.65	1	100%
BCAL	*	*	0.62	1	87%
KLM	*	*	0.63	1	92%
RAIL	29	3	-	11	-
OA	70	2	-	1	-

Route Length	235 miles
Market Size (No. of Passengers)	2000/ day
Value of Time	£4.75/hour
Max. Aircraft Size	300 seater
Aircraft Round Trip Time	3 hours
Aircraft Total Utilisation Time	12 hours
Aircraft Indirect Costs:	
Variable	$0.031/seat mile
Fixed	$11.61/seat hour

BA = British Airways
BCAL = British Caledonian
OA = Foreign Airlines
F = Fare (£)
FQ = Service Frequency/day
LD = Load Factor
JT = Journey Time (hour)
RC = Resource Costs (%)
* are the policy variables

maintenance, crew, depreciation and insurance costs. The aircraft-related costs were all in dollars which in the computer program were converted to pounds in order to be consistent with the unit of currency of other costs. Data on aircraft prices were obtained from Lloyd's Aviation Economist (December, 1983).

Information on rail fare, frequency of service and journey time were obtained from the Thomas Cook continental timetable (1979-1984). Data on numbers of passengers travelling by rail during 1976 to 1981 were collected directly from British Rail authorities.

CHAPTER FIVE

THE MARKET SHARE SUB-MODEL

5.1 INTRODUCTION

It is the purpose of this chapter to discuss some of the widely used choice models and adopt the most appropriate one for estimating the individual air carrier's and rail's market share.

As discussed in the previous part of the study, the airline market is a close approximation to the oligopolistic market in which there are usually a few carriers who are strategically dependent. If in such markets regulations are relaxed, carriers react freely to each other's decisions in different ways (i.e. altering fare levels, service frequency, improving the in-flight services, etc.). To quantify the effects of such changes on individual carrier's market share, there is a need for a sub-model that takes into account the factors which affect passenger's choice of carriers.

In order to identify the properties that the market share sub-model should have, a reference is made to the passengers' choice-related characteristics which were explained in Part I. There are a number of factors that affect passenger choice of carriers which are as follows:

- differentiated products. As discussed in Section 1.3.3, air carriers try to differentiate their product so that each can operate slightly separately from others and can cater for a set of customers who vary in their loyalty. The development of frequent flyer programmes can be referred to as an example of product differentiation by the larger carriers in the US airline industry (see Section 2.5.8). Another example of product differentiation in the airline market is the niche marketing by smaller carriers who recognise that they cannot compete directly with the major airlines (see Section 2.5.8). The other differences in carrier's services can be due to the variety of service attributes such as the type of airports they operate from , passenger processing facilities, types of drinks or quality of food served during the flights, behaviour of staff and of course a good schedule of flights and connections. The differences between carriers service attributes or marketing strategies, which stem from the level of access to economies of scale, scope and density (see Section 1.3.2), affect passengers in different ways. Thus each carrier attracts loyalty of a group of travellers.

- level of information. In the airline markets perfect information may not be available to all the customers. In other words passengers are not always fully aware of all the available choices in the market. As discussed in Section 2.5.8, manipulating CRS screen displays leads to incremental booking for one carrier at the expense of another. Such actions provided opportunity for some of the CRS owners to have more flights booked than the others, even if their services were not the best choice in the market. The length of time involved in the studying all the different types of services and the conditions attached to them also deters passengers from doing a complete search for the best option in the market. Sometimes travellers may not even bother to do a complete search for the best option, and travel with the carrier which has name recognition due to its large scale and scope of operation (see Section 1.3.2).

- nationality of the carriers. In international markets such as in Europe, travellers often associate the national trait of a country with their home carrier. For example Lufthansa may be considered mechanically excellent and punctual because they are German. Thus, if punctuality is very important to the travellers, there is a higher possibility for Lufthansa to be chosen even if there are other carriers in the market with the same level of punctuality (see Section 3.5)

- personal characteristics of passengers. The travellers personal circumstances such as income, sex, age, taste can also influence their choice.

As can be seen there are many factors that can affect the passengers decision when faced with different options. It should be noted that not all the factors that affect travellers' decisions are known, and of those which are known only some are measurable. Therefore in order to quantify the effects of such factors on passengers' decisions as to with which carriers to travel, there is a need for a market share model which can take into account the following characteristics:

- Each carrier's service, in some ways, is different from the rival's in the market. This makes customers choice processes more complicated compared with a situation where they all provide similar services.

- There are many factors that influence passengers choice in terms of which mode or air carrier to choose. Some of which are known (e.g. income, level of information, fare, service frequency, comfort and etc.) and some are unknown.

- Of those known variables that affect the traveller's decision, only some of them are measurable, and some such as passengers' taste or carrier's comfort are immeasurable.

In the following sections the choice theories and some of the choice models and their properties are discussed. This is to identify the model which is most appropriate for determining passengers' choice for each of the airlines and rail.

5.2 THE CHOICE THEORIES

Choice is a fundamental component of the trip-making process. Individuals are often faced with a choice among a number of alternative arrangements of trip attributes such as destination, mode and route. The outcome of such decisions is dependent on the attributes of the alternatives (e.g. costs, time, comfort and etc.) and personal characteristics of the passengers (e.g. income, taste, car ownership and etc.). In order to be able to predict the travellers choice, there is a need for a model which is based on a choice theory that is ideally:

- descriptive, in the sense that it postulates how human beings behave and does not prescribe how they should behave.

- abstract, in that it can be formalised in terms which are not specific to particular circumstances.

- operational, in that it results in models with parameters and variables that can be measured or estimated (Ben-Akiva and Lerman, 1985).

But there is not a single choice theory that meets all these requirements, since each has some limitations of some kind.

Before discussing different types of choice theories, it is important to define the choice process. As Ben-Akiva and Lerman (1985) define, choice is an outcome of a sequential decision-making process that includes the following steps:

- definition of the choice problem,
- generation of alternatives,
- evaluation of attributes of alternatives,
- choice,
- implementation.

Therefore a specific theory of choice is a collection of procedures that defines the following elements:

- decision, which can be the outcome of a decision making process of an individual or a group of persons.

- a set of alternatives, from which any choice is made.

- attributes of alternatives, the attractiveness of an alternative are evaluated in terms of a vector of attribute values.

- decision rules, which are the internal mechanisms used by the decision maker to process the information available and arrive at a unique choice. A common class of decision rules used by decision makers is utility. Utility can be defined as a single objective function expressing the attraction of an alternative in terms of its attributes. It is a measure that the decision maker tries to maximise through his or her choice. In this study the attractiveness of the alternatives are measured by the level of utility that they yield. There are other types of decision rules such as dominance, satisfaction and lexicographic rules which are discussed by Ben-Akiva and Lerman (1985).

In the following sections different types of choice theories (deterministic and probabilistic) are discussed.

5.2.1 Deterministic Choice Theory

According to this theory, the choice process is deterministic and reproducible, implying that if a traveller is repeatedly faced with the same sets of alternatives, the choice made will consistently be the same. It also assumes that consumers are aware of all the available alternatives and their attributes, they use decision rules which are consistent and stable, and they choose the alternative with the highest utility. This theory is often referred to as an "all or nothing " rule. This is because it assigns all the customers to the best alternative. Deterministic choice theory can be applied to a situation where all the attributes of the alternatives (e.g. different operators' services) are identical except for one (e.g. fare) and all the travellers are aware of the level of fares offered by different carriers. In such a circumstance, it is reasonable to assume that travellers will choose the alternative with the lowest fare.

The deterministic model clearly is not an appropriate model to be used to determine the traveller's choice. This is because, as mentioned in the previous section, the attributes of services offered by alternative carriers are different in many ways, and it is not possible to include in the choice function all the variables that can possibly influence their choice. Also travellers may not always be aware of all the available options. There can also be some fluctuation in the manner by which the attributes of carriers are perceived by the travellers or there might not be rational and consistent decision rules at all. Therefore it cannot be assumed that the travellers always choose the best alternative. As Kanafani (1983) points out experience with travel behaviour analysis suggests that a deterministic model of choice may be limited in its replication of real life situations. Therefore a good model of choice might be one in which the choice function is considered a random function that takes on different values with certain probabilities.

5.2.2 The Probabilistic Choice Theory

Probabilistic choice theory is based on the assumption that the choice process is subject to random influences. This theory uses the probabilistic mechanism to capture the effects of unobserved variations among decision makers and unobserved attributes of alternatives. It also takes into account pure random behaviour as well as errors due to incorrect perceptions of attributes and choices of sub-optimal alternatives (Ben-Akiva and Lerman, 1985). In this theory, a decision maker is modelled as selecting the alternative with the highest utility among those variables at the time the choice is made. Because some of attributes of the alternatives are unobserved or cannot be measured easily, the utility is treated as random. Therefore the choice probability of alternative i is equal to the probability that the utility of alternative i, U is greater or equal to the utility of all the alternatives in the choice set C. This can be expressed as follows:

$$P_i = Pr[U_i \geqslant U_j, \text{ all } j \in C] \qquad (5.1)$$

The utility of variable i, U_i, is a function of two components:

(1) the systematic or representative components (v_i), which are the measurable and observable characteristics of the travellers and the alternatives.

(2) the random components or the disturbances (e_i), which include the effect of the unobserved and immeasurable characteristics of the travellers and the alternatives.

This can be written as follows:

$$U_i = V_i + e_i \qquad (5.2)$$

Thus the probability that alternative i is chosen can be expressed as follows:

$$\begin{aligned} P_i &= Pr[U_i \geqslant U_j, \text{ all } j \in C] \\ &= Pr[(V_i + e_i) \geqslant (V_j + e_j), \text{ all } j \in C] \\ &= Pr[(V_i - V_j) + e_i \geqslant e_j, \text{ all } j \in C] \qquad (5.3) \end{aligned}$$

Different assumptions about the distribution of the disturbances result in different probability choice models.

It can be seen that probability choice theory is more applicable to the passenger choice process. This is because, as said in the previous section, carriers offer services which are different in many aspects and affect passengers to different degrees. Of those factors that affect travellers' choice only some are known or are measurable. There is also no certainty that passengers receive complete information about alternative services, or whether they do follow rational decision rules in order to choose a carrier. These imply there is not going to be an "all or nothing" rule, according to which all the passengers would travel by the carrier which yields the maximum utility, but that traveller's choice is affected by random variables and therefore is probabilistic.

In the next section, based on random utility maximisation, two of the most common forms of discrete choice models (which are also known as random utility models) are briefly reviewed and their properties are discussed.

5.2.2.1 The Probability Choice Models

Although there is a wide range of possible choice models the probit and logit models have dominated other possible models in actual applications (see Ben-Akiva and Lerman, 1985, for description of other choice models). In this section these two most common forms of probability models are presented and their properties are discussed.

- The probit model: This model is based on the assumption that the random error term or the disturbances of each utility is independently and normally distributed. The joint density function of these disturbances is the multivariate normal (MVN) function, with mean zero and covariance ..

  The MVN distribution is the multinumial extension of the normal density function. It describes the distribution of a random vector $e=(e_1,e_2,..,e_j)$. This distribution is characterised by a (j-length) vector of means, μ, and a (j*j) covariance matrix, Σ. The notion of $e \sim$ MVN (μ, Σ) indicates that vector e is MVN distributed with mean vector μ and covariance matrix Σ. The covariance matrix includes the variance of components of the random vector, and the covariance between them. For a detailed properties of MVN see Sheffi (1985).

  As said in the previous section, based on utility maximisation theory the choice probability for alternative i is equal to the probability that its utility is the greatest in the choice set. This is expressed as follows:

$$P_i = Pr[U_i \geq U_j, \text{ all } j \in C]$$
$$= Pr[(V_i + e_i) \geq (V_j + e_j), \text{ all } j \in C]$$
$$= Pr[(V_i - V_j) \geq (e_j - e_i), \text{ all } j \in C] \quad (5.4)$$

With the probit model the choice probability cannot be express analytically since the cumulative normal distribution function cannot be evaluated in closed form. Considering a case where there are two alternatives in the choice set, the so called binary case, based on the underlying assumption of the probit model, the random error term e_i and e_j are both normally distributed with zero mean and variance σ_i^2 and σ_j^2 respectively and covariance σ_{ij}. Under these assumptions the difference in error terms $(e_i - e_j)$ also is normally distributed with mean zero and covariance $\sigma^2 = \sigma^2_i + \sigma^2_j - 2\sigma_{ij}$. Using the standard normal transformation, Equation 5.4 implies that

$$P_i = \frac{\phi[(V_j - V_i)]}{\sigma} \quad (5.5)$$

where $\phi(.)$ is the standard cumulative normal curve and V_i and V_j are the systematic components of the utility function of the two variables. The calculation of the probit choice probability where there are more than two variables is not easy. There are two types of approximation to the probit model analytical approximation and Monte Carlo simulation (see Sheffi, 1985, for description of these approaches). A complete analysis of the multinominal probit model can be found in the work by Daganzo (1979).

Although the probit model is based on reasonable assumptions about the distribution of the disturbances, it has the property of not having a closed form which causes some computational difficulties, in particular for large scale problems. Although in the works by Dutt (1976), Hausman and Wise (1976), Daganzo, Bouthelier, and Sheffi (1977) and Albright, Lerman and Manski (1977) some of the computational problems are resolved, the probit model has only been applied to a few and very limited cases in the travel demand literature (Ben-Akiva and Lerman, 1985).

- <u>The logit model</u>: The logit model is based on the assumption that the differences in random components of the utilities are logistically distributed. This assumption is equivalent to assuming that all the disturbances are independently distributed, identically distributed and Gumbel distributed. The assumption that disturbances are Gumbel distributed is for reasons of analytic convenience, as it is an approximation to the normal distribution. The basic properties of Gumbel distribution are discussed by Ben-Akiva and Lerman (1985). Based on the assumption that the differences in random error terms are logistically distributed, the choice probability for alternative i is given by

$$P_i = Pr[U_i \geq U_j, \text{ all } j \in C]$$

$$= \frac{1}{1 + \sum_{j=1}^{n} e^{-\beta(Vi - Vj)}} \quad (5.6)$$

Multiplying the right side of Equation 5.6 (top and the bottom) by $e^{-\beta V_i}$, the choice probability for the alternative i would be as follows:

$$P_i = \frac{e^{-\beta V_i}}{\sum_{j=1}^{n} e^{-\beta V_j}} \quad \text{for all } j \in C \quad (5.7)$$

$$0 < P_i < 1$$

$$\sum P_i = 1$$

where U is the mean utility of the alternatives, β is the scale parameter that defines the variance of disturbances and C is a set of alternatives. The assumption that the disturbances are independent and identically distributed (IID) implies that all the disturbances have the same value of β. Thus the variance of random components of utilities are equal.

The extreme values of β (i.e. $\beta \to 0$ and $\beta \to \infty$) causes two limiting cases for the logit model. As $\beta \to 0$, the variance of disturbances approaches infinity. The choice model then provides no information. Thus the choice probability is purely random. By contrast, as $\beta \to \infty$, the variance of the utility disturbances approaches zero and a deterministic choice model is obtained. This is because all the information about decision makers' preferences is included in the systematic utilities.

One of the widely discussed properties of the logit model is the independence from irrelevant alternatives (IIA) which implies that the ratio of the choice probability of any two alternatives is entirely unaffected by the systematic utilities of any other alternatives. This is because

$$\frac{P_i}{P_k} = \frac{e^{-\beta V_i} / e^{-\beta V_j}}{e^{-\beta V_k} / e^{-\beta V_j}} = \frac{e^{-\beta V_i}}{e^{-\beta V_k}} = e^{-\beta (V_i - V_k)} \qquad (5.8)$$

When the characteristics of the alternatives are similar, the IIA property can give rise to unrealistic predictions. This is because one of the assumptions upon which the logit model is based, is that the disturbances are independent. However, if in the choice set the attributes of at least two alternatives are similar or identical, there would be correlation between the disturbances which is contrary to the independence assumption.

Another property of the logit model is its elasticity which estimates the elasticity of the probability of choosing alternative i with respect to a change in some attribute that is an independent variable in the model. This can be presented as follows:

$$E_i = \frac{\partial P_i / P_i}{\partial U_i / U_i} \qquad (5.9)$$

where E_i is the point elasticity.

It must be noted that the choice elasticity according to the logit model is not constant but is inversely proportional to P_i.

The logit model, despite its limitations, is the most widely used discrete choice model because it is easy to use in the multinomial case as well as binary case. This is considered as the main advantage of the logit compared with other, more sophisticated, discrete choice models (Sheffi, 1985).

5.3 THE MARKET SHARE MODEL

As discussed in Sections 5.2.1 and 5.2.2, the passenger's choice is not deterministic but is probabilistic. From the two probabilistic models discussed in Section 5.2.2.1, the logit is considered to be the most appropriate one for estimating the choice probability for each airline and rail. This is because the choice set under study is comprised of rail and air carriers offering different services (a multi-output situation), and the logit model is easy to use and is more suitable for such multinomial cases.

In terms of applying the logit model to the choice set under consideration, it must be mentioned that air carriers may have some similar characteristics which would make the IIA to some extent inapplicable. But because airlines offer different services (e.g. different fare levels or service frequency) they produce different images in passengers' minds through a variety of means (discussed in Part I and reviewed briefly in Section 5.1). Thus, it can be assumed that the sources of errors contributing to the disturbances are independent. This implies that the reasons why an individual or a group of travellers do not travel by an airline due to some unobserved or immeasurable attributes of its service, are not necessarily the same for other airlines. For example, if all the air carriers provide identical services in every respect, and supposing that passengers follow rational decision rules, then if they decide not to choose one airline, it is reasonable to assume that they do not travel by any other airline. In such a case (identical services) it can be said that the disturbances of the utility of airlines are perfectly correlated and IIA is totally inapplicable. However this is not the case in airline markets as they offer services that are different in many ways. Therefore it is not unrealistic to consider each air carrier as a distinct alternative.

In terms of measuring each carrier's utility, it is assumed that passengers do not pay any attention to specific physical entities such as types of aircraft or train and instead recognise only a bundle of services which each carrier provides. Baumol and Quandt (1966) call this bundle of services, in the context of transport modal choice, an "abstract mode". This concept makes the choice model widely applicable, even for some future mode whose physical entity cannot be known, as long as its attributes such as time or cost can be predicted.

In this study the utility function is presented as passenger generalised cost of travel, (passenger generalised cost of travel and its components are defined in the next section). Supposing there are n carriers (i = 1, 2,. ....,n), operating in a particular market, using the multinomial logit specification, the choice probability for carrier i or carrier i market share can be given as follows:

$$MKS_i = P_i = \frac{e^{-\beta GC_i}}{\sum_{j=1}^{n} e^{-\beta GC_j}} \qquad (5.10)$$

where:

MKS_i	is the market share of carrier (i)
P_i	is the choice probability for carrier (i)
GC	is passenger generalised costs of travel.

5.3.1 Components of Passenger Generalised Costs of Travel

The generalised costs of travel are defined as the sum of two basic costs, which are fare and the cost of time spent in utilising the airline services. The passenger time is affected by the airlines quality of service and on-board journey time. The quality of airline services is restricted to one dimension of service quality, which is frequency of service and in the model is represented by the concept of passenger defer time. Defer time is defined as the difference between the passenger desired departure time and the closest actual departure time. It is assumed each traveller has a desired departure time but because of the inflexibility of service frequency the passenger is constrained to choose the closest departure time to the desired one. It also is assumed that the travellers have no preference for forward and backward rescheduling. Supposing that passengers desired departures times are uniformly distributed over time and the carriers departures recur at regular intervals over a set period of time, the shortest defer (Minimum DF) time would be:

Min. DF = 0

Based on the assumption that passengers have no preference for forward and backward rescheduling and choose the closest departure time to their desired one, the longest defer time (Maximum DF) would be:

$$\text{Max. DF} = 1/2 * Dp/FQ$$

Therefore the average defer time can be calculated as follows:

$$DF = DP / 4\ FQ \qquad (5.11)$$

$$\Delta DF / \Delta FQ < 0$$

where:

DF	is average defer time (hour),
DP	is the airline duration of operations per day (hour)
FQ	is flight frequency per day,

As can be seen from Equation 5.11 the higher the service frequency the shorter the departure time. Defer time is part of the passenger total trip time. The rest of trip time is access time and on-board journey time. Therefore total trip time can be given as follows:

$$TT = DF + ACC + JT \qquad (5.12)$$

$$\Delta TT / \Delta DF > 0$$

$$\Delta TT / \Delta ACC > 0$$

$$\Delta TT / \Delta JT > 0$$

where:

TT	is total trip time (hour),
ACC	is access time (hour) and
JT	is journey time (hour).

To convert the total trip time to a monetary term, it is multiplied by the value of travel time. As defined by Oort (1969), the value of travel time reflects the utility or disutility that a traveller attaches to time spent on different parts of a trip. Hence, a high value of time could indicate that travellers attach a significant amount of disutility to time spent for a particular journey; or that given their activity at the destination, they attach a high opportunity cost to travel time. Although passengers may have different values of time for each part of their trip (i.e. defer time and journey time), in this study a fixed value of time is assumed for all the components of the total trip time.

Thus, the passenger's generalised costs of travel can be presented as follows:

$$GC = F + TT * VT \qquad (5.13)$$

$$\Delta GC / \Delta F > 0$$

$$\Delta GC / \Delta TT > 0$$

$$\Delta GC / \Delta VT > 0$$

where:

GC	is passengers' generalised costs (£)
VT	is passengers' value of travel time (£)
F	is fare (£)

As can be seen from Equations 5.12 and 5.13, as fare or components of total trip time increase, the generalised costs (GC) increase too. The extent of the effect of travel time on the generalised costs of travel depends on the passengers value of the time. If passengers have a very high value of time (e.g. business travellers) any increase in total trip time has a greater impact on the generalised costs and vice versa.

It is assumed that passengers choose the carrier which offers the minimum generalised costs, but due to unobserved characteristics of travellers or carriers, it will be seen in the outcome of the model that the carrier service which yields the minimum passengers' generalised cost does not attract all the travellers.

In order to estimate the market share of any carrier over a particular route, the market share parameter, must be estimated.

5.3.2 Estimation of the Market Share Model Parameter

Although there are different methods for estimating the choice model's parameter, the maximum likelihood and least squares estimations are the only procedures that have been used in almost all actual applications of choice models (Ben-Akiva and Lerman,1985).

In this study the least-squares method for estimating the parameter (β) of the market share model is considered to be more convenient due to the quality of data used.

Considering the market share model (Equation 5.10), the least squares method estimates the parameter β that solves:

$$\min_{\beta} Q = \sum_{i=1}^{n} (y_i - P_i)^2 \qquad (5.14)$$

where:

y_i is the observed choice
P_i is the estimated choice

The necessary conditions for a solution to the above equation are as follows:

$$\frac{\delta Q}{\delta \beta} = -2 \sum_{i=1}^{n} (y_i - P_i) \frac{\delta P_i}{\delta \beta} = 0 \qquad (5.15)$$

or

$$\sum_{i=1}^{n} (y_i - P_i) \frac{\delta P_i}{\delta \beta} = 0 \qquad (5.16)$$

Although this approach yields consistent estimates, it can be computationally difficult and has therefore not been used in practice (Ben-Akiva and Lerman, 1985).

Berkson (1953) has developed an alternative least-squares procedure that has some advantages over The other methods in certain instances such as when the available sample is very large or the data is available in an aggregated form. This procedure is based on the observation that linear-in-parameters choice models can be easily transformed to put them in a form amendable to standard regression analysis. Berkson's procedure divides the sample into homogeneous subgroups and uses the share of each group choosing each alternative as estimates of the choice probabilities. These shares, appropriately transformed, become the dependent variables in the regression. When Berkson's method, extended by Theil (1969), is applied to estimate the parameters of the multinomial logit model (Equation 5.7) the following relationship is obtained:

$$\ln(P_i/P_j) = U_i - U_j = \beta(V_i - V_j) \quad \text{for all } j \qquad (5.17)$$

To prove this see Equation 5.8. Thus, once the observed share of a group choosing alternative i and j (j = 1,..J) as estimates of P_i and P_j, respectively, and the value of $(V_i - V_j)$ are obtained the regression can be used to estimate the value of β .

In this study the data for estimating the parameter of the market share model include a sample of observations (where each observation corresponds to a group of travellers making a choice) on the London-Amsterdam route for six years (1976-1981). Each observation consists of the values of the explanatory variables: rail and individual airline's fare; service frequency; and on board journey time. These are then formulated to passengers generalised costs of travel, as shown in Equation 5.13 and the observed choice which is rail and each air carrier's market share (the dependent variable in this case). The carrier's market share then is used as an estimate of choice probability for each alternative operator. The air carriers in the choice set are British Airways, British Caledonian, KLM and the foreign airlines. In order to enable the estimation of each carrier market share as a function of the available service attributes the market share parameter (β) is estimated from the following equation: (see Equation 5.17)

$$\ln\ (P_i/P_j) = \beta\ (GC_i - GC_j) \qquad (5.18)$$

Tables 5.1(a) and 5.1(b) illustrate the values of $\ln(P_i/P_j)$ and (GC_i-GC_j) respectively. By regressing (GC_i-GC_j) on $\ln(P_i/P_j)$, the following least-squares relationship is obtained:

$$\ln\ (P_i/P_j) = k - 0.097\ (GC_i - GC_j) \qquad (5.19)$$

T ratio = 8.188 (99% Sig.)
RSq = 0.536

Table 5.1(a): The Carriers' Market Share Ratio
(London-Amsterdam, 1976-1981)

ln P_i/P_j	1976	1977	1978	1979	1980	1981
BA/BCAL	1.38	1.24	1.31	1.22	1.15	0.78
BA/KLM	-1.38	-0.23	-2.19	-0.16	-0.14	-0.23
BA/OA	0.71	0.74	1.34	1.80	2.51	1.52
BA/RAIL	1.84	1.84	1.77	1.91	1.96	1.61
BCAL/KLM	-0.92	-1.47	-1.52	-1.52	-1.29	-1.04
BCAL/OA	-0.69	-0.48	0.16	0.58	1.38	0.74
BCAL/RAIL	0.46	0.60	0.46	0.71	0.81	0.83
KLM/OA	0.92	0.97	1.54	1.96	2.53	1.77
KLM/RAIL	1.84	2.07	2.05	2.10	2.07	1.87
OA/RAIL	0.92	1.11	0.44	1.38	-0.55	0.92

P_i/P_j = Carriers market share ratio
BA = British Airways
BCAL = British Caledonian
OA = Foreign Airlines

Table 5.1(b): The Carriers' Generalised Costs Differences (London-Amsterdam, 1976-1981)

GC_i-GC_j	1976	1977	1978	1979	1980	1981
BA-BCAL	-4.80	-5.34	-5.34	-2.71	-5.09	-4.27
BA-KLM	0.34	0.79	0.20	0.00	0.00	0.47
BA-OA	-2.40	-2.38	-2.97	-5.00	-12.20	-4.27
BA-RAIL	-19.30	-17.16	-15.77	-15.80	-12.99	-15.27
BCAL-KLM	5.00	5.54	5.54	2.70	5.09	4.75
BCAL-OA	2.40	2.40	2.40	-2.37	-7.13	0.00
BCAL-RAIL	-14.50	-12.42	-10.40	-13.17	-7.90	-11.00
KLM-OA	-2.70	-3.17	-3.17	-5.09	-12.21	-4.75
KLM-RAIL	-19.6	-17.97	-15.97	-15.89	-12.99	-15.75
OA-RAIL	-16.90	-14.80	-12.80	-10.80	-0.77	-11.00

GC = Generalised costs (£)

As can be seen the estimated parameter has the expected sign and exhibit a reasonable amount of statistical significance. See Figure 5.1 for the fit of least square line. Since the value of k (the constant) is insignificant it can be dropped from the above equation without affecting the least-squares relationship.

The value of β is an indicator to show the characteristic of travellers in terms of the sensitivity of their choice probability with respect to the differences in the perceived utility of the carriers. The higher the value of β the lower the effects of the random components which include the unobserved and immeasurable characteristics of the passengers and the carriers. This results in the higher sensitivity of passengers towards the differences in the generalised cost offered by carriers. Figure 5.2 illustrates the effect of variation in β on the travellers choice probability results. (This point is discussed in the next section).

The study of the empirical data via regression suggested that an incorporation of a modal constant into the passenger generalised costs equation (Equation 5.13) provides a better least-squares relationship. The most significant modal constant appeared to be for British Caledonian which is equal to £7. This probably is due to the effects of operation from a secondary airport (i.e. Gatwick) and possible lower awareness and loyalty associated with a smaller airline which stems from lack of access to economies scale (operation of frequent services on a large network), scope (serving different cities and customers sub-markets) and density (operation on heavily travelled routes) that larger carriers enjoy. The advantages (e.g. name recognition) of such operations are discussed in Section 1.3.2. The incorporation of the modal constant into the BCal generalised costs results in a situation where even if BCal provides the same level of service (i.e. fare and flight frequency) as of the larger carriers, its generalised costs will be higher than its rival. This illustrates the effects of the generalised costs handicap on the operation of the smaller airline under different conditions which are discussed in part III.

5.3.3 <u>The Market Share Model Performance</u>

To illustrate the characteristics of the market share or the logit model, the effect of variation in one of the carriers fare and service frequency on its pas-

Fig. 5.1: Carriers' Market Share Relationship to Generalised Costs

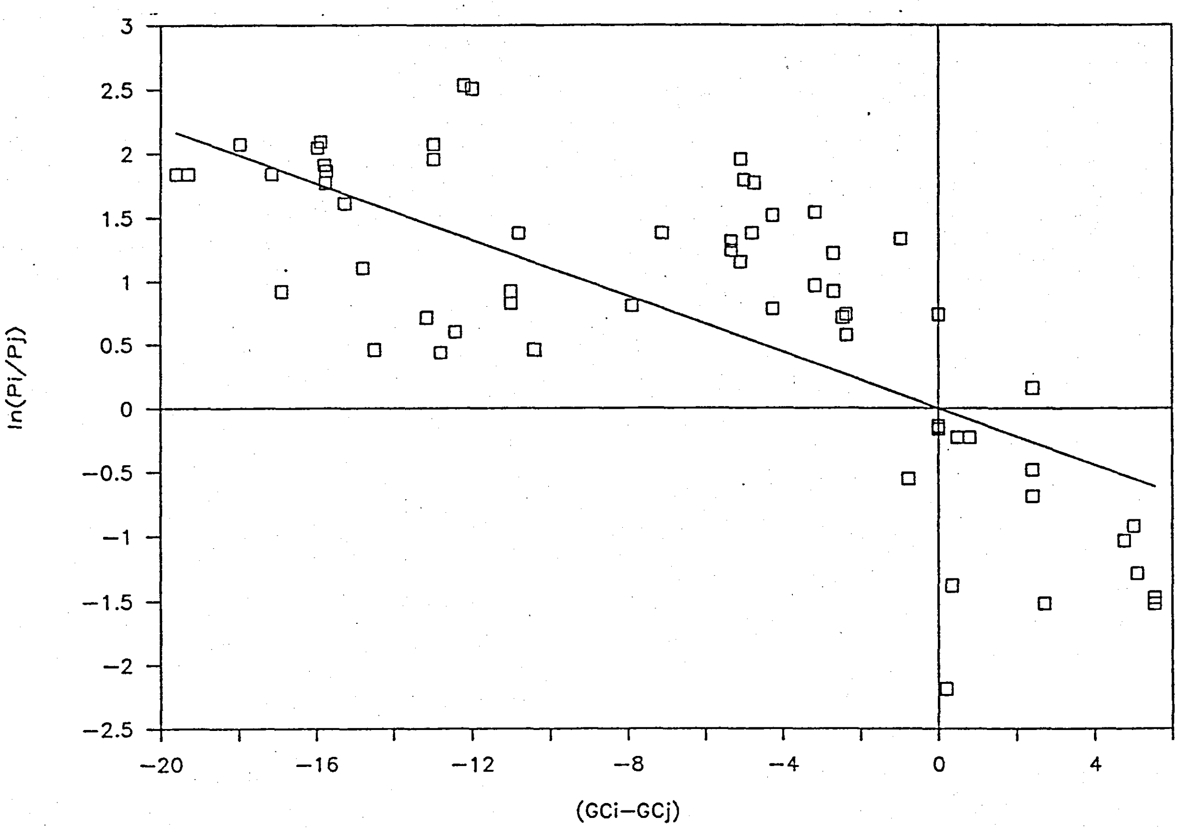
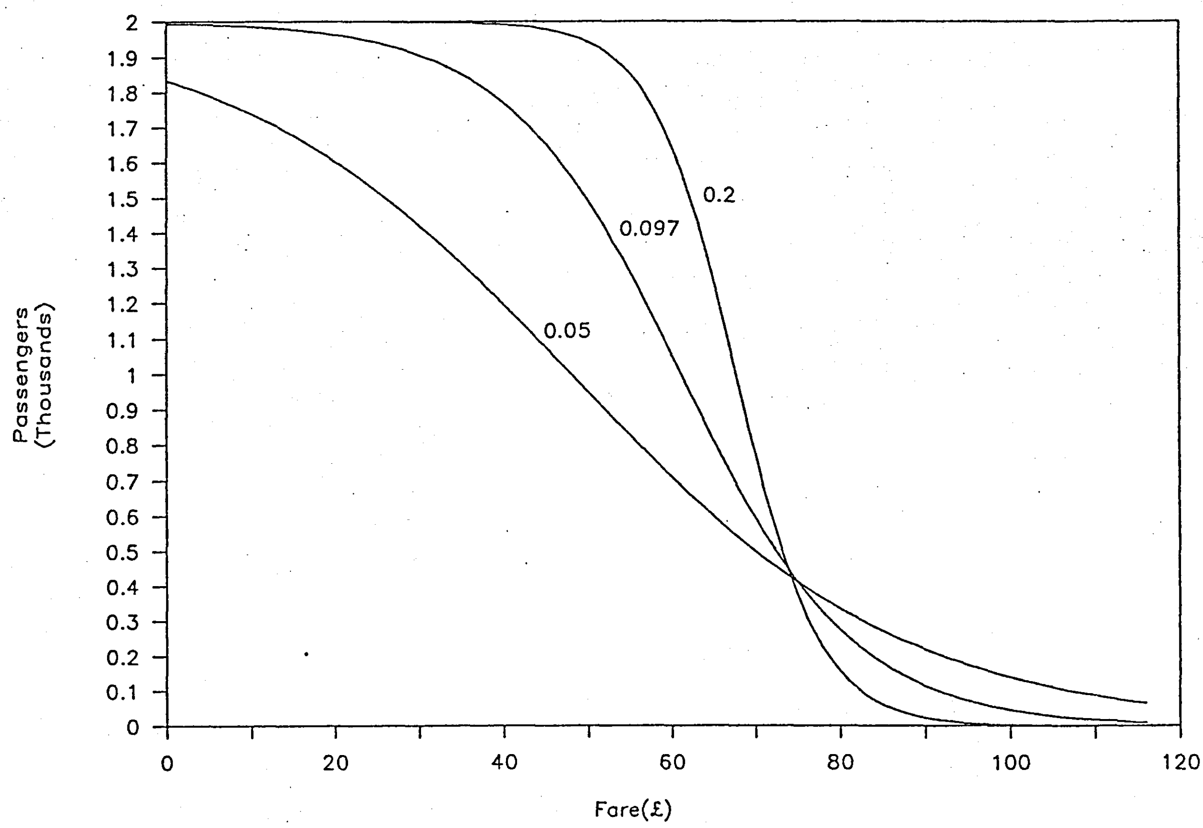


Fig. 5.2: Effect of Beta Value on Passenger Demand



senger demand is studied. Figure 5.3 illustrates the structure of the market share model where the relationships of its components are presented.

To explore the relationship between market share and fare, one of the carrier's (i.e. BA) fares is varied while the other variables that affect its market share at the same time are kept constant. For example it is assumed that all the major air carriers operate at four return flights per day and the foreign air carriers at two. Rail service frequency is assumed to be three. In terms of fare it is presumed that KLM, BCal and the foreign airlines charge £70 and rail £29 (see Table 4.1 for the input data). Figure 5.4 illustrates BA's market share as its fare changes. It can be seen that as BA increases its fare, its passenger demand declines, while other carriers' market share rise. It can also be seen that even when BA's fare is much higher than that of other carriers, it still attracts a certain number of passengers. This illustrates the characteristic of the logit model, that it does not assign all the passengers to the carrier with the lowest passenger generalised costs due to the effects of random variables (i.e. the unobserved and immeasurable characteristics of travellers and attributes of the carriers services). Therefore the expensive carrier in the market can attract some travellers to its service.

It was mentioned in the previous section that the value of the market share parameter (β) reflects the characteristic of the travellers in a market in terms of their sensitivity to the costs associated with making a trip. When the value of the market share parameter is low, the effect of the unobserved and immeasurable attributes of the carriers service and characteristics of passengers is greater on the passengers choice probability. As Figure 5.2 illustrates at each fare level, depending on the value of β, different levels of passengers travel with the carrier under consideration (i.e. BA). For example at higher values of β (β= 0.2) BA attracts a higher volume of traffic, for lower fare levels than the other carriers (i.e. £70), compared with the level of passengers for the same levels of fare at lower β values. However for fare levels higher than those of the rivals it attracts less passengers at higher β value. In other words, the higher the value of the market share parameter the greater the difference in the carriers market share for the same difference in their fares. When BA's fare is in the same region of other carriers' fares the value of β does not affect its passenger demand. This is because travellers choose carriers by comparing their

Fig. 5.3 : Structure of the Market Share Model

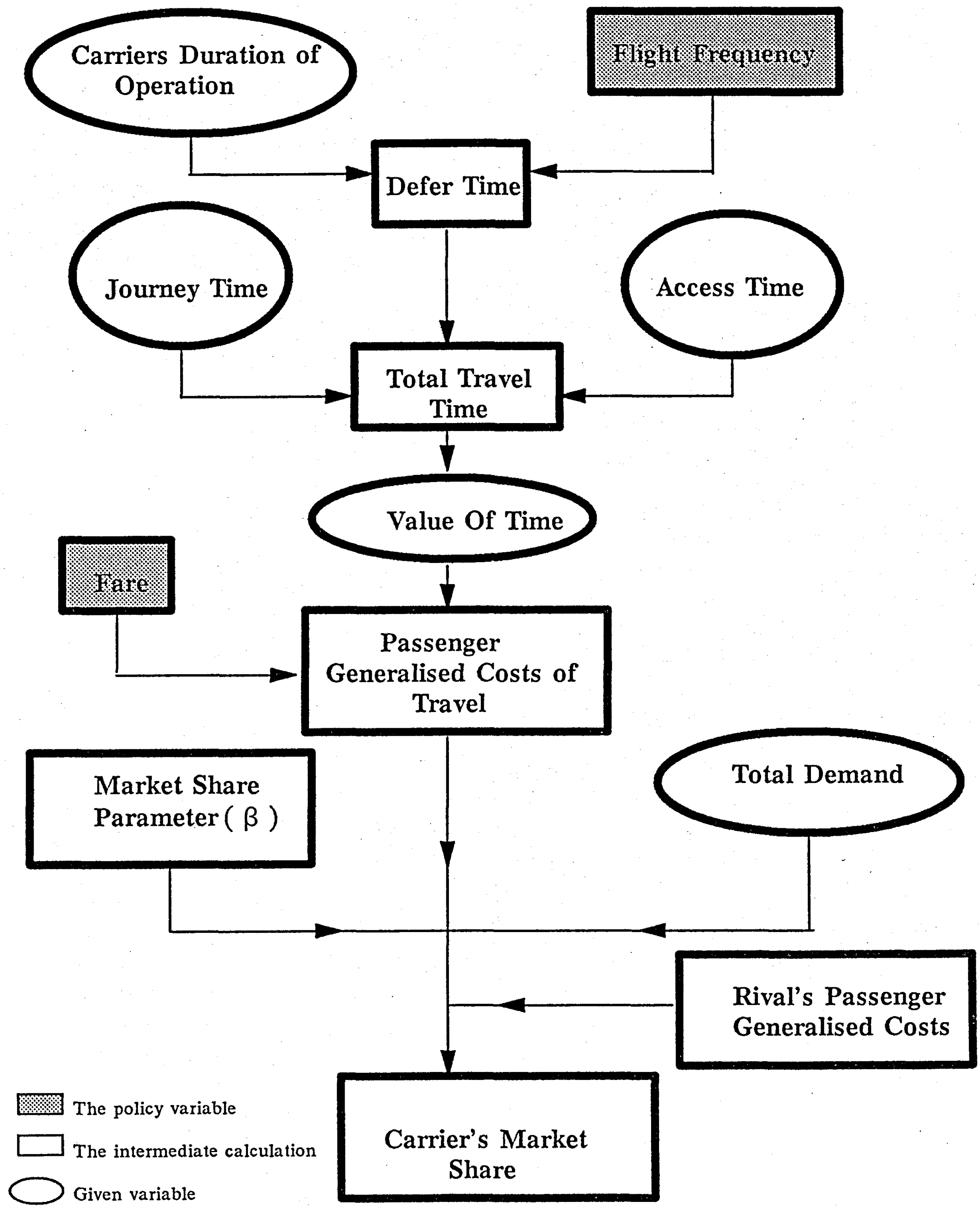
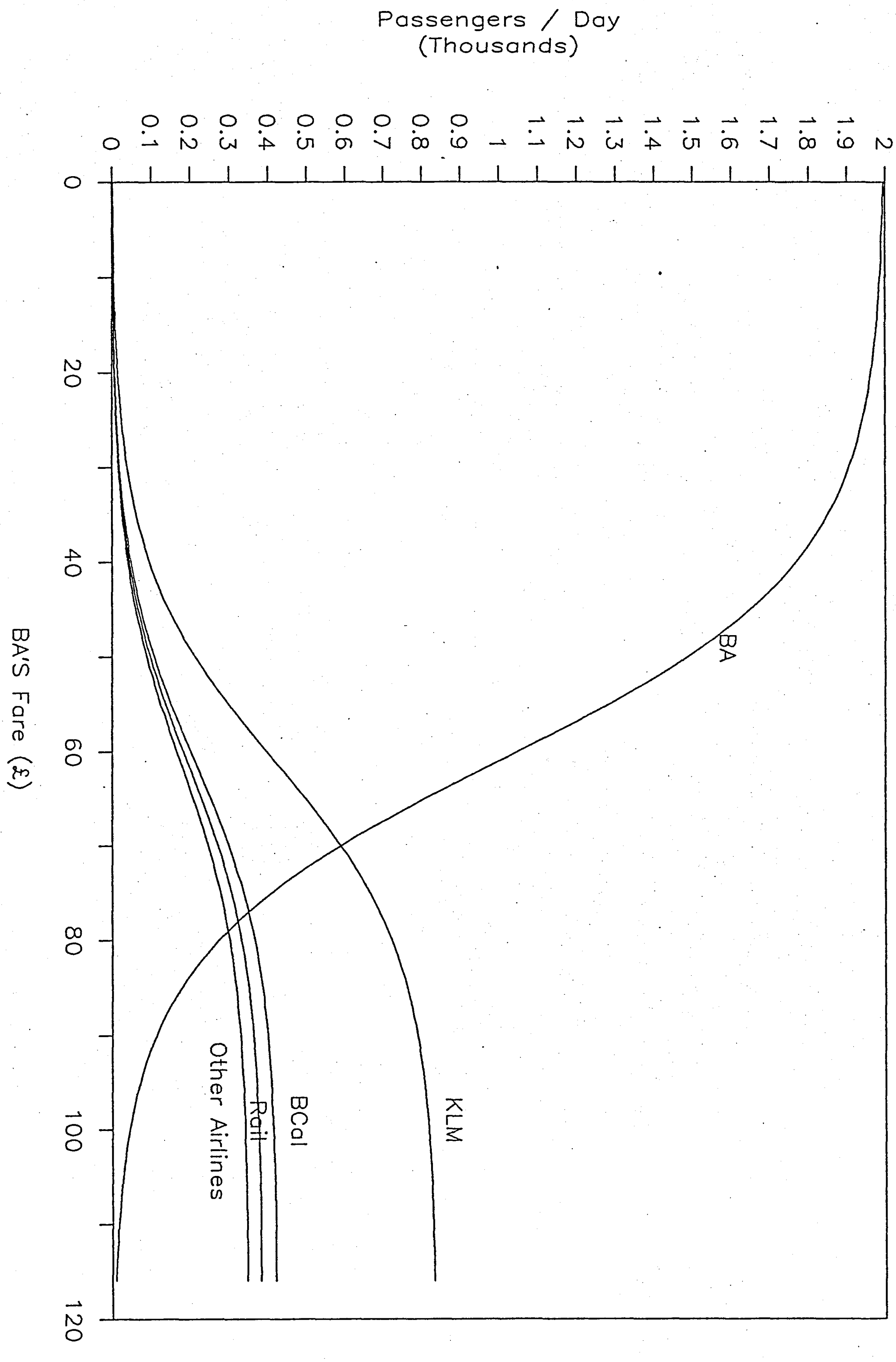


Fig. 5.4: Passengers and Fare



generalised costs. Therefore if the carriers offer similar costs of travel, regardless of the value of β., it attracts the same number of passengers.

