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A THEORY AND APPLICATION OF AIRPORT PRICING: TRANSPORT CANADA INTERNATIONAL AIRPORTS

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled, "A Theory and Application of Airport Pricing: Transport Canada International Airports" submitted by Lorne Olfman in partial fulfillment of the requirements for the degree of Master of Arts.

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ABSTRACT

A number of problems surround the operation and administration of Transport Canada's international airports. One problem is that of a deficit position which requires subsidy from taxpayers. This is accompanied by the ongoing need for further investments to handle peak traffic while excess capacity is available during off-peak hours.

This thesis examines the problems of Transport Canada's airports from the point of view of airport pricing. There is a definitional chapter which outlines the nature of airport use and planning. It is followed by an analysis of the optimal method for setting airport prices: peak and off-peak prices which follow the marginal cost pricing guideline. A comparison of this theory with current pricing policy indicates that the latter is not rational in that it applies equal aircraft related prices at all international airports at all times. This finding leads to a recommendation for peak pricing for Transport Canada international airports with specific reference to Toronto. Included is an impact analysis of such a change.

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TABLE OF CONTENTS

LIST OF TABLES vii

LIST OF FIGURES viii

CHAPTER

1 INTRODUCTION 1

1.1 Statement of Purpose 1
1.2 The Factors 1
1.2.1 The National Transportation Policy 1
1.2.2 The Financial Picture 2
1.2.3 Nature of Airport Use and Planning 3
1.3 Previous Economic Research on Airports 4
1.4 Organization of the Thesis 4
Footnotes to Chapter 1 6

2 CHARACTERISTICS OF THE AIRPORT 7

2.1 Introduction 7
2.2 Airport Subsystems 7
2.2.1 Airfield Subsystem 7
2.2.2 Terminal Building Subsystem 8
2.2.3 Ground Transportation Subsystem 9
2.2.4 Industrial Area 9
2.3 Subsystem Users 10
2.3.1 Aircraft Operators 10
2.3.2 Ground Vehicle Operators 11
2.3.3 Other Users 11
2.4 Measures of Use 11
2.4.1 Airfield Subsystem 12
2.4.2 Terminal Building Subsystem 14
2.4.3 Toronto International Airport 15
2.5 Airport Planning 16
Footnotes to Chapter 2 19

3 THEORY OF AIRPORT PRICING 20

3.1 Introduction 20
3.2 Marginal Cost Pricing 20

3.3 A Simple Economic Model 21
3.3.1 Assumptions Outlined 21
3.3.2 The Case for Peak-Load Pricing 23
3.3.3 Long-Run Applications 24
3.3.4 Interdependent Demands 25
3.4 Revenue Considerations 29
3.5 Summary of Pricing Rules 30
Footnotes to Chapter 3 32

4 TRANSPORT CANADA AIRPORT PRICING 34

4.1 Introduction 34
4.2 Current Prices 34
4.2.1 Aeronautical Prices 34
4.2.2 Non-aeronautical Prices 35
4.2.3 Air Transportation Tax 36
4.3 Current Pricing Policy 37
4.3.1 Theory of the Group Approach 37
4.3.2 Application of the Group Approach 39
4.4 Evaluation of Current Pricing 41
4.4.1 Deficiencies of Current Pricing 41
4.4.2 Strengths of Current Pricing 42
4.4.3 Subsidization and the Group Approach 43
Footnotes to Chapter 4 46

5 PEAK PRICING FOR TRANSPORT CANADA AIRPORTS 48

5.1 Introduction 48
5.2 Focus of Proposals 48
5.3 Methods of Setting Peak Prices 49
5.3.1 Effects of a Transition to Peak Pricing . . . 50
5.3.2 Delay Costs and Peak Pricing 51
5.3.3 Variations of Marginal Cost Peak Pricing . . . 52
5.4 An Example: Peak Pricing for Toronto Airport 54
5.4.1 Units of Charge 54
5.4.2 Time Periods of Use 55
5.4.3 Allocation of Costs 59
5.4.4 Administrative Considerations 62
5.5 Implications and Impacts of Peak Pricing 62
5.5.1 Airlines 63
5.5.2 Other Commercial and Private Aircraft Operators 65
5.5.3 Intermodal Implications 66
5.5.4 Comparative Analysis 68
Footnotes to Chapter 5 70

6 SUMMARY AND CONCLUSIONS 73

6.1 Introduction 73
6.2 Summary 73
6.3 Conclusions 78
Footnotes to Chapter 6 80

SOURCES CONSULTED 81

LIST OF TABLES

Table		Page
2.1	Itinerant Aircraft Movements (000's) at Canadian International Airports for 1978	13
2.2	Aircraft Movements by Weight Group (000's) at Canadian International Airports for 1978	13
2.3	Itinerant Movements During Busiest Hour and Average Hourly Itinerant Movements at Canadian International Airports for 1978	14
2.4	Enplaned plus Deplaned Airline Passengers (000's) at Canadian International Airports for 1978	15
2.5	Average Passengers per Airline Movement at Canadian International Airports for 1978	16
4.1	Financial Data for Fiscal Year 1978/79, Transport Canada International Airports	40
5.1	Percentage of Hourly Excess Capacity Demands for 1975, Toronto International Airport Subsystems	57
5.2	Time Periods of Use for 1975, Toronto International Airport Subsystems	58
5.3	Sample Prices with Peak Pricing for 1978/79, Toronto International Airport Subsystems	61
5.4	Canadian Intercity Modal Traffic Splits, Estimates for 1975	68

LIST OF FIGURES

Figure		Page
2.1	Hourly Traffic for 1975, Toronto International Airport Subsystems	17
3.1	Subsystem Pricing on a Given Day	24
3.2	Representation of Interdependent Subsystem Demands	27
3.3	Optimal Subsystem Prices	28
4.1	A Model of Airport Group Costs	38
5.1	Effects of Peak Pricing	50

CHAPTER 1

INTRODUCTION

1.1 Statement of Purpose

The purpose of this thesis is two-fold: First, to outline a theory of pricing that will be applicable to the special economic characteristics of an airport. Second, to apply this theory in such a way as to suggest changes to the current pricing policy at Transport Canada international airports. It will be shown that pricing can be an effective tool in optimizing airport use and in revenue generation.

1.2 The Factors

The need for this study was prompted by three factors: (1) the conflicting interpretations placed on the National Transportation Policy by airport users and administrators, (2) the continuing financial deficit incurred by Transport Canada international airports, and (3) the nature of airport use as compared to the nature of airport planning. Each of these factors is discussed in the following sections.

1.2.1 The National Transportation Policy

The National Transportation Policy has had a major influence on Canadian airport pricing and planning since 1975. This policy generally states that the transportation system should be equitable and efficient.[1] It calls for the full recovery of costs of mature services (such as international airports), and rational pricing.

"User charges are increased or new ones implemented only after consultation with users, careful review of revenue requirements, careful consideration of all the alternatives, and consideration of the impact on direct users and others."[2]

This interpretation of policy has been questioned by user groups.[3] They believe that the levels of price increases are not justified because current prices are not cost-based. They question the recovery of funds that are to pay for the capital costs of facilities which were not constructed under the new policy. The airports' administrators counter that prices need not be cost related until full cost recovery has been achieved, that airport users should not be subsidized by the general taxpayer, and that full recovery will not include retroactive deficits incurred.

1.2.2 The Financial Picture

The accounting costs of Canada's major airports have been and continue to be subsidized to some degree by the Canadian taxpayer. During the 1978/79 fiscal year, revenue from airport operations and a tax on air passenger tickets offset costs at only one of eight international airports.[4] Taken as a group, the airports were able to generate enough revenue to cover operating costs, administrative overheads, and part of interest on capital. This was the best financial year for the group since 1975.

Financial results have improved over the past few years because user prices have been increased beyond the rate of inflation in order to achieve financial viability for the airport group.[5] However, investment spending over the same period has been tremendous.

Mirabel airport was opened in 1975 with a capital investment of more than $600 million. Calgary's new terminal building complex opened late in 1977 with an initial expenditure of some $140 million. Major investments have also been made recently at Toronto and Vancouver airports. Other costly expansion projects are being planned for Edmonton, Toronto and Winnipeg.

1.2.3 Nature of Airport Use and Planning

Investment takes place in an environment where there are both excess demands and excess capacity. Airport traffic is not constant throughout the day, so that airport size and design, and therefore investment cost, are based on the levels of demand at the busiest times (as well as the size of the largest aircraft). The planning process tends to maintain the status quo of traffic patterns. This means that while the airport operates at less than full capacity most of the time, additional facilities are added when traffic grows to levels that will congest the airport during certain hours.

As the planning process involves the requirement of users' acceptance of prices for new facilities prior to construction, every effort is made to minimize and contain the costs of a particular planned expansion. "Further, the Federal Government has recently increased accountability of the bureaucrat/transportation planner by demanding a defence of (a) higher user charges, and (b) the net deficit to the government and Parliament."[6] However, there is no systematic effort to consider alternatives to expansion; for example the use of existing excess capacity to reduce the size of or to delay the expansion project.

1.3 Previous Economic Research on Airports

Airports have not been one of the major topics of transportation economics literature. In terms of the transportation modes, air is still a relatively new and specialized activity. It represents a rather small volume of total expenditures and trips in the world of transportation.[7] Thus, it is not surprising that some of the classic research into and application of airport economics has been related to the busiest international airports, specifically those in New York and London.[8]

Most of the literature has been concerned with the construction of new airports and how to delay such needs. Research has yielded a number of methods of reducing excess demands and congestion by deleting marginal users, either through pricing or legislation. Yet these represent only short term solutions which mainly affect the smallest aircraft operators. Pricing schemes which distinguish between peak and off-peak traffic regardless of the existing congestion at airports have not been fully dealt with.

1.4 Organization of the Thesis

The following chapters focus on the economics of Transport Canada international airports. Chapter 2 describes the characteristics of an international airport and its users. It includes a statement regarding the current airport planning process.

Chapter 3 delineates a price theory for airports. This theory is based on the use of marginal cost as a pricing guideline, and is derived by application to a simple economic model of the airport. A method of finding optimal peak and off-peak prices is defined. Chapter 4 reviews the current Transport Canada international airports' prices and pricing policy in light of the pricing theory. It is shown that there is a uniformity in aircraft related prices at all international airports and equal prices at all times.

Chapter 5 suggests changes to be made in current Transport Canada airport pricing. Its recommendations concern the application of peak pricing to users of aircraft related facilities. A statement of expected impacts on users and others is included.

A detailed summary of the work is contained in Chapter 6. It concludes by identifying further work that can be done in order to modify the application of marginal cost pricing at international airports.

Footnotes to Chapter 1

[1]Transport Canada, Transportation Policy: A Framework for Transport in Canada, Summary report (Ottawa: Supply and Services Canada, 1975). This policy is further discussed in Chapters 4 and 5.

[2]Z. Haritos, "Transportation User Charges: A Federal Perspective," The Logistics and Transportation Review, XV (No. 5, 1979), p. 580.

[3]These user groups include the Air Transport Association of Canada, the Air Transport Association of America, the International Air Transport Association (IATA), and the Canadian Owners and Pilots Association. Their concern over user prices has been expressed publicly, as well as in numerous negotiations and meetings with Transport Canada officials. See also J. J. Smith, "User Charges and the Canadian Airlines," The Logistics and Transportation Review, XV (No. 5, 1979), 609-622.

[4]This information plus that in the following paragraphs are estimates made by the author from unpublished Transport Canada financial data. The eight airports are named in Chapter 2.

[5]Haritos, "User Charges," p. 586 specifies increases in cash expenditures and revenues between 1971/72 and 1978/79 for the federal Air Transportation Program.

[6]Ibid., p. 580.

[7]For detailed modal costs in Canada see Z. Haritos, "Transport Costs and Revenues in Canada," Journal of Transport Economics and Policy, IX (January, 1975), 16-33. For travel volume percentages see Table 5.4.

[8]The New York research is contained in A. Carlin and R. E. Park, "Marginal Cost Pricing of Airport Runway Capacity," American Economic Review, LX (June, 1970), 310-319. The London research is contained in I. M. D. Little and K. M. McLeod, "The New Pricing Policy of the British Airports Authority," Journal of Transport Economics and Policy, VI (May, 1972), 101-115.

CHAPTER 2

CHARACTERISTICS OF THE AIRPORT

2.1 Introduction

This chapter describes the characteristics of an airport. The airport infrastructure is outlined in terms of four subsystems. User groups are defined. The levels and patterns of use of aircraft operators are specified. It will be shown that the important characteristic of airports is the fact that infrastructure of fixed size and design serves varying types and volumes of traffic.

2.2 Airport Subsystems

An airport is a group of elements which together act as a terminus for the air transportation mode. Each element can be classified into one of four basic subsystems: airfield, terminal building, ground transportation and industrial area. Subsystems serve specific functions in the transportation process. The facilities and services which make up each of the airport subsystems are described briefly below.

2.2.1 Airfield Subsystem

The airfield serves aircraft operations. It is composed of two parts: paved areas and control and navigation.

Paved areas consist of runways, taxiways, and aprons. A runway is the most important of the paved areas because this is where an aircraft lands and takes off. Taxiways are connectors between runways and aprons, and are most often built to maximize the operational use of the runways. Aprons provide short term parking and maneuvering space for aircraft that are loading and unloading passengers and cargo. Aprons are also used for longer term aircraft parking.

Air traffic control provides a traffic management service. It ensures the orderly landing and taking off of aircraft, as well as the orderly use of paved areas by both aircraft and ground vehicles (such as snow blowers and cargo carts). Navigation instruments and paved area lighting allow aircraft to be flown in and out of an airport during dark hours, and during poor weather conditions.

2.2.2 Terminal Building Subsystem

The terminal building provides an interface between the air and ground transportation modes. Terminal buildings are used for combined passenger and cargo operations, or for strictly cargo operations. In Canada, cargo terminals are owned by private companies and are considered part of the industrial area of the airport. The passenger terminal building subsystem has three parts: departure areas, arrival areas, and nonoperational space.

The departure area is made up of a public area, the secure area, and the outbound baggage area. The public area includes check-in counters, U. S. Customs preclearance counters, queuing space in front of counters, waiting lobbies and concourses, and other circulation space. The secure area is exclusively for passengers. It includes security screening points, concourses, and holding rooms. The outbound baggage area is a central distribution point for outgoing luggage.

Arrival areas are different for domestic and international passengers. The domestic arrival area is generally made up of some corridors which also serve the departure area, plus baggage claim devices. The international arrival area includes special corridors that connect building entrances to primary customs inspection points; waiting areas for immigration and health inspection procedures; baggage claim devices; and secondary customs inspection booths. The arrival area includes public lobbies for greeters.

