AIR TRANSPORT PROVISION IN REMOTER REGIONS
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Basil O’Fee was educated in Northern Ireland and was awarded an MA in Geography and Education from Emmanuel College, Cambridge in 1978. He has worked extensively in sales and marketing in the south-east of England, in areas such as gifts, sales promotion and business-to-business multimedia. Moving to Inverness in 1996, Basil joined Highland Airways (HA) and helped the company win its first substantial aviation contracts – delivering freight to the Scottish islands transferring and oil crew out of Aberdeen. In 1999 he became a director of Highland Airways and in 2007 was part of the MBO team that acquired the company from the Atlantic Group of aviation companies. Basil was involved in all aspects of the commercial side of HA – its literature, website, public relations strategy, tender responses – and was the driving force of many of Highland’s sales and marketing initiatives. Basil managed most of the company’s main contracts prior to their subsequent delegation, and remained a major shareholder of the airline until it ceased trading in March 2010. He has been a participant at most of the Aviation in Remote Regions conferences organised by Cranfield University since their inception in 1999. He has presented on the topic of PSOs at two of these conferences.

Romano Pagliari joined the Department of Air Transport at Cranfield University in 1995, having obtained a masters in Transport Studies followed by a PhD in Airport Slot Allocation from the Cranfield School of Management. Romano is currently course director for both full- and part-time MSc programmes in airport planning and management. As an aviation economist, he supports the department’s research and consultancy activities. Recent examples include research in the fields of airport infrastructure charging, economic regulation, airport performance benchmarking and air transport in remote regions. Being born and bred in the Scottish Highlands, Romano also has a keen interest in aviation developments in the Highlands and Islands. His other activities include managing and coordinating both public and client-specific airport-related CPD short courses and membership of the scientific committee of the International Centre for Competitive Studies in Aviation and the editorial board of the Journal of Airport Management.
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Introduction
George Williams

The origins of this book lie in a study that the Air Transport Group at Cranfield University undertook back in 1997/98 on behalf of and in collaboration with the then Norwegian Civil Aviation Administration (Luftfartsverket). The purpose of the study was to compare the significance of air transport and its provision in terms of airport infrastructure in a selection of European countries, to investigate how different airport systems are organised and managed, to compare the cost of providing airport infrastructure and related services, and to examine the importance of aviation as a means of public transport for domestic journeys.

In all, 429 airports situated in 13 countries were examined in the study. While a great deal of data was collected and analysed, it was clear that considerably more work remained to be undertaken before a detailed and accurate comparison could be made of the financial performances of different airport systems. One conclusion of the study was that there was a clear need for further research examining the relative efficiencies of different forms of airport systems. In addition to this, the need for further research on market conditions, air transport policies for remoter regions, aircraft operations and network design and operations became evident. It was undoubtedly the case that lessons could be learnt from the different approaches to air transport provision across Europe. A view emerged that a forum for the exchange of such information would provide an effective means by which to continue the work undertaken in the study. By obtaining the interest and experience of a wide range of airport system operators and organisers, much progress could be made to ensure the dissemination of best practice and the efficient use of scarce resources.

The first Forum on Air Transport in Remoter Regions was held in Nairn in Scotland in 1999, with the aim of bringing together those responsible for managing, operating and regulating both airports and airline services in the remoter parts of Europe. The programme included speakers from Finland, Greece, Iceland, Ireland, Norway, Portugal, Scotland, Spain and Sweden. Their wealth of experience and knowledge gave a unique opportunity for extensive discussion and exchange of ideas on an often-neglected area of air transport.

The first two days of the Nairn Forum were devoted to issues concerning Europe’s smaller regional airports, namely: their organisation and operation, their planning and their economic and social impact. Presentations were given by those responsible for managing and operating these types of airports in Finland, Greece, Iceland, Norway, Scotland and Sweden. The final day began by focusing on the operation of air services in remoter regions and closed with an examination of the different forms of subsidisation that have been adopted.
Following the success of the first forum the event has become a biennial event with a wider coverage than simply Europe. The most recent forum was held in April 2009 in Bergen, Norway. As with previous meetings, representatives of airlines, airport authorities, central and local government departments and agencies, consultancies and academic institutions from across the world were in attendance. On this occasion 20 speakers spoke on five key topics affecting the sector, namely: Environment and Sustainability, Subvention Policy, Safety and Crisis Management, Airport Infrastructure, and Innovation and Managing Change.

