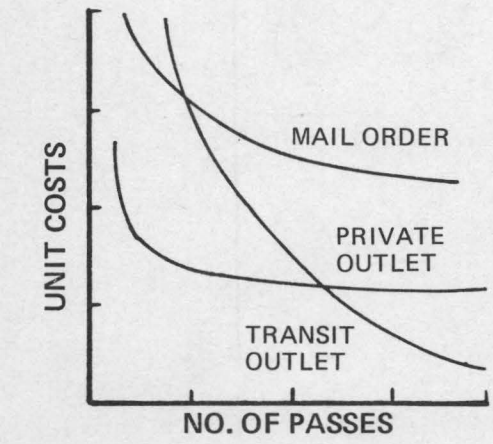
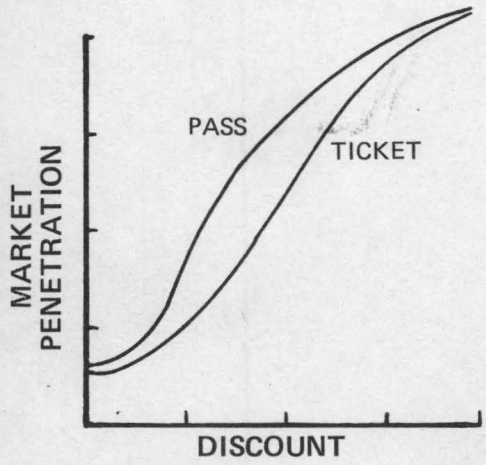
U.S. Department of Transportation
Urban Mass Transportation Administration
Office of Service and Management Demonstrations
Transit Services Division
Washington, D.C. 20590

Transit Fare Prepayment: A Guide For Transit Managers





Prepared By:
ECOSOMETRICS, Inc.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle

Transit Fare Prepayment: A Guide for Transit Managers

5. Report Date
January 4, 1983

6. Performing Organization Code

8. Performing Organization Report No.
RR 125-8

7. Author(s)
Patrick D. Mayworm and Armando M. Lago

9. Performing Organization Name and Address

Ecosometrics, Incorporated
4715 Cordell Avenue
Bethesda, Maryland 20814

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DOT-UT-80005

13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Urban Mass Transportation Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

14. Sponsoring Agency Code

15. Supplementary Notes
Pricing Policy Innovations Division, UPM-33
Office of Service and Management Demonstrations

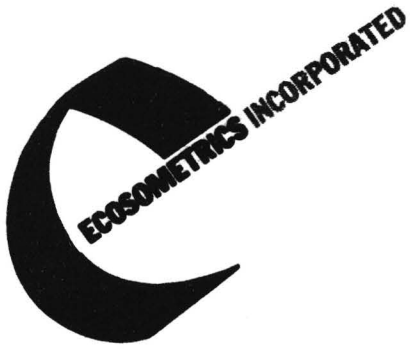
16. Abstract

Transit fare prepayment programs grew rapidly during the past decade with most transit companies today offering riders several prepayment options. The growth in these programs, however, has not been without its cost. The purpose of this manual is to provide transit managers with the information and tools necessary to make informed decisions on the design and pricing of fare prepayment plans.

Specifically, this manual presents information on the true benefits and costs of operating fare prepayment plans. Guidelines on selecting the appropriate plans and distribution methods are provided. More importantly, however, the manual presents guidelines on pricing fare prepayment plans in order to capture passenger revenues. A series of straightforward equations are also provided to assist the transit manager in estimating the impacts of changes in a fare prepayment program.

17. Key Words	18. Distribution Statement
fare prepayment, fares, transit pricing, fare collection costs, passes, tickets, tokens, bus operations	Available to the public through the National Technical Information Service Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	134	



Research Report 125-8

TRANSIT FARE PREPAYMENT: A GUIDE FOR TRANSIT MANAGERS

by

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January 4, 1983

Prepared for

Office of Service and Management Demonstrations
Urban Mass Transportation Administration
U.S. Department of Transportation
Washington, D.C. 20590

Under Contract DOT-UT-80005

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ABSTRACT

Transit fare prepayment programs grew rapidly during the past decade with most transit companies today offering riders several prepayment options. The growth in these programs, however, has not been without its cost. The purpose of this manual is to provide transit managers with the information and tools necessary to make informed decisions on the design and pricing of fare prepayment plans.

Specifically, this manual presents information on the true benefits and costs of operating fare prepayment plans. Guidelines on selecting the appropriate plans and distribution methods are provided. More importantly, however, the manual presents guidelines on pricing fare prepayment plans in order to capture passenger revenues. A series of straightforward equations are also provided to assist the transit manager in estimating the impacts of changes in a fare prepayment program.

PREFACE

This manual is based on the research performed over several years by numerous agencies and organizations. The purpose of this study was to condense the stacks of reports and papers on fare prepayment into a manual that could easily be used by transit managers who were interested in implementing or changing a fare prepayment program. Thus, every attempt was made to provide the reader with only the most useful information, as well as full documentation of the sources of information from which this manual is based.

The manual is divided into seven chapters, a bibliography, and three appendices. Each chapter addresses a separate issue of fare prepayment (e.g., costs, methods of distribution, pricing). Since each chapter was written to stand alone, the reader can proceed to the chapter of particular interest without having read the previous chapters.

In addition to a bibliography, the manual includes three appendices. Appendix A provides a glossary of the major terms used throughout the report. Appendix B summarizes the ten demonstration projects developed by the Office of Service and Management Demonstrations of the U.S. Urban Mass Transportation Administration, highlighting what we have learned or expect to learn. Finally, Appendix C provides the mathematical derivations of the series of equations presented in Chapter 7.

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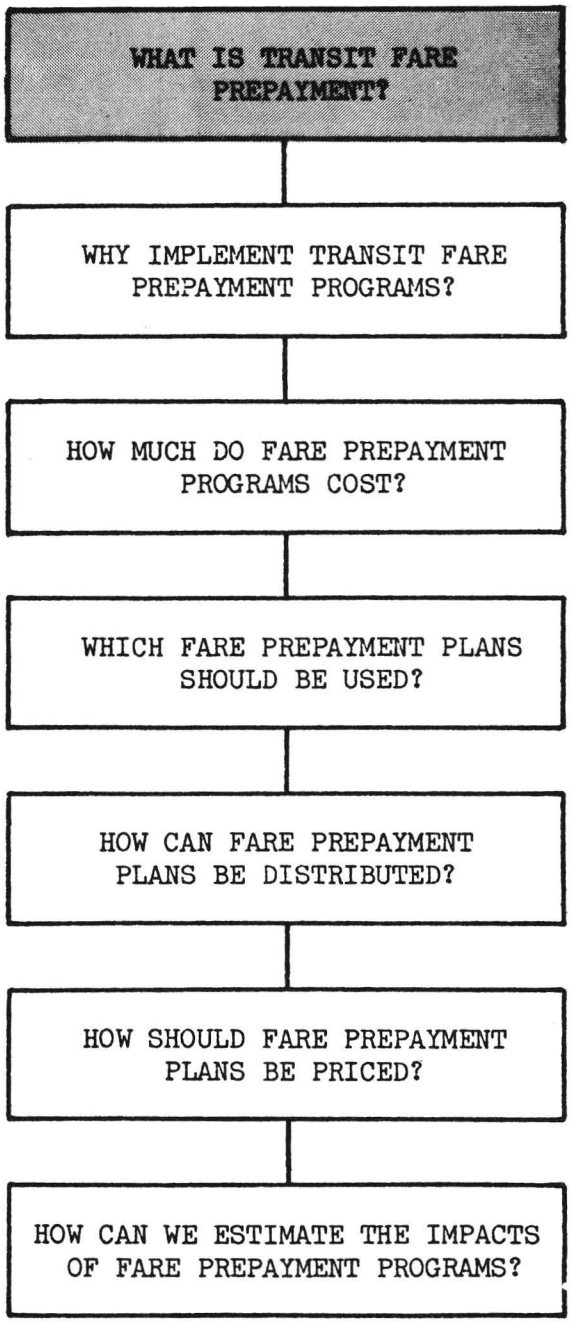
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HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?
HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

1

WHAT IS TRANSIT FARE PREPAYMENT?

Generally referred to as prepaid passes, commuter tickets, and flash passes, transit fare prepayment has been broadly defined as any method of fare payment other than paying cash at the time a trip is taken.[1] Thus, fare prepayment involves purchasing evidence that can later be verified as a substitute for cash in payment for transit rides. Automatic fare collection (AFC), ticketing and billing, and credit card billing are alternative forms of fare payment but involve the post-payment of fares as opposed to fare prepayment.[2]

This chapter introduces the reader to the basic characteristics of fare prepayment programs. Specifically, the chapter describes the features of fare prepayment plans and the elements that make up fare prepayment programs. The three sections presented in this chapter include:

- Fare Prepayment Categories
- Features of Fare Prepayment Plans
- Features of Fare Prepayment Programs

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[1]See W.R. Hershey, et al. Transit Fare Prepayment. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. The Huron River Group, Inc., Ann Arbor, Michigan. August 1976.

[2]Fare post-payment systems are not discussed in this document only because they have had little application in bus transit companies. Research development over the past 10 years on credit card post-payment methods, however, has opened new opportunities for more convenient and equitable pricing policies and for monitoring transit demand.

Before proceeding, it is perhaps useful to begin by providing definitions of terms that are used extensively throughout this report. Fare prepayment categories refer to the generic classifications of fare prepayment in use today (e.g., tickets, tokens, passes). The categories differ primarily in their physical form and design. A fare prepayment plan refers to the category of fare prepayment used, along with the restrictions placed on its usage, such as period of validity and quantity of trips (e.g., off-peak day pass, 10-trip ticket book). In the chapters on costing, the authors refer to the item purchased by an individual as a fare prepayment instrument. Thus, while a roll of 20 tokens and a monthly pass are separate fare prepayment plans, each item can be referred to as an instrument for costing and accounting purposes. Finally, this report defines a fare prepayment program as the combination of fare prepayment plans offered by a transit company, along with the operating and administrative activities involved in the production, distribution, and sales of the plans.

FARE PREPAYMENT CATEGORIES

The most common categories of fare prepayment in use today include tokens, tickets, punch cards, permits, and passes. These categories vary primarily according to boarding procedure and period of validity. Since, for example, punch cards and tickets in one transit company may be referred to as passes in another company, it is important that specific definitions be applied to each fare prepayment category so that the guidelines presented in this document can be clearly understood. A description of the five basic fare prepayment categories is presented below.

Tokens

Tokens are metal, coin-like disks that are dropped into a turnstile at the entrance to a rapid transit station or into a farebox on a transit vehicle. They are the fare prepayment form most similar to cash since they resemble coins. Tokens are also the only form of fare prepayment that must be minted instead of printed. Generally made of brass or less expensive aluminum, tokens range in size from 0.65 to 1.51 inches in diameter.

Unlike other forms of fare prepayment, tokens are reusable and can last for an indefinite period of time. They usually do not expire unless a fare change necessitates replacing all tokens in the system. This is done primarily to avoid hoarding of tokens prior to a fare change.

Tickets

Tickets are cards or pieces of paper that are given to the conductor or dropped into the farebox when a trip is taken. In self-service systems, tickets are validated at wayside locations or on-board the transit vehicle by the passenger. The validated ticket is kept by the passenger and then shown to the inspector on request. Some tickets have stubs that are torn off by the driver and returned to the passenger as a receipt.

Each ticket is usually good for one ride or for each zone in which a trip is taken. In systems with multiple fare categories, tickets are often available in a variety of demonstrations. In addition, tickets are usually sold in books of 10, 20, 40, or 45 tickets, in strips of 10 or 12, or individually from a ticket roll. Tickets usually do not carry expiration dates. One problem with tickets is that they may jam farebox machines that are not specifically designed to handle this type of fare prepayment plan.

Punch Cards

Punch cards are cards or slips of paper with areas in which holes are punched by the driver or conductor -- an operation that increases dwell time and thereby operating costs. Printed usually in the size of a credit card, punch cards are functionally equivalent to most tickets and tokens. One hole is punched per ride or per zone in which a trip is taken. When the specified number of holes has been punched, the card no longer has any value. Punch cards have often been called "punch tickets", "multiple-ride tickets", "commutation tickets", and "punch passes".

Permits

Permits are wallet-size cards that passengers display at the time of boarding. The permit allows the individual to travel at a reduced rate until the permit expires. A photograph or another method of identification on the permit is usually used to limit use of the card to the intended person. Since permits are usually used for long periods of time, the cards are often made of heavy paper stock and coated in plastic.

Permits are ideal for targeting lower fares to special groups, such as students, the elderly, and the handicapped. For these groups, the permit is provided for a nominal fee or free of charge and valid for one year or longer. However, recently there has been a renewed interest in monthly permits for the general population as an alternative to the monthly pass because of their revenue potential. A discussion of the revenue potential of permits is presented in Chapter 2.

Passes

Passes are similar to permits in appearance but generally do not include the photograph of the user because of the cost. Like permits, passes must be displayed to the driver when boarding. However, passes differ from permits in that the passenger rides as many times as desired without paying any additional fee until the pass expires. This affords the user the convenience of not having to carry cash to make a trip. The period of validity of passes can vary considerably. The most common passes include daily, weekly, monthly, semester, and annual passes. In some cases, passes for privileged users have no expiration date.

In transit companies with zone fare structures, passes specific to zones can be made available. However, since most passenger trips occur in the central zone of zone fare systems, a central zone pass can be used as a permit for trips into the outer zones. Thus, differential fares can be charged with only one version of the prepayment instrument.

FEATURES OF FARE PREPAYMENT PLANS

There are numerous features of fare prepayment plans aside from form and boarding procedure as shown in Table 1-1. Designing fare prepayment plans essentially involves determining the proper combination of features, including the category of fare prepayment, period of validity, quantity of rides, pricing policy, and other restrictions on usage. In particular, the proper pricing policy of fare prepayment plans and their ability to raise revenues by taking advantage of the different fare elasticities among transit users has largely been unexplored. Chapter 6 of this document focuses specifically on the pricing issue.

Table 1-1: SELECTED FEATURES OF TRANSIT FARE PREPAYMENT PLANS

Fare Prepayment Category	Period of Validity	Quantity of Rides	Pricing Policy	Time of Day or Week	Client Group	Select Transit Services
Trip Limited • Tokens • Tickets • Punch Cards	Usually Provided Without Expiration Date	• 1 trip • 10 trips • 20 trips • 40 trips • 40+ trips	Explicit Discount Policy (Discount independent of usage, with larger plans offering larger discounts)	• Peak Hours • Off-Peak Hours • A.M. or P.M. Peak with Off-Peak Hours • Weekends • Weekdays • Unrestricted	• General Public • Commuter • Shopper • Student • Elderly and Handicapped • Tourist • New Resident • Other Group	• Multi-Modal • Mode-Specific • CBD-Service • Express Service • Park & Ride Service • Other Special Service
Time-Limited • Permits • Passes	• Daily • Weekend • Weekly • Monthly • Semester • Annually • Permanent	Usually Allowing an Unlimited Quantity of Rides	Implicit Discount Policy (Discount dependent of usage, with longer plans offering larger discounts)			

Selecting the Appropriate Fare Prepayment Instrument

Five generic categories of fare prepayment were identified earlier in this chapter. These include: tokens, tickets, punch cards, permits, and passes. Since these categories differ primarily in form and boarding procedure, selecting the appropriate category essentially involves making trade-offs among costs, boarding and operational impacts, and system and user needs. The principal advantages and disadvantages of all five types of fare prepayment categories are discussed in detail in Chapter 4.

Selecting the Appropriate Period of Validity, Quantity of Rides, and Pricing Policy

As shown in Table 1-1, two general groups of fare prepayment plans exist:

- Trip-limited plans specify the quantity of trips that can be taken and are generally valid for an unlimited period of time. The price per trip is explicitly known. Tokens, tickets, and punch cards are examples of the fare prepayment categories that fall into this group.

- Time-limited plans specify the time period during which trips may be taken. Since generally there is no limit on the quantity of trips that can be taken, the discount level is implicitly known; that is, the average price per trip depends on the frequency of transit usage. Passes and permits fall into this group.

Thus, once the fare prepayment category has been chosen, the fare prepayment manager must specify the period of validity during which transit trips may be taken and/or the quantity of trips that may be taken. Selecting the appropriate limitation on the use of the fare prepayment plan depends primarily on the market for which the plan is being designed. Guidelines on selecting fare prepayment plans are provided in Chapter 4 of this document.

Developing a pricing policy for trip-limited plans, such as tickets and punch cards, is relatively straightforward since the revenue generated per prepaid trip is explicitly known. Thus, prices and discounts can be clearly set.

Time-limited plans, however, require much more consideration when developing a pricing policy since passes and permits usually do not have set limitations on usage. As more trips are taken with the instrument, the average discount per trip -- and thus the potential revenue loss -- will increase. A more thorough discussion of this important issue is presented in Chapter 6.

Selecting Other Appropriate Restrictions on Usage

Fare prepayment plans very often go beyond simple limitations on use and actually restrict the instrument to specific periods of the day, specific client groups, and selected transit services. These restrictions are often set in order to better target the market for which the fare prepayment plan is designed.

Time-of-day restrictions are usually placed on a fare prepayment plan in order to affect demand and revenues. Designed in conjunction with the pricing policy, off-peak plans attempt to shift non-essential rides from the peak hours to the less expensive off-peak period. These peak/off-peak distinctions may also be differentiated by trip purpose. Commuting trips, for example, are usually taken during peak hours, so any plan restricted from the peak hours will apply mostly to non-work travelers. Although shopping trips are usually taken during off-peak hours, some shoppers add traffic to the evening rush hour. Special fare prepayment plans with restrictions on the evening peak may encourage many shoppers to travel earlier in the afternoon.

Transit fare prepayment plans restricted to specific client groups have often been applied to university and social service programs. For example, most off-peak, half-fare plans have been designed for the elderly and handicapped to help comply with the off-peak, reduced-fare program mandated in the Urban Mass Transportation Act of 1964, as amended. Special passes are available to tourists in Los Angeles at a cost of one dollar per day.

Finally, transit fare prepayment plans may be available only to those using specific transit services, such as on buses operating only in the central business district or for park-and-ride service. The most common service restriction involves passes designed exclusively for express service.

FEATURES OF FARE PREPAYMENT PROGRAMS

A fare prepayment program, as defined in this document, is the combination of fare prepayment plans offered by a transit company, as well as the operating and administrative activities involved in the printing, marketing, distribution, and sales of these plans. Just as a fare prepayment plan essentially involves selecting the appropriate fare prepayment category and its limitations and restrictions, a fare prepayment program essentially involves making the following decisions:

- selecting the appropriate combination of plans,
- selecting the appropriate sales distribution methods, and
- selecting the appropriate outlet delivery methods.

The most common features of fare prepayment programs are presented in Table 1-2 and described below.

Table 1-2

SELECTED FEATURES OF TRANSIT FARE PREPAYMENT PROGRAMS

Fare Prepayment Plan Combinations[a]	Sales Distribution Methods	Outlet Delivery Methods
• COMBINATION A: Monthly Pass, 10-Trip Ticket Book, and Daily Pass • COMBINATION B: Weekly Pass and 40-Trip Ticket Book • COMBINATION C: Semester Pass, Monthly Pass, and 20-Token Roll	• On-Board Transit Vehicle • Over-the-Counter - Public Sales Outlets - Private Sales Outlets - Employer Outlets • Direct Mail Programs • Telephone Order Programs • Bank Transfer Payments • Vending Machines	• Transit Staff Delivery • Courier Service Delivery • Certified Mail Delivery

[a]Hypothetical combinations of fare prepayment plans; essentially there is an infinite number of plan combinations from which to choose.

Selecting the Appropriate Combination of Plans

Attention must be given to balancing the combination of plans offered. In some cases, fare prepayment plans can duplicate one another and lead to higher than necessary administrative costs. Punch cards worth 20 one-way trips and 10-trip ticket books, for example, do not complement one another since both are

essentially designed for the same market. For most transit companies, two or three basic fare prepayment options will cover the range of passenger needs if the plans are properly priced relative to one another. A fare prepayment program with too many plans may prove difficult to administer and confusing to the public. As a general rule, a transit company should provide one short-term, trip-limited plan for infrequent users and one long-term, time-limited plan for frequent transit users. A more detailed discussion on this subject is presented in Chapter 4.

Selecting the Appropriate Sales Distribution Methods

Just as transit managers must select the appropriate combination of fare prepayment plans, they must also select the appropriate distribution methods to maximize fare prepayment sales at a minimum cost. Transit fare prepayment plans can be sold to the public in several ways varying from sales on board a transit vehicle to over-the-counter sales at transit-operated, public, and private outlets. New methods of sales distribution have recently emerged, such as direct mail order and telephone order; however, few transit companies employ these sales methods today. In the near future, other methods of sales distribution may be used by transit companies, such as automatic transfer payments and vending machine sales. These methods, as well as traditional sales distribution methods, are currently being tested and evaluated in the Federally-sponsored demonstration project designed by Ecosometrics, Inc. for the Sacramento Regional Transit.[1] The principal sales distribution methods available to transit operators are discussed in Chapter 5.

Selecting the Appropriate Delivery Methods

If fare prepayment plans are directly sold to the public from over-the-counter sales outlets, then transit managers must decide how new supplies of fare prepayment plans are going to be delivered to each outlet on a timely basis. A fare prepayment manager must choose, therefore, the safest, most reliable, and least costly method among several delivery options. The three most widely used delivery methods include:

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[1]See Patrick D. Mayworm, Armando M. Lago, and Beth F. Beach. A Comprehensive Demonstration of Distribution Systems for Transit Fare Prepayment: The Sacramento Regional Transit Project. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Ecosometrics, Inc., Bethesda, Maryland, February 11, 1981.

- transit staff delivery,
- courier delivery, and
- certified mail delivery.

Transit staff delivery is perhaps the safest and most reliable method of getting new fare prepayment plans to sales outlets. It is also very costly. Staff labor and overhead charges must be covered along with the cost of owning and operating a service vehicle.

Courier delivery service is also a reliable method of transporting plans to sales outlets. The cost for such service is reasonable, especially if distances between outlets are great. Most courier services will charge a fixed rate per package regardless of the quantity of instruments within the package. The rate will usually depend on the number of outlets served during each delivery. In very large urban areas, courier companies will often divide the region into several large zones with the per package delivery charge increasing with the distance between zones.

The third and final method of fare prepayment delivery is the U.S. Postal Service. Packages sent certified mail generally arrive on time. Although it is not recommended that high volume outlets be serviced by certified mail, this delivery method is ideal for very low volume sales outlets. Moreover, the cost of sending a package by certified mail increases with package size since postage and envelope costs increase in proportion to volume. A more detailed discussion of alternative delivery methods is presented in Chapter 5.

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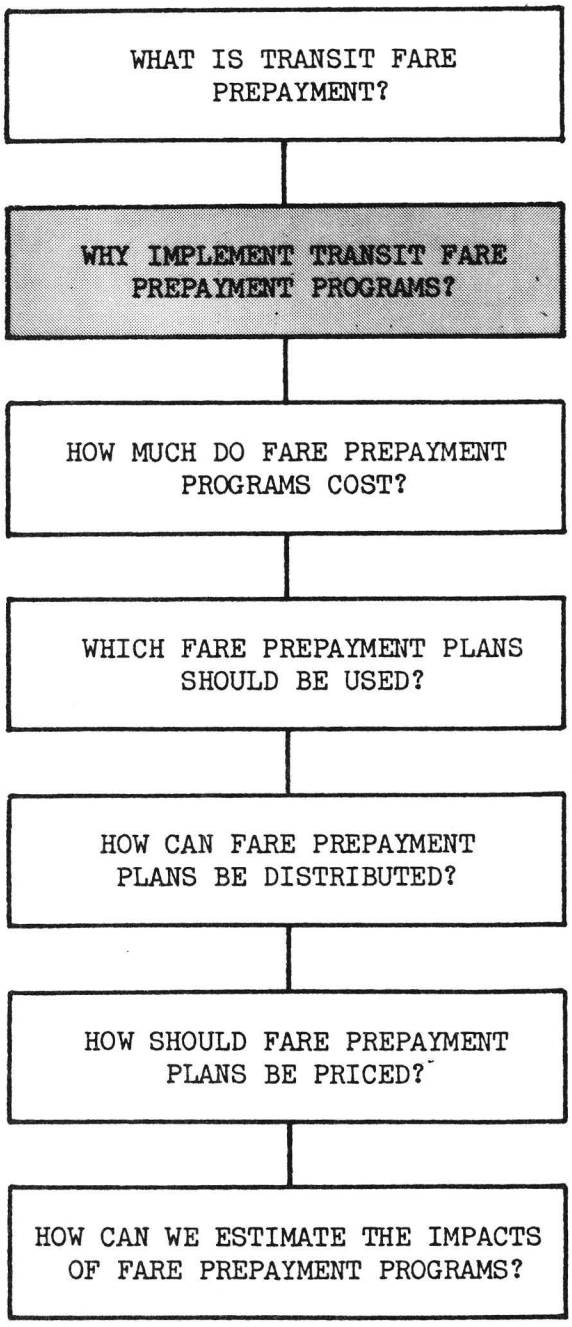
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2

WHY IMPLEMENT TRANSIT FARE PREPAYMENT PROGRAMS?

Transit fare prepayment programs have been developed and implemented for many different reasons. Most reasons refer to some aspect of marketing, indicating a general desire to increase ridership and provide a convenience to transit users. Although these are desirable objectives that have to some extent been met in most programs, they have not been met without their cost. Encouraging riders to purchase fare prepayment plans has generally been done through consumer marketing and price discounting, which often result in significant operating cost increases and revenue losses. As we shall see, offering undue discounts over the cash fare results in huge revenue losses by encouraging existing cash patrons to switch to fare prepayment.

More importantly, there are other real benefits that flow from fare prepayment programs aside from user convenience that can, in fact, improve the financial position of the transit company if attention is paid to the program's design and management. Thus, fare prepayment can be considered a cost-effective operational and marketing tool if the program is designed to take full advantage of the opportunities for reducing operating costs, and if passenger revenues are not lost due to improper pricing.

The best documented evidence on the benefits of fare prepayment programs is presented in this chapter. Contrary to popular belief, the real benefits of fare prepayment programs are not derived from increased ridership and passenger revenues -- which are seldom achieved -- but rather from potential operating cost savings, improvements in cash flow, and passenger convenience. Specifically, this chapter presents evidence that the primary benefits of fare prepayment programs include:

- savings in coin handling costs - Lower cash volumes resulting from increased use of fare prepayment plans reduce the costs associated with sorting and counting coins and dollar bills, repairing fareboxes, and reducing the propensity for theft.

- savings from reduced dwell time - Boarding time can be significantly reduced as the proportion of fare prepayment passengers increases. This benefit depends on management's ability to translate faster boardings into operating cost savings.

- interest on advanced cash flow - Interest payment can be a significant benefit since revenues are collected in advance of services being delivered. However, these benefits are only achieved if sales outlets return and deposit revenues promptly.

- increased user convenience - Fare prepayment plans do provide transit users with an alternative to cash fare payment. As the average transit fare approaches one dollar, riders will find fare prepayment an even more convenient method of paying for transit service.

In addition to these benefits, transit fare prepayment can offer the transit company and its users minor benefits. These secondary benefits include:

- generation of off-peak travel - Although the generation of new transit riders is rare, a significant increase in the number of off-peak rides by previous transit users does occur. Peak period travel is generally unaffected unless large discounts are offered.

- increased revenues due to price discrimination - Because fare prepayment plans can be tailored to specific market groups, they offer transit management the ability to charge different prices for different markets. Thus, management can increase revenues by charging groups more along the lines of what they are willing to pay.

- improved image of the transit company - By meeting market demand, fare prepayment plans can help improve the image of the transit company in the community. Innovative plans and distribution methods designed for different markets can assist the transit company in creating a positive public image.

This chapter presents facts and figures on these and other program benefits, thereby indicating what one should expect, or not expect, from fare prepayment. This review of fare prepayment benefits is divided into three sections, namely;

- operating cost benefits,
- revenue generation benefits, and
- other benefits.

A summary of the principal fare prepayment program benefits is provided at the end of the chapter.

In order for the reader to put these benefits in some perspective, the authors have chosen to compare the estimated monthly benefits of fare prepayment to actual program costs at Tri-Met in Portland, Oregon, a medium-sized transit company. Tri-Met was chosen for this comparison because of its size, the high quality of data available, and the range of fare prepayment plans available. The estimated monthly benefits at Tri-Met are presented in this chapter, while the estimated costs are presented in Chapter 3. The comparison of benefits to costs is presented at the end of Chapter 3.

OPERATING COST BENEFITS

Transit fare prepayment programs can help reduce operating costs by lowering cash handling and cash management costs, reducing boarding times, and shifting non-essential ridership to off-peak hours. The potential operating cost savings in these three areas are reviewed below.

Benefits from Savings in Coin Handling Costs

Fare prepayment plans may result in reduced coin handling costs for a transit company. The lower cash volumes that result from increased penetration of fare prepayment plans reduce the costs of sorting and counting coins and dollar bills, the costs of repairing fareboxes, and the propensity for theft. In a recent review of its fare collection costs, SCRTD in Los Angeles estimated that it spends over $2.7 million annually to collect and process cash fares.[1] This translates into an average coin handling cost of 1.58¢ per cash boarding. If the marginal cost savings due to reductions in coin handling is equal to the average coin handling cost, then a transit company can be expected to save as much as $0.74 per monthly pass sold assuming 47 boardings per month, which is the average trip rate in Portland.[2]

Coin handling cost savings obviously will not occur for tokens or tickets that must be dropped into fareboxes and sorted and separated on a daily basis.

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[1]Southern California Rapid Transit District (SCRTD). "An Analysis of Revenue Collection Costs, FY '80-'81." SCRTD Operations General Department, Los Angeles, California, October 1981.

[2]Tri-Met. "Users' Guide: The Quarterly Line Performance Report." Unpublished internal working document. Portland, Oregon. Winter 1981.

Consequently, savings in coin handling costs can only occur in programs that effectively divert cash users to pass or punch card use. Tri-Met in Portland, however, will soon enjoy significant savings in coin handling costs even with its ticket program as the company moves toward complete self-service fare collection.

Benefits From Reductions in Dwell Time

Since over half of a transit company's operating cost is directly affected by the average transit vehicle speed, operating costs can be saved by reducing boarding times. The faster buses travel, the higher the system's productivity. A 1976 study of several upstate New York transit companies showed that an increase in the average transit vehicle speed of one mile per hour could reduce total operating costs 10 to 18 percent.[3]

One way of increasing vehicle speed is to reduce passenger boarding times through fare prepayment. For example, boarding times for the entire Ottawa - Carleton Transpo system diminished as much as 25 percent as a consequence of the monthly pass program.[4] Based on American sources, Table 2-1 indicates that a savings of two seconds in boarding times can be achieved by having riders use passes, permits, and tickets in lieu of conventional cash fares; a smaller savings of 1/2 second is achieved with tokens.[5] Punch cards, however, actually increase average boarding times because they require driver validation. For this reason, punch cards should be avoided.

Reductions in dwell time will result in reduced run times for transit vehicles and lower demands for driver hours, particularly if bus schedules are revised accordingly. Since the average driver wage and fringe benefit rate in

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[3]See William C. Holthoff and Robert Knighton. "Cost Increases, Cost Differences, and Productivity of Transit Operations in New York State." Planning Research Unit, New York State Department of Transportation, Albany, New York. August 1976.

[4]Bureau of Management Consulting. The Ottawa Bus-Pass System: An Examination of Effects. Prepared for the Urban Transportation Research Branch, Canadian Surface Transportation Administration, Transport Canada. Montreal, Quebec. September 1977.

[5]These savings in boarding times are conservative when contrasted with possible savings in zone fare systems. See, for example the figures on boarding times in zone fare systems presented in Highway Research Board. Highway Capacity Manual. Highway Research Board Special Report No. 87, Transportation Research Board, Washington, D.C. 1965, p. 346.

Portland in 1981 was $16.35,[6] the potential benefit of boarding time savings may be estimated as 0.9¢ per prepaid pass passenger boarding or approximately half that amount for tickets.[7] Since the average pass user in Portland takes 47 trips per month, the cost savings potential due to the monthly pass alone is $0.42 per monthly pass sold.

Table 2-1

BOARDING TIMES AS A FUNCTION OF FARE PREPAYMENT METHOD

Fare Prepayment	Loading Time (in seconds)
Fare Prepayment	1.5 - 2.5
Single-Coin Fare and Token	2 - 3
Multiple-Coin Fare	3 - 4

Source: Wilbur Smith Associates. Bus Use of Highways: Planning and Design Guidelines. NCHRP Report No. 155, Transportation Research Board, Washington, D.C. 1975, p. 4.

Benefits From Shifting Peak Period Ridership

Although the previous items represent the bulk of the conventional cost savings from fare prepayment, other cost savings are still possible if prepayment plans have off-peak provisions. In fact, the potential cost savings can be demonstrated by focusing on the differences in cost and demand behavior during peak and off-peak periods. Total costs per vehicle hour during off-peak periods are at least 30 to 50 percent lower than during the peak period.[8] Also, fare elasticities of demand during off-peak periods are two to three times larger than during the peak period.[9]

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[6]Personal Communication with Tri-Met Official.

[7]Reducing dwell time also reduces fuel consumption. If fuel costs are added to the potential labor benefit, total cost savings would increase another 20-25 percent.

[8]See Herbert Mohring. "Optimization and Scale Economies in Urban Bus Transportation." American Economic Review. September 1972.

[9]See Patrick Mayworm, Armando M. Lago, and J. Matthew McEnroe. Patronage Impacts of Changes in Transit Fares and Services. Research Report 135-1. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Ecosometrics, Inc., Bethesda, Maryland, September 3, 1980.

In practice, however, the peak to off-peak cross elasticities of demand are so low for cash fares (e.g., +0.14 in Denver and +0.03 in Trenton, New Jersey), that the potential for large shifts of peak passengers to off-peak hours is small. In fact the more common effect of reduced-fare, off-peak plans is to attract off-peak cash riders rather than to shift ridership from the peak to off-peak periods. Some trip diversion is possible in cities where an appreciable number of non-work trips are taken during the peak period.

In order to test the potential for reducing peak demand and, thereby, peak period operating costs, Ecosometrics, Inc. designed two Federally-sponsored fare prepayment demonstrations in Tucson, Arizona and Duluth, Minnesota.[10] The Tucson project, which tested all-day and off-peak semester passes and 20-trip punch cards for college students, found that peak/off-peak pricing was effective in reducing morning transit usage by students. By charging 20 percent less for the off-peak options, SunTran was able to reduce the proportion of daily student travel occurring during the morning rush hour from 25.5 percent, before the off-peak options were offered, to 14.9 percent.

The Duluth demonstration involved selling differentially-priced (i.e., peak/off-peak) monthly passes to employees of firms adopting flexible work hour programs. The full-fare monthly pass was good at all time periods of the day, while the reduced-fare pass was restricted from only a one-half hour period of the morning peak. It was hoped that the short time restriction and the price differential would provide the incentive for some peak period transit commuters to slightly adjust their work trip schedule. Preliminary results of this on-going demonstration have shown that a small, but significant impact was felt on morning peak demand. However, the shifts were too small to allow the Duluth Transit Authority to adjust its peak period schedule.

REVENUE GENERATION BENEFITS

There are two specific ways in which fare prepayment programs can increase operator revenues. The first benefit is from the interest that can accrue on

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[10] See Patrick Mayworm and Armando M. Lago. "Rationale and Project Description of the Proposed Second Phase Student Transit Fare Prepayment Demonstration in Tucson, Arizona." Unpublished memorandum to the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Ecosometrics, Inc., Bethesda, Maryland. October 28, 1980; and Patrick Mayworm and Armando M. Lago. Demonstration Plan for the Variable Work Hours/Employee Pass Demonstration Duluth, Minnesota. Research Report 125-4. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Ecosometrics, Inc., Bethesda, Maryland. May 30, 1980.

the advanced payment of fare prepayment revenues. Another benefit is derived from the increased revenues flowing from properly priced fare prepayment plans.