The changes in the level of demand due to changes in fare (passengers elasticity with respect to fare) are illustrated in Figures 5.5(a) and 5.5(b). It can be seen that unlike most demand models that consider a constant elasticity, the changes in passenger levels with respect to changes in the fare levels are not constant but are inversely proportional to the carriers market share. For example the elasticity with respect to BA's fare at £10 (at which it approximately captures 99% of the market) is less than 1% however at £80 is over 6%. This illustrates that when BA has a high market share, the increases in its fare by one percent leads to a decline in its passengers demand which is less than the fall in its traffic due to the same increase in its fare when its market share is lower. This is because as long as BA charges a fare which is lower than that of the rivals the decline in its passenger demand due to increase in its fare is less than when its fare is higher than the fares offered by other carriers in the market. Such a relationship between fare and demand is due to the logit models characteristics in which passengers' choice is a function of the differences in the travelling costs. Therefore the elasticities illustrated by Figures 5.5(a) and 5.5(b) are not the passengers elasticity with respect to BA's absolute level of fare and they are affected by the level of other carriers fare. Thus the closer BA's fare is to the fare charged by the rivals, the higher is the passengers elasticity with respect to increases in its fare. The relationship between fare and demand in Figures 5.5(a) and 5.5(b) also shows that the logit/market share model yields high elasticities. For example for fare levels higher than £50 the elasticity is over 2%. Therefore it can be said (as shown in Figures 5.5(a) and 5.5(b)) that the lower the fare (as compared with the rivals fare) and the higher the resulting market share, and the lower the passengers elasticity with respect to fare. This reflects the logit/market share model property regarding its elasticity (see Sections 5.2.2.1, Equation 5.9).

The interaction between fare and level of passenger demand determines the trend in marginal revenue (the additional revenue due to an increase in the number of passengers by one) and therefore the total revenue. The relationship of the number of passengers and fare with the total revenue is illustrated in Figures 5.6(a), 5.6(b) while with marginal revenue is shown in Figures 5.7(a) and 5.7(b). It can be

Fig. 5.5(a): Elasticity w.r.t. Fare

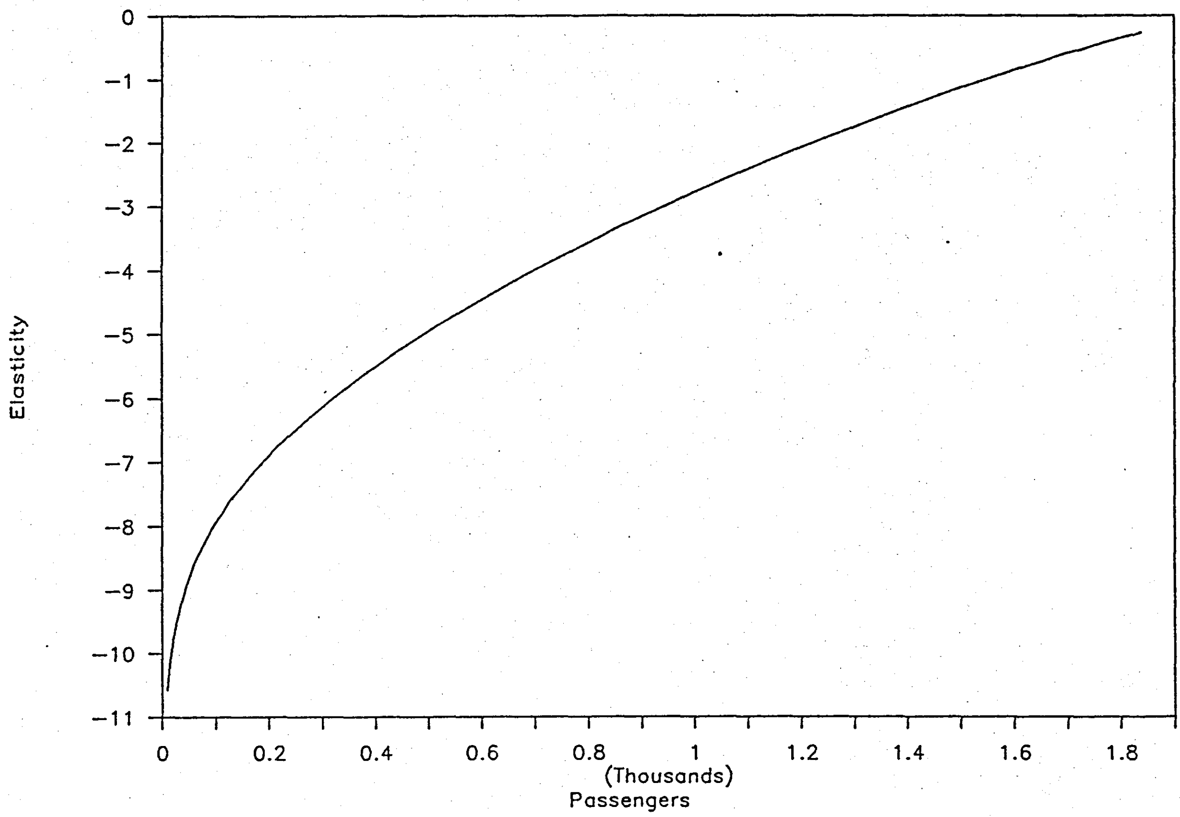


Fig. 5.5(b): Elasticity w.r.t. Fare

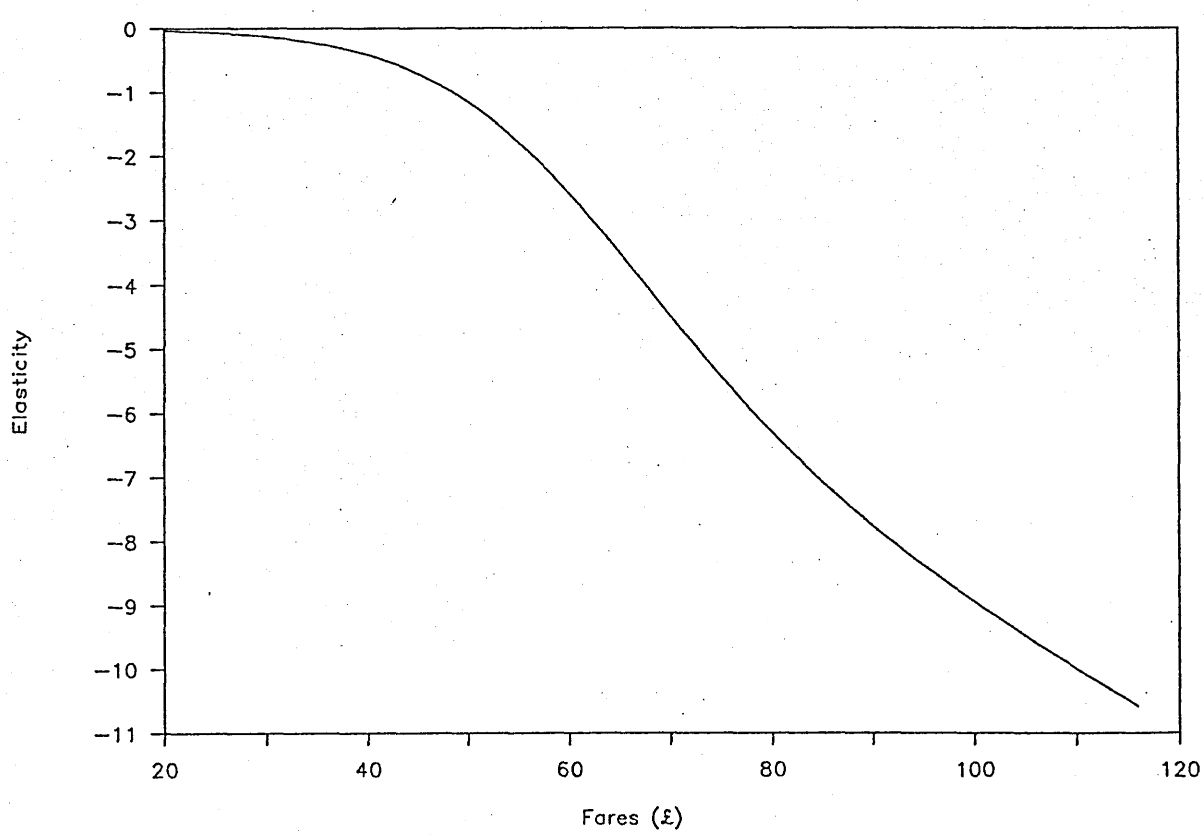


Fig. 5.6(a): Total Revenue and Passengers

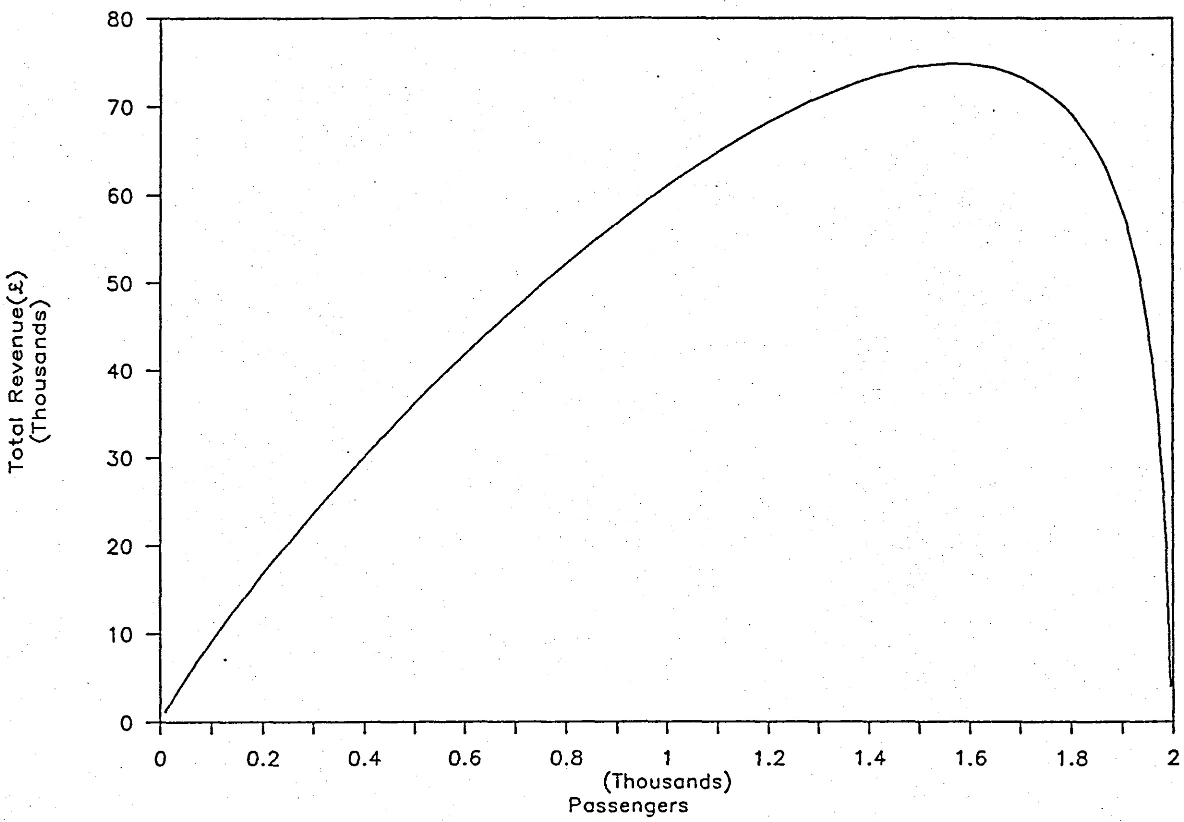


Fig. 5.6(b): Total Revenue and Fare

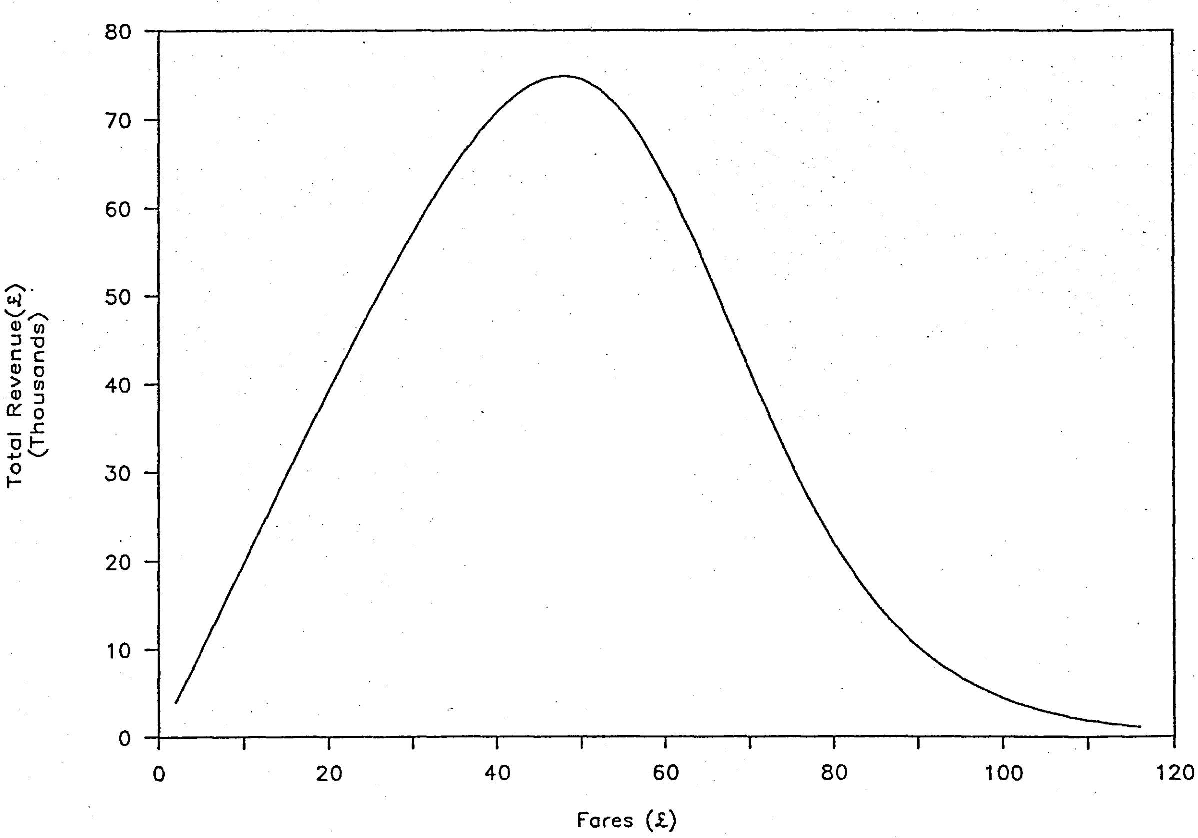


Fig. 5.7(a): Marginal Revenue and Passengers

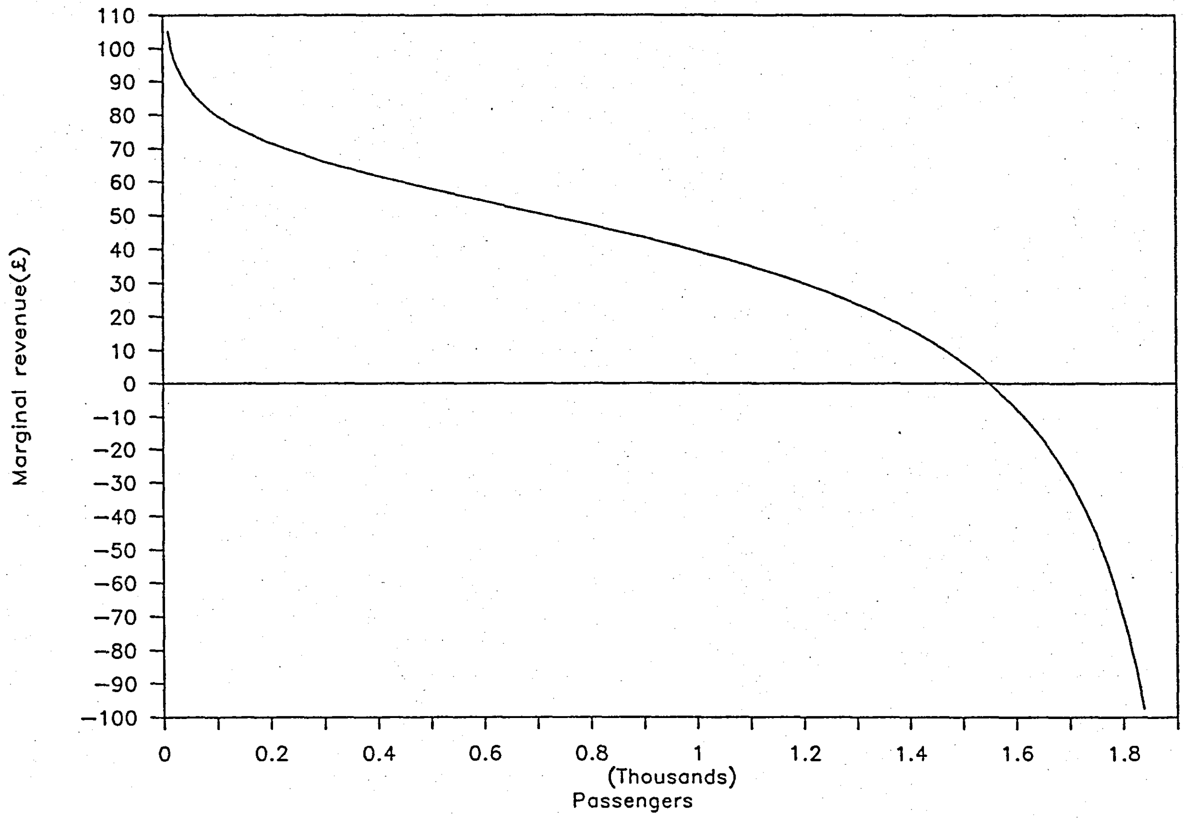
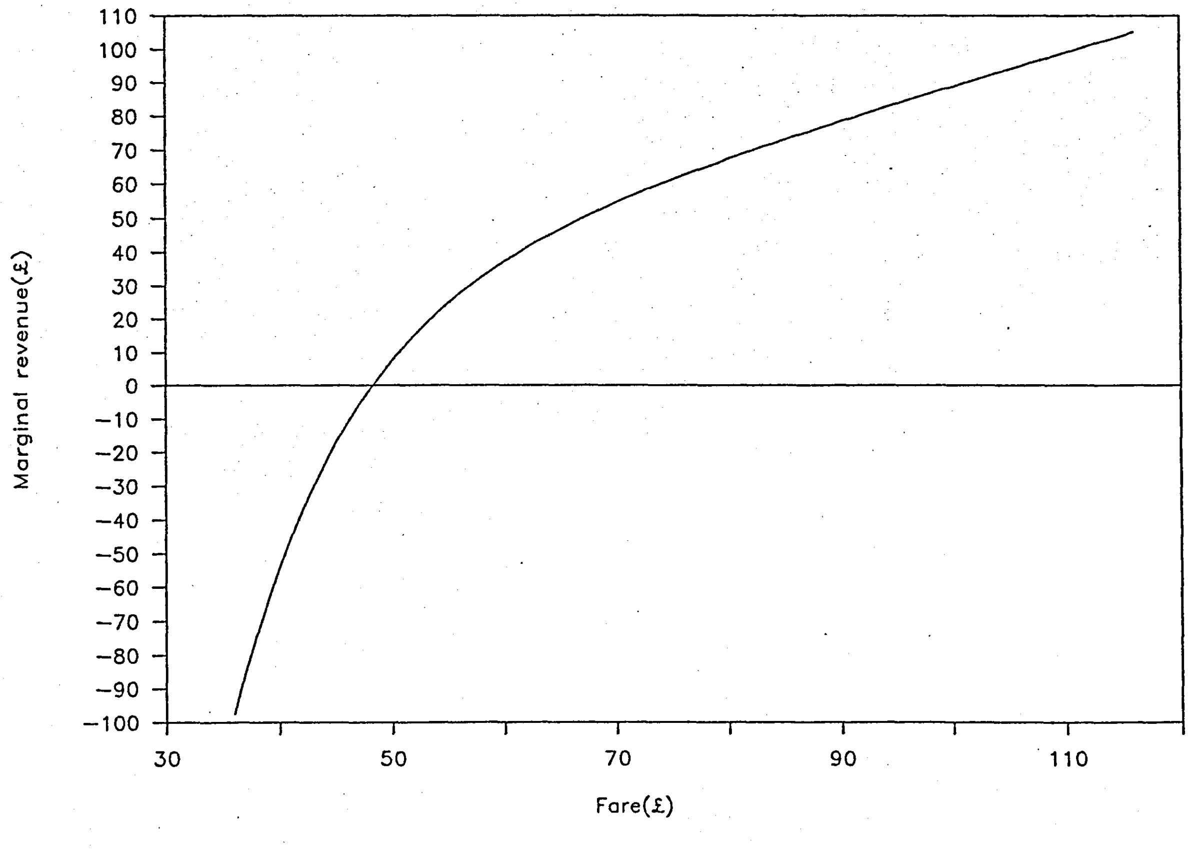


Fig. 5.7(b): Marginal Revenue and Fare

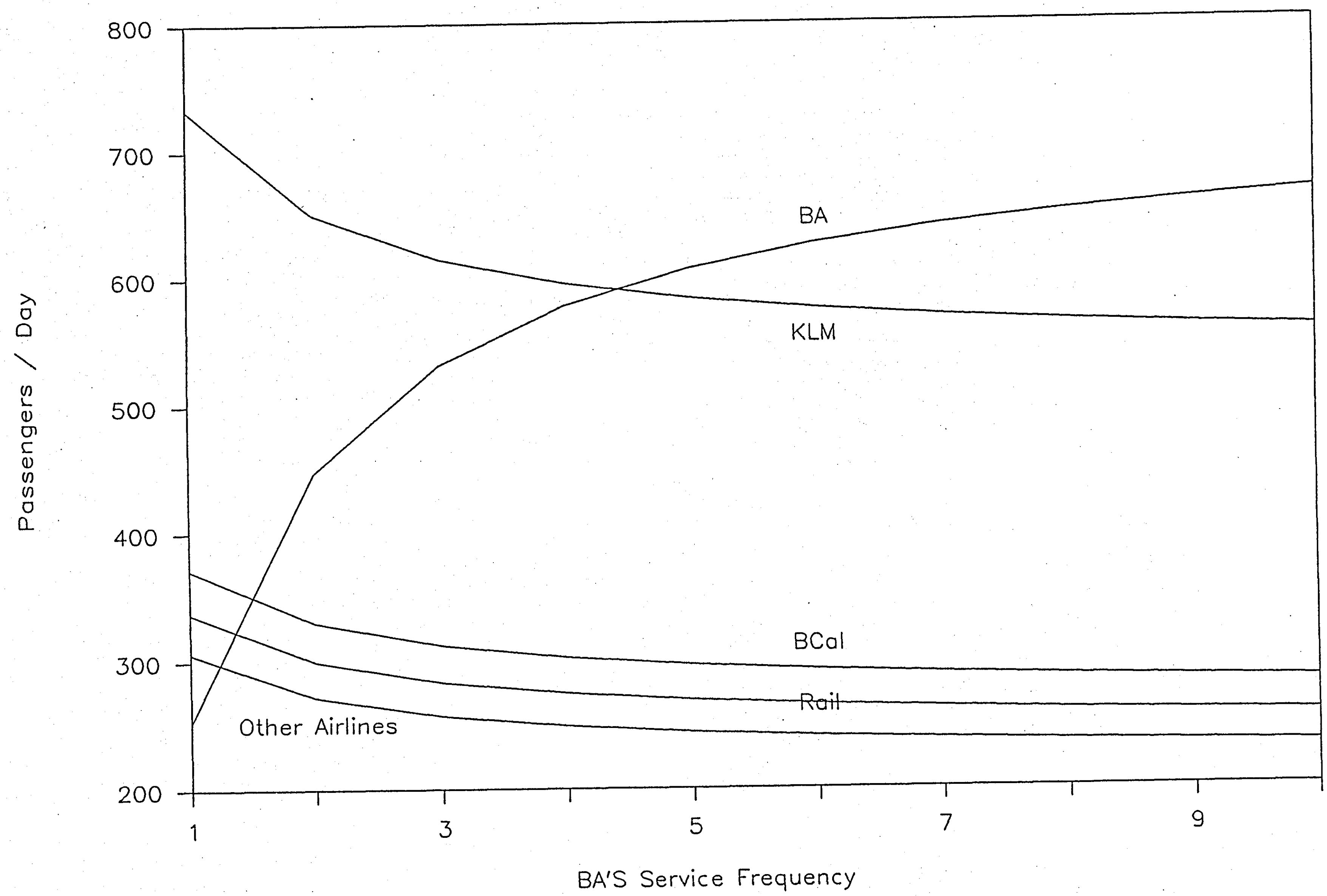


seen from the trend in total revenue that as fare increases from £1, the passenger demand falls but the total revenue increases up to a certain level (equivalent to a fare of £53) after which it start to decline. This can be explained through the marginal revenue relationship illustrated in Figures 5.7(a) and 5.7(b). As can be seen, the decrease in fare and resulting increase in passenger demand lead to a positive marginal revenue declining up to a certain level of fare (i.e. £53) at which the marginal cost is zero. Any decrease in level of fare beyond this point results in an increase in demand but a negative marginal revenue and decline in total revenue. As can be seen, although BA's rival carriers charge a higher fare, the level of fare at which they maximise revenue is much lower than those of other carriers in the market. This is due to the high elasticity of passengers with respect to fares more than £50. When BA increases its fares over the optimum level, it loses passengers at a rate that, despite the increase in its fare, causes revenue to decline. Whereas when it increases its fares from a very low level (i.e. £10) it loses passengers at such a low rate that the total revenue actually rises. Such high elasticities encourage operators to provide services at lower costs to passengers than they would at lower elasticity.

The relationship of passenger demand and service frequency for BA is illustrated in Figure 5.8. Keeping all other variables constant, it is shown that as BA increases its flight frequency, its passenger demand rises too. This is because as the number of flights goes up, the defer time declines (Equation 5.11). The shorter the defer time, the lower the passenger generalised costs (Equations 5.12 and 5.13) and the higher the carrier's passenger demand (Equation 5.10). It can also be seen that as BA 's passenger demand increases the other carrier's passenger demand decreases. Figure 5.8 shows that as BA's service frequency increases the rate of increase in passenger demand declines. This is because the reduction in defer time (Equation 5.11) due to the increase in flight departure become less noticeable and has less effect on passenger demand (i.e. it has a diminishing effect).

It can be seen from Figures 5.4 and 5.8 that the carrier charging a higher fare or operating a lower service frequency can still attract some passengers. This follows the pattern expected from logit model which allows the alternative with the lower utility to capture a share of the market. This is in line with the characteristics of airline markets where due

Fig. 5.8: Passengers and Service Frequency



to different factors such as passengers lack of complete information or variation in passenger tastes or some unknown variables, the carrier with the lowest passengers' generalised costs cannot attract all the travellers in the market.

The relationship between passenger demand and fare and service frequency illustrates that the effect of variation in fare and frequency on demand also follows the pattern expected from general economic theory.

In summary, in this chapter the choice related characteristics of airline markets which were discussed in part I have been briefly reviewed and different choice theories, deterministic and probabilistic, have been discussed. It is concluded that travellers' choice of alternative carriers is not deterministic but it is subject to random influences. Therefore probabilistic models are preferable. This is because individual travellers may not always follow rational decision rules, and also a typical potential traveller is not likely to have perfect information about all the available alternatives in the market. In addition, there are great differences in carriers services which affect passengers' choice and only some of the factors that influence passengers are known or measurable.

Based on the utility maximisation concept, the two most common forms of probability choice models, probit and logit, are presented and their properties are discussed. The multinomial logit model is considered to be more appropriate for estimating each airline and the rail market share than the probit. Each airline offers different levels of service and consequently they yield different levels of utility which in this study is measured by passenger generalised cost. Therefore individual air carriers can be considered as a distinct alternative. To estimate the market share parameter the least-squares procedure is considered to be more convenient as the data set is not very large and is in an aggregated form.

5.4 GENERAL IMPLICATIONS

The use of the logit model to estimate individual carrier market share has some general implications which are as follows:

- it allows the carrier with the highest generalised costs to attract a number of passengers. Therefore even the most expensive carriers have the chance to survive.

- it is not the absolute costs of travelling that affect the passengers choice of a carrier but the differences in the generalised costs. Therefore as long as a carrier is the cheapest among the alternative carriers, it has the highest chance of being chosen and as a result the highest market share.

- the passengers elasticity is not constant but it varies in relation to the difference in the generalised costs of the alternative carriers. Thus the larger the difference the lower is the elasticity. There is generally a high elasticity with respect to the costs associated with travelling. Such high elasticities force the carriers to offer services at the lower costs to passengers (or lower passenger generalised costs) than if the elasticities were lower.

CHAPTER SIX

THE COSTING MODEL

6.1 INTRODUCTION

It is the purpose of this chapter to develop the costing model. This is to calculate each carrier's operating costs associated with serving its market share. To do this the structure and development of the costing model is discussed and its properties are studied.

6.2 THE STRUCTURE OF THE COSTING MODEL

The airline operating costs fall broadly into two groups of costs. Direct operating costs and indirect operating costs. Figure 6.1 illustrates the structure of the costing model.

6.2.1 Direct Operating Costs

These costs include all those costs that are directly associated with the aircraft. They are in turn divided into variable and fixed costs.

- The direct variable costs are:

  a) fuel and oil costs. Fuel consumption depends on a number of factors such as length of routes, number of flights, size and weight of aircraft, wind conditions and so on.

  b) maintenance expenses which cover the costs of maintenance checks and repairs.

  c) airport and en-route charges which cover the costs of landing fees and costs of en-route and aerodrome navigation facilities.

These costs increase as the number of flights or the length of route increases. Also over a given route, as a general rule, the larger the aircraft the lower will be its cost of each unit of output

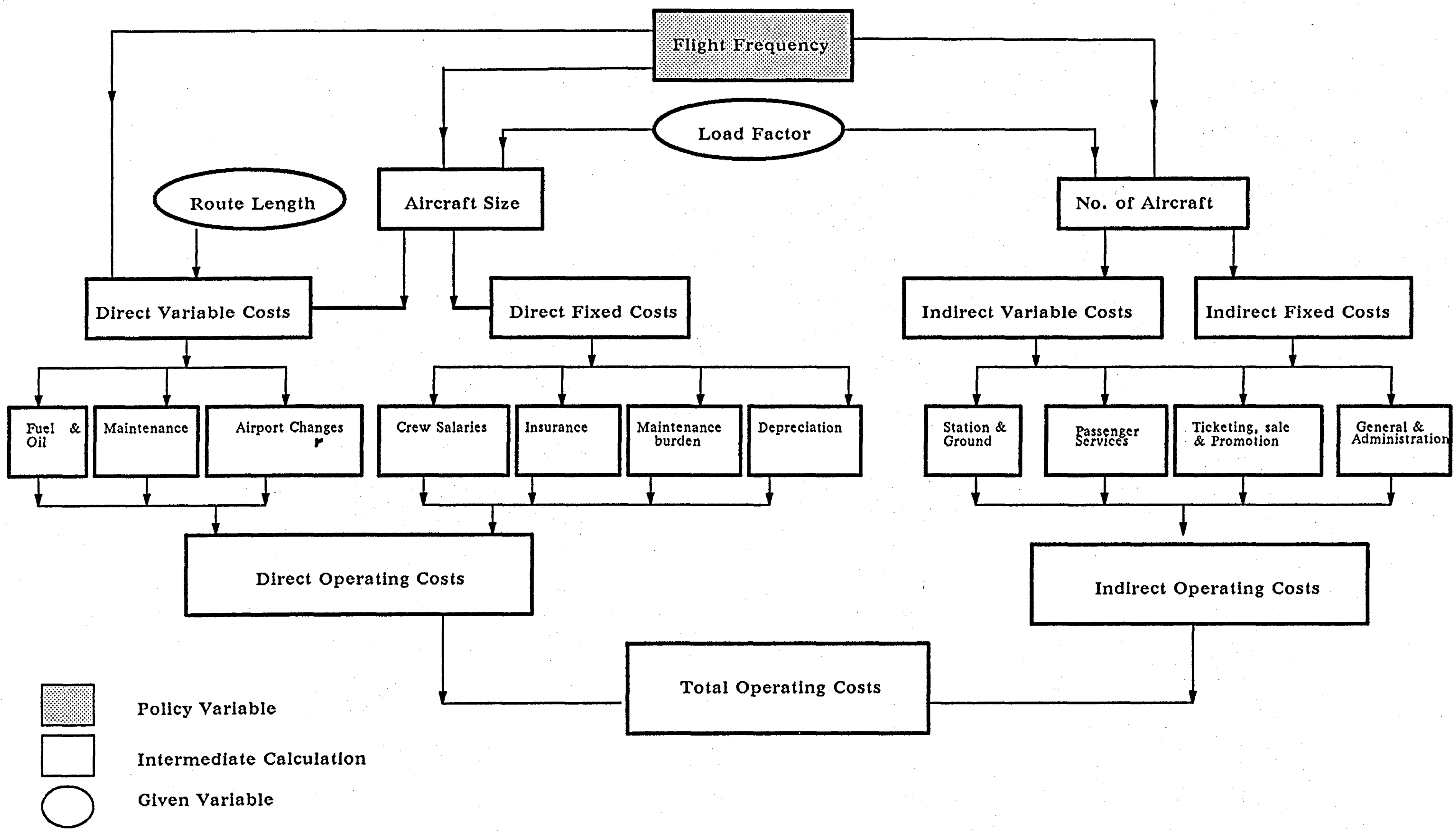


Fig. 6.1 Structure of the Costing Model

(i.e. seat km) but the higher will be the total direct variable costs. This relationship implies that the direct variable costs do not increase in proportion to the size of aircraft. This is because larger aircraft have proportionally lower drag and more payload per unit of weight. At the same time larger and more efficient engines can be used. For example, the Airbus A300 has a maximum takeoff weight which is nearly three times as high as that of the Boeing 737, yet its hourly fuel consumption is only slightly more than twice as high (Doganis, 1985). The other sources of lower unit cost of operation of larger aircraft are labour costs. A large proportion of maintenance costs, which are essentially labour costs, do not increase in proportion to increases in aircraft size.

In order to quantify the relationship between aircraft size and direct variable costs for the purpose of developing a costing model, the collected data on different aircraft size and their related fuel, oil and maintenance costs are used. As said in Section 4.4, the data on aircraft costs are obtained from US Quarterly Aircraft Operating Costs and Statistics. Table 6.1 illustrates the direct variable costs per seat mile for different aircraft sizes. The direct variable costs per seat mile are regressed on aircraft size in log form and the following least square relationship is obtained:

$$\ln DVC = 2.522 - 0.335 \ln ACTS \qquad (6.1)$$

T ratio = 3.19 (99% Sig.)
Rsq =0.421

where:

DVC is direct variable cost/seat mile($)
ACTS is aircraft size

Equation 6.1 can be rearranged as:

$$\log DVC = \ln e^{2.522} + \ln ACTS^{-0.335} \qquad (6.2)$$

or

$$DVC = e^{2.522} * ACTS^{-0.335} \qquad (6.3)$$

or

$$DVC = 12.4 * ACTS^{-0.335} \qquad (6.4)$$

$$\Delta DVC / \Delta ACTS < 0$$

Table 6.1: Aircraft size, Direct Variable Costs per Seat Mile and Crew Costs per Seat Hour (December 1984)

ACTP	ACTS	VC/SH	CR/SH
B737-200	112	2.4	3.70
DC9-10	81	4.3	3.25
DC9-30	112	2.4	3.10
DC9-50	122	2.3	2.40
B727-100	111	2.8	4.48
B727-200	147	2.3	3.30
B757-200	185	1.4	2.52
B767	199	1.6	2.35
B747SP	232	2.6	3.38
L10-11	282	2.0	2.26
A300 B2	280	3.2	3.73
A300 B4	242	1.8	2.47
DC10-10	165	2.0	2.43
DC10-30	259	2.0	1.98
DC10-40	274	2.2	2.03
B747-100	405	1.9	1.80
DC8-71	202	2.0	3.19

Source: AVAMARK. US Quarterly Operating Costs and Statistics. December 1984

ACTP = Aircraft Type
ACTS = Average Aircraft Size
VC/SH = Variable Costs per Seat Hour (Cents)
CR/SH = Crew Costs per Seat Hour ($)

The relationship between aircraft size and direct variable costs per seat mile for the major aircraft types operated by US airlines is illustrated in Figure 6.2. It can be seen that as the size of aircraft increases the direct variable costs per seat mile decrease though there are deviations. Such deviations can be due to new and improved versions of existing aircraft types or to the latest generation of twin-engine aircraft such as Boeing 757, with unit costs lower than those of some larger aircraft. The deviations between the unit costs are also due to the different average sector lengths that the aircraft under consideration are flown in practice.

As discussed in the Chapter Three the input costs such as the price of fuel or oil in Europe are higher than those in the US. Therefore in order to adjust the direct variable unit costs of aircraft operation to the European level it is taken into account that on average the price of fuel in Europe is 31% higher than that of the US (Doganis, 1985). Later in the computer program, on the basis that one pound is equivalent to $1.44, all the costs are converted to pounds. The landing fee is assumed to be constant regardless of size of aircraft.

- Direct fixed costs

These cover the cost of:

a) crew salaries and expenses, which are the direct salaries, allowances, pensions, insurance and any other social welfare payments.

b) maintenance burden, which are the administrative and overhead costs associated with the maintenance function.

c) insurance which is the cost of insuring aircraft. The annual premium paid may vary from 1.5 to 3 percent of the full aircraft purchase price (Doganis, 1985).

d) aircraft depreciation cost, which depends on the depreciation period adopted and residual value assumed. Generally airlines adopt the depreciation period of 14 - 16 years for their wide bodied jets and 8 to 10 years for the smaller short-haul aircraft, with a residual value of 10%. The annual depreciation charges could be calculated as follows (Doganis, 1985):

Annual depreciation =
(Aircraft Price + Spares cost) - residual value / depreciation period

These costs are generally fixed for each aircraft, and as the number of aircraft increases these costs jump to a higher level. This point will be discussed later in the context of total operating costs. The relationship between these costs and aircraft size follows the same pattern as Direct Variable Cost (DVC) and aircraft size. As aircraft size increases the Direct Fixed Cost (DFC) per seat hour decreases although the total DFC increases. To illustrate this relationship, the collected data on aircraft size and its related crew costs and depreciation costs are used. The crew costs and depreciation costs are regressed on aircraft size separately, since in aggregate form there is not a strong relationship between these variables and aircraft size.