Some nonoperational space is open to the public (passengers, greeters and well wishers). These areas are occupied by concession shops, restaurant and bar, and other related services. Nonoperational space not open to the public includes offices, storage, and industrial areas for airlines, government agencies, and other tenants.

2.2.3 Ground Transportation Subsystem

This subsystem provides ground vehicle access between the other airport subsystems, and between the airport and its surrounding region. It also provides vehicle parking. The subsystem network includes roads, passenger terminal building ramps and curbs, and surface lots, plus (at some airports) multi-storey parking.

2.2.4 Industrial Area

Part of this area is leased by airline companies and aircraft service companies for hangars, cargo terminals and service buildings. Also under lease is space for flight kitchens, a fuel farm, and (at some airports) an hotel, or a farming operation. The unleased areas include space for power and heating plants, an equipment garage, and (possibly) storage.

2.3 Subsystem Users

Airport users are individuals, businesses, and government agencies who come into direct contact with one or more of the subsystems. The most important users are aircraft operators because they represent the demand for the special functions that an airport offers. Other user groups include ground vehicle operators, and those who use or serve aircraft operators.

2.3.1 Aircraft Operators

There are three groups of aircraft operators, each distinguished by their purpose for flying.[1] These user groups are termed commercial, private and government aircraft operators.

Commercial aircraft operators transport passengers and cargo at a unit toll price. These operators include major airlines and other commercial airways. The airlines provide regular scheduled domestic and international passenger and cargo flights, plus domestic and international charters. Examples of Canadian airlines are Air Canada and Pacific Western Airlines. The other commercial companies have both regular and irregular scheduled flights, and domestic and international charters.

Private aircraft operators cannot charge a fee to transport passengers and cargo. These operators provide their own flying service whether as individuals or businesses.

Government agencies are considered government aircraft operators when using government aircraft for noncommercial reasons including civil government business, transportation of dignitaries, and military purposes.

2.3.2 Ground Vehicle Operators

These users consist of private automobile owners who may be aircraft passengers, passenger greeters and well wishers, and airport employees; and commercial vehicle operators. Ground vehicle owners who are businesses include car rental agencies; taxicabs and limousines; internal, local, rental and charter buslines; vans and trucks for cargo shipments and delivery of goods; and airline service trucks such as inflight meal vans, fuel trucks, and cargo vehicles.

2.3.3 Other Users

Passengers, greeters, and well wishers are users of pedestrian areas inside and outside the terminal building when not operating ground vehicles. Businesses and government agencies that lease building or land space at the airport can also be considered as airport users.

2.4 Measures of Use

Each user group makes certain demands on the airport subsystems. Demands are generally measured in terms of annual traffic levels and hourly traffic patterns. A limiting factor in the presentation of measures of use is the lack of published data. Annual (and monthly) aircraft and passenger flow statistics for Canadian airports are published by Statistics Canada. The aircraft statistics also contain some data on peak hour traffic. Patterns of use of passengers, and data on ground vehicle operations are not currently published for

Canadian airports.

The following discussion on measures of use focuses on the data published for the airfield and terminal building subsystem activity at major Canadian international airports during 1978.[2]

2.4.1 Airfield Subsystem

Use of the airfield is measured in numbers of aircraft movements. An aircraft movement is classified as either itinerant or local.[3] Itinerant movements are landings or take offs which complete or begin a flight from or to another airport. Local movements are generally training flights which take off, circle and land at one airport. Local movements represent a small percentage of total movements at international airports in Canada.[4]

Commercial aircraft operators, especially airlines, are the dominant users of the airfield subsystem. Total commercial itinerant movements were at least twice as numerous as the combined total of private and government itinerant movements at eight Canadian international airports. Table 2.1 summarizes the annual totals of itinerant movements for the aircraft operators at these airports.

There are a tremendous number of aircraft types currently being flown. Aircraft differ in terms of number of engines and engine type (piston, turbo-jet, or fan jet), body and wing size, and gross take off weight. A compilation of aircraft movements by weight group in Table 2.2 shows that a wide range of aircraft is operated at all Canadian international airports.

Observation of hourly traffic flows indicates that there are extreme differences between an average hourly estimate and actual

TABLE 2.1

ITINERANT AIRCRAFT MOVEMENTS (000's)
AT CANADIAN INTERNATIONAL AIRPORTS FOR 1978

Airport	Commercial Users			Private Users	Govt. Users	Total
	Air-Line	Other	Total			
Mirabel	30.2	6.2	36.4	2.0	2.9	41.3
Halifax	26.5	16.5	43.0	7.4	2.9	53.3
Edmonton	33.5	7.9	41.4	12.2	3.7	57.3
Winnipeg	43.6	29.9	73.5	23.7	15.4	112.6
Calgary	57.2	24.8	82.0	58.1	3.9	144.0
Montreal	87.0	41.5	128.5	40.6	7.8	176.4
Vancouver	77.2	96.1	173.3	63.6	9.8	246.7
Toronto	152.4	35.8	188.2	56.9	4.1	249.2

Source: Statistics Canada, Aviation Statistics Centre, Aircraft Movement Statistics, Monthly (Ottawa: Transport Canada, 1978).

TABLE 2.2

AIRCRAFT MOVEMENTS BY WEIGHT GROUP (000's)
AT CANADIAN INTERNATIONAL AIRPORTS FOR 1978

Airport	Weight Group (lb)		
	0-39,000	39,001-314,000	314,001+
Mirabel	8.6	15.1	17.6
Halifax	25.2	23.6	4.5
Edmonton	21.6	32.4	3.3
Winnipeg	69.2	37.4	6.0
Calgary	93.2	43.2	7.6
Montreal	87.7	77.8	10.9
Vancouver	181.2	51.3	14.2
Toronto	93.8	108.3	47.1

Source: Statistics Canada, Aviation Statistics Centre, Aircraft Movement Statistics, Annual (Ottawa: Transport Canada, 1978).

busiest hour movements.[5] These observations are summarized in Table 2.3. The data confirms that the degree of utilization of the airfield subsystem fluctuates throughout each day. There is also evidence that shows a strong tendency for traffic to be quite heavy at certain times. Of 96 observations showing the busiest hour in each month of 1978 for eight Canadian international airports, more than half occurred during the 1500, 1600, and 1700 hours.[6]

TABLE 2.3

ITINERANT MOVEMENTS DURING BUSIEST HOUR AND
AVERAGE HOURLY ITINERANT MOVEMENTS
AT CANADIAN INTERNATIONAL AIRPORTS FOR 1978

		Average Hourly Itinerant Movements		
Airport	Movements Busiest Hour	During Busiest Day	For Busiest Month	For Year
Mirabel	47	14	7	6
Halifax	33	13	10	8
Edmonton	54	15	9	9
Winnipeg	52	27	21	17
Calgary	57	32	25	22
Montreal	73	40	30	27
Vancouver	134	57	48	38
Toronto	76	52	42	38

Source: Statistics Canada, Movement Statistics, Monthly, 1978.

2.4.2 Terminal Building Subsystem

Use of the terminal building is measured in terms of enplanements and deplanements. Enplanements are passenger boardings and cargo weight loadings; deplanements are passenger disembarkments and cargo weight offloaded. Published data showing the weight of cargo enplanements and deplanements is not distinguished between passenger and cargo terminals, thus the measures of use for passenger terminals will be shown in terms of passenger flows only. Airline passenger statistics for 1978 are shown in Table 2.4.[7]

TABLE 2.4

ENPLANED PLUS DEPLANED AIRLINE PASSENGERS (000's) AT CANADIAN INTERNATIONAL AIRPORTS FOR 1978

Airport	Scheduled Passengers			Intl. Charter Pass.	Total
	Domestic	Trans-Border	Other Intl.		
Halifax	1257.5	48.9	44.5	46.1	1397.0
Mirabel	121.5	23.2	1045.1	351.6	1541.4
Edmonton	2580.5	100.8	70.6	92.9	1844.8
Winnipeg	1734.1	216.5	43.5	61.4	2055.5
Calgary	2323.7	537.3	65.1	101.3	3027.4
Vancouver	3915.0	1231.2	269.4	278.9	5694.5
Montreal	3802.8	1890.2	2.7	119.3	5815.0
Toronto	6499.5	3544.6	1172.0	1206.9	12423.0

Source: Statistics Canada, Air Carrier Traffic at Canadian Airports, Annual 51-203 (Ottawa: Statistics Canada, 1978).

The demands placed on the terminal building by each sector of traffic are somewhat different if guaged on the basis of average passengers per movement. This evidence is summarized in Table 2.5. It can be seen that the average passengers per movement in the international sector are generally somewhat greater than in the domestic and transborder sectors.

2.4.3 Toronto International Airport

An indication of the significant fluctuations in daily traffic patterns at an airport is given in Figure 2.1. This chart shows the percentages of hourly movements (for the airfield subsystem) and passengers (for the terminal building subsystem) over an 18-hour day

TABLE 2.5

AVERAGE PASSENGERS PER AIRLINE MOVEMENT
AT CANADIAN INTERNATIONAL AIRPORTS FOR 1978

Airport	Domestic Sector	Nondomestic Sector			
		Trans-Border	Sched. Intl.	Intl. Charter	Total
Halifax	54	54	148	77	93
Mirabel	12	9	95	84	80
Edmonton	56	44	118	133	73
Winnipeg	47	49	145	77	58
Calgary	52	60	130	113	68
Vancouver	67	108	104	103	107
Montreal	70	79	27	63	78
Toronto	80	76	161	118	92

Sources: Statistics Canada, Aircraft Movements, Annual, 1978, and Table 2.4.

at Toronto International Airport. The percentages are derived from confidential data covering 56 sample days during 1975. An 18-hour day is used because there is a night curfew in effect.

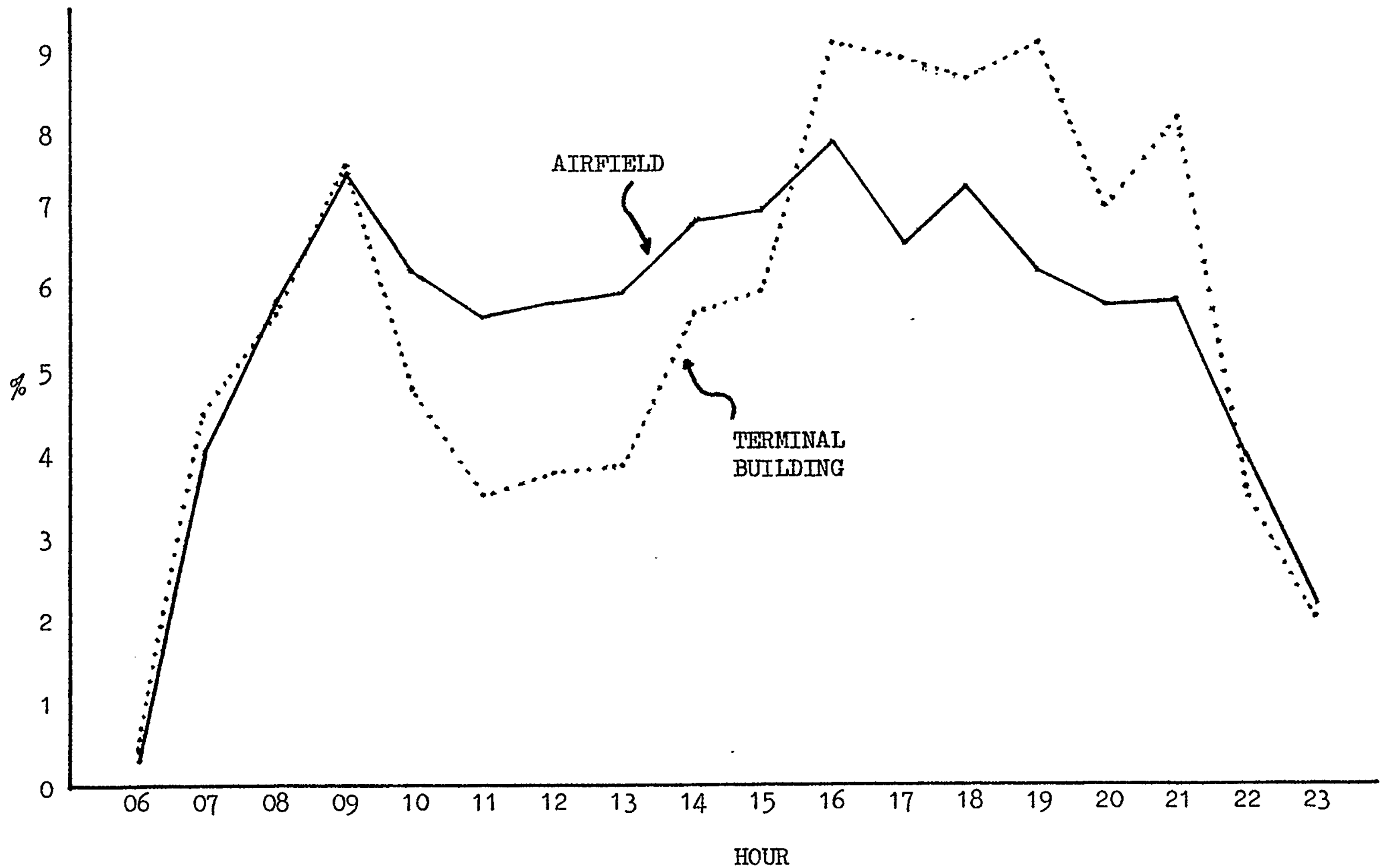
2.5 Airport Planning

The foregoing discussion characterizes an international airport as a complex group of interacting subsystems which serve various user groups. These complexities require "the preparation of a program to guide the physical growth of the airport system over time in the most economical way."[8] Planning is the term used to describe the preparation of such a program. Some of the primary elements of airport planning are aviation demand forecasts, cost and revenue analyses, and pricing policies.[9]

Planning is a process. It takes place in a communicative framework which involves planners, direct users, and others who will be affected by proposed changes. For example, planners develop demand

FIGURE 2.1

HOURLY TRAFFIC FOR 1975
TORONTO INTERNATIONAL AIRPORT SUBSYSTEMS



forecasts using data supplied by aircraft operators and other sources. Plans which are based on forecasts of additional traffic and the use of new aircraft are presented to users for critical review. These plans are finalized when users and planners can agree on their effectiveness in meeting expected demands.

Therefore, the tendency of the current method of airport planning is to ensure that the infrastructure can cope with new aircraft and expected busy periods. Braaksma sums up the planning process by comparing it to a "demand/supply situation":

> For example, peak loads on an airport system cause demand for space. This demand is satisfied via a design which supplies the necessary amount of space. The technology, for example the aircraft, dictates the shape of the supplied space, while the daily flows of traffic dictate the location of that space.[10]

The upshot of the airport planning method is that it perpetuates the excess capacity of subsystems. This excess capacity is caused by the physical nature of the infrastructure — it cannot be varied to precisely handle each type of user and level of demand.[11] And even though excess capacity will be expected in the initial stages of an entirely new development, its perpetuation is not the only alternative for accommodating growth and change.