Benefits from Interest on Advanced Cash Flow

One positive feature of fare prepayment plans is that fares are collected in advance of services being delivered. This improved cash flow from prepayment reduces the financing requirements of the transit company, requirements usually met by a combination of funds from municipal taxes and debt obligations. The improved cash flow thereby results in benefits of interest accruals to the transit operator.

Assuming a uniform daily trip rate per pass holder for the purpose of normalizing trip rates across all plans, and further assuming that passes are purchased the day previous to their use and revenues are deposited on the next day, the interest cash accrual may be approximated by the expression:

$$I = (0.5)(\text{Prepayment Price})(\text{Days} - 1.0)(i/365)$$

where:

I = interest accrual per fare prepayment instrument sold;

Prepayment Price = price or cost of the fare prepayment instrument to the user;

Days = number of days covered by the plan, assuming 30 days for monthly passes, 15 days for 20-trip tickets, and 7.5 days for 10-trip tickets and weekly passes;

i = annual interest rate corresponding to the transit company municipal bond rate

i/365 = daily interest rate

To provide an indication of the range of benefits from interest accruals that can flow from the advance deposit of fare prepayment revenues, Table 2-2 presents estimates of interest that can be earned on different fare prepayment plans.

Table 2-2

BENEFITS PER FARE PREPAYMENT INSTRUMENT SOLD FROM INTEREST ACCRUALS ON ADVANCED CASH FLOW
(Based on Adult Base Fare of $0.65)

Prepayment Plan	Price Per Instrument	Municipal Borrowing Rate 12%	10%	8%
Weekly Pass and 10-Trip Tickets	$ 6.50	$0.007	$0.006	$0.005
20-Trip Tickets	13.00	0.030	0.025	0.020
Monthly Pass	26.00	0.124	0.103	0.083
Semi-Annual Pass	156.00	4.590	3.825	3.060

Source: Calculations by Ecosometrics, Inc.

As illustrated in Table 2-2, the benefits from interest accruals on the advanced cash flow from fare prepayment sales begin to become appreciable for monthly passes and for very long-term plans. However, it must be recognized that for these potential benefits to be achieved, outlets must return the funds from fare prepayment sales promptly; that is, funds must be transferred bi-weekly or at the most within a week after sales. This requirement is often ignored when designing fare prepayment distribution methods.

Benefits From Increased Revenues Due to Price Discrimination

One of the advantages of fare prepayment plans is that they can be designed for specific transit markets. For this reason, fare prepayment plans have the potential for increasing revenues through discriminatory fare policies. In the context of transit pricing, price discrimination refers to the fact that an identical service may be priced differently to reflect differences in demand characteristics, such as trip rate, trip purpose, and income. This deviation from single fare pricing requires two main conditions which can be met by fare prepayment, namely:

- the preclusion of resale, since otherwise riders in the low fare market could resell passes or tickets to those in the high fare market, and
- the ability to divide transit riders according to their elasticities of demand.

In order for fare prepayment programs to be effective in increasing passenger revenues, a transit company must be able to identify unique transit markets and design and price fare prepayment plans for these markets with the intention of capturing more revenues. Unfortunately, the revenue potential of fare prepayment plans has been largely ignored by many transit companies. This is partly due to the fact that little is known about the elasticities of demand for fare prepayment. The scant information available shows that pass riders are more inelastic than cash fare or ticket riders, reflecting the fact that pass users are frequent riders who, like commuters, exhibit low fare elasticities of demand. In support of this view, a British study of passenger demand presents data from Paris, France showing a price elasticity of -0.14 for monthly passes compared to -0.20 for adult single tickets.[11] This same study also quotes from a Midland Red Bus Company study in Great Britain that estimated a fare elasticity of -0.10 for passes contrasted to -0.32 for adult single tickets.

Examples of monthly pass elasticities that have been estimated here in the U.S. include values of -0.36 for Jacksonville[12] and -0.18 to -0.38 for Sacramento employer-promoted monthly pass program.[13] Although these elasticity estimates are reasonable, the econometric demand work conducted on pass programs has failed to analyze passes as rate structures. Thus, while we can assume that the price elasticities of demand for trip-limited plans (i.e., tickets and tokens) are generally close to those found for different market groups paying cash fares, the elasticities of demand for riders using pass plans may be lower reflecting economic concepts akin to income elasticities of demand.[14]

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[11]Bly, P.H. The Effect of Fares on Bus Patronage. TRRL Laboratory Report 733. Department of the Environment, Transport and Road Research Laboratory, Crowthorne, United Kingdom, 1976.

[12]Charles River Associates, Inc. Jacksonville Fare and TFP Study. Preliminary Report. Prepared for the Transportation Systems Center, U.S. Department of Transportation. Charles River Associates, Inc., Boston, Massachusetts. April 1978.

[13]Elizabeth Page. "Factors Influencing the Choice Among Transit Payment Methods: A Study of Pass Usage in Sacramento, CA." Paper presented at the 60th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1981.

[14]For more information see: Armando M. Lago and Patrick D. Mayworm. "Economics of Transit Fare Prepayment: Passes." Transportation Research Record 857. Transportation Research Board, Washington, D.C., 1982.

OTHER BENEFITS

In addition to the benefits from operating cost savings and possible revenue increases, transit fare prepayment plans provide other benefits. For example, they make the payment of fares more convenient for users, they generate off-peak ridership, and they can improve the image of the transit company in the community. These and other benefits are briefly discussed in this section.

Benefits From User Convenience

In the late 1960's when most transit companies changed to "exact fare" policies, many companies also introduced fare prepayment programs to offset the users' inconvenience of having to produce the exact change. For example, AC Transit in Oakland, California began selling ticket books by mail shortly after its exact fare program started. Before implementing its exact fare plan in 1969, SCRTD in Los Angeles distributed a leaflet entitled, "How to Make Exact Fare Convenient." The leaflet described the various prepayment forms available as alternatives to cash -- tokens, tickets, monthly passes, commuter punch cards, and senior citizen permits.[15]

The fact that transit fare prepayment riders enjoy the benefits of increased convenience can hardly be argued. This convenience is demonstrated by the fact that undiscounted ticket and punch card programs sometimes achieve penetration rates of ten percent of all transit trips.[16] In Portland, Oregon, for example, Tri-Met sells over 32,000 ticket books each month at no discount over the equivalent cash fare. However, it is interesting to note that infrequent transit users sometimes prefer cash because it is more convenient than carrying a ticket or pass. Low-income riders, the elderly, and the young also prefer cash or short-term fare prepayment plans, even when other plans are offered at a discount, because they often cannot afford long-term plans. Thus, the convenience of fare prepayment plans is a benefit that regular and frequent transit users enjoy; long-term plans are primarily enjoyed by the more affluent transit riders.

Fare prepayment plans can also be of convenience to a transit operator. For example, the 1974 National Mass Transportation Act calls for reduced fare

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[15] W.R. Hershey, et al., (1976) op. cit., pp. 11-12.

[16] See market penetration formula results in Chapter 7.

programs for the elderly and handicapped during off-peak periods. To make transit fare payment by these groups more convenient and easy for the driver to recognize and enforce, transit operators have developed numerous plans. Passes and tickets are sold at the regular peak fare or eligible persons are given permits that must be displayed when the reduced fare is paid. During the past eight years, special fare prepayment plans for the elderly and handicapped have come into widespread use.

Benefits From Ridership Generation

Ridership generation has long been touted as a major benefit of fare prepayment programs. However, in discussing the subject, it is useful to distinguish between the generation of new riders and the generation of new trips by previous transit riders, which is appreciable for pass plans.

First, the generation of new transit riders is rare. The convenience and potential money savings over cash fares are simply not significant attributes to effect mode shifts. The final evaluation report of the employer-based demonstration in Sacramento identified 5.2 percent of pass buyers during the three-month 25 percent discount period as new transit riders.[17] Most studies of fare prepayment, however, indicate that pass buyers are generally regular transit users. In St. Louis, for example, only 12 percent of pass users were not regular transit riders before the monthly pass was introduced.[18]

However, the generation of new transit trips by previously regular cash payers can be significant in pass programs, especially during off-peak hours. In Atlanta, total trip making by pass users increased 13.8 percent due to the introduction of the monthly pass, but off-peak ridership increased more than 32 percent.[19] In Ottawa, peak period travel by pass buyers was unaffected, while off-peak travel by pass users increased 24 percent.[20] Half of the new

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[17]Douglas Daetz and Michael Holoszyc. Sacramento Transit Fare Prepayment Demonstration. Prepared for the Transportation System Center, U.S. Department of Transportation. Systan Inc., Los Altos, California. July 1981, Appendix D, p. D-20.

[18]W.C. Gilman and Company. A Survey to Evaluate the Criteria Which Influences the Purchase and Use of a Monthly Pass. Prepared for the Bi-State System of St. Louis. W.C. Gilman and Co., St. Louis, Missouri. December 1964, p. 20.

[19]Thomas E. Parody. "Socioeconomic and Travel Behavior Characteristics of Transit Pass Uses." Paper presented at the 61st Annual Meeting of the Transportation Research Board, Washington, D.C. January 1982, p. 7.

[20]Bureau of Management Consulting (1977), op. cit., p. 29.

trips in Ottawa were diverted from other modes and half were trips previously not taken. Thus, the principal effect of introducing fare prepayment plans is to divert individual trips from other payment methods especially cash. Since diversion from cash generally takes place because of the discounts offered by fare prepayment plans, the opportunities for revenue loss are great and considerable attention must be placed on the pricing structure. A more detailed discussion of the subject is presented in Chapter 6.

Benefits as a Marketing Tool and From An Improved Public Image

Introductory fare prepayment plans may be an effective tool as part of a marketing program to promote new service. This is especially true for off-peak special transit services, such as shopper discounts to downtown or special weekend services to recreational facilities. Day and weekend passes have been successful in the few cases in which they have been tried. Also, fare prepayment plans can be used to encourage retail and business financial involvement through merchant validation and reduced-price coupon programs.

Finally, fare prepayment programs, like any service improvement, can assist transit companies in creating a positive public image by offering regular and occasional transit users greater boarding convenience. This service is becoming especially welcome as one-way fares reach $1.00 and as fare structures become more complex.

SUMMARY

This chapter presented a discussion of the major benefits associated with fare prepayment plans. These benefits included the potential for reducing operating costs and increasing revenues, encouraging off-peak ridership, and making the payment of fares easier for both the user and the operator. As a summary, the benefits of fare prepayment plans include:

- the potential savings in coin handling costs -- The most significant opportunity for an operator to reduce costs is by reducing the costs of sorting and counting coins and dollar bills, repairing fareboxes, and reducing the propensity for theft. The possible savings in coin handling costs is 1.58¢ per cash boarding eliminated.

- the reduction in dwell time -- Preliminary evidence suggests that as much as 0.9¢ per passenger boarding could be saved through productivity improvements. This benefit, however, depends on the type of prepayment instrument and management's ability to translate faster boarding into operating cost savings.

- the interest on advanced cash flow -- Interest payment can be a significant benefit if long-term plans are employed and only if the operator receives the money in advance. Very often distribution outlets will hold on to sales revenues until the end of the month in which service is provided. If these funds are deposited into the operator's account at the beginning of the month, interest of between 8 and 12 cents can be earned on every monthly pass issued.

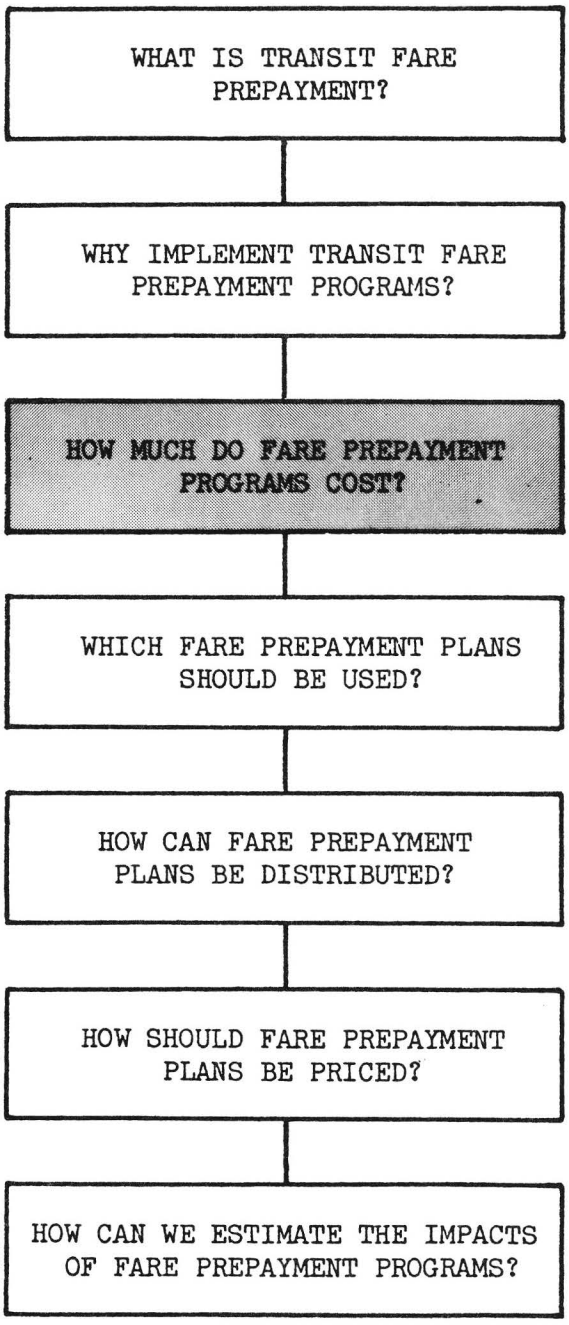
- the generation of off-peak travel and user convenience -- Fare prepayment plans seldom lead to the generation of new riders but may, in the case of pass plans, lead to significant increases in the level of off-peak travel by current cash users. Although most riders are attracted to fare prepayment because of the real and potential discounts offered, many frequent users find prepayment a convenience over cash payment.

- the increased revenues due to price discrimination -- One advantage of fare prepayment plans that has yet to be realized lies in their similarity to the rate structure plans of utility and telephone companies, and thus in their potential for increasing revenues through discriminatory fare policies. Due to the fact that transit users buy different fare prepayment plans and because small adjustments in the prices charged for these plans can easily be affected, fare prepayment is superior to cash fares in its ability to maximize passenger revenues.

- other operating cost savings -- Since some fare prepayment plans require a commitment to a certain level of transit usage, minor long-term operating cost savings can occur by reducing the day-to-day fluctuations in peak period demand. In addition, differentially-priced prepayment plans may be more effective than cash surcharges in effecting slight peak to off-peak hour shifts.

Few transit companies -- through their own efforts or through Federally-sponsored demonstrations -- have been able to document all of the benefits outlined above. This is not because the benefits are not attainable (although some programs are not designed to take advantage of the opportunities just cited), but rather because some transit managers did not pursue these benefits as specific objectives of their fare prepayment programs. In cases where management focuses on achieving these benefits, they will be attained.

3


WHAT IS TRANSIT FARE PREPAYMENT?
WHY IMPLEMENT TRANSIT FARE PREPAYMENT PROGRAMS?
HOW MUCH DO FARE PREPAYMENT PROGRAMS COST?
WHICH FARE PREPAYMENT PLANS SHOULD BE USED?
HOW CAN FARE PREPAYMENT PLANS BE DISTRIBUTED?
HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?
HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

3

HOW MUCH DO FARE PREPAYMENT PROGRAMS COST?

A renewed interest in transit fare prepayment plans began about ten years ago when transit companies were being acquired by local governments and other public entities. Fare prepayment was viewed as a marketing tool to attract riders, as well as a convenience to offset exact fare provisions. But despite this renewed interest, few transit companies today have a clear idea of how much it costs to operate and maintain a fare prepayment program. Some costs, such as printing and sales commission charges, are well known because invoices for these services are frequently received. There are, however, other costs that have seldom been quantified when estimates of the full costs of fare prepayment programs have been made. These costs include the cost of storing fare prepayment plans, the cost of accounting for sales, and the cost of delivering fare prepayment plans to sales outlets.

There are also many program trade-offs a transit manager can make that will affect cost. Staff distribution of monthly passes to suburban sales outlets, for example, can be replaced by courier service or certified mail delivery if sales volumes are low. This could result in a measureable cost savings without affecting the quality or security of the program. Understanding how individual program functions affect costs could help many transit companies improve the cost-effectiveness of their fare prepayment programs.

This chapter presents a description of fare prepayment program costs based on a recent comprehensive study of 11 transit companies by Ecosometrics, Inc.[1] The data used in this study and presented here were collected at the case sites during the summer of 1981. This chapter presents aggregate and activity costs by transit company size. The costs of on-board sales programs are also reviewed. Finally, the chapter concludes with a brief analysis comparing the costs and benefits of the Tri-Met fare prepayment program in Portland, Oregon. The estimated benefits of fare prepayment were reviewed in Chapter 2.

FARE PREPAYMENT PROGRAM COSTS

The operation of a fare prepayment program involves approximately 20 separate functional activities ranging from designing plans for printing to accounting fare prepayment sales. Together, the costs incurred in each of these activities incorporate the total costs of operating a fare prepayment program. These 20 functional activities are presented in Table 3-1 along with the overall cost categories in which each of the functional activities is classified.

This section presents aggregate program costs and the costs by 11 cost categories according to transit company size. The costs were aggregated by company size (i.e., large, medium, small) from the actual costs incurred at each of the case sites used in the study referred to earlier. In addition, on-board sales program costs are presented, also by cost category.

Aggregate Fare Prepayment Program Costs by Transit Company Size

Three indicators of efficiency are used to compare the costs incurred at each transit company. These indicators include: cost per instrument sold, cost per prepaid revenue dollar, and cost per prepaid trip.

The first indicator, cost per instrument, is a unit or average cost figure. To arrive at this figure, total monthly program costs are divided by the number of fare prepayment instruments sold each month. These figures, therefore, represent the total cost of selling each prepayment instrument to the public.

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[1]See Patrick D. Mayworm and Armando M. Lago. The Costs of Transit Fare Prepayment Programs: A Parametric Cost Analysis. Research Report 125-7. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Ecosometrics, Inc., Bethesda, Md., February 15, 1982.

Table 3-1

OVERALL COST CATEGORIES AND FUNCTIONAL ACTIVITIES

Overall Cost Category	Functional Activity
Order Preparation Costs	• Order preparation for delivery to sales outlets • Order preparation for on-board pass sales
Order Delivery Costs	• Order delivery by transit staff • Order delivery by courier service • Order delivery by certified mail
Direct Sales Costs	• Direct sales at transit-operated sales outlets • Direct sales at public and private sales outlets • Direct mail sales and distribution • Telephone order sales and distribution
Recording and Accounting Costs	• Recording sales at transit-operated outlets and headquarters • Accounting for sales at all outlets and headquarters • Accounting for on-board pass sales
Design Costs	• Designing plans for printing
Printing Costs	• Printing fare prepayment plans
Inventory Costs	• Storing fare prepayment plans
Miscellaneous Handling Costs	• Sorting and shredding tickets and other miscellaneous activities
Advertising Costs	• Advertising fare prepayment program
Administrative Costs	• Supervising and administering fare prepayment program
General Overhead Costs	• Overhead at transit-operated sales outlets • Overhead at headquarters

Although many fare prepayment functions exhibit economies of scale (i.e., unit costs will decrease with program size), the Ecosometrics study shows that large transit companies will incur a higher unit cost than small companies as shown by the statistics presented in Table 3-2. This is true because transit companies with large fare prepayment programs spend proportionally more money in two program areas than companies with small programs. These program areas include:

- sales commissions to public outlets - small transit companies can usually secure a network of public outlets without having to pay commissions; and
- advertising - small transit companies with set programs usually do not advertise.

Table 3-2

A SUMMARY OF TRANSIT FARE PREPAYMENT PROGRAM COSTS -- 1981

Transit Company Size[a]	Cost Per Instrument	Cost Per Revenue Dollar	Cost Per Prepaid Trip
Large	$0.857	$0.062	$0.024
Medium	0.439	0.034	0.016
Small	0.136	0.026	0.011
Average	$0.627	$0.055	$0.022

[a]Transit company size is defined by the number of annual revenue passengers as follows:

- Large transit company: More than 50 million annual revenue passengers
- Medium transit company: 10 million to 50 million annual revenue passengers
- Small transit company: Less than 10 million annual service passengers

Source: Patrick D. Mayworm and Armando M. Lago (1982), op cit., p. 147.

As shown in Table 3-2, the largest transit companies spend 86 cents for each instrument they sell. Average-size transit companies spend 44 cents per instrument and small companies spend only 14 cents.

The second indicator also presented in Table 3-2, cost per revenue dollar, represents the amount spent to earn a dollar of prepaid revenue. Large transit companies once again incur proportionally higher costs than small companies.

The difference in costs, however, is very small. A transit company operating a "typical" fare prepayment program can be expected to incur a cost of almost six cents to earn a dollar of prepaid revenue.

The final cost indicator presented in Table 3-2 is cost per trip. Computed by dividing total monthly cost by the total number of one-way trips taken with prepaid plans, this cost indicator identifies how much the transit company must spend to process a prepaid trip. Large transit companies spend slightly more than small companies to process a prepaid trip. The range of costs, however, is very narrow with the average cost per trip at only 2.2 cents.

Fare Prepayment Program Costs by Cost Category and Transit Company Size

The costs per instrument that are presented in Table 3-2 reappear in Table 3-3. This time, however, the unit costs are subdivided by the cost categories identified in Table 3-1 in order to provide an opportunity to compare the costs of individual fare prepayment activities for different transit companies.

As a percentage of cost, direct sales costs clearly are inversely related to transit company size. Once again, this reflects the fact that managers of transit companies with small programs can usually persuade banks and department stores to sell fare prepayment plans without charging a commission. At very large volumes, however, most public outlets will require a commission on sales or another form of payment.

Order delivery, accounting, printing, inventory, and overhead costs generally increase as a percentage of total costs as the size of the transit company decreases. Thus, while direct sales is the dominant cost factor in large companies, accounting, overhead, printing, and delivery costs are greatest at transit companies with small fare prepayment programs. Understanding the differences in the distribution of costs is critical when planning a fare prepayment program.

On-Board Sales Costs By Cost Category

The costs presented above did not include the costs of operating and maintaining day pass and weekend pass programs. These costs were separated because high-volume, day pass programs have very low unit costs. By including these costs with conventional fare prepayment programs costs, total unit costs would have appeared artifically low, making across-site comparisons difficult.

Table 3-3

UNIT TRANSACTION COSTS BY COST CATEGORY AND TRANSIT COMPANY SIZE -- 1981

Cost Category	Large Sites		Medium Sites		Small Sites	
	Cost Per Instrument	%	Cost Per Instrument	%	Cost Per Instrument	%
Order Preparation	$0.017	2.0	$0.020	4.5	$0.005	3.7
Order Delivery	0.013	1.5	0.045	10.2	0.020	14.7
Direct Sales	0.548	63.8	0.158	36.0	0.006	4.4
Recording & Accounting	0.039	4.6	0.074	16.9	0.035	25.7
Design	Negl.	0	0.002	0.5	0	0
Printing	0.088	10.3	0.056	12.8	0.023	16.9
Inventory	0.001	0.1	0.002	0.5	0.002	1.5
Miscellaneous Handling	0	0	0.010	2.3	0.005	3.7
Advertising	0.075	8.8	0	0	0	0
Administrative	0.019	2.2	0.008	1.8	0.004	2.9
Overhead	0.057	6.7	0.064	14.5	0.036	26.5
Total	$0.857	100.0	$0.439	100.0	$0.136	100.0

Source: Patrick D. Mayworm and Armando M. Lago (1982), op. cit., p. 145.

Table 3-4 presents the costs of operating four pass programs by cost category. Of the four programs, only Sacramento is a day pass program. The other three sites sell weekend day passes only.

The monthly costs of operating day pass programs are relatively stable across the four sites, ranging from $1,057 to $1,871 per month. The cost per pass sold, however, varies because of differences in the number of passes sold. Total costs in St. Paul and Seattle are about three to four cents per pass. In Sacramento, a pass costs less than a penny, only because so many are sold. In Tucson, the unit cost is 80 cents due to very low sales volumes and high printing costs. On an average weekend, SunTran prints 3,500 passes but sells less than 500. SunTran's monthly printing costs, however, probably cannot be reduced much, unless they begin printing their passes annually or semi-annually as in St. Paul and Seattle. At the present time, weekend day passes in Tucson are printed weekly.

Table 3-4

MONTHLY TRANSIT COMPANY COSTS FOR ON-BOARD SALES BY COST CATEGORY -- 1981

Cost Category	St. Paul (Weekend Pass)	Seattle (Weekend Pass)	Sacramento (Day Pass)	Tucscon (Weekend Pass)
Order Preparation	$ 51	$ 63	$ 96	$ 39
Accounting	354	290	0	69
Printing	629	614	1,676	1,399
Inventory	2	10	19	Negl.
Overhead	81	80	80	92
Total Monthly Cost	$1,117	$1,057	$1,871	$1,599
Total Monthly Sales	34,927	24,826	209,875	2,000
Cost Per Instrument	$0.032	$0.043	$0.009	$0.800

Source: Patrick D. Mayworm and Armando M. Lago (1982), op. cit., p. 146.

A COMPARISON OF FARE PREPAYMENT PROGRAM BENEFITS AND COSTS

Although there are many reasons for implementing a fare prepayment program, the value of these benefits should always outweigh the costs of operating the program. If they do not, perhaps the program should be streamlined to minimize operating costs or dropped altogether.

Unfortunately, transit managers seldom perform this analysis. Most transit managers "feel" that their programs are cost-effective, yet few actually quantify either their program costs or the expected or potential program benefits. In this chapter and in Chapter 2, however, the authors have presented a summary of the costs of different fare prepayment programs and of the potential benefits that may be derived from these programs.

The measure of benefits and costs will obviously vary according to the size and type of fare prepayment program. However, in order to present a useful comparison of calculated costs with estimates of program benefits, the authors have chosen to review the costs and benefits of one transit company -- Tri-Met in Portland, Oregon. Tri-Met was chosen for this comparison because of its size, the quality of data available, and the types of fare prepayment plans offered. Tri-Met's program costs are also slightly below average when compared to systems of similar size. Some of the program's statistics that are used in this brief analysis are presented in Table 3-5.

Table 3-5

STATISTICS ON TRI-MET'S FARE PREPAYMENT PROGRAM -- 1981[a]

Fare Prepayment	Price	Number of Monthly Boardings	Number of Instruments Sold Per Month
Ticket Books			
Elderly	$1.00	36,221	3,622
Handicapped	1.50	3,046	305
Youth	4.50	57,491	5,749
Adult	6.50	168,967	16,897
Adult w/zone	9.00	60,035	6,003
Monthly Passes			
Youth	$14.00	176,803	5,067
Adult	21.00	857,990	16,679
Adult w/zone	29.00	371,827	7,972
Vancouver	35.00	12,455	276

[a]Calculations made by Ecosometrics, Inc. based on data presented in Tri-Met (1981), op. cit.

Fare Prepayment Program Benefits

The fare prepayment program benefits reviewed in Chapter 2 included the following:

- operating cost benefits, such as reduced dwell time and reduced cash handling,
- revenue generation benefits, such as interest or advanced cash flow, and
- other program benefits, such as user convenience and off-peak ridership generation.

Within each of these categories, there are several specific benefits that can be achieved by a transit company. Estimates of the program benefits for Tri-Met are made here.

One of the major benefits of fare prepayment programs is that cash management and coin handling costs can be reduced since fewer riders pay with cash. The savings in coin handling costs, therefore, can be estimated from the number of prepaid boardings that do not use the cash fare collection system. Since the tickets used in Portland are dropped into the farebox, the only savings in coin handling costs occur as a result of the pass programs.

The average coin handling cost was estimated in Chapter 2 to be $0.0158 per cash boarding. With over 1.4 million monthly pass boardings on Tri-Met each month, the monthly savings in coin handling costs can be as high as $22,421. Since the marginal cost savings in coin handling costs is bound to be less than the unit cost (i.e., because most equipment and labor costs are fixed and cannot be reduced as the number of cash fares drop), the monthly savings figure computed above is an upper bound. Tri-Met may find that the potential coin handling cost savings is only half that amount.

The second major benefit of fare prepayment is the reduction in dwell time. By reducing boarding times, transit managers and schedulers may be able to effect operating cost savings as a result of faster average speeds. The value of this savings has been estimated to be approximately $0.009 per pass boarding and half that amount for tickets. Based on the average monthly trips rates for Tri-Met presented in Table 3-5, the potential monthly savings in operating costs is $12,914 for the pass program and $1,466 for the ticket program. Although a transit manager may not be able to achieve this combined savings immediately

due to the labor contract, this same savings will be achieved in the long-run. The productivity improvements resulting from faster boardings will allow service expansion to take place at little or no extra cost.

A major revenue benefit of fare prepayment is that interest can be earned on advanced cash flow. The cash flow improvement may, in fact, reduce the financing requirements of the transit company requirements usually met by a combination of funds from municipal taxes and debt obligations.

Based on the formula presented in Chapter 2, it is possible to compute the total interest accrued each month by each fare prepayment plan as shown in Table 3-6. The calculations are based on a municipal borrowing rate of 12 percent per annum. Moreover, the interest earned assumes that fare prepayment revenues are deposited a day after the riders begin using the ticket book or monthly pass. Although this is not the case in Portland, it is possible to earn this interest by requiring more prompt revenue collection.

Table 3-6

INTEREST EARNED ON ADVANCED CASH FLOW IN PORTLAND, OREGON -- 1981[a]

Fare Prepayment Plan	Interest Earned Per Instrument	Number of Instruments Sold Per Month	Total Monthly Interest Earned
Ticket Books			
Elderly	$0.00107	3,622	$ 3.88
Handicapped	0.00160	305	0.49
Youth	0.00481	5,749	27.65
Adult	0.00695	16,897	117.43
Adult w/zone	0.00962	6,003	57.75
Monthly Passes			
Youth	$0.06674	5,067	$ 338.17
Adult	0.10011	16,679	1,669.73
Adult w/zone	0.13825	7,972	1,102.13
Vancouver	0.16685	276	46.05

[a]Based on municipal borrowing rate of 12 percent per annum.

Source: Calculations made by Ecosometrics, Inc., from information provided in Patrick D. Mayworm and Armando M. Lago (1982), op. cit.

In addition to the benefits just mentioned, transit fare prepayment programs provide other benefits as indicated in Chapter 2. For example, the monthly pass and 10-trip ticket books provide transit users and Tri-Met with a real convenience that could be quantified if sufficient data were available. There perhaps has been some off-peak ridership generation as a result of the monthly pass program, which is most likely a benefit that outweighs the extra cost in carrying these off-peak trips. Fare prepayment perhaps has also improved Tri-Met's image in the three-county area in which it operates. Moreover, the need for more passengers to prepay fares is critical in Portland since Tri-Met is moving toward total self-service fare collection which will require all riders to carry a pass or validated ticket.

Fare Prepayment Program Costs

Tri-Met's total monthly fare prepayment program costs were estimated by Ecosometrics in its recent study of fare prepayment programs sponsored by UMTA.[2] In this study, Tri-Met's total monthly cost was estimated to be $26,642. This is equivalent to $0.425 per pass or ticket sold, or approximately 1.5 cents per prepaid trip taken. For the size of Tri-Met's fare prepayment program, these costs are slightly below average. Although Tri-Met's delivery costs are very high because staff are used to deliver plans to all urban and suburban outlets, sales, printing, and administrative costs are below the norm. A summary of the average monthly costs in Portland is presented below in Table 3-7.

Table 3-7

AVERAGE MONTHLY COSTS OF FARE PREPAYMENT PROGRAM AT TRI-MET -- 1981

Major Cost Categories	Average Monthly Cost
Order Preparation and Delivery	$ 3,385
Direct Sales and Accounting	15,295
Design, Printing, and Inventory	3,010
Administrative and Overhead	4,952
Total	$26,642

Source: Patrick D. Mayworm and Armando M. Lago (1982), op. cit.

2Patrick D. Mayworm and Armando M. Lago (1982), op. cit.

Summary of Costs and Potential Benefits

A summary of both Tri-Met's fare prepayment costs and potential benefits is presented in Table 3-8. As shown, the potential benefits from the monthly pass and ticket book program greatly exceed the average monthly cost of operating the fare prepayment program. Even if Tri-Met were only able to save half the coin handling costs indicated as a result of reductions in the number of cash fares paid, total benefits would still exceed program costs. Obviously it is important that transit companies take advantage of the interest and operating cost benefits of fare prepayment programs.

Table 3-8

SUMMARY OF FARE PREPAYMENT PROGRAM COSTS AND POTENTIAL BENEFITS: THE TRI-MET EXAMPLE -- 1981[a]

	Average Monthly Costs & Benefits
Program Costs	
Order Preparation and Delivery	$ 3,385
Direct Sales and Accounting	15,295
Design, Printing, and Inventory	3,010
Administrative and Overhead	4,952
Total Costs	$26,642
Potential Benefits	
Savings in Coin Handling Costs	$22,421
Dwell-Time Cost Savings	14,380
Interest Accruals on Cash Flow	3,363
Convenience and Generated Travel	positive
Other Benefits	positive
Total Benefits	$40,164
Benefit/Cost Ratio	More than 1.51

[a]The calculations presented in this table do not include the probable cash revenue losses from diverted cash riders.

Source: Calculations made by Ecosometrics, Inc. (see text).

One cost that has not been mentioned is the revenue lost to the transit company due to fare prepayment price discounting. The ticket book program in Portland resulted in no revenue loss because the tickets are not discounted. They are purchased simply for their convenience. Monthly passes, on the other hand, offer substantial discounts. The effective discount rates given to average Tri-Met pass holders varies from 11 to 37 percent. Since many of these trips would not be taken had the pass not been available, it is difficult to assess exactly how much revenue has been forfeited in order to produce the above-mentioned benefits. A more detailed discussion of the issue of pass pricing is presented in Chapter 6.

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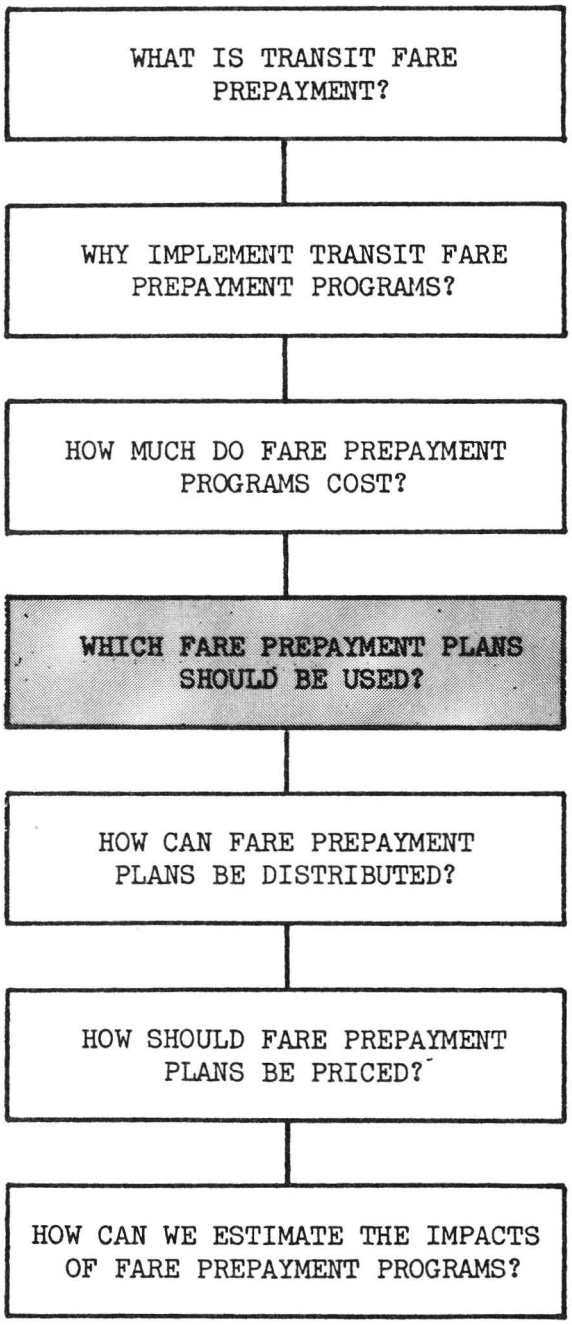
WHAT IS TRANSIT FARE PREPAYMENT?
WHY IMPLEMENT TRANSIT FARE PREPAYMENT PROGRAMS?
HOW MUCH DO FARE PREPAYMENT PROGRAMS COST?
WHICH FARE PREPAYMENT PLANS SHOULD BE USED?
HOW CAN FARE PREPAYMENT PLANS BE DISTRIBUTED?
HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?
HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

4

WHICH FARE PREPAYMENT PLANS SHOULD BE USED?