The crew costs per seat hour and depreciation costs per seat hour are illustrated in Tables 6.1 and 6.2 respectively.

The crew costs are regressed on aircraft size and the following least square relationship is obtained:

$$\ln CW = 3.12 - 0.41 \ln ACTS \qquad (6.5)$$

T ratio = 3.73 (99% Sig.)
Rsq =0.5

where:

CW is crew cost ($)/ seat hour

Equation 6.5 can be rearranged as follows:

$$CW = 22.6 * ACTS^{-0.41} \qquad (6.6)$$

$$\Delta CW / \Delta ACTS < 0$$

The relationship between aircraft size and crew cost is illustrated in Figure 6.3. As can be seen, the larger is the aircraft size, generally the lower is crew costs per seat hour. Although

Table 6.2: Aircraft Size, Aircraft Prices and Depreciation per Seat Hour

ACTP	ACTS	ACTR	DC/SH
BAe146-100	80	14.0	4.37
BAe146-200	110	16.0	3.63
BAe146-300	120	18.0	3.75
F28	80	14.0	4.37
F100	120	18.0	3.75
B737-300	150	24.0	4.00
MD82	180	26.0	3.60
A320	190	33.0	4.34
B757	240	42.0	2.91
A310-200	280	48.5	2.85
A310-300	280	50.5	3.00
B767-200	280	48.5	2.88
B767-300	340	55.5	2.72
A300-600	360	55.5	2.56
DC10-30	380	60.0	2.60
B747-200	550	98.0	2.96
B747-300	660	101.0	2.54

Source: Lloyd's Aviation Economists, December 1984

ACTP = Aircraft Type
ACTS = Average Aircraft Size
ACTR = Aircraft Price ($ Millions)
DC/SH = Depreciation per Seat Hour ($)

crew might be paid more for flying a larger aircraft, the crew cost per seat hour declines. The difference in crew costs of similar aircraft size is due to aircraft types. Developments of aircraft technology have allowed the redesign of cockpits for two man operation rather than three for aircraft such as the Boeing 757 or 767. Such improvements have led to savings in flight crew costs as crew numbers are cut from three to two. Since the data used here is based on American airlines and crew costs of US airlines are higher than in Europe by approximately 30% (Doganis 1985), the adjustment is made to crew costs to bring them in line with European airlines' costs level.

In order to obtain the relationship between aircraft size and depreciation per seat hour, first the aircraft annual depreciation costs are calculated. A depreciation period of 10 years is adopted for aircraft of less than 300 seats and 15 years for more than 300 seats, with a residual value of 10%. On the basis that each aircraft is utilised for an average of 10 hours (Quarterly Aircraft Operating Costs and Statistics, December 1984) the hourly depreciation costs are calculated. Regressing the hourly depreciation costs per seat mile on aircraft size the following least square relationship is obtained:

$$\ln DEP = 2.57 - 0.26 \ln ACTS \qquad (6.7)$$

T ratio = 5 (Sig.99%)
Rsq = 0.67

where:

DEP is depreciation costs ($)/ seat hour.

or

$$DEP = 13.1 * ACTS^{-0.26} \qquad (6.8)$$

$$\Delta DEP / \Delta ACTS > 0$$

Figure 6.4 illustrates the depreciation costs per seat hour in relation to aircraft size. It can be seen that as the size of aircraft increases the depreciation costs per seat hour decrease. The relationship between aircraft size and aircraft costs allows the operating cost model to take into account the economy of utilising larger aircraft.

Fig. 6.2: Direct Variable Costs per Seat mile and Aircraft Size

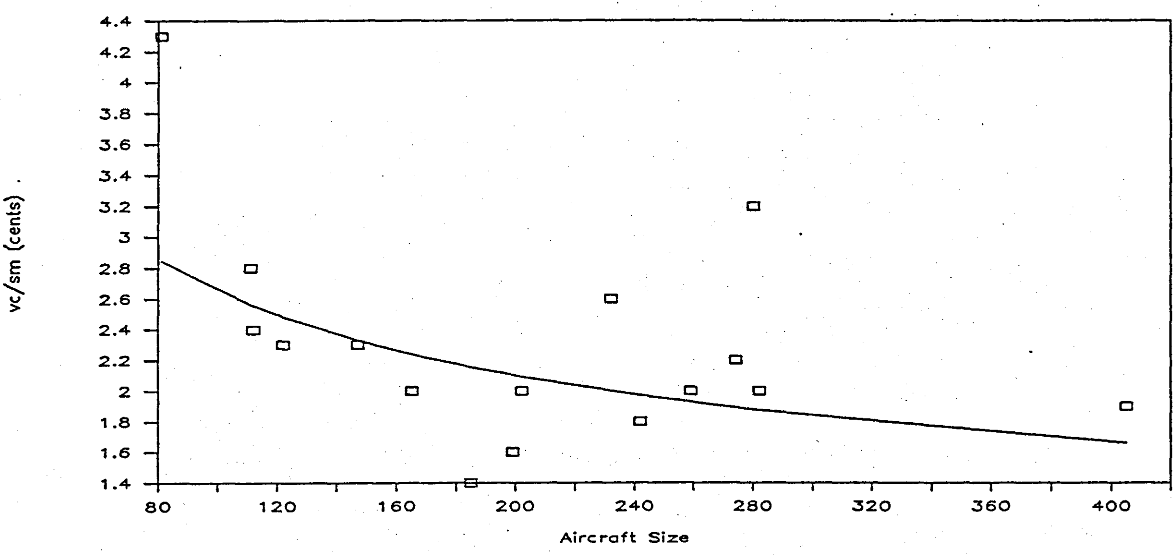


Fig. 6.3: Crew Costs per Seat Hour and Aircraft Size

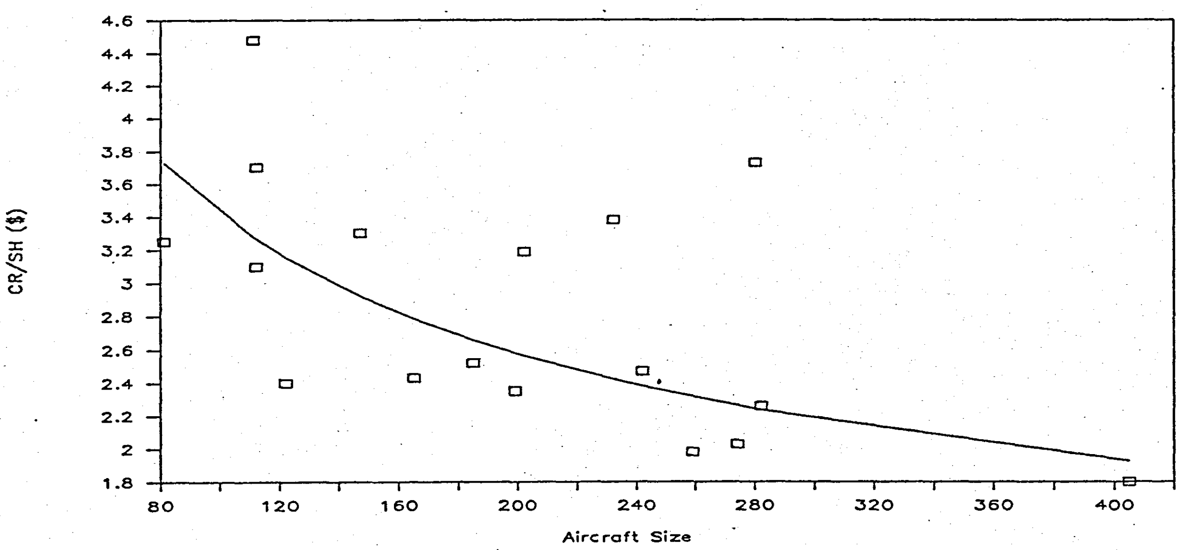
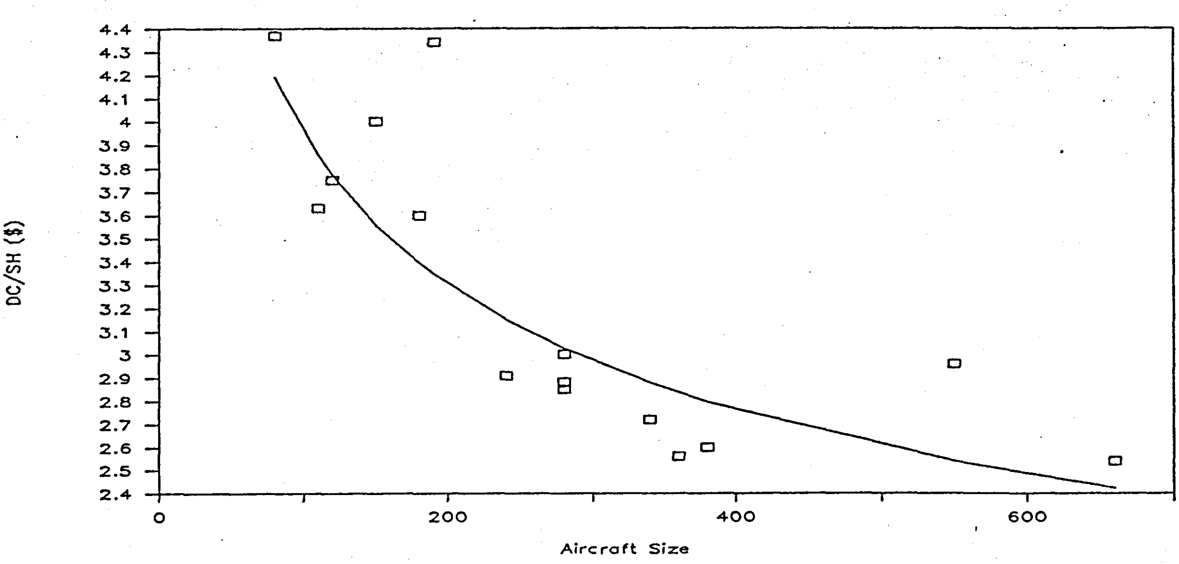


Fig. 6.4: Depreciation Cost per Seat Hour and Aircraft Size



The insurance costs are assumed to be 2% of the aircraft purchase price, and the maintenance burden to be one dollar per seat hour (Avmark, 1984).

6.2.2 Indirect Operating Costs

These costs are not directly related to aircraft operation and are more passenger related. The indirect operating costs (IOC) cover the following costs:

a) station and ground expenses that are all the costs incurred in providing an airline service at an airport which does not include landing fees.

b) passenger services which include the expenses directly related to aircraft cabin staff and other passenger service personnel. It also includes the cost of in-flight catering or accommodation provided for transit passengers and so on.

c) Ticketing, sales and promotion which are the costs directly associated with the expenses of these activities.

d) general and administration costs.

Most of these costs are variable while other parts are fixed. For example, the expenses related to cabin staff in terms of their salary can be fixed while the cost of in-flight catering can vary depending on the number of passengers. Based on ICAO Financial Data (1979-1984), the aircraft average indirect variable costs for the carriers under consideration is calculated as 3.1 pence per seat mile and indirect fixed costs as £11.61 per seat hour.

6.3 THE COSTING MODEL DEVELOPMENT

On the basis of the relationship between various types of cost and aircraft, which was discussed in previous sections, the total variable costs and total fixed costs are calculated as follows:

$$TV = ((DVC + IVC) * ACTS * RL + LDF) * FQ \qquad (6.9)$$

where:

TV	is total variable costs (£/day),
DVC	is direct variable costs (£/seat mile),
IVC	is indirect variable cost (£/seat mile),
ACTS	is aircraft size,
FQ	is flight frequency/day
RL	is route length (mile)
LDF	is landing fee

$$ACTS = D / FQ * L \qquad (6.10)$$

where:

D	is total passenger demand / day
L	is load factor

$$TF = (DFC + IFC) * H * ACTS * N \qquad (6.11)$$

where:

TF	is total fixed costs (£/day)
DFC	is direct fixed costs (£/seat hour)
IFC	is indirect fixed costs (£/seat hour)
H	is aircraft utilisation period (hour)
N	is number of aircraft

$$N = FQ / MN \qquad (6.12)$$

where:

MN	is the maximum number of flights by an aircraft / day

$$TC = TV + TF \qquad (6.13)$$

where:

TC	is the total operating costs (£/day).

6.4 THE COSTING MODEL PERFORMANCE

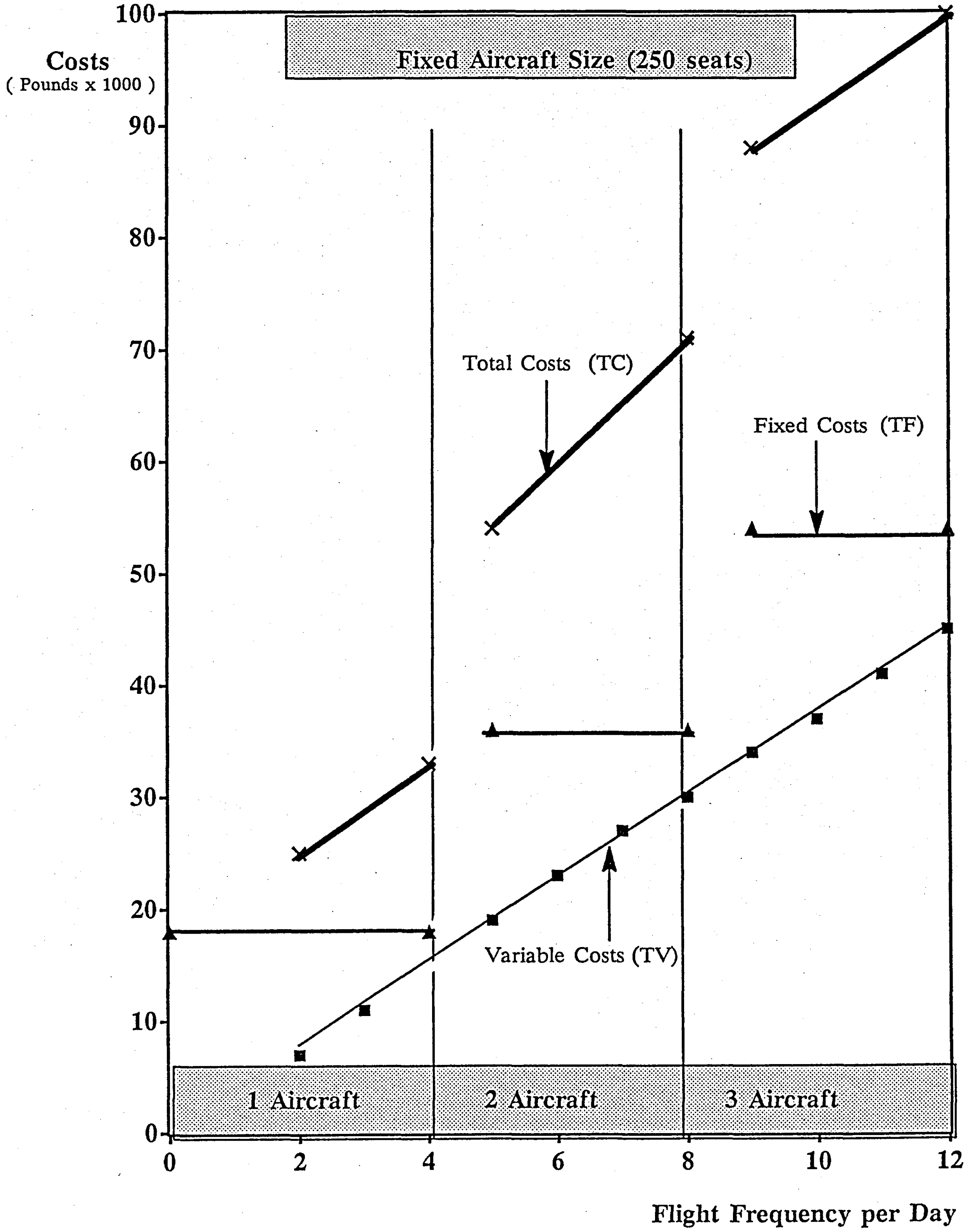
To identify the costing model properties, BA's operating costs for the given route (London - Amsterdam) is examined. The load factor is assumed to be predetermined by each carrier. It is also assumed that each aircraft can make a certain number of return flights per day (i.e. four) and the maximum aircraft size is 300 seats. To illustrate the effect of the increase in service frequency on the costs, it is assumed that the carrier charges a fixed fare and the rivals service frequency and fares are fixed too.

Figure 6.5 illustrates the changes in variable, fixed and total costs as flight frequency increases. In this case it is assumed that the aircraft size is fixed and it is a 250 seater. It can be seen that as the number of flights increases, the variable costs rise proportionally while fixed costs stay constant for each aircraft regardless of the number of flights it makes. When flight frequency is more than four, one more aircraft is required. As a result the fixed costs jump to a higher level and stay constant until an additional aircraft is introduced. It can also be seen from Figure 6.5 that the total operating costs rise as the number of flights goes up, and with the introduction of new aircraft there is a jump in the total costs too. This is due to the effect of fixed costs on the total costs.

For variable aircraft size, the costs relationship with flight frequency is different from the fixed aircraft size. Figure 6.6 illustrates the relationship of variable, fixed and total costs with flight frequency, when aircraft size is variable (aircraft size is a function of level of demand, flight frequency and load factor, (Equation 6.10)). It can be seen that with the increase in flight frequency variable costs increase but the rate of increase is lower than that of the previous case (Figure 6.5). The reason for this is that as the number of flights goes up passenger demand increases, with a declining rate of increase (see Figure 5.8). Given that the load factor is fixed, smaller aircraft are therefore required (see Equation 6.10). Although smaller aircraft have lower variable costs (not lower unit costs), the total variable costs have risen due to the increase in service frequency (Equation 6.9).

For each aircraft, as flight frequency increases fixed costs decrease (as a result of operating smaller aircraft) until one more aircraft is required, which leads to a jump in fixed costs (Equation 6.11). The jump in fixed costs is due to the assumption that carriers operate on a single route and the cost of aircraft is not shared by any other routes. Therefore once an aircraft is acquired all the fixed costs are attributed to the route. This results in a sudden increase in fixed costs as service frequency increases over the assumed maximum number of flights that one aircraft can operate (see Equa-

Fig. 6. 5: Flight Frequency vs Variable, Fixed and Total Costs



tion 6.12). This is called "an integer effect". It can also be seen from Figure 6.6 that the higher the number of aircraft the lower is the rate of decrease in fixed cost as flight frequency increases. This is because the rate of decrease in aircraft size slows down due to the declining rate of increase in passenger demand.

Total costs also decline as service frequency approaches the maximum number of flights that one aircraft can operate per day, after which they rise to a higher level. This follows the trend in fixed costs as service frequency increases. Figures 6.7(a) and 6.7(b) illustrate the trend in the marginal costs and flight frequency and the resulting passenger demand. As can be seen, at a very low service frequency the marginal cost is negative and as the number of flights increases to four, it approaches zero. This is because such an increase in service frequency results in the increase in demand and the decrease in aircraft size (see Figure 6.6). This reasults in reduction in total costs. The increase in flight frequency over the aircraft maximum number of flights per day, and the resulting increase in passenger demand, lead to a jump in the marginal cost. It can be seen that the increase in marginal cost, due to the increase in the number of flight departures from four to five, is less than the increase from eight flights to nine. This is due to the differences in the aircraft size. It is demonstrated in Figure 6.6 that as the service frequency increases smaller aircraft are required and the rate of reduction in the aircraft size slows down. This results in a smaller increase in the marginal cost when service frequency increases from four to five, due to the larger decrease in aircraft size compared with the rise in the number of flights from eight to nine.

The relationship between the marginal cost, fare and the resulting passenger demand is illustrated in Figures 6.8(a) and 6.8(b) respectively. It can be seen that as fare decreases from a high level (i.e. £100), and the resulting passenger demand increases, there is a slight decline in the marginal costs until an additional aircraft is required due to increase in passenger demand. For example when fare decreases from £50, the increase in number of passengers leads to the operation of extra aircraft (two aircraft at eight flights) and the reduction in fare from £34 results in the operation of three aircraft (at twelve flights). This leads to a jump in the marginal cost at such fare levels. The difference in the rise in the marginal cost, at these points as explained above, is due to the aircraft size.

Fig. 6. 6: Flight Frequency vs Variable, Fixed and Total Costs
(Variable Aircraft Size)

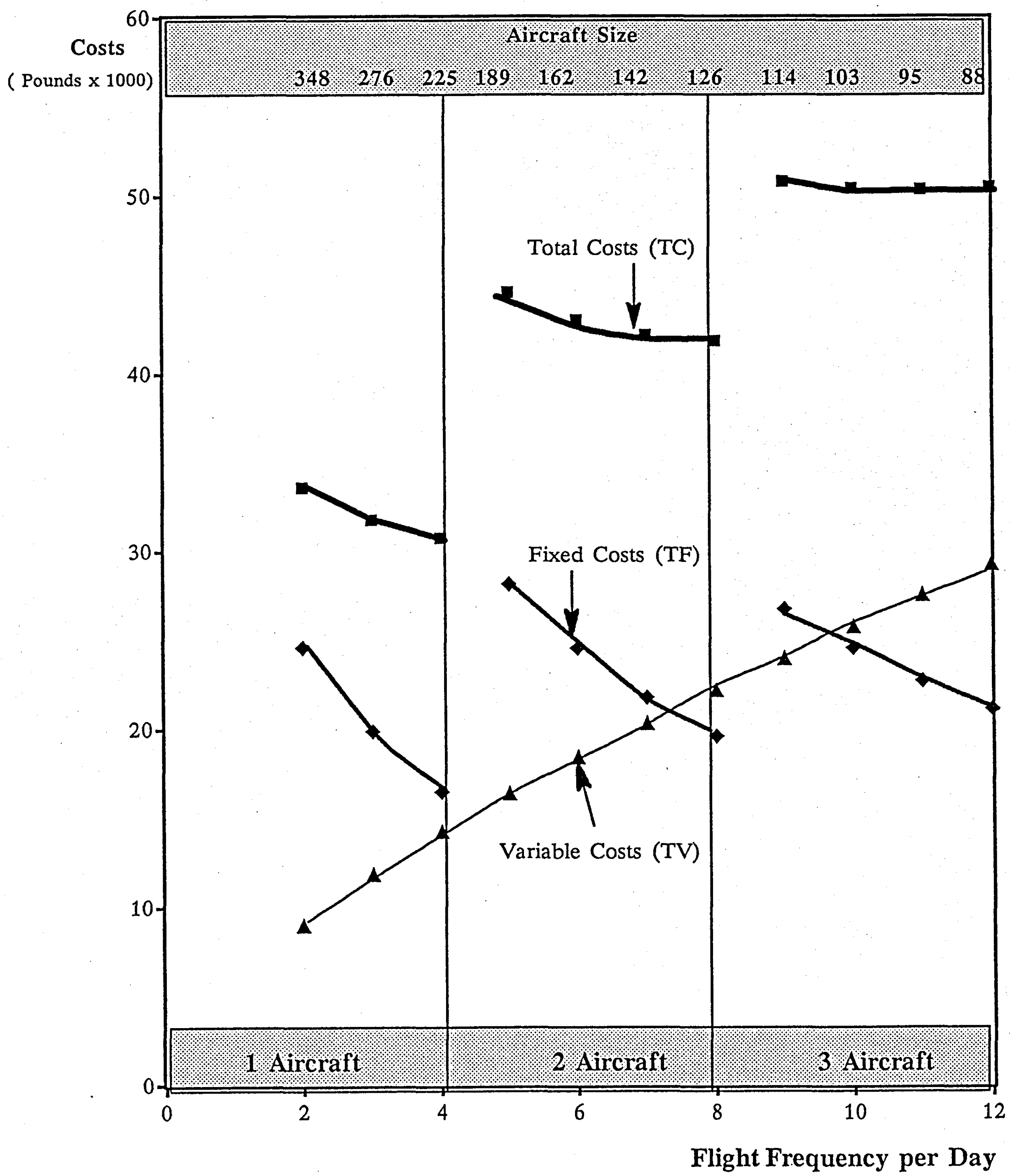


Fig. 6.7(a): Marginal Cost and Service Frequency

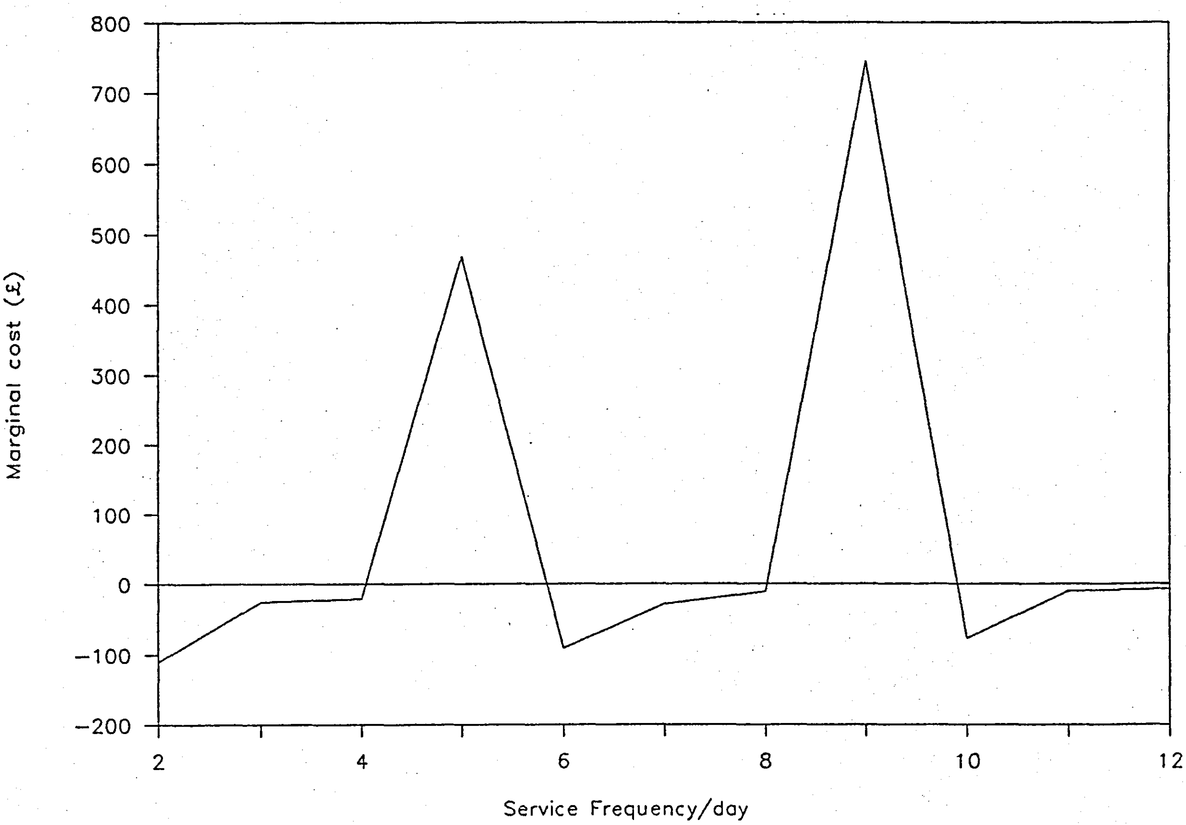


Fig. 6.7(b): Marginal Cost and Passengers

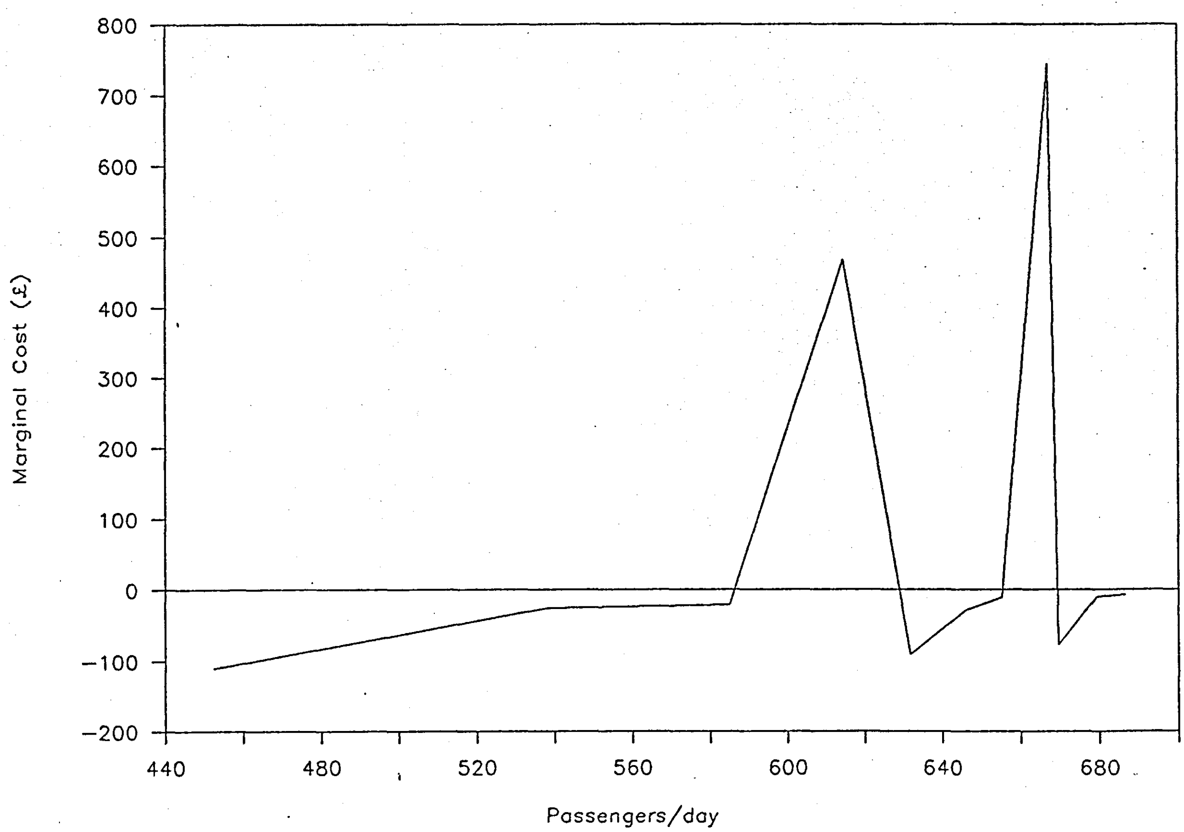


Fig. 6.8(a): Marginal Cost and Fare

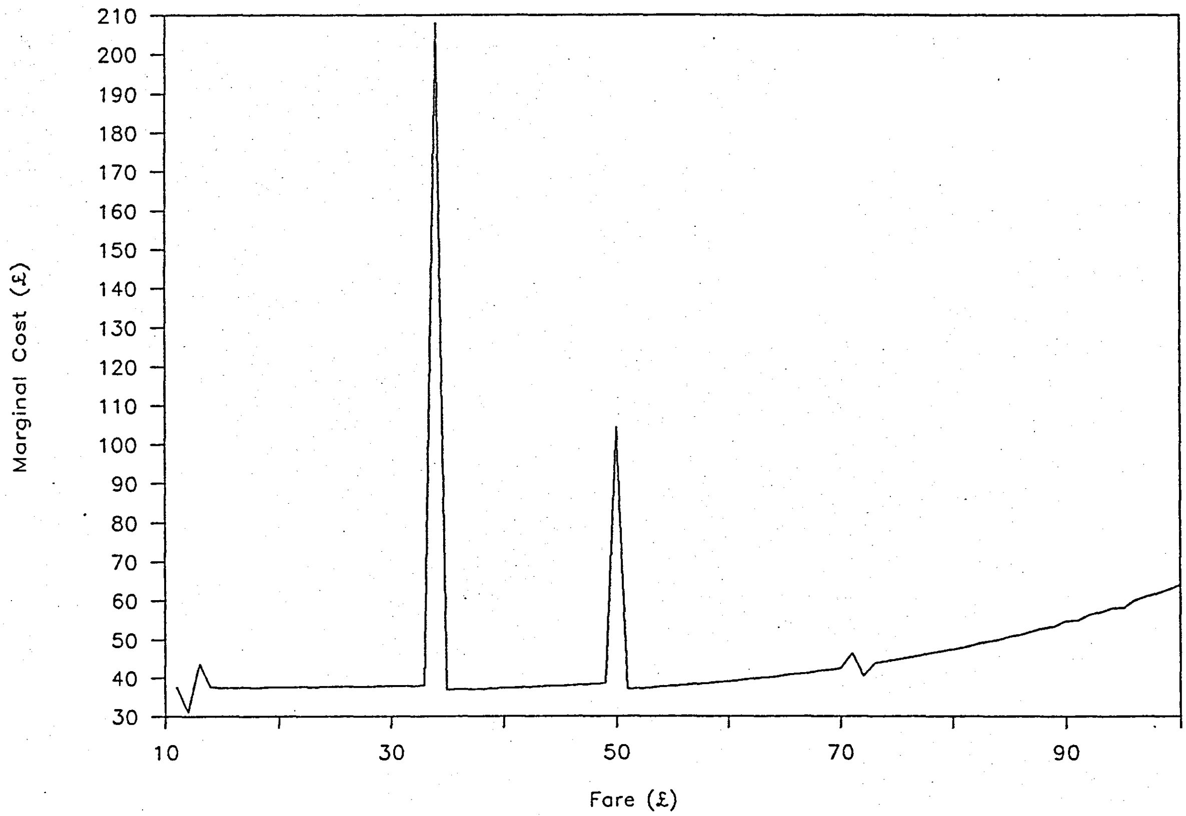
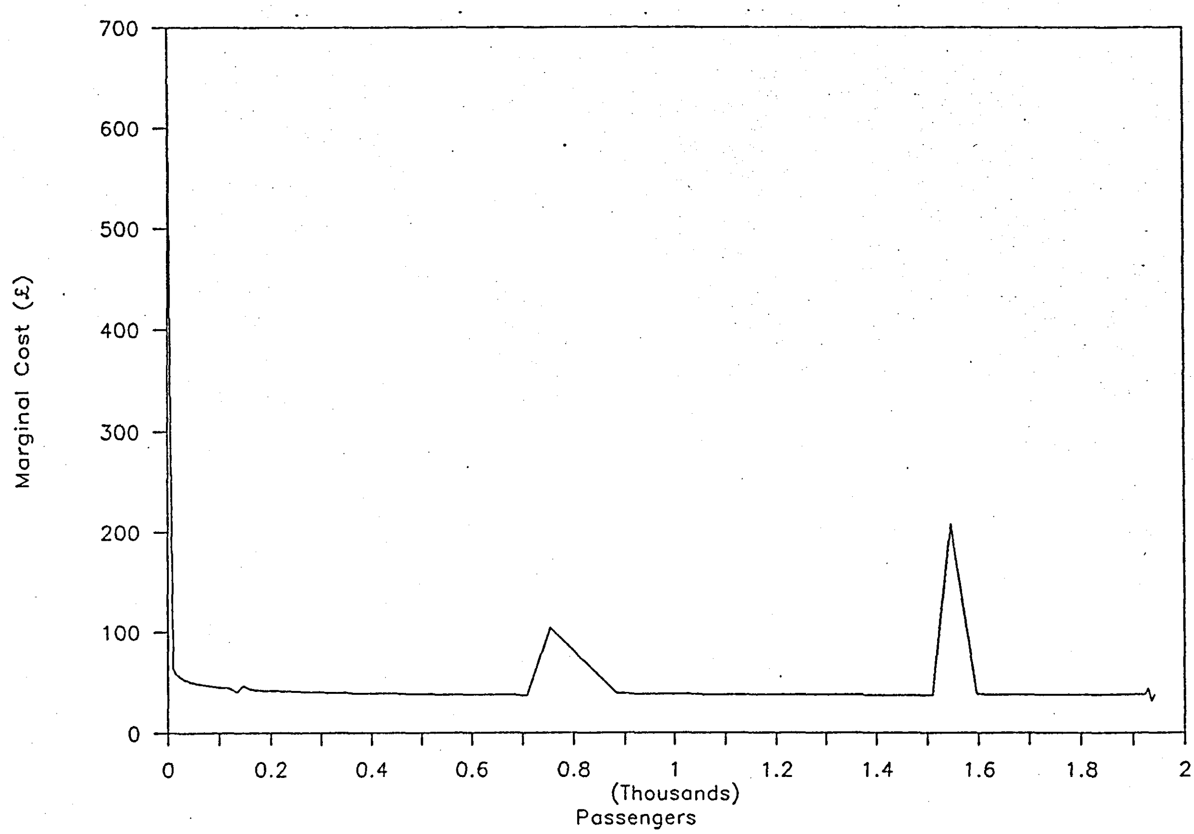


Fig. 6.8(b): Marginal Cost and Passengers



6.5 GENERAL IMPLICATIONS

The implications of using the cost model is that the operator always minimises costs if its flight frequency is equal to the maximum number of flights that each aircraft can operate. This is because as the flight frequency approaches the maximum number of flights that each aircraft can operate per day (i.e. four), passenger demand increases (with a declining rate of increase, see figure 5.8) and aircraft size decreases (Equation 6.10). As a result, while the total variable costs per day increase due to the increase in the number of flights (Equation 6.9), the fixed costs per aircraft decrease due to operation of smaller aircraft (Equation 6.11), leading to the decline in the total operating costs per day (see Figure 6.6). If the carrier increases its service frequency by even one flight more than the daily aircraft's maximum number of flights, it has to operate extra aircraft. Following Equations 6.9 and 6.11, while variable costs are a function of the number of flights, the fixed costs are a function of the number of aircraft. Thus the operation of an extra flight over the aircraft's maximum possible flight frequency, increases the variable costs by the cost of one additional flight whereas results in a sudden jump in the fixed costs (the integer effect). This results in a sudden rise in the total costs. Such a trend in the level of total costs implies that the total costs of operation per day is minimised if the carrier service frequency is equal to the maximum possible number of flights that each aircraft can make. This is due to the assumption that each aircraft is dedicated to the route under the consideration and all the fixed costs are therefore attributed to this route.

In the next chapter the reaction model is discussed. This model receives the output of the market share model (discussed in the Chapter Five) and cost model and simulates the air carriers reactions in terms of changes in their fares and flight frequency, until they reach a possible equilibrium.

CHAPTER SEVEN

THE REACTION MODEL

7.1 INTRODUCTION

This chapter discusses the reaction model. As was illustrated in the structure of the competition model (see Figure 4.1), this model receives the outcome of the market share and operating cost models developed in the previous two chapters. Using the market share model the effect of each carrier's policy (i.e. variation in level of fares or service frequency) on its own and the rivals' passenger demand is measured. With the aid of the costing model the total costs of carrying passengers for each operator are calculated.

The airline market characteristics were discussed in Chapter One. It appeared that the airline market is a close approximation to an oligopolistic market. As discussed there, one of the characteristics of such a market is that firms decisions are interdependent and are strategically linked to one another. In other words each firm recognises that its best choice depends upon the choice of its rivals, therefore they naturally are concerned with how their actions influence the behaviour of their rivals. In order to examine such relationships among the carriers and the possible outcome of such interdependent behaviour, the reaction model is developed in this chapter.

To be able to predict the carriers' behaviour, it is assumed that operators maximise an objective function, which is profit. As mentioned before it is possible that some operators have other objectives such as passenger miles maximisation or passenger generalised costs minimisation, but it is believed that profit maximisation can be an important motive for the carriers particularly when they operate in unregulated environments.

The reaction model demonstrates the reaction of each air carrier to its rivals, taking into account that their objective is profit maximisation. It also determines the possible equilibrium position that they reach. The equilibrium is defined as a consistent condition in which no carrier has any regret in deciding on its policy after observing the choice of the rival carriers. In other words it is a position where all carriers are maximising their objective and, considering the rivals' policy, there is no point in changing their policy.

7.2 STRUCTURE OF THE REACTION MODEL

In order to develop the reaction model two approaches can be adopted: the analytical method or the computational method.

7.2.1 Analytical Method

Assuming there are n carriers in the market and that they compete in terms of fare and service quality, the objective is to calculate each carrier's optimum level of service taking into account the rivals, service level. To do so the following steps ought to be taken:

a) Each carrier's share of market is calculated. The model estimating the carriers passenger demand was explained in Chapter Five. It could be seen from the market share model that each carrier's share of the market (P_i) is a function of not only its own fare (F_i) and service frequency (FQ_i) but is also a function of the rivals' fare and service frequency. Therefore the carriers demand function can be written as follows:

$$P_1 = P_1 (F_1 , FQ_1 , F_2 , FQ_2 , \ldots\ldots F_n , FQ_n)$$

$$\Delta P_1 / \Delta F_1 < 0$$
$$\Delta P_1 / \Delta FQ_1 > 0$$

$$P_2 = P_2 (F_1 , FQ_1 , F_2 , FQ_2 , \ldots\ldots F_n , FQ_n)$$

$$\Delta P_2 / \Delta F_2 < 0$$
$$\Delta P_2 / \Delta FQ_2 > 0$$

$$P_n = P_n (F_1 , FQ_1 , \ldots F_{(n-1)} , FQ_{(n-1)} , F_n , FQ_n)$$

$$\Delta P_n / \Delta F_n < 0$$
$$\Delta P_n / \Delta FQ_n > 0 \qquad (7.1)$$

b) Carriers total operating costs (TC1) are estimated. The costing model is discussed and developed in Chapter Six. The carrier's total operating costs are a function of their passenger demand. Passenger demand being a function of each carrier and the rivals' fare (F) and frequency (FQ), the cost function will have the following form:

$$TC_1 = TC_1 (F_1 , FQ_1 , F_2 , FQ_2 ,..F_n ,FQ_n)$$

$$\Delta TC_1 / \Delta F_1 < 0$$
$$\Delta TC_1 / \Delta FQ_1 > 0$$

$$TC_2 = TC_2 (F_1 , FQ_1 ,F_2 , FQ_2,..F_n , FQ_n)$$

$$\Delta TC_2 / \Delta F_2 < 0$$
$$\Delta TC_2 / \Delta FQ_2 > 0$$

$$TC_n = TC_n (F_1 ,FQ_1,F_{(n-1)} ,FQ_{(n-1)}, F_n , FQ_n)$$

$$\Delta TC_n / \Delta F_n < 0$$
$$\Delta TC_n / \Delta FQ_n > 0 \qquad (7.2)$$

c) The profit function is then obtained which is a function of each carrier's service level and its rivals', and has the following form:

$$P1 = P1 (F_1 , FQ_1 , F_2 , FQ_2 ,...F_n ,FQ_n)$$

$$P2 = P2 (F_1 , FQ_1 , F_2 , FQ_2,...F_n , FQ_n)$$

$$Pn = Pn (F_1 ,FQ_1,..F_{(n-1)} ,FQ_{(n-1)}, F_n , FQ_n) \qquad (7.3)$$

d) To obtain each carrier's optimum service level, the carrier's profit function must be differentiated with respect to its own fare and frequency and equated to zero, as follows:

$$d P_1 /d F_1 = 0 \qquad d P_1 /d FQ_1 = 0$$

$$d P_2 /d F_2 = 0 \qquad d P_2 /d FQ_2 = 0$$

$$d P_n /d F_n = 0 \qquad d P_n /d FQ_n = 0 \quad (7.4)$$

Solving the above equations simultaneously, the optimum service level of each carrier can be obtained. Further analytical development of this approach becomes problematic since each carrier's profit is a function of at least six factors, also analytical solutions will require the introduction of simplifications and restrictive assumptions. Therefore a computational procedure is adopted.

