TCRP

REPORT 95

TRANSIT COOPERATIVE RESEARCH PROGRAM

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Transit Pricing and Fares

Traveler Response to Transportation System Changes

TRANSPORTATION RESEARCH BOARD
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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP REPORT 95

Traveler Response to Transportation System Changes

Chapter 12—Transit Pricing and Fares

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, the Transit Development Corporation, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

Special Notice

The Transportation Research Board, the National Research Council, the Transit Development Corporation, and the Federal Transit Administration (sponsor of the Transit Cooperative Research Program) do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the clarity and completeness of the project reporting.

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FOREWORD

By Stephan A. Parker
Staff Officer
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This "Transit Pricing and Fares" chapter addresses transit ridership response to fare changes as applied to conventional urban area bus and rail transit services. Topics covered are: changes in general fare level, changes in fare structure including relationships among fare categories, and free transit.

This chapter is relatively narrow in its focus. Among other things, it does not cover the combined outcome of implementing fare and service changes in the same time frame. This combination, in the case of fare and headway changes, is covered in the "Frequency Changes with Fare Changes" subsection of Chapter 9, "Transit Scheduling and Frequency." In the case of combined fare and bus routing or service coverage changes, outcomes are presented in the "Service Changes with Fare Changes" subsection of Chapter 10, "Bus Routing and Coverage."

Special fares, offers and free rides introduced in conjunction with marketing activities are addressed in Chapter 11, "Transit Information and Promotion," in various subsections within the "Mass Market Promotions" and "Targeted Promotion" categories. General workforce employee transit fare discounts are covered both here in Chapter 12 and in Chapter 19, "Employer and Institutional TDM Strategies," where the emphasis is more on results as seen from an overall Travel Demand Management context.

For fare changes applied in the context of certain individual service types, see the following chapters and subtopics:

- For available express bus fare information, check Chapter 4, "Busways, BRT and Express Bus."
- For public paratransit fare change evaluations, refer to the "Change in Fares" subsection of Chapter 6, "Demand Responsive/ADA" (found in the "Underlying Traveler Response Factors" section).
- For urban rail fare change findings in addition to those presented here in Chapter 12, check Chapter 7, "Light Rail Transit," and Chapter 8, "Commuter Rail."
- For results of fare policy and pricing changes affecting local area bus circulators and distributors, see the "Circulator/Distributor Routes" subsection of Chapter 10, "Bus Routing and Coverage."

TCRP Report 95: Chapter 12, Transit Pricing and Fares will be of interest to transit planning practitioners; educators and researchers; and professionals across a broad spectrum of transportation agencies, MPOs, and local, state, and federal government agencies.

The overarching objective of the *Traveler Response to Transportation System Changes Handbook* is to equip members of the transportation profession with a comprehensive, readily accessible, interpretive documentation of results and experience obtained across the United States and elsewhere from (1) different types of transportation system changes and policy actions and (2) alternative land use and site development design approaches. While the focus is on contemporary observations and assessments of traveler responses as expressed in travel demand changes, the presentation is seasoned with earlier experiences and findings to identify trends or stability, and to fill information gaps that would otherwise exist. Comprehensive referencing of additional reference materials is provided to facilitate and encourage in-depth exploration of topics of interest. Travel demand and related impacts are expressed using such measures as usage of transportation facilities and services, before-and-after market shares and percentage changes, and elasticity.

The findings in the *Handbook* are intended to aid—as a general guide—in preliminary screening activities and quick turn-around assessments. The *Handbook* is not intended for use as a substitute for regional or project-specific travel demand evaluations and model applications, or other independent surveys and analyses.

The Second Edition of the handbook *Traveler Response to Transportation System Changes* was published by USDOT in July 1981, and it has been a valuable tool for transportation professionals, providing documentation of results from different types of transportation actions. This Third Edition of the *Handbook* covers 18 topic areas, including essentially all of the nine topic areas in the 1981 edition, modified slightly in scope, plus nine new topic areas. Each topic is published as a chapter of *TCRP Report 95*. To access the chapters, select "TCRP, All Projects, B-12" from the TCRP website: http://www4.national-academies.org/trb/crp.nsf.

A team led by Richard H. Pratt, Consultant, Inc. is responsible for the *Traveler Response to Transportation System Changes Handbook, Third Edition*, through work conducted under TCRP Projects B-12, B-12A, and B-12B.

REPORT ORGANIZATION

The *Handbook*, organized for simultaneous print and electronic chapter-by-chapter publication, treats each chapter essentially as a stand-alone document. Each chapter includes text and self-contained references and sources on that topic. For example, the references cited in the text of Chapter 6, "Demand Responsive/ADA," refer to the Reference List at the end of that chapter. The *Handbook* user should, however, be conversant with the background and guidance provided in *TCRP Report 95: Chapter 1, Introduction*.

Upon completion of the *Report 95* series, the final Chapter 1 publication will include a CD-ROM of all 19 chapters. The complete outline of chapters is provided below.

Handbook Outline Showing Publication and Source-Data-Cutoff Dates

General Sections and Topic Area Chapters (TCRP Report 95 Nomenclature)	U.S. DOT Publication: First Edition	U.S. DOT Publication: Second Edition	TCRP Report 95: Source Data Cutoff Date	TCRP Report 95: Estimated Publication Date
Ch. 1 – Introduction (with Appendices A, B)	1977	1981	2003[a]	2000/03/05[a]
Multimodal/Intermodal Facilities				
Ch. 2 – HOV Facilities	1977	1981	1999	2000/05[b]
Ch. 3 – Park-and-Ride/Pool	—	1981	2003[c]	2004[d]
Transit Facilities and Services				
Ch. 4 – Busways, BRT and Express Bus	1977[e]	1981	2003[c]	2005[d]
Ch. 5 – Vanpools and Buspools	1977	1981	1999	2000/04[b]
Ch. 6 – Demand Responsive/ADA	—	—	1999	2004
Ch. 7 – Light Rail Transit	—	—	2003	2005[d]
Ch. 8 – Commuter Rail	—	—	2003	2005[d]
Public Transit Operations				
Ch. 9 – Transit Scheduling and Frequency	1977	1981	1999	2004
Ch. 10 – Bus Routing and Coverage	1977	1981	1999	2004
Ch. 11 – Transit Information and Promotion	1977	1981	2002	2003
Transportation Pricing				
Ch. 12 – Transit Pricing and Fares	1977	1981	1999	2004
Ch. 13 – Parking Pricing and Fees	1977[e]	—	1999	2000/04[b]
Ch. 14 – Road Value Pricing	1977[e]	—	2002–03[f]	2003
Land Use and Non-Motorized Travel				
Ch. 15 – Land Use and Site Design	—	—	2001–02[f]	2003
Ch. 16 – Pedestrian and Bicycle Facilities	—	—	2003	2004[d]
Ch. 17 – Transit Oriented Design	—	—	2003[d]	2005[d]
Transportation Demand Management				
Ch. 18 – Parking Management and Supply	—	—	2000–02[f]	2003
Ch. 19 – Employer and Institutional TDM Strategies	1977[e]	1981[e]	2003	2005[d]

NOTES: [a] Published in TCRP Web Document 12, *Interim Handbook* (March 2000), without Appendix B. The "Interim Introduction," published as Research Results Digest 61 (September 2003), is a replacement, available at http://www4.trb.org/trb/crp.nsf/All+Projects/TCRP+B-12A,+Phase+II. Publication of the final version of Chapter 1, "Introduction," as part of the TCRP Report 95 series, is anticipated for 2005.

[b] Published in TCRP Web Document 12, *Interim Handbook,* in March 2000. Available now at http://www4.nas.edu/trb/crp.nsf/All+Projects/TCRP+B-12. Publication as part of the TCRP Report 95 series is anticipated in 2004 or 2005.

[c] The source data cutoff date for certain components of this chapter was 1999.

[d] Estimated.

[e] The edition in question addressed only certain aspects of later edition topical coverage.

[f] Primary cutoff was first year listed, but with selected information from second year listed.

CHAPTER 12 AUTHOR AND CONTRIBUTOR ACKNOWLEDGMENTS

TCRP Report 95, in essence the Third Edition of the "Traveler Response to Transportation System Changes" Handbook, is being prepared under Transit Cooperative Research Program Projects B-12, B-12A, and B-12B by Richard H. Pratt, Consultant, Inc. in association with the Texas Transportation Institute; Jay Evans Consulting LLC; Parsons Brinckerhoff Quade & Douglas, Inc.; Cambridge Systematics, Inc.; J. Richard Kuzmyak, L.L.C.; BMI-SG; Gallop Corporation; McCollom Management Consulting, Inc.; Herbert S. Levinson, Transportation Consultant; and K.T. Analytics, Inc.

Richard H. Pratt is the Principal Investigator. Dr. Katherine F. Turnbull of the Texas Transportation Institute assisted as co-Principal Investigator during initial Project B-12 phases, leading up to the Phase I Interim Report and the Phase II Draft Interim Handbook. With the addition of Project B-12B research, John E. (Jay) Evans, IV, of Jay Evans Consulting LLC was appointed the co-Principal Investigator. Lead Handbook chapter authors and co-authors, in addition to Mr. Pratt, are Mr. Evans (initially with Parsons Brinckerhoff); Dr. Turnbull; Frank Spielberg of BMI-SG; Brian E. McCollom of McCollom Management Consulting, Inc.; Erin Vaca of Cambridge Systematics, Inc.; J. Richard Kuzmyak, initially of Cambridge Systematics and now of J. Richard Kuzmyak, L.L.C.; and Dr. G. Bruce Douglas of Parsons Brinckerhoff Quade & Douglas, Inc. Contributing authors include Herbert S. Levinson, Transportation Consultant; Dr. Kiran U. Bhatt, K.T. Analytics, Inc.; Shawn M. Turner, Texas Transportation Institute; Dr. Rachel Weinberger, Cambridge Systematics (now of Nelson/Nygaard); and Dr. C. Y. Jeng, Gallop Corporation.

Other research agency team members contributing to the preparatory research, synthesis of information, and development of this Handbook have been Stephen Farnsworth, Laura Higgins and Rachel Donovan of the Texas Transportation Institute; Nick Vlahos, Vicki Ruiter and Karen Higgins of Cambridge Systematics, Inc.; Lydia Wong, Gordon Schultz, Bill Davidson, and Andrew Stryker of Parsons Brinckerhoff Quade & Douglas, Inc.; Kris Jagarapu of BMI-SG; and Laura C. (Peggy) Pratt of Richard H. Pratt, Consultant, Inc. As Principal Investigator, Mr. Pratt has participated iteratively and substantively in the development of each chapter. Dr. C. Y. Jeng of Gallop Corporation has provided pre-publication numerical quality control review. By special arrangement, Dr. Daniel B. Rathbone of The Urban Transportation Monitor searched past issues. Assistance in word processing, graphics and other essential support has been provided by Bonnie Duke and Pam Rowe of the Texas Transportation Institute, Karen Applegate, Laura Reseigh, Stephen Bozik, and Jeff Waclawski of Parsons Brinckerhoff, others too numerous to name but fully appreciated, and lastly the warmly remembered late Susan Spielberg of SG Associates (now BMI-SG).

Special thanks go to all involved for supporting the cooperative process adopted for topic area chapter development. Members of the TCRP Project B-12/B-12A/B-12B Project Panel, named elsewhere, are providing review and comments for what will total over 20 individual publication documents/chapters. They have gone the extra mile in providing support on call including leads, reports, documentation, advice, and direction over what will be the eight-year duration of the project. Four consecutive appointed or acting TCRP Senior Program Officers have given their support: Stephanie N. Robinson, who took the project through scope development and contract negotiation; Stephen J. Andrle, who led the work during the Project B-12 Phase and on into the TCRP B-12A Project Continuation; Harvey Berlin, who saw the Interim Handbook through to Website publication; and Stephan A. Parker, who is guiding the entire project to its complete fruition. Editor Natassja Linzau is providing her careful examination and fine touch, while Managing Editor Eileen Delaney and her team are handling all the numerous publication details. The efforts of all are greatly appreciated.

Continued recognition is due to the participants in the development of the First and Second Editions, key elements of which are retained. Co-authors to Mr. Pratt were Neil J. Pedersen and Joseph J. Mather for the First Edition, and John N. Copple for the Second Edition. Crucial support and guidance for both editions was provided by the Federal Highway Administration's Technical Representative (COTR), Louise E. Skinner.

In the *TCRP Report 95* edition, Brian E. McCollom is the lead author for this volume: Chapter 12, "Transit Pricing and Fares." Contributing author for Chapter 12 is Richard H. Pratt.

Participation by the profession at large has been absolutely essential to the development of the Handbook and this chapter. Members of volunteer Review Groups, established for each chapter, reviewed outlines, provided leads, and in many cases undertook substantive reviews. Though all members who assisted are not listed here in the interests of brevity, their contribution is truly valued. Those who have undertaken reviews of Chapter 12 are William G. Allen, Jr. and Steven Billings.

Finally, sincere thanks are due to the many practitioners and researchers who were contacted for information and unstintingly supplied both that and all manner of statistics, data compilations and reports. Though not feasible to list here, many appear in the "References" section entries of this and other chapters.