The sharing of ideas and experiences of best practice in the provision of air transport from the more remote parts of the world – including Brazil’s Amazon region, the Azores, the Faeroes, Lofoten and Finnmark in Norway and northern Canada – has without doubt proved of benefit to those charged with operating airline services and providing the necessary infrastructure in regions where demand for air transport is small but vital for the well-being of the communities living there.

The purpose of this book therefore is to provide the reader with a flavour of some of the many topics of concern to those responsible for operating, managing, financing and planning the provision of air transport in remoter regions that have formed the subject matter of these biennial forum meetings. As with each forum, the book focuses on five key topic areas, namely: the provision of air services and their impact (Part A), subvention mechanisms (Part B), infrastructure provision (Part C), innovation (Part D) and key issues for the future (Part E). In all, some 20 experts, each with extensive knowledge of operating, regulating, planning or funding air transport in regions with low demand for air transport, have expressed their thoughts and opinions.

In Part A, Svein Bråthen from Molde University College examines the key theoretical issues involved in deciding how much air transport should be supplied in remoter areas; Romano Pagliari from Cranfield University and Luís Silveira, the commercial director of SATA Air Açores, explore the development of air services over the past two decades in, respectively, the Scottish Highlands and Islands and the Azores; Jon Inge Lian from Norway’s Institute of Transport Economics analyses the economic impact of air transport in remoter regions; and Nigel Halpern from Molde University College reviews the marketing of small regional airports.

In Part B, George Williams from Cranfield University examines the experience across Europe of the application of Public Service Obligations (PSOs); Göran Anger, Johan Holmér and Pär-Erik Westin from Sweden’s National Public Transport Agency (Rikstrafiken) explore in detail the tendering process experience of PSOs in Sweden; and Basil O’Fee, the commercial director of Highland Airways, describes his experience of tendering for and operating PSO routes.

In Part C, Rodney Fewings from Cranfield University reviews the provision of airport infrastructure in Europe’s remoter regions; Are Lien from Avinor analyses the problems for smaller regional airports of complying with International Civil Aviation Organization (ICAO) Annex 14; and Svein Bråthen from Molde
University College and Knut Fuglum from Avinor explore the issues involved in developing an airport located in northern Norway over the longer term.

In Part D, Lennart Bergbom from Luftfartsverket and Johan Holmér review the performance of the virtual airlines that have been established in Sweden; Rajkumar Pant from the Indian Institute of Technology Bombay analyses the economic case for using airships to transport passengers and freight in remote parts of India; and consultants Ian Lowden and David Bentley provide an overview of the ICAO’s development scheme for routes with tourism potential.

In Part E, Olav Mosvold Larsen and Jon Sjølander from Avinor examine the issues affecting aviation providers faced with the challenge of climate change; Andy Foster from Cranfield University reviews the options available for airlines seeking to replace their ageing sub-20 seat aircraft; while George Williams explores the impact of measures that have been adopted in Scotland to reduce the high airfares charged to passengers travelling to the remoter parts of the country and Svein Bråthen presents a study from Norway which indicates that airfare reductions on thin routes may have socio-economic benefits for Norway as well as favourable effects for the remoter regions.

That there are many challenges facing those responsible for providing air transport services in the more remote parts of the world is obvious, and this book will hopefully shed light on a part of the transport sector which provides lifeline services for many small communities. A great number of these communities play active roles in their national economies by providing manufacturing skills (e.g. the oil and gas industry), services (e.g. tourism) and natural resources (petroleum and fish). Such issues will probably become more important also in emerging economies such as China and India.

This book is dedicated to the ingenuity, determination, resourcefulness and sheer endurance of the large band of professionals who master these difficulties on a daily basis in conditions that many who live in larger communities would find simply impossible.
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PART A
Provision of Air Services and their Impact
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Chapter 1
Deciding Upon the Right Amount of Air Transport Services in Remoter Regions
– Key Issues
Svein Bråthen

Introduction

Air transport services are a key factor in the transport system in rural areas. They allow human and natural resources to be used efficiently in a modern society. Air transport is very important for long-distance travel and for connecting remote areas to the rest of the world. In order to provide air transport, the air transport industry utilises primary resources, such as labour and capital, as well as intermediate products. Air transport itself is a product which is delivered partly as an intermediate product for other industries and partly for final demand like leisure travel.