7.2.2 The Computational Method

The computational approach is illustrated in Figure 7.1. Assuming that there are three air operators in the market along with rail and foreign airlines, the modelling starts with the first carrier. Assuming the rivals' fare and flight frequency stay unchanged, it charges a fare and operates at a level of service which maximises its objective. In response to this the second carrier adjusts its fare and service frequency considering the changes the first operator has introduced. The second carrier continues adjusting its service level and fare until its objective is fulfilled. The same procedure is followed by the third carrier taking into account the changes in the other two carriers' fare and service level. The first carrier, considering the adjustment the rivals have made, re-examines its fare and service frequency to maximise its objective. This process is repeated until an equilibrium is reached for the three carriers.

As mentioned in Section 4.3, in this study, it is assumed that the carriers' objective is profit maximisation. Therefore each carrier re-examines its service in response to those of the rivals, in order to maximise profit.

Given the input data described in Table 4.1, for a range of fare, service frequency or a combination of them, to obtain the profit earned by each operator the competition model calculates for each carrier their:

- passenger defer time,

- passenger generalised costs,

- passenger demand,

- aircraft size,

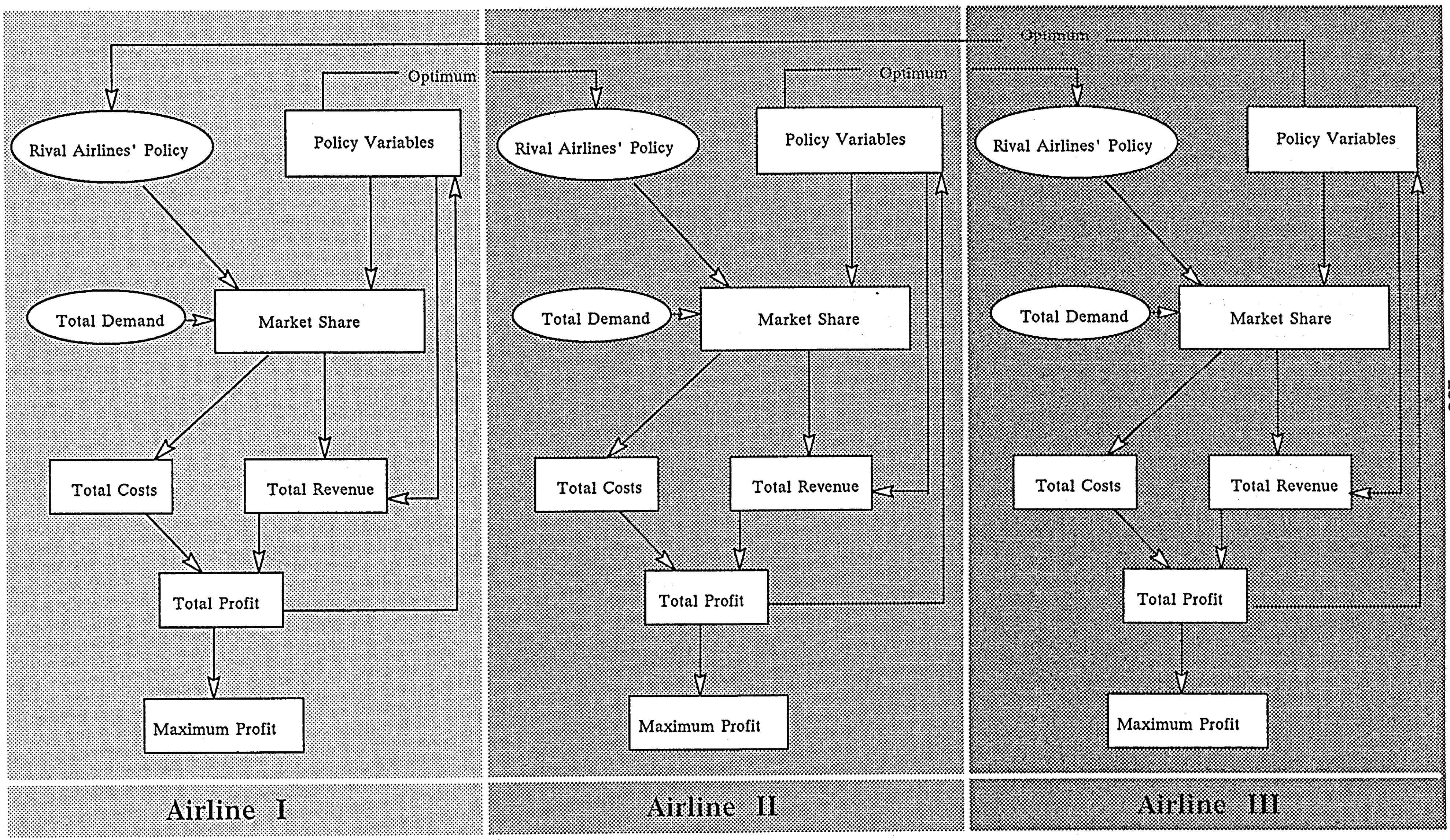


Fig. 7.1 : The Reaction Model

- number of required aircraft,
- revenue,
- total operating costs and
- profit.

The performance of the competition model is discussed in detail in the next section where the model is run under different conditions.

7.2.3 The Reaction Model Performance

In this section a complete base run of the model is demonstrated and the results are discussed in relation to the assumptions. This provides both a validation and evaluation of the basic functioning of the model.

To study the process of the model until the carriers approach an equilibrium and to show the effect of the assumption on the outputs, the model is run under each of the following conditions:

Variable fare
Variable service frequency
Variable fare, service frequency and ease of entry and exit.

The assumptions are referred to in each relevant section.

The listing of the competition model computer program and its sequence is illustrated in Appendix C.

7.2.3.1 Variable fare

Under this condition fare is variable and service frequency is fixed (i.e. each carrier operates at four return flights per day). It is assumed that there are three carriers in the market which react to each other's policy. There are also rail and the foreign airlines operating in the market which do not react to the three main airlines. Furthermore it is assumed that total demand (air plus rail) is constant (the assumption on this matter is discussed in detail in Section 4.3 and the level of service frequency operated by rail and foreign airlines and the fare charged are illustrated in Table 4.1). The computer modelling process for carriers approaching an equilibrium is illustrated in Figure 7.2. The procedure is as follows:

-In the first iteration the model calculates the first carrier's (BA) optimum fare, considering the rivals' present level of fare. To assess the optimum fare, the carrier profit for a range of fares is calculated. (The process of calculating carriers' profit was outlined in the previous section). Then through a maximisation technique the optimum fare at which the carrier's profit is maximised is identified. Figure 7.3(a) illustrates BA's costs and revenue while Figure 7.3(b) shows its profit as the level of fare changes. It can be seen that as fare increases from a low level, revenue increases up to a certain point after which it starts to decline (see Section 5.3.3 for the discussion on the revenue and fare relationship). It can also be seen that the increase in fare results in a reduction in the total costs due to the reduction in passenger demand (this is discussed in Section 6.4). As long as total costs are less than revenue, the carrier is clearly making a profit and where the difference in the total costs and revenue is the largest the carrier is maximising profit (i.e. at fare equal to £53) after which any further increase in fare leads to the decline in profit. Figures 7.4(a) and 7.4(b) illustrate the marginal cost and marginal revenue as fare increases and the resulting passenger demand decreases, respectively. It can be seen as long as the marginal cost is greater than the marginal revenue any increase in fare leads to the decline in number of passengers and increase in the profit until the marginal cost is equal to the marginal revenue where profit is maximised. After this point any increase in fare results in decrease in passenger demand which leads to marginal revenue being greater than marginal cost. As a result the profit declines. It must be mentioned that as fare is reduced from £50 the carrier's passenger demand increases to a level that it needs to operate more than four flights. This explains the trend in the marginal cost and revenue at fares less than £50. For the discussion on the marginal revenue and marginal cost see Section 5.3.3 and Section 6.4 respectively.

- In the second iteration the model calculates the second carrier's (BCal) optimum fare, following the same procedure as for BA. Figure 7.5(a) shows BCal's loss at various levels of fare. This

Fig. 7.2 : Carriers Reaching Equilibrium Under Variable Fare

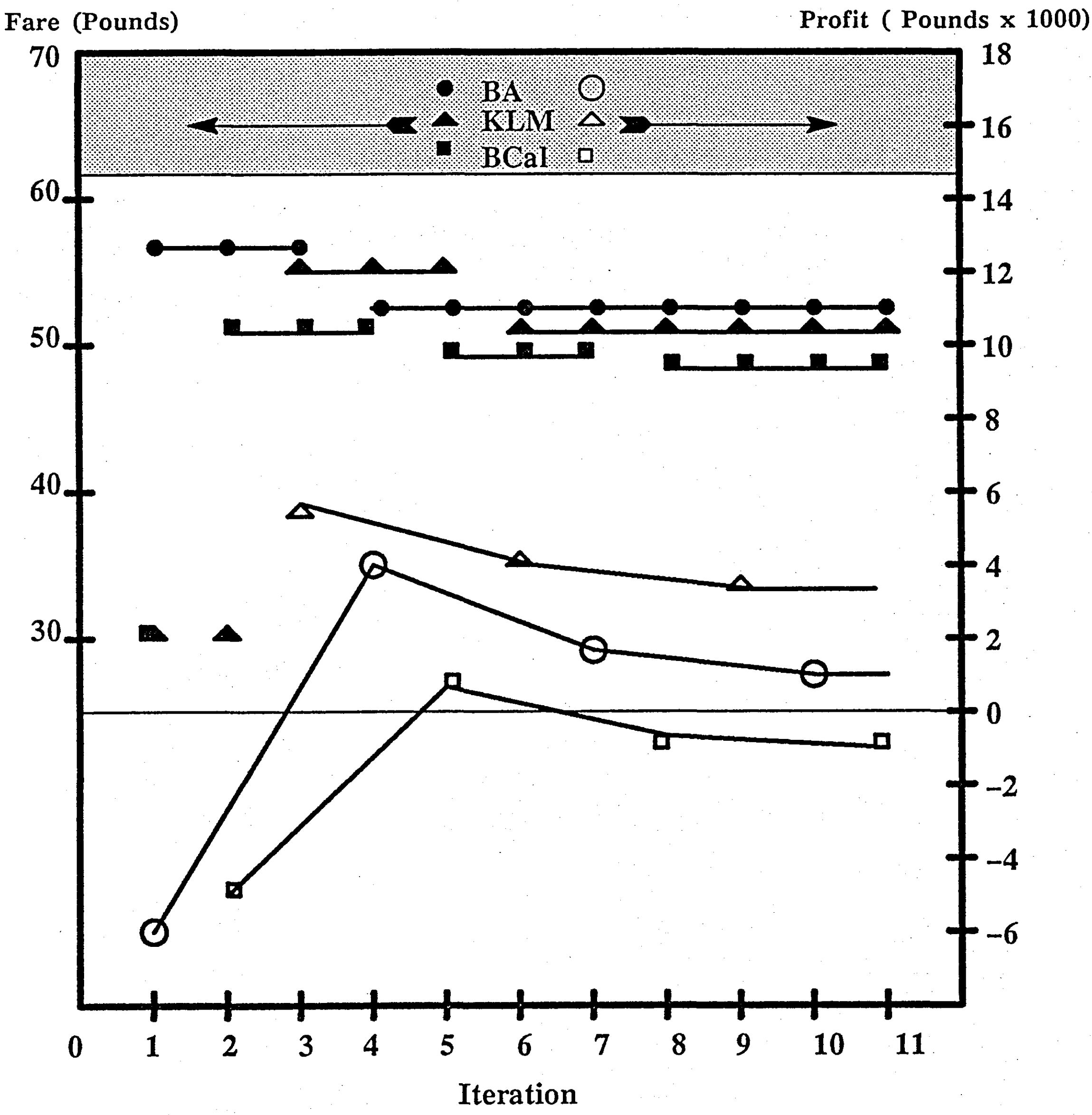


Fig. 7.3(a): Total Costs, Revenue and Fare

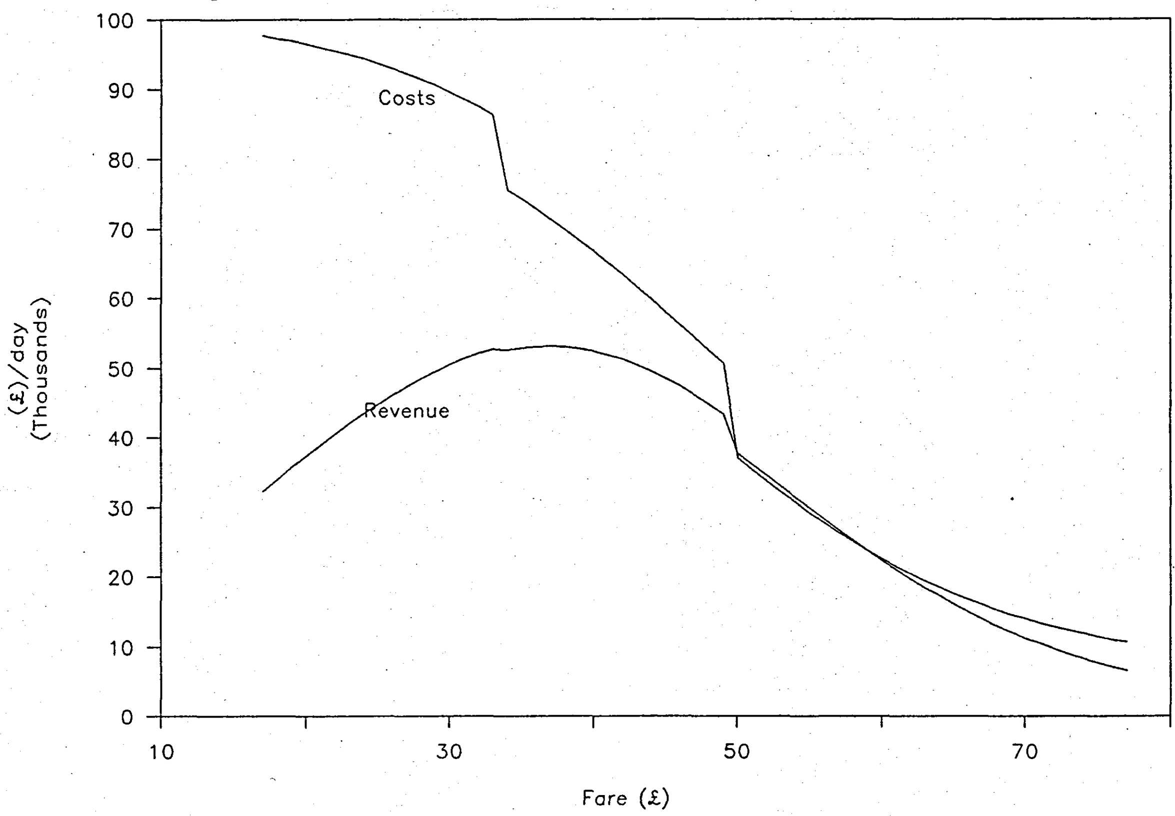


Fig. 7.3(b): Profit and Fare

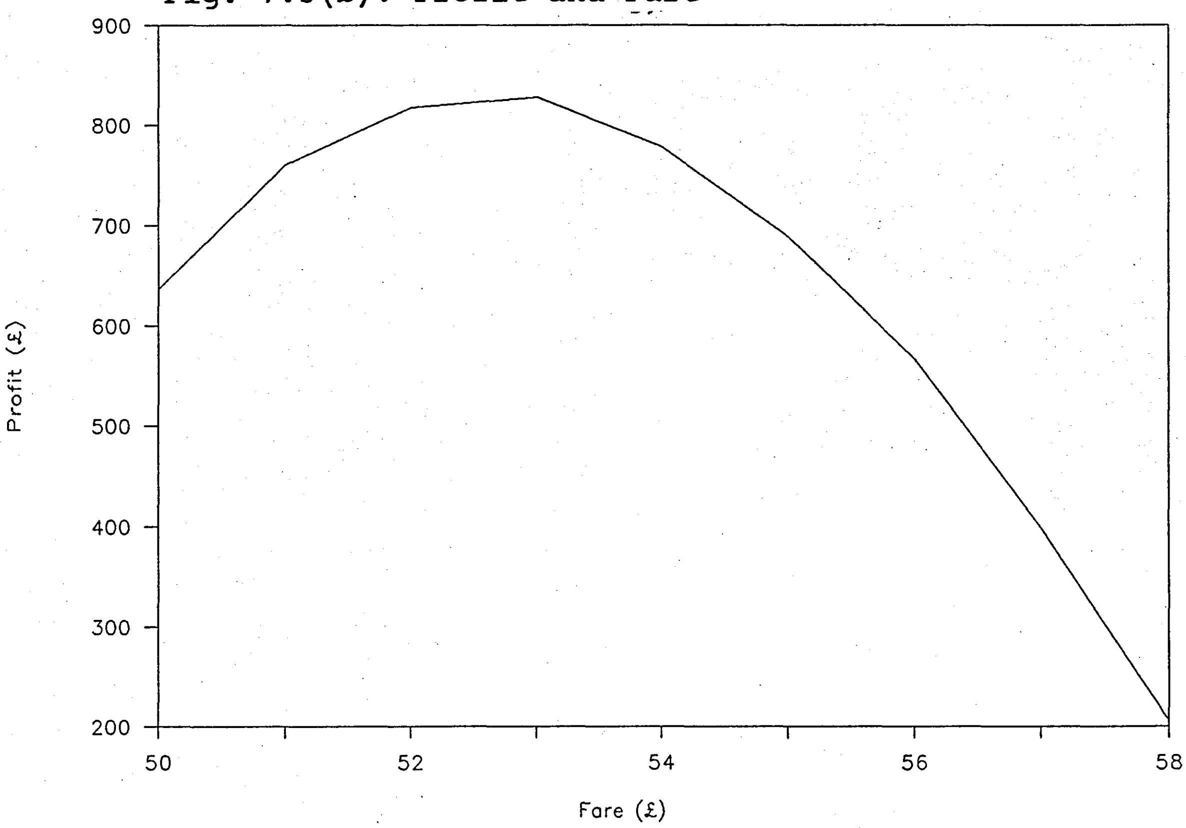


Fig. 7.4(a): Marginal Cost, Marginal Revenue and Fare

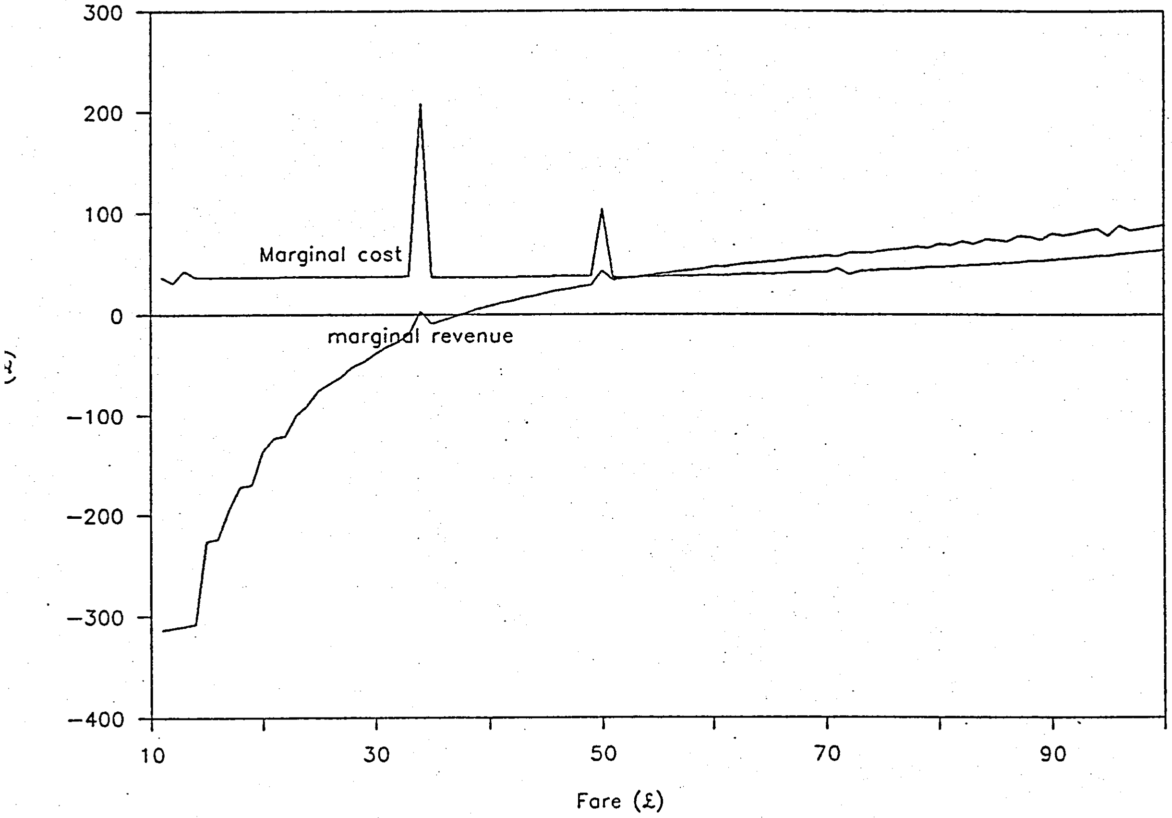
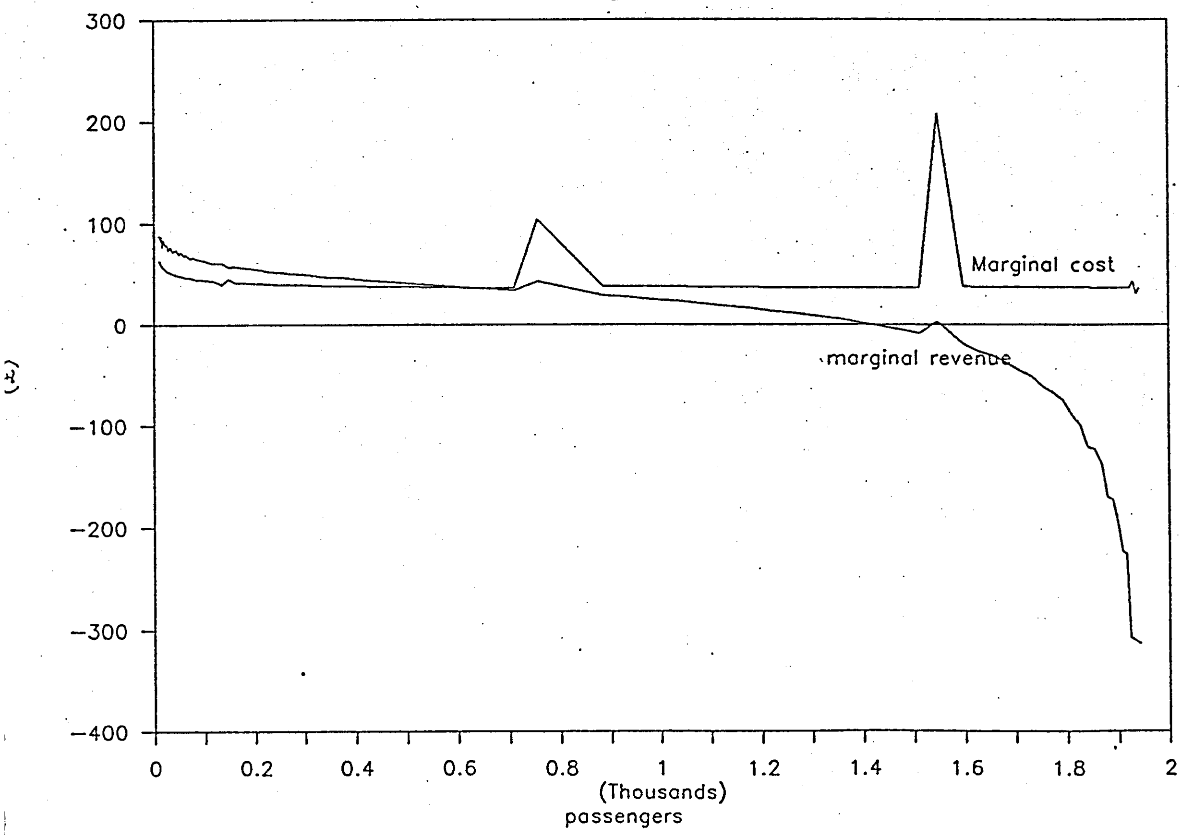


Fig. 7.4(b): Marginal Cost, Marginal Revenue and Passengers



time BA's optimum fare and the third carrier's present level of fare are taken into account in the calculation.

- In the third iteration the third carrier's (KLM) optimum fare is assessed, taking into account the rivals' optimum fares. Figure 7.5(b) demonstrates KLM fares and the resulting profit.

- In the fourth iteration BA's optimum fare is re-calculated in response to the changes in BCal and KLM fares.

It can be seen from Figure 7.2 that each carrier's optimum fare is calculated in every third iteration and once a carrier's optimum fare is assessed it stays constant through the next two iterations. This procedure is continued until each carrier no longer changes its optimum fare. This would be an equilibrium position, since any change in their fare level deteriorates their financial position.

Figure 7.2 also shows that at equilibrium point the highest fare is charged by BA, the lowest fare by BCal. In terms of profit KLM makes the highest profit while BCal makes a loss. The reason for such differences in the carriers' fare and resulting profit lies in the assumptions made about them. These airlines are different from each other in terms of cost structure, load factor and initial generalised costs. Based on 1984 real cost data BA has the highest cost level, BCal's level of cost is 87% and KLM's 92% of BA's. In terms of load factor BA operates at 0.65, BCal at 0.62 and KLM at 0.63. The smaller carrier has a generalised costs handicap which could be due to operating from the secondary airport and passengers having less loyalty which is associated with smaller carriers. This is done by building a modal constant into BCal generalised costs (see Section 5.3.2).

The results indicate that the high cost carrier (BA) charges the highest fare and still makes some profit (revenue/cost ratio of 1.02). This is due to use of the logit model (Equation 5.10) in determining the carriers' market share. As was discussed in Section 5.3.3, this model allows the carrier with the lowest utility to capture a certain share of the market. Therefore although BA charges the highest fare it can still attract some passengers. This is because the logit model is based on the theory that passengers choice is probabilistic. The causes of such a stochastic choice were discussed in Section 5.2.2. The carrier with the generalised costs handicap (BCal),

Fig. 7.5(a): BCal's Profit and Fare

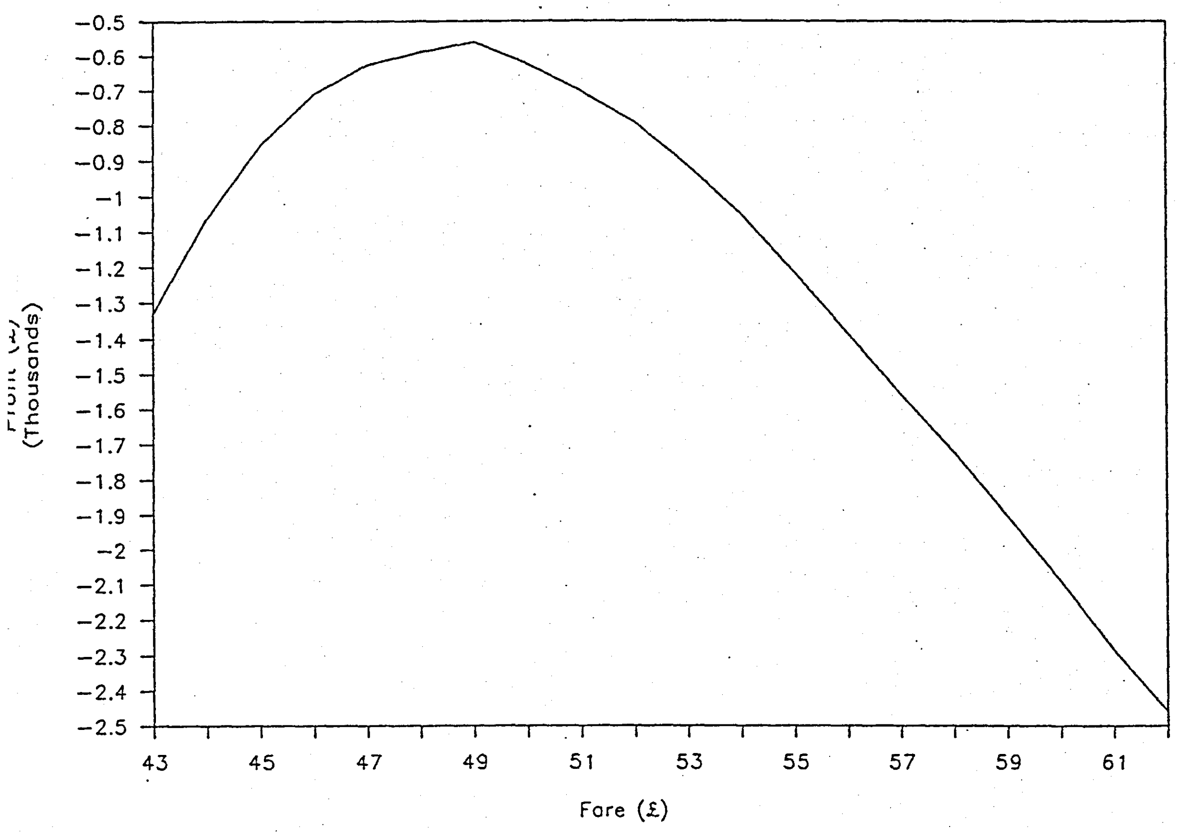
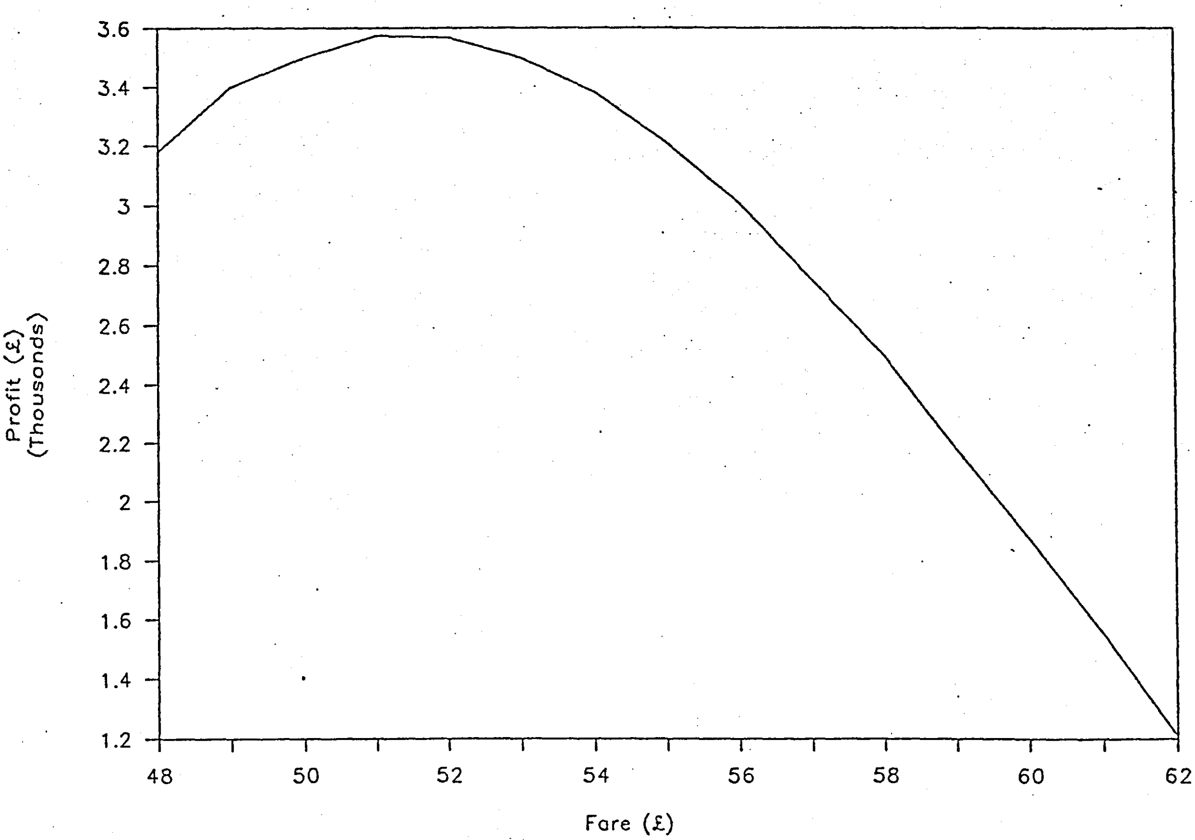


Fig. 7.5(b): KLM's Profit and Fare

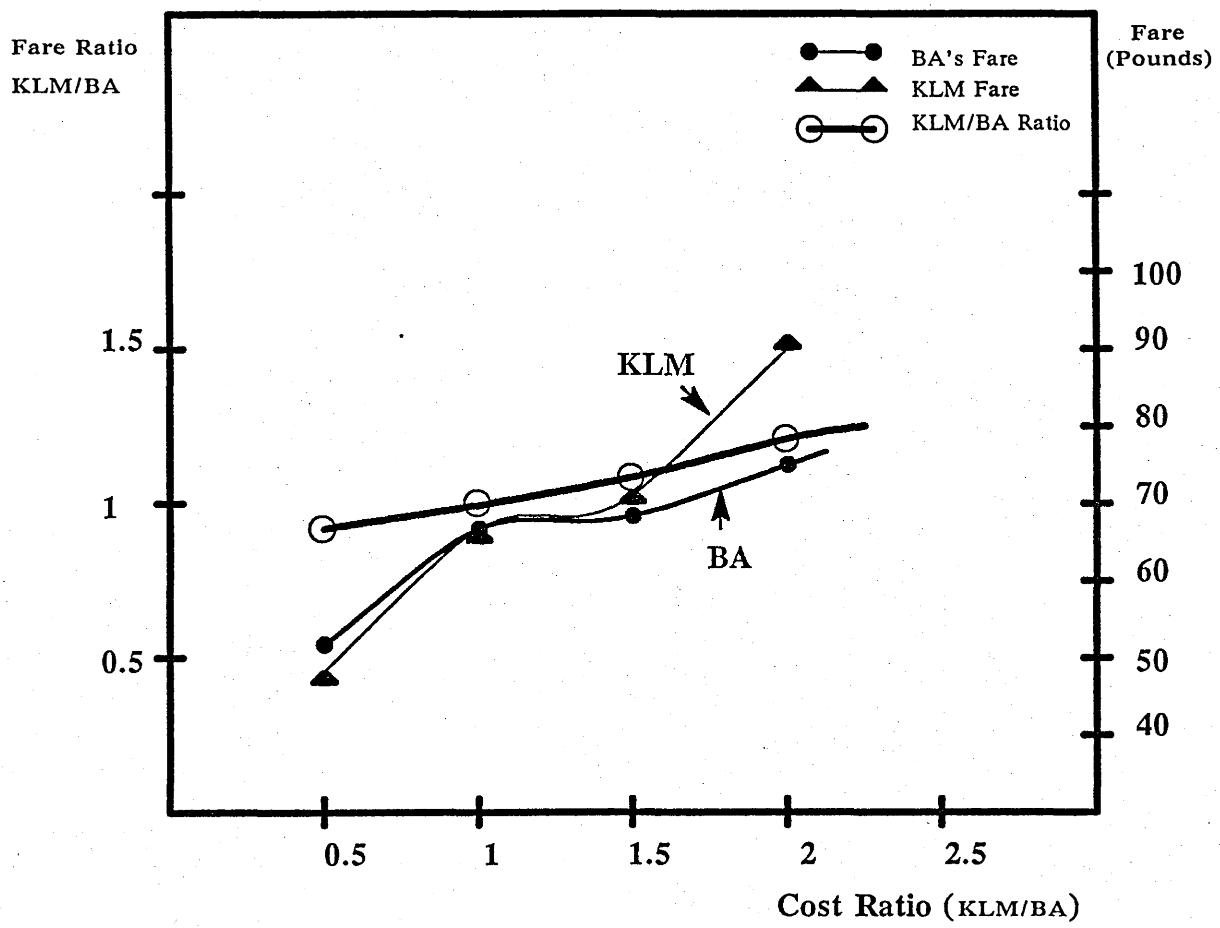


despite charging the lowest fare, makes a loss (revenue/cost ratio of 0.97). This is because, although this carrier has the lowest cost structure, its initial generalised costs are assumed to be higher than the other two carriers. This is as a result of operating from a secondary airport and the lower level of loyalty that passengers might have towards the smaller airlines (this point was discussed in Section 5.3.2). Therefore to obtain the smallest possible loss this carrier has to charge a lower fare (to compensate for it genralised costs handicap). KLM charges a fare which is less than BA's and higher than BCal's, and makes the highest profit. This carrier has an advantage over BA by having a lower cost structure and over BCal by not having a generalised costs handicap. Since the carriers' load factors are not very different from each other, they do not affect the carriers' operation comparatively.

In order to demonstrate the effect of difference in the carriers' cost structure on their level of fares and profit at their equilibrium position, the model is run for two carriers (BA and KLM). BA's level of costs is kept constant and KLM costs are varied. It must mentioned again that rail and foreign airlines are present in the market and do not react to BA's and KLM's policy. Also under this condition carriers can increase their service frequency if they attract more passengers than they can carry by four flights. Figure 7.6 illustrates the trend in the carriers' fare ratio as their cost ratio changes. It can be seen that as KLM costs get closer to those of BA (ratio of KLM to BA costs approaching 1), the difference between the carriers' fares lessens (fare ratio moves towards 1). When the carriers have identical cost structure (their costs ratio=1), they charge identical fares (fare ratio=1). As KLM costs exceed those of BA (cost ratio in excess of 1), the gap in carriers' fares widens (fare ratio in excess of 1). It must be mentioned that when KLM's costs are half those of BA, in order to be able to carry its passengers, it has to operate twice as many flights as BA's. At all the other cost ratios they operate the same number of flights.

Such a relationship illustrates that the closer the cost structure of the carriers the smaller the difference in the level of fares. It also shows that the carrier with the highest cost base always charges the highest fare. It can also be seen from Figure 7.6 that the carriers' fare ratio curve is flattened. This illustrates the effect of competition where carriers charge a fare very close to the level charged by the rival. This results in the fare ratio being

Fig. 7.6 : Carriers Cost Ratio vs Their Fare Ratio



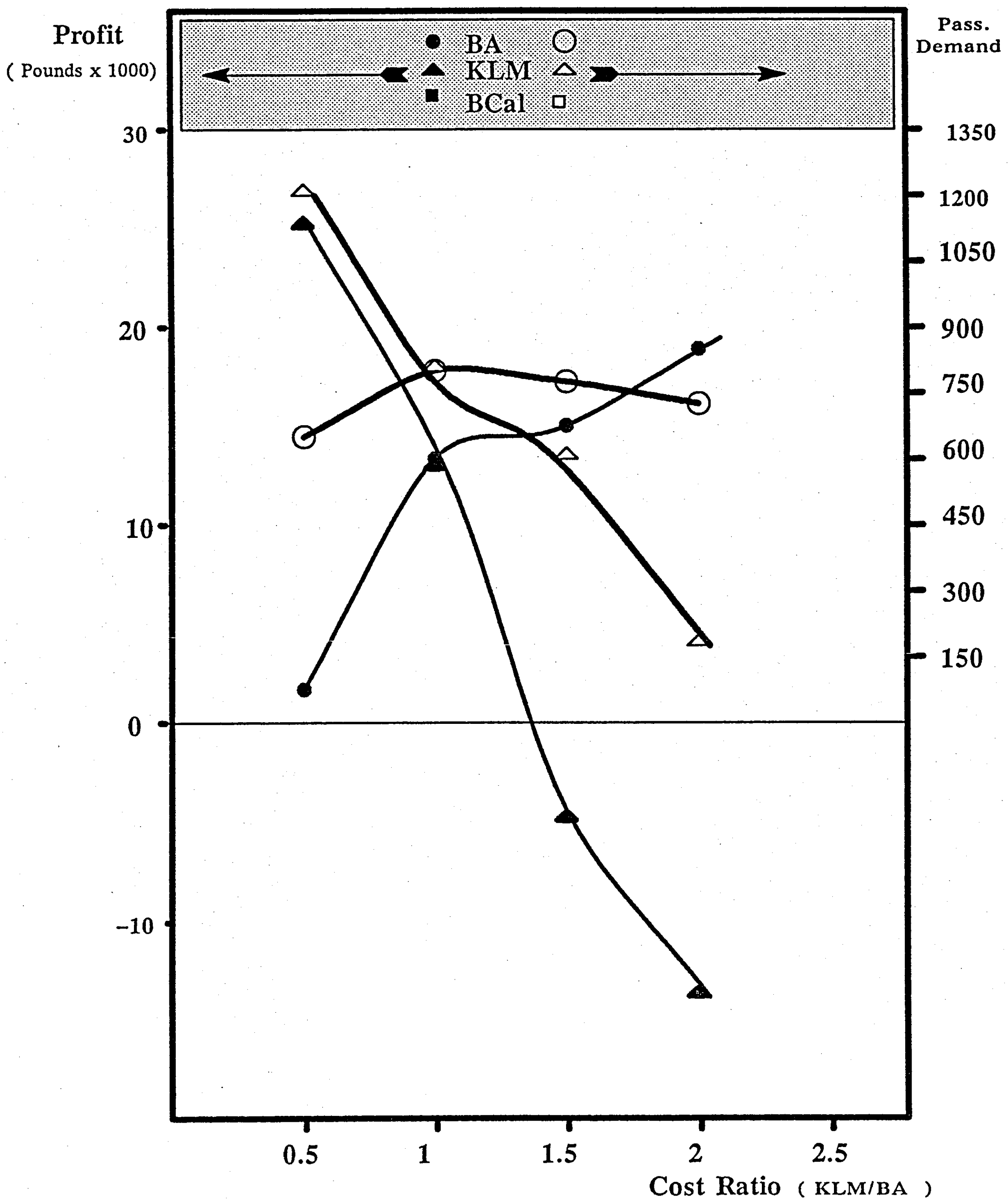
around 1.