CHAPTER 12—TRANSIT PRICING AND FARES

CONTENTS

12 – Transit Pricing and Fares

OVERVIEW AND SUMMARY

This "Transit Pricing and Fares" chapter addresses transit ridership response to fare changes as applied to conventional urban area bus and rail transit services. Topics covered are: changes in general fare level, changes in fare structure including relationships among fare categories, and free transit. Transit pricing focused on certain individual transit modes or services, and fare changes and special fares implemented in connection with service change, promotional, and Travel Demand Management (TDM) programs, are covered in other chapters as detailed below.

Within this "Overview and Summary" section:

- "Objectives of Transit Pricing and Fare Changes" highlights the fiscal, socio-economic, operational and equity reasons for pursuing the types of pricing changes addressed here.
- "Types of Transit Pricing and Fare Change Strategies" explains and categorizes the types of fare changes involved.
- "Analytical Considerations" examines the limitations and complexities of transit pricing research, and how that affects use of the information provided.
- "Traveler Response Summary" encapsulates the findings of Chapter 12. It is not recommended that information in the "Traveler Response Summary" be used without benefit of the context provided by the "Overview and Summary" section as a whole.

Following the four-part "Overview and Summary" are the more detailed presentations:

- "Response by Type of Strategy" provides and examines elasticities and other traveler response measures for each specific approach to transit fare changes and pricing.
- "Underlying Traveler Response Factors" examines the interplay of fare changes with travel and traveler characteristics, demographics and demand.
- "Related Information and Impacts" presents related mode shift, revenue, cost and environmental effects information.
- "Case Studies" examines four quite different examples of changes in transit pricing.

This chapter, being relatively narrow in its focus, relies upon other chapters to cover most applications of transit pricing and fare changes that overlap other areas of interest. Pricing of transit park-and-ride parking is discussed within Chapter 3, "Park-and-Ride/Pool," in the "Underlying Traveler Response Factors"—"User Costs and Willingness to Pay" and "Related Information and Impacts"—"Parking Pricing at Park-and-Ride Facilities" subsections. Available information on express bus service fares is located in Chapter 4, "Busways, BRT and Express Bus." Public paratransit fare changes are covered in the "Underlying Traveler Response Factors"—"Change in Fares" subsection of Chapter 6, "Demand Responsive/ADA." Transit pricing issues encountered in analyzing bus routing and system changes are addressed in Chapter 10, "Bus Routing and Coverage." Fares and fare modifications applied to bus circulator services are specifically found in Chapter 10 under "Response by Type of Service and Strategy"—"Circulator/Distributor Routes."

Three additional instances of reliance on other chapters for rounding out transit pricing coverage do not relate to individual transit service types. Transit fare changes implemented together with service frequency changes are addressed in Chapter 9, "Transit Scheduling and Frequency," under "Response by Type of Strategy"—"Frequency Changes with Fare Changes." Special fares, discounts and free rides offered in conjunction with transit marketing are examined in multiple "Mass Market Promotions" and "Targeted Promotion" applications within Chapter 11, "Transit Information and Promotion." Special fares and purchase methods offered as elements of TDM programs, in addition to the coverage of "Unlimited Travel Pass Partnerships" provided here in Chapter 12 under "Response by Type of Strategy"—"Changes in Fare Categories," are examined in an overall TDM context in Chapter 19, "Employer and Institutional TDM Strategies."

Objectives of Transit Pricing and Fare Changes

The most common objective of transit pricing and fare changes is to increase revenues in response to actual or forecast increases in operating costs. Such changes usually involve fare increases for most transit users. An associated objective is to minimize the ridership loss usually involved in fare increases.

An objective less commonly pursued, mainly because of cost, is use of transit pricing changes to stimulate increased transit usage. Stated objectives for fare-free programs include transit promotion and education, mobility, support of the local economy, and congestion reduction (Hodge, Orrell and Strauss, 1994). Fare reduction objectives are similar, with emphasis on achieving ridership gains. Employer and institution pass programs providing free or deeply discounted employee and student travel via transit are particularly focused on localized traffic mitigation, parking needs reduction, air quality, and accessibility objectives.

Some transit systems use transit pricing to increase transit ridership in, or shift ridership to, the periods of the day or days of the week when service is underutilized, such as midday or evening periods or weekends.

These systems typically offer time-specific fare reductions to encourage ridership in these periods. Transit passes and certain other prepaid fare media including electronic media may be introduced wholly or in part for the purpose of improved revenue handling efficiency and control. This perspective notwithstanding associated objectives of revenue and ridership enhancement also pertain and deserve consideration in application design.

Finally, fare changes may be made to improve fare equity among users. Fare equity can be defined in terms of costs or benefits. From the cost perspective, fare levels are set or changed to reflect the costs of providing individual services, such as higher fares for expensive, peak period express services and lower fares for all-day local services. From the benefits perspective, fare levels are set or changed to reflect the benefits or level of service received by users, such as higher fares for fast, long-distance services and lower fares for slow, local services. Most transit systems consider fare equity when transit pricing and fare changes are made, but few transit systems make changes solely for reasons of fare equity.

Types of Transit Pricing and Fare Change Strategies

Transit pricing changes involve the increase or decrease of the fare charged to a transit rider. While simple in concept, this definition is complicated in application because most transit systems have a large number of fare categories. The primary reason for the large number of fare categories is the variety of purchase methods and rider fare classes typically involved.

Most transit systems offer many ways that a transit rider can pay for a transit trip. While many variations exist, there are three basic types of purchase methods:

- **Individual trip payment,** whereby a single fare is charged every time a transit rider takes a trip. Generally, each time a trip is made the transit rider pays cash or the fare is deducted from a stored-value card. The purchase of transfers is a form of individual trip payment.

- **Multiple-ride tickets or tokens,** sold for a specified number of rides, typically 1, 10, or 20. Often, a discount is provided when tickets or tokens are purchased in bulk, offering savings over making individual trip payments.

- **Unlimited-ride passes or tickets,** permitting the transit rider unlimited travel within a specific time period, typically one week or one month. The passes often are priced to provide a discount to frequent riders, if they chose a pass over making individual trip payments.

Transit systems also differentiate fares among riders on the basis of travel characteristics. These characteristics can be summarized into two types (Kemp, 1994):

- Rider characteristics
  - Demographic and socioeconomic aspects (e.g., age, financial capacity)
  - Affiliation (e.g., transit employee, school)
  - Mobility impairment

- Trip characteristics
  - Trip distance
  - Trip duration
  - Quality of service (e.g., speed, seat availability)
  - Time period (e.g., peak/off-peak, day of week)

When the variety of purchase types and rider fare classes is considered, it is not unusual for a transit system to have more than 10 different fare categories, often for the same trip. A transit system that offers three purchase options (such as individual payment, ten-ride ticket, and a monthly pass), three different rider fares (adult, student, and the elderly), and two different trip fares (express and local services), could have as many as 18 different fare categories (3 times 3 times 2).

In this Handbook, the term fare structure is used to describe the overall fare system used by a transit operator, including:

- The relationships among the fares (prices) charged for each fare category.
- The types of fare categories offered.
- The basis on which fares are calculated ~ flat, zonal, or distance-based.

The following general types of changes in fares and fare structure are discussed in this chapter:

Changes in General Fare Level. This type of change involves increases or decreases in adult fares that are accompanied by corresponding changes in the other fare categories. The percent changes in fare levels among fare categories are kept generally the same, except for differences that occur because of rounding fares to the nearest $0.05 for individual payment or $0.50 or $1.00 for multiple-ride or unlimited-ride tickets.

Changes in Pricing Relationships. This strategy involves altering the pricing relationships among current fare categories. In other words, it does not keep the percent changes in fare levels among fare categories the same, but instead seeks to deliberately modify them. An example is the "Deep Discount Fare" approach, in which the discounts for multiple-ride tickets are increased from smaller discounts to 20 to 30 percent off of cash fares (Oram, 1988; Oram and Schwenk, 1994). Also covered in this category are the charging of different fare levels for different hours of the day and days of the week, and provision of discounts for senior citizens.

Changes in Fare Categories. A common form of this type of change is introduction or withdrawal of a particular fare purchase method. Payment methods typically include individual payment, multiple-ride tickets, and unlimited-ride passes. Alternatively, a fare category change may be defined in terms of rider characteristics, such as with school fares; or trip characteristics, as with express bus fares.

Changes in Fare Structure Basis. This type of fare structure change is concerned with the basis on which fares are calculated. The fare structure basis may be that of a flat (single) fare for the entire system or a major proportion of it, a zonal fare that starts with a common base fare and then adds an increment to it each time a zone boundary is crossed, or a distance-based fare, calculated as a function of over-the-route or airline trip distance.

Free Transit. This type of change eliminates the charging of fares to transit riders altogether. This strategy has been applied to selected operating periods, such as off-peak; to selected services, such as downtown or university shuttle routes; to specific geographic areas, such as central business districts; and to all services during all operating periods. Free transit has also been applied as either a short-term or "permanent" strategy.

Analytical Considerations

The effects of transit pricing and fare changes traditionally have been assessed using elasticities to describe the response of ridership. This approach is useful because it permits comparison of changes that differ in the values of starting and ending fare levels, and in the absolute and relative sizes of the fare changes. It also has pitfalls, in that aggregate elasticities can mask extensive variability among results for differing operating environments, types of transit services, and market groups. Elasticities are discussed further in Chapter 1, "Introduction," under "Use of the Handbook"—"Concept of Elasticity," and in Appendix A, where derivation and application formulae are provided.

The more robust analytical techniques for estimating elasticities utilize some form of "before-and-after" approach, as contrasted to cross-sectional analysis. At a minimum, "before-and-after" analyses require data on the fare levels before and after a transit pricing and fare change, the number of existing riders subjected to the change ("before" ridership), and the response of riders to the change ("after" ridership). In addition, this quasi-experimental data ideally should cover a time span free of significant confounding events such as concurrent service changes, or at least be accompanied by "before-and-after" quantification of confounding events.

Much of the complete data on rider response to transit pricing and fare changes is relatively or very old, and applies primarily to general fare level changes. Many recent studies have focused on results without collecting or presenting the "before" data needed to develop elasticity estimates. While some of this incomplete information is reported here, it does not lend itself to making generalizations potentially applicable to other transit systems.

Fortunately, such new information on transit fare elasticities as there is tends to conform well with earlier findings. Also, most "before-and-after" data pertaining to overall fare level changes are based on tallies rather than surveys, with the primary exception of average fare surveys required in some instances, so that survey size and bias are not a major concern. This suggests that most general fare change relationships derived in the past were both valid at the time and have remained stable, and thus are presumably still valid.[1]

In contrast, fully comprehensive analyses of transit pricing in the categories of relative fare changes among purchase methods and introduction of new purchase methods are scarce irrespective of age. This scarcity is perhaps understandable since this type of analysis requires assessment of rider response to both changes in price of the purchase method, or the altogether new price of a new purchase method, and to the relative price of other purchase methods.

For example, an assessment of rider response to reduction in the cost of a monthly pass requires evaluation not only of the aggregate response of potential riders to the lowered fare, but also the response of riders using other purchase options in the "before" situation, such as cash fare or a weekly pass. It requires estimating the number of riders in each purchase option before the change and the number of riders shifting from each purchase option in response to the change. Such analyses involve more detailed data collection, including rider surveys, than are generally carried out by transit systems. They introduce in a more significant way the issue of survey reliability; not just sample size issues, but also concerns with regard to bias control, questionnaire design, and related survey design and administration problem areas.

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[1] Unless otherwise noted, fare elasticities presented here are short-run elasticities, addressing affects within 1 or 2 years following a change. Some recent investigations, primarily at University College London, have estimated long-run in addition to short-run elasticities. Findings include 1975–1995 mean transit fare elasticities of –0.51 to –0.54 short-run and –0.69 to –0.75 long-run in the United Kingdom and –0.30 to –0.32 short-run and –0.59 to –0.61 long-run in France, international bus fare elasticities of –0.28 short-run and –0.55 long-run, and U.K. bus fare elasticities of –0.2 to –0.3 short-run and –0.4 to –0.6 long-run (Litman, 2004). Possible implications are noted in the "Underlying Traveler Response Factors" section under "Auto Availability" (see footnote 5).

Because fully detailed analyses of relative fare changes and new purchase methods are so scarce and potentially problematical, no generalizations based on quasi-experimental data can be made at this time about the following:

- Unique price elasticities of different purchase methods (e.g., percent change in riders using monthly passes versus percent change in price of monthly passes).

- Unique price cross-elasticities among different purchase methods (e.g., percent change in riders using monthly passes versus percent change in price of cash fares).

- The quantitative effect of convenience factors (e.g., relief from need to carry exact fare offered by passes and electronic fare media).

Partial estimates from available sources are provided, along with limited data on the introduction of new purchase categories. Such information should be used with special caution, particularly with regard to its potential applicability under differing circumstances. Chapter 1, "Introduction," in the section on "Use of the Handbook," provides additional guidance on using the generalizations and examples provided in this *Traveler Response to Transportation System Changes* Handbook. Note that throughout the Handbook, because of rounding, figures may not sum exactly to totals provided, and percentages may not add to exactly 100.

Traveler Response Summary

Aggregate measures of general fare elasticity portray a ridership response to fare changes that varies considerably under different situations, but that exhibits relative consistency when expressed as averages. The effect of bus fare increases and decreases equates on average to an arc fare elasticity of about –0.40.[2] The effect of heavy rail transit (HRT/Metro) fare changes is typically much less: short-run HRT fare elasticities average about –0.17 to –0.18, or about half the bus fare elasticities in the same cities.