Once a decision has been made to go ahead and implement a fare prepayment program, how does one determine which fare prepayment plans to use and what restrictions should be placed on their usage? The general approach has been to survey users and ask them what type of plan they would like. Unfortunately, people do not always react the way they say they will.

This chapter presents preliminary guidelines on selecting the appropriate fare prepayment plan for specific markets. In general, the selection process involves:

- identifying the target market,
- weighing the advantages and disadvantages of alternative plans,
- evaluating the costs of alternative plans, and
- selecting the best plan and the restrictions placed on its usage.

The first section of this chapter reviews the major transit markets and suggests the type of fare prepayment plans that may be appropriate for each group. The advantages and disadvantages of different fare prepayment plans are discussed in this context. In addition, the relative costs of different fare prepayment plans are presented in order to provide further guidance on selecting an appropriate plan.

The second section of this chapter suggests guidelines for establishing a balanced set of fare prepayment plans since most programs offer more than one plan. The key design factor in selecting several plans is that they should complement one another and not compete for the same market. A set of complementary plans will effectively maximize fare prepayment sales at minimum cost.

SELECTING THE BEST FARE PREPAYMENT PLAN

The first task in selecting the appropriate fare prepayment plan is to identify the target group the transit manager is most interested in reaching. Usually, this group shows a high potential for new or increased ridership. Many operators, however, simply want to provide some groups with a convenient, yet cost-effective alternative to cash payment. The target group may be identified either by trip purpose or client group (e.g., commuter, shopper, elderly, youth), or by the specific transit services they use (e.g., off-peak, CBD, or park-and-ride service). This section presents the advantages and disadvantages of fare prepayment plans in the context of different possible target groups. The relative costs of fare prepayment plans are also presented.

Appropriateness of Fare Prepayment Plans by Target Group

Several fare prepayment plans are reviewed here for their applicability to specific markets or target groups. The groups included in this discussion are differentiated by trip purpose, client group, and users of specific transit services. The appropriate markets, advantages, and disadvantages of fare prepayment plans are summarized in Table 4-1.

Commuter Plans

Because of the routine nature of home-to-work travel, commuters usually choose their payment method on cost considerations alone. Their ability to predict the number of rides they will make enables them to select the most economical payment method.[1] In addition, except for low-income riders, commuters are usually able to handle a lump-sum payment in advance. Thus, long-term or

[1]Support for this view comes from the econometric studies by Lawrence B. Doxsey, "The Economics of Demand for Transit Passes." Paper submitted to the Transportation Research Board, Washington, D.C. August 1982; and Elizabeth Page (1981), op. cit.

Table 4-1: THE APPROPRIATE MARKETS, ADVANTAGES, AND DISADVANTAGES OF FARE PREPAYMENT PLANS

Fare Prepayment Plan	Where Is Its Market Potential?	What Are Its Advantages?	What Are Its Disadvantages?
TRIP-LIMITED PLANS Tokens	Suggested for general population, especially for: • infrequent riders • low-income riders	• conform easily to existing fare collection equipment • usually counted automatically with coins • may lead to slight improvements in boarding time • can be reused • easy to carry • usually have no expiration date • may improve cash flow	• difficult to revalue • expensive to mint • not appropriate for zone or other differential-fare system • does not reduce coin handling costs • not appropriate for special client group • bulky to transport to distribution outlets (cannot be mailed)
Tickets	Suggested for general population, especially for: 10-Trip • infrequent riders • shoppers • low-income riders • tourists • off-peak only plans • special routes and districts 20-Trip • commuters • students • special routes and districts 40-Trip • very frequent riders • commuters • students	• may lead to slight improvements in boarding time • can be designed as books or less-expensive strip tickets • conform to self-service fare collection/validation equipment • easy to carry (ticket books are more bulky than strip tickets) • usually have no expiration date • may improve cash flow	• may clog vacuum-operated farebox systems • may lead to increases in cash management costs because it is cumbersome to separate tickets from coins • several dominations are required for zone or other differential-fare system • ticket books are somewhat bulky to send to distribution outlets through the mail

Table 4-1 (continued)

Fare Prepayment Plan	Where Is Its Market Potential?	What Are Its Advantages?	What Are Its Disadvantages?
Punch Cards	Suggested for general population, especially for: 10-Trip • infrequent riders • shoppers • low-income riders • tourists • off-peak only plans • special routes and districts 20-Trip • commuters • students • special routes and districts 40-Trip • very frequent riders • commuters • students	• inexpensive to print • may lead to reduction in cash management costs • appropriate for zone or other differential-fare system • very easy to carry • usually have no expiration date • may improve cash flow	• boarding time will increase because punch cards require driver action • difficult to monitor passenger trips • easy to counterfeit
TIME-LIMITED PLANS Permits	Suggested, for general population, especially for: • commuters • students • elderly and handicapped riders	• appropriate for zone or other differential-zone system • better than passes in maintaining revenues from frequent users • may lead to slight improvements in boarding time • may be used as permanent reduced-fare cards for special client groups • easy to carry and use • may improve cash flow if front-end charge is levied	• cash drop is inconvenient • does not reduce coin handling costs • permits with photographs are very expensive to produce

Table 4-1: (continued)

Fare Prepayment Plan	Where Is Its Market Pote		What Are Its Disadvantages?
Passes	Suggested for general popu tion, especially for: Daily • infrequent riders • shoppers • elderly & handicapped r • low-income riders • tourists • off-peak only plans Weekly • commuters • tourists • park-and-ride plans • introductory plans Monthly • commuters • students • park-and-ride plans Annual • commuters • students • park-and-ride plans	• may improve modal coordination • may improve cash flow	• may lead to revenue loss from diverted cash users if improperly priced • several denominations are required for zone or other differential-fare system • difficult to monitor passenger trips • may be easy to counterfeit

large-quantity plans -- such as an annual or monthly pass, or 40-trip ticket book -- are appropriate for commuters. Monthly permits are also appropriate and can preserve more peak period revenues. However, in cities where a large proportion of the commuters are low-income riders, short-term plans (such as 10-trip tickets and weekly passes) should also be offered because of the difficulties experienced by many low-income riders in financing the front-end costs of long-term plans.

Frequent users experiencing short-term absences will prefer weekly passes, 10-trip multiple-ride tickets, or punch cards. The very infrequent rider, whether a commuter or not, may prefer to purchase transit service by cash or day pass, even when long-term fare prepayment plans are offered at a discount.

One of the more successful ways of marketing fare prepayment plans to commuters is to set up and sell plans -- usually monthly passes -- directly to employees at their work place. Monthly passes are most appropriate because their sale can be easily tied into a payroll deduction program.[2]

Shopper Plans

Day passes and tickets, usually with off-peak only restrictions, are most appropriate for shoppers. Tokens and punch cards are less useful than tickets, but may be used to encourage transit use for shopping. In general, small-quantity plans should be used and marked for off-peak use only. Special marketing programs, such as "Shopper Specials" and merchant validation programs, have been successful in many cities. Often they are partially subsidized by the businesses that benefit directly from them. Although day passes make up only 13 percent of all pass plans, they may prove advantageous for numerous reasons. Riders with limited funds may find them particularly advantageous because they enable riders to consolidate many trips into a single day at a relatively low price. In addition, day passes encourage off-peak trips and do not require a special trip to a sales outlet since they can be sold by the driver.

Student Plans

College commuters seem to have been first in experimenting with annual passes and other long-term fare prepayment methods. In one university community,

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[2]For detailed descriptions of employer-based fare prepayment programs see: Douglas Daetz and Michael Holoszyc. Sacramento Transit Fare Prepayment Demonstration. Prepared for the Transportation Systems Center, U.S. Department of Transportation. Systan, Inc., Los Altos, California. July 1981; and S.G. Associates, Inc. Marketing Transit Through Employers. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Annandale, Virginia. November 1981.

high parking rates and an annual bus pass have encouraged many non-captive riders to use the bus system.[3]

A recently completed demonstration in Tucson, Arizona tested the appropriateness of three forms of fare-prepayment in terms of meeting the needs of college students.[4] During the first phase of the project, a semester pass, monthly pass, and 20-trip punch card were marketed and sold on-campus. Preliminary results indicate that the demand for these plans was greater than originally expected. The semester pass was the most popular of the three plans. In addition, the marketing program itself had the effect of doubling monthly pass sales on campus without reducing the pass price.

During a second phase, both peak and off-peak 20-trip punch cards and semester passes were sold to students to further encourage off-peak transit usage. This phase of the project also appears to have been successful in increasing revenues and reducing morning transit usage by students.

Plans for the Transit Dependent

The transit dependent may include low-income people, grade school and high school students, the young, the elderly, and the handicapped. Fare prepayment programs designed for these groups should emphasize low cost. Low-quantity of tickets can be provided since the front-end cost is usually a problem. It may be found that, because the transit dependent use transit frequently, passes or permits may be most appropriate. Day passes may prove successful for low-income transit users. Most of the permit plans offered by transit companies today are only for the elderly and the handicapped. This has been a logical outgrowth of the 1974 legislative requirement that elderly and handicapped persons be charged no more than one-half the peak-period fare during off-peak hours. Few permit plans are available to the general public.

Tourist Plans

Tourist markets differ significantly among cities. Currently, tourist plans should be designed to meet the special needs of a particular city. For example, special weekend tickets to attractions may be made available. Ticket books or punch cards ranging from five to 20 trips and with time limitations

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[3]W.R. Hershey, et al., (1976) op. cit., pp. 78-79.

[4]Although a final evaluation report has not yet been released, a description of the project is presented in: Patrick Mayworm. Demonstration Plan for the Student Transit Fare Prepayment Demonstration: Tucson, Arizona. Research Report 125-3. Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Ecosometrics, Inc., Bethesda, Maryland. January 1980; and Patrick D. Mayworm and Armando M. Lago (1980), op. cit.

-- say three days -- may be attractive to tourists. Weekend passes or short-term (off-peak) day or multiple-day passes may also be appropriate. Los Angeles, for example, offers tourists unlimited travel for fixed periods of time. Five different transit passes are offered: 3-, 5-, 7-, 10-, and 15-day passes. Passes are priced at $1.00 per day.

Off-Peak Plans

A primary motivation for introducing fare prepayment is to encourage off-peak transit use. Plans similar to those used by shoppers may be incorporated into a fare prepayment program, with time of day being the only restriction. Although all fare prepayment plans can be restricted to the off-peak period, passes and permits have been applied more often. The plans must be marked for off-peak use only, with a surcharge levied when used during peak hours. Discounts should be offered for off-peak use, since not only are the costs of off-peak travel lower, but off-peak demand is more responsive than peak demand to price changes.

The demonstrations in Duluth, Minnesota and Tucson, Arizona included both all-day and off-peak plans and the effect was to increase off-peak ridership and shift a small number of peak riders to off-peak hours. A more detailed discussion of the results of these demonstrations is provided in Appendix B.

Plans for Special Routes and Districts

Transit fare prepayment may be used to encourage riding on select routes or in special districts, such as the central business district. Although most programs of this nature have been fare-free or reduced-fare programs, fare prepayment may be appropriate to encourage ridership while maintaining a strong revenue base. Single tickets or small books of tickets have had the greatest application.

Park-and-Ride Plans

Most existing park-and-ride programs are designed for the commuter. Monthly or annual passes that are priced slightly higher than regular monthly or annual pass may encourage transit riding and help guarantee the financial success of a park-and-ride program. Tickets or punch cards may not be suitable for a such a program.

Introductory and Promotional Plans

Transit ridership can be selectively increased through an introductory trial pass or ticket at a price significantly below the normal rate. The low introductory price would remain in effect for a short period -- say, two months -- and then gradually increase to the normal price. Many people attracted by this initially low price may continue to purchase the pass or ticket beyond the introductory period. It is recommended that a monthly or weekly pass be used because it is easier to relate price to time with a dated instrument rather than a trip-limited one, such as the typical 20-trip ticket or punch card.

Relative Costs of Operating Fare Prepayment Plans

Once a transit manager has identified a set of alternative plans that would be appropriate for the target group under consideration, it is important to select the plan that not only fits with other plans in operation, but also minimizes operating costs. Monthly and weekly passes, for example, may be appropriate for the same group, but their costs are significantly different. Consequently, knowing how much more (or less) it will cost each month to produce and sell one type of fare prepayment plan over another would be useful for planning purposes.

Ecosometrics, Inc. calculated and compared a set of normalized costs for selected fare prepayment plans as part of its study of fare prepayment costs.[5] Two pass plans, three ticket book plans, and a token plan were chosen for the comparison. These six plans are perhaps the most common fare prepayment plans offered by transit companies. They include:

- monthly and weekly passes,
- 10-, 20-, and 40-trip ticket books, and
- tokens sold in rolls of 20.

Total monthly costs were computed for each plan as if it were the only plan sold. For these calculations, the authors developed standardized data so that the plans could be easily compared. The authors assumed, for example, that

[5]Patrick D. Mayworm and Armando M. Lago (1982), op. cit.

the usage of each fare prepayment plan is identical; that is, the same number of prepaid trips are taken each month with each of the six plans. This assumption does not imply that the plans are easily transferable, or that decisions on the selection of a fare prepayment plan should be made on cost and cost alone. As we have already shown, the market for a monthly pass is not the same as the market for a 10-trip ticket book.

In addition, the size of the program chosen for comparison is equivalent to a medium-to-large fare prepayment program about the size of Tri-Met in Portland. Tri-Met, for example, sells 1.75 million prepaid trips each month. Smaller programs will probably witness slightly lower total and unit costs.

Finally, the parameters selected for the analysis represent a unique fare prepayment program. As these parameters change (e.g., type of sales outlets or delivery methods used), so will the estimated program costs. Thus, what is important in this brief cost comparison of fare prepayment plans is not the absolute value of the costs, but rather their relative costs.

The normalized costs of the six fare prepayment plans are presented in Table 4-2. The total monthly cost of operating each of the six plans is presented first, followed by each plan's unit cost and cost per trip.

Table 4-2

MONTHLY NORMALIZED COSTS BY FARE PREPAYMENT PLAN -- 1981
(excluding cost of advertising and cost of funds)

	Monthly Pass	Weekly Pass	10-Trip Ticket	20-Trip Ticket	40-Trip Ticket	20-Token Roll
Total Monthly Cost	$18,801	$35,656	$26,007	$26,908	$18,321	$23,131
Cost Per Instrument	0.470	0.206	0.150	0.242	0.423	0.267
Cost Per Trip	0.011	0.021	0.015	0.012	0.011	0.013

Source: Patrick D. Mayworm and Armando M. Lago (1982), op. cit., p. 153.

Because they are consumed and replaced so rapidly, weekly passes and 10-trip ticket books are the most costly of the six plans to implement. Tokens are slightly more expensive than tickets of the same quantity. Monthly passes and 40-trip ticket books, the two plans with the longest duration, are the least expensive.

The cost of operating fare prepayment programs differs by type of fare prepayment plan because each type of plan has different operating requirements. Weekly passes, for example, must be printed much more frequently than monthly passes. The printing costs for weekly passes, therefore, are significantly greater. An analysis of these functional differences provides the basis for the brief comparisons of fare prepayment plans that follows.

Monthly vs. Weekly Pass

Weekly pass programs are twice as expensive to operate each month as monthly pass programs as shown in Table 4-2. Each weekly pass, however, costs about half of what it would cost to sell a monthly pass since there are over four times as many weekly passes sold each month. The higher total monthly cost for a weekly pass program is due primarily to the higher labor cost in preparing orders and in delivering orders to outlets every week.

Weekly pass programs are substantially more expensive than monthly pass programs in nearly every cost category. The exceptions include direct sales costs and administrative costs. Direct sales costs are only slightly greater for weekly passes because most of the costs incurred in this category are from commissions paid to sales outlets. Commissions are based on a fixed rate of revenues and not on volumes sold. Administrative costs are identical, not only for monthly and weekly passes, but for all programs.

Weekly Pass vs. 10-Trip Ticket Book

Weekly pass programs are 37 percent more expensive than 10-trip ticket book programs primarily because weekly passes have to be prepared and delivered to outlets every week. An assumption used in this analysis is that weekly passes are the only plans that are not prepared and delivered to sales outlets on a monthly basis. If four sets of weekly passes are prepared and delivered monthly,

weekly pass program costs would decrease to a level just above the cost of a 20-trip ticket program. Printing and design costs, however, would remain higher. General overhead costs are higher for weekly passes as a result of the higher labor costs in order preparation and delivery.

10-Trip vs. 20-Trip vs. 40-Trip Ticket Book

Fare prepayment programs using 10-trip ticket books are 24 percent more expensive than programs with 20-trip ticket books, and 42 percent more expensive than programs with 40-trip ticket books. The larger quantity plans are less expensive overall because fewer transactions have to be made and fewer books have to be printed to service the same level of demand. Monthly order preparation and order delivery costs are identical for all three plans. Direct sales costs and overhead costs decrease as the quantity of tickets per book increases because fewer transactions are made requiring fewer people to do the selling and accounting. Printing and inventory costs are also inversely related to ticket book quantity because fewer plans are needed to supply the same number of prepaid trips.

20-Trip Ticket Book vs. 20 Token Roll

The last category of comparison is between 20-trip ticket books and tokens sold in rolls of 20. As shown in Table 4-2, token programs are about 10 percent more expensive than programs using 20-trip ticket books. This higher cost is primarily due to wrapping tokens for reuse and to the high cost of token replacement. If tokens last less than 10 years, minting tokens will be more expensive on a per trip basis than printing ticket books. Thus, there is no real cost advantage to token programs. There are, however, several operational advantages for using tokens. For example, tokens can easily be assimilated into traditional fare collection programs. Tickets, moreover, can cause problems with vacuum-operated fare collection systems.

SELECTING THE BEST COMBINATION OF FARE PREPAYMENT PLANS

Attention must be given to balancing the combination of plans offered. In some cases, fare prepayment plans can duplicate one another and lead to higher

than necessary administrative costs. For most transit systems, two or three basic fare prepayment options will cover the range of consumer needs if the plans are properly priced relative to one another. A program with too many plans may prove difficult to administer and confusing to the public.

The choice of plans will depend less on urban characteristics and more on transit travel characteristics. There seems to be no relationship between city size or other characteristics of the general urban environment and the variation of prepayment plans offered.[6] On the other hand, selecting the appropriate set of plans will depend on:

- specific transit travel characteristics in the city (e.g., a high percentage of student or shopping trips),
- opportunities for shifting peak travel to off-peak periods, and
- opportunities for reaching other market groups with a high potential for new or increased ridership.

The possible combinations of fare prepayment plans are endless, and no one set or combination can be recommended for general use. However, the analysis of recent experiences with transit fare prepayment does suggest that plans should be offered to cover both the frequent and infrequent ridership markets. Specifically, the following guidelines for establishing a balanced set of fare prepayment plans are recommended:

- A relatively low-priced, short-duration option should be made available to meet the needs of low-income people, the transit-dependent, and occasional riders. Day passes or 10-trip ticket books and punch cards may be appropriate. Punch cards should be avoided because of their adverse effects on dwell time.
- Weekly or monthly passes or permits should be provided for frequent riders, complemented by a multiple-trip format, such as strip tickets or ticket books.
- The plans and their respective discount rates should be determined by their ability to encourage greater transit usage at minimum cost to the system. The plans should stimulate off-peak transit use where the marginal cost of providing increased service is low. Low-quantity plans should not be discounted, whereas long-duration plans that encourage regular transit usage, such as monthly passes, can be slightly discounted. Caution should be taken not to extend to peak period users other than nominal discounts because of their inelastic demand response and because of the higher cost of peak period service.

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[6] W.R. Hershey, et al., (1976), op. cit., pp. 68-70.

Some examples of possible fare prepayment plan combinations are presented in Table 4-3. In all three cases, the work trip dominates all other transit trips. Shopping and school trips constitute a large share of the transit market in the second and third cases, respectively.

SUMMARY

This chapter presented preliminary guidelines on the selection of appropriate fare prepayment plans to meet the needs of transit riders and fit into the operating and budget requirements of the transit company. The fare prepayment plans most appropriate for the six principal target groups include:

Commuters

- monthly pass or permit
- 40- or 20-trip ticket book

Shoppers

- day pass
- off-peak, 10-trip ticket book

Students

- semester pass
- 20-trip ticket book

Transit Dependents

- monthly permit
- day pass

Tourists

- multiple day pass
- off-peak, 10- or 20-trip ticket book

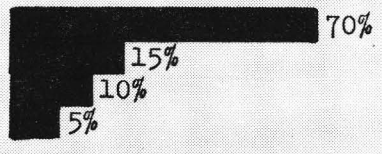
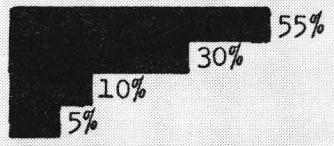
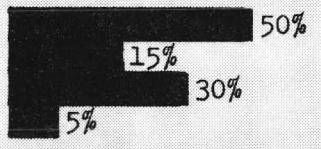
Other Infrequent Riders

- day pass
- 10-trip ticket book

Where two or more fare prepayment plans appear appropriate for the target group, transit management should seriously consider how each plan option will affect fare collection operations and costs. To compare fare prepayment plan costs, a set of normalized costs were computed and are summarized below:

	Cost Per Instrument	Cost Per Trip
Monthly Pass	$0.470	$0.011
Weekly Pass	0.206	0.021
10-Trip Ticket	0.150	0.015
20-Trip Ticket	0.242	0.012
40-Trip Ticket	0.423	0.011
20 Token Roll	0.267	0.013

Table 4-3: EXAMPLES OF FARE PREPAYMENT PLAN COMBINATIONS

	Transit Usage		FARE PREPAYMENT PLAN COMBINATIONS	
			Cities with Predominately High-Income Transit Riders	Cities with Predominately Low-Income Transit Riders
CITY I	Work Trip Shopping Trip School Trip Other		• monthly pass with park-and-ride option • 10-trip ticket	• 20-trip ticket • day pass
CITY II	Work Trip Shopping Trip School Trip Other		• monthly pass or permit • 10-trip ticket (off-peak only)	• 10-trip ticket • shopper day pass (off-peak only)
CITY III	Work Trip Shopping Trip School Trip Other		• monthly pass • student semester pass • 10-trip ticket	• 10-trip ticket • student permit

Finally, this chapter presented guidelines for establishing a balanced set of fare prepayment plans to minimize operating costs and reduce the amount of duplication. It is suggested that a low-priced, short-duration plan be made available to meet the needs of low-income people and infrequent riders. Longer-term, higher-priced passes and permits can complement ticket books and provide a more convenient method of fare payment for commuters and other frequent transit users.

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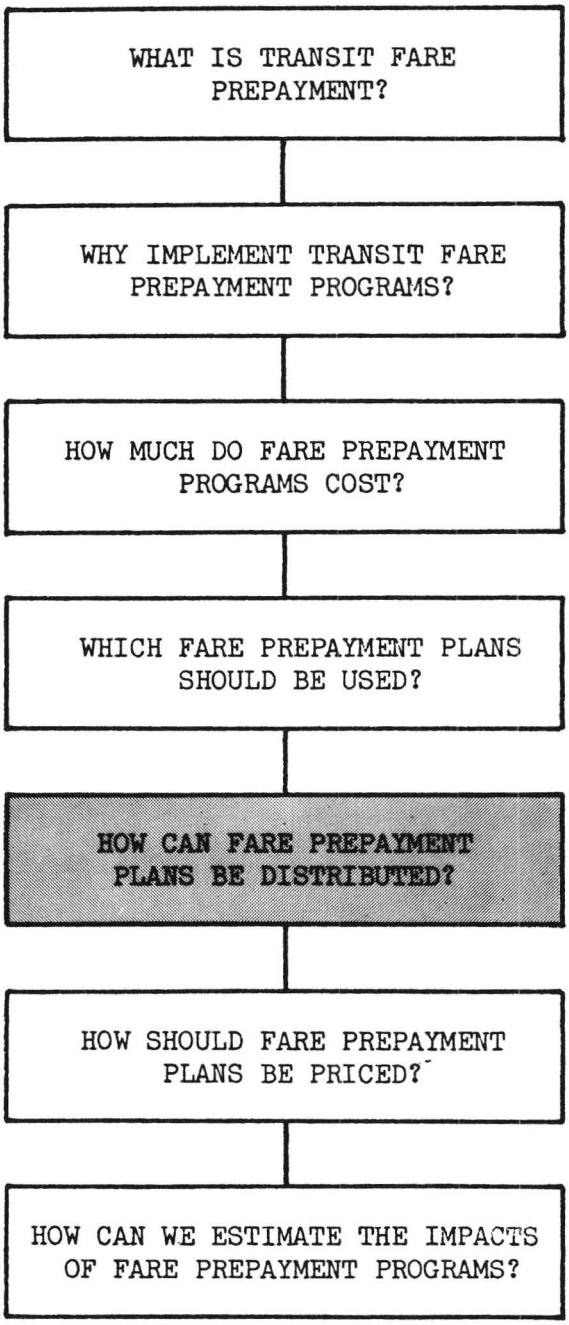
WHAT IS TRANSIT FARE PREPAYMENT?
WHY IMPLEMENT TRANSIT FARE PREPAYMENT PROGRAMS?
HOW MUCH DO FARE PREPAYMENT PROGRAMS COST?
WHICH FARE PREPAYMENT PLANS SHOULD BE USED?
HOW CAN FARE PREPAYMENT PLANS BE DISTRIBUTED?
HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?
HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

5

HOW CAN FARE PREPAYMENT PLANS BE DISTRIBUTED?

The success of a transit fare prepayment program is partly measured by the level of market penetration. Like any other commodity, fare prepayment plans are likely to have a higher level of market penetration if distribution outlets are conveniently located in the region or if other convenient methods are available for selling fare prepayment plans to the public.

Transit fare prepayment plans can be sold to the public in several ways, varying from sales on board a transit vehicle to over-the-counter sales at transit-operated, public, and private outlets. New methods of sales distribution have recently emerged, such as direct mail order and telephone order; however, few transit companies employ these sales methods today. In the near future, automated methods of sales distribution may be used by transit companies to maintain or increase sales at lower cost. Automatic bank transfer payments and vending machine sales are examples of some of the new methods under consideration. These methods, as well as traditional sales distribution methods, are currently being tested and evaluated in a Federally-sponsored demonstration project for the Sacramento Regional Transit.[1] These distribution methods are examined in this chapter.

This chapter also includes a discussion of the three most common methods of order delivery: transit-staff delivery, courier delivery, and certified mail delivery. One or more of these methods must be used to distribute fare prepayment plans to public and private sales outlets.

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[1]Patrick D. Mayworm, Armando M. Lago, Beth F. Beach (1981), op. cit.

METHODS OF SALES DISTRIBUTION

Transit managers must choose among several sales distribution methods in order to maximize fare prepayment sales at minimum cost. Most programs employ the basic methods such as sales at transit company offices and through banks and department stores. Many transit companies operate their own conveniently located sales and information outlets if demand is sufficiently large. In addition, some transit managers are implementing direct mail and telephone order programs, as well as other methods, to make it more convenient for customers located far from sales outlets to purchase fare prepayment plans. A discussion of the principal methods of sales distribution is presented below.

On-Board Pass Sales

On-board sales of pass plans is used in several transit companies that offer day or weekend pass plans. Other forms of fare prepayment are rarely sold by the driver in this country in order to enhance driver safety. In most European cities, however, tickets are sold by the driver, but at a premium price in order to encourage prepayment and to reflect the higher costs of increased dwell time associated with driver involvement in fare payment.

Day passes are sold by the driver because there are few alternatives. Essentially, the rider deposits the amount of cash equal to the pass price into the farebox at the time of boarding. A pass is then issued by the driver allowing the pass holder to take an unlimited number of trips during the period of validity.

On-board sales, therefore, has the advantage that riders do not have to go to an outlet to buy the pass. This has had the effect of encouraging day pass sales in many cities. Sacramento, for example, sells over 200,000 day passes each month. Monthly sales of weekend passes in Seattle and Minneapolis/St. Paul is well over 20,000.

There are, however, many disadvantages to on-board sales of passes. Since money is collected at the time of boarding, benefits of interest accrual do not occur. Similarly, there is no cash handling savings. The most important disadvantage, however, is that on-board sales require driver participation which slows down boarding time and increases operating costs.

Transit-Operated Sales Outlets

Transit-operated sales outlets can be located at transit offices or at outlets located throughout the city. Outlets in the latter category may be owned by the transit company or rented on a monthly basis. In addition to selling fare prepayment plans, outlet representatives also assist riders by providing information on bus schedules, route locations, and special fare programs.

Nearly every transit company operating a fare prepayment program sells plans through transit-operated sales outlets. However, only a limited number of high-volume outlets are operated by transit staff because of the high cost of labor. In general, the costs associated with the operation and support of staff-operated sales outlets include the cost of preparing orders for delivery, actual order delivery, direct sales, recording sales at the outlet, and outlet overhead. It can be shown that these costs increase with the number of sales transactions.[2] The average cost, or cost per sales transaction, however, will decrease as the number of sales transactions increases. At low sales volumes, the average cost at an outlet can be more than $3.00 per sales transaction; at outlets with very high sales volumes (e.g., 10,000 transactions per month), however, the cost per pass or ticket sold is approximately $0.60.[3]

Public and Private Sales Outlets

Public sales outlets include banks, department stores, and other retailers, and are accessible to anyone interested in purchasing fare prepayment plans. Private sales outlets, however, sell only to their own clientele. Private sales outlets are usually located in government buildings and at offices of social service agencies. The key distinction between public/private outlets and transit-operated outlets is that the former do not employ transit company personnel. However, very often public and private outlets will attempt to cover their marginal cost by charging the transit company a commission on sales revenues.

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[2] A full explanation of the costs associated with fare prepayment distribution can be found in Patrick D. Mayworm and Armando M. Lago (1982), op. cit., pp. 168-182.

[3] A sales transaction refers to the individual order made by a transit user when purchasing a fare prepayment plan(s). Most of the costs presented in this chapter are based on the number of transactions (individual purchases) made. The reader will recall that the costs presented in Chapter 3 were costs per instrument, or per card, ticket book, or token roll used. A sales transaction, therefore, could involve the purchase of more than one fare prepayment instrument (i.e., multiple purchases).

Many of the costs associated with distributing and selling fare prepayment plans to staff-run sales outlets are the same for serving public and private outlets. Orders have to be prepared at headquarters and then delivered to all the outlets, and there is an overhead cost for this labor. However, instead of paying salaries and operating expenses for running sales outlets, many public outlets charge a fixed commission on sales. In most small transit systems, public outlets will provide this service and not charge a sales commission. The total average cost to the transit company, therefore, will depend on the commission rate charged and should vary between $0.14 (with zero commission) and $0.80 (with 3% commission) per sales transaction.

Very often public and private outlets will hold on to fare prepayment revenues for three to four weeks. This time delay results in lost interest that the transit company can earn if revenues are transferred sooner.

Several transit companies across the country have begun negotiations with large retail chains for distribution and sales of fare prepayment instruments. Grocery store and department store chains offer an advantage over individual public outlets because of their existing distribution system and sales activity. Tri-Met in Portland, Oregon, for example, negotiated a contract with the Seven-Eleven retail food store chain to distribute and sell fare prepayment instruments. Seven-Eleven operates many 24-hour establishments throughout Tri-Met's service area. The managers of these stores are eager to increase the number of customers entering the stores because this leads to increased sales. In addition, Seven-Eleven was awarded a contract that provides the chain with a financial incentive to maximize fare prepayment sales. The schedule of commissions paid by Tri-Met to Seven-Eleven is as follows:

- 1% commission for sales less than $150,000 per month
- 2% commission for sales from $150,000 to $300,000 per month
- 2.3% commission for sales from $300,000 to $500,000 per month
- 2.6% commission for sales over $500,000 per month

The rising commission rate provides Seven-Eleven with an incentive to sell as many fare prepayment plans as possible.

Tri-Met can benefit substantially from this contract because Seven-Eleven will distribute plans frequently throughout the month from two warehouse locations to all of its retail outlets, sell the plans directly to Tri-Met passengers, account for all sales by location, and deduct all sales commissions from fare prepayment revenues. In addition, Seven-Eleven will mention the transit company and the fare prepayment plans in its advertising program. The total average cost to the transit company for this service is approximately $0.70 per transaction regardless of the volume sold at any particular outlet.

Employer-Distributed Sales Outlets

A rapidly expanding option for sales distribution involves selling fare prepayment plans to workers at their place of employment. This may be an over-the-counter cash transaction or the fare prepayment plans (usually passes) may be purchased through payroll deduction.

In an employer-distributed sales program, the employer acts as an agent selling passes to its employees. Once an agreement is made between the transit company and the employer, passes are delivered or mailed to the work place near the end of each month. A cashier or receptionist will then sell or distribute the passes to participating employees. Unsold passes and revenues are returned to the transit company at the beginning of the following month.

Payroll deduction provides a convenience for employees and minimizes the need for the employer to handle cash and process checks. Consequently, after the initial changes are made, direct payroll deduction is cheaper for the company to administer. Once on the payroll deduction system, it is up to the employee to notify the company if he or she does not want a pass. This helps to maintain employee commitment to the program.

Unfortunately, many employers and their employees do not like the payroll deduction idea. In Sacramento, for example, less than 15 percent of the employers participating in the program used payroll deduction. Evidently the perceived convenience of payroll deduction was off-set by the convenience of easily accessible public outlets.

The costs associated with an employer-distributed pass program are similar to the costs incurred for other public and private outlets, but higher in some categories as shown in Table 5-1. The higher unit costs in Sacramento were primarily due to a greater degree of contact between the transit company and the employer, and due to the low sales volumes at each employer outlet.

Table 5-1

UNIT SALES COSTS FOR REGULAR AND EMPLOYER MONTHLY PASS PROGRAMS IN SACRAMENTO -- 1980

Activity	Public Outlets	Employer Outlets
Materials and Printing	$0.034	$0.034
Administration and Handling	0.033	0.172
Distribution and Sales	0.071	0.117
	$0.138	$0.323

Source: Estimates developed by Ecosometrics, Inc. from data in Douglas Daetz and Michael Holoszyc (1981), Op. Cit.

In addition to the administrative costs incurred by a transit company, employer-distributed fare prepayment will increase an employer's costs slightly. Systan, Inc.[4] found that the average monthly cost to the employer was $30.80, per pass, including $18.12 for pass sales and distribution, $5.81 for surveys and interviews (a demonstration-related activity), $4.54 for payroll deduction, and $2.34 for miscellaneous costs, such as mailing. Among the 48 participating employers, average monthly costs ranged from zero to $168 per pass; the median monthly cost, however, was only $11.25 per pass.

The monthly costs reported in this study were found to be positively correlated with number of passes sold. Excluding the cost of surveys and payroll deduction, Systan, Inc. estimated the following equation:

$$\text{Employer Monthly Costs} = \$6.72 + \$0.34 \times \text{number of passes sold}$$

This equation, however, is overly influenced by a few extreme data points. The use of a marginal cost of $0.50 per pass with no fixed cost was suggested by Systan, Inc. to be more appropriate.