Considering the actual fare charged by BA and KLM in Figure 7.6 , it can be seen that as KLM's costs in relation to BA's increase, not only KLM's fare but also BA's fare increases (it still stays less than KLM's). The increase in KLM's fare is mainly due to the rise in its costs. BA's fare increases because as long as its fare is lower than its rivals it can attract more passengers. This follows the pattern expected from the logit model elasticity which was discussed in the Section 5.3.3.

Figure 7.7 illustrates the airlines' passenger demand and profit as their cost ratio changes. It can be seen that the closer the carriers' cost structure, the smaller the difference between their passenger demand and profit. It was shown that when carriers' level of costs is about the same their level of fares also tend to be similar (Figure 7.6). As a result their market share and profit are similar. This follows the pattern expected from Equation 5.10. Figure 7.7 also illustrates that as KLM costs increase in relation to those of BA, its passenger demand decreases due to the increase in its fare. BA's passenger demand increases (despite the increase in its fare) up to a certain level after which it starts to decline. This is because although its fare rises, it is still lower than KLM's. Thus BA can absorb some of the passengers that KLM has lost. After certain level of fare, BA starts to lose passengers to rail and foreign airlines as a result of further increases in its fare.

It can also be seen from Figure 7.7 that the expensive carrier or the carrier with the higher cost structure can survive depending on the level of costs of providing air service as a whole in the industry. For example when BA costs are twice those of KLM (the ratio of KLM to BA costs is equal to 0.5) the two carriers make a profit whereas when KLM costs increase to twice those of BA (the ratio of KLM to BA costs equal to 2), KLM make a loss and only BA makes a profit. At this point the difference between BA's profit and KLM's loss is greater than the difference between their profits when their cost ratio is equal to 0.5. This is due to a greater difference between these carriers' costs, at cost ratio of 2. As mentioned at the beginning of this section, BA's costs are kept constant and KLM's costs are increased. Therefore when KLM's costs are half those of BA the difference between their costs is smaller than when their costs were twice those of BA's.

Fig 7.7 : Carriers Cost Ratio vs Passenger Demand & Profit



In summary it can be said that the airline with the highest level of cost always charges the highest fare in the competitive market. Such an airline always attracts a proportion of the market. The reason for this was discussed in terms of the properties of the logit model used in estimating the carriers' market share. The expensive carrier can generally survive, depending on the cost of provision of air services as a whole. The smaller carrier with a generalised handicap charges the lowest fare and finds it difficult to continue business. The carrier which has a lower cost level than BA and does not have a generalised cost handicap always performs financially better than its rivals in the market. It was also shown that the smaller the differences in the carriers' cost level, the smaller the differences in the operators' fares and the resulting level of passenger demand and profit. When operation of two of the carriers (BA and KLM) was considered, it was illustrated that the higher cost operator which always charges the higher fare makes the lowest profit.

7.2.3.2 Variable service frequency

Under this condition it is assumed that all the carriers charge a fixed fare of £70 and compete on the basis of service frequency. The process of carriers reaching an equilibrium is illustrated in Figure 7.8. The process, which is similar to that of variable fare condition, is as follows:

-In the first iteration, the model calculates from a range of flight frequencies, the first carrier's (BA) optimum flight frequency, taking into account the rival's present level of service. This is done by calculating BA's profit for different levels of service. Figure 7.9 illustrates BA's profit at various numbers of flights. It can be seen that as flight frequency increases, the profit increases up to a certain level (the maximum number of flights that one aircraft can operate per day which is equal to four flights) after which it drops to a lower level and starts to rise again. The reason for profit starting to decline at four flights per day lies in the assumption that carriers operate on a single route and each aircraft can make a maximum of four return flights per day. This implies that the aircraft is dedicated to the route and would not be used elsewhere. As a result its fixed costs are attributed only to the route under study. It is also assumed that the load fac-

Fig. 7. 8 Carriers Reaching Equilibrium Under Variable Flight Frequency

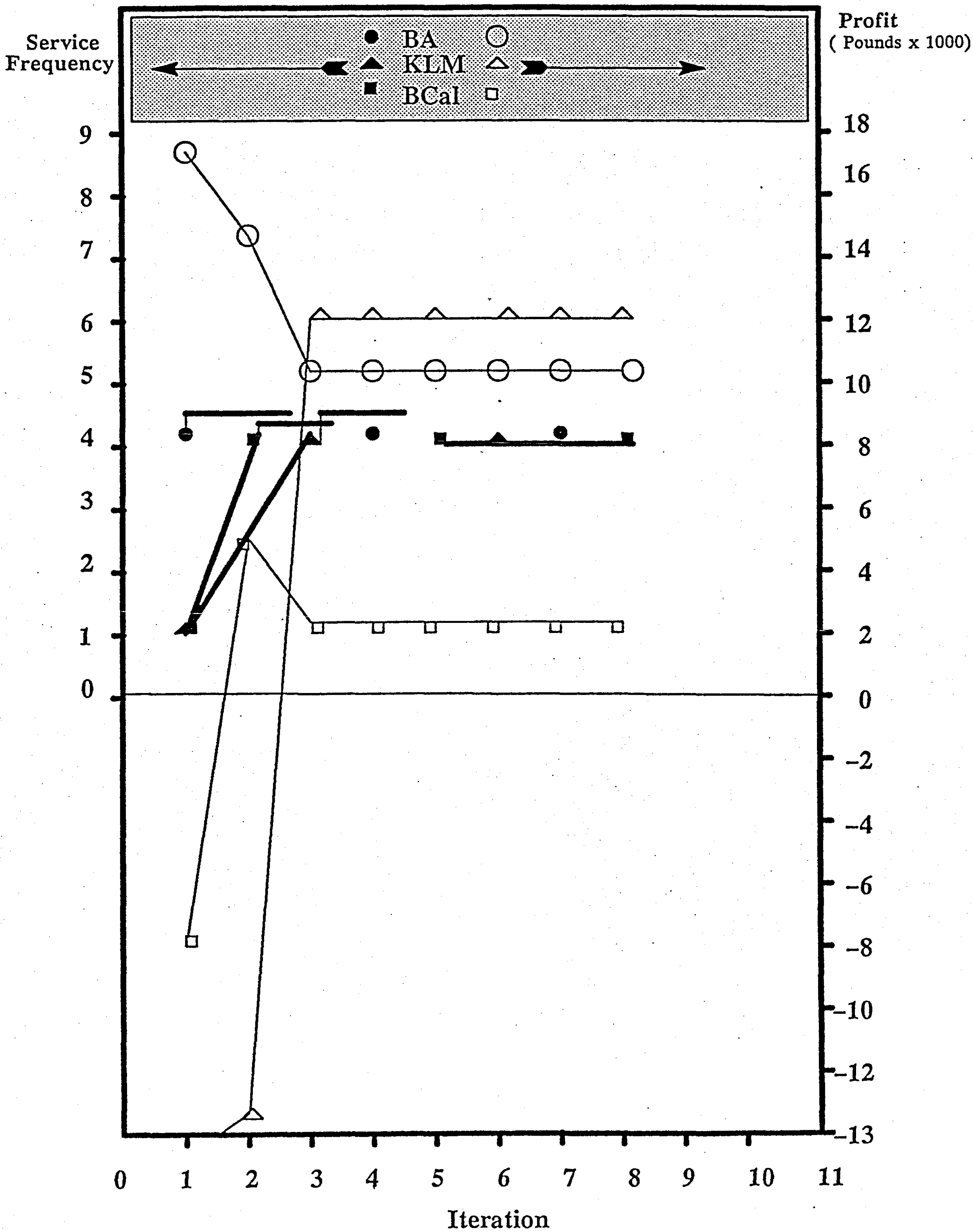
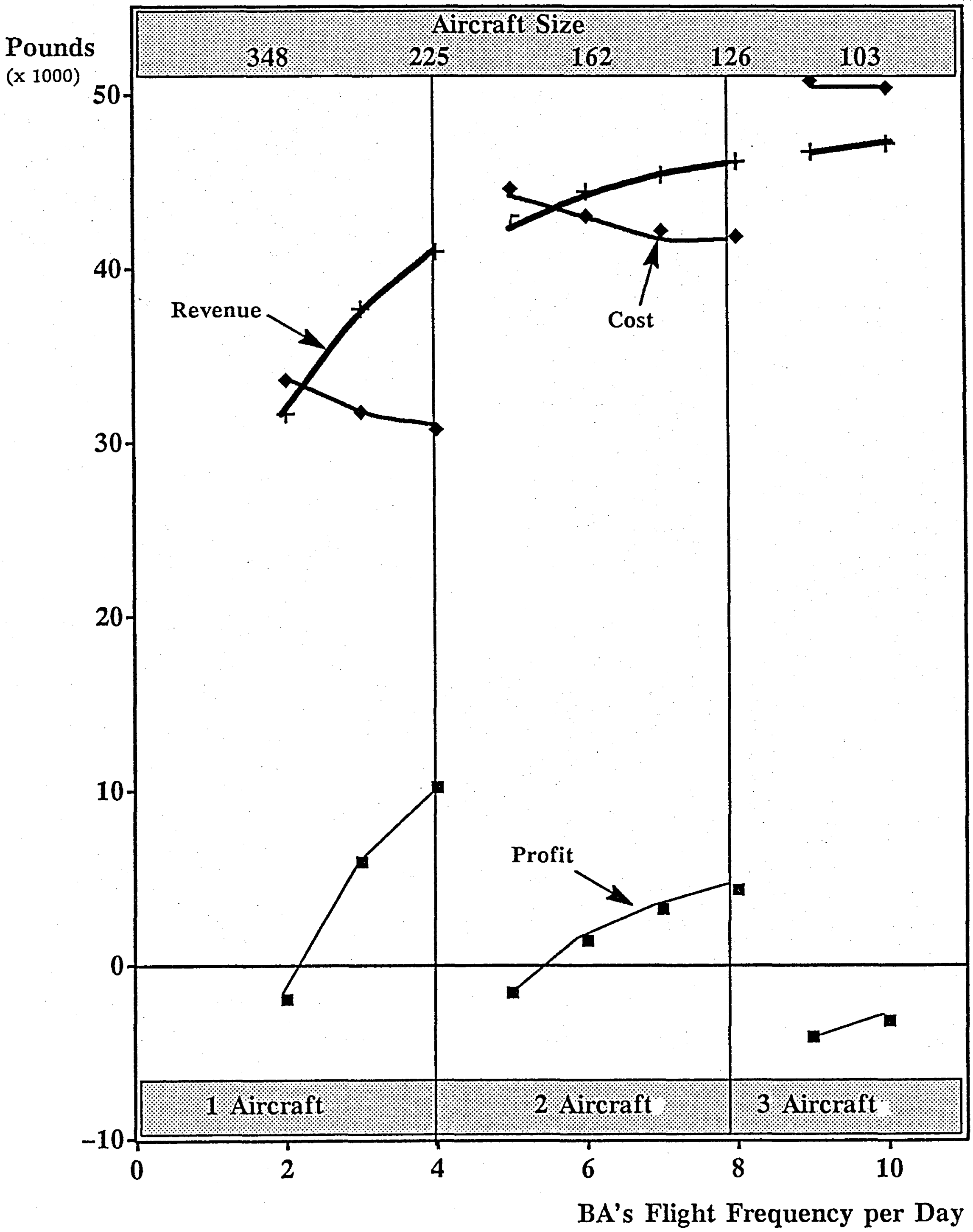


Fig. 7.9 : BA's Flight Frequency vs Cost, Revenue and Profit



tor is fixed and operators can choose the optimum aircraft size. Therefore if carriers operate at less than four flights per day they have to acquire a larger aircraft. This leads to higher operating costs. (The relationship between flight frequency and operating costs was discussed in Section 6.4). At the same time for any service frequency less than four, the carrier market share declines due to higher defer time at lower service frequency (Equation 5.11). Since under this condition fare is fixed, the lower the carrier's passenger demand the lower is its revenue. It can be seen from Figure 7.9 that as service frequency approaches four the operating costs decline and revenue increases. Operation of more than four flights per day results in increase in the number of required aircraft and decrease in aircraft size. Such a situation would lead to a jump in the total operating costs due to the integer effect, and a decrease in profit. Thus four flights per day is the optimum service frequency at which the airline makes the maximum profit.

- In the second iteration, following the above procedure, the model calculates the second carrier's (BCal) optimum flight frequency taking into account BA's optimum service frequency and KLM's present level of service. Figure 7.10 illustrates BCal's profits for different levels of service.

- In the third iteration , taking into account the other two rival's optimum level of service, the third carrier's (KLM) optimum flight frequency is obtained. Figure 7.11 illustrates KLM's various levels of service and its resulting profits.

- This process of calculating carriers' optimum flight frequency is continued until carriers' optimum service frequency does not change in any of the following iterations. This is when the carriers are said to have reached an equilibrium. It can be seen that at such a position each carrier operates the maximum number of flights that each aircraft can operate per day (i.e. four return flights). These results, as said earlier, are mainly affected by the single route assumption which was discussed in the Section 6.4. The highest profit is made by KLM and the lowest by BCal. The pattern of carrier profit making is similar to that of variable fare. In other words KLM is always in a better financial

Fig. 7.10 : BCal's Flight Frequency vs Profit.

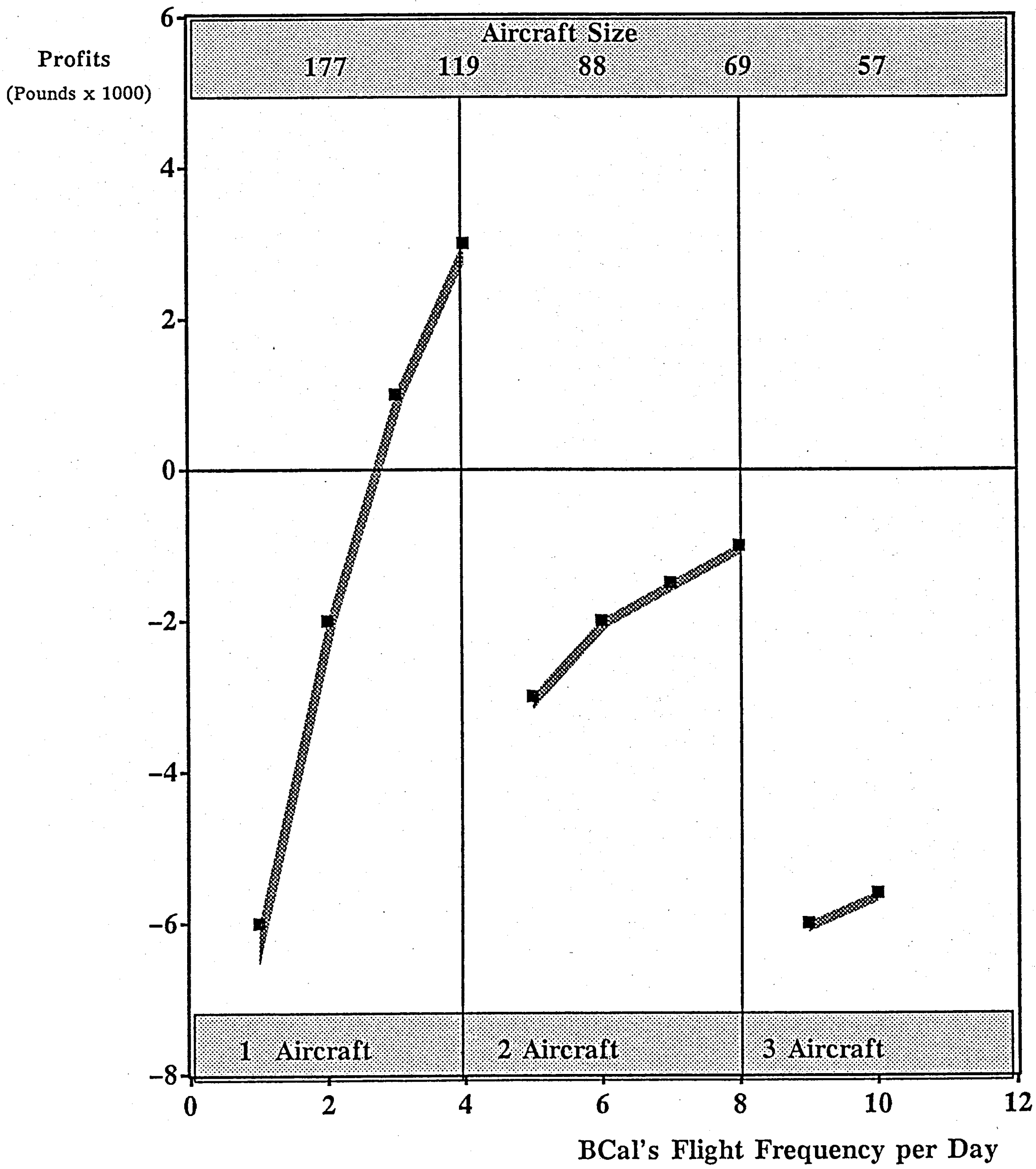
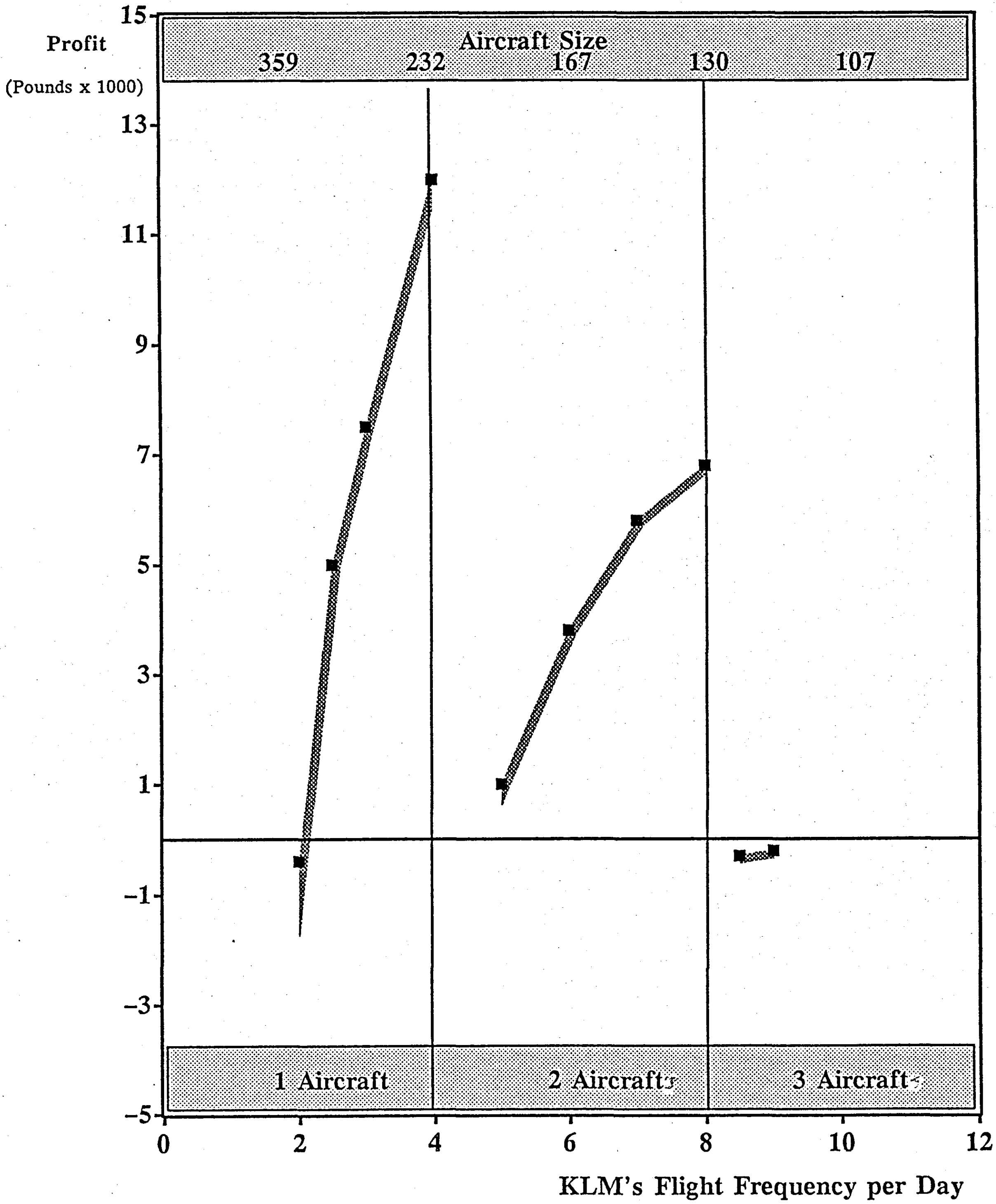


Fig. 7.11 : KLM's Flight Frequency vs Profit.



position. In contrast BCal, despite having the lowest cost level, due to generalised costs handicap, makes the lowest profit.

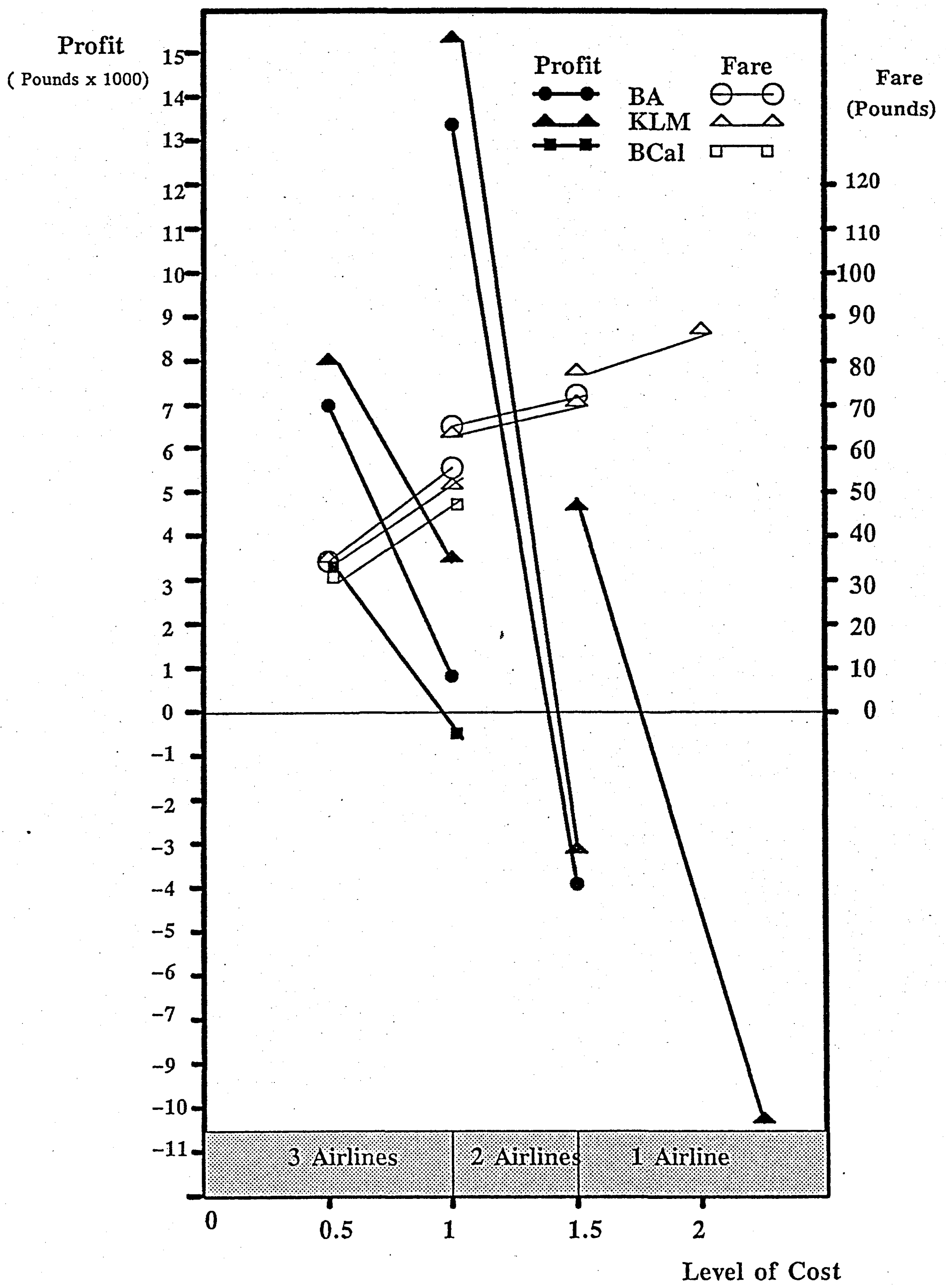
7.2.3.3 Entry and exit

Under this condition fare and service frequency are variable. The costs for provision of air service for all the carriers are also varied. It must be noted that their cost level in relation to each other is not changed (BCal level of costs is 87% of BA's and KLM's costs is 92% of BA's). It is assumed that the airline which makes a loss, as a result of an increase in the costs, leaves the market. Figure 7.12 illustrates carriers' fare and profit at their equilibrium position at different cost levels. Service frequency is not illustrated on the Figure, as each airline's resulting optimum service frequency is four at various levels of cost.

It can be seen that when the costs for all the carriers are halved (cost level=0.5), at equilibrium position, they offer a lower fare and all make a profit. As the level of cost approaches 1 (this is the level that is input to the model), there is a decline in the carriers' optimum fare and profit. At a cost level of 1, only two airlines (BA and KLM) make a profit (maximum profit) and BCal makes the minimum possible loss. It can be seen that once the loss-making carrier leaves the market, at the same cost level, the two surviving airlines optimum fare and profit increase to a higher level. When a further increase in the costs is incurred (cost approaching the level increased by 1.5), a similar picture emerges which is the two surviving carriers' optimum fare increase, and their profit declines. At this cost level both carriers make a loss. When the higher loss-making carrier (BA) leaves the market there is an increase in the optimum fare of the only surviving airline (KLM), and its loss is turned to a profit. When the costs are doubled, there is a further increase in the optimum level of fare and the only carrier left in the market also makes a loss.

Figure 7.12 not only illustrates the effect of rise in airline operating costs on carriers' level of fare and resulting profit, it also shows the impact of exit or entry at each cost level on the airlines' performance. The effect of entry can be observed if the Figure is considered from right to left. Assume that when an airline makes a profit, it encourages another airline to enter the market. KLM's profit at

Fig 7.12 : Carriers Cost Level, Their Optimum Fare & Profit



cost level, increased by 1.5, attracts the operation of a new carrier (i.e. BA) into the market. It can be seen that as a result of operation of the new entrant, fare and profit are pushed down.

The reason for the carriers' higher fare and profit after the exit of the loss-making airline is that when the loss-making carrier leaves the market, a proportion of its passengers is absorbed by the surviving carriers. The level of passenger demand that these carriers attract depends on the difference between their passenger generalised costs and that of rail and foreign airlines. Assuring that the total demand is constant, as long as these carriers passenger generalised costs are lower than rail and the foreign carriers, they can increase their fare and still capture a higher share of market. The elasticity of passenger demand with respect to fare was discussed in the Section 5.3.3. The higher share of market and higher fare at each cost level clearly results in a higher level of profit.

Considering the trend in the surviving carriers' profit, it can be seen that as cost level increases the surviving carriers' profit rises to a certain level, (at cost level=1), after which it starts to fall. This is because as cost level increases from 0.5 to 1, as discussed above, there is a greater increase in the surviving carriers' revenue due to a large increase in their optimum fare and market share. The increase in the fare at this point reflects the increase in cost level. Although the optimum level of surviving air carriers' fare is increased, their resulting passenger generalised costs are still lower than those of rail and the foreign air carriers. When cost level is increased from 1 to 1.5, the only surviving carrier increases optimum fare is increased but at a lower rate. This is because its resulting passenger generalised costs are getting very close to those of rail and foreign airlines. Based on the logit model (Equation 5.10), the closer this carrier passenger generalised cost is to that of rail and the foreign airlines the lower will be its market share. At this point although this carrier increased its fare it does not fully reflect the rate of increase in cost level. This carrier still has a higher market share than rail and the foreign airlines, but the difference is small due to their similar level of passenger generalised costs. All this results in an increase in revenue which is not in line with the rise in cost. This results in a lower level of profit being made by the surviving carrier when costs are increased by 1.5, than when they are increased from 0.5 to 1. These results indicate that the maximum level of profit is earned if the cost level stays at the level which is input to the model (cost level=1), and there are two carriers in the market.

7.3 GENERAL IMPLICATIONS

The implications of the reaction model are as follows:

- In equilibrium, the highest fare is always charged by the carrier with the highest cost base (BA) while the lowest fare is always charged by the carrier which has the generalised costs handicap and the lowest cost base.

- Carriers optimum service frequency, at the possible equilibrium, would always be equal to the maximum number of flights that each aircraft can operate per day. This is mainly due to the property of the costing model (i.e. the integer effect) such that carriers minimise costs at such a level of flight frequency (Section 6.4). It is also due to the trend in passenger demand, namely that as the number of flights increases the increase in passenger demand slows down as a result of the lower reduction in the defer time (Figure 5.8). Therefore as the service frequency approaches the aircraft's maximum number of flights, total costs decrease while passenger demand and revenue increase at a declining rate (Figure 7.9). This results in maximum profit being made at a service frequency equal to each aircraft's maximum number of flights.

- The maximum profit, at the equilibrium position, is always earned by KLM, the carrier which does not have a generalised cost handicap and has the lower cost level than BA. This enables KLM to capture a higher market share than the other two air carriers and to make the highest profit in the market. The lowest profit is earned by BCal which has the generalised costs handicap. The outcome of the reaction model indicates that the higher the cost level, the higher is the fare at equilibrium and the lower is the profit. It also illustrates that the higher the initial passenger generalised costs, the lower is the fare and the lower the profit.

- As the level of cost for all the carriers increases, fares increase, profit decreases and as a result the number of carriers that can continue the operation falls. For a given cost level, once the loss-making airline leaves the market there is a further increase in the surviving carrier's fare and profit. This indicates that for a given cost level, there is a relationship between the number of operators and level of fare and profit. This relationship is: the lower the number of carriers the higher the fare and profit, given that the level of passenger demand in the total market is constant. This is because the lower the number of carriers in the market the higher is the chance for the operating carriers to increase their market share (Equation 5.10) to support a profitable operation.

In this section the behaviour of the competition model approaching equilibrium was studied. The model outcome under three policy variables (fare, frequency and entry or exit) was discussed in relation to the assumptions. This was to validate the model and to illustrate its functioning and assumptions. In the next part, with the aid of the model, carriers' operation under the partially and completely deregulated environments is analysed.

PART III

THE CARRIERS' OPERATION UNDER PARTIALLY AND FULLY DEREGULATED ENVIRONMENTS

INTRODUCTION

In Part I of this study the general characteristics of the airline market were discussed and a number of policy questions was raised regarding the effects of partial deregulation and complete deregulation in Europe. It is the purpose of this part of the study to address these policy questions. This is done with the aid of the competition model which was developed in Part II.

The impacts of the partial deregulation (the effects of deregulation of one aspect of airline operation compared with some other aspects) are discussed in Chapter Eight. While the effects of the complete deregulation on routes and markets, and on carriers with different characteristics, are studied in Chapters Nine, Ten and Eleven respectively. A series of sensitivity tests is undertaken in Chapter Twelve. These explore the effects on the performance of the carriers of variation in some of the assumptions and the input variables.

As mentioned in the previous chapter, initially all the carriers are operating along the same route (London - Amsterdam), at various levels of operating costs (BCal 87% of BA's and KLM 92% of BA's). It is assumed that aircraft size is variable and carriers operate at different predetermined levels of load factor (BA at 0.65, BCal at 0.62 and KLM at 0.63). It is stated in Section 5.3.2 that the smaller carrier (BCal) has a generalised costs handicap. Total passenger demand is assumed to be fixed (2000 per day). These characteristics are later changed in a systematic way, effectively representing other routes. The assumption on the nature of carriers' competition was outlined in Section 4.3.

In the previous chapter, Section 7.2.3, the computer modelling process for carriers reaching equilibrium was discussed. In this part, carriers' performance as illustrated in the tables, only represents the end point of the model's run. The tables demonstrate the carriers' operation, at a position where they are maximising profit or minimising losses at equilibrium. Under each set of operating conditions, the technical results in relation to the properties of the model are discussed and the general implications arising from the carriers' operation are outlined.

CHAPTER EIGHT

THE AIRLINE'S OPERATION UNDER PARTIALLY DEREGULATED ENVIRONMENTS

8.1 INTRODUCTION

It is the purpose of this chapter to address the policy question which was raised in Part I (Section 2.6) in relation to the impacts of partial deregulation.

From an economist's viewpoint, control over three aspects of any industry determines its nature. These are price, level of output and entry and exit of firms into and out of each market. This chapter, examines airline operation when control over each or any combination of these aspects of the airline industry is removed. Table 8.1 illustrates the conditions under which the carrier's operation is analysed. Such analyses determine the differences in the impacts of the different conditions listed in Table 8.1.

Table 8.1 Partially Deregulated Environments

	Deregulation of		
Condition	Fare	Frequency	Market entry/exit
I	NO	YES	NO
II	YES	NO	NO
III	YES	YES	NO
IV*	YES	YES	YES

* This condition is discussed in detail in Chapter Eleven.

Under each condition, the operations of air carriers at their possible equilibrium position are analysed in relation to the properties of the model. The analysis is carried out in terms of carriers' level of fare, flight frequency, resulting passenger generalised costs, passenger demand, aircraft size and financial performance. Then at the end of the chapter the general implications of carriers' operation under partially deregulated environments are outlined.

8.2 DEREGULATED SERVICE FREQUENCY

Under this condition it is assumed that the fare level and market access is regulated and carriers have the freedom to decide on the level of service frequency. Since it is assumed that the carriers objective is profit maximisation (see Section 4.3), they operate at a flight frequency that maximises their profit, taking into account their rivals reactions. Under this condition the carriers therefore charge a fixed fare which is set by the regulators. In order to determine such a level of fare, the industry profit (the sum of carriers' profit) for different levels of fare is calculated. This is illustrated in Figure 8.1. It can be seen that within a certain range of fares (i.e. between £49 and £96) the industry has a profitable operation and at fare equal to £72 it maximises profit. If fare is set too low (less than minimum fare in the range) the industry makes losses despite capturing a large proportion of the market. This is due to the higher costs of operation and lower revenue at such low fares. If the fare is set too high (above the maximum fare in the range), the airline industry loses passengers to the other mode of transport (i.e. rail) or the foreign air carriers. Thus there would not be enough air passengers to support profitable operations. It is therefore unlikely that regulators set fare outside the profitable fare range. Otherwise the loss-making carriers have to either eventually leave the market or, be subsidised. It is also less likely that the fare is set above the level at which the industry maximises profit. This is because such fare levels deter more passengers to travel by air, and also reduce the industry's profit. It seems, therefore, that the fare is set below or at the maximisation level depending on the regulator's objective. In this study it is assumed that the fare is set at £70 (this is a normal fare charged by carriers over the route under consideration in 1985). It is also assumed that carriers can choose the aircraft size which would be a function of their market share and the predetermined level of load factor.

Following the process discussed in the Section 7.2.3.2, each carrier adjusts its service frequency in reaction to changes in the rivals' flight frequency until they reach an equilibrium.

The airlines' operation at their equilibrium position is illustrated in Table 8.2. As can be seen:

- There is a clustering of frequency (i.e. at equilibrium each carrier operates four flights). This is due to the costing model which is based on the assumption that carriers operate on a single route and the total fixed costs of aircraft are dedicated to that route (see Section 6.4 for the properties of the cost model). As a result each carrier's optimum service frequency is equivalent to the maximum number of flights that an aircraft can operate in a day.

- The resulting passenger generalised costs of the two larger airlines (BA and KLM) is the same due to the similar level of operation (the same fare level and service frequency), while BCal's passenger generalised costs are higher by 9% reflecting its higher initial generalised costs. The foreign air carriers and rail passenger generalised costs are higher than BA and KLM by 10%, because of their lower service frequency, and rail's higher on-board journey time.

- The carriers with a higher level of passenger generalised costs capture a lower number of passengers. This is due to the property of the logit/market share model (see Equation 5.10 and Section 5.3.3). As a result BCal's passenger demand is 50% less than the other two air carriers. The same picture emerges when the foreign airlines and rail operation is considered. The difference in the carriers' passenger demand compared with the difference in their generalised costs, illustrates the high elasticity of passengers with respect to the increase in the generalised costs of travel (this point was discussed in Section 5.3.3).

- Although all airlines operate the same number of flights, the results of the model indicate that they would operate different aircraft sizes. This is due to the differences in the carrier's market share and load factor. Thus the two larger airlines (BA and KLM) operate aircraft which are 50% larger than BCal's. (The airlines' operation of fixed aircraft size with variable load factor is discussed in Section 12.4).

- The three air carriers make a profit. KLM earns the highest profit amongst the carriers op-

Table 8.2 : Carriers' Operation Under Deregulated Flight Frequency

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	70	4	78	586	225	1	10218	1.32
BCAL	70	4	85	297	119	1	3218	1.18
KLM	70	4	78	586	232	1	12038	1.41
OA	70	2	87	256	-	-	-	-
RAIL	29	3	86	278	-	-	-	-

BA = British Airways
BCAL = British Caledonian
OA = Foreign Airlines
F = Fare (£)
FQ = Service Frequency
GC = Passengers Generalised Costs(£)

D = Passenger Demand/day
ACT = Aircraft Size
NACT = No. of Aircraft
P = Profits (£)
R = Revenue(£)
TC = Total Costs(£)

erating in the market. As was discussed in Section 7.3, this is due to the advantages that it has over BA by having a lower cost structure, and over BCal by not having a generalised costs handicap. The lowest profit is earned by BCal, despite having the lowest cost level.

The implications of deregulation of service frequency are as follows:

- the British air carriers' capture a higher share of the market than the Dutch carrier. Between the three of them, the British airlines carry 60% of the market while the Dutch carrier serves the rest.

- the market share and profit of the airline with the higher initial generalised cost is lower than the other major air carriers. This is despite the provision of the same level of service and fare as the other major carriers, and having the lowest cost level amongst the carriers operating in the market.