The air transport industry, as well as other production activities, has impacts for resource allocation as well as for value added and income. Air transport services also act as a catalyst in industrial development, particularly in connection with the exploitation of location-specific natural and human resources. These catalytic impacts could be very important both from an economic efficiency and regional balance perspective. They are further discussed in Chapter 4.

To be able to provide efficient air transport services, it is important to have an adequate balance between level of service, air fares and subsidies. Excessively high prices may cause undesirable traffic deterrence and hence the benefits of the resources that are put into the air transport services are not fully utilised. On the other hand, if fares are set too low and/or the level of service is too high, then this may give excess demand and/or too many resources may be put into the air transport system.

In this section, we will discuss some key issues with respect to how the level of service in air transport can be determined, and what the economic consequences of a well-functioning air transport service are. The link between costs, prices and economic efficiency will be an important part in this discussion. Theoretically, the trade-off between fares, subsidies and departure frequency should be balanced so that the marginal willingness to pay for the air services should be equal to the costs of the marginal waiting time for the passengers. Firstly, market imperfections, costs issues and the balance between fares, costs, level of service and subsidies will be discussed. Secondly, tendering as a means of efficient provision of airport
services will be briefly presented. Finally, air transport services and the impact on economic efficiency in remoter areas will be commented on.

**Market Imperfections and Economic Efficiency**

Air transport causes a lot of effects which may call for some kind of attention by the public authorities. One of the analytical approaches that is appropriate when dealing with various problems in air transport economics is applied microeconomics.

In general, the authorities are involved in airline markets because they may fail to achieve economic efficiency, mainly with respect to these three categories:

- inability to provide public goods in line with the society’s preferences;
- the presence of externalities;
- imperfect competition.

Air transport services can be seen as a kind of public good as long as there is excess capacity, and society may have preferences for offering them in remoter areas for equity reasons. External effects are elements of costs and benefits that are not or only partly priced in the market. Examples may be costs of CO₂ emissions and benefits from improved communication in, for example, industrial networks. In most cases, imperfect competition may cause air fares to rise well beyond marginal costs. Imperfect competition based on natural monopolies (increasing returns to scale) may also call for subsidies to maintain economic efficiency.

In this section, we are going to focus mostly on the third of these elements. Indirectly, this element is also a discussion of the right amount of services to be provided in remoter areas; hence the first element will also be discussed. The main source of inefficiency is when the price of a product or service is set differently from the marginal social costs. On low-volume routes, the difference between price and marginal cost may become high, probably too high, without some kind of money transfer, either by means of cross-subsidies or by public subsidies.

**Prices and Subsidies in Air Transport**

We are now going to discuss theoretically what the demand and supply side of air transport in remoter areas may look like. In Figure 1.1, price $P_m$ with the corresponding quantity $Q_m$ is the situation for a profit-maximising monopolist, such as an airline that has a licence to operate a given Public Service Obligation (PSO) route.
Deciding Upon the Right Amount of Air Transport Services in Remoter Regions

The production takes place as long as the marginal revenues (MR) exceed the marginal costs (MSC) at point e. If the monopolist is regulated by the authorities to e.g. charge a price equal to the average cost (AC), then the price will be $P_A$ and the output will be $Q_A$. However, the social optimum is where the price equals the marginal cost (MSC), with the corresponding output $Q_C$. The fixed costs are however not covered, and the financial loss will be the shaded area $P_{fcb}$. This loss has to be covered by subsidies. A first-best pricing regime (price equals the marginal cost) gives a financial loss in a situation with a natural monopoly (increasing returns to scale). A regulatory regime where the monopolist is allowed to charge the price $P_A$, incurs a socioeconomic loss equal to the area $abd$. It is worth noting that in many cases, the capacity is well in excess of demand, meaning that the intersection between the $D$ curve and the $AC$ curve in Figure 1.1 takes place where the $AC$ curve is well above the $MSC$ curve. In those cases, a pure $AC$ pricing policy will incur a higher $P_A$, a significantly larger $adb$ triangle and hence the economic welfare loss to society will also be larger. The slope of the demand curve is also of interest. A steeper, less price-elastic curve will cause a smaller welfare loss.