[4]See Douglas Daetz and Michael Holoszyc (1981), Op. Cit.

Direct Mail Sales

Unlike the previous three distribution methods that involve personal over-the-counter transactions, sales through direct mail programs are handled impersonally through the mail. In general, the customer fills out an order form provided by the transit company and mails this form and the appropriate payment to the fare prepayment agent. Payment is usually by check, money order, or credit card.

Following receipt of mail orders and verification of all credit card purchases, the fare agent mails back to the customer the item(s) requested. Generally there are some conditions on the order, especially on the latest date by which an order for monthly passes must be received in order to ensure return receipt by the beginning of the month. Usually a minimum of ten days is allowed to cover any problems with mail delivery and check verification.

The costs associated with this sales method include labor processing costs, material expenses, recording costs, and overhead expenses. There are no outlet orders to prepare as with sales outlet methods, no staff deliveries are made, and revenues are deposited daily. The monthly cost of processing and distributing passes by mail, therefore, depends only on the number of passes sold each month. At very low volumes, the cost per sales transaction is approximately $2.00. As the number of passes sold increases, the unit costs do not decrease substantially. A minimum cost of $1.40 per sales transaction is all that can be obtained at high sales levels because direct mail programs are extremely labor intensive since each pass order has to be handled individually.

Telephone Order Sales

Telephone order sales programs allow customers to order and purchase fare prepayment plans from the transit company over the telephone, using a major credit card as means of payment. The customer provides the fare agent with his or her credit card number, its date of expiration, name, address, and telephone number. The agent verifies the credit card account and receives an authorization number from the transit company's financial institution. The items purchased are then mailed to the customer. As in the case with mail order, credit card verification is usually made on all purchases, at least initially. If the volume of telephone orders is greater than expected and the

time required to verify credit card accounts is long, the transit company should assess the feasibility of obtaining an independent credit card verification machine. These machines are very expensive and should only be purchased if both the sales volume and sales draft are high. No transit company has yet reached the point where verification machines would be cost-effective.

Like direct mail programs, telephone order programs are labor intensive but do not require a network of sales outlets. The costs associated with this sales activity include the labor costs of receiving each order over the telephone and processing the order, the equipment and material costs, the finance charge for credit card use, and the recording and overhead costs. As with direct mail programs, the average transaction cost for telephone order sales decreases as more fare prepayment plans are sold. However, at volumes over 3,000 monthly transactions, the rate of decrease in the average cost of selling a pass through a telephone order program is negligible. The cost of selling a pass or ticket by this method will not drop below $2.20 at very high levels of demand.

Bank Transfer Payment Methods

Automatic telephone payment (ATP) and pre-authorized funds transfer are two methods available to many bank customers to pay their personal bills through their financial institutions. Using ATP, individuals can pay their bills over the telephone. With a pre-authorized automatic bill paying service, individuals permit companies to debit their account for the balance due.

Both systems can be used by transit companies for placing orders. In general, once an individual's account has been debited and the appropriate funds transferred to the transit company's account, the transit company can then mail the customer the item(s) requested. Since these new methods have not be applied, cost data are not available. They are, however, the subject of the demonstration project in Sacramento mentioned earlier.

Vending Machine Sales

Fare prepayment plans can be purchased off the vehicle in vending machines located at transit centers and at major sales outlets. Although sophisticated machines are used to dispense tickets and passes for rapid rail and commuter rail services, vending machines have not been used for the sales distribution of

of fare prepayment plans for bus use. For this reason, the total operating and servicing cost of vending machines are not known. Minimum purchase and set-up costs, however, are approximately $27,000 per machine, or $3,550 per year assuming a service life of 15 years and a discount rate of 10 percent.

A Comparison of Sales Distribution Methods

Selecting the appropriate combination of sales distribution methods will depend on the type of fare prepayment plans offered, the size and density of the transit service area, and the costs of operating each method. Table 5-2 describes the key features of the different distribution methods discussed in this section. Figure 5-1 presents the costs per sales transaction of the five principal methods of sales distribution. In general, a transit company should provide over-the-counter sales outlets and perhaps an alternative means by which fare prepayment plans can be purchased.

On-board sales of day passes is the only way day passes can be distributed efficiently to the public. Since day passes increase driver workload and passenger boarding times, day pass sales should be minimized by making them attractive only to infrequent riders and off-peak users. Consequently, day passes should be priced at or above two times the peak period fare, or made available only during the off-peak hours and on weekends when demand is low and the cost of providing an extra transit ride is small.

Over-the-counter outlets may be run by the transit company or by a public or private agency. In general these outlets should possess the following qualities:

- provide the public with easy and convenient access,
- be open to the public for as many hours per day and days per week as possible,
- be located at major traffic generators, and
- be easily recognizable by the public.

Depending on the sales commission rates asked by public and private sales outlets, it may be less expensive for the transit company to staff and maintain a sales outlet if very high outlet volumes are obtained. In general, staff-operated outlets are less expensive to operate at volumes over 10,000 transactions per month than public outlets charging 2 1/2 percent in commissions as shown in Figure 5-1. Since most staff-operated outlets operate below this level, their utility must be judged and justified on grounds other than costs.

Table 5-2

GUIDELINES ON SELECTING SALES DISTRIBUTION METHODS

ON-BOARD SALES - On-board sales are only appropriate for the distribution of day or weekend passes, and these programs should only be offered to occasional users during off-peak hours. There are no financial benefits or operating benefits of on-board sales programs. Sales of day passes, however, does encourage greater off-peak travel.

TRANSIT-OPERATED SALES OUTLETS - Sales outlets operated by transit staff are expensive to operate at low sales volumes unless part-time labor is used. Public and private sales outlets are more efficient in selling fare prepayment plans to the public except at volumes in excess of 10,000 transactions per month. Most transit-operated outlets also perform other functions, such as providing passengers with information on the transit system.

PUBLIC AND PRIVATE SALES OUTLETS - Public and private over-the-counter sales outlets are the most common methods of sales distribution. They are also the most efficient methods provided that very low or no sales commissions are assessed and prepayment revenues are transfered quickly. Contracting with an agency to market, distribute, and sell fare prepayment plans may be a cost-effective alternative if wide distribution throughout the region is required.

EMPLOYER-DISTRIBUTED SALES OUTLETS - Another alternative to public and private sales outlets is to sell plans (usually passes) through places of employment. Employer distribution, while excellent for marketing and promotional reasons, is more expensive to maintain and is generally competitive with public sales outlets. They are appropriate where large corporations and employment centers exist.

DIRECT MAIL SALES - Because of the high processing costs, direct mail sales of fare prepayment plans should be very selective. First, direct mail programs should be marketed to those who cannot easily purchase fare prepayment through less-expensive public outlets. Second, in order for it to be cost-effective, direct mail distribution should be available for purchasing only expensive, long-term plans, such as monthly and annual passes.

TELEPHONE ORDER SALES - Like direct mail programs, telephone order sales and distribution is expensive to operate with little or no economies of scale. Consequently, telephone order programs should be geared to that segment of the population without easy access to public outlets. Only long-term, expensive plans should be purchased over the telephone and charged to a major credit card.

BANK TRANSFER PAYMENT METHODS - Automatic telephone payment and pre-authorized funds transfer methods are convenient and innovative ways for frequent transit users with high incomes to purchase fare prepayment on a regular basis. These methods, which have yet to be tried, are extensions of the direct mail and telephone order sales methods. The demand for bank transfer payment methods is expected to be very small.

VENDING MACHINE SALES - Vending machines may be appropriate to augment an existing public outlet network and should be placed only where passenger traffic is exceptionally high. Moreover, they should only be used to prevent public outlets from charging sales commissions by relieving peak demand at banks and department stores. At transit-operated outlets, vending machines may be appropriate if they reduce the labor requirement at the outlet.

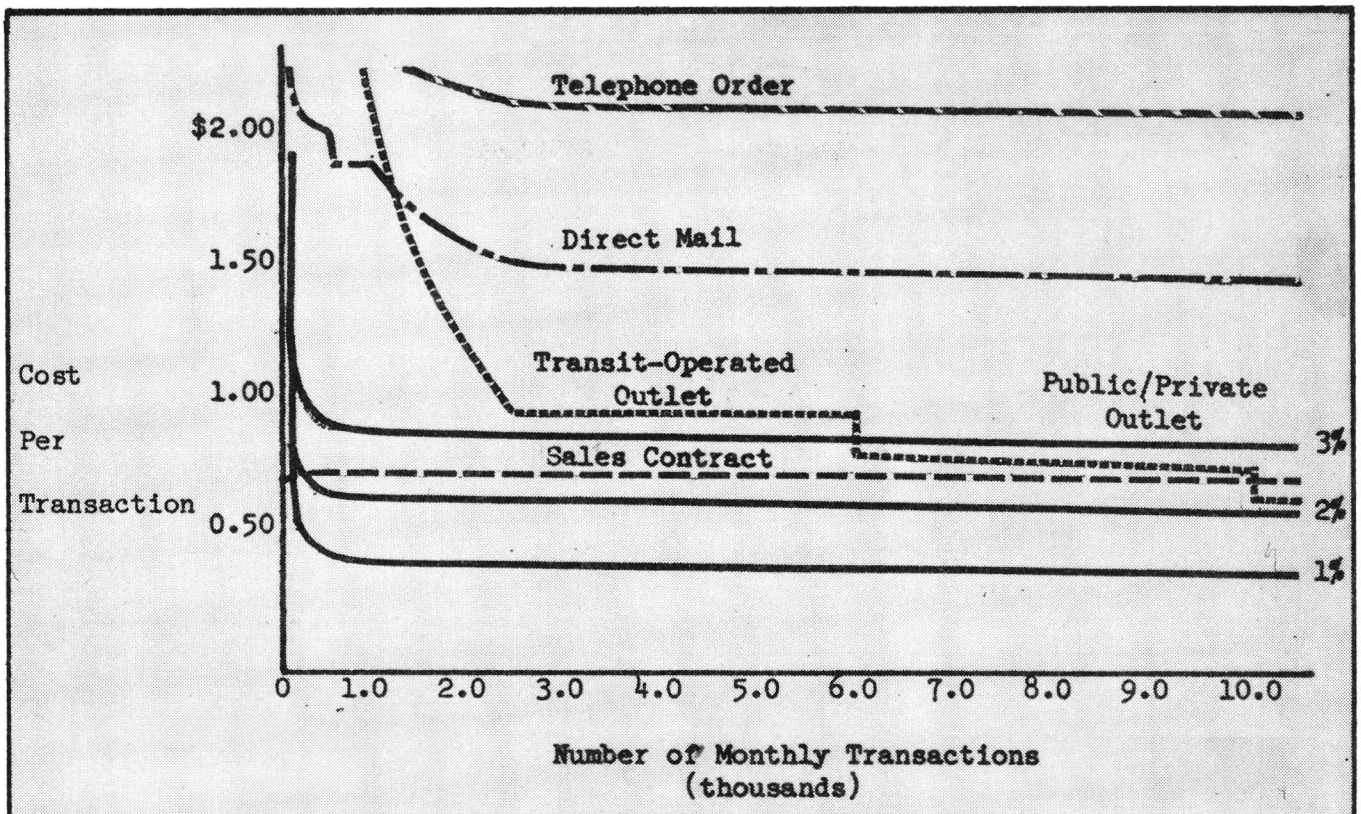

Figure 5-1: A COMPARISON OF AVERAGE COSTS FOR FIVE DISTRIBUTION METHODS AT HIGH SALES VOLUME

Source: Patrick D. Mayworm and Armando M. Lago (1982), op. cit., p. 181.

Transit managers should seriously consider negotiating a contract with a retail chain for the distribution and sales of fare prepayment plans, since such contracts can be less expensive for the transit company than distributing through public outlets that charge high commissions. In addition, contracting for the distribution and sales of fare prepayment plans frees the transit company from these activities.

Most transit companies have developed employer-promoted pass programs after implementation of public and private outlets. In many of these cases it took a good deal of effort to build an employer-based program primarily because such programs compete directly with over-the-counter sales outlets. For example, the Chicago Transit Authority began selling passes through public outlets after an employer program had been in operation for two years. The number of participating employers did drop after the public outlets were opened, indicating the two methods are somewhat competitive. A similar result recently occurred in a demonstration in Duluth, Minnesota.

Although encouraging employers to sell passes to their employees does increase the visibility of the transit company in the community, employer-based programs require a significant amount of time and effort to develop. Once in place, however, the operating costs should not be significantly different from the costs of operating other outlets if attention is placed on selecting the most efficient delivery method.

Telephone order and direct mail programs should not be considered substitutions for over-the-counter sales methods. These programs are relatively expensive to operate with little or no economies of scale, as shown in Figure 5-1. In order to make them cost-effective, they should only be marketed to those without access to lower cost public and private sales outlets.

Bank transfer payment methods, while convenient for the transit company, will probably never be a popular method of fare payment. Vending machines, however, may effectively relieve high volume sales outlets of the pressures imposed by fare prepayment sales. In this way, vending machines may be cost-effective in minimizing operating costs by reducing the need to increase staff or charge sales commissions. Moreover, vending machines may be necessary for transit systems adopting self-service fare collection procedures.

METHODS OF ORDER DELIVERY

Successful fare prepayment programs, whether they are large or small, will always involve a network of conveniently located sales outlets. In some cases these outlets are owned and operated by the transit company; however, most often sales outlets are business and public institutions such as banks, department stores, employers, schools, and social service agencies. Regardless of how the outlets are managed, it is important that a new supply of fare prepayment plans be delivered to each outlet on a timely basis. A fare prepayment manager must choose, therefore, the safest, most reliable, and least costly method among several delivery options. This section of the chapter presents a review of the three principal delivery methods: transit staff delivery, courier delivery, and certified mail delivery.

Transit Staff Delivery

Transit staff delivery is perhaps the safest and most reliable method of getting new fare prepayment plans to sales outlets. It is also very costly.

Staff labor and overhead charges must be covered along with the cost of owning and operating a service vehicle.

The Ecosometrics, Inc. report on fare prepayment costs[5] shows that the cost of servicing each outlet depends only on the average distance and the travel time between outlets. The cost of servicing each outlet increases as the congestion in the city increases and as the distance between outlets increases. This cost does not depend on the number of fare prepayment instruments delivered to each outlet. Thus, the average costs of servicing two outlets the same distance away from the transit offices can be significantly different.

Courier Delivery

An alternative and reliable method of transporting plans to sales outlets is a professional courier service. Use of courier service may be ideal for programs just beginning because it provides flexibility to handle unexpected changes in demand. In addition, courier service eliminates the need for staff and vehicle time spent on this activity. Transit personnel can thus be used more effectively for other tasks. This service provides same day pick-up and delivery.

The cost for courier service is reasonable, especially if distances between outlets are great. Most courier businesses will charge a fixed rate per package or outlet regardless of the quantity of instruments within the package. The rate will usually depend on the number of outlets served during each delivery. In very large urban areas, courier companies will often divide the region into several large zones with the per package delivery charge increasing with the distances between zones.

Certified Mail Delivery

The third and final method of fare prepayment delivery is the U.S. Postal Service. Packages sent certified mail generally arrive on time. Although it is not recommended that high volume outlets be serviced by certified mail, this delivery method is ideal for very low volume sales outlets.

The cost for this service is a function of the number of instruments sent to each outlet. As the volume increases, so does the first class postage rate and the size -- and thus cost -- of the envelopes used in mailing plans to sales outlets.

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[5]Patrick D. Mayworm and Armando M. Lago (1982), op. cit.

A Comparison of Order Delivery Methods

The choice of order delivery methods should depend on the type of fare prepayment plans sold, the characteristics of the service area, and the volume of instruments delivered to each outlet. Obviously, if tokens are the only fare prepayment plans being delivered, certified mail cannot be used. However, for most ticket and pass programs, transit managers should select the combination of delivery methods that results in the least cost to the transit company.

Based on these three methods of delivery, the cost of delivering fare prepayment plans to each sales outlet can be as low as $2.05 using certified mail or over $20 if staff are used for the delivery. The actual cost per outlet in a particular setting will depend on the number of outlets served, the average distance between outlets, the density of the city, and the number of fare prepayment instruments delivered to each outlet. Given this information, it is possible to choose the least costly method of fare prepayment delivery.

Figure 5-2 presents the costs of servicing each outlet in a medium density environment. All three methods of fare prepayment delivery are represented. Certified mail costs increase as the number of passes sent per outlet increases. Courier delivery costs are not affected by the volume of passes sent to each outlet but rather on the number of outlets served. For this illustration, it is assumed that more than 50 sales outlets are served during each delivery period. Transit staff delivery costs depend on the distance (and time) between outlets. The delivery costs per outlet for one and two mile average distances between outlets are shown in Figure 5-2.

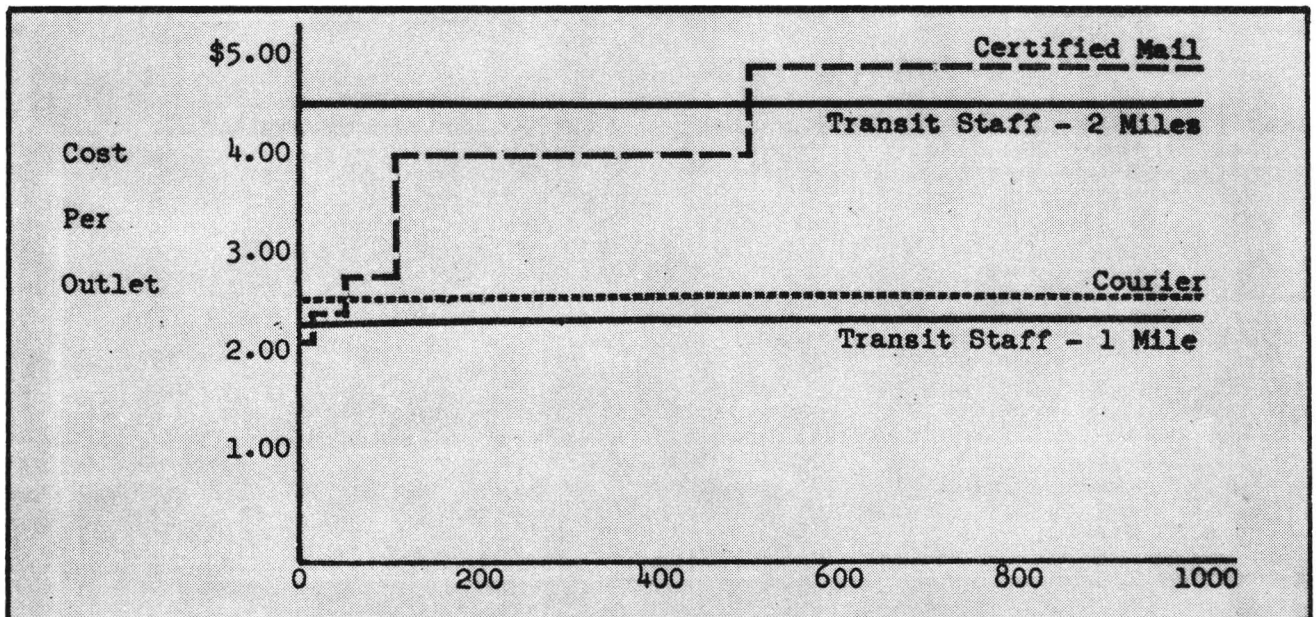

Figure 5-2: COMPARISON OF DELIVERY METHOD COSTS IN A MEDIUM DENSITY ENVIRONMENT - 1981

Source: Patrick D. Mayworm and Armando M. Lago (1982), op. cit., p. 164.

With the costs of the three delivery methods superimposed on Figure 5-2, it is possible to determine which method results is the least cost to the transit company at different volumes of passes delivered. Certified mail is the least costly method at volumes below approximately 50 passes per outlet. Beyond that volume, transit staff delivery is the most economical method if outlets are spaced one mile apart on average. If the distances between outlets is greater than one mile, courier service is least costly.

Moreover, any one of the three methods can be the lowest cost delivery method depending on the set of conditions under which the transit company is operating. Since the same volume of passes is usually not sent to all sales outlets, utilization of more than one delivery method could result in the lowest operating cost to a transit company. For example, in a low density site where outlets are spaced two miles apart on average, transit staff should be used for the delivery of passes to high volume outlets only; that is, staff delivery should be employed only when more than 50 passes are delivered to an outlet. For those outlets receiving less than 50 passes, certified mail should be used. Thus, the combination of staff and certified mail delivery will result in the lowest operating cost for the program.

SUMMARY

This chapter presented a review of the principal methods of fare prepayment sales distribution and order delivery. Several sales distribution methods were reviewed ranging from on-board sales of day passes to a subscription distribution service using pre-authorized funds transfer. The three most common forms of fare prepayment delivery to sales outlets were also discussed.

The first section of this chapter showed that telephone order and direct mail programs are relatively expensive programs to operate with little or no economies of scale. In order to make them cost-effective, they should only be marketed to individuals without access to lower-cost public and private over-the-counter sales outlets.

Depending on the sales commission rates asked by public and private sales outlets, it may be less expensive for the transit company to staff and maintain a sales outlet if very high outlet volumes are obtained. In this review it was pointed out that a staff-operated outlet servicing over 10,000 pass sales per month is less expensive than public outlets charging more than 2 1/2 percent

in commissions. Most staff-operated outlets, therefore, must be judged and justified on grounds other than costs.

Also, transit managers should seriously consider negotiating a contract with a retail chain for the distribution and sales of fare prepayment plans, since such contracts can be less expensive if public outlets charge higher commissions. In addition, contracting for the distribution and sales of fare prepayment plans frees the transit company from these activities.

The second section in this chapter showed that any one of three fare prepayment delivery methods can be the lowest cost delivery method depending on the set of conditions under which the transit company is operating. Moreover, since the same volume of passes is usually not sent to all sales outlets, utilization of more than one delivery method could result in the lowest operating cost to a transit company. For example, in a low density site where outlets are spaced two miles apart on average, transit staff should be used for the delivery of passes to high volume outlets only; that is, staff delivery should be employed only when more than 50 passes are delivered to an outlet. For those outlets receiving less than 50 passes, certified mail should be used. Thus, the combination of staff and certified mail delivery will result in the lowest operating cost for the program.

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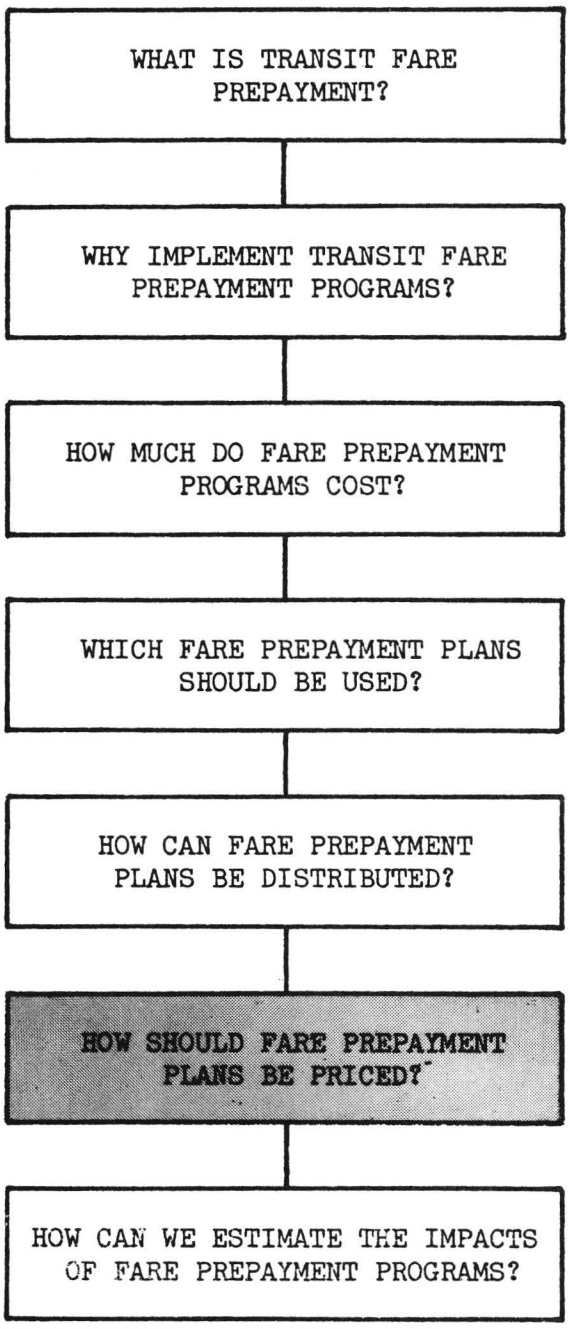
WHAT IS TRANSIT FARE PREPAYMENT?
WHY IMPLEMENT TRANSIT FARE PREPAYMENT PROGRAMS?
HOW MUCH DO FARE PREPAYMENT PROGRAMS COST?
WHICH FARE PREPAYMENT PLANS SHOULD BE USED?
HOW CAN FARE PREPAYMENT PLANS BE DISTRIBUTED?
HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?
HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

6

HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?

Like any other service or good, public transit services are priced in order to generate revenues to cover the costs of providing service. Although there are some who would argue that transit should be free, most political leaders and professionals agree that the users should pay for at least a portion of the cost of operating a transit system. How much we should charge will depend on the level of outside subsidy available, the cost of services offered, and the characteristics of the users. The task in any pricing analysis, therefore, is to use this information to develop a fare policy that is revenue efficient and equitable.

The amount of subsidy that is available to cover operating expenses will determine how much revenue must be collected. As operating subsidies diminish, new farebox revenue goals have to be established in order to maintain the same levels of service and new fare policies must then be developed to meet these revenue goals. Designing an equitable fare policy essentially involves choosing a fare structure, fare level, and fare collection system.

The cost of providing transit services is another important factor that should enter into every pricing analysis. Since the cost of a transit trip differs by trip length, quality of service, and time-of-day, every attempt should be made to charge users in proportion to the costs they cause the transit system to incur. The closer we are able to charge transit riders according to the cost of the services they use, the more equitable the pricing structure will be.

The final major element involved in price setting concerns the characteristics of users. There are many factors affecting a person's decision to travel, of which fare is only one. Moreover, transit users do not all place the same weight on fares when determining whether or not to take a transit trip. Commuters, for example, are known to value the time spent going to and from work more than the fare paid. Since transit users respond differently to fare changes, a more efficient fare policy will take advantage of users different fare elasticities of demand.

Efficient and equitable fare structures are often very difficult to design because of operational problems and because complex fare structures are often hard for users to understand. Transit managers, therefore, have to trade-off the equity and revenue efficiency advantages of complex fare structures against increased operating and user costs. Fortunately, transit fare prepayment plans are available and can be designed to minimize the cost associated with complex fare structures.

Fare prepayment plans are useful instruments for differentially pricing transit service because certain plans are attractive only to certain groups of users (e.g., monthly passes to frequent users, such as commuters). The key to designing an equitable and efficient fare policy, therefore, is in managements' ability to design fare prepayment plans for specific markets with the appropriate restrictions, and to price the plans judiciously.

This chapter discusses the appropriateness of using fare prepayment plans as instruments of fare policy and presents guidelines on pricing fare prepayment plans. A short review of the economics of fare prepayment plans is presented first. Although the economics of fare prepayment plans differ, how we price each plan will depend almost exclusively on the market group for which the plan is designed.

THE ECONOMICS OF FARE PREPAYMENT PLANS

In order to develop a sound pricing policy, it is important to first understand how revenues are affected by the prices we charge. For example, whenever tickets, tokens, or punch cards are offered without discounts over the equivalent cash fare, the incentive for using the plan is simply the convenience of avoiding cash. Thus, little or no revenue changes can be expected. The situation for passes and permits, however, is quite different. No matter what price we

charge, there will always be a proportion of riders who are receiving discounts. As discussed below, pricing pass and permit plans will depend on the market group for which the plan is designed and the trip frequency distribution of pass and permit users.

Transit fare prepayment plans, when identified by their pricing policy features, can be categorized into one of two groups as illustrated in Figure 6-1: trip-limited and time-limited plans. Trip-limited plans specify the quantity of trips that can be taken and are generally valid for an unlimited period of time. The price per trip is explictly known and, therefore, the discount offered is always determined. Tokens, tickets, and punch cards fall into this pricing category.

The second group, time-limited plans, specifies the time period during which trips may be taken. Since in general there is no limit on the quantity of trips that can be taken, the discount level is implicitly known; that is, the average price per trip (and discount) depends on the frequency of transit usage. Passes and permits fall into this category.

As shown in Figure 6-1, both trip- and time-limited fare prepayment plans can be identified by their pricing policy feature. In general, three pricing policies can emerge:

- trip-limited plans provided as simple substitutes for cash,
- trip-limited plans provided with explicitly determined discount levels, and
- time-limited plans provided with implicitly determined discount levels.

Simple Substitutes For Cash

Tokens, tickets, and punch cards can be provided simply for their convenience as substitutes for cash payment. Many transit riders enjoy the benefits of increased convenience alone as demonstrated by the fact that undiscounted trip-limited plans sometimes achieve penetration rates of ten percent of all trips.[1] Thus, short-term plans that are marketed to infrequent riders should be priced equal to the cash fare (i.e., no discounts). Discounts over the peak period cash fare are only advised when the plans are restricted to specific market groups (e.g., shoppers) or time periods (e.g., midday, weekend).

[1]See Chapter 7.

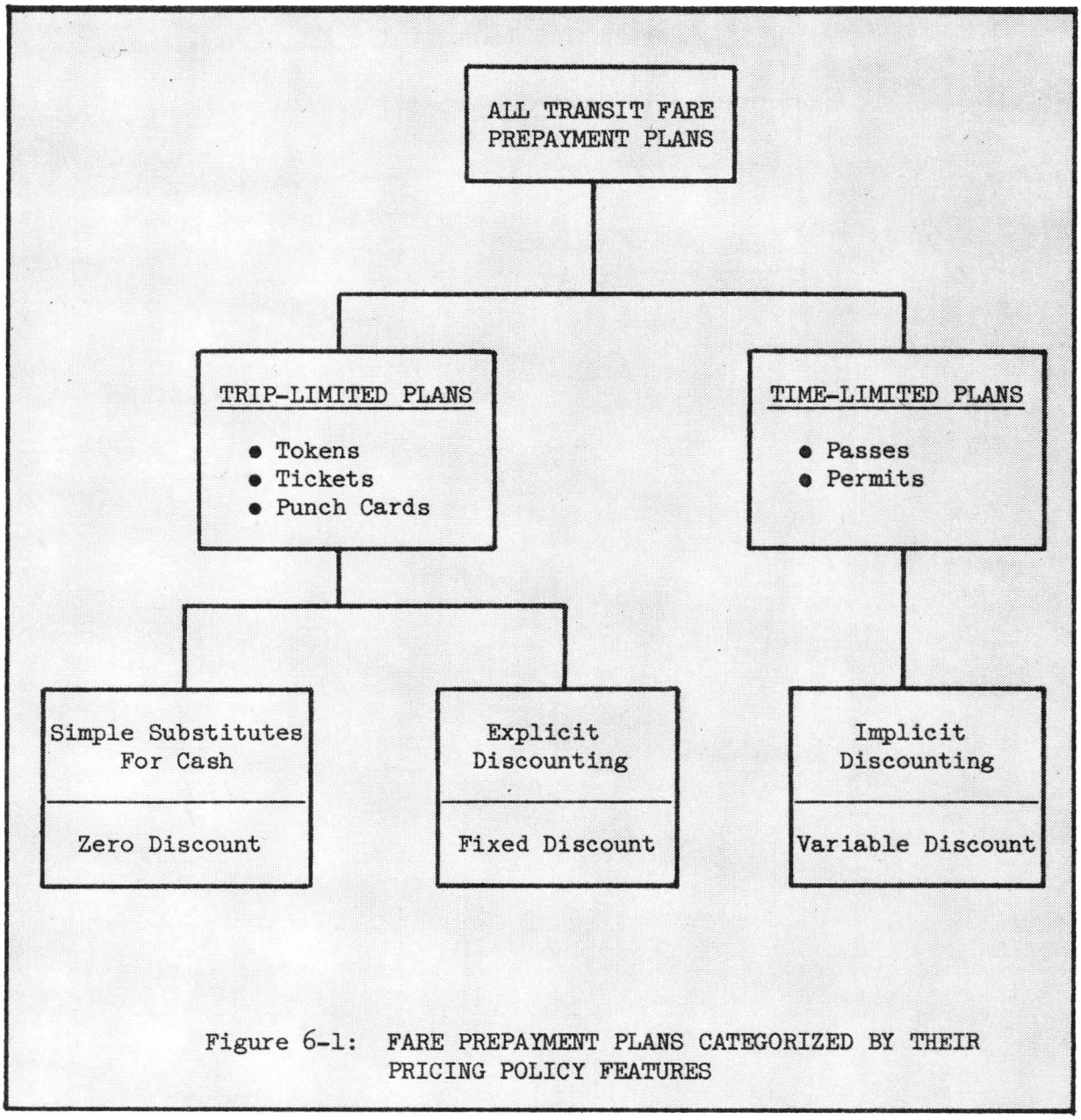

Figure 6-1: FARE PREPAYMENT PLANS CATEGORIZED BY THEIR PRICING POLICY FEATURES

Explicit Discounting

Transit fare prepayment plans can offer r
as direct substitutes for cash, but also an ac
discounts offered on tokens, tickets, and pu
known; that is, a fixed number of rides are
One study of fare prepayment found that appr
prepayment plans offering discounts are expli
available to the general public.[2] Of all t
have discounts of more than 30 percent and an addi
However, most of these heavily discounted or free plans are not available to the general public.

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The explicit discounting of transit fare prepayment plans is generally motivated by:

- a feeling that a discount is appropriate for bulk purchases,
- a marketing judgement that discounts and convenience together will encourage ridership in a cost-effective way, and
- a policy decision that low-cost transit, under certain conditions, can achieve some other public purpose. In such cases, discounts (say to the elderly, the handicapped, students, low-income people, etc.) are determined more by policy than by consideration of marginal cost-effectiveness.

In practice, discounts should be determined after carefully analyzing the net operating cost savings and revenue impacts of fare prepayment plans. Bulk purchases, for example, can be sold at a slight discount since the net operating cost savings per prepaid trip increases with longer-term plans. Table 6-1 presents data on the costs and benefits of operating 10-, 20-, and 40-trip ticket book programs. Based on a cash fare of $0.65, the three plans yield a net operating cost savings of up to 1.19 cents for every cash trip substituted by a prepaid trip. The maximum discounts suggested by this information are presented in the last column of the table. Note that only a 1.8 percent discount can be justified for 40-trip ticket book programs. Discounts greater than 1.8 percent will usually result in revenue losses exceeding operating cost savings. In some programs that are efficiently run, discounts of up to 5 percent can be justified on long-term ticket programs. It is this conservative,

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[2]Hershey, et al. (1976), op. cit. p. 64.

cost-based approach to transit fare prepayment pricing that is used throughout this chapter. It should be remembered from earlier chapters that, since no new riders are generated, the consequence of giving discounts larger than those justified for cost reasons is to divert cash riders, which will result in a net revenue loss.

Table 6-1

NET OPERATING COST SAVINGS OF TICKET BOOK PROGRAMS -- 1981

(cents per prepaid trip)

Fare Prepayment Plan	Fare Prepayment Costs[a]	Cost Savings[b]			Net Savings	Savings as a Percentage of Fare[c]
		Coin Handling	Dwell Time	Interest		
10-Trip Ticket Book	1.50	1.58	0.45	0.06	0.59	0.91%
20-Trip Ticket Book	1.20	1.58	0.45	0.13	0.96	1.48%
40-Trip Ticket Book	1.10	1.58	0.45	0.26	1.19	1.83%

[a]Table 4-2

[b]Chapter 2

[c]Based on fare of $0.65.