8.3 DEREGULATED FARE

Under this condition carriers have the freedom to decide on the level of fare, but they are unable to vary service frequency, and market entry is regulated. Under this condition the carriers therefore operate a fixed number of flights which is determined by the regulators. In order to identify such a fixed level, the industry profit for different levels of service frequency by each carrier is calculated (see Figure 8.2). In this study it is assumed that the regulators set service frequency at four flights per carrier per day. This is because at any service frequency less than four the carriers' cost is higher (see Figure 6.6), and a lower level of passengers travel by air (see Figure 5.8) due to the increase in passenger defer time (Equation 5.11). Therefore it is beneficial neither to the passengers nor to the operators. If the flight frequency is set at a higher level, (e.g. eight flights), the industry operating costs fall by a large amount due to the costing model integer effect. There is not therefore going to be a large increase in the airlines market share due to the declining rate of increase in passenger demand as service frequency increases (see Figure 5.8). Therefore it is assumed every carrier operates four flights per day. Such an assumption

Fig. 8.1: Industry Profit and Regulated Fare

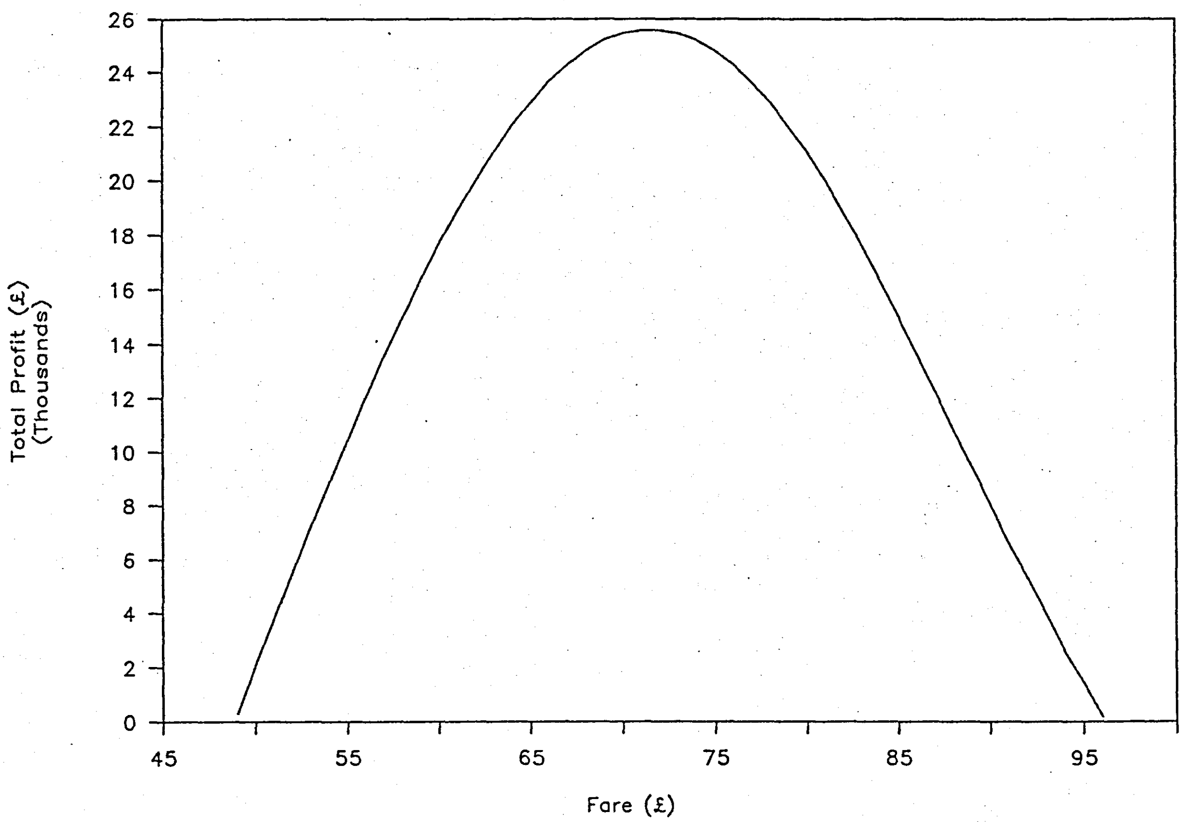
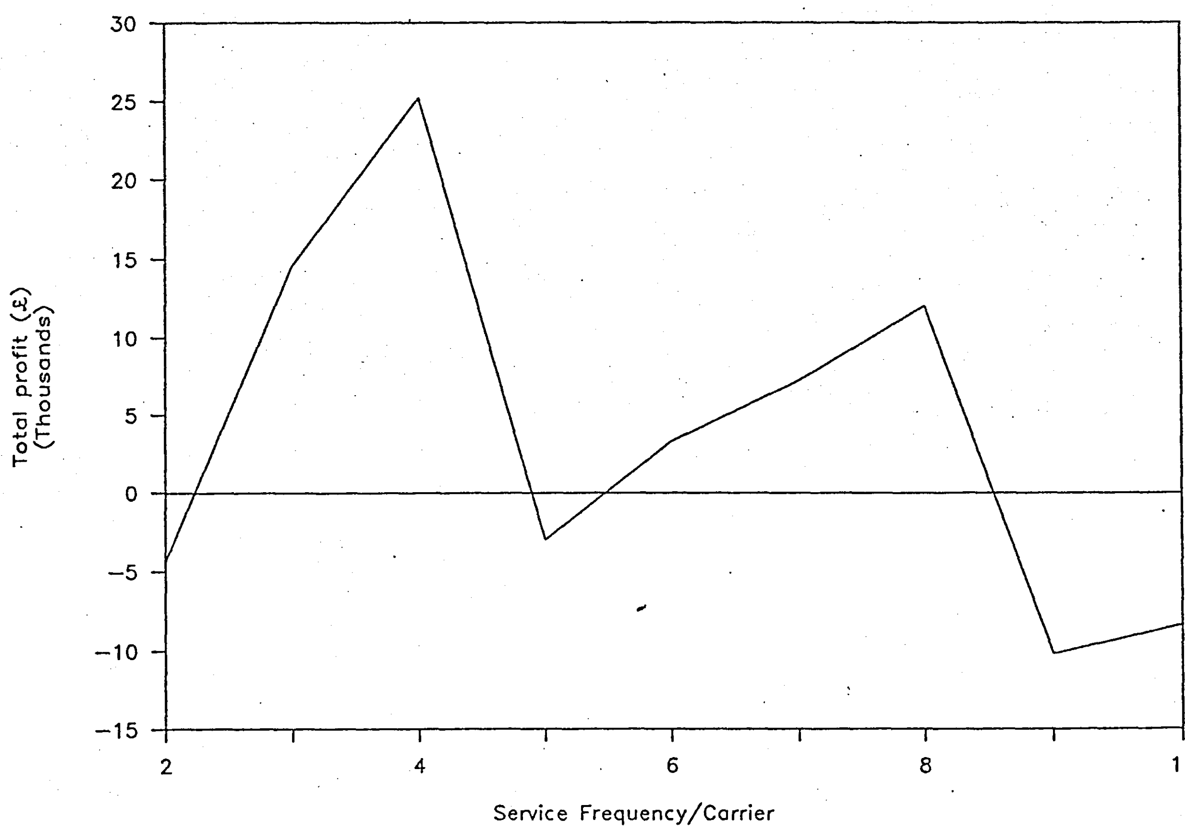


Fig. 8.2: Industry Profit and Regulated Service Frequency



also enables the comparison of the effects of fare deregulation with those of deregulated flight frequency (or regulated fare). This is because in both cases carriers operate at an equal level of flight frequency.

Table 8.3 illustrates the model's end results (carriers equilibrium position) for a deregulated fare. The analysis of the carriers' operation indicates that:

- BCal charges the lowest fare in the market. This is to compensate for its higher initial generalised costs. Whereas BA, which has the highest cost level (8% higher than that of KLM and 13% higher than that of BCal), charges the highest fare. This illustrates the relationship between costs and fare, that the carrier with the highest resource cost charges the highest fare in the market (see Section 7.2.3.1). This also shows why the US high cost carriers had to lower their resource cost in order to be able to offer competitive fares in the markets which lower-cost carriers entered (Section 2.5.5).

- BCal's passenger generalised costs are higher than those of BA and KLM despite charging the lowest fare. This is because of its higher initial passenger generalised costs. KLM has the lowest passenger generalised costs due to having cost level lower than that of BA (enabling it to offer a lower fare), and having lower initial passenger generalised costs than Bcal. KLM generalised costs are lower than those of BA by 3% and those of BCal by 6.5%. Rail and the foreign airlines' generalised costs are higher than that of the air carriers by 40% . This is because of rail's higher on-board journey time, and the foreign airlines' higher fare and lower service frequency.

- The carrier with the lowest passenger generalised costs (KLM) , has the highest share of the market. This follows the pattern expected from the market share model (Section 5.3.3). KLM's passenger demand is higher than that of BA by 21% and BCal by 46%. Rail and the foreign airlines' market share are the lowest. They have 2.5% of the market. This is due to their higher passenger generalised costs.

- As far as financial performance is concerned, KLM makes the highest profit while BCal makes a loss and BA makes a small profit. The pattern of the carriers' financial performance follows the

Table 8.3 : Carriers' Operation Under Deregulated Fare

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	53	4	61.3	623	239	1	827	1.02
BCAL	48	4	63.3	513	206	1	-588	0.97
KLM	51	4	59.3	716	300	1	3574	1.10
OA	70	2	86.8	53	-	-	-	-
RAIL	29	3	86.0	57	-	-	-	-

* For the key to the variable symbols see table 8.2

pattern of their passenger generalised costs. As mentioned before KLM has a better position compared with BA since its cost level is lower by 8%, and compared with BCal because its initial generalised costs are lower.

Comparing the airlines' operation under deregulated fare (Table 8.3) with that under deregulated frequency (Table 8.2) shows that:

- prices at the competitive level are lower by 24% to 31% than the regulated fare. It was noted in the Section 5.3.3 that one of the implications of using the logit/market share model is that passengers have high elasticities with respect to the costs of travelling. When carriers compete on fare level, any reduction in fares reduces the passenger generalised costs directly and increases the carriers' market share. Due to passenger high elasticity with respect to fares, if one carrier reduces its fare by 1%, for example, it attracts extra passengers at a level that encourages the other carriers in the market to reduce their fare in order to operate at a competitive level. Such a situation leads to reduction in the fare level of all the carriers. This is unlike carriers' operation under deregulated flight frequency, where at a certain level of flight departures, (depending on passengers' value of time), any increase in service frequency, (through reduction in the defer time), reduces passenger generalised costs by a small amount. As a result the passenger demand does not increase by a large amount.

- passenger generalised costs of travelling by air are lower by 22% to 26% than deregulated flight frequency. This is due to the lower fare charged by the carriers under deregulation of prices.

- airlines' market shares are improved (BA by 1%, KLM by 9% and BCal by 72%) compared with their market share under no frequency regulation/ regulated fare. This illustrates that deregulation helps the airlines, in particular the generalised costs handicapped carriers, to improve its market share. This is because it has the freedom to charge a lower fare to compensate for its higher initial generalised costs. The foreign airlines and rail market share has declined by 80%. This is because the difference in passenger generalised costs of the air carriers and those of rail and the foreign airlines are greater as a result of the lower fares charged by the air carriers. This is due to the market share model's property (Equation 5.10), that namely is the larger the differences in the carriers' generalised costs, the greater the differences in their market share.

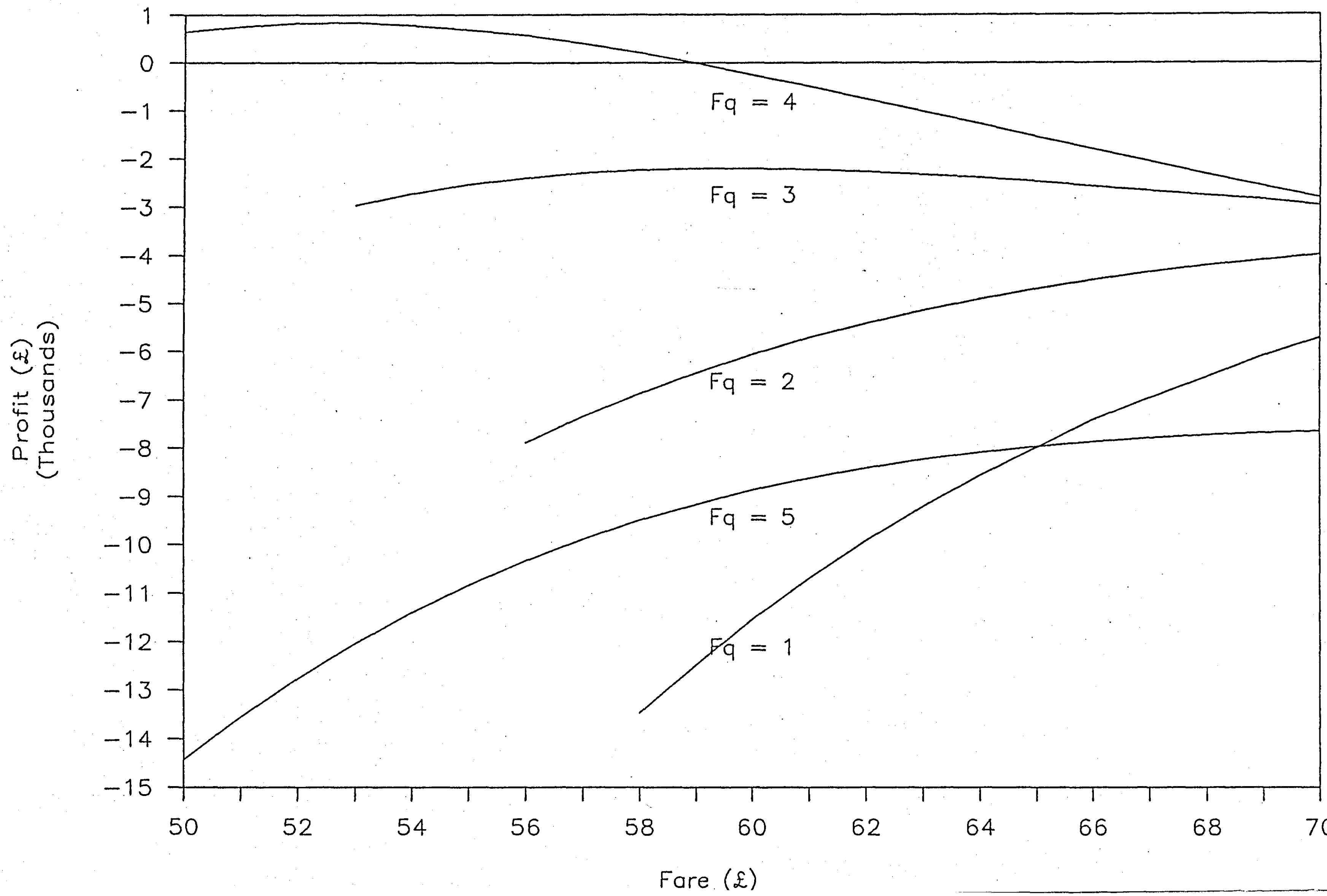
- despite the increase in the air carriers' market share, their profit is reduced under the deregulated fare which is due to the lower fares. BA's profit is lower by 91%, KLM's by 70% and BCal's by 118%. This illustrates that high regulated fare supports more carriers in the market. Unless, that is, under deregulated fare carriers lower their resource cost or employ policies that differentiate their product so that they can attract passengers on other bases than fare (the effect of reduction in the cost base of the carriers on their financial performance is discussed in Chapter Eleven). The impact of the fare competition on profitability of carriers' operation follows the trend in the US airlines' profit in the post deregulation period (see Section 2.5.6) when carriers' profit declined due to competing mainly on fare, before they started to employ other marketing strategies (e.g. the frequent flyer programmes, see Section 2.5.8) to attract passengers rather than lowering the fare levels.

8.4 DEREGULATED FLIGHT FREQUENCY AND FARE

Under this condition it is assumed that carriers are free to decide on the level of frequency as well as fare, but market entry is regulated. Each carrier adjusts its combination of fare and service frequency in response to changes in its rivals combination of fare and frequency , until they reach an equilibrium. This process is similar to that of variable fare (discussed in Section 7.2.3.1), with the difference that under this condition, carriers' profit for different combinations of fare and frequency is calculated. The outcome of such an operation is the same as the carriers' operation under deregulated fare (Table 8.3) due to the costing model integer effect.

Figure 8.3 illustrates the profit of one of the carriers (BA) for different combinations of flight frequency and fare. As can be seen, at any service frequency lower or higher than four flights, this carrier makes a loss; whereas at four flights (at

Fig. 8.3: Profit and Different Combination of Fare and Service Frequency



which the aircraft is completely utilised over the day), as fare increases the profit increases too until fare is £53 after which profit declines. The reason for four flights being an optimum is due to the assumption that carriers operate on a single route and one aircraft can be operated for a maximum of four return flight per day (the property of the costing model). The consequences of operating an aircraft below or over the maximum number of flights was discussed in Section 6.4.

Since the pattern of service offered under deregulated fare and frequency is the same as that under deregulated fare, only the carriers' operation is not discussed as it was analysed in the previous section. The carriers' operations under a free market (deregulated fare, service frequency and entry and exit) are discussed in Chapter Eleven where operation of carriers with different characteristics is discussed.

8.5 GENERAL IMPLICATIONS

The analysis of carriers operation under deregulated service frequency/regulated fare and deregulated fare/regulated service frequency implies that:

(1) Competitive prices are lower than regulated fares. This is because it is generally unlikely that the regulators set fares below the competitive levels. If they do so, the air carriers' financial performance deteriorates to the extent that the existing number of carriers in the market cannot continue the operation without being subsidised. Therefore to ensure the carriers, and as a result the industry, profitable operation it appears that fares are set above the competitive levels by the regulators.

(2) Competitive fares increase the airlines' market share, in particular that of the carrier with the generalised costs handicap. This is because the less advantaged carriers (those who operate from a secondary airport or have a lower level of passenger loyalty associated with smaller airlines) can lower their fare to compensate for what has caused their higher initial generalised costs.

(3) Regulated fare supports carriers. This is because under deregulated fares, the carriers make

a lower level of profit and the airline with the generalised costs handicap makes a loss. This illustrates that under fare competition the carriers need to operate more efficiently (e.g. lowering their cost structure) or to employ policies that differentiate their service from those of the rivals (e.g. operation of frequent flyer programmes) in order to operate profitably.

(4) Under deregulated fares, passenger generalised costs are lower and as a result more passengers travel by air than under deregulated service frequency. This is because any reduction in fare leads to reduction in passenger generalised costs, whereas as the impact of the increase in service frequency on passenger generalised costs diminishes. As a result in the markets where passengers' value of time is not very high, the effect of reduction in fare is more than the effect of the increase in service frequency on passenger generalised costs. Such a situation encourages carriers to reduce fares as an effective way of attracting passengers. This leads to operation of carriers at lower fare and higher market share.

Such analyses also show that, under any of the conditions, the carrier with the higher cost base always charges the higher fare. The airline with the highest initial passenger generalised costs, charges the lowest fare and has a poor financial performance compared with the other two major carriers. The carrier without the initial generalised costs which also has a lower cost level than its rival (the carrier that has the highest cost level) makes the highest profit in the market.

In this chapter the effect of partial deregulation is discussed. In the next three chapters the impact of free competition on routes (Chapter Nine), in markets (Chapter Ten) and on carriers (Chapter Eleven) with different characteristics is analysed.

CHAPTER NINE

AIRLINE OPERATION ON ROUTES OF DIFFERENT CHARACTERISTICS

9.1 INTRODUCTION

It is the aim of this chapter to address the policy questions related to the effects of deregulation. This is to illustrate the extent to which the impacts of deregulation on air carriers' operation may vary according to the types of routes (short-sparse, short-dense, long-sparse and long-dense routes).

The policy questions are: would deregulation lead to higher fares being charged and a much lower number of flights being offered on short and sparse routes than on long and dense routes? Would deregulation result in a loss of air coverage in very sparse routes?

The reason for the possibility of sparse and dense routes receiving different levels of services is that the cost of serving lightly travelled routes is higher due to the operation of smaller aircraft. This leads to higher fares which in turn have negative effects on the level of demand. Such situations deter the airlines from operating on sparse routes. This results in a reduction in competition. Under regulation, air carriers can use revenue earned on profitable (near monopoly) routes to subsidise services on less dense routes. Under deregulation, where competition is permitted on the profitable routes, there would not be sufficient revenue to subsidise services to small communities, and there is the possibility that carriers would abandon them. Even if an airline serves these routes, they tend to set fares at a higher level and operate at lower service frequency due to the high costs of operation and lack of competition on these types of routes. By contrast, more airlines are attracted to dense route (as explained in Section 2.5.1). The tense competition coupled with lower operating costs per passenger (due to operation of larger aircraft) leads possibly to lower fares and higher service frequency.

In order to test such hypotheses, the competition model is run to equilibrium for carriers' operation in different types of routes (short-dense, short-sparse, long-dense and long-sparse). Then the model outcome is discussed in terms of carriers' fare level, flight frequency, the resulting passenger generalised costs, market share and financial performance, and finally the general implications arising from the carriers' operation on routes of different characteristics are outlined.

9.2 THE CARRIERS' OPERATION ON SHORT-SPARSE AND SHORT-DENSE ROUTES

In order to analyse the impacts of free competition on the carriers' operation in short routes (sparse and dense) it is assumed that the length of the route is 235 miles (equivalent to London - Amsterdam), the flow on dense routes is 4000 passengers per day each way and on sparse routes 1000 passengers per day (see Table 4.1 for the value of the input data).

After running the competition model for carriers' operation, on short sparse routes, the end result indicates that at the equilibrium position, all the carriers' incur losses. These are illustrated in Table 9.1. The reason for the loss-making operation of the carriers is that there are not sufficient passengers to generate enough revenue to cover the carriers' costs. As discussed in the Section 6.4 this is mainly due to the property of the cost model (the integer effect), that the carriers' optimum service frequency is always equal to the maximum number of flights that each aircraft can operate per day (i.e. four). On the sparse routes where passenger demand is low, the generated revenue does not support such a level of service. To increase the revenue the carriers cannot charge higher fares than the competitive level due to the passengers high sensitivity with respect to generalised costs (Section 5.3.3). It was discussed in Section 8.3 that when carriers compete on fare, every reduction in fare attracts more passengers and encourages each carrier to reduce its fare in response to the rivals price cut. This will occur until any further reduction, taking into account the rivals fare levels, would not improve its financial performance. This generally results in lower fares.

Assuming that the carrier which makes the highest loss leaves the market, the operator with the generalised costs handicap (BCal) would be the first carrier to leave.

The operation of the two national carriers at the end result of the model is presented in Table 9.2. As

Table 9.1 : Carriers' Operation on the Short Sparse Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	55	4	63	316	121	1	-3000	0.85
BCAL	51	4	66	236	95	1	-3293	0.78
KLM	53	4	61	383	152	1	-1318	0.94
OA	70	2	87	33	-	-	-	-
RAIL	29	3	86	35	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 9.2 : BA's and KLM's Operation on the Short Sparse Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	57	4	65	405	155	1	-795	0.96
KLM	55	4	63	492	195	1	1455	1.06
OA	70	2	87	48	-	-	-	-
RAIL	29	3	86	55	-	-	-	-

* For the key to the variable symbols see table 8.2

can be seen, the carrier with a higher cost base (BA) is making a loss. This carrier therefore is assumed to leave the market too.

Table 9.3 illustrates the service level on the short sparse route when the loss-making carriers have ceased their operation and the surviving airline is maximising profit. It was discussed in Section 7.3 that KLM always has a better financial performance than the other two carriers due to not having a generalised costs handicap and having a lower cost level than BA. This is the reason for this carrier's survival in the sparse routes. It can be seen from the carriers' operation on such a route, that as the number of carriers operating in the market fell the level of fare and, as a result, passenger generalised costs, increased and the remaining carriers' financial performance improved. This follows the pattern in carriers' operation in relation to the properties of the model which was discussed in Section 7.2.3.3. The carriers' operation on short sparse route also illustrates that if the loss-making carriers wanted to continue their operation they needed to be subsidised. This was the reason for the US air carriers, when market entry and exit was regulated, subsidising their sparse routes from the profit they were earning on the more profitable routes (Section 2.2).

In order to illustrate the difference in carriers operation on short routes with different density, the competition model is run to equilibrium for the short dense route (Table 9.4) and its outcome is analysed and then compared with that for the short sparse route (Table 9.3). The results indicate the following differences:

- fares on the short dense route are lower than the sparse route by an average of 15%. This is mainly due to the difference in the level of competition between these routes and the aircraft size. On the dense route the three air carriers can operate profitably, therefore they all stay in the market and compete. This results in lower fares. However in the sparse route only one carrier can survive. It was noted in Section 7.2.3.3 that the larger the number of carriers in the market the lower is the fare. The other factor that contributed to the lower fare was the aircraft size. In dense routes carriers operate larger aircraft which leads to lower unit cost of operation (Equations 6.4, 6.6 and 6.8). For example KLM's cost per passenger at equilibrium in the sparse route is 4% higher than that in the dense route. It can be seen that the model result

Table 9.3 : The Surviving Air Carrier's Operation on the Short Sparse Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
KLM	65	4	73	641	254	1	10729	1.35
OA	70	2	87	172	-	-	-	-
RAIL	29	3	86	188	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 9.4 : Carriers' Operation on the Short Dense Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	55	8	62	1511	291	2	8866	1.12
BCAL	54	4	69	710	286	1	6404	1.20
KLM	55	8	62	1511	299	2	13177	1.19
OA	70	2	87	130	-	-	-	-
RAIL	29	3	86	141	-	-	-	-

* For the key to the variable symbols see table 8.2

is in line with the trend in the fare levels on short sparse routes following the US airline deregulation. It was noted in Section 2.5.5 that the average fare on most short sparse routes increased after deregulation due to the higher costs of operation and less competition on such routes. Passengers on dense routes on the other hand, have experienced lower fares than the sparse routes.

- service frequency on the dense route is five times than on the sparse route. This is because the level of passenger demand on the sparse route could only support the profitable operation of one carrier. However, on the dense route all the carriers could continue their operation. As a result of such a difference in the level of service frequency between the sparse and dense routes, the passenger defer time (Equation 5.11) on the dense route is five times lower than that in the sparse route. On the dense route the passenger average defer time is 9 minutes, while on the sparse route is 45 minutes.

- the air carriers' generalised costs on the dense route are lower by an average of 14% due to the lower fares and more service departures. As a result, a higher share of the market (nearly 20%) is attracted to the rail service in the thinner route, whereas in the dense route rail market share is 4% (86% lower than on the sparse route). This illustrates that there is going to be more competition from rail on short sparse routes than on short dense routes under free competition. This is because on the sparse route the difference in passenger generalised costs of travelling by air and rail is less, due to the higher fare and lower level of service frequency offered by the air carrier. Based on the market share model the smaller the difference in the carriers' generalised costs the smaller the difference in their market shares (Equation 5.10).

- in terms of financial performance all the carriers on the dense route are making a profit at equilibrium, whereas on sparse routes two of the loss-making carriers had to leave and only one survived. This indicates the possibility of monopoly operation on lightly travelled routes. The differences in the carriers' operation on each route is due to the assumption made about them in terms of their cost level and the initial generalised costs. The implications of such an assumption on the carriers' performance was discussed in the Section 7.3. The surviving carrier (KLM) makes a profit on the sparse route but it is 23% less than what it makes on dense routes, despite the intense competition on such a route. This would explain why following deregulation most of the US trunk carriers left the thinner routes and concentrated their operation mainly on the heavily travelled routes where they could make more profit (Section 2.5.2).

In order to analyse the effect of reduction in the total demand on the level of air operation on sparse routes, the surviving carrier operation at different levels of passenger demand is analysed. Tables 9.5(a) and 9.5(b) illustrate such an operation for a total passenger demand of 600 and 400 respectively. It can be seen that as passenger demand falls there is a very small increase in fare, service frequency stays unchanged, smaller aircraft are operated and the profit declines. At 400 passengers per day the air carrier actually makes a loss. The number of flight departures is unaffected because of the property of the costing model (the integer effect, see Section 6.4). The level of fare is not changed because if the carrier charges a higher fare the difference between its generalised costs and those of the rail and the foreign airlines becomes very small and as a result more air passengers will be lost to the rail and the foreign air carriers.

Because at 400 passengers per day the only major air carrier also makes a loss, there would be a high possibility of this carrier leaving the market altogether. Therefore government subsidy and control over such low density routes is considered necessary, if such routes are to continue, since without it, such markets may not receive air coverage by the major air carriers at all. That is probably why a 10 year subsidy programme was planned at the beginning of deregulation for small communities (see Section 2.4) to ensure that these types of markets receive air services.

In order to study the effects of length of routes on the carriers' operation on sparse and dense markets, in the next section the competition model is run to equilibrium for a long sparse route and a long dense route. Such analyses illustrate whether the differences in carriers' operation on dense and sparse routes are also affected by the route length.

Table 9.5(a): The Surviving Air Carrier's Operation on the Short Sparse Route (Passenger Demand = 600)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
KLM	65	4	73	385	153	1	3333	1.15
OA	70	2	87	104	-	-	-	-
RAIL	29	3	86	113	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 9.5(b): The Surviving Air Carrier's Operation on the Short Sparse Route (Passenger Demand = 400)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
KLM	66	4	74	248	98	1	-158	0.99
OA	70	2	87	74	-	-	-	-
RAIL	29	3	86	80	-	-	-	-

* For the key to the variable symbols see table 8.2

9.3 CARRIERS' OPERATION ON LONG-SPARSE AND LONG-DENSE ROUTES

The purpose of analysing the performance of carriers on long sparse and dense routes is to illustrate whether carriers' operations on long routes (sparse and dense) follow the same pattern as discussed for short routes. To do so the level of demand on long routes assumed to be the same as on a short route (i.e. passenger demand is 1000 and 4000 on sparse and dense routes respectively). The long route is assumed to be four times longer than the short route. As a result of aircraft longer journey time on the long route, the aircraft's maximum number of flights per day is lower (i.e. two). The journey time on the long route is 3.5 hours by air and 22 hours by rail; the fare charged by the foreign airlines is £200 and by rail £84. This route is similar to London - Rome. It is assumed that duration of airline operation is 16 hours per day and the maximum aircraft size is 400 seats. However the duration of carriers' operation on short routes is assumed to be 12 hours and the maximum aircraft size is 300 seats.

In order to analyse the carriers' operation on long sparse and dense routes, their operations at their equilibrium positions are compared. The modelling process by which carriers approach equilibrium was discussed in Section 7.2.3.

Table 9.6 illustrates the carriers' performance on the long sparse route. As can be seen, all the carriers are making a loss due to the same reasons discussed for the short sparse routes. Therefore the highest loss-making carrier leaves the market, which in this case, unlike on the short route, is the carrier with the highest cost base. This is because on long routes, although the passengers fare per mile is lower than on short routes due to operation of larger aircraft (Equations 6.4, 6.6 and 6.8) , the actual fare is higher as result of longer length of journey. It was noted in Section 7.3 that the high cost base carrier always charges the highest fare. Therefore on the longer route the differences between fares are greater due to the higher fares being charged. As a result the higher cost base carrier attracts a lower level of passengers on the longer route due to passengers' high elasticity with respect to the differences in the carriers generalised costs (Section 5.3.3). This results in the highest loss being made by the more expensive carrier. Based on the assumption that the highest loss-making carrier leaves the market, on the long route BA (the highest cost base

Table 9.6 : Carriers' Operation on the Long Sparse Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	134	2	160	186	143	1	-3966	0.86
BCAL	120	2	153	366	295	1	-1340	0.97
KLM	125	2	151	444	352	1	-91	0.99
OA	200	2	231	1	-	-	-	-
RAIL	84	3	195	7	-	-	-	-

* For the key to the variable symbols see table 8.2

carrier) ceases its operation.

Table 9.7 demonstrates the operation of the two surviving major carriers at their equilibrium on long sparse routes. It can be seen that the carriers make a profit. This is because they have attracted more passengers and have sufficient revenue to cover their costs as compared with short sparse routes. This is because on the long route there is less competition from rail and the differences between the fares they charge and those of the foreign airlines are greater. As a result the two major carriers' generalised costs are much lower than those of rail and the foreign airlines in the long route.

The carriers' operation at equilibrium on the long dense route is illustrated in Table 9.8. The difference in the carriers' operation between long routes follows the same pattern as of the short routes. That is : on long sparse routes fares are higher, service frequency is lower, a lower number of airlines can operate profitably, and the surviving carrier profit is lower than on the long dense route. The difference between long and short routes is that on the short sparse route one carrier survives, as where on the longer route, with the same level of passenger demand, two carriers remain in the market due to a lower level of competition from rail than on the longer routes.

9.4 GENERAL IMPLICATIONS

The differences in operation of the carriers between long and short routes with different levels of passengers (dense and sparse) indicate that:

(1) Under deregulation passengers on the sparse route pay more than on the dense routes. This is because sparse routes support a lower number of airlines and smaller aircraft are utilised on such routes. It was noted in Section 7.2.3.3 that the lower the number of carriers in the market the higher is the level of fares. This gives support to the hypothesis made in relation to the level of fares under deregulation on sparse and dense routes that passengers on the lightly travelled routes tend to pay more than those on dense routes. This also follows the pattern of fares on such routes following the US airline deregulation (Section 2.5.5).

Table 9.7 : The Surviving Air Carriers' Operation on the Long Sparse Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BCAL	131	2	164	488	393	1	6157	1.11
KLM	138	2	164	488	386	1	7052	1.12
OA	200	2	231	1	-	-	-	-
RAIL	84	3	195	24	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 9.8 : Carriers' Operation on the Long Dense Route

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	139	4	160	1035	398	2	9750	1.073
BCAL	130	6	157	1465	394	3	17036	1.10
KLM	137	6	156	1465	386	3	19821	1.11
OA	200	2	231	2	-	-	-	-
RAIL	84	3	195	37	-	-	-	-

* For the key to the variable symbols see table 8.2

(2) Sparse routes passengers experience a higher defer time due to the lower number of flights offered on this type of route. This is because the level of demand on such routes does not support more flight departures.

(3) The proportion of passengers travelling by air on short dense routes is higher than that on short sparse routes. This is due to the intense competition from rail on short sparse routes, and the higher fare and lower service frequency offered by the only surviving air carrier on such a route. On long routes there is less competition from rail due to rail's very long journey time. This demonstrates that there would be more competition from rail in Europe where the majority of the routes are short (the average route length is 468 miles).

(4) There is a tendency to monopolistic operation on short sparse routes. This is because on such a route only one air carrier could survive due to a low level of passenger demand, and the competition with rail, which results in a smaller air market being shared amongst the airlines. This illustrates that in Europe, where the routes are generally short, sparse routes may experience a monopolistic operation. There is also a probability of loss of air coverage on very lightly travelled routes.

(5) Carriers always make more profit on dense routes compared with sparse routes, and the level of profit increases on longer routes due to the operation of larger aircraft and lower level of competition from rail.

CHAPTER TEN

CARRIERS' OPERATIONS IN DIFFERENT TYPES OF MARKETS

10.1 INTRODUCTION

In this chapter the policy question in relation to the impact of deregulation in different types of markets (i.e. tourist and business) is addressed. The question being posed is: would deregulation result in market segmentation? In other words, would the tourist orientated markets be served at lower fares and lower service frequency while the business orientated markets receive frequent services at higher prices?

On the basis that business travellers are less price sensitive (as in most cases the employers pay the fare) than tourists and have a higher value of time, a hypothesis is postulated that under deregulation, where carriers are free to set fares and decide on service frequency airlines serve business markets at higher service frequency, by smaller aircraft and at higher fares. However since tourist travellers are less time sensitive and consequently do not place a high value on reductions in the defer time, they are served by bigger aircraft, at lower service frequency and lower fares. As discussed in Section 5.3.1 the defer time is the time difference between the desired and the actual flight time. The more flight departures, the shorter the defer time (Equation 5.11). For the definition of passenger's value of time see Section 5.3.1.

In order to test such an hypothesis and to illustrate the extent to which the differences in the market characteristics affect the level of service (i.e. fare and flight frequency) offered in tourist and business markets, different values are attached to the travellers' time. The higher the passengers' value of time the higher their sensitivity with respect to the reduction in journey time. With the aid of the competition model, the operation of carriers in terms of their fare, service frequency, passenger generalised costs, market share and financial performance in markets where passengers have different value of time are examined. The model's end results for these markets is illustrated in Tables 10.1 to 10.6. These tables demonstrate carriers operation at their equilibrium where they are either maximising

Table 10.1 : Carriers' Operation at Passenger Value of Time of £2.40/hr

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	52	4	56	512	196	1	-1374	0.95
BCAL	48	4	59	383	154	1	-2274	0.89
KLM	50	4	54	622	247	1	837	1.03
OA	70	2	81	47	-	-	-	-
RAIL	29	3	58	439	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 10.2 : Carriers' Operation at Passenger Value of Time of £7.15/hr

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	53	4	65	666	256	1	1498	1.04
BCAL	48	4	67	549	221	1	-102	0.99
KLM	52	4	64	734	291	1	3956	1.11
OA	70	2	93	47	-	-	-	-
RAIL	29	3	115	6	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 10.3 : Carriers' Operation at Passenger Value of Time of £9.50/hr

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	53	4	67	688	265	1	1845	1.05
BCAL	49	4	73	514	207	1	-61	0.99
KLM	52	4	69	758	300	1	4365	1.13
OA	70	2	99	41	-	-	-	-
RAIL	29	3	143	1	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 10.4 : Carriers' Operation at Passenger Value of Time of £23.50/hr

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	53	4	95	741	285	1	2689	1.07
BCAL	50	4	99	503	202	1	284	1.01
KLM	53	4	95	741	294	1	4816	1.14
OA	70	2	134	16	-	-	-	-
RAIL	29	3	314	1	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 10.5 : Carriers' Operation at Passenger Value of Time of £35.60/hr

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	56	8	105	841	162	2	-1869	0.92
BCAL	49	4	118	231	93	1	-3824	0.75
KLM	55	8	104	927	183	2	1844	1.04
OA	70	2	164	3	-	-	-	-
RAIL	29	3	456	1	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 10.6 : Carriers' Operation at Passenger Value of Time of £47.50/hr

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	57	8	122	884	170	2	-240	0.99
BCAL	51	4	141	143	58	1	-4493	0.62
KLM	56	8	121	974	193	2	3697	1.07
OA	70	2	194	1	-	-	-	-
RAIL	29	3	599	1	-	-	-	-

* For the key to the variable symbols see table 8.2

profit or minimising the possible losses.

In the following sections carriers' performance under free competition in tourist and business markets are compared. Following this the general implications of operating in such markets are discussed.

10.2 CARRIERS' OPERATION IN TOURIST MARKETS COMPARED WITH BUSINESS MARKETS

The model's end results (carriers operation at an equilibrium) for markets with different passengers' value of time are illustrated in Tables 10.1 to 10.6. Based on the assumption that the market with the lower passengers' value of time (e.g. £2.40) is a tourist market and with the higher passengers' value of time (e.g. £47.5) is a business market, the model's carriers equilibrium position indicates that:

- as the value of passengers' time increases the carrier's level of fare increase but at a low rate. For example fares in the business market (value of time equal to £47.5) are between 7% and 10% higher than those in the tourist market (value of time equal to £2.40). This is because for a given value of time each carrier, taking into account the rivals' fare level, finds it profitable to lower its fare to attract extra passengers until the increase in the costs due to the rise in passenger demand is greater than the increase in revenue. This is where the marginal revenue is equal to the marginal cost (see Section 7.2.3.1). Such a situation leads to the lower fares. The carriers' level of fare in each market follows the pattern which was discussed in Section 7.2.3.1) in which the higher cost base carrier charges the highest fare while the generalised costs handicap carrier, whose resource cost is the lowest amongst all, charges the lowest fare in the market.

- service frequency in the business market is 66% higher than that in the tourist market. The reason for such a higher level of flight frequency in the business market is due to the effect of value of time on the reduction in journey time (Equation 5.13). The higher the value of time the greater the impact of a reduction in the journey time. Therefore in the business market any increase in the number of flights reduces passenger generalised costs by a larger amount than in the tourist market. This results in a higher proportion of passengers being attracted to the airline with a higher service frequency than in the tourist market. The relationship between flight frequency and passenger demand for different passenger's value of time is illustrated in Figure 10.1. Such a difference in passengers response to the increase in the number of flights results in more flights being offered in markets with higher passenger values of time. It can be seen from Tables 10.5 and 10.6 that only BA and KLM have increased their service frequency in the markets with the higher values of time. This is because if it increases the number of flights, it cannot attract enough passengers to justify such an increase in service frequency due to its generalised costs handicap.

- business passenger generalised costs are higher by an average of 55%, despite the increase in service frequency. This is mainly due to the higher value of time (Equation 5.13). The increase in fare has also contributed to such an increase in the business travellers generalised costs. In the business markets the difference in the generalised costs of BCal, BA and KLM is greater. This is due to BCal's lower flight frequency and the resulting higher defer time. Rail's generalised costs are much higher than the air carriers in the business market as a result of its higher journey time (higher on board travelling time and lower service frequency).

- in terms of market share, the two national carriers (BA and KLM) increase their market share in the business market (BA by 69% and KLM by 56%). However BCal and rail's share of the business market decline (BCal by 63%.and rail by nearly 99%). This can be explained by the difference in these carriers' generalised costs which are discussed above. Based on the logit/market share model the greater the difference in carriers generalised costs the greater the difference in their market share (Equation 5.10).

- as was expected, the model output indicates that carriers use smaller aircraft for business travellers. BA's aircraft are smaller by 14%, KLM's by 20% and that of BCal by 62%. The reason for using smaller aircraft is the higher service frequency. In the case of BCal it is due to its lower share of the market.

- in terms of the profit, it can be seen from Figure 10.2 that as the value of time increases, carriers' financial performance (at equilibrium) improves up to a certain level (that is value of time = £23.40) after which their profit drops. This is because with the increase in passengers' value of time (as can be seen from Tables 10.1 to 10.6) rail loses more passengers to air carriers due to increasing effect of the longer rail on-board journey time and lower service frequency on its generalised costs (Equation 5.12) and the resulting market share (Equation 5.10). The air carriers capture these extra passengers and can still operate at four flights per day by larger aircraft. This results in the increase in revenue being greater than the increase in the total costs due to the operation of larger aircraft.

As the passengers' value of time increases above £23.40, the air carriers operate at a higher service frequency. KLM is the first carrier that acquires extra aircraft (this carrier always carries more passengers due to the advantages that it has over the other two airlines, see Section 7.3). It was discussed in Section 7.3 that carriers at equilibrium always operate at a service frequency which is equal to the maximum number of flights that each aircraft can operate per day due to the costing model integer effect. Thus operation of two aircraft by KLM leads to eight flights at the equilibrium position. This results in a jump in KLM's operating costs, but such an increase is covered by the extra passengers that are attracted from BA and BCal into this carrier service due to the operation of a higher number of flights. As can be seen, as a result of such an operation BA and BCal's profits turn into losses. The profits of BA and BCal continue to decline while KLM's profit rises due to the operation of a higher service frequency.