Rider sensitivity to fare changes appears to decrease with increasing city size. As a general rule, ridership appears to be less sensitive to fare changes where transit is in a strong competitive service and price position vis-a-vis auto travel than it is where transit service is marginal. No significant differences in aggregate elasticities for fare increases versus decreases, or for large versus small changes, have been consistently discerned within the range of normal experience.

Off-peak transit ridership exhibits roughly twice the sensitivity to fare changes of peak period ridership. Thus, even uniform fare decreases or increases diminish or accentuate, respectively, the differences between the peaks and valleys of weekday transit loadings. Charging lower fares in the off-peak periods relative to peak periods further enhances off-peak usage relative to peak usage. Most of this increase is the result of off-peak trips new to transit. Peak period riders, senior citizens

[2] A fare elasticity of –0.4 indicates a 0.4 percent decrease (increase) in transit ridership in response to each 1 percent fare increase (decrease), calculated in infinitesimally small increments. The negative sign indicates that the effect operates in the opposite direction from the cause. An elastic value is –1.0 or beyond, and indicates a demand response that is more than proportionate to the change in the impetus. (See "Concept of Elasticity" in Chapter 1, "Introduction," and Appendix A, "Elasticity Discussion and Formulae.")

excepted, show only extremely limited propensity to shift to off-peak riding in response to off-peak fare reductions.

Individual market segments described by type of fare purchased have been found to have sharply differing sensitivities to fare change. The "Deep Discount Fare" approach to transit pricing focuses discounts on the market segment consisting of infrequent riders who exhibit interest in fare savings. While the hypothesis that infrequent transit riders can thereby be encouraged to ride more often gains only marginal support from evidence to date, deep discounting does appear to help minimize ridership loss in responding to need for increased revenues. It also reduces the use of cash in fare payment, a fare handling cost advantage if prepaid fare use is enough to achieve economies of scale.

All transit systems receiving federal funding in the United States are now required to offer senior citizens half fare discounts during off-peak periods. These reduced fare programs did not significantly increase senior citizen transit usage. The average senior citizen fare elasticity indicated is –0.21. A modest shift of elderly riders from the peak to off-peak typically occurs, however, when reduced fares are offered to the elderly only in off-peak periods.

When an unlimited ride pass is introduced for the first time and without an overall fare increase, revenue loss relative to not having the pass almost always occurs. Pass introduction may be used to soften the impact of a cash fare increase, however, in which case some revenue gain overall may be expected. Both fare prepayment discounting and introduction of unlimited ride passes appear to garner more ridership gain than would equivalent across-the-board fare reductions, at least in the case of large, complex transit systems converting to multi-use electronic fare media. New York City saw 6 percent annual ridership growth over 5 years with such actions.

Public/private commuter pass programs and related unlimited travel pass partnerships are providing a new source of public transportation funding. By all appearances, these programs are becoming quite successful in localized transit ridership enhancement, reduction of single occupant vehicle commuting, and parking demand mitigation. Such programs are often implemented in conjunction with other inducements to reduce single occupant auto use, and these are the cases exhibiting the most notable results.

Provision of free bus transit service was an idea tested in a number of federally-funded demonstrations in the 1970s. Limited evidence from these experiments suggests that rider response to citywide fare elimination is not particularly different, in proportion, than a corresponding response to fare reduction. The exception is free fare zones implemented in downtown business districts. In such applications, a major source of riders is prior walk trips, and fare elasticities appear to be above average. Free fare zones and free shuttles in downtowns are particularly attractive for lunchtime travel. Weekday usage ranges from bus circulators with 1,000 daily boardings to the 25,000 or so trips daily that make use of Seattle's fare-free zone and the 45,000 weekday trips on Denver's free downtown shuttle.

Faced with otherwise equivalent conditions, peak period riders, riders making journey to work trips, and "captive" riders without travel alternatives are significantly less responsive to fare changes than are riders in opposite circumstances. The effect of income and age is less clear, but it appears that most fare changes have affected ridership of lower income groups and non-youth passengers less than other groups. In most but not all cases examined, driving an auto is the alternate mode of choice for about one-third to one-half of the riders who shift to and from transit in response to systemwide fare changes.

Practically all the known observed values of fare elasticities fall in the range between zero and –1.0, which in economic terms, means rider response to fare changes is inelastic. Thus if a transit system wants to increase total fare revenues, it should increase fare levels, but expect some ridership loss. Likewise, reducing fare levels will almost always increase ridership, but at a cost of revenue loss. Operating costs associated with serving passengers attracted through fare reduction are likely to be less significant, particularly where scheduling is based more on policy than demand. Synergistic effects are very important: fare reduction measures in tandem with other strategies have proved especially effective in multi-objective situations, particularly when focused on congested areas with good transit service.

RESPONSE BY TYPE OF STRATEGY

Changes in General Fare Level

Impacts of changes in general fare level have primarily been studied using aggregate measures of fare elasticity. These measures reflect systemwide ridership response to fare changes and are thus averages of the responses across transit modes, purchase types, rider types, and trip characteristics. A simplifying assumption usually made is that the percent changes in fare levels is the same among fare categories except for minor differences that occur because of rounding fares to the nearest $0.05 for individual payment or $0.50 or $1.00 for multiple- or unlimited-ride tickets.

Transit ridership response thus measured has been found to vary considerably among different fare change situations, but with a strong consistency on average. Furthermore, when aggregate ridership responses are examined by mode of transit, size of service area, time-of-day, and other important factors, useful patterns and findings emerge that suggest explanations for some of the variations found among individual cities or market segments (Mayworm, Lago and McEnroe, 1980).

Urban Transit Overall

Throughout the United States and Europe, the most commonly observed range of aggregate fare elasticity values is from –0.1 to –0.6 (Webster and Bly, 1980). The aggregate fare elasticity average for U.S. cities, excluding those with HRT/Metro, is about –0.4 when calculated using log or mid-point arc elasticity. When cities with HRT/Metro are included, the average is less.

A common fare-change rule used by many transit systems for aggregate ridership response to bus fare changes is loosely based on the Simpson & Curtin formula. The formula itself was derived from a regression analysis of before-and-after results of 77 surface transit (bus and streetcar) fare changes. It describes a shrinkage ratio relationship, not an elasticity relationship, and estimates ridership change as follows (Curtin, 1968):

$$Y = 0.80 + 0.30X$$

Where:

Y = Percent loss in ridership as compared to the prior (before) ridership

X = Percent increase in fare as compared to the prior (before) fare

The formula does not follow mathematical conventions used by most economists. The estimated percent loss in ridership is expressed as a positive, rather than a negative, number. The percent changes in fare and in ridership are expressed as whole percentage numbers rather than as decimals. For example, the percent loss in ridership that will result from a 10 percent increase in fares is estimated using this formula as follows:

$$\begin{aligned}\text{Percent loss in ridership} &= 0.80 + (0.30 * 10) \\ &= 0.80 + 3.00 \\ &= 3.8 \text{ percent}\end{aligned}$$

The common fare-change rule into which this formula evolved over the years states that an overall fare increase (decrease) of 10 percent will result in ridership loss (gain) of 3 percent. While easy to remember, this simplification ignores the impact of the regression constant (0.80) and introduces a large estimation error for small fare changes, as illustrated in Table 12-1.

Table 12-1 Comparison of Simpson & Curtin Formula and Common Fare-Change Rule for Fare Increases

	Percent Ridership Loss Estimated		Percent Difference
Percent Fare Increase	**Formula**	**0.30 Common Rule**	**Formula vs. Common Rule**
5%	2.3%	1.5%	–34.8%
10	3.8	3.0	–21.1
15	5.3	4.5	–15.1
20	6.8	6.0	–11.8
25	8.3	7.5	–9.6
30	9.8	9.0	–8.2
35	11.3	10.5	–7.1
40	12.8	12.0	–6.3

The Simpson & Curtin formula was estimated as a shrinkage ratio from fare changes that ranged from 10 to 40 percent. For this range of price changes, the formula equates to a midpoint fare elasticity value of between –0.39 and –0.41, as demonstrated in Table 12-2.[3]

A separate study of 281 fare increases in 114 U.S. cities between 1950 and 1967 found that the average shrinkage ratio was –0.33 with results ranging from –0.004 to –0.97 (Dygert, Holec and Hill, 1977). This average is about the same as the Simpson & Curtin formula, and can be shown to be equivalent to an arc elasticity of –0.35 to –0.42 for fare increases in the 10 to 40 percent range. More recent studies have computed arc elasticities directly.

[3] For further information on differences between and uses of shrinkage ratios and fare elasticities, see "Concept of Elasticity" in Chapter 1, "Introduction," and also Appendix A, "Elasticity Discussion and Formulae." These and all subsequently presented fare elasticities pertain to a short-run time frame unless otherwise noted (as in the "London Transport Fare Elasticities and Travelcard Impact" case study). See the "Overview and Summary," under "Analytical Considerations" (footnote 1), for a note concerning short-run versus long-run elasticities including selected recent research values.

Table 12-2 Conversion of Simpson & Curtin Formula to Midpoint Arc Fare Elasticity Values

Percent Fare Increase	Arc Elasticity
10%	–0.41
15	–0.39
20	–.039
25	–0.39
30	–0.40
35	–0.40
40	–0.41

Source: Replication of computation reported in Pratt, Pedersen and Mather (1977).

Inclusion of systems with HRT/Metro tends to lower fare elasticity averages, as in most of the national averages assembled in the late 1970s by the International Collaborative Study of the Factors Affecting Public Transport Patronage. Mean fare elasticities and standard deviations obtained were –0.37 ±0.06 for Australia (including several estimates for work purpose travel only but no HRT), –0.34 ±0.04 for West Germany, –0.33 ±0.03 for the United Kingdom, and –0.23 ±0.03 for the United States. This particular sample for the United States was heavily weighted with observations from cities operating HRT (Webster and Bly, 1980). A sample drawn upon by Ecosometrics, Inc., for several of the more disaggregate analyses presented further on averaged –0.28 ± 0.16. That sample covered rail and bus, involved mostly U.S. cities, and was limited to the results of quasi-experimental (before and after) studies (Mayworm, Lago and McEnroe, 1980).

Important results of these studies are not just the fairly close agreement on average values for fare elasticity, but also the range or variability of the results. Take, for example, the –0.28 estimate of mean fare elasticity for the Ecosometrics sample. With a standard deviation of ±0.16, this implies that a shade over two-thirds of the elasticity observations probably lie in-between –0.12 and –0.44, defined by one standard deviation (0.16) around the mean (–0.28). Correspondingly, the rest of the observations are probably less than –0.12 or more than –0.44.

The wide range of observed elasticities leads to a need for explanatory factors to help describe rider response to fare changes. Key factors that have been postulated include transit mode, population of service area, direction of fare change, and time of day.

Transit by Mode

A study completed by the American Public Transit Association (APTA) in 1991 provides a recent, comprehensive examination of fare elasticities for the bus transit mode. The Handbook authors interpret the results as indicating that the Simpson & Curtin formula (but not the common fare-change rule which evolved from it), as coverted to a midpoint arc fare elasticity value of between –0.39 and –0.41, is still a valid representation of aggregate rider response to bus fare changes. The APTA study developed auto-regressive integrated moving average (ARIMA) models based on bus ridership data 24 months before and 24 months after a fare change for 52 U.S. transit systems. Monthly information on other factors that may influence ridership including transit service levels, employment, and gas prices was also included. The fare elasticities for all bus systems averaged –0.40, with a standard deviation of ±0.18 (Linsalata and Pham, 1991).

The results of the Simpson & Curtin formula and the APTA study are also relatively consistent with the findings of other research. The Ecosometrics study, for example, found an average bus fare elasticity of –0.35 for 12 fare changes in the United States and Europe (Mayworm, Lago and McEnroe, 1980).

While the average fare elasticity for bus systems appears to be about –0.4, the elasticity values vary widely among systems. Elasticity values in the APTA study varied from –0.12 to –0.85 among the 52 transit systems while the elasticity values in the Ecosometrics study ranged from –0.16 to –0.65.

Available studies, summarized in Table 12-3, have shown that bus fare elasticities are about two times greater than HRT/Metro fare elasticities. In other words, rapid transit ridership is indicated to be roughly twice as resistant to fare change as bus ridership. One possible explanation for this difference is that HRT typically operates where congestion and parking costs are highest, while itself offering higher speed advantages. The available travel alternatives are thus relatively less attractive, dampening shifts between transit and auto in response to fare changes.

Table 12-3 Bus and HRT/Metro Fare Elasticities

City	Period	Bus	Rail	Source
Chicago[a]	1981–1986	–0.43	–0.18	LTI Consultants, Inc., and E. A. France and Associates (1988)
London	1971–1990	–0.35	–0.17	London Transport (1993)
New York	1948–1977	–0.32	–0.16	Mayworm, Lago and McEnroe (1980)
New York	1970–1995	–0.20 to –0.30	–0.10 to –0.15	Jordan (1998)
New York	1995	–0.36	–0.15	Charles River Associates (1997)
Paris	1971	–0.20	–0.12	Webster and Bly (1980)
San Francisco	1984–1986	—	–0.31	Reinke (1988)

Note: [a] Shrinkage ratios converted to arc elasticities by Handbook authors.

The elasticity result for the BART system in San Francisco stands out as being twice as large in absolute value as those for the other HRT systems. This difference may reflect the different character of much of the BART operating environment, where parallel freeways make the auto and express bus services more viable as travel alternatives than is typical for the other cities listed in Table 12-3, excepting perhaps Chicago.