Footnotes to Chapter 2

[1]The classification presented herein is based on statistical surveys produced by Statistics Canada. The full definition of each user group is given in the publication: Aircraft Movement Statistics which is published monthly and annually by the Aviation Statistics Centre and Transport Canada.

[2]Eight international airports were selected. These airports are owned and operated by Transport Canada, the federal Department of Transport, and were selected on the basis of traffic volume and level of scheduled international traffic. The airports are: Calgary, Edmonton (International), Halifax, Mirabel (serving the Montreal region), Montreal (Dorval), Toronto (International), Vancouver, and Winnipeg.

[3]The technical definitions of types of flights are also contained in the movements statistics documents.

[4]The percentage of local movements at eight Canadian international airports in 1978 ranged from less than 5 at Montreal, Toronto and Vancouver, to a high of 40 at Edmonton.

[5]Average hourly estimates were based on an 18-hour day because there are few movements between midnight and 6 AM (0600) due to noise curfews (among other reasons).

[6]Statistics Canada, Aviation Statistics Centre, Aircraft Movement Statistics, Monthly (Ottawa: Transport Canada, 1978).

[7]Passenger sectors are defined in the publication: Statistics Canada, Air Carrier Traffic at Canadian Airports, Annual 51-203 (Ottawa: Statistics Canada, 1978). The domestic sector includes passengers who have an origin and destination within Canada. The transborder sector is comprised of all passengers travelling between Canada and the United States. The other international sector includes all other travellers whose origin or destination is outside Canada. International charters are comprised of transborder and other international passengers.

[8]J. P. Braaksma, A Computerized Design Method for Preliminary Airport Terminal Space Planning (Waterloo, Ontario: The Transport Group of Waterloo University, 1978), p. 12.

[9]J. A. Foster, "Planning a Major Civil Airport," in Airport Economic Planning, ed. by G. P. Howard (Cambridge, Mass.: The MIT Press, 1974), 3-20.

[10]Braaksma, Computerized Planning, p. 9.

[11]A discussion of the characteristics of transportation infrastructure is presented in J. M. Thomson, Modern Transport Economics (Harmondsworth, Eng.: Penguin Education, 1974).

CHAPTER 3

THEORY OF AIRPORT PRICING

3.1 Introduction

This chapter outlines a framework within which airport pricing policies can be developed. A general discussion of marginal cost pricing underlines the relationship between pricing and investment. A simple economic model is used to demonstrate the need for peak-load pricing at airports. Deviations from strict marginal cost pricing in order to achieve specific revenue targets are also described.

3.2 Marginal Cost Pricing

Transportation economists seem to agree that "no sound pricing policy can be developed without using marginal cost as one of the principal determinants."[1] A textbook definition of marginal cost states that it "is the addition to total cost resulting from the addition of the last unit of output."[2] The command to fix prices equal to marginal cost for a given level of output in transportation industries was brought into prominence by Harold Hotelling.[3]

Hotelling's work is based on the principle that the attainment of a welfare (or Paretian) optimum "is contingent upon the fulfilment of a single rule. . . . requiring that the value, at the margin, of any class of factor be the same in all occupations in which it is used."[4]

A prime consideration in the development of prices is the optimization of resource allocation based on the specific characteristics of an economic unit. Airports have unique economic characteristics. The discontinuities caused by extremely lumpy investments, the variable output versus the fixity of operating costs, and capacity based on peak demands together indicate that marginal cost pricing of airports is more than a matter of deriving a price function and "plugging in" various levels of output.[5]

"So far as the allocation of resources is concerned, there are two possible conflicting aims of a pricing policy: (1) to lead to an optimum use of existing capacity; and (2) to help produce the best possible investment decisions."[6] Short-run marginal cost pricing is consistent with obtaining optimal output; it also provides a measure of the costs versus the benefits of investing in additional capacity.

3.3 A Simple Economic Model

The following discussion outlines the theoretical approach to airport pricing as derived from a simple and static view of the airport. Since each airport subsystem has quite different user groups and associated outputs, the model applies to a specific subsystem rather than an entire airport.[7] The analysis follows from Webb's treatment of these issues.[8]

3.3.1 Assumptions Outlined

An airport subsystem will be defined as an indivisible plant such that each level of capacity serves much more than one additional unit of traffic. Capacity is the maximum level of use that can be made of the subsystem in a given period of time (for example, an hour). A more general definition of capacity is the maximum comfortable output that can be derived during a particular time interval. As an example, runway capacity is usually measured in terms of the number of movements that can be served without causing any delays of, say, more than three minutes. It will be assumed that the existing capacity of the subsystems has been in place, and that some demands will meet and exceed capacity.

Airport demands vary during each day. Two levels of demand per day will be assumed for the sake of simplicity. Each demand is of equal duration (occurs for twelve, not necessarily consecutive, hours). Initially, demands will be considered independent, this being referred to as the firm-peak case. In order to introduce a further simplification, it will be assumed that levels of demand do not grow over time and are not affected by changing aircraft technology. This constancy of demand will be henceforth referred to as fixed demand.

Three types of costs are relevant and are assumed as being present. "Fixed costs" include capital expenditures in the form of depreciation, interest on debt, and taxes; plus administrative overheads of a central agency.[9] "Variable costs" are operating expenditures for serving traffic and maintaining facilities. These costs remain fairly constant with increasing levels of use of an airport subsystem since traffic occurs in a random fashion.[10] The manpower costs are generally constant, while certain costs associated with wear and tear and variable energy requirements increase with higher traffic volumes.

The third relevant cost item is referred to as negative externalities. It is not normally a direct or budgeted airport expenditure. Since airports are owned by and serve the public, the costs associated with disruptions in expected service play a necessary part in the achievement of an efficient economic unit. It is impossible for one user to reimburse others for the cost of delays or noise. Yet these costs should be paid for, and it is the airport authority that can ensure payment. In the context of this analysis, negative externalities are those caused by congestion. As an example of the magnitude of delay costs, if an aircraft with hourly operating costs of $1,000 carrying 50 passengers whose time is valued at $10 per hour were delayed for 5 minutes, this would amount to a negative externality of some $125. Delays increase exponentially as traffic demands grow geometrically toward and past capacity.[11]

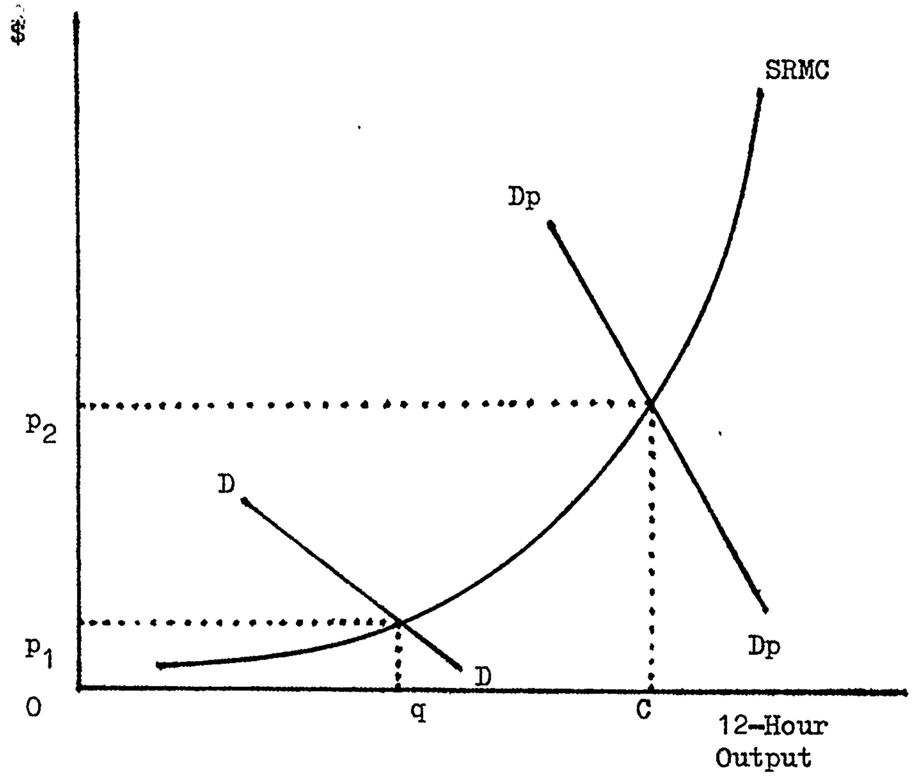
3.3.2 The Case for Peak-Load Pricing

An illustration of the two levels of demand for a particular airport subsystem on a given day is presented in Figure 3.1. The demand curves refer to peak (DpDp) and off-peak (DD) traffic. Capacity can be roughly estimated from the point where the marginal cost curve (SRMC) begins to rise rapidly. Peak demand imposes much higher levels of marginal cost than the off-peak demand.

Since capacity of a fixed nature cannot be adjusted to serve these separate levels of traffic, two prices will be required to maximize surplus (equal to short-run marginal cost). The price for off-peak users will be p_1 giving output of Oq, and the price for peak users will be p_2 giving output of OC. This peak price can be considered as earning the facility a quasi-rent. It can be thought of as comprising both congestion costs (the costs of delays on all users) and the opportunity costs of the usual factor inputs.

FIGURE 3.1

SUBSYSTEM PRICING ON A GIVEN DAY



3.3.3 Long-Run Applications

Economists generally look to long-run marginal cost as an alternative pricing guideline to short-run marginal cost because of a number of constraints that would arise through the use of the latter. These constraints include administration and calculation difficulties resulting from fluctuations over time, from problems of explanation to users, and from the possibility that full cost recovery will not be achieved.[12] With the introduction of long-run marginal cost comes the substitution of capital (or capacity) costs into the pricing formula. It is recognized that capacity extensions will be required in order to satisfy excess demand.

The shift from short-run to long-run marginal cost pricing is, in effect, a shift to long-run incremental cost pricing because in the case of an airport subsystem a lump of investment will be needed to serve one more unit of traffic. Kahn indicates that a key feature of this shift is in its outlook. "Marginal costs look to the future, not to the past: it is only future costs for which additional production can be causally responsible; it is only future costs that can be saved if that production is not undertaken."[13] This is especially important where a future lump of investment is required while capacity is still available in existing infrastructure during some time periods.

Therefore, the general economic principle is that only peak users should pay capital costs. The off-peak users in a firm-peak situation are not responsible for such costs. Kahn sums up as follows:

> Notice how the intensity and elasticity of demand helps determine the level of marginal costs. For those hours of the day at which demand is insufficiently strong or responsive to a toll covering only operating expenses, long-run marginal costs include only those operating expenses; for those times of day at which demand is strong or so responsive to a lower toll as to cause congestion, LRMC [long-run marginal cost] necessarily includes capital costs as well.[14]

3.3.4 Interdependent Demands

Observations of airport subsystem demands indicate that these are not independent, as has been postulated thus far. That is, a change in the price (or other factors) pertaining to a group of users in one time period will have an effect on the levels of demand of user groups in other time periods. The derivation of an optimal set of prices when there are interdependent demands will be demonstrated in the following paragraphs.[15]

Assume a single subsystem with two fixed and interdependent equal duration demands — peak and off-peak — where price is the factor which is common to both demands. The basic relationship is as follows: an increase in price for users of one period will result in an increase in demand (an outward shift of the demand curve) for the other period. Thus, for a range of prices pertaining to one period, a group of demand curves can be identified for the other period with corresponding prices equal to marginal cost. In this way, two sets of prices can be derived among which there will be one combination that is equivalent to both sets. This combination represents the optimal pair of prices for the airport subsystem.

A hypothetical example will be used to illustrate this derivation of optimal prices. For a range of off-peak prices the peak demand curves Dp_0, Dp_2, Dp_6, Dp_{10}, and Dp_{14} in Figure 3.2 are constructed. The subscripts denote corresponding off-peak prices. Note that with increasing off-peak prices peak demands increase. Peak prices are determined by the intersection points of the peak demand curves and the marginal cost curve (MC). Therefore, for

off-peak prices: 0, 2, 6, 10, 14,

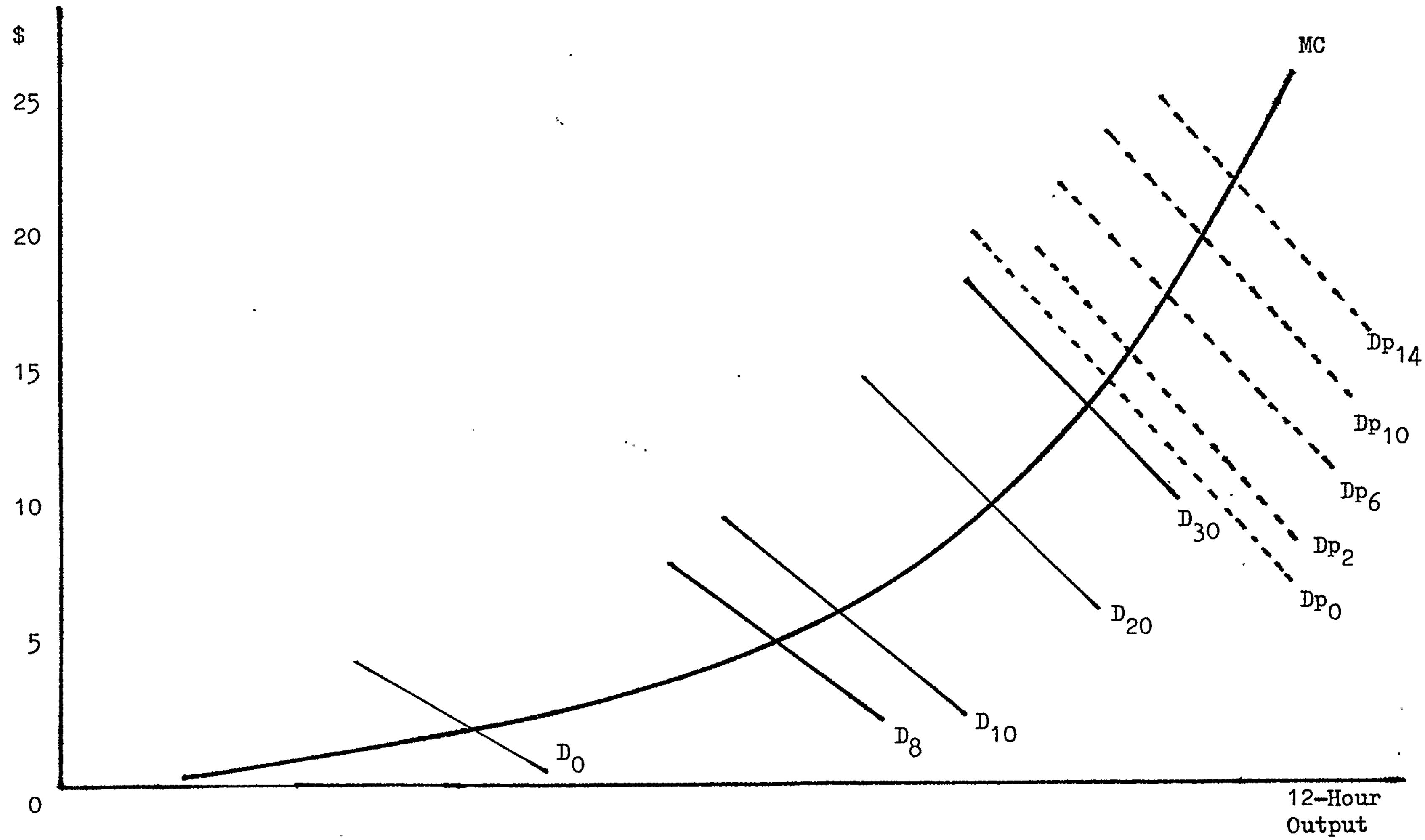
peak prices are: 15, 16, 18, 20, 22. Similarly, a range of peak prices yield the off-peak demand curves D_0, D_8, D_{10}, D_{20}, and D_{30} so that for peak prices equal to: 0, 8, 10, 20, 30,

off-peak prices are: 2, 5, 6, 10, 14.