When the value of passengers time is £33 BA operates at eight flights per day. This results in a drop in KLM profit and a further increase in BCal's losses. This is because BA captures a proportion of their market share due to the increase in its flight frequency. BA's profit declines slightly too due to the jump in its operating costs (the costing model integer effect). As the value of time increases beyond this point the financial performance of the generalised costs handicapped carrier (BCal) continues to deteriorate due to the operation of lower levels of service frequency meanwhile BA and KLM's

Fig. 10.1: Passengers and Service Frequency at Different Value of Time

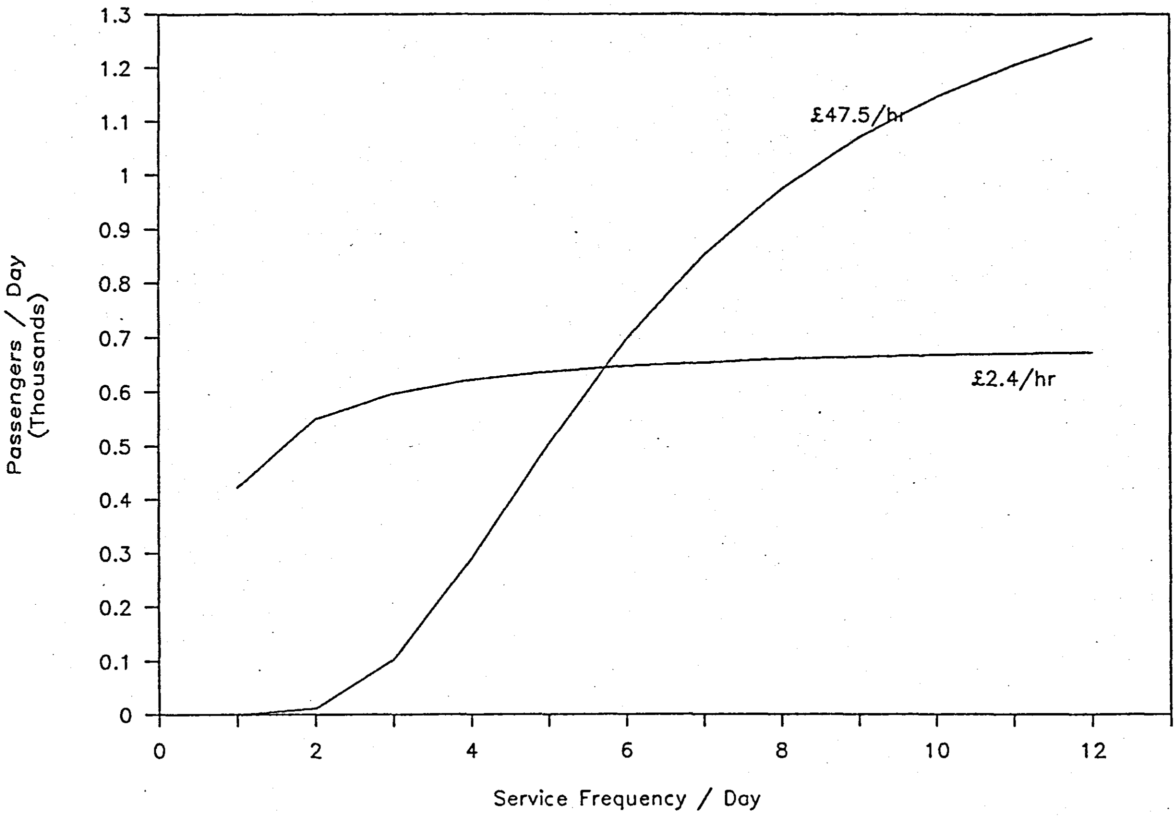
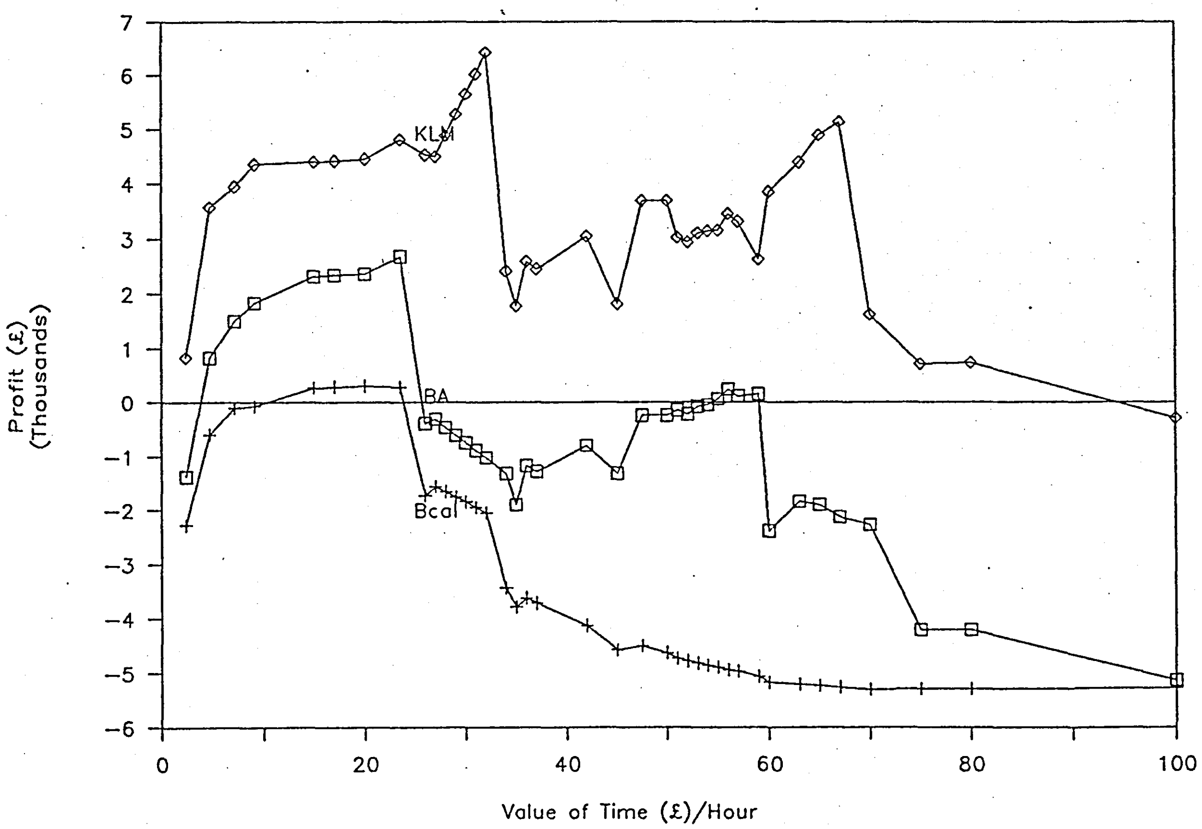


Fig. 10.2: Airlines' Profit at Equilibrium and Value of Time



financial performance improves until the further increase in the value of time results in an increase in KLM's number of flights (i.e. from eight to twelve). The carriers' financial performance follows the same trend as when KLM increases its service frequency from four to eight due to the same effects. It can be seen that at very high value of time (i.e. £100) all the carriers make losses. BCal makes losses due to loss of its passengers to the other two air carriers. KLM and BA incur losses as a result of operation of a large number of flights and yet not charging a high fare due to the competition.

10.3 GENERAL IMPLICATIONS

The implications arising from operating in different types of markets are as follows:

(1) Under deregulation business travellers will be served at higher service frequency by smaller aircraft, but not at much higher fares than the tourists due to the effect of fare competition. Whereas tourists receive a lower number of flights due to having a lower value of time and consequently not appreciating the reduction in the defer time. This illustrates that high value of time leads to higher service frequency but not much higher fares (the increase of value of time from £2.40 to £47.50 per hour leads to an increase of 66% in flight frequency and between 7% and 10% in fare).

(2) Within a certain range of value of time (i.e. £10 to £23) all the carriers operate profitably in the markets. Whereas outside this range the number of carriers operating profitably at the equilibrium is lower. This is because where passengers' value of time is very low, rail which offers a lower fare attracts a large proportion of the market as its longer journey time and defer time do not deter the passengers to travel by rail. Where the value of passengers' time is high, the carriers (i.e. BA and KLM) operate at higher service frequency, and as a result their financial performance deteriorates. The carrier with the generalised costs handicap makes a loss as its passengers are attracted by the rivals with the lower generalised costs.

CHAPTER ELEVEN

OPERATION OF CARRIERS WITH DIFFERENT CHARACTERISTICS

11.1 INTRODUCTION

It is the purpose of this chapter to address the policy implications of the impact of the entry of lower cost carriers to the market of the more established carriers. The questions are: would deregulation, which allow the entry of new carriers to the markets, lead to lower fares and higher service frequency? And what are the effects on the incumbents' operations?

The newer or smaller airlines usually have a lower resource cost due to different work roles, low labour costs, and cheaper equipment which enables them to offer fares at discount levels (see Section 2.5.5). Normally such low fares attract passengers but it must be borne in mind that in the long term new entrants give up some of the cost advantages as their work-force matures or their equipment becomes more varied.

To test this hypothesis, the carriers' operations on the short dense route (where the three major air carriers make a profit) after the entry of a lower cost base airline are examined. Such analyses are carried out for entrants with different levels of resource cost (i.e. 40%, 50% and 60% that of the older carrier with the highest cost base). Then the reaction of the older airlines in terms of whether to carry on the operation until the level of new entrant's cost base increases or to reduce their own resource cost, is studied. Finally the effect of the second entry on the existing carriers' performance is discussed. Such an analysis gives useful insights, especially into the question of the amount of service and fares charged which are likely to result from the entry of a low cost base carrier to a market where the existing carriers are making a profit.

11.2 THE IMPACT OF LOWER COST NEW ENTRANT

Here it is assumed that the only difference between the entrant and the older airlines is the level of resource cost. The advantages that the incumbents might have (e.g. name recognition or access to the CRS, as described in Section 1.3.2) are not taken into account. This is mainly to isolate the effect of cost differences on the carriers' operation.

Tables 11.1, 11.2 and 11.3 illustrate the model outcome for the carriers' operation on short dense routes at equilibrium, where the new entrant cost base is 40%, 50% and 60% of BA's cost base respectively.

To study the effect of such an entry, the performance of the older airlines before the entry of a lower cost carrier (Table 9.4, the carriers' operation on the short dense route) is compared with that of after the entry at the carriers' equilibrium position. The results indicate that:

- the entry of the lower resource cost carrier leads to lower fares. For example when the new entrant resource cost is 40% of the older airline (BA), the average fare is lower by 20%, but as the resource cost of the new entrant increases the level of fares in the market increases too, but stays lower than the level before the entry. It can be seen that the low cost entrant always offers the lowest fare in the market and as its cost level increases the difference in fares charged by the entrant and the older carriers becomes smaller. This illustrates that the higher the number of carriers in the market the lower the fare which follows the relationship between fare and the number of carriers in the market discussed in Section 7.2.3.3 (Figure 7.12). It also shows that the lower the cost base of the entrant the lower is the average fare in the market. This is due to the fare and carriers' cost base relationship (see Section 7.2.3.1, Figure 7.6). When the entrant has a lower cost base it can offer cheaper fares. This leads to lower fares (lower than before the entry of the new carrier) being charged by the older carriers. This confirms the effect of ease of market access on reducing fares, upon which the advocates of deregulation in the US and in Europe have based their arguments for more flexibility in the regulation of air transport (Section 3.4).

- total service frequency after the entry increases, but as the cost level of the new entrant increases, the total number of flights offered in the market declines. For example when the new entrant's resource cost is 40% that of BA, serv-

Table 11.1 : Carriers' Operation after a New Entry
(The Entrant's Resource Costs=40% those of BA)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	50	4	58	567	218	1	-1734	0.94
BCAL	47	4	62	358	155	1	-2634	0.87
KLM	48	4	56	689	273	1	441	1.01
NE	38	12	44	2287	272	3	44477	2.04
OA	70	2	87	36	-	-	-	-
RAIL	29	3	86	39	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 11.2 : Carriers' Operation after a New Entry
(The Entrant's Resource Costs=50% those of BA)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	52	4	60	740	284	1	1933	1.05
BCAL	46	4	61	671	270	1	248	1.00
KLM	52	4	60	740	293	1	4058	1.12
NE	45	8	52	1733	309	2	39057	2.00
OA	70	2	87	57	-	-	-	-
RAIL	29	3	86	62	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 11.3 : Carriers' Operation a New the Entry
(The Entrant's Resource Costs=60% those of BA)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	54	4	62	779	299	1	4079	1.11
BCAL	48	4	63	707	285	1	2101	1.06
KLM	55	4	63	707	280	1	5621	1.17
NE	48	8	55	1657	295	2	34381	1.76
OA	70	2	87	72	-	-	-	-
RAIL	29	3	86	79	-	-	-	-

* For the key to the variable symbols see table 8.2

ice frequency is higher by 17% than the level before the entry. When the entrant's costs increase to 50% of the older carrier's costs, the total frequency declines by 17%, reaching the level prior to entry. When it is 60% of the older carrier's costs, service frequency stays unchanged. This is because the lower the entrant's resource cost the lower the increase in its total costs for any increase in the number of flights. Therefore when its cost base is 40% of the older carrier's costs, it can offer more flights. This leads to the attraction of the incumbents' passengers to its service and consequent decrease in their flight frequency. When the entrant'resource cost is very low it operates at such a level of service that despite the lower number of flights offered by the older carriers the total number of flight departures in the market is higher. But as its cost base increases, its service frequency decreases, (although it still offers more flight frequency than the older carriers) but the total number of flights in the market is unaffected.

- passenger generalised costs after entry are lower, reflecting the lower fare and in some cases higher service frequency (i.e. the entrant's resource cost is 40% of the incumbent's).

- there is a decline in the established carriers' passenger demand after the entry of the new carrier. When the new entrant's resource cost is 40% of the older ones, their market share is down by an average of 54%. This is because the new entrant has captured some of their passengers due to its lower fare and higher service frequency. Assuming that the total size of the market is constant, with the entry of a new carrier, this is to be expected. The lower the generalised costs of the new entrant, the higher is the number of the passengers which are attracted to its service and the lower the incumbent carriers' market share (logit/market share model property, Equation 5.10).

- the entry of the low cost entrant leads to the reduction in the incumbents' profit. It was noted in Section 7.2.3.3 (see Figure 7.12) that the higher the number of carriers in the market the lower is the profit. As the new entrant's resource cost increases, the older carriers profit increases, while the entrant's financial performance deteriorates. This is because as the cost base of the entrant increases the costs of extra flights are higher. Therefore it charges a higher fare and operates at lower service frequency. However, its profit remains more than that of the incumbents due to having a lower resource cost.

The effects of the entry of a lower cost carrier on the incumbent operation, in particular when the new entrant cost structure is very low (e.g. 40% of the older carriers), encourages the older airlines to reduce their cost base in order to operate more competitively. This was how the American airlines responded to the low cost new entrant (see Section 2.5.4). In the next section the effects of employing such a policy are discussed.

11.3 THE OLDER CARRIERS' REDUCTION IN THEIR RESOURCE COST

After the entry of a low cost carrier into the market, the older carriers can either wait until the new entrant loses its advantages (an unlikely case), or they can reduce their resource cost in order to put themselves in a more competitive position. If they wait, their pattern of operation will be the same as in the previous section.

Table 11.4 illustrates the end result of the model run for carriers' operation when the older airlines reduce their costs by 25% in response to the entrant with cost structure of 40% of the established carriers. The comparison of the carriers' operation at equilibrium before and after the older carriers reduce their costs (Table 11.1 with Table 11.4) indicates that:

- the reduction in the older carriers' costs leads to a further reduction in average fare. This is because the incumbents' fares are reduced (by an average of 8%) although there is an increase of 5% in the new entrant's fare. This is because the closer the cost structure of the carriers, the smaller the difference in their fares (see Figure 7.6). This illustrates that the entry of a lower cost carrier is likely to make the older carriers more efficient, which results in lower fares being offered in the market.

- total service frequency is reduced by 17%. This is due to the fall in the new entrant's service frequency. The older carriers' service

Table 11.4 : Carriers' Operation after a New Entry
(Incumbents Reduce Resource Costs by 25%)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	46	4	54	796	306	1	7657	1.26
BCAL	40	4	55	722	291	1	4717	1.19
KLM	47	4	55	722	286	1	8591	1.34
NE	40	8	47	1692	302	2	37097	2.21
OA	70	2	87	34	-	-	-	-
RAIL	29	3	86	37	-	-	-	-

* For the key to the variable symbols see table 8.2

frequency is unchanged, because the increase in their market share does not justify the increase in service frequency. The entrant has to reduce its service frequency since part of its market share is absorbed by the older carriers. The older carriers operate at four return flights each due to the costing model integer effect (see Section 6.4).

- the existing carriers' market share has increased as a result of reducing their costs by 25%. BA's market share has increased from 14% to 20%, BCal's from 9% to 18%, KLM's from 12% to 18%. The entrant's passenger demand declines from 57% to 42%. This is due to the reduction in the generalised costs of the incumbents.

- the older carriers not only do not make a loss, they even make a profit (but still lower than the level before the entry), while the entrant's profit declines by 17%. Although the entrant's profit declines when the existing airlines reduce their resource cost, it makes the highest profit because its cost structure is still the lowest amongst the carriers in the market.

It can be seen that as the older carriers reduce their costs (i.e. by 25%) they can operate more competitively and efficiently.

In the next section the effect of a second entry to the market is discussed.

11.4 <u>THE IMPACT OF THE SECOND ENTRY</u>

In this section the effects of a second entry to the market is discussed. The second entry is assumed to take place when the first entrant's resource cost is 50% of the older airlines. This is when they all make a profit. This attracts a new carrier to the market. It is also assumed that the second entrant's resource cost is 50% that of BA.

The results of such an operation after running the model to equilibrium, are illustrated in Table 11.5. Comparing the carriers' operation before the entry of the second entrant (Table 11.2) with the carriers' operation after the second entry to the market (Table 11.5) illustrates that the effects are similar to those of the first entry. These are as follows:

Table 11.5 : Carriers' Operation after the Second Entry
(The Entrant's Resource Costs=50% those of BA)

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	50	4	58	550	215	1	1941	0.93
BCAL	47	4	62	373	150	1	-2772	0.85
KLM	48	4	56	660	265	1	273	1.00
NE	44	8	50	1170	208	2	22295	1.764
NE2	44	8	50	1170	208	2	22295	1.764
OA	70	2	87	35	-	-	-	-
RAIL	29	3	86	38	-	-	-	-

* For the key to the variable symbols see table 8.2

- the average fare in the market is reduced by 4%. The entrant's fare is the lowest in the market, due to having a lower cost base.

- the total service frequency is increased by 40%, since the second entrant is offering eight flights per day, while the rest of the carriers operate the same number of flights as they were providing before the entry (i.e. four flights per day by each incumbent and eight flights by the first entrant). The incumbents' optimum flight frequency is unchanged due to the costing model integer effect. The first entrant operates at a service frequency which is equal to the second entrant's, due to having the same characteristics (i.e. the same resource cost and generalised costs).

- the market share of all the incumbent carriers declines: BA's from 18.5% to 14%, BCal's from 17% to 9% , KLM's from 18.5% to 16.9% and the first entrant's from 44% to 29%. This is as a result of the second entrant attracting part of the incumbent carriers' passenger demand.

- in terms of profit, the older carriers show a poor financial performance. The highest loss is made by BCal due to having the highest initial generalised costs, then BA and KLM just cover costs. The first and second entrants make a profit. The first entrant's profit is reduced by 56% compared with that before the second entry to the market.

It can be seen that the pattern of the effects of the second entry on the incumbents' operation is similar to that of the first entry. These are that, after the entry level of fare is pushed down, service frequency is increased and the incumbents' market share and profit are decreased.

11.5 GENERAL IMPLICATIONS

The impacts of the entry of lower cost carriers to the market where the older carriers are making a profit imply that:

(1) The entry of a lower cost carrier leads to lower fares. This can also illustrate the effect of introducing discount fares, if the fare the entrant charges is assumed to be the discount

fare charged by one of the existing carriers. This shows that the introduction of lower fare due to the discount fares bring the prices down in the market.

(2) The higher the number of carriers in the market the lower the fares and profit.

(3) The entry of the lower cost carriers is likely to encourage the more established carriers to reduce their resource costs, which would lead to further reductions in the fares and a more efficient airline industry.

(4) The lower the entrant's resource cost the lower the fares in the market.

(5) If the older airlines do not get involved in an unfair competition or if there is equal access to the economies that the more established carriers usually enjoy (see Section 1.3.2), the lower cost entrant can survive in the market and compete effectively.

The impact of ease of market access by the lower cost carriers confirms the arguments of the advocates of liberalisation in Europe (see Section 3.4). These are that more flexibility in regulation leads to a more efficient industry in the sense that in order to operate competitively the carriers need to bring their costs under better control; and that competition leads to lower fares and lower excessive profit earned by the carriers operating in the market.

In the next chapter the sensitivity of the model's outcome to variation in some of the assumptions and input data, is examined.

CHAPTER TWELVE

SENSITIVITY ANALYSES

12.1 INTRODUCTION

In this chapter a series of sensitivity tests are undertaken to analyse the changes in the model output (carrier's performance at the possible equilibrium position in terms of fare, service frequency, passenger generalised costs, market share and finance) due to changes in some of the assumptions and variation in the model's single input parameters. The competition model consists of the market share model (Chapter Five), the costing model (Chapter Six) and the reaction model (Chapter Seven). The reaction model simulates the carrier's operation which receives the outcome of the market share and the costing model. To show the changes in the value of the models' components, the market share model and the costing model are represented below. The market share model is as follows:

$$MKS_i = P_i = \frac{e^{-\beta GC_i}}{\sum_{j=1}^{n} e^{-\beta GC_j}} \qquad (5.10)$$

$$GC_j = F_j + (TT_j * VT) \qquad (5.13)$$

where:

MKS_i	is the market share of carrier (i),
GC	is the passenger generalised costs (£),
F	is the fare (£),
TT	is the total travelling time (hours),
VT	is the value of time (£/hour).

The costing model has the following form:

$$TV = ((DVC + IVC) * ACTS * RL + LDF) * FQ \qquad (6.9)$$

where:

TV	is total variable costs (£/day),
DVC	is direct variable costs (£/seat mile),
IVC	is indirect variable cost (£/seat mile),
ACTS	is aircraft size,
FQ	is flight frequency/day,
RL	is route length (mile,)
LDF	is landing fee.

ACTS = D / FQ * L (6.10)

where:

D	is total passenger demand / day,
L	is load factor.

TF = (DFC + IFC)* H * ACTS * N (6.11)

where:

TF	is total fixed costs (£/day),
DFC	is direct fixed costs (£/seat hour),
IFC	is indirect fixed costs (£/seat hour),
H	is aircraft utilisation period (hour),
N	is number of aircraft.

N = FQ / MN (6.12)

where:

MN	is the maximum number of flights by an aircraft /day.

TC = TV + TF (6.13)

where:

TC	is the total operating costs (£/day).

The sensitivity of carriers' operations is tested with regard to the changes in the level of the input variables to the above equations. The assumptions and the variables upon which the sensitivity tests are carried out are as follows:

- BCal's equal access to the economies of scale, scope and technology. This is done by elimination of the modal constant from BCal generalised costs (GC, Equation 5.10).

- Variation in the value of the market share parameter (. , Equation 5.10).

- Operation of fixed aircraft size (ACT) and variable load factor (L, Equation 6.10).

- Variation in predetermined level of load factor, when aircraft size is variable (L, Equation 6.10).

- Changes in the maximum number of flights that one aircraft can operate per day (MN, Equation 6.12).

All these tests are implemented on carriers' operations under deregulation and on a short (London - Amsterdam) medium density (2000 passengers per day) route. The passenger value of time in all these tests is £4.75 per hour. The carriers cost relation remains unchanged (BCal's cost to 87% and KLM's cost 92% of BA's respectively). The effect changes in the route length (RL), density (the total passenger demand), the value of passenger time (VT) and the carriers' resource cost level were discussed in the previous three chapters.

12.2 EQUAL ACCESS TO THE ECONOMIES OF SCALE, SCOPE AND TECHNOLOGY

In all of the previous model's runs BCal had a higher initial generalised costs and it is shown that this carrier, despite having the lowest resource cost amongst the air carriers in the market, cannot perform financially as well as its rivals and in most cases it makes a loss. As explained in Section 5.3.2, this appears to be as result of operating from a secondary airport and of lower passengers loyalty that usually associated with the smaller carriers. This could be due to the lack of access to the economies of scale (operation of frequent services on a large network), of density (operation on dense network), of scope (serving different points) and of technology (e.g. computerised ticket distribution systems). The advantages of such operations for larger airlines include name recognition, ability to offer different types of services, operation of hub and spoke networks, influencing the travel agents, higher level of advertising and so on and these were discussed in Section 1.3.2. These types of advantages increase the loyalty of passengers to the larger carriers.

In order to examine the effects of BCal's equal access to such economies, its initial generalised costs is brought to the same level as of the other two major carriers. To implement such a change in the model the modal constant initially built into this carrier's generalised costs is removed.

The carriers' operation at equilibrium under such a condition is presented in Table 12.1. Comparing these results with those of BCal's operation when its initial generalised costs is higher than its rivals (Table 8.3) illustrates that:

- BCal's fare is increased by 4%. This is because this carrier does not charge a significantly lower fare than the other two carriers to compensate for its higher initial generalised costs. Although BCal charges a higher level of fare it is still the lowest amongst the air carriers due to having the lowest cost structure.

- the optimum service frequency of all the major carriers is the same and is equal to the maximum number of flights that an aircraft can operate per day due to the costing model integer effect.

- BCal's passenger generalised costs is down by 8% despite the increase in its fare, due to omitting the modal constant from its passenger generalised costs.

- BCal, as a result of its lower passenger generalised costs, has attracted 36% more passengers. This follows the pattern expected from Equation 5.10 given that total demand is constant. The increase in BCal's market share therefore results in a decline in passenger demand of BA by 8% of KLM by 16%, of the foreign airlines by 17% and rail by 16%.

- such a situation enables BCal to make the highest profit in the market which is due to operating from the main airport, and to the assumption that it has equal access to the advantages that larger carriers enjoy and also having the lower resource cost. As a result, BA not only makes no profit it incurs a loss. KLM's profit declines by 54%. This is because these carriers lose part of their market share to BCal. At the same time they cannot increase their fares to increase their revenue as they will lose even more passengers to BCal.

This test provides an insight into how important it

Table 12.1: Carriers' Operation Following BCal's Equal Access to the Economies of Scope, Density and Technology

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	52	4	60	576	222	1	-472	0.984
BCAL	50	4	58	699	281	1	3385	1.11
KLM	51	4	59	635	251	1	1661	1.05
OA	70	2	87	44	-	-	-	-
RAIL	29	3	86	48	-	-	-	-

* For the key to the variable symbols see table 8.2

is for smaller, lower cost carriers to have equal access to the advantages that larger carriers have due to the size of their operation and access to the main airports. It was shown that unless the smaller, lower cost carriers have access to such economies they cannot operate competitively. This point was raised in Chapter One where it was discussed that putting the carriers in the same footing is the key to competition, otherwise the industry , as is happening in the US domestic market (see Section 2.5.2), will be dominated by a few larger carriers thus limiting the effects of competition. It is therefore important in Europe, under a free, competitive environment, to provide opportunities for the small, lower cost carriers to compete with the larger carriers on equal terms. Otherwise, as shown in the pervious model runs, the carrier with some initial disadvantages despite having a lower resource cost makes a loss under most conditions. This results in an inability of such carriers to continue operations and in most cases they are absorbed by the larger carriers. The results also show that if the small, lower cost carriers have access to the same advantages as the larger carriers, the major carriers financial performance deteriorates unless they bring their resource costs to the same level as the smaller carrier (the effect of such operations were discussed in the previous chapter). This explains why the major carriers in the US domestic market try to limit the effects of competition by taking advantage of their size through moves such as strong hub and spoke operations, frequent flyer programmes, CRSs and ownership of feeder carriers (see Chapter Two for detailed discussion of the US airline operations since deregulation).

12.3 VARIATION IN THE VALUE OF THE MARKET SHARE PARAMETER

It was discussed in Section 5.3.3 that the value of the market share parameter is an indicator of the characteristics of the market for which it is estimated. The higher the value of β the lower is the effect of the random components which include the effects of unobserved and immeasurable characteristics of the passengers and the carriers. As a result, at higher values of the market share parameter, the sensitivity of the passengers with respect to the differences in the carriers' generalised costs is higher (see Equation 5.10) and therefore the cheaper carrier has a stronger probability of being chosen.

After running the model to equilibrium, where the market share parameter varied by +/- 50%, it can be seen from Tables 12.2(a) and 12.2(b) that:

- at higher β values, fares are lower by an average of 27% (compared with fares when the β value is decreased by 50%). This is because, as Figures 5.2 illustrates at higher β values, any reduction in fare attracts a greater number of passengers. Such a situation pushes the level of fares down.

- optimum service frequency is the same under the two conditions because the changes in the carrier's market share does not support operation of extra aircraft. It was discussed in Section 6.4 that due to the costing model integer effect, the increase in passenger demand must support eight flights in order to justify two aircraft.

- more passengers (37%) travel by major airlines when the β value is high. This is because there is a greater difference in passenger generalised costs of the air carriers, rail and the foreign airlines. At higher values of the market share parameter, BA's and KLM's passenger generalised costs are 3% lower than BCal's and each attracts 26% more travellers. Whereas when values of β are reduced for a similar differences in the carriers generalised costs the number of passengers that BA and KLM attract is 10% more than BCal. This follows the pattern discussed in Section 5.3.3 that: the higher the β value the higher the cheaper carriers market share for the same difference in their generalised costs.

- in terms of finances, carriers have a less profitable operation at higher β values mainly due to the lower level of fares.

This test illustrates that on routes where the estimated market share parameter is high, fares are lower and despite the higher number of passengers travelling by air, carriers do not perform profitably.

12.4 CARRIERS' OPERATION WITH FIXED AIRCRAFT SIZE AND VARIABLE LOAD FACTOR

This test is undertaken for two reasons: firstly, because when deregulation is introduced, existing operators are normally faced with a fleet of aircraft

Table 12.2(a): Increase in the Value of the Market Share Parameter by 50%

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	49	4	57	721	277	1	-514	0.98
BCAL	44	4	59	539	217	1	-2394	0.90
KLM	49	4	57	721	286	1	1573	1.04
OA	70	2	87	10	-	-	-	-
RAIL	29	3	86	12	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 12.2(b): Decrease in the Value of the Market Share Parameter by 50%

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	66	4	74	492	189	1	5237	1.19
BCAL	61	4	76	447	180	1	4351	1.19
KLM	65	4	73	517	205	1	7097	1.26
OA	70	2	87	268	-	-	-	-
RAIL	29	3	86	279	-	-	-	-

* For the key to the variable symbols see table 8.2

from previous operations and it is not realistic to assume they can acquire a new fleet of optimum aircraft size. Secondly, such runs demonstrate the extent to which the ability to purchase the optimum aircraft size influences the carriers operation. It is assumed that the aircraft are 300 seater and the carriers can vary the load factor. The process for modelling carriers reaching equilibrium, is similar to the process discussed in Section 7.2.3, except that instead of calculating aircraft size by rearranging Equation 6.10, load factor is calculated.

Table 12.3 illustrates the model's output when carriers operate the fixed aircraft size. Comparing such an operation with that of the variable aircraft size and fixed load factor (Table 8.3) shows that when aircraft size is fixed (300 seater), the following features occur:

- service frequency is lower in total by 41%. This is because for a fixed aircraft size, the fixed cost is constant while the variable cost increases with the increase in the number of flights, leading to a rise in the total cost. Therefore, as Figure 6.5 illustrates, the lower the number of the flights the lower the total costs. As a result, carriers try to fill the aircraft at very high load factors in order to reduce the total costs. The extent to which the carriers can reduce service frequency depends on passengers sensitivity with respect to the reduction in number of flights.

- fares are lower by an average of 58%. This is because each carriers find it more economical to reduce fares to compensate for lower service frequency than operating at higher service frequency and higher fares. If carriers provide more flight departures they do not attract enough passengers to support the increase in the costs. On the other hand if they operate at low service frequency and charge higher fares they lose passengers to rail or to the foreign airlines. Such a situation encourages the carriers to lower their fares and operate fewer flights.

- passenger generalised costs are lower by an average of 43% despite the decrease in service frequency. This is due to the lower fares charged by the operators.

- although air carriers together have attracted more passengers, they all make a loss mainly due to the very low fares they charge. This is be-

Table 12.3: Airline Operation with Fixed Aircraft Size (300 seater)

Carrier	F	FQ	L	GC	D	NACT	P	R/TC
BA	26	2	0.94	38	564	1	-15078	0.49
BCAL	19	2	0.94	38	564	1	-15159	0.41
KLM	24	3	0.96	34	863	1	-10459	0.66
OA	70	2	-	87	5	-	-	-
RAIL	29	3	-	86	6	-	-	-

L is Load factor

* For the key to the rest of variable symbols see table 8.2

cause each carrier, taking into account its rivals' fare and number of flights, finds it economical to lower its fare and attract enough passengers to operate at a high load factor and lower service frequency. This process leads to a situation where all charge such low fares that none of them makes any profit.

This test illustrates the effect of competition when aircraft size is fixed and load factor is variable. Under previous conditions when aircraft size is variable and load factor is fixed, the reduction in the service frequency (i.e less than four) results in higher costs due to the operation of larger aircraft. However when aircraft size is fixed any reduction in flight frequency results in lower total costs. Under this condition where load factor is variable, the reduction in fare and as a result the increase in passenger demand for each flight, increases the load factor but not the costs. Therefore at each number of flights carriers reduce the fare until the load factor is quite high (i.e. well above 90%). Any further reduction in fare results in the operation of extra flights. In comparison when load factor is fixed (at around 65%), if the reduction in fare leads to increases in load factor above the fixed level, the operation of extra flights is required. Therefore when carriers operate at fixed levels of load factor (which is also much below 100%) and variable aircraft size, their fares at equilibrium are set at higher levels than when aircraft size is fixed and load factor is variable. This is due to the difference in the level of load factor above which extra flight is required.

12.5 <u>VARIATION IN CARRIERS' PREDETERMINED LOAD FACTORS WITH VARIABLE AIRCRAFT SIZE</u>

This sensitivity test is undertaken to analyse the effects of variation in the predetermined level of load factor on the carriers operation. To do so, operators load factor is varied by +50% and -25%.

The model's final output is presented in Tables 12.4(a) and 12.4(b). It can be seen that operating at higher load factor leads to:

- carriers charging fares which are lower, by an average of 37%, than when the load factor is reduced by 25%. This is because at higher load factor, carriers cannot reduce their service fre-

Table 12.4(a): Carriers' Operation Following Increase in the Pre-Determined Level of Load Factor by 50%

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	42	4	50	688	177	1	2848	1.20
BCAL	38	4	53	514	138	1	312	1.02
KLM	41	4	49	758	201	1	4894	1.19
OA	70	2	87	20	-	-	-	-
RAIL	29	3	86	22	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 12.4(b): Carriers' Operation Following Decrease in the Pre-Determined Level of Load Factor by 25%

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	67	4	75	544	277	1	580	1.02
BCAL	60	4	75	544	295	1	-77	0.99
KLM	67	4	75	544	289	1	2405	1.07
OA	70	2	87	178	-	-	-	-
RAIL	29	3	86	193	-	-	-	-

* For the key to the variable symbols see table 8.2

quency from four flights due to the costing model integer effect. Therefore in order to operate four flights per day at a higher load factor they need to attract a higher number of passengers. This leads to lower fares.

- the optimum service frequency under the two conditions is equal to the maximum number of flights that one aircraft can operate in one day. In practice , carriers with a higher load factor operate lower numbers of flights by larger aircraft. But here, due to the costing model integer effect the carriers operate four return flights and adjust the aircraft size accordingly. Following Equation 6.10, for a fixed number of flights with the increase in load factor, smaller aircraft are required, despite the slight increase in the level of demand.

- the passenger generalised cost is lower, reflecting the lower fare charged and as a result more passengers (20%) travel by the major air carriers.

- the carriers are financially in a better position when operating at a higher load factor, as BA makes 79% more profit, and KLM 51%. BCal makes a loss when operating at lower load factor.

This test illustrates that operating aircraft at higher load factor not only results in passengers lower generalised costs, but also improves the carriers' financial position given that the number of flights is not affected. This outcome is also applicable even if service frequency is reduced in markets where passengers do not highly value the reduction in travelling time. This is the reduction in service frequency and the resulting increase in the defer time does not deter passengers from travelling as long as fares are reduced.

12.6 VARIATION IN AN AIRCRAFT'S MAXIMUM NUMBER OF FLIGHTS PER DAY

In all the previous runs it was assumed that each aircraft can make four return flights per day (this is based on the assumption that carriers operate twelve hours a day and each return flight takes three hours). It is the aim of this section to analyse the effects of changes in the maximum number of flights that one aircraft can operate in a day, on the carriers' performance at their equilibrium.

The model's end results when an aircraft's maximum number of flights are varied by +/-50%, are illustrated in Tables 12.5(a) and 12.5(b). It can be seen that:

- when the maximum number of flights per day is reduced by 50% (i.e. to two), fares are higher by an average of 64% compared with a 50% increase in maximum number of flights. This is because, if fares are brought down, (when aircraft operate two flights/day) carriers' passenger demand increases to a level where an extra aircraft will be required. Such a situation increases the total costs by an amount that does not justify the increase in the carriers demand (marginal cost greater than marginal revenue). However, when an aircraft can operate six return flights per day (50% increase), in order to best utilise the aircraft 100% (i.e. six return flights), the carriers need to attract more passengers and they bring the fare down.

- the carriers' optimum service frequency in both cases (+/- 50%) is equal to the maximum number of flights that one aircraft can operate due to the costing model integer effect.

- when the aircraft can operate a maximum of six flights per day, the three airlines (BA, BCal and KLM) carry 97% of the passengers which is due to their high service frequency and lower fares. However when the maximum number of flights is two, they carry 55% of the total market, foreign airlines 21% and rail 24%.

- aircraft are bigger with the lower maximum number of flight condition, which follows the pattern expected from Equation 6.10.

- when the aircraft's maximum number of flights is higher, the carriers's financial performance deteriorate due to the operation of higher level of a service frequency.

The sensitivity of carriers' operation to changes in the maximum number of flights by one aircraft shows that if the aircraft's maximum number of flights can be increased (through increasing either the duration of carriers operation per day or reduction in the aircraft speed) passengers benefit by experiencing lower generalised costs whereas the carriers' financial performance deteriorated due higher level of

Table 12.5(a): Carriers' Operation Following Increase in Aircraft Maximum Flight Number by 50%

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	45	6	52	728	186	1	-750	0.98
BCAL	42	6	56	494	132	1	-2912	0.88
KLM	45	6	52	728	192	1	1301	1.04
OA	70	2	87	25	-	-	-	-
RAIL	29	3	86	28	-	-	-	-

* For the key to the variable symbols see table 8.2

Table 12.5(b): Carriers' Operation Following Decrease in Aircraft Maximum Flight Number by 50%

Carrier	F	FQ	GC	D	ACT	NACT	P	R/TC
BA	77	2	88	362	278	1	-125	0.99
BCAL	70	2	88	362	292	1	31	1.00
KLM	77	2	88	362	287	1	1455	1.05
OA	70	2	87	439	-	-	-	-
RAIL	29	3	86	478	-	-	-	-

* For the key to the variable symbols see table 8.2

service frequency by smaller aircraft. This result is affected by the assumption about the total size of the market as being fixed. This is because when carriers operate at higher service frequency, despite attracting rail and the foreign airlines' passengers they cannot carry enough passengers to support such an increase in the number flight departures.

12.7 GENERAL IMPLICATIONS

These sensitivity tests provide insight into how carriers' performances are affected if some of the assumptions or the value of input parameters are varied. The outcomes imply that:

(1) If equal opportunity is given to all the air operators (in terms of operating from the main airport and having access to the advantages that the larger operators have) the economic efficiency that can be attained in a competitive market is more likely to be achieved. This is because the small lower cost carriers can operate competitively with the larger carriers. The larger carriers, in order to improve their position, are more likely to reduce their resource cost to the same level as the lower cost carriers. However if the small, lower cost carriers cannot compete on equal terms, the larger carriers take advantage of the size of their operation leading to uneconomical operation of the smaller carriers. This has been shown in the US deregulated domestic market to result in the smaller carriers being absorbed by the larger ones. Such a situation leads to the emergence of a few carriers that dominate the market.

(2) Air carriers' operating on routes with higher estimated values of market share parameter ,where passengers are sensitive to reductions in passenger generalised costs, charge lower fares and do not perform financially as well as when the value of β is low and passengers are less sensitive to differences in passengers generalised costs. This is because when the value of the market share parameter is low the effects of the random components of utility function, which include the unobserved and immeasurable characteristics of the travellers and the carriers, are more. Therefore the influence of generalised costs on passengers choice is less than when the β value is higher. This enables every carrier to charge

higher fares without losing a great number (less than when the β value is higher) of passengers to the rivals.

(3) Carriers operating fixed aircraft size (300 seater) at variable load factor charge a lower fare, operate at higher level of load factor and as a result offer a lower level of service frequency at equilibrium than carriers operating optimum aircraft size at a fixed level of load factor. The carriers' financial performance deteriorates when operating fixed aircraft size at variable load factor compared with the operation of optimum aircraft size and fixed levels of load factor.

(4) At higher load factors, the carriers offer fares which are lower than when load factor is reduced and they all make higher profit. This is when the number of flights is not affected.

(5) Carriers operating aircraft capable of making more flights per day (i.e. six), offer a lower level of fare. They capture a higher share of the market but in terms of finance are slightly worse off due to the higher number of flight departures and the fixed total number of passengers.

CHAPTER THIRTEEN

CONCLUSIONS

13.1 INTRODUCTION

In this chapter the technical and policy conclusions of the study are discussed. The shortcomings of the competition model are outlined and finally a number of suggestions are made for the further research.