There is very limited information on aggregate fare elasticities for commuter railroad (CRR) service. The four observations in Table 12-4 suggest that the CRR values are similar to those for HRT. This is plausible since CRR service operates on its own right-of-way and often offers speed advantages compared to the automobile.

The elasticity observation of –0.20, reported in Table 12-4 for New York's Metro North CRR system, matches the fare elasticity in use for some time by that agency for planning purposes. Metro North planning also distinguishes between commuters (regular users) and noncommuters (irregular users). The elasticities assigned, presumably based on internal studies, have been –0.15 for commuters and –0.30 for non-commuters (Levinson, 1990b).

Table 12-4 Commuter Railroad Fare Elasticities

Location	Fare Elasticity	Source
Australia	–0.18	Hensher and Bullock (1977)
Boston	–0.09	Pratt and Copple (1981)
New York/Long Island Railroad	–0.22	Charles River Associates (1997)
New York/Metro North	–0.20	Charles River Associates (1997)

It is probably reasonable to speculate that, like HRT, CRR elasticities are sensitive to the availability of viable travel alternatives. Partial evidence for the Washington, DC, area suggests CRR fare elasticities higher than those presented in Table 12-4, in the presence of highly developed competitive automobile and Metro facilities. (See "Commuter Rail" under "Frequency Changes with Fare Changes" in Chapter 9, "Transit Scheduling and Frequency.")

In contrast to HRT and CRR fare elasticities, scattered evidence suggests that ridership on bus feeder services to HRT may be significantly more sensitive to fare increases than other bus ridership (Pratt and Copple, 1981). Information on response to express bus service pricing is extremely limited and contradictory. That which is available is reported in Chapter 4, "Busways, BRT and Express Bus." No 20th Century fare sensitivity studies that separate out Light Rail Transit (LRT) have been encountered. (See Chapter 7, "Light Rail Transit," and Chapter 8, "Commuter Rail," for any newer LRT and CRR findings that may have been located.) Demand responsive and ADA (Americans with Disabilities Act) paratransit fare elasticities are covered in Chapter 6, "Demand Responsive/ADA," under "Underlying Traveler Response Factors"—"Change in Fares for the General Public" and "Change in Fares for ADA Clientele."

Collectively, the available fare elasticities by mode suggest a major fare sensitivity difference between at least the primary transit modes of bus services on the one hand, and HRT and CRR on the other. However, there remains significant variation in the response of riders to fare changes that cannot be explained solely on the basis of transit mode.

Population of Service Area

Several studies have suggested that rider sensitivity to fare changes decreases with increasing city size (Dygert, Holec and Hill, 1977; Grey Advertising, 1976; Mayworm, Lago and McEnroe, 1980). For example, as shown in Table 12-5, Ecosometrics reported mean arc elasticities varying from –0.35 in areas with city populations of less than 500,000 to –0.24 in areas with central city populations of greater than one million (Mayworm, Lago and McEnroe, 1980). The 1991 APTA study is of special interest in that the relationship was observed even though rail transit was withheld from the sample. Bus fare elasticity values from the 32 urbanized areas with a population under one million averaged –0.43 with a standard deviation of ±0.19, versus –0.36 ±0.15 for the 20 larger urban areas. The effect is muted, however, in the case of the APTA busonly sample (Linsalata and Pham, 1991).

The variance of the results was so large in some of these studies that the differences in average fare elasticities between adjacent city size categories are probably not statistically significant. However, the overall spread from the smallest to largest size categories may well be significant (Webster and Bly, 1980), and the differences are consistent in direction. One possible explanation for this apparent relationship of higher fare elasticities in smaller cities is that the option of auto travel is most convenient and least expensive in such cities, or, conversely, the higher levels of transit service that can be sustained in larger cities better serve to retain riders. Another explanation is that differences in transit mode are at work, except in the APTA bus-only study, and are correlated with population size. Larger cities have more HRT/Metro service, whose riders are less responsive to fare changes than are bus riders.

Table 12-5 Transit Fare Elasticities by City Size

Central City Population	Mean	Standard Deviation	Cases
Greater than 1 million	–0.24	±0.10	19
500,000 to 1 million	–0.30	±0.12	11
Less than 500,000	–0.35	±0.12	14

Source: Mayworm, Lago and McEnroe (1980).

Direction and Size of Fare Change

Limited data, including some which is contradictory, suggests that the ridership responses to fare decreases do not differ significantly from rider responses to fare increases (Webster and Bly, 1980). A review of 23 fare changes in United States cities selected for similar size, summarized in Table 12-6, found that the fare elasticities were not significantly different for fare increases and fare decreases (Mayworm, Lago and McEnroe, 1980).

Table 12-6 Elasticities for Fare Increases and Decreases in Cities of Similar Size

Fare Change	Mean and Standard Deviation	Number of Cases
Increase	–0.34 ± 0.11	14
Decrease	–0.37 ± 0.11	9

Source: Mayworm, Lago and McEnroe (1980).

Two English studies examined the effects of inflation and concluded that the fare elasticity of fares decreasing due to inflation is the same as the elasticity of fare increases (Bly, 1976; Fairhurst and Morris, 1975). This suggests that transit systems could increase fares to keep pace with inflation and not lose ridership, although conclusive studies of systems that have attempted this have not been found.

Neither the magnitude of the initial fare nor the percentage increase has been shown to have any discernible effect on fare elasticity (Mayworm, Lago and McEnroe, 1980). For the most part, however, there is actually little information on fare changes beyond 20 or 30 percent in magnitude, aside from the introduction or cessation of free fares.

One reported instance of a large fare change occurred in Sheboygan, Wisconsin, when all categories of fixed route transit fares were increased by 64 to 71 percent in 1995. On one hand, the overall response, which exhibited an arc elasticity of –0.53 for total unlinked trips, was well within the expected range for a small-city bus operation. On the other hand, the increase to a $1.25 cash fare elicited heightened interest in the savings of buying tokens, even though the relative savings changed only from a 26.7 percent to a 28.0 percent discount. Token use increased 24 percent in the face of a 21 percent decline in revenue boardings. Attempting to calculate a cross-elasticity based on the relative price of tokens versus cash fares produces a very large value of negative twelve (–12.0), suggesting that unexplained factors—likely the magnitude of the fare increase—were at work. The 64 to 71 percent fare increases by fare category translated, including also the effect of pass use changes, to an average fare increase of only 54 percent (Billings, 1996; elasticity and average fare computations by Handbook authors).

Time of Day

Across-the-board fare changes (thought not to have involved introduction or significant modification of peak/off-peak fare differentials) have been found to affect off-peak transit ridership more than peak period transit riding. This means that even without a change in the proportional relationship of peak and off-peak fares, fare changes will affect the distribution of transit riding over the hours of the day. Fare increases heighten the differences between the daily peaks and valleys of transit usage, while fare decreases diminish the differences.

The 1991 APTA study separately analyzed peak and off-peak data for six bus systems. One of those systems (Sacramento, California) is excluded here because LRT was opened during the observation period. Results for the remaining five cities, presented in Table 12-7, show a consistent pattern of higher fare elasticities in off-peak periods; roughly twice as high as the peak period fare elasticities on average (Linsalata and Pham, 1991).

Table 12-7 Peak and Off-Peak Bus Fare Elasticities

Urbanized Area	Peak Bus Fare Elasticity	Off-Peak Bus Fare Elasticity
Spokane, Washington	–0.32	–0.73
Grand Rapids, Michigan	–0.29	–0.49
Portland, Oregon	–0.20	–0.58
San Francisco, California	–0.14	–0.31
Los Angeles, California	–0.21	–0.29

Note: Sacramento is excluded because LRT service was started during the observation period.

Source: Linsalata and Pham (1991).

This relationship, of off-peak ridership being roughly twice as sensitive to fare changes as peak ridership, is consistent with the findings from older studies made in London, New York, and Stevenage, England. These findings, summarized in Table 12-8, suggest also that peak-period travelers are less responsive to fare changes than travelers during other periods, and on both bus and HRT services.

There are very limited and partially contradictory data on rider response to fare changes during the different off-peak periods—middays, evenings, late night, Saturdays, and Sundays. The data do suggest that overall, fare elasticities for evening and weekend service are not substantially different from the values observed for midday service (Mayworm, Lago and McEnroe, 1980; Fairhurst and Morris, 1975). Following a major 1970s fare reduction in Atlanta, coupled with service improvements, the reported ridership increase over trend line patronage was 28 percent on weekdays, 41 percent on Saturdays, and 79 percent on Sundays (Bates, 1974). The provision of free intra-central business district (CBD) transit in Portland and Seattle resulted in substantially increased transit usage during the midday period, especially during the conventional lunch hour (Pratt and Copple, 1981).

Table 12-8 Peak and Off-Peak Bus and Heavy Rail Transit Fare Elasticities

City / Transit Mode	Peak	Off-Peak	Source
London / Bus	–0.27	–0.37	Rendle, Mack and Fairhurst (1978)
London / HRT	–0.10	–0.25	Rendle, Mack and Fairhurst (1978)
New York / HRT	–0.04	–0.11	Mayworm, Lago and McEnroe (1980) from Lassow (1968)
Stevenage, England / Bus	–0.27	–0.87	Smith and McIntosh (1974)

The common explanation for the differences in rider responses in peak and off-peak periods is the concentration of work and school trips in peak periods. These trips are typically made every day, and are mostly non-discretionary. If travel alternatives are unattractive or unavailable, riders making non-discretionary trips will accept fare increases with little change in their riding frequency. In contrast, off-peak trips often are made for other purposes such as shopping, medical, recreational, and personal business. These trips are more discretionary and can be postponed or combined when riders are faced with fare increases.

A further explanation to be considered is that transit services are generally more frequent and often more comprehensive during peak periods, while all-day parking charges may make auto use a more expensive alternative. As the converse is true in the off-peak, that is when shifting of modes may be more likely to occur in response to fare changes.

Changes in Pricing Relationships

Fare structure changes include changing the pricing relationships among current fare categories, introduction of new fare categories, and alteration of the basis on which fares are charged, i.e., flat, zonal, or distance-based. This section covers the first of these three types, namely, changing the relative prices among fare categories. This approach is actually less common than establishment of new fare categories, and most of the examples discussed here, it could be argued, do involve some degree of new fare category introduction.

Discount Prepaid Fares

Changing the level of discounts offered for prepayment of fares is one form of alteration in fare structure pricing relationships. Fare prepayment may involve purchase of multiple-ride tickets, tokens, stored fare, or unlimited-ride passes. Examples of prepayment discounts include the sale of 10-ride tickets at a cost of nine times the price of a one-way cash fare, and monthly passes priced at a value of 36 times the price of a one-way cash fare.

Changing the relative pricing of the purchasing options has drawn attention through the promotion of a strategy known as "deep discounting." This strategy calls for establishing the discount for multiple-ride ticket or token prepayment at a minimum of 25 percent of the base fare, the equivalent of selling 10-ride tickets at a cost of 7-1/2 times or less of the price of a oneway cash fare. This is accomplished either by raising cash fares, where generation of new revenues is of immediate concern, or by reducing the prepayment price. Marketing to emphasize the availability and advantage of the discount fares is an integral part of the deep discounting approach (Oram, 1988; Oram and Schwenk, 1994).

The purchase instrument selected for discounting is one that can be used to advantage by infrequent riders, that is to say, persons who do not use transit enough to justify pass purchase. Although originally conceived of as being bulk ticket or token purchase, the purchase instrument could equally well be discounted stored fare. The working hypothesis behind the anticipated effectiveness of this strategy in revenue generation and rider retention is as follows:

"The deep discount fare strategy motivates riders to increase their usage by providing major savings on a multi-ride purchase of tickets or tokens. Deep discount fares in effect surcharge riders who do not take advantage of savings opportunities easily available to them and continue to pay cash. Yet, since these people choose not to save, they can be assumed to largely continue using transit despite the higher fare. That is, they demonstrate fare insensitivity, to an even greater extent than is usual for the aggregate transit market" (Oram, 1988).

Benefits anticipated for discounting prepayment of fares, and deep discounting in particular, include:

- Minimizing ridership losses in the face of need to increase revenues. It is hoped that targeting larger fare increases to users with low fare sensitivities will be more productive than uniform fare increases for all riders.

- Reducing the use of cash in fare payment. It is hoped that changing relative pricing can induce more riders to move to prepayment of fares and, thereby, improve revenue control and the financial advantages of receiving payment before the cost of providing service is incurred.

Table 12-9 summarizes results of four case studies of deep discounting. The evaluations focused on aggregate system impacts, with some exploration of effects on the infrequent rider market segment. Although limited by available data, the system results could be assessed based on the implicit objective of meeting or exceeding the revenue targets while minimizing ridership losses. The evaluation was made more difficult by effects of an expanding economy in Denver, and to some extent in Chicago, and severe localized recessions in Philadelphia and Richmond (Multisystems, 1991; Trommer et al, 1995).

Significant shifts took place in the fare purchase methods elected by the riding public. Cash and pass usage in Chicago dropped by 27 and 13 percent, respectively, when compared to the previous year (Multisystems, 1991). In Denver, deep discount tickets accounted for nearly 10 percent of total revenue in the first year, taking away from cash, pass, and ticket sales. The share of cash sales declined from 50.1 to 48.8 percent. On Philadelphia's City Transit Division, the cash revenue share declined from 34.6 to 27.0 percent over a four year period. The cash revenue share declined from 61.9 to 48.8 percent in Richmond in the first year (Trommer et al, 1995).