**Price Elasticity Is An Important Measure**

The price elasticity gives percentage change in demand following percentage change in prices, and is used for assessing, e.g., revenue effects of air fare adjustments. As seen below, the price elasticity is an important measure when assessing efficient prices and level of service in air transport in remoter areas.
There are not many studies of price elasticity for air transportation. The most recent one is Njegovan (2006), who cites a number of other studies. One of them is Dargay and Hanly (2001) who used a time series from 1989 to 1998 to estimate a price elasticity of -0.6 for outbound international tourism from the UK. An interesting feature of this study was that other factors like currency parity and relative prices affected the demand for air services even more. Njegovan (2006) found the price elasticity in the same market to be -0.7, based on a time series from 1993 to 2003.

One of the most cited studies is Gillen et al. (2003), who examined 21 studies of price elasticity in various air transport segments in different countries. These studies were mainly based on time series analyses. This study is also the main source of information to support European Commission (2005), where the consequences of fuel taxes in the European Economic Area are discussed. Figure 1.2 summarises the findings from Gillen et al. (2003).

The variations appear to be quite large. Short-haul domestic (which is a significant part of the market for air transport services in remoter areas) has a median of -0.7, varying between -0.6 and -0.8. Domestic leisure travel is considerably more elastic, with a median of -1.5, varying between -1.3 and -1.7. A Norwegian study (Helgheim, 2002) of two domestic markets shows a price elasticity of mainly between -0.6 and -1.0, with a leisure travel segment ranging as high as -1.4. The interesting feature of this study was that it indicated an increasing elasticity with higher air fares, which is in good accordance with economic theory. Rekdal (2006) used network model simulations indicating somewhat lower price elasticity for air transport in the range of -0.41 to -0.76.

![Figure 1.2 Variations in direct price elasticity for air transport services](image)

*Source: Gillen et al. (2003).*
Optimal Pricing of Air Transport Services with Subsidies

In connection with regional air services, the trade-off between economic efficiency (price $P_c$ and the economic loss $P_{c,fcb}$) and cost coverage (price $P_A$ with traffic loss $Q_c - Q_d$) will often end in a discussion of compromising between public financial outlays and making the air transport services reasonably priced to make the system serve the remoter regions in an adequate way. This discussion tends to be more important on routes where the payload is low and where a minimum level of service has to be provided (less demand causes the intersection between the average cost curve $AC$ and demand $D$ to be well towards the left of point $a$ in Figure 1.1), as compared to the PSO routes where traffic is rather high (intersection between $AC$ and $D$, say, between point $c$ and $a$ in Figure 1.1). One way to do this is to price the services optimally, however constrained by the maximum level of subsidies the public authorities are willing to pay. In practice, this means that the authorities are willing to cover some of the shaded area in Figure 1.1, but not all of it. We call this pricing strategy the optimal departure from marginal cost pricing, or second-best pricing. We talk about a financial constraint, namely the maximum subsidy that the authorities are willing to accept or, conversely, the minimum revenues that have to be collected from the passengers to ensure that the ‘maximum subsidy’ criterion is met and at the same time maximise economic efficiency. We are now interested in how this can be done so as to minimise the economic welfare loss (the ‘deadweight loss’).

Consider a ‘thin’ regional air transport route where there are two market segments in a monopolised market. A reasonable assumption is that these markets have different price elasticity. The demand $x_i = x_i(p_i)$ is dependent on the price level. Conversely, the prices are dependent on the demand:

$$ p_i = p_i(x_i)(i=1,2) $$

The cost function for both market segments is expressed as:

$$ C = c_i(x_i) + c_f(x_f) + B $$

$C$ is total costs, $B$ is fixed costs, $c_i x_i$ are variable costs dependent on traffic for each market segment.