It can be seen that for the two sets of prices noted above, only one pair, peak price equal to 20 and off-peak price equal to 10, appears in both cases. This is borne out by plotting the pairs of

FIGURE 3.2

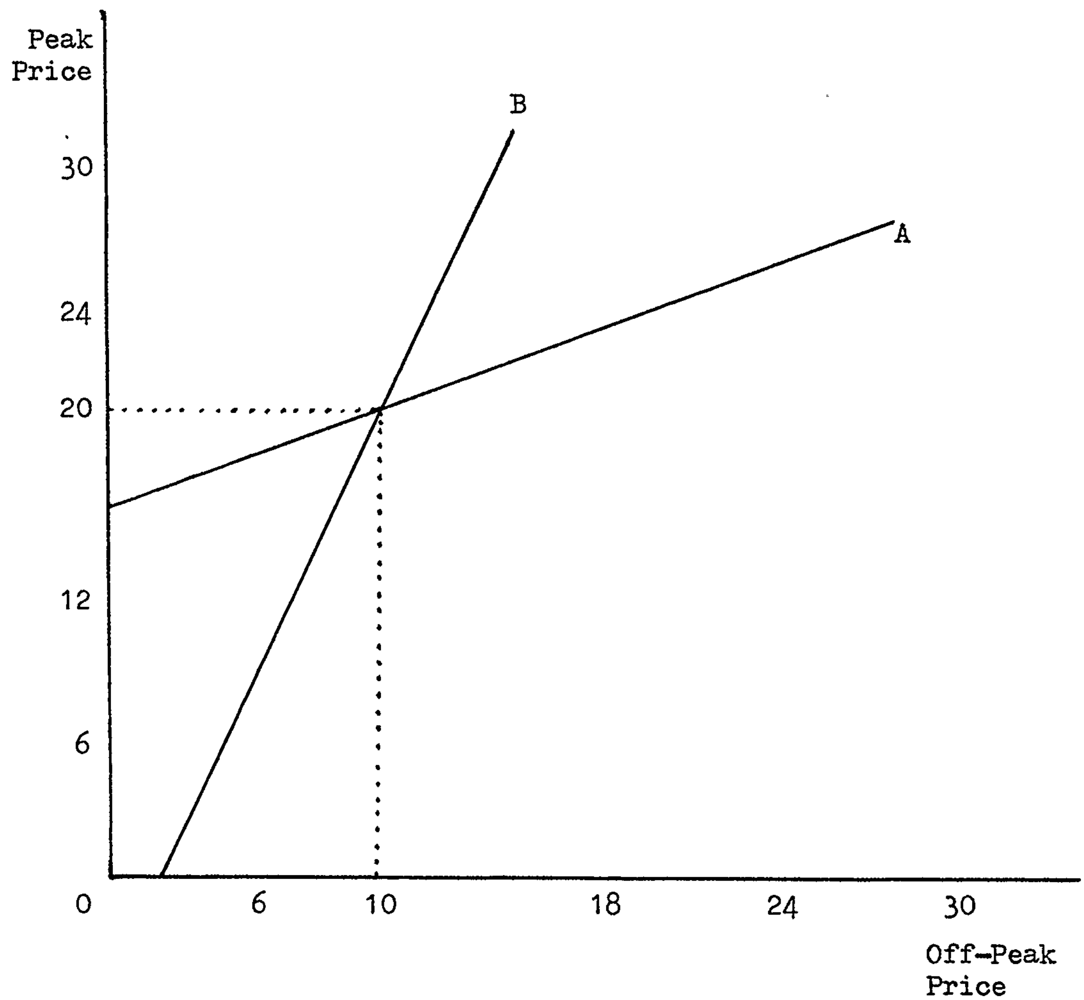
REPRESENTATION OF INTERDEPENDENT SUBSYSTEM DEMANDS



prices as shown in Figure 3.3. The first set of pairs, where off-peak price was varied, can be joined to form line A; and the other set forms line B. These lines intersect at one point such that peak price is equal to 20, and off-peak price is equal to 10.

FIGURE 3.3

OPTIMAL SUBSYSTEM PRICES



One consequence of interdependent demands may be that of shifting-peaks. The essential difference between the firm- and shifting-peak cases lies in the strength of the so-called off-peak demand. This level of demand, which was nowhere above capacity in the firm-peak case, exceeds capacity in the shifting-peak case. Thus, over a period of a few hours demand may be strong enough in any hour that, given a peak price applied to the busiest level of demand, this could cause traffic to shift to what had previously been a relatively less busy hour, thereby making this the peak. An existing congestion problem would not be solved but merely transferred in time.

3.4 Revenue Considerations

It has already been mentioned that one of the major criticisms regarding strict marginal cost pricing is in regard to its making of financial deficits, that is, necessitating subsidization. There are two possible reasons for this result depending upon whether the production function of the firm exhibits constant or increasing returns to scale. Assuming that airports show increasing returns to scale, the problem lies with the possibility that demand is everywhere below average total cost, and as such, a marginal cost price cannot meet total costs.[16]

The classic prescription for making up the deficit was proposed by Hotelling in the form of a lump-sum tax. One drawback to taxation in regard to financing an industry deficit is that it "involves a redistribution of income in favour of the consumers of the product of the decreasing-cost industry."[17] As a practical example in the case of airports, it can be seen that taxation of all to subsidize those who fly is not in the spirit of an equitable economic solution.

A proposed alternative to subsidization through taxation was perfect discriminatory pricing. "With this policy each consumer would face the same set of prices at the margin (so that the optimality conditions would be unaffected) but a set of different prices for the intra-marginal units."[18] While this method of pricing maintains the efficiency criteria, it would be exceedingly expensive and difficult to implement since perfect discriminatory pricing requires perfect knowledge and that each consumer be treated individually.

A compromise pricing structure is that of a two-part tariff. In this case, the price consists of the marginal cost element plus an additional charge to cover costs of meeting a financial target. All users would pay something above marginal cost. This something could be in the form of a value of service supplement. The value of service supplement might take the form of third degree discriminatory prices which would distinguish between users, in an average sense. In the context of airport pricing, this would be a definite benefit because various user groups use similar airport facilities.

It should be emphasized that pricing supplements would be required to maintain financial viability on an accounting basis. Peak prices generate quasi-rents which are above the airport's accounting costs, but these will be used to either finance future investment, or to reimburse users for negative externalities, if possible.

3.5 Summary of Pricing Rules

Marginal cost can be used as an effective pricing guideline. It distinguishes between peak and off-peak traffic demands such that those who require a higher than average level of capacity will be responsible for the capacity costs. The peak responsibility means that prices for peak users will be greater than for off-peak users to the extent that some peak demand is not satisified by existing capacity. A price supplement to marginal costs may be required from all users in order to meet financial targets.

Footnotes to Chapter 3

[1]W. S. Vickrey, "Some Implications of Marginal Cost Pricing for Public Utilities," Papers and Proceedings of the American Economic Association, LV (May, 1955), pp. 612-613.

[2]E. Mansfield, Microeconomics: Theory and Application (New York: W. Norton & Company, Inc., 1970), p. 167.

[3]H. Hotelling, "The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates," Econometrica, VI (1938), 242-269.

[4]E. J. Mishan, Welfare Economics (New York: Random House, 1967), p. 18.

[5]The characteristics of an airport are described in Chapter 2.

[6]I. M. D. Little and K. M. McLeod, "The New Pricing Policy of the British Airports Authority," in Airport Economic Planning, ed. by G. P. Howard (Cambridge, Mass.: The MIT Press, 1974), pp. 447-8.

[7]See Chapter 2. For example, passenger and cargo traffic would not be a useful measure of combined airfield and terminal building subsystem output because airfield traffic includes private and government flights that do not use terminal buildings.

[8]Michael G. Webb, Pricing Policies for Public Enterprises, MacMillan Studies in Economics (Tiptree, Essex: The Anchor Press Ltd., 1976). See chapter 3: "Peak Loads and Joint Costs," pp. 32-40.

[9]The textbook definition of fixed costs is that of costs which cannot be varied in the short-run. See Mansfield, Microeconomics, p. 160.

[10]See Chapter 2 for a discussion of random traffic patterns at airports.

[11]A diagram of this phenomenon is shown in P. K. Dygert, "Pricing Airfield Services," in Airport Economic Planning, ed. by G. P. Howard (Cambridge, Mass.: The MIT Press, 1974), p. 406.

[12]This latter possibility will be further discussed in the following section 3.4.

[13]Alfred E. Kahn, The Economics of Regulation: Principles and Institutions, Vol. I: Economic Principles (New York: John Wiley & Sons, Inc., 1970), p. 88.

[14]Ibid., p. 89.

[15]This analysis was suggested by D. L. McLachlan.

[16]See Chapter 4 regarding data on airports as decreasing-cost plants.

[17]Webb, Pricing Policies, p. 72.

[18]Ibid., p. 73.

CHAPTER 4

TRANSPORT CANADA AIRPORT PRICES

4.1 Introduction

This chapter describes the current Transport Canada international airport prices and pricing policy, and compares it to the theoretical pricing framework. Current prices are described in terms of three categories: aircraft related, other than aircraft related, and tax. Current policy is described in terms of its group approach to achieving the aim of full cost recovery. An evaluation shows that, although there are strengths in current pricing and the use of the group approach, there are also deficiencies which prevent current pricing from achieving desired economic goals.

4.2 Current Prices

Prices will be referred to in the context of levies that are made in order to generate airport revenue. The governing body of the world aviation community, ICAO (International Civil Aviation Organization), broadly defines revenue sources as "aeronautical" (aircraft related) and "non-aeronautical" (other than aircraft related).[1] Along with these revenues, Transport Canada levies a tax on passengers, a source not recognized by ICAO.[2]

4.2.1 Aeronautical Prices

These prices are levied directly on aircraft operators in the form of user charges, and indirectly in the form of a concession fee on aviation fuel and oil.

The Air Services Fees Regulations define the user charges that Transport Canada applies in respect of the use of airports by aircraft.[3] The application of two prices, landing fees and general terminal fees, generates much of user charges revenue. These prices have the following features:

(1) equivalent levels at all international airports;

(2) varying structures based on size of aircraft, and origin or destination of flight; and

(3) no structuring related to the modification of forecast excess demands or the suppression of existing excess demands.

Other user charges which are equal at all international airports include a security fee per enplanement, and parking fees per unit area occupied per day. Fees related to the use of passenger loading bridges and transfer vehicles are applicable at a few airports only.

Concession fees on aviation fuel and oil are standard per litre levies on the delivery price of these products at all airports. The fuel companies, who have a legal agreement with Transport Canada, pass on the fee directly to aircraft operators. These fees are not user charges because application to retail prices is at the discretion of fuel distributors, and because aircraft operators do not purchase fuel on each use of an airport. The fee on gasoline is somewhat higher than the fee on turbofuels.[4]

4.2.2 Non-aeronautical Prices

There are three sources of non-aeronautical revenue: rates, fixed rents, and concession rents. The price levels that generate these revenues vary between airports.

Rates are charged for the use of specific facilities and services.[5] These prices are levied on the basis of variable use. Examples of rates are car parking charges and sales of utilities.

Fixed rents are per unit area occupied charges for the use of building and hangar space, and of land. This space is usually made available in conjunction with the construction of operational areas of subsystems. Typical tenants include airlines, aviation services, businesses, and some government agencies.

Concession rents are "in lieu of" charges for the privilege of selling goods and services to airport users. Most terminal building concessionaires are chosen on the basis of the highest tendered bid, which combines a percentage of gross sales backed by an annual minimum guarantee. Some other concessionaires, such as bus services and flight kitchens, often pay a predetermined concession fee.

4.2.3 Air Transportation Tax

This tax is applied to most air travellers who will enplane through at least one Canadian airport.[6] The tax is usually levied when a ticket is purchased. It is calculated on the basis of ticket price as follows:

(1) a percentage up to a maximum amount for travel within Canada and the United States; or

(2) a fixed amount for travel to other destinations.

Tax revenues are allocated to individual airports on the basis of annual passenger traffic.

4.3 Current Pricing Policy

Pricing policy encompasses the process of establishing, revising, and monitoring prices in conjunction with the achievement of specific goals. The primary goal envisioned for Transport Canada international airports is that of full cost recovery.[7] A group approach is the method used to maximize the potential for achieving this aim. The theory of the group approach, and its application by Transport Canada are outlined below.