Table 12-9 Deep Discounting Ridership and Revenue Results

Location	Date	Fare Change	First Year Results	Source
Chicago	1990	Increased rail and peak bus cash fare 25% and increased discount for tokens from 5% to 28% with other changes.	**Ridership**: Increased 0.7% weekdays (down Sundays by 17.5%).[a] **Revenue:** The objective was a 4.1 percent increase. Revenue increased 6.1 percent.	Multisystems, (1991)
Denver (Peak period only)	1989	Increased cash fare (Denver-local by 33%) and offered up to 28% discount on new 10-trip ticket.	**Ridership**: Rose 2.9 percent in comparison to decline of 5.5 percent in 1987 when cash fares increased.[b] **Revenue:** Increased as intended.	Trommer et al (1995)
Philadelphia (City Transit Division)	1990	Increased cash fare 20% and increased discount for tokens from 20% to 30%. Reduced minimum purchase from 10 to 2 tokens.	**Ridership:** The rate of decline increased only 0.3 percentage points while the rate of Philadelphia job loss grew 1.2 percentage points. **Revenue:** Increased—average fare increased by 5.8%.	Trommer et al (1995)
Richmond	1992	Increased cash fare 33% and offered 25% discount on new 10-trip ticket.[c]	**Ridership**: Declined 14.5% in 1992, compared to 9.4% in 1991. **Revenue:** Declined 3.9% in FY 1992, the same as in FY 1991.	Trommer et al (1995)

Notes: [a] Chicago ridership and revenue data is for the first 8 months of the program. The drop in Sunday ridership was attributed to elimination of a Sunday all-day pass and introduction of weekdays only weekly passes in addition to the normal weekly pass.

[b] This comparison is clouded by economic expansion in 1989 versus recession in 1987, but the major difference suggests that the deep discount strategy was effective.

[c] This made the 10-trip ticket fare equivalent to the old cash fare. Ticket users were also relieved of paying the pre-existing 10¢ transfer charge. Weekly passes were discontinued.

The documented results suggest that the deep discounting approach is useful in addressing the objectives of minimizing ridership losses in the face of the need to increase revenues, and in minimizing cash fare payment. Fewer riders appear to be lost when larger fare increases are targeted to users with low fare sensitivity than when uniform fare increases are given to all riders. It is posited that part of the ridership loss in Richmond was attributable to a price for the 10-trip ticket that was out of reach for infrequent transit dependent users, with no option to buy lesser quantities as in Philadelphia (Trommer et al, 1995). This loosely fits with a warning that deep discounting, "while based on good economics, has inequity implications that may affect its applicability in some transit settings." It has also been warned that it is unlikely that deep discounting can result in revenue increases without the accompanying single trip payment fare increases (Lago, 1994).

Interactions at the market segment level in response to deep discounting are complex and less well studied than aggregate impacts. Three factors—trip frequency, willingness to take advantage of savings, and sensitivity to cost (i.e., fare elasticity)—have been cited as being important in understanding market segment response (Oram and Schwenk, 1994):

- Trip frequency defines the purchase options that potentially meet the needs of different rider segments. Infrequent riders making less than eight one-way trips per week tend to purchase cash fares, multiple-ride tickets, and tokens because they do not make enough trips to "breakeven" on an unlimited-ride pass. Frequent riders making more than eight one-way trips a week, however, often purchase multiple-ride tickets, tokens, and unlimited-ride passes because they can easily take advantage of the cost savings offered.

- Willingness to take advantage of the offered savings is important because experience indicates that not all riders will shift to discounted media, forgoing the savings and continuing to pay a cash fare (Oram and Schwenk, 1994; Fleishman, 1998). Some riders cannot gather the necessary money to purchase the discounted media. Other infrequent riders are concerned about not being able to use the discounted media within a reasonable amount of time. Some riders simply find it more convenient to continue to pay the cash fare.

- Sensitivity to cost is the final factor. Sensitivities and the corresponding elasticities may vary by age (youth, adult, senior citizen), trip purpose (work and non-work), and time period of travel (peak and off-peak).

Detailed before-after studies have not been conducted to estimate these elasticities. Instead, practically the only estimates of these elasticities are provided by the documentation of *assumed* elasticities used by forecasters. It has been stated that these assumed values are typically based on (Fleishman, 1998):

- Results of stated-preference surveys of current and potential riders,

- Experience from forecasts of other similar changes, and

- Professional judgment.

An example of the market segment elasticities assumed is provided by those used to project the impacts of deep discounting in Louisville, Kentucky. The assumed Louisville elasticities, shown in Table 12-10, are based on experience that shows lower fare sensitivity by cash riders who choose not to take advantage of savings provided by discounted prepaid media (Oram and Schwenk, 1994). It should be noted that other sources of recommended market segment elasticities not only address partially different market breakdowns, but also appear to arrive at somewhat different conclusions regarding relative fare sensitivities (see Mayworm, Lago and Knapp, 1984, for example).

Whereas the assumptions underlying Table 12-10 put the elasticity of pass users at the same low level as the elasticities of cash riders who do not shift to prepayment discounts, another authority characterizes pass users as being even more inelastic. This observation is coupled with a warning that giving deep discounts to pass riders would surely result in revenue losses, adding to the complexity of deep discount pricing. An example is provided from the Milwaukee County Transit System. In Milwaukee, in spite of a 19 percent increase in the price of cash fares and an expansion of service, applying a 9 percent discount to both 10-trip tickets and weekly pass programs led to an overall revenue loss of –0.5 percent (Lago, 1994). On the other hand, an analysis of a fare increase affecting *both* cash fares and passes in Hartford produced pass elasticities two to three times the size of the overall fare elasticity, which was a low –0.1 (Levinson, 1990a).

Table 12-10 Assumed Fare Elasticities Used to Project Deep Discounting Impacts for Transit Authority of River City (Louisville)

Fare Type	Assumed Elasticity
Adult Peak Cash Fare Remainder[a]	–0.05
Adult Off-Peak Cash Fare Remainder	–0.15
Adult Ticket Shifters[b] from Peak	–0.25
Adult Ticket Shifters from Off-peak	–0.35
Current Peak Tickets	–0.35
Current Off-peak Tickets	–0.45
Current School Cash	–0.20
New Reduced School Cash Shifted from Peak	–0.40
Current School Tickets	–0.40
New Reduced Tickets from School Cash	–0.35
Current Senior Tickets	–0.35
Passes	–0.15

Notes: [a] Riders choosing to pay cash despite the availability of prepaid discounts.
[b] Riders who shift to prepaid discounts.

Source: Oram and Schwenk (1994).

A fundamental problem in assessing changes to the relative pricing of different fare types is the interaction between the factors *willingness to take offered savings* and *sensitivity to price.* This interaction might be termed the cross-elasticity of demand among different fare types. The Louisville elasticities in Table 12-10 reflect only the factor *sensitivity to price* and require a separate estimate of the split of riders for the factor *willingness to take offered savings.* Clearly, these factors are not independent and more research is needed to investigate both market segment elasticities per se and the cross-elasticity of demand among different fare types. Available evidence suggests that shifts among fare types can be substantial.

The ability of deep discounting to engender more transit usage by infrequent riders has been explored in a limited way with rider surveys. Approximately 10 percent of Chicago token users reported making extra trips not made before. In Denver, the corresponding response was 20 percent of discounted ticket book users. In neither case was the amount of increase quantified. Philadelphia's survey showed that not many new riders had been induced to use the system. In Richmond, results indicated that the discounted ticket program neither attracted many new customers nor appeared to have increased use among infrequent riders. New riders disproportionately paid their fare in cash. The surveys in all four cities reported very high rates of satisfaction with the discount fare programs (Multisystems, 1991; Trommer et al, 1995).

Peak Versus Off-Peak Fares

Another type of change to the relative prices in a fare structure is introduction of differentiation between peak and off-peak fares, with lower fares charged for travel in off-peak periods than in peak periods. This change is made for one or more of the following reasons:

- To better reflect the higher costs of providing service in peak periods.
- To shift riders from the crowded peak period service to less crowded off-peak service.
- To promote ridership growth in underutilized off-peak periods.

Since uniform fare changes typically affect off-peak more than peak riding, as discussed with respect to "Changes in General Fare Level" under "Time of Day," charging lower fares in the off-peak periods should further increase off-peak usage relative to peak usage. Available experience is presented in Table 12-11. Results are shown in terms of before and after percentages of total ridership occurring in the peak periods. The lesser percentages in the "after" condition indicate that reduction in off-peak fares did enhance off-peak usage relative to peak riding.

Table 12-11 Peak Ridership as a Percent of Daily Ridership Before and After Reduction of Off-Peak Fares

	Peak/Off-Peak Fare		Peak Ridership %		
City	**Before**	**After**	**Before**	**After**	**Source**
Denver[a]	35¢/25¢	50¢/free	50%[b]	30%	De Leuw, Cather and Company (1979a)
Louisville	50¢/50¢	50¢/25¢	45%	33%	Pratt and Copple (1981)
Lowell	25¢/25¢	25¢/10¢	76%	73%	Mass Transportation Commission (1964)
Trenton[a, c]	30¢/15¢	30¢/free	68%[d]	55%	De Leuw, Cather and Company (1979b)

Notes: [a] Off-peak free fare demonstration.
[b] Assumed before ratio.
[c] Includes evening service.
[d] Estimated before ratio.

Data for the off-peak free fare demonstrations included in Table 12-11 were utilized to estimate cross-elasticities of peak demand with respect to off-peak fares (i.e., relative change in peak ridership compared to relative change in off-peak fares). Cross-elasticity values of 0.14 and 0.03 were estimated for Denver and Trenton, respectively. These low values suggest that most riders in peak periods are traveling to work and have limited flexibility in work starting times and are thus unlikely to shift to traveling in the off-peak (Mayworm, Lago and McEnroe, 1980).

Factors that will affect the change in off-peak ridership include the percentage reduction in the off-peak fares, the relative difference between peak and off-peak fares, and the percentage of peak riders who could conveniently shift their trips to off-peak periods. Growth in overall system ridership over the entire day for the cases listed in Table 12-11 ranged from no discernible increase in Lowell, Massachusetts, to 10 to 15 percent in Trenton and 34 percent in Denver (Pratt and Copple, 1981).

Fare Discounts for Senior Citizens

All transit systems receiving federal funding in the United States are required to offer senior citizens half fare discounts during off-peak periods. Perhaps as a result, there has been little experimentation or change in senior citizen fares relative to base fares in the past 25 years.

Data collected over 25 years ago suggest that reduced fare programs did not significantly increase transit usage by senior citizens. In 16 of 90 such programs studied in the United States, the reduced fare had little or no effect on the number of elderly passengers (Dygert, Holec and Hill, 1977). The average senior citizen fare elasticity indicated was –0.21.

A shift of elderly riders from the peak to off-peak period typically occurs when reduced fares are offered to the elderly only in the off-peak periods. In Pittsburgh, a 45 percent off-peak fare reduction for the elderly increased off-peak senior citizen riding by an estimated 51 percent, and decreased peak riding by 19 percent. In Milwaukee, 14 percent of elderly passengers switched from peak to off-peak riding, and in Los Angeles, about 10 percent shifted (Roszner and Hoel, 1971; Dygert, Holec and Hill, 1977; Caruolo and Roess, 1974).

The data for the Pittsburgh and Los Angeles senior citizen fare changes were utilized to estimate cross-elasticities of peak demand by the elderly with respect to off-peak fares of 0.38 and 0.26, respectively (Mayworm, Lago and McEnroe, 1980). These cross-elasticities are higher than those calculated for general transit riders in the Denver and Trenton free fare demonstrations, but still suggest that a substantial number of elderly riders in peak periods are unwilling or unable to change their time of travel.

Changes in Fare Categories

A relatively common fare structure change is the introduction of new fare categories. As used here, a fare category consists of a unique combination of purchase option, rider category, and trip type. New fare categories covered in this section include introduction of a different purchase option, such as a monthly pass, and creation of a new rider category, such as university or employer participants in unlimited travel pass partnerships.

The analytical complexities of quantitatively evaluating the modification or introduction of new fare categories, based on quasi-experimental data, were introduced in the "Overview and Summary" section of this chapter under "Analytical Considerations." These complexities, and the frequent lack of complete information on the "before" condition, are such that rider responses can often be characterized only in broad-brush terms such as resultant change in system ridership.

New Purchase Options

Table 12-12 summarizes various implementation results for new fare purchase options, primarily passes. Most of this information is from surveys and analyses made only after the fare changes, and not on the basis of before and after information. Some of the results are known to have been confounded by external events such as an expanding local economy, as will be identified in further discussion.