The financial constraint can now be expressed in a way that the revenue minus fixed and variable costs should at least equal the revenue necessary to satisfy the maximum subsidy constraint:

$$ [p_1 x_1 + p_2 x_2] - [c_1(x_1) + c_f(x_f) + B] \geq \Pi $$

We are now going to maximise the consumer surplus (the area between the demand curves and the cost curve), given the budget constraint (or subsidy constraint) $\Pi$. This can be expressed as:
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(4) Maximise \[ \int p_1(x_1)dx_1 + \int p_2(x_2)dx_2 - c_1(x_1) - c_2(x_2) - B \]
given the constraint \[ p_1x_1 + p_2x_2 - c_1(x_1) - c_2(x_2) - B \geq \Pi \]

By using Lagrange’s method for partial derivation, we get:

(5) \[ \frac{p_1 - c_1}{p_1} \cdot e_1 = \frac{p_2 - c_2}{p_2} \cdot e_2 \]

Equation (5) is useful in practical pricing policies. \( p_1 \) and \( p_2 \) are the air fares in each market segment, \( e_1 \) and \( e_2 \) are the price elasticity for each segment and \( c_1' \) and \( c_2' \) are the marginal costs. The economic interpretation of the equation is that if there are binding financial constraints, prices should be set higher than the marginal costs. The difference from marginal cost pricing should be higher in the market segment with the lowest price elasticity, implying that the price is set higher in the segment with the least price sensitivity. This is done to ensure a minimum welfare loss. The achievement is therefore important because the welfare loss for the consumers in each market segment is minimised.

The price elasticity in each segment has to be different in order to differentiate the prices, but the marginal cost can be equal (which is normally the case in an aircraft with two market segments). Imagine that market 1 is the market for business travel (low price elasticity) and market 2 is the market for leisure travel. The marginal costs and the demand elasticity are normally known, and the point of departure is to set the prices in one of the segments as the ‘target price’. For example, one might want to have a low fare for leisure travel. Equation (5) can then be used to calculate the price in the other market segment in order to satisfy the subsidy constraint. The subsidy constraint can be determined by considering the average variable costs per passenger that are caused by each departure. The difference between total costs and the average variable costs per departure can be considered as the optimal subsidy level, given that the correct level of service (LOS) is established, such as aircraft size and departure frequency. The correct LOS can be determined by studying the level where the waiting time costs for the passengers is equal to the costs of an incremental increase in the number of departures. By doing these considerations, optimal fares can be set, dependent on the capacity offered in the market, the price elasticity and the marginal costs of providing the service.

There are of course elements that make this a bit more complicated. One is the level of service that should be provided and the corresponding aircraft costs. In general, pricing policies should aim at maximising the payload for each departure. In general, empty seats represent a loss to society. Either the capacity is above optimality or the air fares are set too high. The pricing framework described above
offers a reasonable compromise between marginal cost pricing and the need to contain public spending on air transport services.

More often than not, determination of LOS is based on fairly simple, intuitive assessment because of limited information about the market segments and their ability to carry the economic costs of the services. The subsidy level may also be set based on equity or regional balance considerations and not only from criteria based on economic efficiency. However, cost-benefit analyses can be applied to assess the adequate level of air transport services, based on the criteria above.

A study by Jansson (2007) indicated clearly that a 20 per cent reduction in air fares for the PSO routes in Norway would give a better overall economic efficiency because of the passenger benefits and positive system effects in the transport network in general. In addition to the overall net efficiency gains, the regional balance effects may be considered as positive given a political objective to favour remoter regions: passengers in the PSO system are expected to be the winners. These results underline the importance of getting the prices right in remote air transport services. However, this study did not aim at optimising the level of service.

### Aircraft Operating Costs

Aircraft operating costs are one of the most important factors when determining the LOS. The cost structure of an airline can be considered in different time-scales such as day, week, month, year, which is dependent on the purpose. It can be shown that airline costs have a stepwise upward sloping curve, where the steps are caused by aircraft capacity expansion.

As a practical approximation to these costs, Janic (1999) has estimated a regression model to quantify the average costs per flight dependent on the aircraft size/capacity and non-stop route length as follows:

\[ C(n,d) = 7.934 \cdot n^{0.603} \cdot d^{0.656} \]

where \( C(n,d) \) is average costs per flight;

\( n \) is aircraft seating capacity; and

\( d \) is route length.

As can be seen, the model indicates the existence of economies of scale both with respect to route length and aircraft size. Data from 21 western European airlines are used, and the model explains nearly 90 per cent of the variations. The statistical diagnosis suggests that the equation and the coefficients are significant at the level of 5 per cent and 1 per cent. The coefficients, which have values less than 1, indicate that there are economies of scale both with respect to aircraft size and route length. Figure 1.3 shows the economies of scale with respect to route length for different aircraft, with flight distances up to 400 km. The figure also indicates the scale effects related to aircraft size.