4.3.1 Theory of the Group Approach

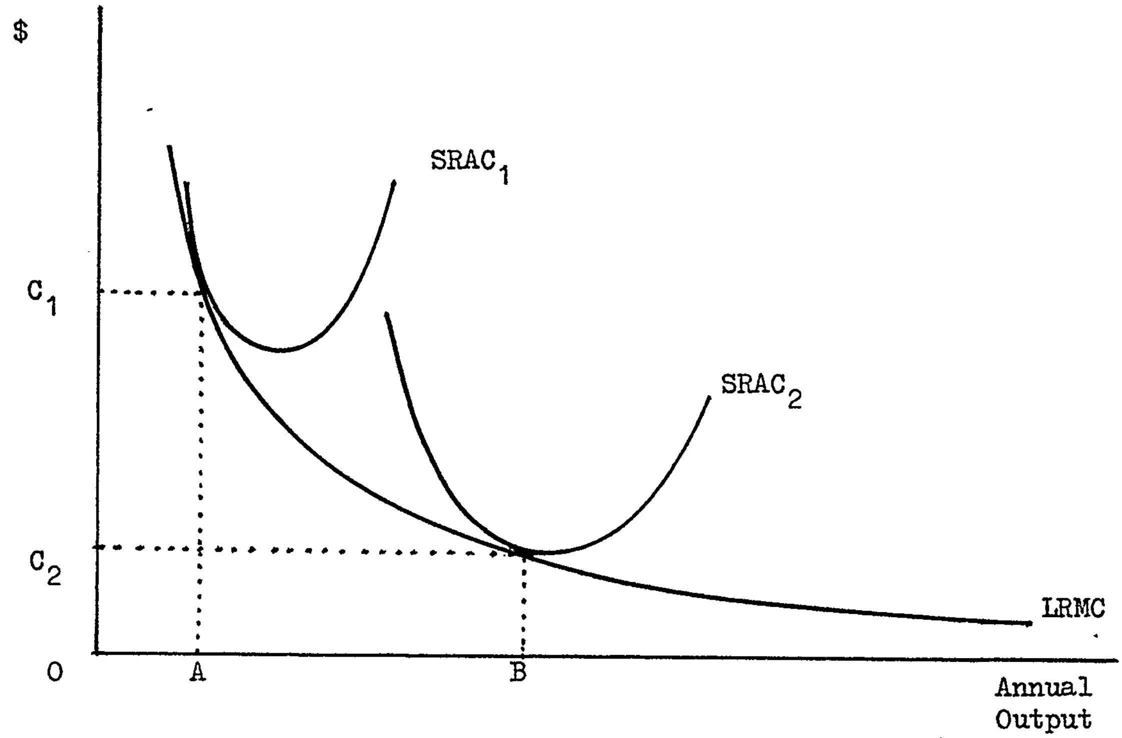
An international airport group consists of airports that have traffic links (common users) as well as similar financial targets. These airports can be quite different in terms of levels of traffic, as shown in Chapter 2. It is also reasonable to assume that the airports are in different stages of development.[8]

The group can be represented by an economic model. Such a model was constructed by Doganis and Thompson based on data from British airports.[9] The airports were varied in size so that cost (and revenue) behaviour could be simulated over a wide range of output levels. The authors' findings "seem to suggest a continuously downward sloping long-run average cost curve (LRAC) for airports."[10] This curve, as illustrated in Figure 4.1, forms an envelope that encompasses a number of individual airports. The airports are designated by the short-run average cost curves $SRAC_1$ and $SRAC_2$.

Airports operating on $SRAC_1$ have a higher average cost per unit output than airports operating on $SRAC_2$ (OC_1 greater than OC_2). The general price levels at $SRAC_1$ airports must necessarily be higher

FIGURE 4.1

A MODEL OF AIRPORT GROUP COSTS



than $SRAC_2$ airports if the financial target of full cost recovery, average cost equal average revenue, is to be met at both types, independently. Yet, the Doganis and Thompson study indicates that airports do not break even until reaching a size comparable to the $SRAC_2$ type: "Clearly then, as the airport expands, the effective 'price' per unit of output also increases."[11]

The group approach means that advantage is taken of the fact that enough revenue will be generated by the high prices and outputs typical of $SRAC_2$ type airports in order to subsidize the relatively low revenue expected at $SRAC_1$ type airports. Adopting this approach avoids the need to change the traditional pattern of airport pricing in order to meet financial targets.

4.3.2 Application of the Group Approach

Transport Canada's group approach is to establish, revise, and monitor prices on two levels. Each airport has control over non-aeronautical prices, and the administrative agency that oversees airports controls aeronautical prices plus the Air Transportation Tax. All revenues are collected by or allocated to individual airports. Airports which generate revenue in excess of costs then make transfer payments into a group fund to subsidize other airports that cannot cover costs.

The objective for each airport is to establish rates and fixed rents at levels that will provide for the full recovery of the annual costs associated with these prices. In addition, concession rents, which for the most part are determined by the tendering process, can be expected to produce revenue far in excess of the costs of providing space and services for concessionaires.

Expected annual revenues from non-aeronautical sources, and the expected annual revenues (based on existing price levels) from aeronautical sources plus the Tax, for all airports in a group, are compared to the expected total costs of all airports in the group. A resultant shortfall will lead to increases in one or more of the group controlled prices.

The total costs that are to be recovered are not equal to the actual annual expenditures of the group. Price setting costs are comprised of the following:

(1) direct and indirect operating expenses of each airport, including maintenance and repair of facilities;[12]

(2) overhead expenses, being an allocated portion of the costs

of administrative agencies that oversee airports; and

(3) capital expenses which include depreciation and interest on the existing assets of each airport.[13]

Actual expenditures consist of items (1) and (2) above, plus the net funds (borrowed from the Federal Treasury) required to construct new facilities, or to upgrade existing facilities.

Table 4.1 summarizes the annual revenues and price setting costs of Transport Canada international airports for fiscal year 1978/79. Per passenger figures are used, with enplaned plus deplaned passengers being a proxy for annual output. Also shown is the estimated dollar deficit or surplus of each airport. The rather high figures for Mirabel are somewhat explained on the cost side by its complete newness in terms of land area and infrastructure, and on the revenue side by the huge proportion of international traffic that it serves.

TABLE 4.1

FINANCIAL DATA FOR FISCAL YEAR 1978/79[a]
TRANSPORT CANADA INTERNATIONAL AIRPORTS

Airport	Passengers 1978[b] 000's	$ Per Passenger 1978/79		(Deficit)/ Surplus $ 000's
		Revenue	Cost	
Halifax	1397.0	4.52	8.10	(5000)
Mirabel	1541.4	16.85	48.52	(48808)
Edmonton	1844.8	4.90	6.69	(3302)
Winnipeg	2055.5	5.23	7.75	(5190)
Calgary	3027.4	5.03	9.39	(13220)
Vancouver	5694.5	4.86	5.93	(6095)
Montreal	5815.0	4.86	6.12	(7305)
Toronto	12423.0	5.55	5.32	2815

[a]Estimated by the author from unpublished Transport Canada financial data. The fiscal year begins April 1.

[b]See Table 2.4.

In comparison with the airport group model depicted in Figure 4.1, it can be seen from the (price setting) costs per passenger and annual outputs of the eight airports that each is not necessarily operating on the long-run curve. This could be due to differing levels of development, and inflating capital costs over time. The revenue per passenger is fairly constant for all the airports (except Mirabel). This can be explained by the equivalent Transport Canada prices which are applied to all international airports. The fact that the eight airports, if taken as a group, would not comprise a financially viable whole indicates that there is a discrepancy between current pricing policy and practice. This discrepancy will be further discussed in the next chapter.

4.4 Evaluation of Current Pricing

This evaluation will describe the deficiencies and strengths of current Transport Canada international airport pricing as it pertains to the achievement of economic goals, including optimal resource allocation and full recovery of costs. The merits of a group approach to cost recovery are also assessed. Deficiencies and strengths will be determined by comparison to the pricing rules established in Chapter 3 which are based on the need to meet economic goals.

4.4.1 Deficiencies of Current Pricing

The most evident deficiency is that prices do not vary by time period, even though excess hourly demands exist or are forecast to occur in the near future. Typically, demand is currently suppressed through administrative measures, or not at all, until new facilities can be constructed to accommodate excess demands. Operational prices are not determined by using marginal cost pricing guidelines, nor by using actual costs of airport subsystems.

A second deficiency is that operational prices are not related to the costs of specific subsystems, as is evidenced by equal prices at a group of airports. Also, more than one price is applicable in each subsystem of an airport. The least complicated and practical pricing method would be that which applies one price based on the particular costs of each subsystem at each airport.

Another deficiency is that the capital costs to be recovered through pricing should be determined by economic rather than accounting considerations. Currently, capital costs are to be paid through annual depreciation and interest expenses based on actual dollars expended rather than on replacement value. Recovery of these expenses simply repays past and existing debts, but does not guide future investment spending. Once an asset has been constructed its costs are considered as "sunk".

> Sunk costs . . . are invariant with respect to all changes of output which are technically possible, given the character and capacity of the sunk asset. They are invariant, moreover, for all future time. If a cost is truly sunk, it need not be recovered, via pricing, even in the long run. This is not to say that it should not be.[14]

The goal of economic pricing is to ensure that investments beyond the original stage do not become sunk costs. It is these investment costs that should be recovered through pricing, preferably in advance of and during the construction period.

4.4.2 Strengths of Current Pricing

The important strength of current Transport Canada international airport pricing is that it is geared to the achievement of financial targets.[15] This includes operational prices which have value of service elements, plus alternate revenue sources to supplement operational revenue.

Value of service supplements are the recommended device for generating revenue additional to that produced by marginal cost prices. Also known by the term "ability to pay", this pricing method "depends on the proportion airport charges bear to the net operating revenue from the flight. . . . this is correlated with all-up-weight; but . . . depends also on the number of passengers and the length of the flight."[16] These factors are evident in the existing aeronautical prices, as a group. These factors could also be measured by flight revenue only, "and one could suggest that a rational basis for airport charges would be the value of tickets sold for that flight."[17] Thus, the current tax on passenger tickets has significance as an aeronautical revenue source.

Fixed and concession rents cannot be levied on the basis of airport pricing theory. The space in buildings or the land available for tenancy is, in effect, in addition to and outside the realm of the airport's operational requirements. If a profit can be extracted from these rents, the extra revenue could be used to reduce the level of value of service supplements on operational prices. Since value of service prices above marginal cost will decrease somewhat the overall optimization of traffic levels, the ability to minimize these prices is a bonus.

4.4.3 Subsidization and the Group Approach

A group approach to cost recovery can be considered a strength of current pricing when subsidization of airports is necessary. Subsidies are generally required in two cases: during an initial period when an airport is building its demand to a design level; or when deficits have been incurred (as is the case with many Transport Canada airports), and are in the process of being wiped out, gradually through rational pricing.[18] Subsidies can come from users (cross-subsidization) or general taxpayers.

Taxpayer subsidies are not considered equitable for a mature industry such as transport in major markets. This is because if a subsidy is required it shows that users value the service at less than the value of resources needed to provide it. In addition, any subsidy could distort the competitive nature of the transport industry depending on the level of subsidy between modes. Cross-subsidies within a particular mode are not desirable because users choose between parts of each mode (that is, routes) rather than between modes as a whole (for example, air versus rail). While this type of subsidy does distort competition, it may prevent the need for taxpayers' contributions, and thus can be considered a more equitable alternative.

Cross-subsidy between airports can be undertaken without reducing the effectiveness of the marginal cost pricing guideline. This is because non-aeronautical prices can be used to generate necessary cross-subsidy revenue without directly affecting airport operations. Doganis and Thompson found that "the greater the annual volume of passengers handled, the greater was the proportion of total revenue generated by non-aeronautical prices."[19] This indicates that busy airports will be able to generate profits that can be pooled to maintain the financial viability of a group of airports while encouraging growth at smaller airports. Continuing requirements for cross-subsidization by one or more airports would imply the need for a review of the status of those airports as part of the group.

Footnotes to Chapter 4

[1]R. S. Doganis and G. F. Thompson, "Establishing Airport Cost and Revenue Functions," Aeronautical Journal, LXXVII (July, 1974), p. 293.

[2]International Civil Aviation Organization, Charges for Airports and Route Air Navigation Facilities, Statements by the Council to Contracting States, Doc. 9082-C/1015 (Ottawa: Information Canada, 1974).

[3]Transport Canada, Civil Aeronautics Directorate, Air Services Fees Regulations, 1979.

[4]The fee level for gasoline, which was previously equal to the fee on turbo fuels, was increased during 1978 to generate additional revenue from private aircraft operators. This user group accounts for almost all the light, gasoline burning aircraft being flown. Because it is administratively inefficient to produce and collect very small bills for landing fees (which are based on weight), it was determined that raising the concession fee on gasoline was a reasonable alternative. As such, the concession fee could be construed as a landing fee, that is, as a user charge.

[5]Rates are enforced by legal agreement or by Regulations.

[6]Travellers on small, irregular scheduled flights are not subject to the Tax. The Tax is enforced under the Air Transportation Tax Act which is part of the federal Excise Tax Act. It is theoretically a general tax source that is currently earmarked for use by Transport Canada.

[7]Transport Canada, Transportation Policy: A Framework for Transportation in Canada, Summary report (Ottawa: Supply and Services Canada, 1975) is the government's current statement of objectives for the Canadian transportation system. One goal of the Policy is "that the transportation system should be accessible, equitable and efficient." (p. 30) The document recognizes that one factor in the achievement of its goals is to ensure that users of mature transportation services, such as international airports, "pay for the costs of providing the services." (p. 14) Like any policy statement, it has been left open to interpretation. The result being that Transport Canada's airport administrators have found the concept of full cost recovery to be synonomous with the achievement of "financially as well as operationally efficient" airports that will be "provided in direct response to users demands." (Transport Canada, Principles, Pricing and Financing Branch, "Pricing and Investment Criteria: Airports and Related Facilities and Services," 1976, pp. 12 and 14.)

[8]Of the eight international airports previously mentioned, major capital expenditures have been made at Calgary, Mirabel (new), Toronto and Vancouver in the 1970's. Relatively minor changes have been made at the other airports over the same period.

[9]Doganis and Thompson, "Airport Functions," 285-304. The authors used 1969 data from 18 British airports.

[10]*Ibid.*, p. 290.

[11]*Ibid.*, p. 298.

[12]Direct operating expenses include salaries and wages, materials, and other such cost items. Indirect operating expenses include employee fringe benefits, grants in lieu of taxes, and local administrative overheads.

[13]Annual depreciation is calculated by the "straight-line" method. Interest during 1978/79 was charged as 8 percent of net book value of depreciated assets for that year. See also discussion in Z. Haritos, "Transportation User Charges: A Federal Perspective," *The Logistics and Transportation Review*, XV (No. 5, 1979), pp. 593-594 ("Methodology Considerations").

[14]J. R. Nelson, "Pricing Transport Services," in *Transport Investment and Economic Development*, ed. by G. Fromm (Washington, D. C.: The Brookings Institution Transport Research Program, 1965), p. 207.

[15]Even though the goal is to achieve full cost recovery of Transport Canada's international airport group, less than three-quarters of total costs are covered annually. Revenue is sufficient to pay for operating and overhead costs. The aim is to gradually phase in full cost recovery by the mid-1980's. (Transport Canada, Rate Economics Branch, "Phase II Carp Study: Proposals on Cost Allocation, Airport Classification and Fee Increases," 1977.)