Table 12-12 Selected Cases of Introducing New Purchase Options

Location	Date	Fare Change	Results	Source
Atlanta, Georgia	1979–1980	Monthly Pass priced at 40 and later 34 times cash fare; cash fares increased concurrent with introduction and modification.	After 2 months, used by 12.7% of customers, representing 17.8% of all linked transit trips and 13.6% of revenue. Of pass users 95% made same/more than breakeven trips.	Parody (1982)
Bridgeport, Connecticut	1981–1985	Three slightly discounted prepayment mechanisms including pass, Fare Cutter Card, tokens.[a]	Roughly 1 out of 20 trips made using prepayment mechanisms after 4 years; 18% weekday pass, 15% Fare Cutter Card, 67% tokens.	Donnelly and Schwartz (1986)
Chicago, Illinois	1991	$5 Weekend Commuter Railroad Pass	Sold 625,000 in FY 1995, 39% over 1992. Grew another 20% in 1996. Of users, 55% say pass influenced them to ride.	Volinski (1997)
Cincinnati, Ohio	1981–1983	Monthly Pass priced at 40 times cash fare.	Purchased by 9% of riders (27% of peak period adult riders). Induced new transit trips equivalent to 1.3% of system ridership.	Fleishman (1984)
Livermore, California	1990s	$6.00 10-ride ticket and $24.00 40-ride punch-pass. (Raised cash fare to $1.00.)	Annual ridership increased 15% and farebox revenue 16%.	Volinski (1997)
London, England	1983–1984	Travelcard pass good on bus and Underground plus associated changes.	20% to 33% passenger mile increases and 4% to 16% revenue increases attributed to new fare structure, as contrasted to average fare changes.	London Transport (1993)
New York City	1997–1999	Free transfers between bus and subway, stored fare prepayment discount and unlimited ride passes.	Subway ridership up 6.6% weekdays, 11.5% weekends; bus up 26.0% weekdays, 27.2% weekends. Revenue loss of 4.0%.	Tucker (1999)
St. Petersburg, Florida	1990s	All-day pass priced at 2.5 times base fare. (Eliminated all transfers.)	Ridership increased 6% and farebox return increased from 16% to 24% in first six months.	Volinski (1997)

Note: [a] Peak period only Commuter Pass essentially failed and was replaced by weekly pass. See text for description of Fare Cutter Card.

In the case of a monthly or weekly pass, the so-called breakeven number of trips is equal to the pass price divided by the cash fare. Experience indicates that transit users who ride more than the breakeven number of trips are the primary potential buyers of such passes. Few who ride less make the purchase. Therefore, revenue loss relative to not having the pass almost always occurs when a pass is introduced for the first time (Mayworm and Lago, 1983). Improved revenue control and reduction in fare collection costs (less handling of cash) are often achieved, however, with the degree of effectiveness depending on the overall fare structure and the popularity of the pass.

Pass introduction may be used to soften the impact of a cash fare increase, in which case some degree of revenue gain may be expected. In Atlanta, introduction of a monthly pass concurrent with a 67 percent cash fare increase provided a revenue increase from those who became pass users of 36 percent (Parody, 1982).

Rider surveys corroborate the importance of cost savings to the potential pass buyer. Several studies surveyed riders and found cost savings reportedly the major factor in a rider's choice of purchase option (Parody, 1982; Meyer and Beimborn, 1998). This is consistent with analysis of pre-payment options at 23 transit systems, which suggests that the majority of riders make a mental calculation of the breakeven points among options and choose the most economical one (Mayworm and Lago, 1983). Survey responses from Atlanta giving the reasons for buying a monthly pass are provided in Table 12-13.

Table 12-13 Reasons for Buying a TransCard (Monthly Pass) in Atlanta

Reason Stated	Percent Responding, First Reason	Percent Responding, Second Reason
Save money	56.2%	16.9%
Convenience/no need for cash	28.4	43.8
Allows stopovers	4.8	4.7
Easier/faster to board bus	4.5	9.8
Pay once a month	2.3	7.5
Easier to transfer	1.9	12.7
Other	1.7	2.1
Offset fare increase	0.2	2.5
Total	100.0	100.0

Source: Parody (1982).

A survey of monthly pass users in Cincinnati found somewhat contrary indications in that most riders cited convenience as the major factor in their purchase decision. The pass was priced at 40 times the one-way cash fare and did not offer significant cost savings. Even so, only 11 percent of purchasers hadn't already been consuming transit service at the breakeven trip rate of 10 rides per week (Fleishman, 1984).

Convenience, specifically no need for cash, indeed has a degree of importance for riders. In Atlanta, as shown in Table 12-13, 28 percent of the monthly pass users cited convenience as their first reason for buying the pass and another 44 percent cited it as their second reason.

There is evidence that the provision of an unlimited ride pass will induce pass holders to ride more. Pass holders in Atlanta increased their transit usage by an average of 1.6 trips per week. Two-thirds of these trips were for non-work purposes. It was hypothesized that there is less opportunity to expand the number of commuter work trips made by transit, since work trips are more or less fixed in number, and would be the most likely trip type for the rider to be already making via transit (Parody, 1982). More information on the Atlanta experience is provided in the case study, "Introduction of a Monthly Pass in Atlanta."

An innovative prepayment mechanism with characteristics of a permit plan, the Fare Cutter Card, was tested in a Bridgeport, Connecticut, demonstration. After paying a $15.00 initial fee for the monthly permit, a reduced cash fare of 25¢, as compared to the normal 60¢ cash fare, was paid for every trip. The breakeven point of 43 trips per month was subsequently, during a fare increase, lowered to 35 trips per month. The lower front-end cost of this purchase option was designed to be more attractive than a conventional pass to low-income users. The Fare Cutter Card was retained after the demonstration. As can be seen in Table 12-12, however, it addressed a very narrow market niche (Donnelly and Schwartz, 1986; Mayworm and Lago, 1983).

The New York and London introductions of new fare categories are in a special class not just because of the very large multi-modal systems involved, but also because of their facilitation by systemwide conversion to electronic fare media. MTA New York City Transit (NYCT), at six-month intervals starting in July 1997, implemented systemwide free transfers between bus and subway, a multi-ride stored fare prepayment discount, and unlimited-ride passes. Other changes, such as an express bus fare reduction from $4.00 to $3.00, took place as well.

Weekday fare media use in September 1997 was approximately 52 percent tokens/cash, with the rest taken up by regular pay-per-ride stored fare MetroCards. By September 1998, the split was 27.1 percent tokens/cash, 14.7 percent regular MetroCards, 34.2 percent bonus bulk purchase (10 rides or more) MetroCards, and 24.1 percent unlimited ride passes. Comparing September 1998 year-to-date with two years previous, NYCT subway unlinked trips increased 6.6 percent on weekdays and 11.5 percent on weekends, while bus unlinked trips were up 26.0 percent on weekdays and 27.2 percent on weekends (Tucker, 1999). The average fare dropped from $1.37 for the full year of 1996 to $1.15 for the full year of 1998, yet revenues as of September were reported to be down only 4.0 percent. The average fare for the last six months of 1998, reflecting the full impact of 7 and 30 day unlimited ride passes, was $1.12.

In assessing these early results, great care must be taken to consider aspects of the changes not reflected in the NYCT average fares, as well as the impact of highly favorable economic and demographic conditions. The ability to avoid carrying exact fare on buses by using a MetroCard was brand new in 1996. With universal bus/rail free transfer introduction, whereas previously bus to bus transfers were controlled by route, location and direction, bus riders now had a less restrictive transfer between buses. Subway riders who had walked to and from the subway could now, with MetroCard, choose a free bus ride for subway access. All these privileges extended to the subsidized privately operated bus lines. It was also now possible to "round trip" on a single fare using various combinations of bus and subway routes. Selective NYCT transit service improvements were undertaken, particularly on the bus system, to mitigate overloads. The local economy was highly prosperous concurrent with the fare system changes, with expanding employment, high population growth among immigrants, and a substantially reduced crime rate (Tucker, 1999; New York City Transit, 1999).

A quantitative indicator of the economic and demographic expansion is the 4.8 percent growth in New York City total employment between December 1996 and December 1998. On the basis of preliminary ridership and average fare data for the full 1998 year as compared to 1996 (New York City Transit, 1999), an overall bus and subway fare elasticity can be computed for the fare system changes. If New York City total employment is taken as a surrogate for the favorable economic and demographic conditions, and the fare elasticity computation is made deflating ridership growth by this employment growth, the result exhibits roughly twice the sensitivity that prior systemwide fare elasticity experience for across-the-board fare changes in New York would foretell. This outcome is at least suggestive of a very positive response to the changes in fare structure and pricing and related conveniences.[4]

In London, the May 1983 fare structure revisions and introduction of Travelcard, a pass good on both buses and the HRT “Underground,” led to a 30 percent increase in bus passenger miles and a 48 percent increase in Underground passenger miles. Part of this was attributable to a drop in average bus fare paid of 19 percent, and a drop in average Underground fare paid of 28 percent. Yet, when this fare level change was isolated out in a 20-year time-series analysis by the London Transport Planning Department, the fare structure revisions and introduction of Travelcard alone were shown to have had their own positive impacts.

These Travelcard impacts included increases in bus revenues of 4 percent, bus passenger miles of 20 percent, Underground revenues of 16 percent, and Underground passenger miles of 33 percent (London Transport, 1993). The only unaccounted-for causes left to attribute this to would be the existence of differential fare elasticities (as hypothesized in deep discounting), time savings in fare purchase and payments, pure convenience of the Travelcard, or some marketing phenomenon related thereto. Additional details on the London experience and analyses are provided in the case study, “London Transport Fare Elasticities and Travelcard Impact.”

New York and London’s experiences may be compared with the Chicago Transit Authority’s initial introduction of automated fare collection, which involved no new purchase options other than the availability of stored fare at the previous cost of tokens. The 11 percent bulk purchase discount was in effect transferred from tokens to the new farecards. All other pricing remained unchanged. Implementation was completed in September 1997. With the token discount eliminated, and a major farecard promotion, token purchase dropped from 41.9 percent of all revenue in October 1996 to 11.2 percent in October 1998. Cash payment dropped from 52.1 to 40.9 percent of revenues, remaining popular on buses, which lack the advantage of in-station farecard vending machines. Pass use remained essentially unchanged. Farecard purchases accounted for 42.0 percent of all revenues by October 1998. Customer satisfaction levels were up, and the massive losses of ridership that occurred throughout much of the 1990s stopped, with 1998 boardings up 1 to 2 percent over 1997. This improvement is credited to the automatic fare collection, enhanced HRT service, and rehabilitated and cleaner stations. Phase-in of new purchase options, some with cost savings, started in November 1998 (Foote, Patronsky and Stuart, 1999).

Unlimited Travel Pass Partnerships

A relatively new form of prepayment mechanism and new source of public transportation funding has developed in the form of public/private commuter pass programs and related unlimited travel pass partnerships. The partnerships are between transit operators on the one hand, and employers or other institutions such as universities on the other. The operator provides the prepayment mechanism to facilitate employer subsidy of unlimited ride transit passes. The employer makes the purchase and gives them—or makes them available to—its employees (and students for schools) free or at a low purchase price. The impetus for these travel pass partnerships is traffic mitigation and air quality enhancement, with benefits to the employer that also include parking needs reduction and enhancement of employee benefits.

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[4] The positive response continued longer-term, attributed roughly 1/3 to the economy and 2/3 to the new fare options and other factors. Stored fare, bulk discount, free transfer, and pass introduction was completed in January 1999 with a $4 one-day “fun pass.” Subway and bus average weekday ridership rose from 5.3 million daily boardings in 1996 to 7.0 million in 2001, a 31% increase. This growth was anchored heavily in expanded use of transit for non-work travel, up 62% from 1990 to 2000. Apparent continuation of this trend, inferred from loading patterns, allowed modest growth to continue into 2002 despite the 9/11 attacks and recession (Schaller Consulting, 2002).

Some of the examples for which ridership results are available were associated in a major way with bus service changes, and are reported on in Chapter 10, "Bus Routing and Coverage," under "Response by Type of Service and Strategy"—"Service Changes with Fare Changes"—"Service Changes with Unlimited Travel Pass Partnerships." Other examples are listed in Table 12-14.

Table 12-14 Introduction of Unlimited Travel Pass Partnership Programs

Location	Date	Fare Change	Results	Source
Denver	1991	Eco Pass made available to employers.	Increase in transit use to and from work of 0.8 trips per week per employee at participating sites.	Trommer et al (1995)
Milwaukee	1994	Unlimited ride pass for UWM students, accompanied by two new bus routes.	Transit mode share of students for university access increased from 12% to 26% in first year. Transit use for work/shopping up ±50%.	Meyer and Beimborn (1998)
Seattle	1993	FlexPass (annual) made available.	Typical increase in transit ridership at participating sites of 140%.	Volinski (1997)
Seattle	1991	Unlimited ride pass for UW employees and students.	Ridership increased 35% in 1 year in response to U-Pass and other program elements including market-rate parking fees.	Williams and Petrait (1993)

By all appearances, these unlimited travel pass programs are becoming quite successful. It is important to recognize that the employer programs are often implemented in conjunction with other inducements to reduce single occupancy auto commuting, and that university programs are typically undertaken together with parking fee increases, such that the results are not attributable solely to the fare subsidy aspect. The full spectrum of incentives, disincentives, and impacts is examined comprehensively in Chapter 19, "Employer and Institutional TDM Strategies."

The Eco Pass of the Denver Regional Transportation District is a prototypical example of unlimited travel pass partnerships designed for employers. Eco Passes are distributed free to all employees at participating sites. Eco Pass holders get both unlimited transit travel and access to a guaranteed ride home.

Table 12-15 provides estimates of the weekly transit usage increases for employees with Eco Passes one year into the program. Transit usage is defined here as any trip made on transit during the week by the employee, including on Denver's downtown shuttle (free to all). The averages are stratified by level of bus service available. They are based on surveys with acknowledged accuracy and bias control limitations (Schwenk, 1993). The relationships among levels of service available appear rational, but the growth percentages that might be calculated from Table 12-15 should be used with caution.