Implicit Discounting

Transit fare prepayment plans that offer implicit or potential discounts include passes and permits. The potential discount provided by these plans depends on the frequency of their use. The more often one travels with a monthly pass, for example, the lower the average fare paid and the greater the discount. In terms of the economics of fare prepayment plans, pricing of both passes and permits is analogous to "two-part tariffs" where there is a fixed

charge equivalent to the pass or permit price, and a marginal charge per trip taken. For pass plans the marginal charge is zero; for permits it is equal to the cash drop.[3]

Passes are usually offered to the general public and the complete price is paid in advance. Individuals holding passes can use the transit service as often as desired at no additional cost. In some cities this has resulted in very high average trip rates as shown by the data in Table 6-2. Notice that the average pass user in every city is riding more often than would be required to break even at the equivalent cash fare level. Consequently, the average pass user is receiving an effective discount over the cash fare. In the larger cities where the opportunities for off-peak and weekend transit travel are the greatest, the average monthly trip rates are over 50. In Milwaukee and Chicago the average number of monthly unlinked trips is 91 and 107 trips respectively.

Table 6-2

AVERAGE MONTHLY TRIP RATES FOR PASS HOLDERS IN SELECTED CITIES[a]

City	Pass Type	Average Monthly Trip Rate[b]	Break-Even Trip Rate
LARGE CITIES			
Los Angeles	Monthly	78.0	40.0
Milwaukee	Weekly	62.4	43.3
Chicago	Monthly	59.5	50.0
Philadelphia	Monthly	58.0	49.2
Oakland	Monthly	56.3	36.0
MEDIUM CITIES			
Ottawa-Carleton	Monthly	55.9	30.0
St. Louis	Monthly	53.6	48.0
Portland	Monthly	51.4	32.3
St. Paul	Monthly	47.2	40.0
SMALL CITIES			
Sacramento	Monthly	46.2	34.3
Tucson	Monthly	41.6	34.3

[a]Pass programs shown are for adult base passes only

[b]Linked trips only

[3]For a more comprehensive discussion on the economics of pass and permit plans, see: Armando M. Lago and Patrick D. Mayworm. "Economics of Transit Fare Prepayment: Passes." Transportation Research Record 857. Transportation Research Board, Washington, D.C. 1982.

How high the pass is priced relative to the equivalent cash fare will also affect the average trip rate. Pass plans with high break-even rates tend to be attractive only to those who ride frequently. Thus, the average trip rate for pass buyers should increase and decrease with the break-even rate. The data provided in Table 6-3 on Seattle's monthly pass program over several years provides some evidence in support of this theory.

Table 6-3

ACTUAL TRIP RATES AND BREAK-EVEN RATES FOR THE MONTHLY PASS PROGRAM IN SEATTLE

Year of Survey	Break-Even Rate	Trip Rate
1979	32.50	47.28
1981	38.00	50.79
1977	43.30	53.00

Source: 1981 figures computed by Ecosometrics from data collected on-site. 1979 and 1977 figures from Patricia A. Fullmer. Metro Monthly Pass Survey. Prepared for Seattle Metro Transit. Quality Controlled Services, Seattle, Washington, 1977 and 1979.

The analysis of monthly pass programs presented in Chapter 2 showed that most pass trips are trips that were previously taken and paid for in cash, although some off-peak trip generation has been acknowledged. Since the average pass user is receiving a significant discount over previous cash fare levels, many transit companies are witnessing huge revenue losses. To illustrate the revenue loss potential due to cash fare diversion, consider the cash ridership trip frequency data for St. Louis shown in Table 6-4. If the monthly pass is priced at 40 times the equivalent one-way cash fare, 9.5 percent of the regular transit riders will receive an instant price discount averaging 20 percent over what they paid previously.[4] Transit management's only hope is that cash

[4]This assumes that all riders taking more than 40 trips per month will buy a monthly pass and not ride more often.

riders in the 32-40 monthly trip rate category will buy a pass priced at 40 times the one-way fare. This, however, seldom happens and revenue loss occurs when a monthly pass is introduced for the first time.

Table 6-4

MONTHLY TRIP RATE DISTRIBUTION OF CASH RIDERS IN ST. LOUIS BEFORE THE INTRODUCTION OF THE MONTHLY PASS

Number of Monthly Trips	Proportion of Cash Riders	
70	0.5%	
56	2.0	9.5% Receive Discount
50	3.0	Averaging 20%
44	4.0	
40	25.0	Pass Priced at 40
36	11.5	Trips per Month
32	12.0	
28	1.0	
24	8.0	
20	7.0	
16	8.0	
12	2.0	
8	10.0	
4	2.0	
2	4.0	
	100%	

Source: W.C. Gilman and Company (1964), op. cit.

Pass programs, therefore, are seldom self-financing since pass holders can travel as often as they like. Many economists argue that this is inefficient and that in an optimal two-part tariff structure, the marginal or per trip charge should be set equal to the marginal cost each user imposes on the system and not equal to zero as in the case with passes. For pricing transit services, this suggests that the fixed charge should be set at the individuals' maximum willingness to pay, while the per trip cost should be set equal to the marginal cost of off-peak service. These are the basic characteristics of permit plans.

Permits were once popular when transit companies were privately owned and operated. Today, permit plans provide an ideal procedure for implementing two-part tariffs. In the first place, permit plans provide a relatively easy method of discriminating among user groups with different fare elasticities, such as commuters, students, and the elderly. Moreover, permit plans allow the transit company to charge a per trip fare equal to the marginal off-peak cost. The per trip charge is usually paid in cash but could be paid with tickets in order to preserve the economic advantages of fare prepayment plans.

Permit plans offer another advantage over pass plans in that they provide an excellent adjunct or supplement to distance-based fare structures, enabling distance-based fares to reflect the demand elasticities unique to each user group. Although there has been very little experimentation with permit plans, we note that the plan offered in Bridgeport, Connecticut contains some of these features.

GUIDELINES ON PRICING FARE PREPAYMENT PLANS

Through market group identification, transit fare prepayment plans can offer a transit manager more opportunities for meeting specific revenue and ridership goals. In addition, properly priced fare prepayment plans may be instrumental in diverting certain groups of riders from the more expensive peak period. Fare prepayment plans, therefore, can be key elements of a fare policy that attempts to maximize ridership levels for selected groups and maximize the revenues obtained from the entire system.

This section presents guidelines on pricing fare prepayment plans. The plans most appropriate for time-of-day and distance-based fare structures are presented first, followed by pricing recommendations for fare prepayment plans designed for specific market groups. Special fare programs are also reviewed. The pricing recommendations are summarized in Tables 6-5 through 6-7.

The authors want to emphasize that they are not advocating that transit companies reduce fares when discounts are recommended. Instead, full-priced services should be increased over time with the discounts representing differences in the prices offered. Thus, if off-peak discounts are contemplated, peak period fares should be increased until the recommended off-peak discount is established.

Table 6-5

GUIDELINES ON PRICING PLANS IN DIFFERENT FARE STRUCTURES

Fare Structure	Type of Plan	Pricing Guidelines
Flat Fare Structure	Tickets, Tokens, and Punch Cards	No discount if less than 20 trips are purchased in advance
		1-5% discount if more than 20 trips are purchased in advance
	Passes and Permits	Price for commuter market (see Table 6-5)
Peak/Off-Peak Fare Structures	Unrestricted Plans as Above	As above
	Off-Peak Restricted Plans	10-20% discount over unrestricted prices described above
Zone Fare Structures	Base Zone Plans as Above	As above
	Outer Zone Tickets, Tokens, and Punch Cards	No discount over equivalent cash zone fare if less than 20 trips are purchased in advance
		1-5% discount over equivalent cash zone if more than 20 trips are purchased in advance
	Outer Zone Passes and Permits	Equivalent cash zone fare times number of one-way commuter trips

Table 6-6

GUIDELINES ON PRICING PLANS FOR SELECT TARGET GROUPS

Target Group	Type of Plans	Pricing Guidelines
Commuter	Tickets, Tokens, and Punch Cards	No discount if less than 20 trips are purchased in advance
		1-5% discount if more than 20 trips are purchased in advance
	Monthly Passes	52-60 times the peak fare in large cities
		43-52 times the peak fare in small cities
		40-45 times the peak fare for distant commuters
	Annual Passes	11 times the appropriate monthly pass price
	Weekly Passes	10-15 times the peak fare
Shopper	Off-Peak Day Passes	2-3 times the off-peak fare or 1-2 times the peak fare
	Off-Peak Tickets	No discount over existing off-peak fare or 10-20% discount over peak fare
College Student	Tickets	No discount if less than 20 trips are purchased in advance
		1-5% discount if more than 20 trips are purchased in advance
	Off-Peak Tickets	10-20% discount over unrestricted prices just described
	Semester Passes	3 1/2-4 times the appropriate monthly pass price
	Off-Peak Semester Passes	10-20% discount over the appropriate unrestricted semester pass price
Transit Dependent	Off-Peak Tickets and Permits	50% discount over peak fare according to Federal law
		10-20% discount for others[a]
Tourist	Day Passes	3-times the peak fare for each day of validity
	Off-Peak Day Passes	3-times the off-peak fare for each day of validity
	Off-Peak Tickets	Off-Peak Fare or 10-20% discount over peak fare

[a]Discounts above this level should be subsidized and administered by a welfare or social service agency through a user-side subsidy program.

Table 6-7

GUIDELINES ON PRICING SPECIAL FARE PROGRAMS

Special Fare Program	Type of Plans	Pricing Guidelines
Special Routes and Districts	Off-Peak Tickets and Tokens	10-20% discount over peak fare
	Off-Peak Day Passes	2-3 times the off-peak fare or 1-2 times the peak fare
Park and Ride	Tickets and Punch Cards	Price for commuter market (see Table 6-6) plus the cost of daily parking
	Passes	Price for commuter market (see Table 6-6) plus the cost of daily parking times the number of pass days
Introductory and Promotional	Tickets (Dated)	10-20% discount over peak fare
	Day Passes	1-2 times the peak fare

Pricing Plans By Fare Structure

Although there are many different types of fare structures a transit company can adopt, the three principal forms are flat fare, peak/off-peak fare, and distance-based fare structures. Guidelines on pricing plans for different fare structures are presented in Table 6-5.

All of the fare prepayment plans discussed in this report are appropriate for transit companies with flat fare structures since only one form of the fare prepayment plan has to be provided. Tickets, punch cards, and tokens should be provided with no discount over cash unless 20 or more rides are purchased in advance. Discounts of between one and five percent are then possible, however, the authors recommend offering no discounts to avoid revenue losses. As was shown in Table 6-1, an appropriate pricing policy is not to extend discounts greater than 2-3 percent unless other benefits are realized, such as peak to off-peak travel time shifts. Weekly or monthly passes for the general public are also appropriate and should be priced for the frequent user and commuter market.

Transit companies with peak/off-peak fare differentials have rarely provided fare prepayment plans restricted to only peak or off-peak periods. Nevertheless, all fare prepayment plans can have peak or off-peak restrictions. For example, two types of monthly passes are provided at different price levels in Duluth, Minnesota to encourage commuters to shift their morning work arrival time by only 15 minutes.[5] The full day, unrestricted pass sells for $20 and the pass restricted from only a 30-minute period during the peak of morning rush hour sells for $17, a 15 percent discount. Although the demonstration is not completed, the project appears to have had a small but significant impact on morning peak demand.

Similarly, a demonstration project in Tucson, Arizona was designed to test the appropriateness of fare prepayment plans for college students. In response to an unexpected increase in transit demand during the early morning peak, both peak and off-peak 20-ride punch cards and semester passes were sold to students to encourage morning peak users to ride after 9:00 a.m. The off-peak semester pass cost 20 percent less than the all-day pass, and the off-peak punch card was 22 percent less expensive than its all-day counterpart. This pricing structure was effective in reducing peak morning transit usage by students,

[5]Patrick D. Mayworm and Armando M. Lago (1979), op. cit.

even as the fare prepayment program expanded. Without peak/off-peak pricing, 25.5 percent of daily student transit travel occurred between 6 and 8 a.m. With differential pricing, this proportion dropped to only 14.9 percent.

As already mentioned, punch cards and passes can be used to differentially price transit by time-of-day. Tickets and tokens can also be restricted to select periods of the day. Plans restricted to the off-peak hours can be priced anywhere between 10 and 20 percent below their unrestricted counterparts to reflect operating cost differences. Passes restricted to the off-peak period can act as permits during peak hours by requiring pass holders to deposit cash into the farebox. The cash drop should be as high as 25 cents.[6] This method of pricing is especially attractive for companies seriously considering permit plans for commuters.

Distance-based fare structures in most transit companies in this country are in the form of zone fare structures. Thus, the more zone boundaries one crosses, the more one must pay. Passes of different denominations are available in some cities, with each denomination corresponding to a specific zone or set of zones. This requires the transit company to either print many pass denominations, or print one pass and a stamp or sticker corresponding to each outer zone. The stamp or sticker can be fixed to the base pass. An even simpler and lower cost option is to print only one, base-zone pass and use it as a permit for trips to and from all outer zones. This is especially useful in cities where a majority of the passenger trips occur in the first zone.

Tickets and punch cards (and to some extent passes) have been used frequently in zone fare systems, especially for commuter railroad service. Like passes, tickets can be printed in several denominations corresponding to the zones in the system. A more common policy in European cities is to print only one ticket type and require one ticket to be validated or deposited into the farebox for each zone crossed during any trip. Similarly, punch cards can be designed for zone fare structures with a hole punched for each zone crossed. The card is no longer valid when all the holes are punched.

Whether the plan used for the zone fare system is a pass, ticket, or punch card, the incremental fare charged for each zone should approximate the marginal cost of providing the extended trip. The larger the distance between zone

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[6]The cash drop should be at least as great as the difference between peak and off-peak cash fares.

boundaries, the larger the incremental charge. The incremental charge in small zone systems should be $0.10 to $0.15 per zone, while in larger zones the incremental charge can be as high as $0.50.

Zonal charges for monthly pass plans should be computed from the incremental zone fares for cash payers and the expected average monthly commuter trip rate from the outer zones. The trip rates for these users should be lower than the trip rates for pass users from the base zone since there are usually less opportunities for off-peak, evening, and weekend travel for suburban commuters. Discounts, however, should not be offered since suburban commuters generally exhibit the highest incomes and the lowest fare elasticities of demand.

Pricing Plans For Selected Markets

In addition to identifying the basic fare structure for the majority of transit trips, transit managers have usually identified specific groups for whom reduced or premium fares should be charged. Transit fare prepayment plans are ideal for target pricing since the plans designed for one group usually cannot be bought or used by another. Fare prepayment also facilitates the enforcement of different fare categories by the driver. The five most common market groups that are served by transit and for whom fare prepayment plans are appropriate include commuters, shoppers, students, the transit dependent, and tourists. Each of these categories were described in some detail in Chapter 4 and the most appropriate fare prepayment plans were identified. This section presents guidelines on how these plans should be priced. The pricing guidelines are summarized in Table 6-6.

Commuter Plans

Commuters should be provided with long-term plans such as annual or monthly passes and 40-trip ticket books. In cities where most commuters cannot afford the front-end cost of long-term plans, 20-trip tickets or weekly passes may be appropriate. Trip-limited plans, such as ticket books and punch cards, should be priced at the equivalent peak period cash fare. For bulk purchases, such as 40-trip ticket books, a discount of no more than 5 percent may be appropriate to encourage ticket usage. Such a small discount will have a negligible effect on peak period riding.

Monthly passes are primarily designed for the frequent transit user and should be priced accordingly. Although each transit company is unique in terms of its ridership distribution and off-peak travel opportunities, some guidelines on the proper pricing of monthly passes can be advanced. In large transit systems in which off-peak service levels are relatively high, monthly passes should be priced between 52 and 60 rides. In some cases passes can be priced at levels over 60 times the base fare. For smaller systems in which the potential for greater off-peak travel is limited, monthly passes could be priced at lower levels of 43 to 52 riders. Suburban commuters (for example on commuter railroads) and express bus rides generally do not use transit service during the evenings and on weekends and prices of 40 to 45 times the one-way cash equivalent fare may be appropriate. Nevertheless, transit managers must be sure that there is enough off-peak capacity to serve the extra off-peak ridership generated by monthly pass users. If monthly passes are priced at/or below the trip rates recommended above, revenue losses will occur, thereby exacerbating the difficult financial position of transit companies.

Weekly passes and annual passes exhibit the same effects as monthly passes and, therefore, care must be taken when pricing these plans for the commuter market. Weekly passes should be priced at 10 to 15 one-way peak period rides. Because of vacations and holidays, annual passes should be priced at eleven times the monthly pass price and restricted to an individual.

Finally, fare prepayment plans sold through places of employment should not be permanently discounted by the transit company; however, every attempt should be made to encourage employers to subsidize transit for their employees. Short-term promotional discounts to encourage the buildup of an employer-promoted program may be appropriate. In Sacramento, for example, a 25 percent discount was offered to all monthly pass purchases at places of employment over a three-month period. The new riders attracted by the discount who continued to use transit after the discount ended appeared to have generated sufficient revenues during an eight-month period to recover the $12,000 lost during the three-month sales period.[7] Although offering permanent discounts to commuters using monthly passes will always result in revenue losses, short-term promotional discounts may be appropriate for specific purposes and under certain conditions.

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[7]Douglas Daetz and Michael Holoszyc (1981), op. cit., p. 7-6.

Shopper Plans

Shoppers seldom use transit during the morning rush hour, but often return home during the evening rush hour. In order to encourage individuals to make shopping trips by transit and at the same time discourage travel during the peak hours, off-peak fare prepayment plans discounted over the peak period fare should be designed and marketed.[8] Day passes or 10-trip ticket books or strip tickets are appropriate plans for this purpose. Day passes should be priced at two or three times the off-peak discounted fare; tickets should be priced at the off-peak rate. All shopper plans, however, should be restricted to the off-peak hours, evenings, or weekends.

Student Plans

It is difficult to provide guidelines on the pricing of fare prepayment plans for grade school and high school students since decisions on such plans are a matter of public policy to be determined by each transit company and its local government and school board. If reduced fares are to be charged, permits, tickets, and tokens can be used.

College students, however, should not be given large discounts since they often take transit trips during peak hours. Semester passes and multiple-ride tickets restricted to the off-peak period may be appropriate in some communities and discounts from 20 to 30 percent are recommended.

Plans for the Transit Dependent

Plans designed and administered for the transit dependent could include day passes, tickets, and permits. Unlike other market groups, the prices charged for targeted disadvantaged groups are usually determined by public policy. However, the reduced fares that result should be subsidized by the city government or public welfare agency and not by the transit company. Public transportation is not a welfare service. A user-side subsidy program

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[8] Off-peak shopping trips can be promoted without substantial discounts by involving downtown merchants in the promotional effort. For a description of one method, see Peter B. Everett. "Management Plan for Token Reinforcement for Off-Peak Patronage in Spokane, Washington." Prepared for the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. The Pennsylvania State University, University Park, Pennsylvania. November 4, 1980.

funded and administered by an appropriate welfare agency would allow the transit company to price its services more efficiently, while still providing certain groups with subsidized transportation. Perhaps the most serious problem in the way we price transit service today is in our desire to maintain low fares for the transit dependent. By not selectively targeting the fares we charge, we have instead acknowledged a fare policy that provides low fares to all transit users, including those willing and able to pay much more.

Tourist Plans

Tourists will generally find ticket books or weekend and day passes appropriate for their travel needs. In order to encourage off-peak use of the transit system, all tourist plans should be restricted to off-peak hours. Since tourists usually take more than two trips each day, multiple day pass plans should be priced at three times the one-way off-peak fare for each day of pass validity. Multiple-ride tickets should be priced at the off-peak or marginal trip rate.

Pricing Special Fare Programs

Although there are numerous special fare programs that a transit company can develop, the three most common applications for which fare prepayment plans may be appropriate are presented below. The pricing guidelines for these programs are summarized in Table 6-7.

Plans for Special Routes and Districts

Transit fare prepayment plans have been designed for selected routes or districts in order to encourage ridership. These programs are almost always designed to increase off-peak ridership for shopping or recreational purposes. Consequently, the plans have been short-term passes or low-quantity tickets with a fare policy that mirrors off-peak and shopper programs. Thus, discounts on the order of 10 to 20 percent are appropriate if the travel occurs during off-peak hours or on weekends.

Park-and-Ride Plans

Most park-and-ride services are designed to help the commuter get to and from work by public transportation. Convenience and travel time savings are the most important factors affecting the success of such programs, not price. Consequently, monthly passes or other commuter plans should be provided and priced to cover the added expense of the parking facility. Depending on the type and location of the parking facility, the price charged for the fare prepayment plan should be augmented anywhere from $0.50 to $2.00 per day. It is not unusual, therefore, that a monthly pass park-and-ride program in a large urban area could cost twice as much as the monthly pass itself.

Introductory and Promotional Plans

Introductory plans should be used selectively over short periods of time (i.e., one to two months) to encourage ridership on specific routes, in new areas, or as a promotion for a new program. Trip-limited plans should not be used unless they are dated. In the Phoenix, Arizona and Austin, Texas reduced-price promotion demonstrations, tickets were favored over passes during the one-month discount period primarily because they were valid after the discount period.[9] Reduced-price promotion should be selective and carefully planned since new buyers are usually regular cash users. Moreover, the objectives of a promotional pricing campaign should be clearly stated before implementing such a program. Revenue generation should never be an objective of reduced fare pricing because transit demand is price inelastic.

SUMMARY

The appropriateness of using fare prepayment plans as instruments of fare policy was reviewed in this chapter, and guidelines on pricing options were presented. The chapter began with an introduction on the economics of fare prepayment plans, which, by their pricing feature, can be categorized into trip-limited and time-limited plans. Trip-limited plans, such as tickets, can

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[9]See: Pamela Bloomfield and John Crain. Transit Fare Prepayment Demonstrations in Austin, Texas and Phoenix, Arizona. Final Report. Prepared for the Transportation Systems Center, U.S. Department of Transportation. Crain and Associates, Menlo Park, California. June 1979.

be sold at full fare or at an explicitly defined discount level. The ridership and revenue impacts of pricing trip-limited plans are similar to the impacts of cash fare policies.

Time-limited plans, such as passes, offer potential discounts to their users since travel frequency is usually not restricted during the period of validity of the pass. The more frequently one travels, the greater the discount received. Pricing pass plans, therefore, requires careful consideration of pass usage, cash fare diversion, off-peak usage, and trip generation. Unfortunately most monthly pass programs were developed without consideration of all these factors and substantial revenue losses have resulted due to underpricing.

The second half of this chapter was dedicated to presenting guidelines on pricing fare prepayment plans designed for specific markets. Pass and ticket plans designed for the commuter should be priced at the full peak period fare. Very long-term plans, such as 40-trip tickets, can be provided with discounts of one to five percent in proportion to the savings received as a result of fare prepayment usage (see Chapter 2). Weekly, monthly, and annual passes must be priced carefully and at least capture the revenue foregone from previous cash purchases.

Other fare prepayment plans should be designed for specific markets which encourage travel during the off-peak hours. Off-peak pricing of fare prepayment plans should reflect the lower cost of providing off-peak service, but discounts beyond 25 percent over the peak period fare should be avoided. If special low-fare programs for the transit dependent are considered appropriate policy, fare prepayment plans should be subsidized and administered by a welfare agency through a user-side subsidy program. This special funding procedure gives the transit company the ability to price its services more efficiently. Fare prepayment plans, therefore, can be instrumental in helping a transit company increase passenger revenues with minimal impact on the population.

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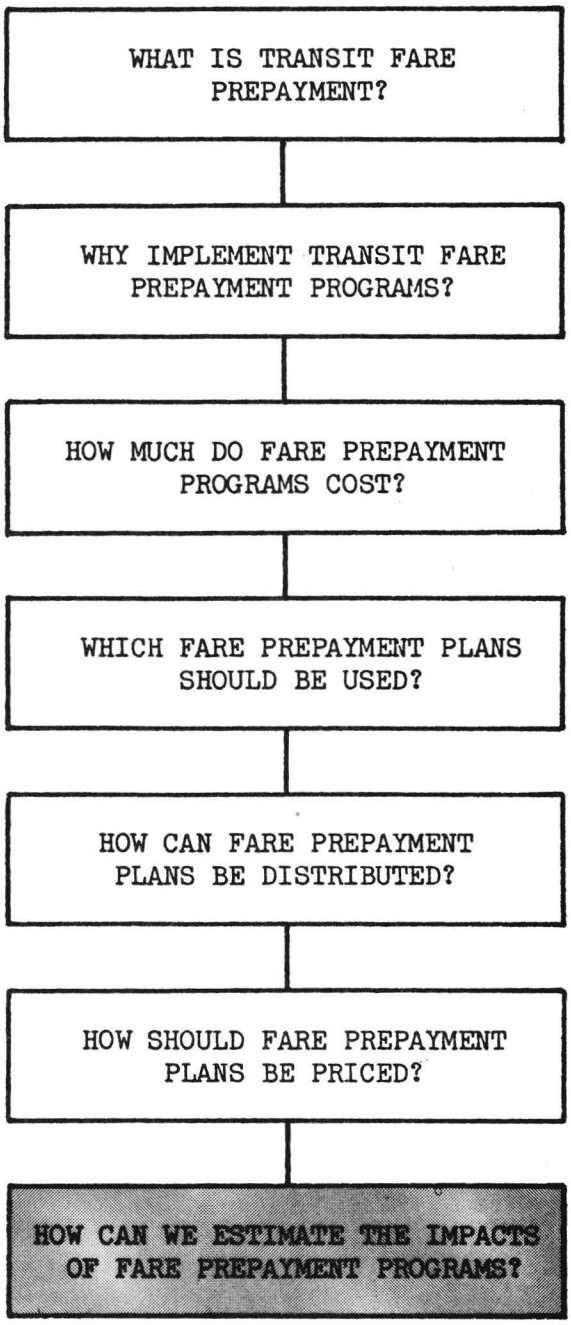
WHAT IS TRANSIT FARE PREPAYMENT?
WHY IMPLEMENT TRANSIT FARE PREPAYMENT PROGRAMS?
HOW MUCH DO FARE PREPAYMENT PROGRAMS COST?
WHICH FARE PREPAYMENT PLANS SHOULD BE USED?
HOW CAN FARE PREPAYMENT PLANS BE DISTRIBUTED?
HOW SHOULD FARE PREPAYMENT PLANS BE PRICED?
HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

7

HOW CAN WE ESTIMATE THE IMPACTS OF FARE PREPAYMENT PROGRAMS?

Decisions on the implementation of any transit policy are usually based on careful consideration of the impacts the policy will have on ridership, revenues, and operating and capital costs. Policies on the design of fare prepayment programs are no different and can, in fact, have a significant impact on ridership and revenues. For example, in the last chapter, it was pointed out that a low price charged for fare prepayment plans can have a detrimental effect on system-wide passenger revenues since most purchasers of discounted plans are diverted cash users. The price discount, however, will have a positive effect on sales and a marginal impact on ridership. Thus, a decision on fare prepayment pricing essentially involves trading-off revenue losses against ridership and sales improvements. This chapter provides some of the basic tools and guidelines for estimating program impacts so that more informed decisions can be made before a program is implemented or changed.

Decisions on fare prepayment program design and pricing are usually based on projected ridership, sales, and revenue levels. In addition, understanding and estimating a program's operating costs are important since a decision on whether or not to implement a program should be based on a complete analysis of the program's costs and benefits. Since an analysis of program costs and benefits was discussed in Chapters 2 and 3, this chapter will focus on techniques and formulae for estimating fare prepayment program impacts on ridership,

sales, and revenues. Specifically this chapter presents the steps that should be followed for estimating these impacts as a result of either the introduction of a new plan or changes in the price structure of an existing plan. A brief discussion of the impacts of adopting short-term promotional discounts is also provided. The chapter concludes with a summary of the analysis tools presented here.

ESTIMATING THE IMPACTS OF NEW FARE PREPAYMENT PLANS

Accurately estimating the impacts of new fare prepayment plans is a large task that requires detailed information on the characteristics of the transit system, its riders, and the type of fare prepayment program to be put in place. For example, actual sales of new monthly passes will depend, in part, on the ridership distribution by tripmaking frequency, the level of marketing effort, the number of conveniently located sales outlets, and the number of months after the initial introduction of the pass. These and other factors must be considered when planning the introduction of new fare prepayment plans. This section of the chapter provides a framework for the analysis of ridership, sales, and revenue impacts, as well as a series of straightforward models that can be used for estimating such things as the average number of trips taken by pass users and the long-term market penetration of adult fare prepayment plans.[1]

Table 7-1 provides a summary of the steps presented here for estimating the ridership, sales, and revenue impacts of new programs. Each of these seven steps is described below in detail.

Step 1: Collect Appropriate Statistics

The first step in this analysis is to bring together some basic information on the transit system and on the fare prepayment program that is proposed for

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[1]Although there are a few sophisticated logit models of fare prepayment (mostly for monthly passes), such as those by Lawrence B. Doxsey (1982) and Elizabeth Page (1981), they have not been adopted here because the thrust of this analysis is to develop models that can be easily applied. Doxsey's and Page's models require a greater degree of information than the one presented here. Moreover, they require tripmaking information on each rider in a sample and do not produce estimates of the number of trips taken. These models, while a welcome addition to the literature, are still in an early stage in their eventual application. They are also applicable only in the cities in which they were calibrated, thereby lacking the flexibility required of the guidelines provided in this chapter.

Table 7-1

SUMMARY OF THE STEPS TO FOLLOW
WHEN ESTIMATING THE IMPACTS OF NEW PLANS

Step 1:	Collect Appropriate Statistics -- Some statistics on the transit system and information on the new fare prepayment program must be collected in order to estimate the impacts of the new program.
Step 2:	Compute Average Trip Rate -- The average number of trips taken per instrument is critical for computing the discount offered. Although the trip rate is explicitly known for tickets, tokens, and punch cards, the average trip rate for pass programs must be estimated using the models provided.
Step 3:	Compute Effective Discount Rate -- Based on the price charged and the average trip rate, it is then necessary to compute the discount offered to the average plan user.
Step 4:	Compute Market Penetration Rate -- Based on the characteristics of the plan, including average trip rate and discount rate, one can then estimate the degree of market penetration that can be expected in the future. A model is also provided for this purpose.
Step 5:	Compute New Ridership Levels by Fare Category -- The next step in the sequence is to determine the new total ridership level, as well as the ridership levels by fare category.
Step 6:	Compute Total Fare Prepayment Sales per Period -- Using the new ridership and average trip rate figures, one can compute the number of instruments that will be sold per period.
Step 7:	Compute New Revenue Levels -- In this final step, new revenue levels are computed from pricing, ridership, and sales information.

implementation. Although much more information should be assembled as part of a detailed planning and design process, only a few statistics are required for the preliminary analysis proposed here. The information required includes:

Existing Transit System Statistics

- Total monthly revenue passengers
- Total monthly passenger revenues
- Annual vehicle miles of service provided
- Peak-to-base ratio (i.e., number of vehicles utilized during the peak divided by the number of vehicles utilized during the off-peak)
- fare elasticity of demand
- average one-way cash fare

New Fare Prepayment Program Statistics

- Type of fare prepayment plan proposed (e.g., monthly pass, 10-trip ticket)
- Number of trips that can be taken per instrument (for trip-limited plans only)
- Price of the plan
- Break-even rate for time-limited plans (i.e., price of the plan divided by the equivalent one-way fare)

As the reader will note, the information identified above is all that is needed to perform the calculations that follow.

Step 2: Compute Average Trip Rate

The number of trips taken per fare prepayment instrument by transit riders depends on the type of plan purchased. For trip-limited plans, no computations are necessary. A 10-trip ticket book, for example, can be used for only 10 one-way trips, a 45-trip ticket book for 45 one-way trips, etc. Since ticket books, punch cards, and tokens are trip-limited plans, the number of trips that can be taken per instrument is explicitly known.

Time-limited plans, such as passes and permits, generally do not have limits on the number of trips that can be taken during any period of time. As shown in Table 6-2 of Chapter 6, the average trip rate for monthly pass buyers is above 40 trips per month. Moreover, the actual number of trips taken per month appears to be related to at least two factors: the degree of off-peak service available and the break-even rate. It makes intuitive

sense that pass holders will exhibit more tripmaking as the opportunities for off-peak riding increase. Transit properties with considerable off-peak service (generally the larger properties) will find that pass users ride quite often.

How high the pass is priced relative to the equivalent cash fare will also affect the average trip rate. Pass plans with high break-even rates tend to be attractive only to those who ride frequently. Thus, the average trip rate for pass buyers should be positively correlated with the break-even rate.

To test these theories, the authors collected data on the trip rate experiences of 23 transit companies nationwide and ran an ordinary least-squares regression on these cross-sectional data. The result of this exercise yielded the following expression:

$$(1)\quad \ln MTRIPS = 3.7619 + \underset{(7.66)}{0.0829}\ \ln(VMILES/PBRATIO) + \underset{(3.42)}{0.0898}\ DBK; \qquad R^2 = 0.455 \quad (23 \text{ cases})$$

where the numbers in parentheses are the F-statistics of the regression coefficients, ln represents logarithmic transformations to base e (i.e., natural logarithms), and the variable definitions are given by:

MTRIPS = average number of trips taken per month per pass holder

VMILES = total number of annual vehicle (passenger car) revenue miles of service provided in millions[2]

PBRATIO = ratio of the number of revenue vehicles operated during the peak to the number of revenue vehicles operated during the base

DBK = dummy variable for the monthly break-even rate, which takes on a value of 1 if the actual equivalent break-even rate is greater than or equal to 40 one-way trips per month, or 0 if the actual equivalent break-even rate is less than 40 one-way trips per month[3]

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[2]The model is only appropriate for transit companies operating more than one million annual vehicle revenue miles of service. Guidelines for companies operating less than one million annual vehicle revenue miles are presented in the text.

[3]Every attempt was made to model the actual break-even rate instead of relying on the dummy variable. However, the multicollinearity between the actual break-even rate and the level of off-peak service made it difficult to develop statistically significant coefficients for the break-even rate variable. The best model developed with the actual break-even rate variable is presented below.

$$MTRIPS = 37.6353 + \underset{(24.04)}{0.5419}\ (VMILES/PBRATIO) + \underset{(1.33)}{0.2690}\ MBKEVEN; \qquad R^2 = 0.590 \quad (23 \text{ cases})$$

The variable definitions used in Equation (1) are used here except MBKEVEN, which represents the actual monthly break-even trip rate instead of the dummy variable. Notice that the dependent variable is the actual monthly trip rate and not the logarithmic transformation of this variable.

This equation is based on observations of weekly, bi-weekly, monthly, and annual passes, and can be used to estimate average trip rates for each of these plans. However, since the model was calibrated from data on equivalent monthly trip rates, the actual break-even rates for annual, bi-weekly, or weekly passes must be converted to equivalent monthly rates for use in Equation (1). This is done simply by dividing the annual pass break-even rate by 12 and multiplying the break-even rate for bi-weekly and weekly passes by 2.16 and 4.33 respectively.

Similarly, the output of the model provides an estimate of the average number of trips taken per month by the pass buyer. The average trip rate for an annual pass user should be 12 times the output suggested by Equation (1), while the output should be divided by 2.16 and 4.33 for bi-weekly and weekly passes respectively.

The ratio of annual vehicle miles of service to the peak-to-base ratio was selected as the variable to represent the level of off-peak service only because data on off-peak service are not easily available. The ratio selected is statistically significant and is a good proxy for off-peak vehicle miles of service.