The objective of this study was to explore the rivalrous behaviour of airlines under deregulation and to provide insight on how individual airline's fare and service frequency interact in different competitive environments. The US experience has shown (see Chapter Two) that the outcome of deregulation not only depends on the situation at hand prior to the removal of regulation (e.g. the regulatory position and the general economic climate) it also depends on the characteristics of the route, the market and the carriers involved in the competition. This study has therefore aimed to explore the extent to which carriers' operation is affected by such characteristics.

To do so, a competition model was developed which simulates the competitive behaviour of the carriers and identifies their equilibrium position in terms of level of the fare, the service frequency, the resulting passenger generalised costs, carriers market share and profit.

In the design of the model certain general characteristics of the airline market are taken into account which are: rivalrous behaviour amongst the carriers and their strategic interdependence; product differentiations in the market; passengers usually do not have perfect information about all the available services; carriers do not compete on equal terms; and the airlines' profit is only affected by the operation of carriers in the market (the existing carriers and the entrants) not by the threat of entry. This implies that carriers' profit is only affected by the actual entry not the threat of it. The model is based on the European data and because the average route length in Europe is short the rail competition with the air carriers also is taken into account.

The main components of the competition model are the logit or the market share model, the costing model and the reaction model. The market share model calculates the individual carrier's market share as a function of all the carriers' service levels in the market (i.e. level of fare, service frequency and journey time) and passengers value of time. The market share model, unlike the classic economic models, does not allocate all the traffic to the best carrier, which is the carrier with the minimum generalised costs. Therefore the use of the logit model enables the simulation of the carriers competitive process. However if an "all or nothing " role is adopted, the carrier with the lowest generalised costs captures all the market whereas the logit model allows the carrier with the highest generalised costs to attract a number of passengers. This is because this model is based on the assumption that passengers choices are probabilistic and are subject to random influences. The sources of the random influences are the unknown or immeasurable characteristics of passengers or the carriers. Based on this model the amount of the traffic carried by each carrier depends on the differences in their generalised costs. The sensitivity of passengers to such differences is affected by the estimated value of market share parameter (β). The higher the value of the parameter the lower is the influence of the random components which include the effects of the unobserved and immeasurable characteristics of the travellers and the carriers. In other words the higher the value of the market share parameter the greater the differences in the carriers market share due to the same difference in their generalised costs.

The other component of the competition model is the costing model. This model is based on the assumption that carriers operate on a single route and all the fixed costs of the aircraft are attributed to the route under the consideration (i.e. London-Amsterdam). Based on the duration of the carriers' operation and the aircraft return journey time it is presumed that each aircraft can operate a maximum of four flights per day. Such assumptions result in the total costs being minimised when the aircraft is operated at four flights per day, given that aircraft size is variable and load factor is fixed. Due to the single route assumption, if one flight more than the aircraft's maximum number of flights is operated, there will be a sudden rise in the total costs (the integer effect). Such a property of the costing model encourages carriers to operate each aircraft at four return flights per day. Thus if two aircraft are acquired, the optimum number of flights will be eight. Such a characteristic of the costing model does not generally encourage service frequency competition.

The reaction model is another part of the competition model which receives the output of the market share and the costing model and simulates the competitive process of the carriers until they reach a possible equilibrium position.

The competition model is run to equilibrium under different competitive conditions and the carriers' competitive behaviour and the interactions between their fare levels and service frequency under each condition is examined. Bearing in mind the characteristics of airline market in general and the European market in particular, the outcome of the model runs offers a number of technical and policy conclusions.

13.2 TECHNICAL CONCLUSIONS

In this part of the study, carriers' operation at equilibrium was analysed under partially deregulated environments (deregulated fare, deregulated service frequency and deregulated fare and flight frequency) and under complete deregulation in different types of routes, markets and when carriers have different cost levels. The analysis of the results suggests the following general technical conclusions:

(1) The resource cost handicapped carrier (the carrier with the highest resource cost level) always charges the highest fare, given that every thing else is equal, and attracts a certain number of passengers. This is despite offering the highest fare in the market due to the property of the logit/market share model. Whether this carrier can always survive or not, depends on the characteristic of the route it operates on, the market it serves and the difference between its level of resource cost and those of the rivals.

(2) The generalised cost handicapped carrier (the carrier with the highest initial generalised costs) always charges the lowest fare, given that every thing else is equal. The disadvantages with this carrier operation is due to the lack of access to the economies of scale, scope and density, such as name recognition, operation from the main airport, ability to offer different

types of services and better ability to influence travel agents. This type of advantage increases the passengers loyalty to the larger carriers who serve many points and operate on dense routes. The generalised costs handicapped carrier does not generally perform financially as well as the larger carrier despite having the lowest resource cost in the market.

(3) Competitive fare levels are more likely to be lower than the level set by the regulators. This is because if regulated prices are lower than the competitive fares the carriers' profit declines to the level at which the existing number of carriers cannot stay in the market without being subsidised.

(4) Deregulation of fare enables the generalised costs handicapped carrier to improve it market share more than the other airlines, as it can have the flexibility to adjust its fare to compensate for its disadvantages. The competitive prices generally increase the airlines market share and result in the reduction of the number of rail's passengers.

(5) Regulation supports carriers. This is because under deregulation, carriers make less profit and in some cases make losses. This encourages carriers to operates more efficiently if they want to continue their operation. However under regulation, by allowing airlines to charge higher fare, they make profit and as a result the need to improve efficiency is not as great as under competition.

(6) Passengers on the sparse route pay higher fares than the dense route for the same length of flight. The sparse route travellers also experience higher defer time, which is a function of number of flights offered on the route, than the heavily travelled route passengers.

(7) There is a tendency to a monopolistic operation of one of the major air carriers on the short sparse route, and loss of air coverage on the very lightly travelled routes. On this type of route rail carries a larger proportion of the market than short dense routes due to the higher air fares and lower level of flight departures.

(8) The level of profit on the long and dense routes is higher than on the short and sparse routes for a given number of operators. This

encourages entry of new carriers to these types of markets. Whether the carriers can enter and if they do, whether their competition is effective all depends on the characteristics of the entrant and the incumbents, in terms of their resource cost level, access to airport landing slots and the economies of scale, scope and density (this is discussed later in this section).

(9) Tourist orientated markets (markets with the lower passengers value of time) receive a lower level of service frequency and a slightly lower fare compared with the business orientated markets. Thus the lower the passengers' value of time the lower is the level of fare and service frequency. This illustrates that business travellers benefit more than the tourists under competition. This is because the business orientated markets are served at a higher number of flights but are not charged much higher fares than the tourists orientated markets. The higher service frequency is due to the fact that business travellers are more sensitive to reduction in travelling time than the tourists. The reason for not being charged at much higher fares than the tourist orientated market is as a result of competition amongst the carriers.

(10) The entry of a new lower cost carrier brings the fares to a lower level and has a negative effect on the incumbent's financial performance. The lower the entrant's resource cost the lower the fares, so as the incumbent's profit falls, providing that the entrant has equal access to those economies that the incumbent carrier enjoys, both can compete on equal terms.

(11) There is a relationship between the number of carriers in the market, fare levels and carriers' profits. The higher the number of carriers operating in a market, the lower is the level of fares and the resulting profit.

The competition model has allowed the quantitative estimates of all these effects under various competitive conditions.

13.3 THE POLICY CONCLUSIONS

Here several policy conclusions in relation to the carriers competition are drawn which are as follows:

(1) The analysis of carriers operation in different competitive environments indicates that competition leads to lower fares and a more efficient airline industry as experience in the US has emphasised. This is because, as was shown in Chapter Eight, when regulated fare is higher, price competition lowers the fares and the carriers' profit. Therefore carriers, in order to have a profitable operation, need to bring their resource costs down. This results in a more efficient airline industry. Although the pressure on fare due to the competition depends on the characteristics of the market, route and carriers, under all the competitive conditions, fare levels have not been more than the regulated fare.

(2) The effects of competition (i.e. lower fares and efficiency of airline industry), as shown in Chapter Eleven, are enhanced with the entry of a carrier (the lower cost carrier in particular) to the market. This clearly requires that the entrant has the same access to the airport facilities as that of the incumbents. Otherwise the operating conditions would be in favour of the carriers already in the market. Therefore deregulation of airlines without equal access to airport facilities limits the effectiveness of the competition.

(3) The entry can be effective if the entrants have access to the same economies of scale, scope and density that the incumbents enjoy. In Europe, if airline operation become free of the controls and regulations, the economic benefit of free competition is more likely to be achieved. This is because in Europe there are well experienced, lower costs and well known charters which can enter the scheduled airlines market and compete effectively. This is because these carriers have similar access to the economies that the scheduled carriers would have. Under deregulation the entry of the charter carriers who have lower resource costs, as shown in Chapter Eleven, will lead to pressure on scheduled fares and more efficient airline operations.

(4) Due to the existence of economies of scale, scope and density in the airline markets, the smaller carriers have to find some ways of achieving such economies in order to be capable of competing with the larger carriers. It was shown in this study, through running the competition model under different conditions, that the carrier which has some initial disadvantages

(that is due to operation from secondary airport and lower passengers loyalty as result of the smaller scale operation) always has a poor financial performance compered with the other carriers in the market, despite having the lowest resource cost. Such a situation encourages the smaller carriers either to merge, be acquired or get into some kind of agreements with the larger airlines. This would result in a few very large carriers to operate in the markets which would limit the effectiveness of competition.

In order to achieve the maximum economic benefits from airlines competition the smaller airlines can be allowed to merge or enter some alliances with each other, while the larger carriers be prevented from such activities. This would enables the smaller carriers to compete effectively with the larger carriers. Otherwise the larger carriers become larger through mergers and acquisitions and the market will be dominated by a few large carriers, as has happened in the USA.

13.4 SHORTCOMINGS OF THE MODEL

The model, despite its achievements in being able to illustrate the fare and service frequency interactions and determining the carriers equilibrium position under different competitive conditions and quantifying the effect, has several shortcomings which are as follows:

(1) In the real world, carriers' operation consists of a complex route network whereas in this study a point to point approach is considered. This, as stated before, results in the integer effect of the costing model.

(2) In the model development it is assumed that the total market size (rail plus air) is fixed and any reduction in overall air fares or increase in air service frequency could attract rail passengers. However the lower air fare or higher service frequency does not just attract the rail travellers but may generate trips that would not have been made before.

(3) In reality rail operators would probably react to air operators' policy. In this study it is supposed that while air carriers' policies in terms of fare and frequency affect rail market

share, there is no reaction from rail operators.

(4) In calculating the defer time (the difference between the passengers desired and the closest actual departure time) it is assumed that the passengers are indifferent in forward and backward rescheduling. However in some cases, in particular in business markets, passengers have a strong preference for departing at a certain time. Therefore they may not mind to travel by the earlier flight but not by the flight which is after their desired departure time, even if it is closer to their desired departure time than the earlier flight.

(5) In the design of the model it is assumed that carriers compete on the number of flights. However in reality, they compete on the time of the flight departure as well as the service frequency, in particular in the business markets where a peak in the level of demand at certain times of the day (i.e. early mornings and late afternoons).

Many of these shortcomings arise from conscious simplifications to enable a meaningful yet manageable analytical technique to be developed and applied in the available time. Despite the shortcomings, as discussed in Section 4.2, it has overall advantages over similar methods used in this field so far.

13.5 SUGGESTIONS FOR FUTURE RESEARCH

Future research activity should be considered within the following area:

(1) The competition model can be extended so that it can simulate the interaction between fare and service frequency on the airline network , rather than on a single route, under different competitive conditions. Teodorovic and Krcmar-Nozic (1989) have developed a model that determines flight frequencies on an airline network where there is competition which can be used as a basis for such a development.

(2) More research can be undertaken to incorporate the effect of the carriers' competition on departure time. In the study by Evans (1987), the departure time competition between two bus operators is discussed.

(3) A measurement technique can be developed to forecast the total number of passengers (rail plus air) under different competitive environments and also take into account the fluctuation in the level of passenger demand across the day.

(4) Rail operations can be studied to develop a rail costing model. Such a model would quantify the effect of rail policy, in response to the airlines operation, on its finance.

(5) More research can be undertaken to identify the factors that affect the variation in the value of the market share parameter in the airline markets and whether the generalised costs should be used in determining the carriers market share in opposed to the generalised time. The study by Gunn (1983) discusses this issue.

(6) More research is needed to explore the effect of carriers' different objectives (rather than profit maximisation) on the airline performance under various conditions.

(7) The model can also be applied in other circumstances. For example to examine the impact of the City airport and the long term consequences of the Channel Tunnel and high speed trains on airlines operation under competition.

(8) The competition between the operators of other modes of transport (i.e. the bus industry) can be analysed by the application of the model developed in this study.

In conclusion, modelling competition is a complex process. In this study, based on a series of assumptions, an attempt has been made to model the competitive behaviour of the carriers in terms of their level of fares and service frequency. The model offers the policy makers a tool to quantify the possible outcome of carriers operation under different competitive conditions. This provides an initial basis for the exploration of the effects of competition in the different operating environments.

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APPENDIX A

EUROPEAN GOVERNMENTS' AVIATION OBJECTIVES

On Behalf of The Consumer

- Reasonableness of tariffs
- Simple, comprehensible tariff structure
- Convenient interlining arrangements

On Behalf Of Airlines

- Economics viability of airlines
- Improvements in airline efficiency
- Maximisation of market opportunities for their airlines

On Behalf Of Other Parts Of The Air Transport System

- Avoidance of capacity problems, such as airport congestion

On Behalf Of Other Aspects Of The Public Interest

- Maintenance of services to smaller communities
- Protection of tax payers against airline subsidies
- Avoidance of excess airline profits
- Benefits for the tourist industry
- National economic, prestige and cultural objectives
- Environmental protection
- Efficient use of resources
- A balance between air and surface transport
- Maintenance of safety standards

Source: Weathcroft and Lipman (1986)

APPENDIX B

THE AIR TRAFFIC RIGHTS

These traffic rights or freedoms of the air apply to scheduled international air transportation, and are as follows:

- The First Right

The right to fly across the territory of another state without landing.

- The Second Right

The right to land in another country for technical purposes, such as refuelling.

- The Third Right

The right to put down in another state passengers, mail and cargo taken on in the country to which the aircraft belongs.

- The Fourth Right

The right to take on in another country passengers, mail and cargo to be put down in the country to which the aircraft belongs.

- The Fifth Right

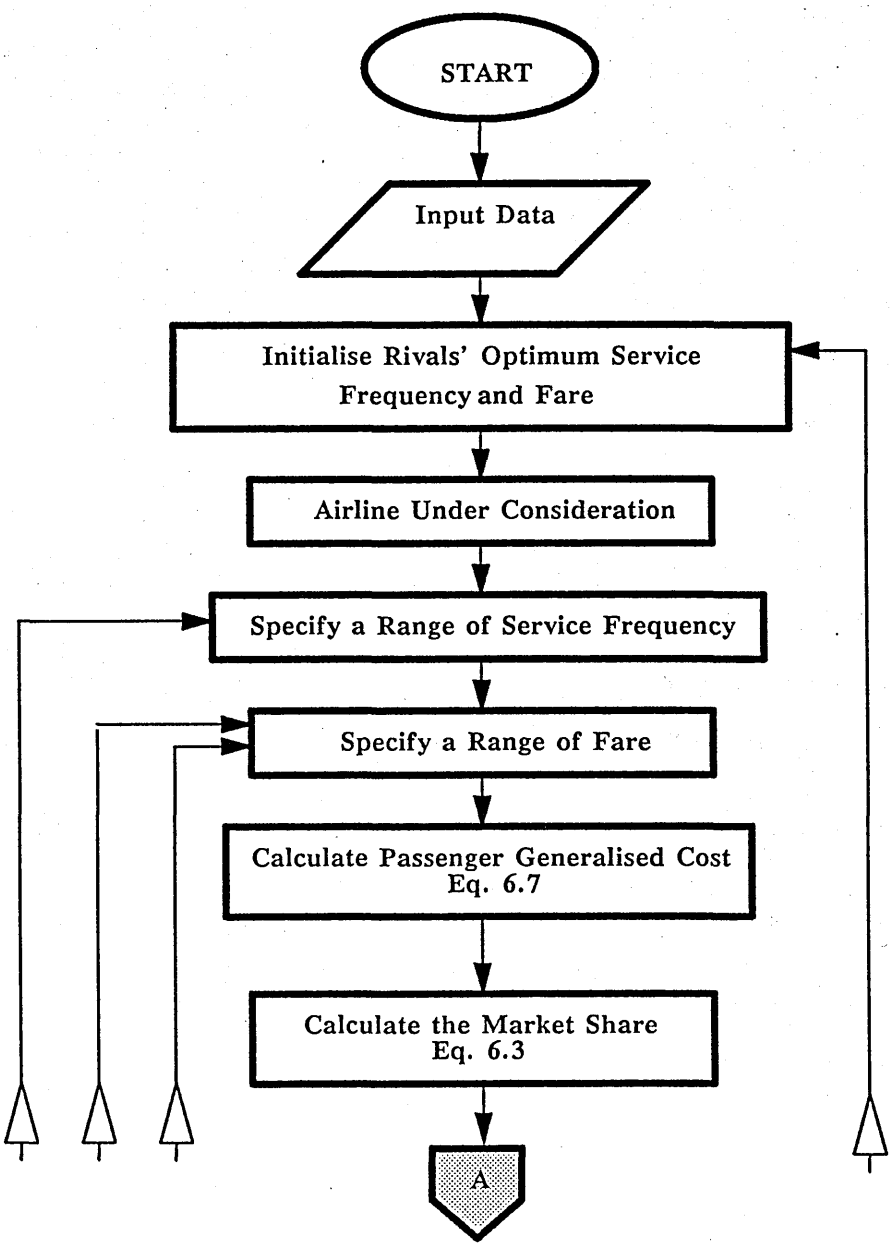
The right to carry passengers, mail and cargo between two other countries.

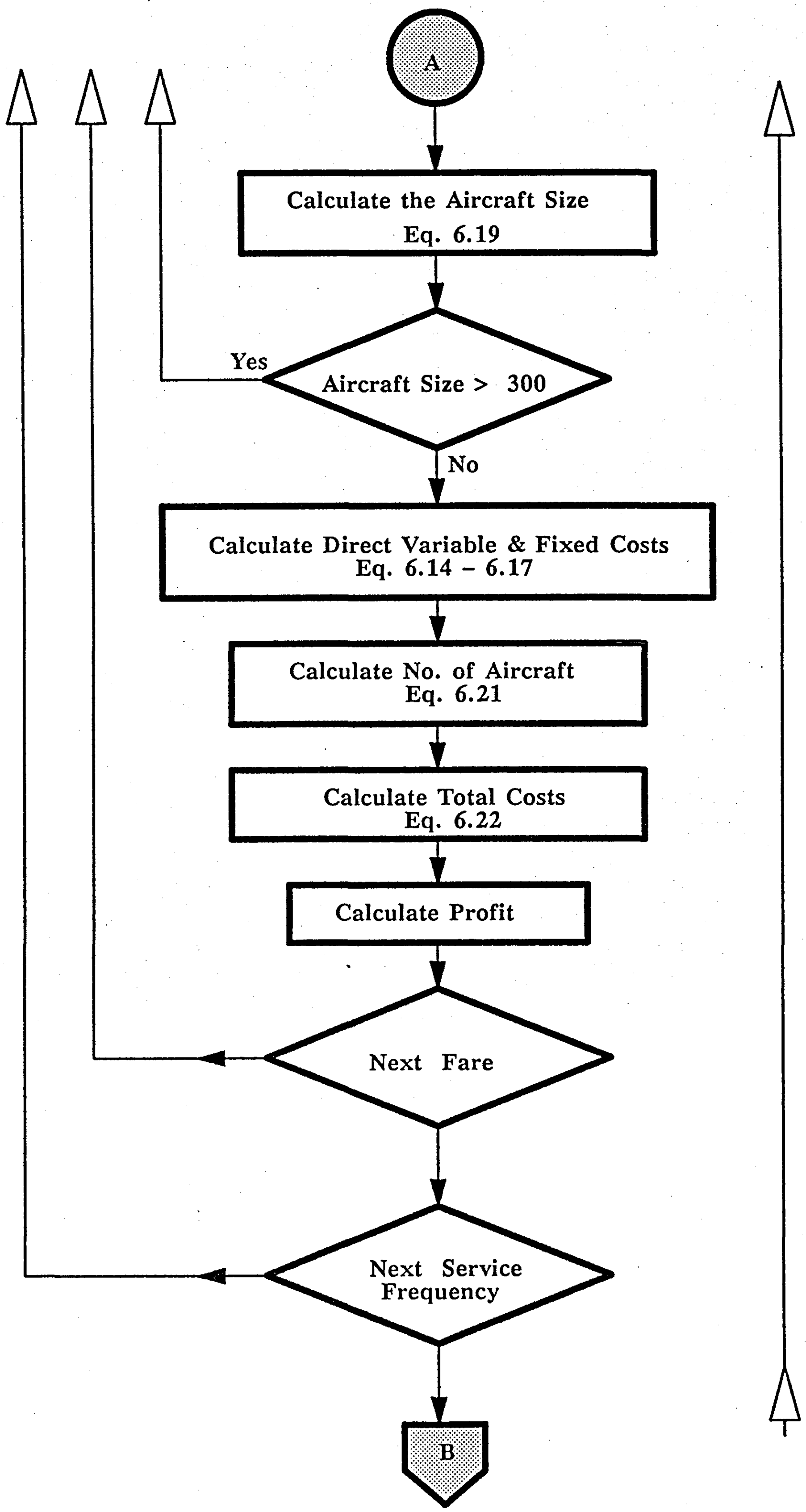
APPENDIX C

THE MODEL FLOW-DIAGRAM AND THE COMPUTER PROGRAM LISTING:

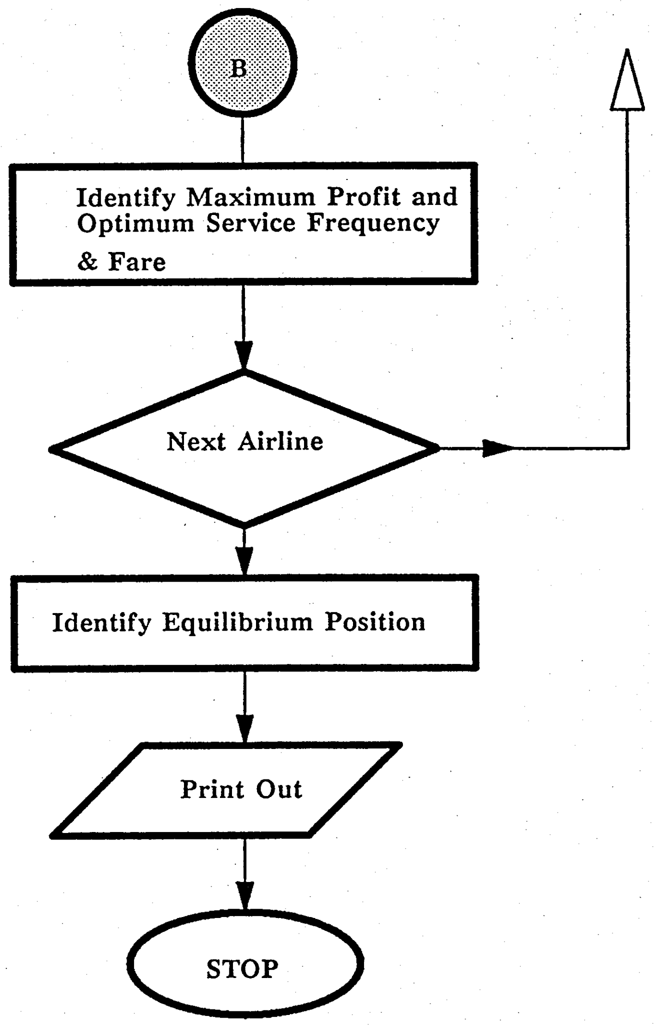
Fig. C.1 illustrates the sequence of the computational operation of the model.

Fig. C.1 : The Model Flow-diagram





A
Calculate the Aircraft Size
Eq. 6.19
Yes
Aircraft Size > 300
No
Calculate Direct Variable & Fixed Costs
Eq. 6.14 – 6.17
Calculate No. of Aircraft
Eq. 6.21
Calculate Total Costs
Eq. 6.22
Calculate Profit
Next Fare
Next Service
Frequency
B


B
Identify Maximum Profit and Optimum Service Frequency & Fare
Next Airline
Identify Equilibrium Position
Print Out
STOP

LIST OF THE COMPUTER PROGRAM:

```
  5 REM ==================================================
  6 REM =                COMPETITION MODEL               =
  7 REM ==================================================
  8 REM
  9 REM
 10 REM ###### Major Airlines: British Airways,
                               British Caledonian,
                               KLM.
 11 REM ###### Input Data
 15     MODE 3
 20     @% = &0002030A
 30     VT = 4.75
 40     BETA = 0.097
 50     TD = 2000
 60     LDF = 2160
 70     FQOA = 2
 80     FQR = 3
 90     DI = 235
100     NFQ = 4
110     IVC = 0.0306
120     INFC = 11.61
130     DOP = 6
140     LBA = 0.65
150     LBCAL = 0.62
160     LKL = 0.63
170     FOA = 70
180     FR = 29
185 REM ###### Initialisation
190     PBA2 = 0 : PBCAL2 = 0 : PKL2 = 0
200     X1 = 1 : X2 = 20 : X3 = 10 : X4 = 100
210     X5 = 4 : X6 = 4  : X7 = 30 : X8 = 30
220     X9 = 4 : X10= 4  : X11= 30 : X12= 30
230     Y1 = -900000
240     Y2 = 0
250     Y3 = 0
259 REM ###### British Airways
260     PBA1 = Y1 : FBA1 = 0 : FQBA1 = 0 : CBA1 = 0 :
        DBA1=0 : ACTBA1 = 0 : NCBA1 = 0 : RBA1 = 0 :
        TCBA1 = 0
269 REM ###### British Caledonian
270     PBCAL1 = Y2 : FBCAL1 = 0 : FQBCAL1 = 0 : CBCAL1 =
        0 : DBCAL1 = 0 : ACTBCAL1 = 0 : NCBCAL1 = 0 :
        RBCAL1 = 0 : TCBCAL1 = 0
279 REM ###### KLM
280     PKL1 = Y1 : FKL1 = 0 : FQKL1 = 0 : CKL1 = 0 :
        DKL1 = 0: ACTKL1 = 0 : NCKL1 = 0 : RKL1 = 0 :
        TCKL1 = 0
289 REM ###### FOREIGN AIRLINES
290     FOA1 = 0 : FQOA1 = 0 : COA1 = 0 : DOA = 0
299 REM ###### RAIL
```

```
300      FR1 = 0 : FQR1 = 0 : CR1 = 0 : DR1 = 0
309 REM ###### Range of Fare & Frequency
310      FOR FQKL = X9 TO X10 STEP 1
320      FOR FKL = X11 TO X12 STEP 1
330      IF X10 > X9 THEN 390
340      FOR FQBCAL = X5 TO X6 STEP 1
350      FOR FBCAL = X7 TO X8 STEP 1
360      IF X8 > X7 THEN  390
370      FOR FQBA = X1 TO X2 STEP 1
380      FOR FBA = X3 TO X4 STEP 1
389 REM ###### Calculate Passenger Generalised Costs
390      CBA = FBA + ( (3/FQBA) + 1 ) * VT
400      CBCAL = FBCAL + 7 + ( (3/FQBCAL) + 1 ) * VT
410      CKL = FKL + ( (3/FQKL) + 1 ) * VT
420      CR = FR + ( (3/FQR) + 11 ) * VT
430      COA = FOA + ( (3/FQOA) + 1 ) * VT
440      BA = 1
450      BCAL = EXP ( - BETA * (CBCAL - CBA) )
460      KL = EXP ( - BETA * (CKL - CBA) )
470      R = EXP ( - BETA * (CR - CBA) )
480      OA = EXP ( - BETA * (COA - CBA) )
490      SUM = BA + BCA + KL + R + OA
499 REM ##### Calculate Passenger Demand
500      DBA = INT (TD / SUM ) + 1
510      DBCAL = INT ( TD * BCAL / SUM ) + 1
520      DKL = INT ( TD * KL / SUM ) + 1
530      DR = INT ( TD * R / SUM ) + 1
540      DOA = INT ( TD * OA / SUM ) + 1
549 REM #####  Calculate  Aircraft Size
550      ACTBA = DBA / ( FQBA * LBA )
560      ACTBCAL = DBCAL / ( FQBCAL * LBCAL )
570      ACTKL = DKL / ( FQKL * LKL )
580      IF X2 > X1 THEN 617
          ELSE 600
590      IF ACTBA > 300 THEN 1210
600      IF X6>X5 THEN 610
          ELSE 655
610      IF ACTBCAL > 300 THEN 1530
620      IF X10 > X9 THEN 630
          ELSE 640
630      IF ACTKL > 301 THEN 1660
639 REM ##### Calculate Direct Variable and Fixed Costs
640      DVCBA = 0.1245 * (ACTBA ^(-0.335))
650      DVCBA = ((DVCBA-0.14*DVCBA)*1.31) + 0.14*DVCBA
660      DVCBCAL = 0.1245 * ( ACTBCAL ^(-0.335) )
670      DVCBCAL = ((DVCBCAL-0.14*DVCBCAL)*1.31) +
                   0.14*DVCBCAL
680      DVCKL = 0.1245 * (ACTKL ^(-0.335))
690      DVCKL = ((DVCKL-0.14*DVCKL)*1.31) + 0.14*DVCKL
700      DPBA = 13.1 * (ACTBA ^ (-0.26))
710      WBA = 0.7 * ( 22.6 * ( ACTBA^(-0.41) ) )
720      DFCBA = DPBA + WBA + (0.02 * DPBA) + 1
730      DPBCAL = 13.1 * (ACTBCAL ^ (-0.26))
740      WBCAL = 0.7 * ( 22.6 * ( ACTBCAL^(-0.41) ) )
```

```
750      DFCBCAL = DPBCAL + WBCAL + (0.02 * DPBCAL) + 1
760      DPKL = 13.1 * (ACTKL ^ (-0.26))
770      WKL = 0.7 * ( 22.6 * ( ACTKL^(-0.41) ) )
780      DFCKL = DPKL + WKL + ( 0.02 * DPKL ) + 1
779  REM ##### Calculate the Number of Aircraft
790      NCBA = INT (FQBA / NFQ)
800      IF NCBA - INT (FQBA / NFQ) = 0 THEN
            NCBA = FQBA / NFQ
810      IF NCBA - INT (FQBA / NFQ) < > 0 THEN
            NCBA = 1 + INT (FQBA / NFQ)
820      NCBCAL = INT (FQBCAL / NFQ)
830      IF NCBCAL - INT (FQBCAL / NFQ) = 0 THEN
            NCBCAL = FQBCAL / NFQ
840      IF NCBCAL - INT (FQBCAL / NFQ) < > 0 THEN
            NCBCAL = 1 + INT (FQBCAL / NFQ)
850      NCKL = INT (FQKL / NFQ)
860      IF NCKL - INT (FQKL / NFQ) = 0 THEN
            NCKL = FQKL / NFQ
870      IF NCKL - INT (FQKL / NFQ) < > 0 THEN
         NCKL = 1 + INT (FQKL / NFQ)
879  REM ##### Calculate Total Costs
880      TCBA = ( ( (DVCBA + IVC) * ACTBA * FQBA * DI ) +
                  (LDF * FQBA) + (DFCBA + INFC) * DOP *
                  ACTBA * NCBA ) / 1.44
890      TCBCAL = ( ( (DVCBCAL + IVC) * ACTBCAL * FQBCAL *
                      DI) + (LDF * FQBCAL) + (DFCBCAL +
                      INFC) * DOP * ACTBCAL * NCBCAL) /
                      1.44
900      TCBCAL = TCBCAL * 0.87
910      TCKL = ( ( (DVCKL + IVC) * ACTKL * FQKL * DI ) +
                  (LDF * FQKL) + (DFCKL + INFC) * DOP *
                  ACTKL * NCKL) / 1.44
920      TCKL = TCKL * 0.92
929      REM ##### Calculate Profit
930      PBA = (DBA * FBA) - TCBA
940      PBCAL = (DBCAL * FBCAL) - TCBCAL
950      PKL = (DKL * FKL) - TCKL
960      IF X10 > X9 THEN  1010
970      IF X2 > X1 THEN  1030
980      IF X6 > X5 THEN  990
990      IF PBCAL < PBCAL1 THEN 1090
1000     IF X6 > X5 THEN 1040
1010     IF PKL < PKL1 THEN 1090
1020     IF X10> X9 THEN 1040
1030     IF PBA < PBA1 THEN 1090
1038 REM ##### Identify Max. Profit & Optimum Service
1040     PBA1 = PBA : FBA1 = FBA : FQBA1 = FQBA :
         CBA1 = CBA : DBA1 = DBA : ACTBA1 = ACTBA :
         NCBA1 = NCBA : RBA1 = DBA * FBA:
         TCBA1 = TCBA
1050     PBCAL1 = PBCAL : FBCAL1 = FBCAL :
         FQBCAL1 = FQBCAL : CBCAL1 = CBCAL :
         DBCAL1= DBCAL : ACTBCAL1 = ACTBCAL :
         NCBCAL1 = NCBCAL : RBCAL1 = DBCAL * FBCAL :
```

```
        TCBCAL1 = TCBCAL
1060    PKL1 = PKL : FKL1 = FKL : FQKL1 = FQKL :
        CKL1 = CKL : DKL1 = DKL : ACTKL1 = ACTKL :
        NCKL1 = NCKL : RKL1 = DKL * FKL :
        TCKL1 = TCKL
1070    FOA1 = FOA : FQOA1 = FQOA : COA1 = COA :
        DOA1= DOA
1080    FR1  = FR : FQR1 = FQR : CR1 = CR : DR1= DR
1090    GOTO 1190
1098 REM ##### Print out
1100    PRINT "FBA " FBA, "FQBA " FQBA, "CBA" CBA ,
              " DBA" DBA , "ACTBA" ACTBA, " NCBA "  NCBA,
              "RBA"  DBA * FBA, "TCBA " TCBA, "PBA" PBA,
              "R /TC" (DBA* FBA) / TCBA
1110    PRINT
1120    PRINT "FBCAL " FBCAL, "FQBCAL " FQBCAL,
              "CBCAL" CBCAL , " DBCAL" DBCAL ,
              "ACTBCAL" ACTBCAL, " NCBCAL "  NCBCAL,
              "RBCAL"  DBCAL * FBCAL, "TCBCAL " TCBCAL,
              "PBCAL" PBCAL, "R /TC" (DBCAL* FBCAL) / TCBCAL
1130    PRINT
1140    PRINT "FKL" FKL, "FQKL" FQKL, "CKL" CKL,
              " DKL" DKL, "ACTKL" ACTKL, " NCKL"  NCKL,
              "RKL"  DKL* FKL, "TCKL"  TCKL, "PKL" PKL,
              "R /TC" (DKL* FKL) / TCKL
1150    PRINT
1160    PRINT "FOA " FOA, "FQOA " FQOA, "COA" COA ,
             " DOA" DOA
1168    PRINT
1170    PRINT "FR " FR, "FQR " FQR, "CR" CR , " DR" DR
1180    PRINT
1190    IF X6 > X5 GO TO 1530
1200    IF X10 > X9 THEN 1660
1210    NEXT FBA
1220    NEXT FQBA
1230    IF X2 > X1 THEN 1300
1240    IF X10 > X9 THEN 1250
         ELSE 1270
1250    PRINT ".................... KLM ................"
1260    IF X10 >X9 THEN 1310
1270    IF X6> 55 1249
1280    PRINT ".................... BCAL ..............."
1290    GOTO 1310
1300    PRINT".................... BA ................."
1310    PRINT
1320    PRINT "FBA1 " FBA1, "FQBA1 " FQBA1, "CBA1" CBA1 ,
                " DBA1" DBA1 , "ACTBA1" ACTBA1,
                " NCBA1 " NCBA1, "RBA1"  RBA1,
                "TCBA1 " TCBA1, "PBA1" PBA1,
                "R1 /TC1" (DBA1* FBA1) / TCBA1
1330    PRINT
1340    PRINT "FBCAL1 " FBCAL1, "FQBCAL1 " FQBCAL1,
              "CBCAL1" CBCAL1 , " DBCAL1" DBCAL1,
              "ACTBCAL1" ACTBCAL1, " NCBCAL1 "  NCBCAL1,
```

```
            "RBCAL1"  RBCAL1, "TCBCAL1 "
            TCBCAL1, "PBCAL1" PBCAL1,
            "R1 /TC1" (DBCAL1* FBCAL1) / TCBCAL1
1350    PRINT
1360    PRINT "FKL1" FKL1, "FQKL1" FQKL1, "CKL1" CKL1,
            " DKL1" DKL1, "ACTKL1" ACTKL1,
            " NCKL1"  NCKL1, "RKL1"  RKL1,
            "TCKL1" TCKL1, "PKL1" PKL1,
            "R /TC" (DKL1* FKL1) / TCKL1
1370    PRINT
1380    PRINT "FOA1 " FOA1, "FQOA1 " FQOA1, "COA1" COA1 ,
            " DOA1" DOA11
1390    PR1INT "FR1 " FR1, "FQR1 " FQR1, "CR1" CR1 ,
             " DR1" DR1
1400    PRINT "----------------------------------------"
1410    IF X6 > X5 THEN 1560
1420    IF X10 > X9 THEN 1690
1430    FQBA = FQBA1 : FBA = FBA1
1440    X1 = FQBA1 : X2 = FQBA1 : X3 = FBA1 : X4 = FBA1
1450    FQKL = FQKL1 : FKL = FKL1
1460    X5 = 4 : X6 = 5 : X7 = 30 : X8 = 70
1470    IF PBA1 = PBA2 AND PBCAL1 = PBCAL2 AND PKL1 = PKL2
          THEN 1480 ELSE 1490
1480    IF ACTBA1 < 300 AND ACTBCAL1 < 300 AND ACTKL1 < 301
          THEN 1490
1490    PBA2 = PBA1 : PBCAL2 = PBCAL1 : PKL2 = PKL1
1500    PBCAL1 = -900000
1510    PRINT
1520    GOTO 340
1530    NEXT FBCAL
1540    NEXT FQBCAL
1550    GOTO 1280
1560    X1 = FQBA1 : X2 = FQBA1 : X3 = FBA1 : X4 = FBA1
1570    FQBA = FQBA1 : FBA = FBA1
1580    X5 = FQBCAL1 : X6 = FQBCAL1 : X7 = FBCAL1 :
        X8 = FBCAL1
1590    FQBCAL = FQBCAL1 : FBCAL = FBCAL1
1600    X9 = 4 : X10 = 5 : X11 = 30 : X12 = 70
1610    IF PBA1 = PBA2 AND PCAL1 = PBCAL2 AND PKL1 = PKL2
          THEN 1620 ELSE 1630
1620    IF ACTBA1 < 300 AND ACTBCAL1 < 300 AND
           ACTKL1 < 301 THEN 1630
1630    PBA2 = PBA1 : PBCAL2 = PBCAL1 : PKL2 =PKL1
1640    PKL1 = -900000
1650    GOTO 310
1660    NEXT FKL
1670    NEXT FQKL
1680    GOTO 1250
1690    X1 = 4 : X2 = 5 : X3 = 30 : X4 = 70
1700    X5 = FQBCAL1 : X6 = FQBCAL1 : X7 = FBCAL1 :
        X8 = FBCAL1
1710    FQBCAL = FQBCAL1 : FBCAL = FBCAL1
1720    FQKL = FQKL1 : FKL = FKL1
1730    X9 = FQKL1 : X10 = FQKL1 : X11 = FKL1 :
```

```
        X12 = FKL1
1735 REM ###### Identify Equilibrium Position
1740    IF PBA1 = PBA2 AND PBCAL1 = PBCAL2 AND
          PKL1 = PKL2 THEN 1750 ELSE 1760
1750    IF ACTBA1 < 300 AND ACTBCAL1 < 300 AND
          ACTKL1 < 301 THEN 1810
1760    PBA2 = PBA1
1770    PBCAL2 = PBCAL1
1780    PKL2 = PKL1
1790    PBA1 = -900000
1800    GO TO 370
1810    PRINT "................. Equilibrium ............"
1820    PRINT
1830    PRINT "FBA1 " FBA1, "FQBA1 " FQBA1, "CBA1" CBA1 ,
              " DBA1" DBA1 , "ACTBA1" ACTBA1,
              " NCBA1 " NCBA1, "RBA1"  RBA1,
              " TCBA1 " TCBA1, "PBA1" PBA1,
              " R1 /TC1" (DBA1* FBA1) / TCBA1
1840    PRINT
1850    PRINT "FBCAL1 " FBCAL1, "FQBCAL1 " FQBCAL1,
             "CBCAL1" CBCAL1 , " DBCAL1" DBCAL1,
             "ACTBCAL1" ACTBCAL1, " NCBCAL1 "  NCBCAL1,
             "RBCAL1"  RBCAL1, "TCBCAL1 "
             TCBCAL1, "PBCAL1" PBCAL1,
             "R1 /TC1" (DBCAL1* FBCAL1) / TCBCAL1
1860    PRINT
1870    PRINT "FKL1" FKL1, "FQKL1" FQKL1, "CKL1" CKL1,
             " DKL1" DKL1, "ACTKL1" ACTKL1,
             " NCKL1"  NCKL1, "RKL1"  RKL1,
             "TCKL1" TCKL1, "PKL1" PKL1,
             "R /TC" (DKL1* FKL1) / TCKL1
1880    PRINT
1890    PRINT "FOA1 " FOA1, "FQOA1 " FQOA1, "COA1" COA1 ,
             " DOA1" DOA11
1900    PRINT
1910    PR1INT "FR " FR, "FQR1 " FQR1, "CR1" CR1 ,
              " DR1" DR1
1920    PRINT "----------------------------------------------"
```