At those participating employment sites with more than 10 daily bus trips, an increase on the order of two one-way bus rides per employee per week was estimated to have occurred. The total use of bus service was found to be related to the level of bus service provided, with the highest usage occurring in downtown Denver. The highest absolute increase per employee apparently occurred in the suburban city of Boulder, a stronghold of travel demand management (TDM), while the highest percentage increase occurred in more typical suburbs.

Table 12-15 Denver Eco Pass Program Increases in Weekly Transit Usage

Location	Outer Suburban	Suburban	Boulder	Downtown Denver
Service Available[a]	1–9 bus trips	10–24 bus trips	25–64 bus trips	over 64 bus trips
Ridership Rate[b]				
Before Eco Pass	0.6	0.6	1.4	5.1
After Eco Pass	1.8	2.5	3.7	7.3
Net Increase	1.2	1.9	2.3	2.2

Notes: [a] Bus trips of service per day.
[b] One-way bus rides per employee per week for all travel.

Source: Schwenk (1993).

At 15 months after Eco Pass introduction, in December 1992 (subsequent to the surveys used in Table 12-15), pass holders represented 2.3 percent of total revenue boardings on the RTD system. As of April 1993 there were 498 companies enrolled in Eco Pass, covering 21,276 people (Schwenk, 1993). That year a weighted sample survey indicated that use of transit for work access increased for Eco Pass holders from an average of 2.3 days to 2.7 days per week, an increase of 0.4 days or 0.8 trips per week (Trommer et al, 1995). Note that these would be exclusively linked work purpose trips, whereas the trips of Table 12-15 would be trips of all purposes at any time of the day.

The FlexPass of King County Metro (Seattle) is a second major example of unlimited travel pass partnerships designed for employers. FlexPasses work together with companion King County Metro and employer programs to offer a menu of enhancements to alternatives to single occupancy vehicle (SOV) commuting. The specific offerings at an employment site are selected by the employer, and each employee may choose among them. Many employers make FlexPasses a free benefit, but some ask for a small co-payment, which must not exceed half of what the employer pays. As of 1999 the employer paid $1.17 per estimated transit trip, calculated on the basis of an annual survey of actual usage, with Metro and employer cost sharing of new transit usage in the initial years (Koss, 1999). An experimental program was being tested to reduce administrative costs and facilitate inclusion of small employers by computing transit usage on the basis of area average mode shares (Hansen, 1999).

Selected program descriptions and results for the King County Metro FlexPass employer program are provided in Table 12-16. All of the program sites included in Table 12-16 are outside of the Seattle CBD at locations ranging from the CBD fringe to outlying areas. Very positive increases in transit usage and reductions in SOV travel for work commuting are shown, with the greatest SOV reductions in downtown suburban Bellevue and the fringe of the Seattle CBD, both locations well served by transit.

Table 12-16 Sampling of Employer Offerings and Shifts in Mode Share—Metro FlexPass Customers

Employer and Type	Location	Offerings	Mode Share Change		
Employer A: Engineering 280 employees	Downtown Bellevue	• FlexPass transit ($7/mo. co-pay) • $40/month vanpool subsidy • parking subsidy for carpools • Home Free Guarantee	SOV Transit Vanpool Carpool	61% to 36% 17% to 36% 1% to 2% 12% to 13%	1995 to 1997
Employer B: Engineering 85 employees	Downtown Bellevue	• FlexPass transit • carpool parking subsidy • Home Free Guarantee	SOV Transit Carpool	74% to 39% 3% to 41% 20% to 18%	1995 to 1997
Employer C: Sales and production 250 employees	Bothell	• FlexPass transit • CB+ voucher for Carpool ($20/mo.)	SOV Transit Vanpool Carpool	90% to 73% 1% to 7% 0% to 3% 8% to 17%	1996 to 1997
Employer D: Software 650 employees	Seattle—Lake Union	• FlexPass transit • $65/month vanpool subsidy • CB+ vouchers for all HOVs ($20/mo.) • Metro Home Free Guarantee • Metro Rideshare Plus service	SOV Transit Vanpool Carpool Bike/Walk	61% to 56% 11% to 12% 2% to 1% 15% to 16% 8% to 12%	1996 to 1998

Note: Continued on next page.

Table 12-16 Sampling of Employer Offerings and Shifts in Mode Share—Metro FlexPass Customers (continued)

Employer and Type	Location	Offerings	Mode Share Change		
Employer E: Health care delivery, research 1,800 employees	Multiple sites, all in Seattle CBD ring—First Hill, Lake Union	• FlexPass transit • 100% vanpool subsidy • Home Free Guarantee • reduced parking cost for carpools, vanpools • lockers, showers, towel service for bikers/walkers • shuttles between worksites	SOV Transit Vanpool Carpool Bike/Walk	48% to 34% 9% to 19% 0% to 1% 13% to 15% 8% to 10%	1996 to 1997
Employer F: Telecommunications 250 employees	Seattle—Lake Union	• FlexPass transit • $65/month vanpool subsidy • CB+ vouchers for carpool, bicycle, and walk ($20/mo.) • Metro Home Free Guarantee	SOV Transit Carpool Bike/Walk	80% to 66% 6% to 14% 10% to 15% 2% to 3%	1996 to 1998
Employer G: Natural resource processing	Multiple sites—south King County, north Pierce County	• FlexPass transit • 100% vanpool subsidy—3 counties • carpool, bike, walk incentives of $1/day for non-SOV commute • personalized RideMatch • shuttles to/from park & ride, between work-sites via Business Use of Vans program • internal guaranteed ride home • high management profile/commitment	SOV Transit Vanpool Carpool Bike/Walk Telecommute	83% to 74% 0.15% to 0.20% 3.6% to 4.3% 10.5% to 17.6% 0.6% to 1.1% 0.8% to 2.1%	1996 to 1997

Source: King County Metro (1998).

The "typical" program in the Table 12-16 selection has achieved in two years a 133 percent increase in transit usage and an 18 percent SOV reduction with FlexPass, $65/month vanpool subsidy, $20/month vouchers for carpooling, bicycling and walking, and Metro's guaranteed ride home program (King County Metro, 1998; Koss, 1999).

Unlimited travel passes also have been used successfully in university settings, as was indicated in Table 12-14. The University of Washington's U-Pass program is a prime example. The U-Pass is an unlimited ride pass for UW employees, staff, and students. It was instituted in 1991 along with other benefits and strategies such as free carpool parking on campus, subsidized vanpools, a reimbursed ride home for employee emergencies, discounts at stores and restaurants, and an increase in the cost of monthly parking permits from $24 in 1990 to $36 in 1991, reaching $46.50 in 1998. In addition, the U-Pass program itself was accompanied by bus routing changes associated with the opening of the Seattle Bus Tunnel and bus frequency improvements.

Shifts in campus mode shares between 1990 (before U-Pass) and 1998 include an increase in the transit share from 21 to 29 percent, an increase in the carpool/vanpool share from 10 to 12 percent, and a decrease in the drive-alone share from 33 to 25 percent (University of Washington, 1998). Because of the highly significant non-transit strategies included in UW's U-Pass program, more complete coverage is reserved for Chapter 19, "Employer and Institutional TDM Strategies." Other similar university programs are covered in Chapter 10, "Bus Routing and Coverage."

The number of employer partnerships covered by King County Metro's various commuter programs, including FlexPass customers, the University of Washington's U-Pass, and nontraditional transit programs, has increased from 120 in 1995 to 467 in mid-1998. The number of employees and students covered has grown from 55,800 in 1996, when there were 296 partnerships, to 73,000 in 1998 (King County DOT, 1998).

Changes in Fare Structure Basis

In the past 20 years, there have been very few documented studies of transit systems changing the basis on which fares are calculated. When transit systems were privately owned, distance-based or zonal fares were relatively common. After public takeover, however, most transit systems—particularly small and medium-sized operations—opted for simple, flat fare systems. Distance-based or zonal fares were retained primarily in instances where trip distances were long, with commuter rail as the extreme example, or sometimes when routes crossed political boundaries of local governments. Studies of the earlier fare structure base changes in the United States were generally inconclusive with respect to effects on transit ridership, aside from the obvious observation that flat fare systems favor long trips by giving them the least cost per mile (Pratt, Pedersen and Mather, 1977).

The possibility of fare sensitivity differentials as a function of trip distance becomes relevant in consideration of fare structure changes.

Studies in London, done when their base fare covered a much shorter distance than was ever representative of U.S. systems, showed nearly twice the sensitivity to fares for trips under a mile in length (fare elasticity of –0.5 to –0.55) as compared to somewhat longer trips (elasticity of –0.25 to –0.3) (Mayworm, Lago and McEnroe, 1980). Trips of under a mile are in the realm of walking as a modal option, and this is likely a major reason why such trips exhibit higher fare elasticities. Where this becomes relevant to U.S. fare structures is in the case of CBD fare-free zones and similar applications, discussed under "Free Transit."

A small urbanized area system that experimented with reintroduction of zone fares was Broome County (BC) Transit in New York State. It operated 40 buses on a pulse-scheduled system centered on Birmingham, New York, with a service area population of 215,000. BC Transit management perceived zonal pricing as one alternative to periodic across-the-board fare increases. In a federally-funded demonstration, fare zone limits were set approximately three miles from the Birmingham central business district at boundaries with other municipalities. The zone charges were imposed concurrently with an overall adult cash fare increase of the same magnitude.

It was found that the overall system elasticity to the fare changes, associated in part with the imposition of zone fare charges, was in the range expected for any fare change. The sensitivity of only those passenger trips affected by the zone fares was not separately examined. The results suggested that zone fares do not have the potential for significantly increasing revenues in small transit systems. Only 30 percent of BC Transit riders were affected by the zone fares (Andrle, Kraus, and Spielberg, 1991).

Free Transit

The provision of free transit service is an idea that was tested in a number of federally funded demonstrations in the 1970s. However, with the increasing pressure on transit funding sources, many transit systems abandoned thoughts of offering free service. Nevertheless, free transit service is offered on selected services in over 50 instances, as shown in Table 12-17. A majority of the free transit services involve bus operations in central business districts (CBDs) and universities.

Table 12-17 Number of Fare-Free Transit Operations by Service Category and Mode

Service	Bus	Light Rail	Trolley Bus	Total
Central Business District	21	3	1	25
Local/Neighborhood	4	0	0	4
University	11	0	0	11
Parking Lot	5	0	0	5
Feeder	3	0	0	3
Other Regular Services	5	1	0	6

Source: American Public Transit Association (1997).

Available traveler response information on recent and current free transit operations is very sketchy. Ridership data and one instance of a calculated fare elasticity are provided for downtown circulators and shuttles, some of which are or were free, in Chapter 10, "Bus Routing and Coverage." See all three subtopics under "Response by Type of Service and Strategy"—"Circulator/Distributor Routes." Weekday passenger volumes for the free shuttles and circulators covered there range from 45,000 in Denver to less than 1,000 in Richmond. It was the Richmond, Virginia, operation that allowed calculation of an elasticity: approximately –0.33 when a fare was imposed.

Table 12-18 presents the fare elasticity results of an analysis of 12 demonstrations, undertaken prior to 1980, where free fares were offered. Four of the applications involve free fares limited to CBDs.

For two of these, both off-peak and all-hours fare elasticities were calculated, providing six CBD cases. Overall, the 14 cases are almost equally divided between off-peak only and all-hours free-fare observations. All but one are from small to moderately large U.S. cities.

Table 12-18 Free Transit Fare Elasticities—Mean and Standard Deviation

Service Restriction	Off-Peak	All Hours
CBD	–0.61 ± 0.14 (3 cases)	–0.52 ± 0.13 (3 cases)
Senior Citizens	–0.33 (1 case)	None
Students	None	–0.38 (1 case)
No Restrictions	–0.28 ± 0.05 (4 cases)	–0.36 ± 0.28 (2 cases)

Source: Mayworm, Lago and McEnroe (1980).

The average fare elasticity for the non-CBD applications in Table 12-18, primarily the "No Restrictions" cases but also the senior citizen and student examples, is –0.32. The analysts concluded that elasticities for non-CBD free fare applications are generally lower than comparable elasticities for reduced fare programs (Mayworm, Lago and McEnroe, 1980). However, omitting the one observation from a very large city, a value of –0.08 from Rome, Italy, the average for non-CBD applications becomes –0.35. This seems hardly different from the fare reduction findings of the same study, summarized earlier in Table 12-6.

The CBD applications exhibited the highest fare elasticities, averaging –0.52 for all hours and –0.61 for off-peak hours alone. This is a logical outcome, because CBDs are characterized by large numbers of walking trips, and the free fare can be expected to attract a substantial number of these if service is frequent. As was presented in the preceding "Changes to Fare Structure Base" discussion, the one source of elasticities differentiated by trip distance—from London—suggests that trips under one mile in length are almost twice as sensitive to fare as somewhat longer trips. Indeed, the all hours fare elasticities calculated for London trips under one mile in length were in the closely comparable –0.5 to –0.55 range (Mayworm, Lago and McEnroe, 1980).

Perhaps the best known of the fare-free CBD applications are those which have been in place for about 25 years in Portland, Oregon, and Seattle, Washington. In the 1970s, both cities instituted fare-free service for trips taken entirely within the CBD on regular bus service. Each program involved elimination of a dime-fare downtown shuttle. In Portland, roughly a nine-fold ridership increase was estimated for intra-CBD trips after an average fare of 22.5¢ was abolished and service improvements were made (Pratt and Copple, 1981). In Seattle, surveys showed that the fare-free service had resulted in a three-fold increase after eight months over the intra-CBD ridership previously carried on all buses (Colman, 1979). Surveys and analyses in both cities identified a small favorable impact on usage of fare-paid transit service into and out of the CBD. (See also the case study, "CBD Fare-Free Zones in Seattle, Washington, and Portland, Oregon.")