Equation (1), therefore, can be used to forecast how many trips will be taken by the average pass buyer. Figure 7-1 illustrates the relationship between vehicle revenue miles of service and monthly trip rate as described by the equation, assuming the peak-to-base ratio is 2.15 at all service levels. Notice that for very small transit properties, the predicted monthly trips rate drops quickly. The model, therefore, should be used only for properties operating more than one million vehicle revenue miles of service annually. For smaller systems, the following relationship is appropriate for all pass plans:

(2) $$TRIPS = 1.15 \times BKEVEN$$

where:

TRIPS = average number of trips taken per period per pass holder

BKEVEN = actual break-even rate of the pass plan

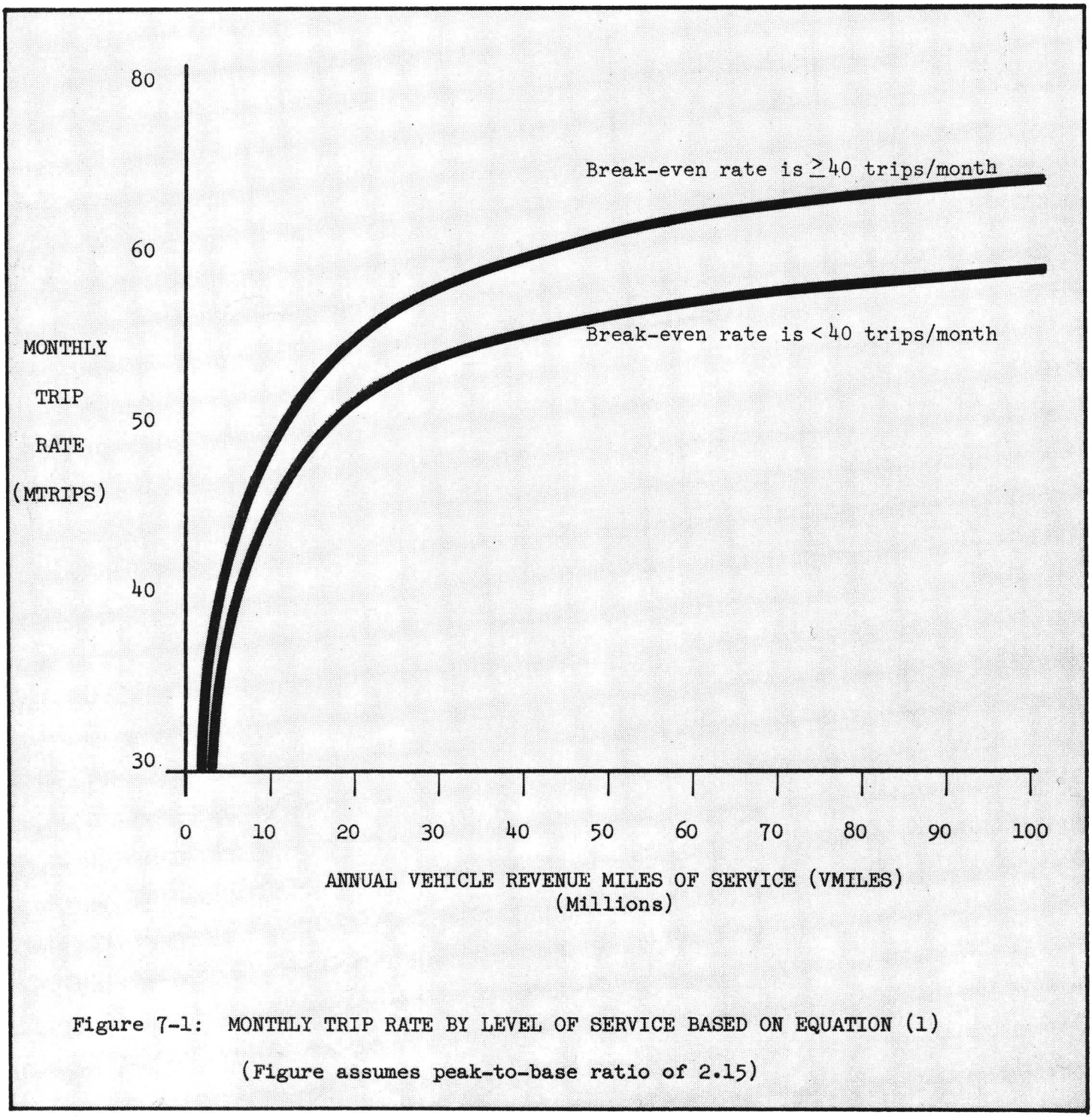

Figure 7-1: MONTHLY TRIP RATE BY LEVEL OF SERVICE BASED ON EQUATION (1)

(Figure assumes peak-to-base ratio of 2.15)

Step 3: Compute Effective Discount Rate

With the actual or average trip rate now known, it is possible to compute the discount given to fare prepayment buyers. The formula for computing discount is as follows:[4]

$$(3) \qquad DISC = \left(\frac{FARE - (PRICE/TRIPS)}{FARE} \right) \times 100$$

where:

DISC = actual or average discount rate provided for fare prepayment buyers, expressed as a percentage

FARE = equivalent one-way cash fare, in dollars

PRICE = full price of the fare prepayment plan, in dollars

TRIPS = average number of trips that are taken with the fare prepayment plan

All of the terms used in Equation (3) are self-explanatory. If the actual number of trips that can be taken by a particular fare prepayment plan is not known, Equations (1) or (2) should be used.

Step 4: Compute Market Penetration Rate

The marketing objective of any new fare prepayment program is to sell as many tickets or passes as possible. Generally, marketing managers will identify the degree of market penetration that they hope to achieve. Although many factors will affect the level of market penetration (including number of sales outlets, age of plan, and size of target population), the three most important variables appear to be the discount over cash fare, the length or period of validity of the plan, and the number of competing fare prepayment plans.

With the objective of being able to forecast market penetration, the authors collected data on 97 transit fare prepayment programs across the country. The model developed from this cross-sectional data set is presented below:

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[4]The derivation of this equation, as well as the derivation of all the numbered equations in this chapter, appear in Appendix C.

$$(4a)\quad \ln\left(\frac{\text{PENRATE}}{1-\text{PENRATE}}\right) = -\underset{}{1.1469} + \underset{(104.52)}{0.0597\ \text{DISC}} - \underset{(15.91)}{0.3874\ \ln\text{TRIPS}} - \underset{(14.46)}{0.2596\ \text{COMP}}$$

$$R^2 = 0.599 \quad (97 \text{ cases})$$

where the numbers in parentheses are the F-statistics of the regression coefficients, ln represents logarithmic transformations to base e (i.e., natural logarithms), and the variable definitions are given by:

PENRATE = proportion of total revenue passenger trips that will be taken with the fare prepayment plan, expressed as a decimal fraction

DISC = actual or average discount rate provided for fare prepayment buyers, expressed as a percentage as given by Equation (3)

TRIPS = average number of trips that are taken with the fare prepayment plan

COMP = total number of different fare prepayment plans that are available to revenue passengers

All of the coefficients in Equation (4a) have the correct sign. The coefficient for the discount variable is positive since one would expect the market penetration to increase as the discount increases. The coefficient for trips is negative, suggesting that the convenience of long-term plans is off-set by the inconvenience of paying high front-end costs. Finally, the coefficient for the variable representing the number of competing plans in the system is negative, indicating that the market share of a particular plan will decrease as the number of fare prepayment choices increases.

The model presented in Equation (4a) provides an estimate of the percentage of all revenue passengers that would use the fare prepayment plan once the program is fully established. The model, for example, does not provide an estimate of the market share of monthly passes for the adult market only. Since data on individual markets (e.g., adults, elderly, handicapped, and students) were not available, the authors calibrated the model for all revenue passengers. Moreover, the 97 cases used to calibrate the model are adult, general population plans and do not represent programs for specific markets, such as college student passes or off-peak shopper plans.

Penetration Adjustment Factors

Equation (4a) was estimated from a large data sample of 97 transit fare prepayment programs. This equation, however, excludes consideration of the impact advertising and marketing have on increasing market penetration because of the difficulty of collecting such data. One would expect that the more people are aware of a fare prepayment program and the easier it is to obtain a fare prepayment plan, the greater will be the volume of plans sold.

To test this theory, the authors collected marketing and advertising information at 16 transit companies and used this information to develop a series of adjustment factors that would compensate for very high levels of marketing and advertising. Specifically, the authors were interested in determining whether or not marketing and advertising could help reduce the errors resulting from the use of Equation (4a). Information on two variables were obtained:

- number of sales outlets, and
- advertising costs per rider.

The authors defined RESIDUALS as the difference between the actual and predicted estimates from Equation (4a) and developed the following adjustment factors:

Adjustment No. 1

$$\text{RESIDUALS} = -0.4091 + \underset{(11.83)}{0.0047}\ \text{OUTLETS}$$

$$R^2 = 0.497 \qquad (14 \text{ cases})$$

Adjustment No. 2

$$\text{RESIDUALS} = -0.2089 + \underset{(4.20)}{0.3741}\ (\text{AD/RIDER})$$

$$R^2 = 0.245 \qquad (15 \text{ cases})$$

Adjustment No. 3

$$\text{RESIDUALS} = -0.4579 + \underset{(13.91)}{0.0047}\ \text{OUTLETS} + \underset{(2.99)}{0.2787}\ (\text{AD/RIDER})$$

$$R^2 = 0.577 \qquad (16 \text{ cases})$$

The numbers in parentheses are the F-statistics of the regression coefficients and the variable definitions are given by:

RESIDUALS = actual minus predicted estimates of Equation 4(a)

OUTLETS = number of fare prepayment sales outlets (public, private, and employer)

AD/RIDER = ratio of monthly advertising expenditures (actual dollars) for this fare prepayment plan to the total number of monthly riders (cash and fare prepayment) in thousands

In the validation tests performed, the first adjustment factor involving only outlet information proved to be superior to the others and its use is recommended in conjunction with Equation (4a). Using this adjustment factor with Equation (4a) results in the following expression:

$$(4b) \qquad \ln\left(\frac{\text{PENRATE}}{\text{1-PENRATE}}\right) = -1.1469 + 0.0597\ \text{DISC} - 0.3874\ \ln\text{TRIPS}$$

$$-0.2596\ \text{COMP} + 0.0047\ \text{OUTLETS}$$

Figures 7-2 and 7-3 present the market penetration curves for 10-trip tickets and monthly passes based on Equation (4b).

Step 5: Compute New Ridership Levels by Fare Category

One of the most important impacts that must be considered before program implementation concerns the number of riders that will use the plan after implementation. In general, fare prepayment users behave in the same way as cash users. If the cost of riding is reduced, the number of trips that will be taken will increase. However, since ridership response to fare changes (including pass and ticket plans) is inelastic, price reductions will result in a

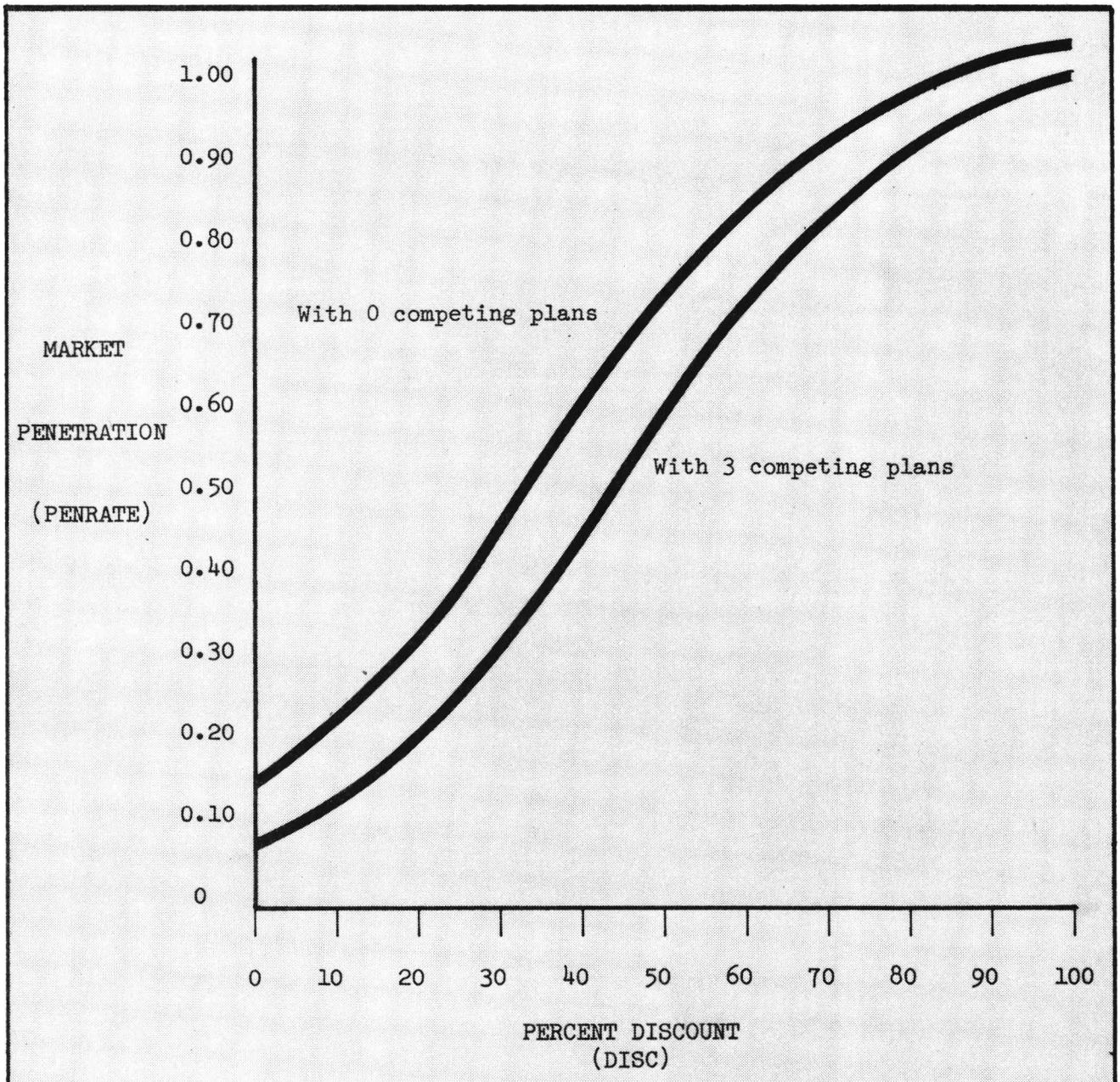

Figure 7-2: MARKET PENETRATION FOR A 10-TRIP TICKET AS A FUNCTION OF DISCOUNT OVER CASH AND NUMBER OF COMPETING PLANS

(Assuming 50 Outlets)

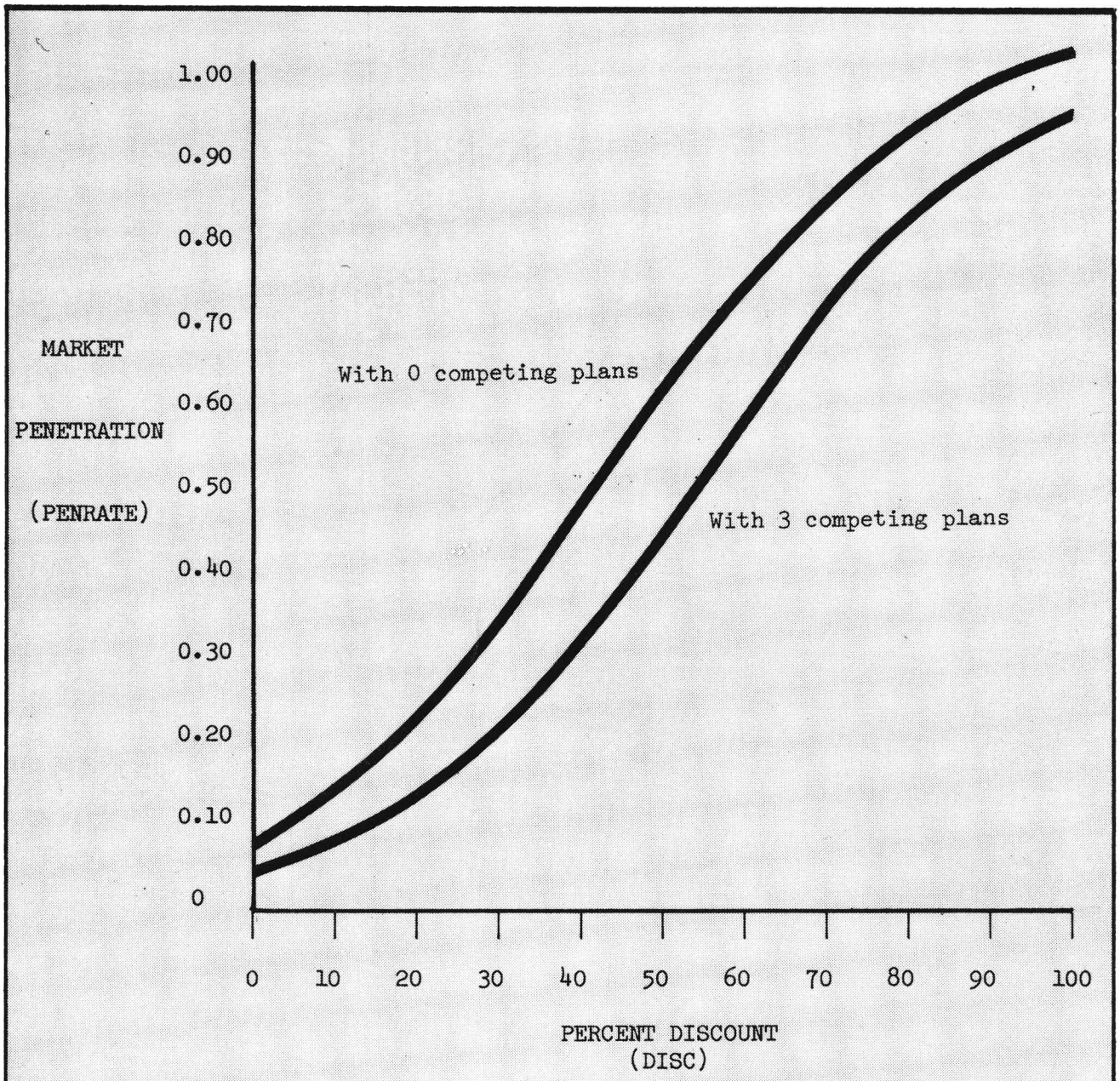

Figure 7-3: MARKET PENETRATION FOR A MONTHLY PASS AS A FUNCTION OF DISCOUNT OVER CASH AND NUMBER OF COMPETING PLANS

(Assuming 45 Trips Per Month and 50 Outlets)

revenue loss to the transit company.[5] The ridership response to the introduction of a new pass or ticket program, therefore, can be analyzed in a way similar to that used to estimate the ridership impacts of fare changes.

It is important to understand that the introduction of a new fare prepayment plan will have a negligible effect on attracting new riders to the system. The more common impact is that both infrequent and frequent transit users will ride more often if some discount is provided. Therefore, it is convenient to speak of new transit rides (by either frequent or occasional users) instead of new transit riders.

As illustrated in Figure 7-4, the sources of all prepaid transit trips include new or generated trips and trips previously paid for by cash or other prepayment plans. It is important to quantify both of these sources for the revenue calculations that follow.

To begin, we must estimate the number of trips that will be diverted from cash or other fare prepayment plans to the new prepayment plan. This ridership level is computed using the following formula, which is derived in Appendix C:

$$(5) \qquad RIDES_D = \frac{(RIDES_1)\ (PENRATE)}{1 - (E_f)\ (DISC/100)\ (1 - PENRATE)}$$

where

$RIDES_D$ = number of prepaid one-way trips that were previously paid for by cash or other fare prepayment plan

$RIDES_1$ = total number of revenue trips taken now, before the introduction of the fare prepayment plan, expressed in daily, monthly, or annual figures

PENRATE = expected market penetration rate, as given by Equation (4a) or (4b)

E_f = fare elasticity of demand, expressed as a negative quantity

DISC = actual or average discount rate provided for fare prepayment buyers, expressed as a percentage as given by Equation (3)

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[5]See, for example, Armando M. Lago, Patrick D. Mayworm, and J. Matthew McEnroe. "Transit Ridership Responsiveness to Fare Changes." Traffic Quarterly. January 1981.

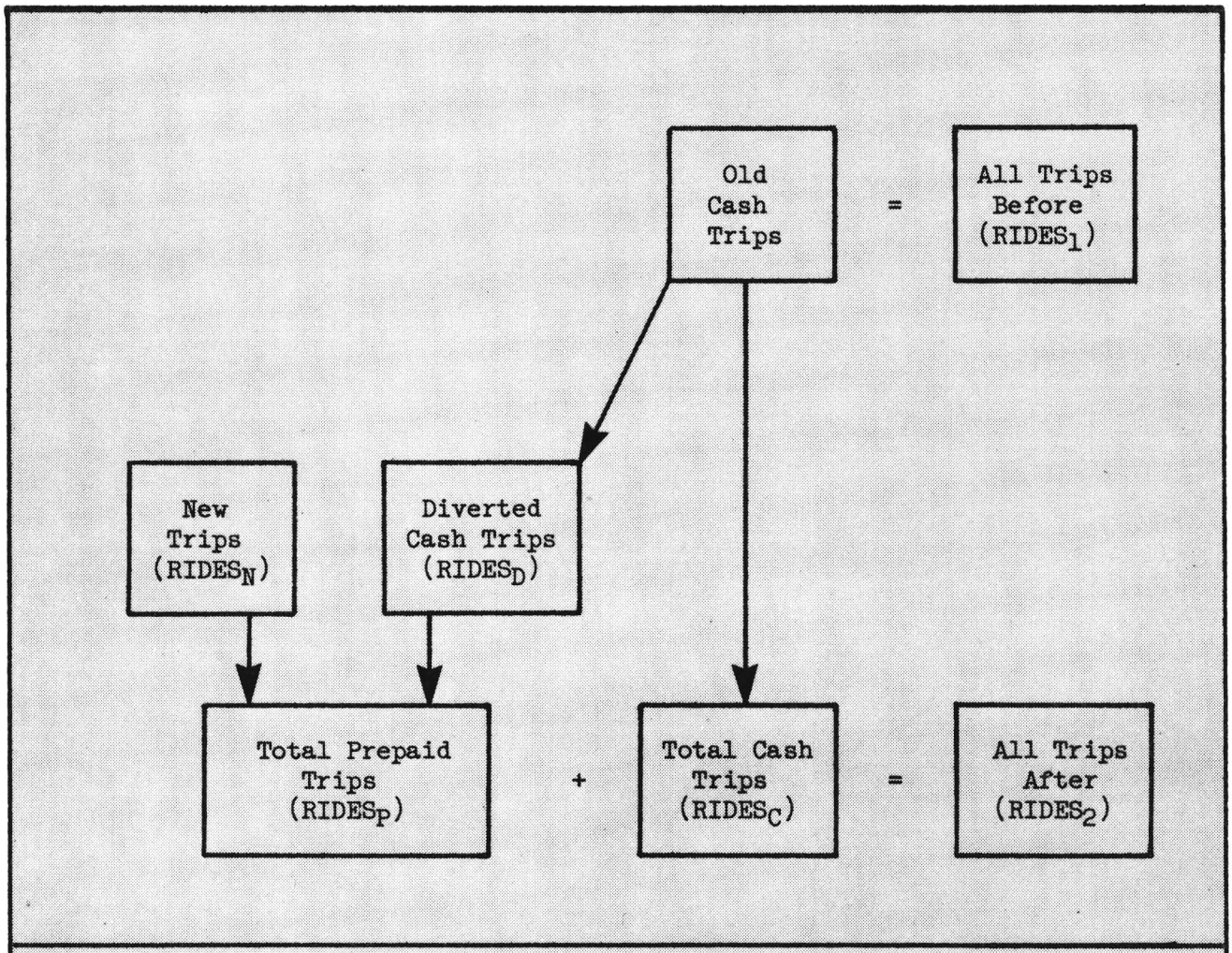

Figure 7-4: BASIC RIDERSHIP CATEGORIES BEFORE AND AFTER THE INTRODUCTION OF A FARE PREPAYMENT PLAN

Equation (5) provides an estimate of the total number of trips that will be diverted to the fare prepayment plan once the program is fully established. The only potentially unknown variable in the equation is E_f, or the elasticity of demand. Since most prepaid riders respond to discounts like cash riders, the authors suggest applying cash fare elasticities as appropriate.[6] In his analysis of monthly transit pass users in Atlanta, Parody found that pass users increased their riding 13.8 percent as a result of the pass program. Because of the effective discount provided, this results in an average fare elasticity of demand of -0.37, or what one would expect from cash users.[7]

The next important quantity that must be estimated is the number of new trips that will be generated due to the effective discount over the cash fare. These new trips will be a function of the number of diverted riders, since only these trips actually receive the price discount. The formula for computing the number of new transit trips is:

$$(6) \qquad RIDES_N = -(RIDES_D)(E_f)(DISC/100)$$

where:

$RIDES_N$ = number of prepaid one-way trips that were not taken by transit before the fare prepayment plan existed

$RIDES_D$ = number of prepaid one-way trips that were previously paid for by cash or other prepayment plan, as given by Equation (5)

E_f = fare elasticity of demand, expressed as a negative quantity

DISC = actual or average discount rate provided for fare prepayment buyers, expressed as a percentage as given by Equation (3)

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[6]See earlier discussion on page 19. In addition, there is a legitimate concern in the economics literature on two-part tariffs (i.e., pass and permit plans) suggesting that the demand elasticity is similar in its economic concept to the income elasticity of demand for pass riders, whose value in many cases is lower than the fare elasticity of demand. These concepts are explored in more detail in Armando M. Lago and Patrick D. Mayworm (1982), op. cit.

[7]In addition, work trips increased 7.3 percent resulting in a fare elasticity of -0.19, while non-work trips increased 32.4 percent resulting in a fare elasticity of -0.75. See: Thomas E. Parody. "Socioeconomic and Travel Behavior Characteristics of Transit Pass Users." Paper presented at the 61st Annual Meeting of the Transportation Research Board, Washington, D.C. January 1982.

In addition to just knowing how many trips have been generated within the system as a result of the new fare prepayment plan, it is interesting to note where these trips came from. In the case of the previously mentioned research done in Atlanta by Parody (1982), 65 percent of new transit trips were taken for non-work purposes. Surveys performed in Ottawa following the introduction of their monthly pass in 1976 showed that the sources of the new or generated transit travel were evenly split between new trips (i.e., trips not previously taken by any mode) and trips taken by another mode, as shown in Table 7-2.[8] Similar to the results provided in Parody (1982), the surveys in Ottawa found that two-thirds of these new transit trips were taken for shopping, while the rest were split among work, recreation, school, and other purposes.[9]

Table 7-2

MODES PREVIOUSLY USED FOR NEW TRANSIT TRIPS ONLY

Previous Mode Used	Percent of New Transit Trips
Trip Not Made Before	44
Automobile or Taxi	28
Walking or Bicycle	23
Other	4

Source: Bureau of Management Consulting (1977), op. cit., p. 40.

[8]Bureau of Management Consulting (1977), op. cit., p. 40.

[9]Bureau of Management Consulting (1977), op. cit., p. 38.

The total number of trips that will be taken with the fare prepayment plan can, therefore, be computed as follows:

$$(7) \qquad RIDES_P = RIDES_D + RIDES_N$$

where:

$RIDES_P$ = total number of prepaid one-way trips

$RIDES_D$ = number of prepaid one-way trips that were previously paid for by cash or other fare prepayment plan, as given by Equation (5)

$RIDES_N$ = number of prepaid one-way trips that were not taken by transit before the fare prepayment plan existed, as given by Equation (6)

Total ridership after implementation of the new fare prepayment plan can be easily computed from the results of Equation (7) as follows:

$$(8) \qquad RIDES_2 = RIDES_1 + RIDES_N$$

where:

$RIDES_2$ = total number of revenue trips taken after implementation of the new fare prepayment plan, expressed in daily, monthly, or annual figures

$RIDES_1$ = total number of revenue trips taken before the introduction of fare prepayment plan

$RIDES_N$ = number of prepaid one-way trips that were not taken by transit before the fare prepayment plan existed, as given by Equation (6)

Finally, the new level of cash ridership can be estimated by subtracting all prepaid trips from the total ridership level as follows:

$$(9) \qquad RIDES_C = RIDES_2 - RIDES_P$$

where:

$RIDES_C$ = total number of cash one-way trips that will be taken after implementation of the new fare prepayment plan

$RIDES_2$ = total number of revenue trips taken after implementation of the new fare prepayment plan, as given by Equation (8)

$RIDES_P$ = total number of prepaid one-way trips, as given by Equation (7)

Step 6: Compute Total Fare Prepayment Sales Per Period

In addition to information on actual fare prepayment ridership, marketing managers need to know how many prepayment instruments will be sold each period. This information is used to estimate printing requirements and other program needs. The following equation should be used to compute sales levels:

$$(10) \qquad SALES = (RIDES_P)/(TRIPS)$$

where:

SALES = total number of fare prepayment instruments sold per period (i.e., daily, weekly, monthly, etc.)

$RIDES_P$ = total number of prepaid one-way trips that will be taken per period, as given by Equation (7)

TRIPS = average number of trips that are taken with the fare prepayment plan, as given by Equation (1) or (2) for pass plans

Step 7: Compute New Revenue Levels

The final step in the analysis of the impacts of a new fare prepayment program is to estimate the revenue impacts. Since transit ridership increases at a rate less than the discount provided, revenue losses will occur if discounts are offered. As pointed out in Chapter 6, discounts should be carefully selected and justified on the basis of cost, on the specific revenue goals of the transit company, and on the opportunities for market segmentation through price discrimination. More importantly, however, past demonstrations of fare prepayment have shown that, while most riders purchase fare prepayment plans because of the savings, other marketing and non-pricing promotional efforts are more cost-effective in increasing sales.

Based on the new ridership and sales levels estimated in the previous steps, new system-wide revenues can be computed from the following equation:

$$(11) \qquad REV_2 = (RIDES_C)(FARE) + (SALES)(PRICE)$$

where:

REV_2 = new system-wide revenues generated from cash and prepaid trips per period, in dollars

$RIDES_C$ = total number of cash one-way trips that will be taken after implementation of the new fare prepayment plan, as given by Equation (9)

FARE = average one-way cash fare, in dollars

SALES = total number of fare prepayment instruments sold per period, as given by Equation (10)

PRICE = full price of the fare prepayment plan, in dollars

It is important to note that the variable $RIDES_C$ refers to those revenue passengers not purchasing the new fare prepayment plan. They may include purchasers of other plans already operational. If this is the case, the FARE variable should correspond to the average fare paid by these revenue passengers.

Table 7-3 is presented as an example of how the seven steps can be used to estimate the impacts that may result from the introduction of a monthly pass. Although a monthly pass is used in this example, any type of fare prepayment plan can be analyzed in a similar fashion. In addition to the data presented in Step 1 in Table 7-3, the authors assume that there are no other forms of fare prepayment available for the general public. Moreover, the results of this analysis are assumed to be the effects of the monthly pass program six months after implementation of the full support program (e.g., the advertising and distribution network).

ESTIMATING THE IMPACTS OF CHANGES IN FARE PREPAYMENT PRICE

Most transit companies operating in the United States today offer some form of fare prepayment. Based on a February 1981 survey of 241 transit agencies across the country, the American Public Transit Association (APTA) determined that just over 50 percent of these properties sell monthly transit passes.[10] The Huron River Group, Inc. estimated that approximately 93 percent of U.S. transit systems have some form of fare prepayment.[11] Thus, the most common impact that must be analyzed is the impact of regular price changes in an existing fare prepayment program.

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[10]See Parody (1982), op cit., p. 1.

[11]Hershey, et al. (1976), op. cit., p. 41.

Table 7-3

AN EXAMPLE OF HOW TO ESTIMATE THE IMPACTS
OF A NEW MONTHLY PASS PROGRAM

STEP 1: COLLECT APPROPRIATE STATISTICS

Existing transit system statistics:

- total monthly revenue passengers = 1,500,000
- total monthly passenger revenues = $750,000
- annual vehicle miles of service = 10,000,000
- peak-to-base ratio = 2.50
- fare elasticity of demand = -0.37
- average one-way cash fare = $0.50

New fare prepayment program statistics:

- type of fare prepayment plan proposed = monthly pass good for unlimited rides for the general public
- number of trips that may be taken per instrument = unknown
- price of the plan = $20.00
- break-even rate = 40 one-way trips per month (i.e., $20/$0.50)

STEP 2: COMPUTE AVERAGE TRIP RATE

(1) $\ln MTRIPS = 3.7619 + 0.0829\,[\ln(10/2.50)] + 0.0898(1)$

$\ln MTRIPS = 3.9666$

$TRIPS = 53$ trips per month

STEP 3: COMPUTE EFFECTIVE DISCOUNT RATE

$$(3)\quad DISC = \left(\frac{\$0.50 - (\$20/53)}{\$0.50}\right) \times 100 = 25\%$$

STEP 4: COMPUTE MARKET PENETRATION RATE

$$(4a)\quad \ln\left(\frac{PENRATE}{1 - PENRATE}\right) = -1.1469 + 0.0597(25) - 0.3874(3.9666) - 0.2596(0)$$

$$\ln\left(\frac{PENRATE}{1 - PENRATE}\right) = -1.1911$$

$$\left(\frac{PENRATE}{1 - PENRATE}\right) = 0.3039$$

$$PENRATE = 0.23 \text{ or } 23\%$$

Table 7-3 (continued)

STEP 5: COMPUTE NEW RIDERSHIP LEVELS BY FARE CATEGORY

(5) $RIDES_D = \frac{(1,500,000)(0.23)}{1 - (-0.37)(0.25)(1-0.23)} = 322,069$ trips per month

(6) $RIDES_N = -(322,069)(-0.37)(0.25) = 29,791$ trips per month

(7) $RIDES_P = 322,069 + 29,791 = 351,860$ trips per month

(8) $RIDES_2 = 1,500,000 + 29,791 = 1,529,791$ trips per month

(9) $RIDES_C = 1,529,791 - 351,860 = 1,177,931$ trips per month

STEP 6: COMPUTE TOTAL FARE PREPAYMENT SALES PER PERIOD

(10) SALES = (351,860)/(53) = 6,639 monthly passes per month

STEP 7: COMPUTE NEW REVENUE LEVELS

(11) $REV_2 = (1,177,931)(\$0.50) + (6,639)(20) = \$721,745$ per month

(i.e., $28,255 monthly revenue loss)

This section of the chapter presents guidelines on how to estimate the ridership, sales, and revenue impacts of price changes. Few new formulae are presented here since this analysis follows closely from that just presented. Table 7-4 presents a summary of the steps that should be followed when analyzing the impacts of price changes.

Step 1: Collect Appropriate Statistics

In addition to the information that must be assembled for the analysis of new programs, fare prepayment managers should provide statistics on the current fare prepayment program. Information on the prices charged, sales levels, revenues brought in, and -- in the case of pass plans -- estimates of the number of trips taken per instrument.

Step 2: Compute Existing and Future Average Trip Rates

The number of trips taken with trip-limited plans (e.g., 10-trip ticket books, 40-trip punch cards) is always known. The only way future trips rates will change for these programs is if the denomination changes.

In the case of passes, however, all pass buyers do not ride at the same frequency. Some monthly pass buyers will use their pass for 65 one-way trips per month, while others will only ride 40 times. Therefore, in order to estimate the average discount provided by the program, it is necessary to estimate the average pass buyer trip rate. Equation (1) was provided in the last section for estimating the average trip rate of any pass plan. However, if the actual average trip rate is known, then this value should be used. Equation (1) was provided for those who do not have a reliable estimate of the existing average trip rate.

As indicated by Equation (1), the average trip rate of a pass program is based, in part, on how the pass is priced relative to the equivalent cash fare (i.e., the break-even rate). Thus, if the break-even rate changes due to a price change, then one would expect the average trip rate to adjust upward or downward accordingly. Equation (12) is provided for the purpose of estimating the new average trip rate of a pass program due to a change in the break-even rate.[12]

[12]Equation (12) is based on the regression analysis documented in Appendix C.