[16]I. M. D. Little and K. M. McLeod, "The New Pricing Policy of the British Airports Authority," in *Airport Economic Planning*, ed. by G. P. Howard (Cambridge, Mass.: The MIT Press, 1974), p. 459. Note that for cargo or general aviation flights, the number of passengers is not a factor since neither of these user groups require terminal building facilities.

[17]*Ibid.*, p. 460.

[18]Gradualism is a principle which is recognized by ICAO for making reasonable increases in airport users' fees over a period of time when large increases have been shown to be required.

[19]Doganis and Thompson, "Airport Functions," p. 293.

CHAPTER 5

PEAK PRICING FOR TRANSPORT CANADA AIRPORTS

5.1 Introduction

This chapter proposes changes to current Transport Canada international airports' aeronautical prices that will encourage efficient use of airport facilities and services. Methods of developing peak prices are discussed. As an example, a pricing structure that distinguishes between time periods of use is suggested for Toronto International Airport. The implications and impacts of revised aeronautical prices on airport users plus effects on other transport modes are outlined.

5.2 Focus of Proposals

The evidence of Chapter 4 indicates that Transport Canada international airports should levy aeronautical prices on the basis of peak and off-peak use. This means that the additional costs associated with users of the airfield and terminal building subsystems during the busiest times of the day should be reflected in higher prices for these users. The nature and form of the so-called peak prices will be discussed in the following sections.

Since this paper is concerned with peak charges, specific revisions to value of service elements of current prices will not be suggested. It was found that current aeronautical prices are in the form of value of service prices, and that this is a strength of

Transport Canada international airport pricing. The strength lies in the generation of revenue in a manner which encourages increased airport use. This is not to imply that current value of service prices are fully or independently effective. For example, aeronautical prices are equal at each airport in the international group, but these could be changed to reflect individual airport needs. One constraint that could be introduced is that of ensuring subsystem operating costs would be paid for by local users in proportion to capacity utilization. In addition, the Air Transportation Tax which was shown to be equivalent to an aeronautical value of service price, could be applied in a similar manner.

It is also beyond the scope of this analysis to suggest changes to non-aeronautical prices. Most prices applicable to nonoperational parts of the airport are specified under lease agreements to which proposed changes would have to be directed. The ground transportation subsystem need not be considered for specific price changes because it can be expected that changes which influence traffic in aircraft related facilities will have similar effects on ground transportation facilities. Such facilities are provided in conjunction with the demand for air travel.

5.3 Methods of Setting Peak Prices

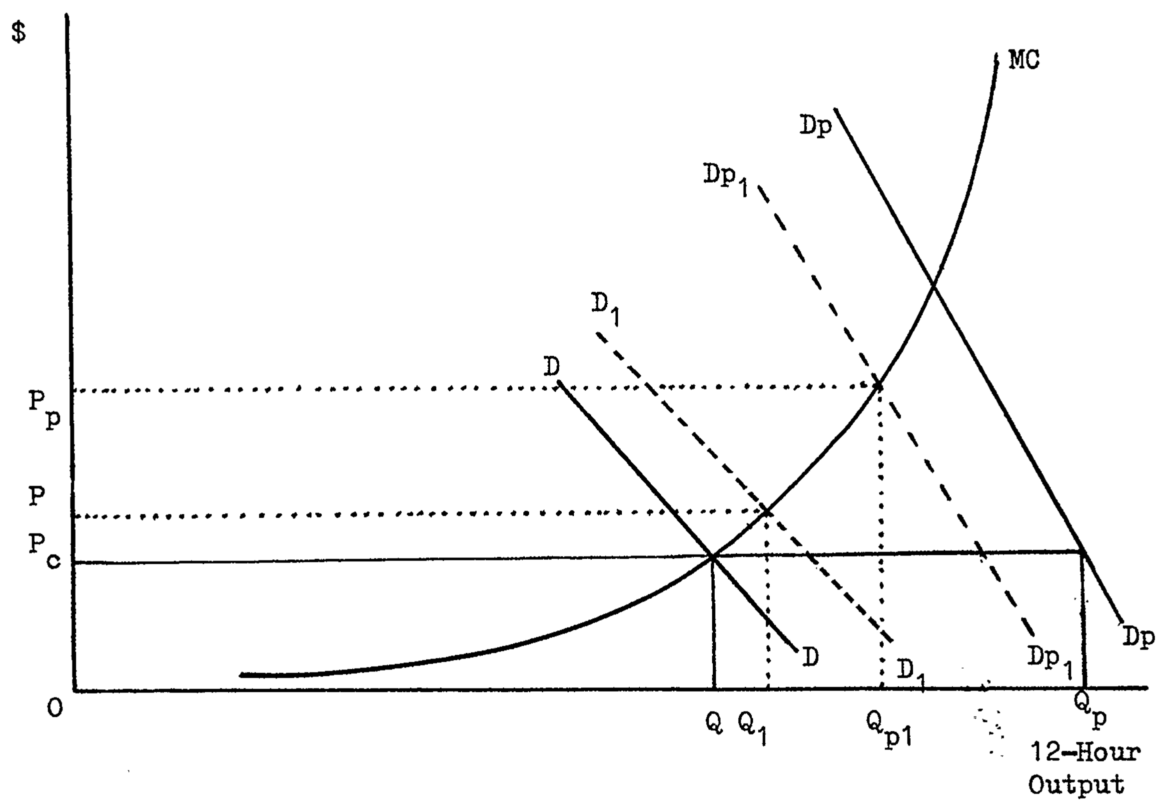
The theory of airport pricing specifies that marginal cost be used as a pricing guideline in order to optimize benefits and efficiency. This means that peak prices should be set by equating peak users' demand to marginal cost. The recognized method for estimating marginal costs of a transportation facility is to calculate users' costs which will include any delay costs incurred. In respect of this complex task, airport administrators have opted for peak charges that can be explained easily and applied simply.

5.3.1 Effects of a Transition to Peak Pricing

This analysis assumes an airport subsystem with fixed interdependent demands, and current prices which are equal during all time periods and are equivalent to the marginal cost of serving off-peak users. The situation is depicted in Figure 5.1. The two levels of demand are represented by DpDp (peak) and DD (off-peak) with price for both equal to P_c. In this case, output is Q_p during the peak period, and Q during the off-peak period.

FIGURE 5.1

EFFECTS OF PEAK PRICING



The transition to peak pricing dictates a higher price for peak users than for off-peak users. Based on the analysis presented in Section 3.4.4, an optimal pair of prices can be derived for the peak and off-peak periods. In Figure 5.1, the peak and off-peak prices are shown as P_p and P, respectively, with corresponding demand curves Dp_1Dp_1 and D_1D_1. The new outputs are Q_{p1} during the peak period, and Q_1 during the off-peak.

It can be expected that an optimum pair or set of prices will not be actually applied. At least two factors will necessarily require a deviation from optimality. First, it is intuitively obvious that actual patterns of demand do not fall into neat groupings, and the airport traffic data confirm this statement. For administrative reasons it will be necessary to simplify a pricing scheme in order to produce a workable number of tariff units.

> Since demand is unlikely to be stable within each of the chosen separate parts of the demand cycle, some consumers will inevitably be asked to pay the peak price even though they do not contribute to the peak demand. But some averaging across consumers is inevitable, and is part of the price paid for comparative simplicity of tariff structure.[1]

Second, as was noted previously, the revenue derived from peak pricing may be higher than the internal airport costs because marginal cost includes externalities. It may therefore be necessary to reduce the level of peak prices or to adjust the ratio of peak and off-peak prices. In either case, this would require a move away from an optimal solution.

5.3.2 Delay Costs and Peak Pricing

The complexity associated with marginal cost pricing is that of estimating appropriate demand and cost functions. The approach for airport subsystems has been to use derived demand such that cost functions are calculated for users to include delays due to congestion. This approach assumes that the proper costs of operating the airport are currently being passed on to users. A classic application of the method was made by Carlin and Park who estimated the full marginal costs of runway use at New York City airports.[2]

Sandford Borins applied a similar calculation methodology to all the subsystems at Toronto International Airport.[3] He obtained cost functions as follows:

> Average and marginal social cost curves can be derived by multiplying the average and marginal service times by the cost incurred by the average user during a unit of service time. For example, since runway capacity is measured in seconds, the cost would be the avoidable cost to the average plane of using the runway for a second, which would include the marginal operating costs incurred by the airline, and the time cost, in dollars, borne by the passengers.[4]

From this formulation, equilibrium flows occur when price equals average social costs. "By means of congestion tolls equal to the difference between marginal and average social cost at each facility, marginal social cost pricing can be adopted."[5]

5.3.3 Variations of Marginal Cost Peak Pricing

There has not been a practical application of the delay cost pricing methodology. One reason, as suggested by Carlin and Park, is that calculated prices are just too high compared to existing prices. Their study "proposed new structures of landing charges . . . where prices would be proportional but not equal to the full marginal delay costs imposed by each flight."[6] Another, and possibly more important reason, relates to administrative factors. It seems that airport administrators are not convinced that the benefits outweigh the costs of explaining and implementing a rather complex pricing formula which could cause structural changes in traditional airport use patterns.

The alternative, adopted at a very few airports, has been to apply a peak (or congestion) price of a fixed amount during busy times. At New York airports a minimum fee of $25 was imposed in 1968 to displace some low-value flights during peak times; the later Carlin and Park recommendations were not applied. When the British Airports Authority (BAA) decided to implement peak pricing in 1972, its first attempt was to levy a £20 surcharge during peak hours with the following proviso:

> The height of the peak charge was chosen in ignorance, since there was no experience to go on, and because it was difficult to interpret the effects of the policy of managing the peak. The knowledge that such management could and would be maintained until more knowledge of the elasticity of demand was built up permitted the British Airports Authority to choose initially a rather lower peak charge than it otherwise might have done.[7]

The management referred to is that of requiring users to consult the Authority regarding flight scheduling.

The BAA has since adopted more complex peak pricing at London airports. There are now two levels of peak charges applicable to both the airfield and terminal building subsystems.[8] These prices are essentially variations on the fixed charge formula rather than derivations using the delay cost pricing methodology.[9] Subsystem costs are allocated to users on the basis of estimated use and value of service, and so determine the peak to off-peak price ratios. Prices are still applied in conjunction with traffic management policies.

5.4 An Example: Peak Pricing for Toronto Airport

Thus far it has been shown that peak pricing should be implemented at Transport Canada international airports, and that one method for doing so has been presented by Borins who calculated a set of congestion tolls for Canada's largest airport, Toronto International. Among reasons for the failure of airport administrators to implement such prices is their reluctance to utilize a complex pricing methodology. Therefore, this example puts forward a simpler way of setting prices at Toronto, one similar to that being applied by the BAA.

The aim of this example is to outline considerations, data, and calculations that would be needed to determine short-run (that is, assuming fixed demand) peak supplements for aeronautical prices. In order to focus on the derivation of peak charges, it will be assumed that all users will pay a minimum value of service price based on annual operating costs. The supplements which are calculated herein would represent a first step in an iterative process to find a new optimum for the airport.

5.4.1 Units of Charge

Three criteria governing the choice of units of charge are as follows: First, data to support price units should be available or easily obtained. Second, simplicity and convenience must be key words in the development process. Third, separate airfield and terminal building subsystem prices should be applied to enable the determination of a price for "airfield only" users.[10]

A composite aircraft-weight based price for the airfield subsystem would be simple, somewhat cost related, and in keeping with the general unit of charge currently used for value of service prices. The application of a price on landings and take offs is necessary if time periods of use are to be utilized effectively. It is suggested that the widely accepted landing fee per unit weight (that is, per 1000 lb or Kg) be adopted as the unit of charge for peak prices.

Terminal building construction costs are usually closely related to the expected flow of passengers who are boarding or leaving aircraft. There are additional facilities in the form of inspection services for deplaning international passengers. This indicates that terminal building subsystem prices should be levied per enplanement and per deplanement, and should distinguish between domestic and international passengers.

5.4.2 Time Periods of Use

Identification of time periods of excess demand will be uniquely determined for each airport subsystem. Selection of time periods will depend on traffic patterns as well as the level of detail desired. Numerous methods of identification have been utilized or suggested, with each being generally related to measurements of strained capacity.

London airports define time periods of use related to hourly and seasonal traffic patterns.[11] At Heathrow, the "Peak" period extends from 0600 to 0859 for aircraft arrivals, and from 1000 to 1359 for departures, and covers the months of April through October. The "Standard" period includes all other hours in April through October. The "Off-peak" period extends from November through March.

Borins found four periods of each day at Toronto in which significant similarities in traffic levels could be identified.

> These periods were chosen after inspection of . . . traffic flows through the airport showed that flows were relatively constant within these periods: . . . the early morning rush (7 to 9 a.m.), the mid-day lull (9 a.m. to 4 p.m.), the evening peak (4 p.m. to 8 p.m.) and the slackening of traffic between 8 p.m. and 11 p.m."[12]

The goal of a time period selection is a distinction between those users whose demands are in excess of capacity, and those whose are not. A comparison can be made between expected (or actual) traffic flows and excess capacity traffic levels in each subsystem. This comparative process will yield a tabulation of how often the capacity of a particular subsystem is strained. Capacity is a difficult value to define. Since there are both static and dynamic elements in each subsystem, a capacity value for an entire subsystem is based on subjective evaluations. Even though capacity standards are recognized, disagreements between airports and users might arise in regard to capacity definitions, especially where the calculation of prices is concerned.

Assuming that acceptable capacity figures can be derived, it is possible to tabulate the number of excess capacity demands by clock hour. One recognized measure of capacity, the 90th percentile distribution, is utilized here. This measure defines an excess capacity demand as a traffic level which is one of the busiest, so that these busiest demands make up 10 percent of total traffic in a year.[13] Thus, sample data for Toronto International Airport shows that some 5 percent of total annual hours (based on an 18-hour day) representing the busiest traffic levels generate some 10 percent of total annual traffic.[14] If these levels are made to represent excess capacity, then a selection of time periods can be derived as follows.

Define three time period types as peak, shoulder, and off-peak. Those clock hours where there are regular occurrences of excess demands will be peak hours, those where there are few occurrences (some of which could be caused by spillovers from peaks) will be shoulder hours, and those where there are little or no excess demands will be off-peak hours. The interpretation of the terms "regular", "few", and "little or no" can be gleaned from the data in Table 5.1. This table shows the percentage of excess capacity occurrences in each Toronto subsystem based on 1975 sample data. It can be seen that while some interpretive criteria will be necessary, there are obvious division points in the data. A detailed analysis leads to a time period selection as shown in Table 5.2.

TABLE 5.1

PERCENTAGE OF HOURLY EXCESS CAPACITY DEMANDS FOR 1975 TORONTO INTERNATIONAL AIRPORT SUBSYSTEMS

	Percentages		
Hour[a]	Airfield	Domestic Term. Bldg.	International Term. Bldg.
0600	0.0	0.0	0.0
0700	0.0	0.0	0.0
0800	0.0	0.0	0.0
0900	15.4	6.4	0.0
1000	7.7	0.0	0.0
1100	3.1	0.0	2.5
1200	1.5	0.0	0.0
1300	0.0	0.0	0.0
1400	13.8	0.0	0.0
1500	9.2	0.0	7.5
1600	18.5	17.0	20.0
1700	4.6	2.1	30.0
1800	18.5	27.7	10.0
1900	3.1	23.4	20.0
2000	3.1	4.3	0.0
2100	1.5	19.1	10.0
2200	0.0	0.0	0.0
2300	0.0	0.0	0.0
	100.0	100.0	100.0

[a]Each Hour period encompasses minutes 00 through 59.

Source: Unpublished Transport Canada traffic data.

TABLE 5.2

TIME PERIODS OF USE FOR 1975
TORONTO INTERNATIONAL AIRPORT SUBSYSTEMS

Period	Hours		
	Airfield	Domestic Term. Bldg.	International Term. Bldg.
PEAK	0900 1400 1600 1800	1600 1800 1900 2100	1600 1700 1900
SHOULDER	1000 1100 1500 1700 1900 2000	0900 1700 2000	1500 1800 2100
OFF-PEAK	0600 0700 0800 1200 1300 2100 2200 2300	0600 0700 0800 1000 1100 1200 1300 1400 1500 2200 2300	0600 0700 0800 0900 1000 1100 1200 1300 1400 2000 2200 2300

Source: Unpublished Transport Canada traffic data, and Table 5.1.

Table 5.1 also indicates that the busy hours in the airfield and terminal building subsystems do not fully coincide. While commercial airline passenger aircraft use both the airfield and terminal building subsystems, other aircraft do not. This means that it might be necessary to coordinate the time periods in each subsystem so that alternatives will be available to aircraft operators who want to shift their flights from peak to other times. It could mean that an airline peak hour price for the airfield subsystem would be levied in a shoulder or an off-peak hour.

5.4.3 Allocation of Costs

A calculation of peak price ratios can be accomplished by allocating costs to users of the peak and shoulder time periods in accordance with their percentage of excess demands for each subsystem. First, the costs to be allocated must be determined. Although there are a number of possibilities, two particular methods, above average capital costs and estimated revenue from congestion tolls of a delay cost model, are examined below.

The "above average capital costs" alternative is based on the assumption that construction costs of facilities which are in addition to those required by the average (hourly) level of traffic should be borne by peak and shoulder users. This requires that the construction costs of various levels of subsystem capacity be determined. The current average level of traffic can then be matched up to a specific amount of construction cost, leaving the remaining current total construction cost to be allocated for peak pricing purposes.

A number of factors relating to the principle of simplicity and convenience should be mentioned. First, it is not a simple task to match capacity levels to specific construction costs. Second, the amount of annual capital costs based on percentages of depreciation and interest must be determined. It should also be noted that average construction costs must be either borne by all users through some other fee, written off as "sunk" costs, or assumed as having already depreciated.

The "delay cost model" alternative could be used if an airport marginal cost pricing model (for example, such as the one developed by Borins for Toronto) has been prepared. While the application of the model might not be administratively acceptable, the total amount of congestion tolls recommended by the model could be collected from excess capacity users through cost allocation pricing. One drawback of this alternative is that it might not be any more convenient than applying prices proposed by the delay cost model.

All peak and shoulder time period users will be together considered as creating a proportionate need for extra facilities. A certain percentage of costs for each subsystem would be allocated to those who fly during peak periods, and the remainder of costs would be allocated to shoulder time period users. Referring to Tables 5.1 and 5.2, and using the airfield subsystem as an example, the costs could be allocated in proportion to excess demand occurrences. It can be seen that 66.2 percent of excess demands occurred in peak hours, and 30.8 percent in shoulder hours, for a total of 97 percent. The proportion of peak hour occurrences is 68.3 percent (66.2 divided by 97) which determines the amount of costs to be allocated to peak users; 31.7 percent of costs would be allocated to shoulder time period users. Similarly, the domestic and international terminal building subsystems' peak users would be allocated 87.2 percent and 71.8 percent of costs, respectively.[15]

Although some 10 percent of traffic occurs when the capacity of subsystems is exceeded (as per the 90th percentile method), the actual number of users who will be paying peak (and shoulder) prices will be much higher. At Toronto, about 67 percent of airfield subsystem weight, and 58 and 49 percent of domestic and international passengers would be subject to peak/shoulder prices.

Table 5.3 shows the order of magnitude aeronautical prices that could be applicable at Toronto International Airport with a change to peak pricing. The "Average" prices reflect the net 1978/79 operating costs per traffic unit to be paid for by all users. The "Supplements" represent per unit allocated costs for the peak and shoulder time period users.[16] These price supplements are derived from rough estimates of 1978/79 costs based on the utilization of the two cost determination methods described above. Each generated similar guesstimates of some $5 million for the domestic terminal building subsystem, $7.5 million for the international terminal building subsystem, and $10 million for the airfield subsystem.

TABLE 5.3

SAMPLE PRICES WITH PEAK PRICING FOR 1978/79
TORONTO INTERNATIONAL AIRPORT SUBSYSTEMS

Price	per 1000 lb taking off or landing Airfield	per enplaned or deplaned passenger Domestic Term. Bldg.	per enplaned or deplaned passenger International Term. Bldg.
AVERAGE	$ 0.27	$ 0.29	$ 0.67
SUPPLEMENTAL			
Peak Hours	0.73	1.43	3.55
Shoulder Hours	0.27	0.43	1.57

Source: Unpublished Transport Canada traffic data for 1975 and 1978, and cost data for 1978/79.

As an example, an airplane landing during the 1600 hour (peak) would be priced at $1.00 per 1000 pounds compared to 54 cents per 1000 pounds during the 1900 hour (shoulder), or 27 cents per 1000 pounds during the 2200 hour (off-peak). If this aircraft unloaded domestic passengers, the prices would be $1.93 per passenger during the 1600 and 1900 hours (peaks for the domestic terminal building subsystem) and 29 cents per passenger during the 2200 hour (off-peak).

5.4.4 Administrative Considerations

One objective of establishing the various levels of prices detailed in Table 5.3 is to provide a tool for decision making. The set of prices would be a first iteration. The users then must decide what traffic shifts they will make. Further iterations will no doubt follow.

A number of requirements must be considered for smooth administration. There should be decision time frames established so that prices for a particular period can be agreed upon in advance; a typical time frame could be the airline scheduling period of 90 days. The mechanism for generating alternatives must be effective. It must be decided in which order users will be able to suggest changes and make scheduling revisions.

5.5 Implications and Impacts of Peak Pricing

The following discussion outlines the anticipated effects of implementing peak pricing at Transport Canada international airports. Specific effects are examined from the point of view of airlines and other commercial and private aircraft operators. Intermodal effects are described. Finally, a general comparison between current and suggested pricing methods is presented.

5.5.1 Airlines

In order to determine the impact of peak pricing on airlines it will be necessary to briefly describe the economics of the airline industry. It is a regulated industry, the characteristics of which include the following:[17]

> In the scheduled air carrier industry, market equilibrium is achieved when fares are equal to the average cost of producing the service. . . . it is not realistic to make an economic analysis of just one route; consideration must also be given to all other routes that are linked to the one under consideration. One must not overlook the costs of scheduling, routing, and positioning of aircraft. . . . Not enough is known about costs and cost allocation techniques within the industry to set fares appropriate to recover costs on a route-by-route basis.[18]

These characteristics are reflected in the method used to calculate standard fares. A general formula "consisting of a fixed terminal charge and a variable line-haul charge" is utilized.[19]

Thus, the costs associated with any particular flight are assumed to have a specific amount of fixed cost. Included in this cost are the airfield and terminal building subsystem prices. These prices amount to a small percentage of total airline costs. For example, 2.65 percent for scheduled Canadian air carriers during 1978.[20]

The airlines use a differential pricing policy "to fill some of the excess capacity and reduce the problem of peaking."[21] Discount fares are derived from the general fare formula, but are restricted by "applicability periods (minimum and maximum length of stay, time of departure, and day of the week), number of passengers in a group, family fares, and inclusive tours."[22] With the introduction of time period subsystem prices, the airlines will have to make choices similar to those made by their passengers.

As a result of the implementation of time period pricing at Heathrow, little change occurred in the pattern of airline traffic, especially in the short term.[23] Similar results can be expected if peak pricing is introduced at specific Transport Canada international airports. One reason is that the airlines need not pass additional costs on to specific passengers, but can mix all cost increases through the general fare formula. The amount of a price increase, although it might be substantial at each airport, will be small in comparison to total airline costs. Another significant influence is the rather rigid nature of flight times. This factor is caused by travellers' demands for the best possible flight departure and arrival hours, and by the airlines' desire to maximize the routing pattern of each aircraft.

The impact of peak prices on airlines will inevitably depend on the number of Transport Canada (and possibly outside Canada) airports at which such prices will apply, and on the magnitude of estimated costs for allocation to peak and shoulder users. The amount of savings that could be achieved by an airline shifting one daily flight is significant in dollar terms.

Based on the sample prices derived for Toronto (see Table 5.3), if Air Canada shifts an arriving B747 international flight from a peak to a shoulder hour, it could realize annual savings of about $255,000.[24] This amount would double if the shift were from a peak to an off-peak hour.[25] Compare such savings to annual costs of some

$1.24 billion and net income of $47.5 million for Air Canada in 1978.[26] Another example is that of Pacific Western Airlines moving a daily departing B727 domestic flight from a shoulder to an off-peak hour.[27] In this case the annual saving would be some $31,000 compared to annual costs of some $0.13 billion and net income of $7.7 million during 1978.[28]

5.5.2 Other Commercial and Private Aircraft Operators

While airlines have an extensive route structure which can be utilized to spread out specific increases in user charges costs, other commercial operators often use one airport as a base for much of their business. Since user charges are a fixed cost for aircraft operators, the impact of price increases will be greater as the average length of flight decreases. The short haul market is the most competitive of the transportation markets, so that peak prices, or alternatively, less attractive flight times, could have more serious implications for other commercial aircraft operators.

Under the proposed prices for Toronto airport, an operator flying a Convair aircraft on a daily domestic flight in a shoulder hour would stand to achieve savings of some $11,000 annually given a shift to an off-peak hour.[29] This can be compared with average annual operating costs of $2.41 million and net income of $70,900 for such companies in Canada during 1978.[30] When minimum fees were imposed during peak periods at New York City air carrier airports, much lobbying by commuter aircraft operators because of substantial cost increases led to the imposition of such fees only on aircraft carrying fewer than 25 persons.

The effect of peak pricing on "airfield only" users can be gleaned from the following description of events at New York's air carrier airports:

> In July 1968, the authority raised the minimum landing and take-off fees for aircraft seating fewer than 25 persons from $5 to $25 during peak hours. The declared intention of the new policy was to give general aviation and air taxis price incentives to fly at off-peak hours and uncongested airports. . . . The results were striking. General aviation declined by 30 percent during peak hours, suggesting that a substantial amount of this use was of marginal value.[31]

It is evident that small commercial and private operators have the least capacity to absorb additional landing costs, but have a greater ability to shift flight times. There do exist alternative airfields for general aviation aircraft that do not cater to airline and other commercial traffic.

5.5.3 Intermodal Implications

Subsidies are being paid to all modes of transport in Canada as stated by Gibberd:

> . . . on either an expenditure or on a cost basis, the subsidy per passenger-mile is largest for rail at 8.11¢ followed by air in the 1.4¢ to 2.5¢ range and road at less than 1¢. On an expenditure basis, it is seen that the largest total subsidy, both freight and passenger, goes to road followed by air, marine and rail. The order on a cost basis changes in that air receives the smallest subsidy.[32]

These are aggregate data which indicate that there is not full cost recovery of the transport modes. While full cost recovery cannot be expected because the government may wish "for example, to assure a higher degree of regional development," it is an objective of the government to reduce subsidies in all modes such that there will be inter-modal equity, and economic efficiency.[33] It is questionable whether aggregate subsidy levels between modes should be equalized.

> The calculation of aggregate numbers to compare the modes is not particularly relevant to particular cost recovery issues. . . . Clearly no mode of transport can be comfortably aggregated into a homogeneous whole.[34]

Since the time of Gibberd's study, the government has been most active in reducing the air mode subsidy, this being partly due to its dominant ownership of air infrastructure as compared to rail. This could mean that a shift in the competitive nature of mature markets (especially short haul) is taking place, although no data has been presented to confirm this hypothesis.

The Canadian Transport Commission has studied intercity passenger travel in Canada quite extensively. One study predicts transportation scenarios based on changing prices for using different modes.[35] It provides base year (1975) estimates of the modal traffic split. These results are presented in Table 5.4, and show that the air mode dominates the long haul travel market, but still has a very low share of the short haul market. The study indicates that the air mode is price sensitive, especially in the short and medium haul markets.[36] One scenario proposed air fare increases which would eliminate cross-subsidies from the medium and long haul to the short and medium haul markets. As a result, there would be a noticeable reduction in short haul air traffic. However, the study also showed that if road fuel prices were to double through the application of automobile gasoline taxes, there would be an almost equally noticeable gain in air traffic, especially on short haul routes.

Another study compares the air and rail modes.[37] It shows that between 1970 and 1975 there was a substantial increase in fares

TABLE 5.4

CANADIAN INTERCITY MODAL TRAFFIC SPLITS
ESTIMATES FOR 1975

Mode	Percentages			
	All Trips (100)	Short Trips 0-500 Miles (94)	Medium Trips 500-1000 Miles (3)	Long Trips 1000+ Miles (3)
AUTO	88.5	91.9	43.1	20.3
AIR	5.4	2.7	39.3	58.2
BUS	4.5	4.2	8.7	9.7
RAIL	1.7	1.2	8.9	11.8

Source: Canadian Transport Commission, Research Branch, Intercity Passenger Transport in Canada: Analysis of the Consequences of Alternative Pricing and Network Strategies by J. C. Rea, Research Report No. 254 (Ottawa: Canadian Transport Commission, 1976), p. xiii.

in both modes. These increases were highest for air in the short haul sector, and highest for rail in the long haul sector. In contrast, during the period 1972 to 1974, rail travel declined in all markets except the very short haul Southwestern Ontario sector, but the air mode had substantial traffic growth even on short haul segments such as Montreal-Ottawa-Toronto.[38] It is evident that travellers' tastes are influential in the determination of cross-elasticities for the air and rail modes.