Table 7-4

SUMMARY OF THE STEPS TO FOLLOW WHEN ESTIMATING THE IMPACTS OF PRICE CHANGES

STEP 1:	Collect Appropriate Statistics -- Some statistics on the transit system and information on the existing fare prepayment program must be collected in order to estimate the impacts of the new pricing strategy.
STEP 2:	Compute Existing and Future Average Trip Rates -- The average number of trips currently taken, as well as the number that can be expected under the new price structure, must be computed. For tickets, tokens, and punch cards, the average trip rate is always explicitly known.
STEP 3:	Compute Effective Discount Rate -- The effective discount rate currently offered, as well as that proposed in the future, can be estimated from the prices and average trip rates.
STEP 4:	Compute Future Market Penetration Rate -- Based on knowledge of the existing market penetration level and changes in discount rates, the future market penetration rate of the fare prepayment plan can be estimated.
STEP 5:	Compute New Ridership Levels by Fare Category -- Since a price change will lead to an adjustment in ridership levels, the analysis must include a series of calculations to identify future ridership levels by fare category.
STEP 6:	Compute Future Fare Prepayment Sales Per Period -- Using the forecasted ridership and average trip rate figures, one can easily compute the number of instruments that will be sold per period.
STEP 7:	Compute New Revenue Levels -- In this final step, future revenue levels are computed from pricing, ridership, and sales information.

$$(12) \quad TRIPS_2 = TRIPS_1 + \frac{0.70\ (BKEVEN_2^2 - BKEVEN_1^2)}{\sqrt{6096 + 0.70\ (BKEVEN_1 + BKEVEN_2)^2}}$$

where:

$TRIPS_2$ = future average number of trips taken per period per pass holder

$TRIPS_1$ = existing average number of trips taken per period per pass holder

$BKEVEN_2$ = future break-even rate[13]

$BKEVEN_1$ = existing break-even rate

Step 3: Compute Effective Discount Rate

Equation (3), which is provided on page 100, should now be used to compute the discount rate given to fare prepayment buyers under the existing and future price structures.

Step 4: Compute Future Market Penetration Rate

A change either upward or downward in the price of the fare prepayment plan may have an effect on the level of market penetration. If, for example, the discount for fare prepayment buyers increases due to a price change, one would expect a larger proportion of transit riders to purchase the fare prepayment plan. This is exactly what is indicated by the model presented as Equation (4a).

Based on Equation (4a), the future market penetration rate can be estimated from the following formula:[14]

$$(13) \quad PENRATE_2 = (PENRATE_1)\ [1 + (0.0597)\ (1 - PENRATE_1)\ (\Delta DISC)]$$

where:

$PENRATE_2$ = future proportion of total revenue passenger trips that will be taken with the fare prepayment plan after the fare change, expressed as a decimal fraction

$PENRATE_1$ = existing proportion of total revenue passenger trips that are taken with the fare prepayment plan before the fare change, expressed as a decimal fraction

$\Delta DISC$ = change in the effective discount rate as a result of the price change (i.e., $\Delta DISC = DISC_2 - DISC_1$), expressed as a percentage

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[13]Recall that the break-even rate (BKEVEN) is equal to the pass price divided by the equivalent one-way cash fare.

[14]Recall that the deviation for all equations in this chapter appear in Appendix C.

Step 5: Compute New Ridership Levels by Fare Category

Computing future ridership levels as a result of price changes in existing fare prepayment programs is somewhat more complicated since prices can either increase or decrease relative to the cash fare. If prices decrease, trips will be diverted from cash and new trips will be generated. However, if prices increase, some existing prepaid trips will be lost and others will be diverted back to cash. The direction of these ridership changes is illustrated in Figure 7-5. For clarity of presentation, ridership calculations for price decreases are presented first, followed by the calculations needed to estimate future ridership levels resulting from price increases.

Price Decreases

If the price of the fare prepayment plan is decreased relative to the equivalent cash fare, future prepaid trips will increase due to diverted cash trips and new generated trips. The number of diverted cash trips can be estimated from the following equation:

$$(14) \qquad RIDES_D = \left(\frac{(RIDES_1)\ (PENRATE_2)}{1 - (E_f)\ (\Delta DISC/(100-DISC_1))\ (1-PENRATE_2)} \right) - RIDES_{P1}$$

where:

$RIDES_D$ = number of future prepaid one-way trips that are currently paid for by cash or other prepayment plan

$RIDES_1$ = total number of revenue trips that are currently taken

$PENRATE_2$ = future proportion of total revenue passenger trips that will be taken with the fare prepayment plan after the fare change, expressed as a decimal fraction, as given by Equation (13)

$RIDES_{P1}$ = total number of prepaid one-way trips that are currently taken

E_f = fare elasticity of demand, expressed as a negative quantity

$\Delta DISC$ = change in the effective discount rate as a result of the price change, expressed as a percentage (i.e., $\Delta DISC = DISC_2 - DISC_1$)

$DISC_1$ = effective discount rate of fare prepayment plan before the price change, expressed as a percentage

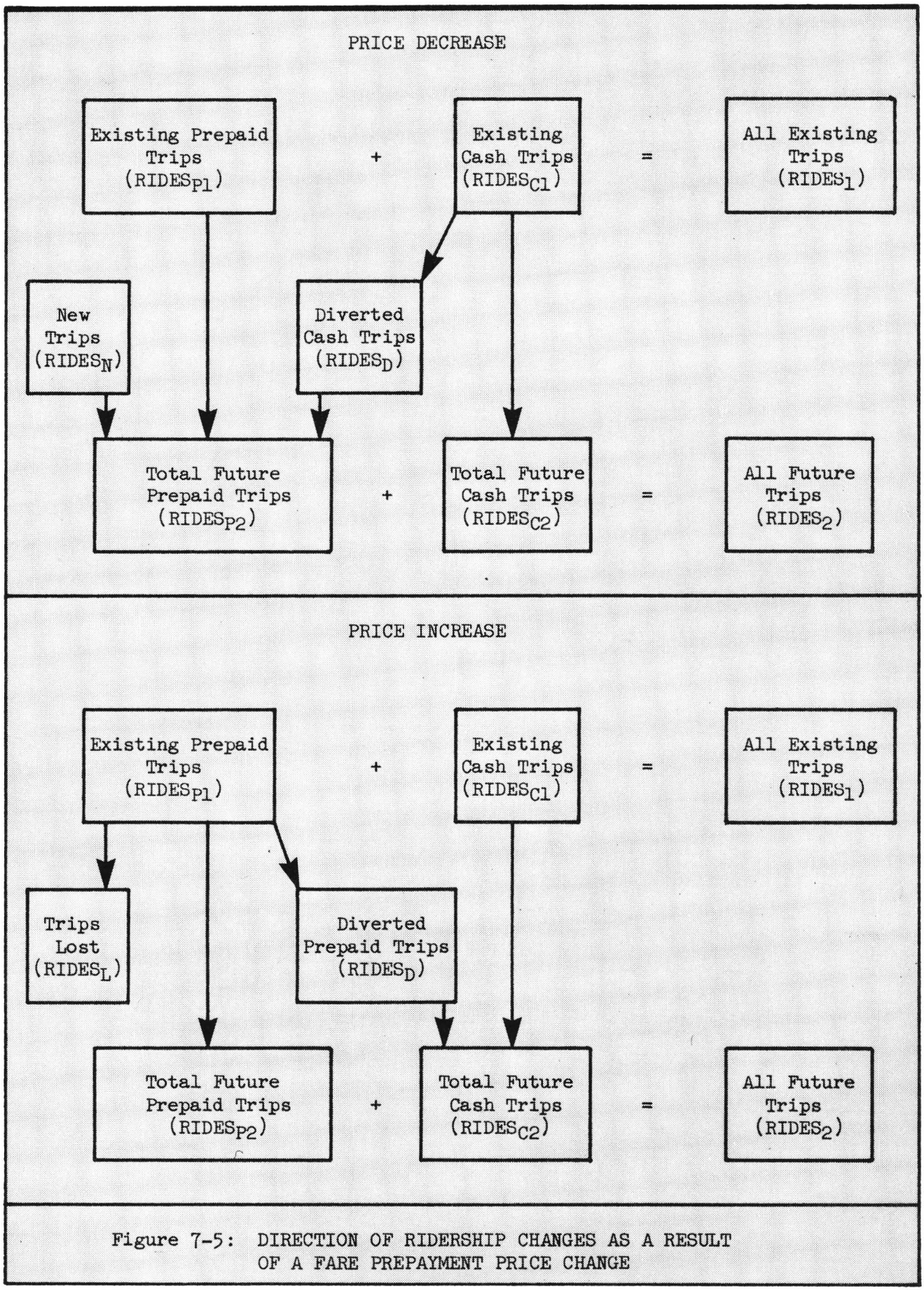

Figure 7-5: DIRECTION OF RIDERSHIP CHANGES AS A RESULT OF A FARE PREPAYMENT PRICE CHANGE

The number of trips generated by the discount can be computed from the total population of trips affected by the discount, namely:

$$(15) \qquad RIDES_N = - (RIDES_{P1} + RIDES_D) (E_f) (\Delta DISC/(100-DISC_1))$$

where:

$RIDES_N$ = number of new one-way trips generated by the change in discount

$RIDES_{P1}$ = total number of prepaid one-way trips that are currently taken

$RIDES_D$ = number of future prepaid one-way trips that are currently paid for by cash or other prepayment plan, as given in Equation (14)

E_f = fare elasticity of demand, expressed as a negative quantity

$\Delta DISC$ = change in the effective discount rate as a result of the price change, expressed as a percentage (i.e., $\Delta DISC = DISC_2 - DISC_1$)

$DISC_1$ = effective discount rate of fare prepayment plan before the price change, expressed as a percentage

The other important equations for estimating future ridership levels include:

$$(16) \qquad RIDES_{P2} = RIDES_{P1} + RIDES_D + RIDES_N$$

$$(17) \qquad RIDES_2 = RIDES_1 + RIDES_N$$

$$(18) \qquad RIDES_{C2} = RIDES_2 - RIDES_{P2}$$

where the new variable definitions are:

$RIDES_{P2}$ = total number of future prepaid one-way trips

$RIDES_2$ = total number of future revenue trips

$RIDES_{C2}$ = total number of future cash trips

Price Increases

If the price of the fare prepayment plan is increased relative to the equivalent cash fare, future prepaid trips will decrease due to trips diverted back to cash plus a loss in marginal trips. The number of trips diverted from prepayment to cash can be estimated from the following equation, which is derived in Appendix C.

(19)

$$RIDES_D = (RIDES_{P1})\ [1-(E_f)(\Delta DISC/(100-DISC_1))(1-PENRATE_2)] - (RIDES_1)(PENRATE_2)$$

All of the variables in the above equation have been defined earlier. The variable $RIDES_D$, however, refers to those trips diverted from prepayment to cash. Note that the elasticity variable is expressed as a negative quantity, as is $\Delta DISC$, since $DISC_2$ is less than $DISC_1$.

Another important equation to be used in this ridership analysis is:

(20) $$RIDES_L = (RIDES_{P1})(E_f)[\Delta DISC/(100-DISC_1)]$$

where the new variable is defined as:

$RIDES_L$ = number of prepaid trips currently taken that will be lost due to the price increase

Note once again that both E_f and $\Delta DISC$ are negative quantities.

The remaining equations include:

(21) $$RIDES_{P2} = RIDES_{P1} - RIDES_D - RIDES_L$$

(22) $$RIDES_2 = RIDES_1 - RIDES_L$$

(23) $$RIDES_{C2} = RIDES_2 - RIDES_{P2}$$

Step 6: Compute Future Fare Prepayment Sales Per Period

The future level of fare prepayment sales can be easily computed from the ridership levels estimated above and the trip rates estimated in Step 2. The formula for computing future sales was given in Equation (10).

Step 7: Compute New Revenue Levels

The final step in the analysis of a fare prepayment price change is to estimate future system-wide revenues. As given in Equation (11), future revenues will equal the sum of cash and prepaid fare revenues.

Table 7-5 provides the reader with an example of how to use the seven steps just described. This example, following the one presented in Table 7-3, concerns an unlimited-ride monthly pass program. However, the example provided here is of a change in a monthly pass price from $20 to $25 with no change in the cash fare. For simplicity, the authors assume that no other fare prepayment plans exist and the program effects will be realized 3-6 months after the price change.

ESTIMATING THE IMPACTS OF SHORT-TERM PROMOTIONAL DISCOUNTS

Occasionally, transit marketing managers will offer promotional incentives to transit riders to increase fare prepayment sales and generate transit riding. Often these incentives are in the form of price discounts. Since transit demand is price inelastic, one would expect any price reduction to lead to revenue losses. Is there any evidence to suggest that short-term price promotions are cost-effective?

The Office of Service and Management Demonstrations (SMD) of the Urban Mass Transportation Administration (UMTA) performed several fare prepayment demonstrations during the past few years which provide information on the ridership and revenue impacts of short-term price promotions. The reduced-price promotion demonstrations in Phoenix, Arizona and Austin, Texas,[15] for example, were designed to test three types of promotion on fare prepayment sales, ridership, and costs. These promotional methods included:

- temporary price discounts,
- intensive advertising and promotional campaigns, and
- expansion of sales outlets

15See: Pamela Bloomfield and John Crain (1979), op. cit.

Table 7-5

AN EXAMPLE OF HOW TO ESTIMATE THE IMPACT
OF A MONTHLY PASS PRICE INCREASE

STEP 1: COLLECT APPROPRIATE STATISTICS

Existing transit system statistics:

- total monthly revenue passengers = 1,529,791
- total monthly passenger revenues = $721,745
- annual vehicle miles of service = 10,000,000
- peak-to-base ratio = 2.50
- fare elasticity of demand = -0.37
- average one-way cash fare = $0.50
- monthly pass price = $20
- other monthly pass statistics = see Table 7-3

New fare prepayment program statistics:

- new fare prepayment price = $25 per month
- new break-even rate = 50 one-way trips per month (i.e., $25/$0.50)

STEP 2: COMPUTE AVERAGE TRIP RATE

$$(12) \qquad TRIPS_2 = 53 + \frac{0.70(50^2 - 40^2)}{\sqrt{6096 + 0.70\ (90)^2}} = 59$$

STEP 3: COMPUTE EFFECTIVE DISCOUNT RATE

$$(3) \qquad DISC = \left(\frac{\$0.50 - (\$25/59)}{\$0.50}\right) \times 100 = 15\%$$

STEP 4: COMPUTE FUTURE MARKET PENETRATION RATE

$$(13) \qquad PENRATE_2 = (0.23)\ [1 + (0.0597)(0.77)(-10)] = 0.12 \text{ or } 12\%$$

STEP 5: COMPUTE NEW RIDERSHIP LEVELS BY FARE CAREGORY

$$(19) \qquad RIDES_D = (351,860)[1-(-0.37)(-10/(100-25))(1-0.12)] - (1,529,791)(0.12)$$

$$RIDES_D = (351,860)[1-(0.0493)(0.88)] - 183,575$$

$$RIDES_D = 336,595 - 183,575 = 153,020 \text{ trips per month}$$

$$(20) \qquad RIDES_L = (351,860)(-0.37)[-10/(100-25)] = 17,358 \text{ trips per month}$$

$$(21) \qquad RIDES_{P2} = 351,860 - 153,020 - 17,358 = 181,482 \text{ trips per month}$$

$$(22) \qquad RIDES_2 = 1,529,791 - 17,358 = 1,512,433 \text{ trips per month}$$

$$(23) \qquad RIDES_{C2} = 1,512,433 - 181,482 = 1,330,951 \text{ trips per month}$$

STEP 6: COMPUTE FUTURE FARE PREPAYMENT SALES PER PERIOD

$$(10) \qquad SALES = (181,482)/(59) = 3,076 \text{ monthly passes per month}$$

STEP 7: COMPUTE NEW REVENUE LEVELS

$$(11) \qquad REV_2 = (1,330,951)(\$0.50) + (3,076)(\$25) = \$742,376 \text{ per month}$$

(i.e., $20,631 monthly revenue increase)

The research concluded that an expansion of outlets did not lead to significant increases in fare prepayment sales. Although all methods of advertising have their merits, the most cost-effective advertising modes proved to be those targeted at regular transit riders. On-bus advertising and publicity at sales outlets are more cost-effective than the more expensive media campaigns.

Concerning price discounts, buyers of fare prepayment plans are very sensitive to price differentials between the plans and cash fare. As expected, sales and transit usage increased during the promotional period and total transit revenues dropped. The revenue loss was due to the fact that a majority of the new buyers were previously cash users.

In both cities, monthly passes and tickets were temporarily discounted. Tickets were the favored instruments primarily because they were valid after the discount period. In other words, individuals were purchasing tickets at the reduced rate and using them weeks and even months after the promotional period ended.

Very few new riders responded to the price promotion. Only about two percent of the promotional sales were attributable to previously non-transit riders. Moreover, conversion to fare prepayment did not induce increased transit usage. The long-term transit trip rates did not increase as a result of the price promotion.

Following the discount period, sales returned approximately to their former levels. An exception was the monthly pass in Austin where, two months after the discount period, sales remained relatively high. In addition, 15 percent of new buyers were still purchasing fare prepayment plans one year after the sales period.

SMD also designed and implemented an interesting demonstration in Sacramento which involved the solicitation and sales of monthly passes through employers.[16] During one three-month period a year after the project began, monthly passes sold through employers were discounted 25 percent to encourage employer participation in the program. Most of the firms participating in the demonstration began selling passes to their employers during this promotional period.

Pass sales through employers nearly tripled during the 25 percent discount period, with many pass purchasers having previously purchased passes through public outlets. Total pass sales during the final month of the discount period

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[16]See: Douglas Daetz and Michael Holoszyc (1981), op. cit.

increased 26 percent over the pre-promotion period. In addition, the discount induced a slight increase in transit travel but no change in the average trip rate by pass holders. The price promotion did not significantly induce modal shifts to transit.

Immediately after the discount period, pass sales through employers dropped 50 percent. However, there was an approximate 60 percent retention rate for new riders attracted by the discount. Since new riders made up 10 percent of total pass usage during the discount period, six percent of pass ridership after the discount period was generated by the promotional price reduction -- a significant improvement.

Concerning revenue impact, the three-month discount period resulted in an estimated 11.4 percent decline in employer revenues during the period. The discount was reported to be economically beneficial, however, because the entire revenue loss was recovered in about six months by the new riders attracted to the system by the price promotion.

SUMMARY

The ability to accurately estimate the ridership, sales, and revenue impacts of fare prepayment programs is key to making informed decisions on transit policy. This chapter provided some of the basic tools and guidelines for estimating program impacts so that more informed decisions can be made before a fare prepayment program is implemented or changed.

The first part of the chapter presented the steps to follow for estimating the impacts of introducing a new fare prepayment plan. The specific formulae for computing ridership, sales, and revenue levels were provided, as well as two easy-to-apply forecasting models. The first model can be used for forecasting the average number of trips taken by pass buyers during the period of validity of the pass. As the model indicates, pass trip rates increase as the opportunities for off-peak travel increase and as the break-even rate increases. The second model presented in this chapter forecasts the future market penetration rate of a fare prepayment plan. The model estimates the market share as a function of the discount over cash fares, the quantity or period of validity of the plan, and the number of plans competing for revenue passengers.

In the second part of the chapter, guidelines were presented for estimating the impacts of changes in the price of an operational fare prepayment plan. Although the steps to be followed in the analysis are identical to those used in the analysis of new programs, some of the equations differ. The most important difference is that existing plans can have both price increases and price decreases. Thus, some of the equations used in the analysis will depend on the direction of the fare change.

Finally, the chapter presented some evidence of the impacts of short-term, price promotions on fare prepayment sales, ridership, and revenues. Using two Federally-funded demonstrations as case studies, the following conclusions were drawn:

- short-term promotional discounts will lead to large diversions of trips from cash or other prepayment plan since transit riders are very sensitive to price differentials between plans and cash fare;
- very few non-transit riders respond to fare prepayment price promotions;
- sales will increase during the price promotion, especially sales of tickets and other plans that do not have date limitations (i.e., some hoarding occurs);
- following the discount period, fare prepayment sales will eventually drop back to a level slightly above pre-promotion levels; thus, some ridership retention occurs; and
- fare prepayment revenues will drop during the sales period, but may be recovered six-to-twelve months after the original price is restored if some prepaid trips are retained.

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APPENDIX A

APPENDIX A

GLOSSARY

GLOSSARY

This glossary defines the terms frequently used in this report. The numbers following each definition refer to the pages in the text where the term first appears or where the subject is extensively discussed.

BANK TRANSFER PAYMENT -- A fare prepayment distribution program in which customers can order and pay for fare prepayment plans through their financial institutions. Automatic telephone payment (ATP) and pre-authorized funds transfer are two methods available. (p. 62).

BREAK-EVEN RATE -- The break-even rate is defined as the pass price divided by the equivalent one-way cash fare. The break-even rate refers to the number of one-way trips that must be taken by a pass holder in order to benefit economically from purchasing a pass rather than paying by cash (pp. 76-80).

CATEGORY -- A fare prepayment category refers to the generic classification of fare prepayment in use today. Five distinct categories of fare prepayment are defined in this report (i.e., tickets, tokens, punch cards, passes, and permits). The categories differ primarily in their physical form and design (pp. 2-4).

CERTIFIED MAIL DELIVERY -- A method of fare prepayment delivery by which the U.S. Postal Service delivers fare prepayment plans certified mail to each sales outlet. (p. 67).

COURIER DELIVERY -- A method of fare prepayment delivery by which a professional courier service delivers fare prepayment plans to each sales outlet. (p. 62).

DIRECT MAIL SALES -- A fare prepayment distribution program in which customers order fare prepayment plans by mail is referred to as direct mail sales. (p. 61).

EFFECTIVE DISCOUNT RATE -- The effective discount rate refers to the discount rate offered on a fare prepayment plan based on actual usage. Thus, an effective discount rate for pass and permit plans can only be determined if the average trip rate is known. The effective discount rate is also known as the average discount rate. (p. 100).

EMPLOYER-DISTRIBUTED SALES OUTLET -- Any private sales outlet that distributes fare prepayment plans only to its own employees is referred to as an employer-distributed sales outlet. (pp. 59-60).

EXPLICIT DISCOUNTING -- Explicit discounting refers to the pricing of a fare prepayment plan when the discount rate is explicitly known; that is, when each fare prepayment ride is offered at a fixed discount rate. Explicit discounting is only possible with trip-limited plans. (pp. 75-76).

FARE ELASTICITY OF DEMAND -- The fare elasticity of demand is defined as the ratio of the proportional change in transit demand (ridership) to the proportional change in transit fare. The elasticity of demand is a convenient measure of the relative responsiveness of transit ridership to changes in transit fares. (p. 104).

FARE PREPAYMENT CATEGORY -- see *CATEGORY*

FARE PREPAYMENT INSTRUMENT -- see *INSTRUMENT*

FARE PREPAYMENT PLAN -- see *PLAN*

FARE PREPAYMENT PROGRAM -- see *PROGRAM*

FLAT FARE STRUCTURE -- A fare structure in which all adult cash riders pay the identical one-way fare, regardless of time period or distance travelled, is referred to as a flat fare structure. (pp. 80-86).

IMPLICIT DISCOUNTING -- Implicit discounting refers to the pricing of a fare prepayment plan when the discount rate cannot be fixed; that is, when the discount rate is based on the frequency of transit usage. Pass and permit plans offer implicit discounts. (pp. 76-80).

INSTRUMENT -- A fare prepayment instrument refers to the physical item purchased by a transit rider. Thus, while a roll of 20 tokens and a monthly pass are unique fare prepayment plans, each item is referred to as an instrument for costing and accounting purposes. (p. 2).

MARKET PENETRATION RATE -- The market penetration rate refers to the proportion of revenue passenger trips that is taken by a particular fare prepayment plan. (pp. 100-103).

PASS -- A pass is similar to a permit in appearance but generally does not include the photograph of the user because of the replacement cost. Like permits, passes must be displayed to the driver when boarding. However, passes differ from permits in that the passenger rides as many times as desired without paying any additional fee until the pass expires. (p. 4).

PEAK/OFF-PEAK FARE STRUCTURE -- A fare structure in which all adult cash riders pay a higher one-way fare during peak hours than during off peak hours is referred to as a peak/off-peak fare structure. (pp. 80-86).

PEAK-TO-BASE RATIO -- The peak-to-base ratio is a number that is computed by dividing the number of buses used during the peak by the number of buses used during the base period. The ratio provides an indicator of the distribution of bus service throughout the day. (pp. 97-99).

PERMIT -- A permit is a wallet-size card that passengers display at the time of boarding. The permit allows the individual to travel at a reduced rate until the permit expires. A photograph or another method of identification on the permit is usually used to limit use of the card to the intended person. (pp. 3-4).

PLAN -- A fare prepayment plan refers to the category of fare prepayment used, along with the period of validity, quantity of rides, and special restrictions placed on its usage. Examples include monthly passes and off-peak, 10-trip ticket books. (pp. 4-7).

PRICE DISCRIMINATION -- Price discrimination refers to a pricing policy which charges riders different rates depending on trip rate, trip purpose, and elasticity of demand. (pp. 18-19).

PRIVATE SALES OUTLET -- Any sales outlet that sells fare prepayment plans only to its own clientele is referred to as a private sales outlet. Employers and social service agencies are examples of private sales outlets. (pp. 57-59).

PROGRAM -- A fare prepayment program refers to all of the activities and elements involved in the production and distribution of fare prepayment plans. A program, therefore, refers to the combination of fare prepayment plans offered by a transit company, along with the operating and administrative activities involved in the printing, marketing, distribution, and sales of these plan. (pp. 7-10).

PUBLIC SALES OUTLET -- Any sales outlet, other than a transit-operated sales outlet, that sells fare prepayment plans to anyone interested in purchasing a plan is referred to as a public sales outlet. Banks and department stores are examples of public sales outlets. (pp. 57-59).

PUNCH CARD -- A punch card is a card or slip of paper with areas in which holes are punched by the driver or conductor each time a trip is taken. Printed usually in the size of a credit card, punch cards are functionally equivalent to most tickets and tokens. (p. 3).

SALES TRANSACTION -- A sales transaction refers to the individual order made by a transit user when purchasing a fare prepayment plan(s). A sales transaction is the operation that takes place at the point of distribution (e.g., sales outlet, office headquarters for direct mail order). (p. 57).

SELF-SERVICE FARE COLLECTION -- Also known as the honor system, self-service fare collection requires each transit rider to carry a pass or ticket as proof of fare payment. It is called self-service because it is the responsibility of the individual to carry a properly validated fare prepayment instrument. (pp. B-21-22).

TELEPHONE ORDER SALES -- A fare prepayment distribution program in which customers order fare prepayment plans by telephone is referred to as telephone order sales. (pp. 61-62).

TICKET -- A ticket is a card or piece of paper that is given to the conductor or dropped into the farebox when a trip is taken. Tickets are sold individually, in strips, or in books of any denomination. (p. 3).

TIME-LIMITED PLAN -- A fare prepayment plan that specifies the period of validity during which an unlimited number of trips may be taken is referred to as a time-limited plan. The price per trip is determined by the frequency of trips taken. Passes and permits are examples of time-limited plans. (pp. 6, 73-80).

TOKEN -- A token is a metal, coin-like disk that is dropped into a turnstile at the entrance to a rapid transit station or into a farebox on a transit vehicle. Tokens are the fare prepayment form most similar to cash since they resemble coins. Tokens are sold individually or in rolls. (p. 2).

TRANSACTION -- see *SALES TRANSACTION*

TRANSIT FARE PREPAYMENT -- Any method of advance fare payment of transit service is referred to as transit fare prepayment (TFP). Fare prepayment, therefore, involves purchasing evidence (e.g., in the form of tickets, tokens, or passes) that can later be verified as a substitute for cash in payment for transit rides. (p. 1).

TRANSIT-OPERATED SALES OUTLET -- A sales outlet that is operated by the transit company is referred to as a transit operated sales outlet. The outlet may be owned or rented by the transit company. (p. 57).

TRANSIT STAFF DELIVERY -- A method of fare prepayment delivery by which personnel from the transit company deliver fare prepayment plans to each sales outlet. (pp. 66-67).

TRIP-LIMITED PLAN -- A fare prepayment plan that specifies the quantity of trips that can be taken and not the period of validity is referred to as a trip-limited plan. The price per trip is explicitly known. Tokens, tickets, and punch cards are examples of trip-limited plans. (pp. 6, 73-80).

TRIP-RATE -- The trip rate refers to the number of one-way linked trips that are taken with one fare prepayment instrument. The term is generally used for pass plans and refers to the number of trips taken during the period of validity of the plan. (pp. 76-80).

USER-SIDE SUBSIDY -- A subsidy for urban public transportation that is paid directly to the user (rider) in the form of vouchers or special fare prepayment plan is referred to as a user-side subsidy. Most public transit companies today do not utilize user-side subsidy methods, but rather are paid directly for the subsidy and must pass a reduced-fare on to their customers. (pp. 88-89).

VENDING MACHINE SALES -- A fare prepayment distribution program in which customers can purchase fare prepayment plans through vending machines located at major transfer points and major activity centers. (pp. 62-63).

ZONE FARE STRUCTURE -- A fare structure in which all adult cash riders pay a one-way fare according to the number of zones transversed is referred to as a zone fare structure. (pp. 80-86).

APPENDIX B

APPENDIX B

THE OFFICE OF SERVICE AND MANAGEMENT DEMONSTRATIONS (SMD) FARE PREPAYMENT PROJECTS: THEIR OBJECTIVES AND SUMMARY RESULTS

THE OFFICE OF SERVICE AND MANAGEMENT DEMONSTRATIONS (SMD) FARE PREPAYMENT PROJECTS: THEIR OBJECTIVES AND SUMMARY RESULTS

The Office of Service and Management Demonstrations (SMD) of the Urban Mass Transportation Administration has to date developed ten demonstration projects involving fare prepayment projects. Six of these projects are complete, three are on-going, and one is proposed. The ten projects include:

- Reduced-price promotion: Phoenix, Arizona and Austin, Texas (complete)
- Employer-sponsored distribution: Sacramento, California and Jacksonville, Florida (complete)
- College student program: Tucson, Arizona (complete)
- Variable work hours/employee pass program: Duluth, Minnesota (complete)
- Alternative distribution systems for transit fare prepayment: Sacramento, California (on-going)
- Monthly pass pricing: Cincinnati, Ohio (on-going)
- Self-service fare collection: Portland, Oregon (on-going)
- Ticketing and billing: Santa Cruz, California (proposed)

This appendix summarizes each of these projects, highlighting what we have learned or expect to learn. The appendix concludes with a summary of the project results and presents a list of some of the outstanding issues on the design and management of fare prepayment programs.

REDUCED-PRICE PROMOTION

PHOENIX, ARIZONA AND AUSTIN, TEXAS

Demonstration Objectives

- To test the impact of temporary price discounts on transit fare prepayment sales, ridership levels, and transit costs.
- To test the impact of intensive advertising and promotional campaigns on fare prepayment sales, ridership levels, and transit costs.
- To test the impact of an expansion of sales outlets on fare prepayment sales, ridership levels, and transit costs.

Summary of The Program

In both Phoenix, Arizona and Austin, Texas, transit fare prepayment instruments were sold at reduced prices during two promotional discount periods. Discounts of 20 percent and 40 percent on all instruments were available at each demonstration site during two separate periods. Each discount period lasted one month and was separated by six months at full fare. In Austin, the 40 percent discount was tested first, followed by the 20 percent discount period. The order was reversed (20/40) in Phoenix.

The discount tickets sold in the Austin demonstration were valid indefinitely; in Phoenix, discount tickets were good for only two months. At both sites intensive media and marketing campaigns were run and new distribution outlets were opened.

What We Have Learned

- Buyers of transit fare prepayment plans are very sensitive to price differentials between the plans and cash fare. Although sales and usage increased during the promotional period, total transit revenues dropped. This is due to the fact that a majority of the new buyers were previously cash users.

- Tickets were favored instruments, primarly because they were valid after the discount period.

- Very few non-transit riders responded to the price promotion. Only two percent of the promotional sales were attributable to previously non-transit riders.

- After the discount period, sales returned approximately to their former sales. An exception was the monthly pass in Austin where two months after the discount period sales remained relatively high. In addition, 15 percent of new buyers were still purchasing fare prepayment plans one year after the sales period.

- Conversion to fare prepayment did not induce increased use of fare prepayment. The long-term transit trip rates did not increase.

- The most cost-effective advertising mode proved to be those targeted at regular transit riders. On-bus advertising and publicity at sales outlets are more cost-effective than the more expensive media campaigns.

- Expansion of outlets did not lead to increases in sales of fare prepayment.

- The unit costs in Phoenix and Austin were very high. The combined ticket and pass program costs per instrument sold in 1980 dollars were:

	Austin	Phoenix
Materials and Printing	$0.054	$0.092
Handling, Distribution and Sales	0.741	0.139
Advertising and Publicity	0.155	0.008
TOTAL	$0.950	$0.239

- The anticipated benefits were not realized. Benefits, such as improved cash flow, reduced boarding times, simplified cash management, and increased revenues, were not realized primarily because of the structure of the prepayment programs and the objectives of the demonstration.

For More Information

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EMPLOYER-SPONSORED DISTRIBUTION

SACRAMENTO, CALIFORNIA AND JACKSONVILLE, FLORIDA*

Demonstration Objectives

- To test the impact on pass sales, and thereby transit riding, of various methods of marketing monthly passes through employers.
- To increase transit ridership through extended availability of prepaid passes.
- To institute payroll deduction as a form of pass payment.
- To develop, test, and evaluate strategies for obtaining employer participation.
- To test the impact of price discounts.
- To improve the relationship between the transit authority and the local business community.
- To improve the transit authority's cash flow through earlier passenger revenue receipts.
- To advance transit passes as an employee fringe benefit.

Summary of the Program

The Sacramento demonstration involved the solicitation and sales of monthly passes to employers. During a three-month period one year after the project began, monthly passes sold through employers were discounted 25 percent to encourage employer participation in the program. Most of the firms participating in the demonstration began selling passes to their employees during this promotional period. Unlike the very successful employer-distributed programs in Boston and Chicago, the Sacramento Regional Transit had an extensive public distribution network for pass sales prior to promoting sales through employers.

*This summary is of the Sacramento project only since Jacksonville's evaluation report was only recently released and could not be reviewed in time.

What We Have Learned

- During the 25 percent discount period, pass sales through employers nearly tripled, many pass purchasers having previously purchased passes through public outlets. Total pass sales during the final month of the discount period increased 26 percent.

- Immediately after the discount period, pass sales dropped 50 percent.

- The discount induced a slight increase in transit travel but no change in the average trip rate by pass holders. The pass program in general did not significantly induce modal shifts to transit.

- There was an approximate 60 percent retention rate for new riders attracted by the discount. However, the new riders made up only 10 percent of total pass usage during the discount period. Thus, 6 percent of pass ridership after the discount period was generated by the promotional price reduction (similar to that of transit users in general).

- The three-month discount period resulted in an estimated 11.4 percent decline in employer revenues during the period. The discount was reported to be economically beneficial, however, because the revenue loss was recovered in about six months by the new users attracted.

- Less than 15 percent of the employers used payroll deduction. The perceived convenience of payroll deduction was off-set by the convenience of easily accessible public outlets.

- Fewer employers took up the idea of subsidizing the purchase by employees of monthly passes. Only three employers subsidized the passes bought by their employees.

- The costs to employers for operating the program was believed to be small by the management of these firms. In 1980 dollars, the average employer cost was approximately $0.50 per pass per month.

- The employer program was more expensive for the transit authority to operate than distribution through public outlets. The unit costs in 1980 dollars were:

	Public Outlets	Employer Outlets
Materials and Printing	$0.034	$0.034
Administration and Handling	0.033	0.172
Distribution and Sales	0.071	0.117
TOTAL	$0.138	$0.323

For More Information

Sacramento, California

Sacramento Regional Transit District. "Demonstration Application Program Narrative." Grant application to the Office of Service and Methods Demonstrations, U.S. Urban Mass Transportation Administration. Sacramento Regional Transit District, Sacramento, California. November 1977.

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COLLEGE STUDENT PROGRAM

TUCSON, ARIZONA

Demonstration Objectives

- To develop and implement a balanced set of fare prepayment instruments that will meet the needs of college students, be simple and inexpensive to administer, and will not place a financial burden on the transit operator.
- To increase student transit riding, especially during off-peak hours and on weekends and holidays.
- To reduce campus and off-campus parking demand.