5.5.4 Comparative Analysis

Over the past few years, the price of using Canadian international airports has been rising. Price increases resulted from inflationary trends in the economy, and from the government's transportation policy. Among its principles, the policy states that users will pay the full cost of facilities which had previously been subsidized by the general taxpayer.[39] This requirement was derived in part from the concept of equity: "the users of the transportation service who benefit directly will be burdened with the costs, while the non-users, i.e., the general taxpayer, will not be required to pay for facilities and services which do not benefit them."[40]

The general taxpayer has continued to subsidize the international (mature) airport user despite price increases (see Table 4.1). Much of the current subsidy is used to pay for capital costs which are being incurred in the form of depreciation and interest. The current policy of price increases for the users of mature airports has been confirmed for the future through negotiations with the air industry associations. In addition there are plans for increased investment spending on airports. Thus, the introduction of a peak pricing scheme should not place a significantly different total cost burden on users compared to one expected from the current pricing policy. However, the impact on specific users will be distributed differently.

The application of efficiency pricing via peak pricing and overall price increases should be matched by efficiency on the cost side. It will be necessary to maintain the consultation process with users regarding capital expenditures, and to continue with the minimization of operating costs. Even if full cost recovery cannot be achieved through price revisions, the implementation of peak pricing at Transport Canada international airports should lead to reduced needs for capital investments and associated operating costs.

Footnotes to Chapter 5

[1]Michael G. Webb, Pricing Policies for Public Enterprises, MacMillan Studies in Economics (Tiptree, Essex: The Anchor Press Ltd., 1976), pp. 39-40.

[2]A. Carlin and R. E. Park, "Marginal Cost Pricing of Airport Runway Capacity," American Economic Review, LX (June, 1970), 310-319.

[3]S. F. Borins, "Pricing and Investment in a Transportation Network: The Case of Toronto Airport," Canadian Journal of Economics, XI (November, 1978), 680-700.

[4]Ibid., p. 683.

[5]Ibid., p. 684.

[6]R. D. Eckert, "The Economics of Airport Demand and Pricing," in Airport Economic Planning, ed. by G. P. Howard (Cambridge, Mass.: The MIT Press, 1974), p. 436.

[7]I. M. D. Little and K. M. McLeod, "The New Pricing Policy of the British Airports Authority," in Airport Economic Planning, ed. by G. P. Howard (Cambridge, Mass.: The MIT Press, 1974), p. 458.

[8]British Airports Authority, Conditions of Use, 1977. London airports are the only western world airports where time period pricing is applied for both the airfield and terminal building subsystems. At Heathrow Airport, a runway movement charge that is equal for all aircraft applies during peak hours. In addition, aircraft using the terminal buildings pay "Landing Fees" that consist of a weight and a passenger element. The weight element, payable only on landings, is levied per weight unit, depends on flight origin, and varies by time period. The passenger element is levied per arriving and departing passenger, depends on flight origin, and applies only during designated peak or standard hours. An aircraft operator pays up to 5 times as much to land during peak as compared to off-peak times.

[9]Information obtained during conversations by the author with British Airports Authority officials in 1977 in London.

[10]The accounting system utilized at Transport Canada international airports distinguishes between the costs of the airfield and terminal building subsystems.

[11]BAA, Conditions of Use.

[12]Borins, "Pricing and Investment," p. 684. Note that the period from midnight through 6 a.m. is not included because there is a curfew in effect at Toronto airport during this period. In terms of the 24-hour clock, Borins' time periods are 0700 to 0859, 0900 to 1559, 1600 to 1959, and 2000 to 2259, respectively.

[13]It assumes that the facility is operating at or near defined annual capacity levels.

[14]The sample hourly data for 1974 and 1975 is not released to the public. The author has obtained these data during his employment with Transport Canada. Its contents have been interpreted for the purposes of this thesis, but actual figures cannot be shown.

[15]These figures are derived as follows: For the domestic terminal building subsystem, all excess demand occurrences were applicable, and 87.2 percent were peaks. Thus, 12.8 percent of costs would be allocated to shoulder users. For the international terminal building subsystem, 97.5 percent of the excess demand occurrences were applicable since 2.5 percent were deemed off-peak. Of the remainder some 71.8 percent (70 divided by 97.5) were peaks. Thus 28.2 percent of costs would be allocated to shoulder users.

[16]Note that the 1975 hourly traffic patterns have been applied to 1978/79 volumes and costs for the purposes of up-to-date price comparisons.

[17]The Air Transport Committee of the Canadian Transport Commission is responsible for the regulation of the air industry in Canada.

[18]N. K. Taneja, The Commercial Airline Industry (Lexington, Mass.: D. C. Heath and Company, 1976), pp. 40-41.

[19]Ibid., p. 213.

[20]Statistics Canada, Air Carrier Financial Statistics, Annual 51-206 (Ottawa: Statistics Canada, 1978).

[21]Taneja, Airline Industry, p. 42.

[22]Ibid., p. 67.

[23]These estimates were obtained by the author during conversations with British Airports Authority officials in 1977 in London.

[24]A Boeing 747 aircraft has a Gross Take Off Weight (GTOW) of 775,000 pounds, and its 407 seats would carry some 244 passengers with a 60 percent load factor. The 60 percent factor is a typical figure for most airline scheduled traffic based on the author's estimates at Toronto International Airport.

[25]See Chapter 3, Section 3.3.4 for discussion of shifting-peaks.

[26]Statistics Canada, Air Carrier Financial Statistics, 1978.

[27]A Boeing 727 aircraft has a GTOW of 191,000 pounds, and its 139 seats would carry some 83 passengers with a 60 percent load factor.

[28]Statistics Canada, Air Carrier Financial Statistics, 1978.

[29]A Convair 660 aircraft has a GTOW of 57,000 pounds, and its 30 seats would carry some 18 passengers with a 60 percent load factor.

[30]Statistics Canada, Air Carrier Financial Statistics, 1978. This average is based on the operating costs of some 169 Canadian "other commercial" (Levels III and IV) air carriers.

[31]Eckert, "Economics of Airport Demand," p. 436.

[32]J. Gibberd, "Direct and Indirect Subsidies in the Air Mode in Comparison with Other Modes of Transportation," Canadian Aeronautics and Space Journal, XXIII (January/February, 1977), p. 57.

[33]Z. Haritos, "Transportation User Charges: A Federal Perspective," The Logistics and Transportation Review, XV (No. 5, 1979), p. 582.

[34]Donald A. Hinks, "Transport Canada's User Charge Policy," The Logistics and Transportation Review, XV (No. 5, 1979), p. 626.

[35]Canadian Transport Commission, Research Branch, Intercity Passenger Transport in Canada: Analysis of the Consequences of Alternative Pricing and Network Strategies, by J. C. Rea, Research Report No. 254 (Ottawa: Canadian Transport Commission, 1975).

[36]Ibid., pp. 23-24.

[37]Canadian Transport Commission, Research Branch, Pricing and Subsidy of Air and Rail Passenger Transport, by P. M. Bunting, E. E. Johnston, A. Ray, and K. Mozersky, Research Report No. 246 (Ottawa: Canadian Transport Commission, 1976).

[38]Some of the rail traffic decline during this period was due to reduction in services.

[39]Transport Canada, Transportation Policy: A Framework for Transport in Canada, Summary report (Ottawa: Supply and Services Canada, 1975). See also, footnote 7, Chapter 4.

[40]Haritos, "Transportation User Charges," p. 578.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 Introduction

Transport Canada owns and operates the eight major international airports in Canada. More than one billion dollars has been invested in this transportation infrastructure. Further large investments have been and are being planned because of predicted traffic growth and changes in aircraft technology. Yet, airports are not fully utilized during a large part of the day. Traffic tends to peak at certain times, and it is these peaks that are accommodated by and define the size of the infrastructure. The aim of this thesis was to examine the utilization of existing excess capacity as an alternative to congestion of or expansion of existing facilities.

6.2 Summary

The characteristics of an airport were defined as a first step to making such an examination. An international airport can be viewed as a system which is composed of four subsystems. The two subsystems directly related to aircraft operations are the airfield and terminal building, and it is these which are the subjects for analysis. Aircraft operators can be grouped as commercial, private, and government. In terms of use, the commercial operators are the most important at international airports.

It was shown that international airports differ in size although each serves the same type of traffic. At each airport subsystem various levels of utilization occur throughout the day such that traffic peaks are in evidence. Movements, that is, landings and take offs are measures of use of the airfield subsystem; enplaned and deplaned passengers are measures of use for the terminal building subsystem. If peak traffic levels cause congestion, then airport administrators and users get together to plan additional facilities. The use of existing excess capacity is not formally considered as an alternative to congestion.

From an economist's point of view, the use of this method of planning does not produce an efficient allocation of resources. It has been suggested by transportation economists that economic efficiency can be optimized through the use of marginal cost pricing. While this method of pricing provides many benefits, there remains much controversy regarding the strictness with which it should be applied.

A simple economic model was developed in order to analyze the application of marginal cost pricing to airport subsystems. The model referred to an airport subsystem with two levels of daily demand which do not grow over time (are fixed). Costs were defined in terms of operating and capital expenditures, and with respect to negative externalities which arise from congested facilities.

It was shown that given two levels of demand which are independent (the firm-peak case), then two prices, one for the peak demand and one for the off-peak demand, will be required to maximize economic surplus. These prices would equal the short-run marginal cost of using the airport subsystem during each period. Long-run marginal cost is generally used as a pricing guideline when it is difficult to estimate short-run costs.

When demands are interdependent, a change in price for one time period will lead to a change in the demand for other time periods. An optimal pair of prices, say for peak and off-peak time periods, can be derived by analyzing the change in demands of both time periods due to changes in corresponding prices of both. Interdependent demands may lead to shifting peaks in which case congestion would merely be transferred in time if the peak period users were to bear all the additional costs associated with congestion.

One major criticism of strict marginal cost pricing is that it results in financial deficits when there are decreasing average costs per unit output. It has been suggested that value of service pricing be utilized, with some loss of efficiency, to generate additional revenue which would avoid the necessity of subsidizing airport users.

Pricing theory was compared with the current Transport Canada international airport pricing scheme. The first step in this comparison was to explain the nature of the current pricing system. It was shown that Transport Canada airport prices are aeronautical (aircraft related), non-aeronautical, and taxation (Air Transportation Tax). Aeronautical prices include subsystem user charges, and a concession fee on aviation fuel. Non-aeronautical prices include such items as rents and automobile parking fees. The Tax is levied on passengers on the basis of ticket price and trip destination.

Transport Canada's pricing policy for international airports calls for full cost recovery using a group approach. Revenues from high volume, low cost per unit output airports can be used to subsidize low volume, high cost per unit output airports where a group of airports have similar types of traffic. This method would really require differentiated prices for equivalent services at different airports, but the policy of Transport Canada for international airports is to have all charge the same prices.

In addition to this locational discrepancy between pricing policy and practice, it is also shown that there are other weaknesses in current pricing. Deficits in the airports' accounts are prevalent, and the need for additional revenue seems to have blinded policy makers to the need for changes in pricing practice which would lead to greater economic efficiency. There is no evidence to suggest that time-differentiated (peak) pricing schemes are being seriously considered. Current prices are not cost related, this fact having invited strong criticism from airport users. Also, prices are set to recover sunk costs which in theory need not be recovered. The existing simplistic application of equal prices at all airports at all times is not rational. "Equality of charge is economic only if there is equality of cost."[1]

There are strengths in current pricing which pertain to revenue generation. Value of service elements already exist in aeronautical prices, and non-aeronautical prices are geared to generate profits. Further, the group approach, if applied temporarily on an "infant industry" basis to assist growing airports, will be able to reduce or eliminate taxpayer subsidy, although this means that some user cross-subsidies will be maintained.

The evidence indicated that peak pricing should be applied to aeronautical prices at Transport Canada international airports. It was noted that the transition from current to peak pricing should lead to a shift in demand such that there will be an increase in social welfare (surplus) through the optimization of prices. Methods of peak pricing were described, and it was noted that although the estimation of users' costs (including delay costs) provides a sound method of calculating marginal cost prices, this approach has not been considered administratively feasible by airports.

The alternative practice has been to levy fixed charges during specific busy hours. A hypothetical example of this alternative method of peak pricing is presented in the context of Toronto International Airport. Methods of determining units of charge; defining peak, shoulder, and off-peak users; and allocating costs are discussed; and a sample set of prices is derived.

Expected implications and impacts of peak pricing on users and others are examined. Short-run peak prices would likely result in few changes by airlines because these operators have fairly inelastic responses to price changes, partly due to their own application of average cost pricing. Other commercial operators have higher price elasticity because much of their business is flown in the highly competitive short haul markets, so they could lose traffic to the airlines or to other transport modes. Many private aircraft operators would be forced to move to different time periods, or to other airports.

The impact of airport peak pricing on other modes of transportation can be expected to be small, although there may be some loss of airport traffic to surface modes, depending on price levels. It was also noted that planned general airport price increases (toward full cost recovery) which have been specified by current pricing policies would be substituted by peak prices which would be applicable to fewer users who would bear a similar total cost burden.

6.3 Conclusions

The work presented herein demonstrates the need for a more rational pricing structure for Transport Canada international airports. Specifically, it is recommended that peak pricing be introduced for the airfield and terminal building subsystems. This should tend to reduce demand during peak hours and thus smooth out the use of existing infrastructure. Moreover, it will lead to reductions in the amount of investment spending required due to the need for fewer expanded facilities.

While this work did not discuss growth in airport demand and changes in aircraft technology, these dynamic factors must be considered in practical applications of peak pricing. With growth in demand, additional facilities will be required, but the size of and timing of such investments can be determined in conjunction with peak pricing through the use of present value calculations.[2] This places importance on the knowledge, gained through forecasting, of expected demands.

There are two factors that tend to suggest that peak pricing could be applied successfully at Transport Canada international airports. First, since the government owns the airports, it can apply a consistent approach to its pricing policy and structure. Second, the policy for the transportation system in Canada visualizes a more rational and equitable pricing structure than is currently applied.

Further study to support and refine peak pricing for Canadian airports must be undertaken. The application of value of service prices, including the Air Transportation Tax, and the implications of a group approach to cost recovery are controversial issues that should be further analyzed. It should be determined if marginal cost pricing can be effective in a closed environment without wide application elsewhere; and as well, what ramifications it will have on airports in other countries and on the aircraft industry. Much work is yet to be done with regard to quantifying travellers' tastes and preferences for air travel. Finally, before the full effects of a revised airport pricing scheme can be determined, user charges must be developed for the extensive Canadian en route navigation system which is also owned by Transport Canada.

Footnotes to Chapter 6

[1] W. Arthur Lewis, Overhead Costs: Some Essays in Economic Analysis (New York: Augustus M. Kelley Publishers, 1970), p. 35.

[2] Michael G. Webb, Pricing Policies for Public Enterprises, MacMillan Studies in Economics (Tiptree, Essex: The Anchor Press Ltd., 1976), pp. 59-62.

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