Summary of The Program

In August 1979, the City of Tucson's SunTran system began marketing and selling a semester unlimited-ride pass, a monthly unlimited ride pass, and a 20-ride unlimited-duration ticket plan. The monthly pass and 20-ride ticket were priced at a cash equivalent discount rate of 14 percent; the semester pass expected effective-discount rate was set at 29 percent.

In response to an unexpected increase in transit demand during the early morning peak, a second phase was developed for the demonstration project. During this two-semester phase, both peak and off-peak 20-ride tickets and semester passes were sold to students to further encourage off-peak transit usage. Prices on all fare prepayment plans were increased substantially.

What We Have Learned to Date

The demonstration project was recently completed and although no formal evaluation reports have been issued, the following preliminary results are apparent:

- The demand for the student fare prepayment plans has been greater than originally expected. This is especially true of the semester pass. During the 1980 spring semester, approximately 30 percent of the passenger trips were taken with the semester pass; about half still pay by cash.

- Although the monthly pass and 20-ride ticket are somewhat competitive as expected, there is evidence to suggest that, if appropriately priced, all three plans can be cost-effectively provided.

- Comparing the spring semesters of 1980 and 1981, total sales more than doubled, transit travel increased 13 percent, prices increased, but the weighted average price paid for all three instruments remained unchanged.

	Spring 1980			Fall 1980		
Prepayment Instrument	Cost	Sales	Revenues	Cost	Sales	Revenues
Semester Pass	$35	786	$27,510	$35	1,400	$49,000
Monthly Pass	12	274	3,288	12	345	4,140
20-Ride Ticket	6	711	4,266	6	1,579	9,474
TOTAL		1,771	$35,06		3,324	$62,614

	Spring 1981			Fall 1981		
Prepayment Instrument	Cost	Sales	Revenues	Cost	Sales	Revenues
Semester Pass-All Day	$50	563	$28,150	$50	501	$25,050
Semester Pass-Off-Peak	40	411	16,440	40	274	10,960
Monthly Pass	17	475	8,075	17	976	16,592
20-Ride Ticket-All Day	9	640	5,760	9	771	6,939
20-Ride Ticket-Off-Peak	7	1,460	10,220	7	1,700	11,900
TOTAL		3,549	$68,645		4,222	$71,441

- Peak/off-peak pricing of the semester pass and 20-ride ticket was effective in reducing morning transit usage by students. During the spring semester of 1980, 25.5 percent of daily student transit travel occurred between 6-8 a.m. In 1981 that proportion had dropped to 14.9 percent.

- The marketing program itself had the effect of doubling monthly pass sales on campus, since such passes were sold at the university prior to the demonstration.

- No significant decrease in parking demand can be attributed to the demonstration. Approximately 700 more daily automobile trips would have been taken without the demonstration. This is only 2-3 percent of campus automobile travel, or that amount which falls within the daily variance of automobile travel.

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VARIABLE WORK HOURS/EMPLOYEE PASS PROGRAM

DULUTH, MINNESOTA

Demonstration Objectives

- To spread existing peak period transit demand over a longer period of time.
- To increase transit ridership especially during the fringes of the peak and off-peak hours.
- To improve the operating ratio of the Duluth Transit Authority (DTA) and reduce the operating deficit through reductions in transit operating costs.

Summary of the Program

The Duluth demonstration project has been designed to include two phases. The first phase involves the introduction of a variable work hours program focusing on the Duluth central business district. To facilitate commuter transit usage, encourage minor temporal shifts in peak period travel, and help identify those commuters who are employed by firms participating in the variable work hours program, the DTA provided such firms with monthly transit passes to sell to their employees. One of two monthly passes may be purchased:

- a full fare pass that may be used during all time periods of the day
- a reduced-fare pass that may be used for time during the day excluding the one-half hour period between 7:30 and 8:00 a.m.

It was hoped that the combination of a heavily-marketed variable work hours program and differentially-priced monthly passes would provide the incentive for some peak period transit commuters to slightly adjust their work trip schedule.

During the second phase of the demonstration project, the DTA opened up sales of both passes to all DTA patrons. However, it was felt that the success of this phase was based on the ability of DTA to effectively market the variable

work hours concept. Only by convincing downtown employers to adopt variable work hours programs, will peak period commuters have a choice in deciding their work arrival times; and it is only through choice that differentially-priced passes will be successful.

What We Have Learned To Date

- The demonstration has had a small, but significant impact on morning peak demand. Some peak period commuters have adjusted their work start times (generally to earlier hours) in response to the demonstration. More commuters, however, have not formally changed their work start times but are travelling earlier to take advantage of the price discount. Approximately 15 percent changed to an earlier hour, five percent to a later hour, and 80 percent make no change in their travel time. There has been no significant spread in the evening peak.

- Pass users appear to have increased their off-peak transit usage slightly. Preliminary evidence suggests that pass buyers ride more frequently during the off-peak than they did before the passes were available.

- Peak period shifts are too small for DTA to adjust its peak-period schedule. Reduced-pass sales grew during the second phase but did not result in a significant demand shift. Most reduced-priced passes were purchased by existing off-peak users, such as low-income riders and the transit dependent.

- The variable work hours program is not perceived to be beneficial to employers; they must be sold on the concept. Market research conducted before the demonstration revealed that employers did not perceive a transportation problem and, therefore, could not associate any benefit with the variable work hours program. For such a program to be successful, employers must perceive a transportation problem.

- The two monthly pass plans have caused problems with driver compliance. Although most pass holders understand the difference between the two passes, very often passengers will board the bus during the restricted half hour with the reduced-price pass and not pay the penalty fee because of a lack of driver enforcement.

For More Information

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ALTERNATIVE DISTRIBUTION SYSTEMS FOR TRANSIT FARE PREPAYMENT

SACRAMENTO, CALIFORNIA

Demonstration Objectives

- To obtain and summarize information on the fixed and incremental costs of setting up, operating, and administering different distribution methods.
- To obtain information on sales revenues and identify their sources, whether from other distribution methods, cash payment, other fare prepayment plans, or new travel.
- To obtain and summarize information on the market profiles of the users of each fare prepayment distribution method, identifying the diversions from other distribution methods.
- To provide a cost-effectiveness analysis of each method and identify the factors that affect the success of each distribution method.

Summary of The Program

The Sacramento demonstration project began in 1981 and involves the sequential introduction of seven fare prepayment distribution methods. The costs, benefits, and ridership impacts of each distribution method will be analyzed, as well as the procedures used in their administration. The seven distribution options under investigation include:

- over-the-counter public and private outlets,
- employer outlets,
- direct mail order,
- direct telephone order,
- automatic telephone payment and order using bank bill payer services,
- pre-authorized funds transfers, and
- vending machines.

The first two methods portray the base or existing distribution program in Sacramento. These methods will be evaluated based on existing and easily available data. The remaining five techniques will be implemented sequentially over the two-year period of the demonstration -- one technique building upon a growing base program. In this way, each technique will be evaluated on its own merit and on the effect its introduction has on the existing distribution system.

A final review and adjustment phase has been included as part of this demonstration project to provide a period of time during which changes can be made to the distribution program. The purpose of this final phase is to put in place a cost-effective distribution network in Sacramento, thereby guaranteeing program continuation after Federal support ends.

What We Hope To Learn

- The Sacramento demonstration will provide answers to the following two principal questions:
  - What will this distribution system cost and how much revenue can we expect?
  - What are the institutional and administrative problems and issues?

- Specifically, the demonstration will provide information on:
  - the full fixed and incremental costs of setting-up, operating and administering different fare prepayment distribution methods;
  - the marginal costs of offering each new distribution method;
  - the sales and revenue impacts of introducing new distribution methods;
  - the sources of these revenues;
  - the distribution methods which attract new riders;
  - the ridership characteristics of those utilizing each distribution method; and
  - the factors that affect the cost-effectiveness and success of each method.

For More Information

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MONTHLY PASS PRICING

CINCINNATI, OHIO

Demonstration Objectives

- To analyze the full benefits of providing monthly passes and the full costs of starting up, promoting, and operating a monthly pass program.
- To develop a methodology for setting monthly pass prices, identifying the appropriate data to collect and the analysis of that data for determining the optimum pass price subject to budgetary and/or market penetration constraints.

Summary of the Program

The Queen City Metro Pass Pricing Demonstration began in October 1981 with the introduction of the monthly pass and will run for 18 consecutive months. The demonstration will consist of two phases. During the first phase, a subcontractor developed a practical methodology of pass pricing, analyzed Queen City Metro ridership revenues, and cost data, and recommended to Queen City Metro staff a price for each monthly pass (by zone and express service) in order to maximize passenger revenues subject to deficit and market penetration constraints. In October 1982, the monthly pass prices changed in response to the subcontractor and staff recommendations. Ridership, revenues, and costs will again be analyzed during the second phase to test and refine the pricing methodology.

What We Hope to Learn

The proposed monthly pass pricing demonstration has been designed to provide detailed information to the transit industry on the costs and benefits of operating a monthly pass program. In addition and most importantly, this demonstration will develop a methodology and guidelines for analyzing ridership, revenues, and costs in order to properly price plans subject to financial constraints.

For More Information

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SELF-SERVICE FARE COLLECTION

PORTLAND, OREGON

Demonstration Objectives

- To test the applicability of the European self-service proof-of-payment method of fare collection to American transit systems, as well as a phased approach to its implementation.
- To demonstrate how self-service fare collection should be introduced in the U.S.
- To test the economic impact of self-service on various service modes.
- To test the ability of self-service fare collection methods to increase the productivity of Tri-Met's routes, especially on those routes where the new articulated buses will be operating.
- To provide the mechanism to allow Tri-Met to easily adopt a finer zone fare system.

Summary of the Program

This new demonstration project involves the introduction of system-wide self-service fare collection and the deployment of Tri-Met's first articulated buses. The first of three phases, involving training, hardware procurement, and legal work, has already been completed.

The second phase of the project began in the Fall of 1982 with the introduction of limited self-service. This limited form of self-service is designed to minimize confusion and the risk of fare evasion at the outset. Proof of payment is required and a program of fare inspection has been initiated. During this inital phase of operation, it is possible for Tri-Met to revert back to conventional fare collection if necessary without severe impact on operations.

Once the self-service concept of fare collection is established, a gradual transition to the third, full self-service phase will occur. With full self-service, passengers will be allowed to enter and exit through all doors on all vehicles. The fare evasion potential and, hence, the inspection rate will be higher.

What We Hope To Learn

The Portland self-service fare collection project will provide answers to the following questions:

- How and under what conditions should self-service transit fare collection be introduced in the U.S.?
- What operating cost savings are directly attributable to the self-service program?
- Is it possible to obtain a 6-10 percent productivity improvement as experienced by most European systems?
- How should each payment method be priced to obtain the desired distribution of fare payment methods to make the self-service system effective?

For More Information

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TICKETING AND BILLING

SANTA CRUZ, CALIFORNIA

Demonstration Objectives

- To test the feasibility of operating an automated on-board contract billing system;
- To test the effectiveness of fare post-payment by organizations;
- To test self-service vending and on-board validation of transit fare prepayment; and
- To test the ability of these techniques to increase transit utilization.

Summary of the Program

The proposed Ticketing and Billing (TAB) Demonstration consists of two principal phases: introduction of an automated aggregate contract billing system and implementation of a self-service fare purchase and collection system.

The aggregate contract billing system allows passengers possessing a special pass to board and ride all transit vehicles at no cost to the passenger. Passengers receive the special pass from their employer who has contracted with the transit agency to pay for rides taken by their employees. Currently, the driver manually records all of the information on contract riders for billing purposes. With the automatic recording of data on contract pass usage, the number of categories for contract passess will be increased and the workload for the driver will be reduced since the responsibilities for data recording and transcribing activities will be removed.

During the second phase, the transit authority will implement self-service fare collection. Public outlets will be expanded, wayside automatic vending machines will be introduced, and on-board ticket vending and ticket validation equipment will be installed. Initially, drivers will continue to monitor and control fares as they do now. Ultimately, special inspectors will be employed to check compliance as full self-service fare collection is operational.

What We Hope To Learn

The proposed Santa Cruz demonstration has been designed to provide specific information on the applicability of contract billing and post-payment in a small transit operation. Specifically, the demonstration is expected to answer the following questions:

- how much will it cost, and
- how effective will the system be in reducing driver workload, and increasing contract riders?

The self-service fare collection phase is expected to provide information in the following areas:

- the economic and operational feasibility of self-service fare collection,
- the operational advantage in terms of the system's ability to implement an array of fare zones and fare differentials, and
- the impact on passenger loading procedures, dwell times, and vehicle productivity.

SUMMARY

This appendix presented information on the existing Office of Service and Management Demonstrations (SMD) transit fare prepayment program. From these demonstration projects, we have been able to obtain valuable information on the design of price promotions, the management of employer-distributed programs, and the selection of prepayment programs for specific market groups.

From these demonstrations and from parallel research projects, we can make the following generalizations:

1. Transit fare prepayment programs and fare collection in general do not constitute a major proportion of total operating costs. Fare collection in most transit operations amounts to only one to three percent of total operating costs.

2. The success of transit fare prepayment programs is not a result of price discounts. If fare prepayment sales is a measure of success without constraints on deficit levels, then, yes, price discounts will affect the success of the program.

3. Discounts on fare prepayment plans in operation today have been overemphasized, resulting in unnecessary revenue losses. Trip-limited plans, such as tickets, should not be discounted at all and pass plans should be priced based on actual trip utilization as opposed to arbitrary levels of 40 or 45 trips per month.

4. Transit fare prepayment programs do not attract new riders to the transit system. Most users of new fare prepayment plans previously paid by cash or another fare prepayment instrument. New riders generally constitute less than six percent of all fare prepayment users. Off-peak ridership by previous transit users, however, does increase.

5. The benefits of fare prepayment are real and therefore such programs should be adopted. However, in order to realize these benefits, it is necessary that the transit operator develop specific management objectives and adjust the program as required from time to time.

6. Marketing programs and temporary price promotions should be targeted to specific groups. For example, many price promotions of fare prepayment have resulted in cash users temporarily switching to prepayment to take advantage of the discount. This usually has resulted in long-term revenue loss.

7. Employer-promoted and public over-the-counter outlets are competitive distribution systems, especially if operated in the same area. Employer programs, however, have unique advantages over conventional outlets. They are, for example, an alternative to paying commissions to outlets.

8. Differentially-priced, peak/off-peak fare prepayment programs have only a minor effect on peak demand. Pricing policies and institutional programs such as those demonstrated in Duluth, Minnesota may be more successful in cities where traffic congestion is acute. In addition, price surcharges during one peak may not have a significant impact on the other peak period.

Although these insights can assist us now in designing fare prepayment programs, there remain many outstanding issues. Some of the important questions we need to answer include:

1. How should we select fare prepayment instruments to meet the needs of the public as well as the operational and financial needs of the operator?

2. How should we select the appropriate distribution system to minimize operating costs using simple and readily available supply cost and demand information?

3. How should we design fare prepayment instruments in order to improve the interface between such instruments and fare collection equipment?

4. Should we be re-assessing the value of permit plans, especially in those systems about to implement self-service fare collection?

5. What methods should we be using for determining the price levels of pass and permit plans of different duration and type of restriction?

6. What are the benefits of operating different fare prepayment programs, and do these benefits outweigh the costs? How can programs be designed to maximize these benefits?

7. What are the trade-offs between market penetration of prepayment plans (positively correlated with price discounts) and the concomitant benefits associated with increased prepayment utilization, and the revenue and cost impacts of fare prepayment use. Can we put together a simple approach for analyzing fare prepayment plans and their features with the goal of maximizing such benefits under budgetary constraints?

The Office of Service and Management Demonstrations will be addressing some of these issues in the demonstration projects in Sacramento, Santa Cruz, Cincinnati, and Portland. Other projects will be developed in the near future which build upon what we have learned, but focus more on the methods to be employed in designing and pricing fare prepayment plans. It is evident that the full opportunities for adopting fare prepayment programs in a cost effective fashion are just beginning to be explored.

APPENDIX C

APPENDIX C

DERIVATIONS OF THE EQUATIONS PRESENTED IN CHAPTER 7

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Chapter 7 presented a series of equations and formulae for estimating fare prepayment program impacts on ridership, sales, and revenues. Many of these equations were presented without any justification on how they were derived. This appendix, therefore, is provided to show how each equation in Chapter 7 was derived mathematically. Each equation is numbered in this appendix as it is numbered in Chapter 7.

(1) Trip Rate Model

$$\ln MTRIPS = 3.7619 + 0.0829 \ln(VMILES/PBRATIO) + 0.0898\ DBK$$

This model was estimated using ordinary least-square regression of cross-sectional data collected on the trip rate experiences of 23 transit companies nationwide. Since the model was estimated from actual data, no derivation is required.

(2) Trip Rate Model for Small Systems

$$TRIPS = 1.15 \times BKEVEN$$

This relationship between the average pass trip rate and the pass break-even rate was provided in equation (1) for transit systems operating more than one million vehicle revenue miles of service annually. For smaller systems, Equation (1) may provide inaccurate estimates. Consequently, the authors provided Equation (2), which is based on the experiences of several small transit operations.

(3) Equation for the Discount Rate

$$DISC = \left(\frac{FARE - (PRICE/TRIPS)}{FARE} \right) \times 100$$

This equation is based on the standard method for computing the discount rate. Since the new average price per trip (PRICE/TRIPS) is subtracted from the average cash fare (FARE), the term will be positive for most types of analysis. The positive decimal fraction is multiplied by 100 to obtain a percentage.

(4a) Market Penetration Model

$$\ln \left(\frac{PENRATE}{1-PENRATE} \right) = -1.1469 + 0.0597\ DISC - 0.3874\ \ln TRIPS - 0.2596\ COMP$$

This model, like the trip rate model presented as Equation (1), was estimated using ordinary least-squares regression of cross-sectional data collected on the fare prepayment penetration rates of 97 programs nationwide. Since the model was estimated from actual data, no derivation is required.

(4b) Market Penetration Model with Adjustment Factor

$$\ln \left(\frac{PENRATE}{1-PENRATE} \right) = -1.1469 + 0.0597\ DISC - 0.3874\ \ln TRIPS - 0.2596\ COMP + 0.0047\ OUTLETS$$

This equation is presented as Equation (4a) with an adjustment for the number of sales outlets. The adjustment factor is based on an analysis of 14 fare prepayment programs across the country. Since this factor was estimates from actual data, no derivation is required.

(5) Equation for Diverted Ridership

$$RIDES_D = \frac{(RIDES_1)\ (PENRATE)}{1 - (E_f)\ (DISC/100)\ (1-PENRATE)}$$

This equation can be derived from the following four equations, which are given by definition:

(a) $RIDES_P = (RIDES_2)\ (PENRATE)$

(b) $RIDES_P = RIDES_D + RIDES_N$

(c) $RIDES_2 = RIDES_1 + RIDES_N$

(d) $RIDES_N = -\ (RIDES_D)\ (E_f)\ (DISC/100)$, (See Equation (6) for a derivation of this equation)

Using (a) and (b):

$$RIDES_D + RIDES_N = (RIDES_2)\ (PENRATE)$$

Substituting (c):

$$RIDES_D + RIDES_N = (RIDES_1 + RIDES_N)\ (PENRATE)$$

$$RIDES_D + RIDES_N = (RIDES_1)\ (PENRATE) + (RIDES_N)\ (PENRATE)$$

$$RIDES_D + RIDES_N - (PENRATE)\ (RIDES_N) = (RIDES_1)\ (PENRATE)$$

$$RIDES_D + (RIDES_N)\ (1 - PENRATE) = (RIDES_1)\ (PENRATE)$$

Substituting (d):

$$RIDES_D - (RIDES_D)\ (E_f)\ (DISC/100)\ (1\text{-}PENRATE) = (RIDES_1)\ (PENRATE)$$

$$(RIDES_D)\ [1 - (E_f)\ (DISC/100)\ (1 - PENRATE)] = (RIDES_1)\ (PENRATE)$$

Therefore:

$$RIDES_D = \frac{(RIDES_1)\ (PENRATE)}{1 - (E_f)\ (DISC/100)\ (1 - PENRATE)}$$

(6) Equation for New Transit Ridership

$$RIDES_N = - (RIDES_D) (E_f) (DISC/100)$$

This equation is derived from the most common definition of fare elasticity (also known as the shrinkage factor):

$$E_f = [(Q_2 - Q_1)/Q_1]/[(F_2 - F_1)/F_1]$$

Thus:

$$Q_2 - Q_1 = (Q_1) (E_f) [(F_2 - F_1)/F_1]$$

But:

$(F_2 - F_1)/F_1 = - (DISC/100)$, from Equation (3)

$Q_2 - Q_1 = RIDES_N$

$Q_1 = RIDES_D$, since only diverted ridership is affected by the discount offered by the fare prepayment plan

Therefore:

$$RIDES_N = - (RIDES_D) (E_f) (DISC/100)$$

(7) Equation for Total Prepaid Ridership

$$RIDES_P = RIDES_D + RIDES_N$$

This equation is true by definition.

(8) Equation for Total Ridership After Implementation

$$RIDES_2 = RIDES_1 + RIDES_N$$

This equation is true by definition.

(9) Equation for New Level of Cash Ridership

$$RIDES_C = RIDES_2 - RIDES_P$$

This equation is true by definition

(10) Equation for Fare Prepayment Sales

$$SALES = (RIDES_P)/(TRIPS)$$

Since TRIPS is defined as the number of one-way trips taken per fare prepayment instrument, SALES, or the number of instruments purchased per period, is equal to the number of prepaid trips divided by the number of trips per instrument.

(11) Equation for New Revenue Levels

$$REV_2 = (RIDES_C)\ (FARE) + (SALES)\ (PRICE)$$

Total revenues equal cash revenues plus prepaid revenues.

(12) Equation for Future Average Trip Rates

$$TRIPS_2 = TRIPS_1 + \frac{0.70\ (BKEVEN_2^2 - BKEVEN_1^2)}{\sqrt{6096 + 0.70\ (BKEVEN_1 + BKEVEN_2)^2}}$$

This equation is obtained from a regression of data on the monthly trip rates and break-even rates during several periods of time in Seattle, Washington. The regression equation is:

$$TRIPS^2 = 1524 + 0.70\ BKEVEN^2$$

or

$$TRIPS = \sqrt{1524 + 0.70\ BKEVEN^2}$$

Taking the derivative of this equation:

$$\frac{\partial\ TRIPS}{\partial\ BKEVEN} = (0.5)(1524 + 0.70\ BKEVEN^2)^{-\frac{1}{2}}\ (2)(0.70)(BKEVEN)$$

$$\frac{\partial\ TRIPS}{\partial\ BKEVEN} = \frac{0.70\ BKEVEN}{\sqrt{1524 + 0.70\ BKEVEN^2}}$$

Since we are concerned with finite changes in the break-even rate:

$$\partial \text{TRIPS} = \text{TRIPS}_2 - \text{TRIPS}_1$$

$$\partial \text{BKEVEN} = \text{BKEVEN}_2 - \text{BKEVEN}_1$$

$$\text{BKEVEN} = (\text{BKEVEN}_1 + \text{BKEVEN}_2)/2$$

Thus:

$$\text{TRIPS}_2 = \text{TRIPS}_1 + \frac{0.70\ (\text{BKEVEN}_2^2 - \text{BKEVEN}^2)}{\sqrt{6096 + 0.70\ (\text{BKEVEN}_1 + \text{BKEVEN}_2)^2}}$$

(13) Equation for Future Market Penetration Rate

$$\text{PENRATE}_2 = \text{PENRATE}_1\ [1 + 0.0597\ (1\text{-PENRATE}_1)\ (\Delta\ \text{DISC})]$$

Recall from Equation (4a):

$$\ln\left(\frac{\text{PENRATE}}{1 - \text{PENRATE}}\right) = -1.1469 + 0.0597\ \text{DISC} - 0.3874\ \ln\text{TRIPS} - 0.2596\ \text{COMP}$$

Let the right side of the above equation equal u. Thus:

$$\ln\left(\frac{\text{PENRATE}}{1 - \text{PENRATE}}\right) = u$$

$$\frac{\text{PENRATE}}{1 - \text{PENRATE}} = e^u$$

$$\text{PENRATE} = e^u - (\text{PENRATE})\ (e^u)$$

$$\text{PENRATE} + (\text{PENRATE})\ (e^u) = e^u$$

$$(\text{PENRATE})\ (1 + e^u) = e^u$$

Therefore:

$$\text{PENRATE} = (e^u)/(1 + e^u)$$

Taking the partial derivative of this equation with respect to DISC:

$$\frac{\partial \text{PENRATE}}{\partial \text{DISC}} = (1 + e^u)^{-1} (e^u)(\partial u/\partial \text{DISC}) + (e^u)(-1)(1+e^u)^{-2}(e^u)(\partial u/\partial \text{DISC})$$

$$\frac{\partial \text{PENRATE}}{\partial \text{DISC}} = (\text{PENRATE}_1)(\partial u/\partial \text{DISC}) - (\text{PENRATE}_1)^2 (\partial u/\partial \text{DISC})$$

$$\frac{\partial \text{PENRATE}}{\partial \text{DISC}} = (\text{PENRATE}_1)(\partial u/\partial \text{DISC})(1 - \text{PENRATE}_1)$$

Since we are interested in the increment of time before and after the price change:

$$\partial \text{PENRATE} = \text{PENRATE}_2 - \text{PENRATE}_1$$

$$\partial \text{DISC} = \text{DISC}_2 - \text{DISC}_1 = \Delta \text{DISC}$$

Moreover:

$$(\partial u/\partial \text{DISC}) = + 0.0597$$

Thus:

$$\text{PENRATE}_2 - \text{PENRATE}_1 = (\text{PENRATE}_1)(0.0597)(1-\text{PENRATE}_1)(\Delta \text{DISC})$$

$$\text{PENRATE}_2 = \text{PENRATE}_1 + (\text{PENRATE}_1)(0.0597)(1-\text{PENRATE}_1)(\Delta \text{DISC})$$

$$\text{PENRATE}_2 = (\text{PENRATE}_1)[1 + (0.0597)(1 - \text{PENRATE}_1)(\Delta \text{DISC})]$$

(14) Equation for Diverted Ridership as a Result of a Price Decrease

$$RIDES_D = \left(\frac{(RIDES_1)\ (PENRATE_2)}{1 - (E_f)\ [\Delta DISC/(100-DISC_1)]\ (1 - PENRATE_2)} \right) - RIDES_{P1}$$

This equation can be derived from the following four equations, which are given by definition:

(a) $RIDES_{P2} = (RIDES_2)\ (PENRATE_2)$

(b) $RIDES_{P2} = RIDES_D + RIDES_N + RIDES_{P1}$

(c) $RIDES_2 = RIDES_1 + RIDES_N$

(d) $RIDES_N = (RIDES_{P1} + RIDES_D)\ (E_f)\ [\Delta DISC/(100-DISC_1)]$ For a derivation of this elasticity formula, see Equation (15) below.

Using (a) and (b):

$$RIDES_D + RIDES_N + RIDES_{P1} = (RIDES_2)\ (PENRATE_2)$$

Substituting (c):

$$RIDES_D + RIDES_N + RIDES_{P1} = (RIDES_1)\ (PENRATE_2) + (RIDES_N)\ (PENRATE_2)$$

$$RIDES_D + RIDES_N - (RIDES_N)\ (PENRATE_2) + RIDES_{P1} = (RIDES_1)\ (PERNATE_2)$$

$$(RIDES_D + RIDES_{P1}) + (RIDES_N)\ (1\text{-}PENRATE_2) = (RIDES_1)\ (PENRATE_2)$$

Substituting (d):

$$(RIDES_D + RIDES_{P1}) - (RIDES_{P1} + RIDES_D)\ (E_f)\ [\Delta DISC/(100-DISC_1)]\ (1 - PENRATE_2) = (RIDES_1)\ (PENRATE_2)$$

$$(RIDES_D + RIDES_{P1})\ [1 - (E_f)\ (\Delta DISC/(100-DISC_1))\ (1 - PENRATE_2)] = (RIDES_1)\ (PENRATE_2)$$

$$RIDES_D + RIDES_{P1} = \frac{(RIDES_1)\ (PENRATE_2)}{1 - (E_f)\ [\Delta DISC/(100 - DISC_1)]\ (1 - PENRATE_2)}$$

$$RIDES_D = \left(\frac{(RIDES_1)\ (PENRATE_2)}{1 - (E_f)\ [\Delta DISC/(100 - DISC_1)]\ (1 - PENRATE_2)} \right) - RIDES_{P1}$$

(15) Equation for New Prepaid Ridership

$$RIDES_N = -\ (RIDES_{P1} + RIDES_D)\ (E_f)\ [\Delta DISC/(100-DISC_1)]$$

The definition of the elasticity of demand (shrinkage ratio) is as follows:

$$E_f = [(Q_2 - Q_1)/Q_1]/[(F_2 - F_1)/F_1]$$

$$Q_2 - Q_1 = (Q_1)\ (E_f)\ [(F_2 - F_1)/F_1]$$

The ridership base affected by the price decrease includes existing prepaid users and diverted cash users. Thus:

$$Q_1 = RIDES_{P1} + RIDES_D$$

$$Q_2 = RIDES_{P2}$$

Therefore:

$$Q_2 - Q_1 = RIDES_N$$

The average fares for the Q_1 and Q_2 groups are as follows:

$$F_1 = \frac{(PRICE_1/TRIPS_1)\ (RIDES_{P1}) + (FARE)\ (RIDES_D)}{RIDES_{P1} + RIDES_D}$$

$$F_2 = (PRICE_2)/(TRIPS_2)$$

For clarity, let:

P_1 = $PRICE_1$ $\quad$ R_D = $RIDES_D$

P_2 = $PRICE_2$ $\quad$ T_1 = $TRIPS_1$

R_{P1} = $RIDES_{P1}$ $\quad$ T_2 = $TRIPS_2$

F = FARE

Thus:

$$\frac{F_2 - F_1}{F_1} = \frac{(P_2/T_2)\,(R_{P1}) + (P_2/T_2)\,(R_D) - (P_1/T_1)\,(R_{P1}) - (F)\,(R_D)}{(P_1/T_1)\,(R_{P1}) + (F)\,(R_D)}$$

$$\frac{F_2 - F_1}{F_1} = \frac{[(P_2/T_2) - (P_1/T_1)]\,(R_{P1}) + [(P_2/T_2) - F]\,(R_D)}{(P_1/T_1)\,(R_{P1}) + (F)\,(R_D)}$$

Although this formula for the percentage change in average fares is correct, it is too cumbersome for the model. It can be simplified, however, if we assume that the number of diverted riders is small relative to the number of total prepaid riders. In this situation, $R_D = 0$. Thus:

$$\frac{F_2 - F_1}{F_1} = \frac{(P_2/T_2)\,(R_{P1}) - (P_1/T_1)\,(R_{P1})}{(P_1/T_1)\,(R_{P1})}$$

$$\frac{F_2 - F_1}{F_1} = \frac{(P_2/T_2) - (P_1/T_1)}{(P_1/T_1)}$$

However:

$$DISC_1/100 = (F_0 - F_1)/F_0$$

$$DISC_2/100 = (F_0 - F_2)/F_0$$

Or:

$$F_1 = F_0 - (F_0)\,(DISC_1/100)$$

$$F_2 = F_0 - (F_0)\,(DISC_2/100)$$

Thus:

$$\frac{F_2 - F_1}{F_1} = \frac{(F_0)\ [1 - (DISC_2/100)] - (F_0)\ [1 - (DISC_1/100)]}{(F_0)\ [1 - (DISC_1/100)]}$$

$$\frac{F_2 - F_1}{F_1} = \frac{(DISC_1/100) - (DISC_2/100)}{1 - (DISC_1/100)}$$

$$\frac{F_2 - F_1}{F_1} = \frac{DISC_1 - DISC_2}{100 - DISC_1}$$

If:

$$\Delta DISC = DISC_2 - DISC_1$$

Then:

$$\frac{F_2 - F_1}{F_1} = -[\ \Delta\ DISC/(100 - DISC_1)]$$

Returning to the elasticity definition and substituting the fare and ridership equations:

$$RIDES_N = -\ (RIDES_{P1} + RIDES_D)\ (E_f)\ [\Delta DISC/(100 - DISC_1)]$$

(16) Equation for Total Prepaid Ridership After Price Decrease

$$RIDES_{P2} = RIDES_{P1} + RIDES_D + RIDES_N$$

This equation is true by definition.

(17) Equation for Total Ridership After a Price Decrease

$$RIDES_2 = RIDES_1 + RIDES_N$$

This equation is true by definition.

(18) Equation for New Cash Ridership After a Price Decrease

$$RIDES_{C2} = RIDES_2 - RIDES_{P2}$$

This equation is true by definition.

(19) Equation for Diverted Ridership as a Result of a Price Increase

$$RIDES_D = (RIDES_{P1})\ [1 - (E_f)(\Delta DISC/(100-DISC_1))(1 - PENRATE_2)] - (RIDES_1)(PENRATE_2)$$

This equation can be derived from the following four equations, which are given by definition:

(a) $RIDES_{P2} = (RIDES_2)\ (PENRATE_2)$

(b) $RIDES_{P2} = RIDES_{P1} - RIDES_D - RIDES_L$

(c) $RIDES_2 = RIDES_1 - RIDES_L$

(d) $RIDES_L = (RIDES_{P1})\ (E_f)\ [\Delta DISC/(100-DISC_1)]$ (This equation is derived below in Equation (20)).

Using (a) and (b):

$$RIDES_{P1} - RIDES_D - RIDES_L = (RIDES_2)\ (PENRATE_2)$$

Substituting (c):

$$RIDES_{P1} - RIDES_D - RIDES_L = (RIDES_1)\ (PENRATE_2) - (RIDES_L)\ (PENRATE_2)$$

$$RIDES_{P1} - RIDES_D - RIDES_L\ (1 - PENRATE_2) = (RIDES_1)\ (PENRATE_2)$$

Substituting (d):

$$RIDES_{P1} - RIDES_D - (RIDES_{P1})\ (E_f)\ [\Delta DISC/(100-DISC_1)]\ (1 - PENRATE_2) = (RIDES_1)\ (PENRATE_2)$$

$$(RIDES_{P1})\ [1 - (E_f)\ (\Delta DISC/(100-DISC_1)\ (1 - PENRATE_2)] - RIDES_D = (RIDES_1)\ (PENRATE_2)$$

Rearranging the equation:

$$RIDES_D = (RIDES_{P1})[1 - (E_f)(\Delta DISC/(100-DISC_1))(1 - PENRATE_2)] - (RIDES_1)(PENRATE_2)$$

(20) Equation for Lost Ridership as a Result of a Price Increase

$$RIDES_L = (RIDES_{P1})\ (E_f)\ [\Delta DISC/(100-DISC_1)]$$

The definition of the fare elasticity of demand was provided in the derivation of Equation (15). The new terms are:

$Q_1 = RIDES_{P1}$

$Q_2 = RIDES_{P2} + RIDES_D = RIDES_{P1} - RIDES_L$

$Q_2 - Q_1 = RIDES_L$

$F_1 = (PRICE_1)/(TRIPS_1)$

$F_2 = (PRICE_2)/(TRIPS_2)$ (see Equation (15))

Thus:

$(F_2 - F_1)/F_1 = -[\Delta DISC/(100 - DISC_1)]$, as derived for Equation (15)

Therefore:

$$RIDES_L = (RIDES_{P1})\ (E_f)\ [\Delta DISC/(100 - DISC_1)]$$

(21) Equation for Total Prepaid Ridership After a Price Increase

$$RIDES_{P2} = RIDES_{P1} - RIDES_D - RIDES_L$$

This equation is true by defintion.

(22) Equation for Total Ridership After a Price Increase

$$RIDES_2 = RIDES_1 - RIDES_L$$

This equation is true by definition.

(23) Equation for New Cash Ridership After a Price Increase

$$RIDES_{C2} = RIDES_2 - RIDES_{P2}$$

This equation is true by definition.

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