A recent review of over 20 free-fare programs is selectively summarized in Table 12-19. Only those programs for which quantitative results were presented are shown individually, and programs deemed inconclusive are omitted. This free-fare program review concluded that free-fare programs result in significant increases in ridership, typically higher than the increase predicted by the Simpson & Curtin rule (Hodge, Orrell, and Strauss, 1994). The evidence appears to be essentially anecdotal, however. On balance, it seems most likely that CBD free-fare programs do attract more ridership than average bus fare elasticity values would predict, but that other applications fall within normal ranges of ridership response to lowered or otherwise altered fare levels, particularly when city size is taken into account.

Table 12-19 Fare-Free Transit Program Results

Location	Time Frame	Description	Objectives	Results
Amherst, MA; UC Davis, CA; University of Iowa	1976, 1990 and 1971, respectively, to present	System (Amherst and Davis) or sector (IA); university settings	Mobility or mobility and congestion mitigation	Ongoing university and community or university area programs rated successful.
Austin, Texas	Oct. 1989—Dec. 1990	System wide; medium size city	Promotion and education	Successfully met objectives. A 75% ridership increase; some problem riders.
Burlington, Vermont	1991 and Spring of 1992	One single route to airport, K-12 school program	Promotion, mobility and education	Considered highly successful; 56% ridership increase, 25% carryover.
Chelan-Douglas and Island Counties, WA; Commerce, CA	1991, 1987 and 1962, respectively, to present	System wide; small city/rural area (WA) or metropolitan area small city (CA)	Mobility	On-going programs rated successful.
Corpus Christi, TX; Monterey Park, CA	Summer 1987 and 1986-88, respectively	System wide, for kids (TX) or for all (CA)	Mobility (and connection to regional transit in CA)	Considered unsuccessful. Problems related to students and joy-riding.
Juneau, AK; Topeka, KS	1985 and May 1988, respectively	Shuttle along one route (AK) or systemwide (KS)	Promotion (and congestion in AK)	Considered successful as a promotion (and education device in KS).
Logan, Utah	April 1992—present	Systemwide; small city	Mobility	On-going; 2,500 rides/day initially, later 3,700/day.
Marin County, CA; Olympia, WA	1989 & 1990, respectively, to present	Special shuttles to ferry and community college	Congestion mitigation and other	Successful in attracting ferry commuters (CA); highly successful (WA).
Salt Lake City, Utah	October 1979	System wide; medium size city	Promotion & education	Considered successful with a 13% increase in ridership.
Various CBD programs	Varies with program	Downtown areas of medium to large cities	Congestion, mobility, and aid to CBD economy	Results vary. Generally considered successful.

Note: "Time Frame" limit of "present" is as of early 1990s.

Source: Hodge, Orrell and Strauss (1994).

Earlier compilations provide the original 1976 implementation results for the Amherst fare-free transit operation in Massachusetts. The service came about when free university bus service was expanded into the surrounding community. The expansion attracted 4,000 daily riders, 40 percent of whom were prior auto drivers. The free transit in Commerce, California, was attracting use of 7 to 8 percent of the population daily when reviewed in the 1970s, twice the average then pertaining for comparable size towns (Pratt and Copple, 1981). However, it has been pointed out that Commerce is a rather unique industrial city, with a small population consisting of mostly lower-income residents.

As noted in Table 12-19, the Topeka Metropolitan Transit Authority (TMTA) offered a promotional free month of bus service in Topeka, Kansas during May 1988. Compared to May 1987, ridership increased 83.2 percent on weekdays, 153.4 percent on Saturdays and 93.3 percent overall. Ridership on the downtown circulator route increased 156 percent. Only one bus a day was added to address problems of overcrowding (Topeka Metropolitan Transit Authority, 1988). One might infer from this information that much of the weekday ridership increase probably occurred for non-work purposes and mainly in off-peak hours, and that there is likely to be adequate capacity in small transit systems to accommodate large increases in ridership of this type.

UNDERLYING TRAVELER RESPONSE FACTORS

The understanding of transit rider response to fare and pricing changes is similar to, but more complicated than, understanding consumer response to price changes of commercial products such as soap, soda pop, and televisions. Several reasons have been cited for the more complicated nature of rider response (Charles River Associates, 1997):

- Travel is predominately derived demand. Most travel is not made as an end in itself, but to serve some other purpose at the origin or destination of the trip. Therefore, changes in the demand for these activities can greatly influence travel. These activities often are referred to as "external factors." The level and concentration of employment and shopping activities are often cited as external factors that greatly affect transit ridership.

- Travel involves decisions in many "dimensions." Often, travelers do not make a simple "buy/no buy" decision. Instead, they consider issues such as:

  — *Whether* to make a trip at all or combine it with other trips (trip frequency),

  — *Where* to travel to (destination choice),

  — *When* to travel (schedule choice),

  — *How* to travel (mode choice), and

  — By which *route* to travel (path choice).

- The level of service provided by a transportation facility is not constant. For a fixed level of supply, the more that is purchased, the worse it gets. This fall-off in the quality of the product becomes most marked when the demand is approaching the capacity of the facility and crowding becomes severe. For supply that is not fixed, often the more that is purchased, the better it gets, perhaps in terms of more frequent bus or train service.

These reasons may help explain the variability that is found in fare elasticities observed among transit systems. People have many ways to react to travel situations that do not meet their liking. These choices vary by transit system depending on the demographic and economic characteristics of the service area and the level and types of service provided by the transit system. Despite these differences, there are some key factors that affect rider response to fare and pricing changes. Among these factors are trip purpose, automobile availability, household income, age, and transit use frequency.

Trip Purpose

Trip purpose is thought to be an important reason for many aspects of the variability among fare elasticities. There is little in the way of reported data on this topic, however, aside from estimates available from cross-sectional models, which give contradictory results (Webster and Bly, 1980). The information presented here is from quasi-experimental studies.

A federal university research study examined fare changes in three cities and found that riders making shopping trips were two to three times more responsive to fare changes than were riders making work trips. The elasticities developed are presented in Table 12-20 (Habib et al, 1978).

Table 12-20 Work and Shopping Bus Fare Elasticities

City	Work	Shopping
Baltimore (1976)	–0.09	–0.20
Birmingham (1975)	–0.05	–0.15
Richmond (1976)	–0.08	–0.25

Source: Habib et al (1978).

A detailed set of fare elasticities for a variety of trip purposes was estimated from a free-fare demonstration in Trenton, New Jersey. Although the demonstration was conducted only during off-peak periods, the results still suggest that riders making work trips are significantly less responsive to fare changes than are riders making non-work trips. The fare elasticities developed are given in Table 12-21 (De Leuw, Cather and Company, 1979b).

Auto Availability

It is commonly believed in the transit industry that people with cars available to make their trip—choice riders—behave differently than people who do not have an automobile at their disposal—captive riders. Choice riders are expected to be more sensitive to fare changes than are captive riders, who do not have another travel alternative.[5]

[5] Assumed here, essentially, is a fixed prevalence of auto availability, consistent with use of short-run fare elasticities. In contrast, long-run elasticities, introduced in the "Overview and Summary" under "Analytical Considerations" (footnote 1), reflect the effects of longer-term household decisions such as auto ownership and residence and workplace location (Litman, 2004), making them of perhaps elevated interest to strategic and urban planners. The few long-run estimates encountered range from twice corresponding short-run elasticities down to no discernable difference.

Table 12-21 Off-Peak Fare Elasticity Values by Trip Purpose—Trenton Free-Fare Demonstration

Trip Purpose	Arc Elasticity
Work	–0.11
School	–0.19
Shop	–0.25
Medical	–0.32
Recreation	–0.37
Social	–0.25
Other	–0.19
Weighted Aggregate Value	–0.19

Source: De Leuw, Cather and Company (1979b).

Limited evidence supports this common belief. Fare elasticity results from the off-peak free-fare demonstrations in Denver and Trenton, listed in Table 12-22, show that captive riders—or riders with no automobile owned—are least responsive to fare changes (De Leuw, Cather and Company, 1979a and 1979b). Likewise, a study of work purpose trips on London buses found that trips made by choice riders had a higher fare elasticity (–0.41) than trips made by captive riders (–0.10) (Collins and Lindsay, 1972).

Table 12-22 Off-Peak Fare Elasticity Values by Automobile Availability and Ownership—Denver and Trenton Free Fare Demonstrations

City and Category	Fare Elasticity
Denver	
Captive Riders	–0.25
Choice Riders	–0.31
Trenton	
0 Autos Owned	–0.25
1 Auto Owned	–0.31
2 Autos Owned	–0.25
3 Autos Owned	–0.31

Source: De Leuw, Cather and Company (1979a and b).

Household Income

The effect of income on fare elasticities is not well researched. Based on the discussion of automobile availability, it might be expected that riders with high incomes would be more responsive to fare changes than low income riders, because income is highly correlated to automobile ownership. However, a contrary view could be taken that high income riders are less responsive because the fares paid are a relatively insignificant percentage of their expenditures.

The off-peak free fare demonstrations in Denver and Trenton provide some evidence, albeit not overwhelming, that high income riders are more responsive. Elasticities by income level from these demonstrations are given in Table 12-23.

Table 12-23 Off-Peak Fare Elasticity Values by Income Level—Denver and Trenton Free Fare Demonstrations

Household Income	Denver Fare Elasticities	Trenton Fare Elasticities
Under $5,000	–0.28	–0.09
$5,000 to $9,999	–0.24	–0.10
10,000 to 14,999	–0.25	–0.41
15,000 to 24,999	–0.28	–0.08
25,000 or more	–0.31	–0.43

Source: Mayworm, Lago and McEnroe (1980) from De Leuw, Cather and Company (1979a and b).

The higher elasticities for both high and low income groups in Denver may be the result of the off-peak nature of the experiment. Whereas the higher income households produced most of the new transit trips, the lower income households produced the largest shifts in existing riders from the peak to the off-peak (De Leuw, Cather and Company, 1979a). The latter phenomenon would not occur in an across-the-board fare change.

One source of information that could be interpreted as supporting the contrary view that low income riders are most responsive to fare changes is a study of the 1966 fare increase on the New York subway system (Lassow, 1968). The results, converted into elasticities, are shown in Table 12-24. They indicate that low income subway users were at least three times more responsive during all times of the day to fare changes than were average subway users. However, as noted in a review of the experience, the automobile was not a realistic travel alternative for most subway trips undertaken by New York households because of roadway congestion and high parking costs (Mayworm, Lago and McEnroe, 1980). These difficulties would have been particularly so in 1966, leaving walking or trip suppression the only logical responses available, something more likely for travelers tightly constrained monetarily.

Table 12-24 New York Subway 1966 Fare Elasticities by Income

Time Period	Low Income Users	All Users
Morning Peak	–0.16	–0.03
Afternoon Peak	–0.29	–0.06
Midday	–0.34	–0.10
Evening	–0.74	–0.18
Late Evening	–0.49	–0.04
All Weekday Hours	–0.31	–0.07

Source: Elasticities calculated by Mayworm, Lago and McEnroe (1980) from Lassow (1968).

Typically, where significant socio-economic differences have been identified, it has been noted that new bus riders attracted by overall fare decreases tend to have higher incomes and higher auto ownership than previous bus riders (Pratt and Copple, 1981). The 1966 New York experience notwithstanding, the converse should generally hold true. Indeed, in response to the 1975 New York City fare increase, the greater amount of work trip mode shifting was exhibited by those heads of households with income over $15,000, or with 13 or more years of education, or owning one or more autos (Obinani, 1977).

Age Category

The effect of age in response to fare changes is another area where limited and occasionally contradictory evidence is encountered. In the 1975 New York City fare increase mentioned above, the greater amount of work trip mode shifting was also exhibited among those heads of households over 35 years old (Obinani, 1977), who undoubtedly were mostly the same persons as those with the higher incomes. However, in other instances where age differences have been identified, new bus riders attracted by overall fare decreases have typically been identified as being younger than previous bus riders (Pratt and Copple, 1981). The difference in at least this comparison is probably associated with trip purpose. The 1970s New York analysis pertained to work travel only, while the other observations have generally covered all trip purposes, including those typical of travel by youths.

Here again, the off-peak free fare demonstrations in Denver and Trenton provide the most detailed information. Table 12-25 presents the response, in terms of elasticities, to the free offpeak fares. Caution should be applied, however, in any attempt to use this information outside of its context of off-peak transit usage and free (or at least very low) fare.

Table 12-25 Off-Peak Fare Elasticity Values by Age Category—Denver and Trenton Free Fare Demonstrations

Rider Age Range	Denver Fare Elasticities	Trenton Fare Elasticities
1 to 16 years	–0.32	–0.31
17 to 24 years	–0.30	–0.24
25 to 44 years	–0.28	–0.08
45 to 64 years	–0.18	–0.15
65 and more years	–0.16	–0.14

Source: Mayworm, Lago and McEnroe (1980) from De Leuw, Cather and Company (1979a and b).

The implied higher sensitivity of children to transit fares is supported by 1970s investigations in England and Canada that found the elasticities of children's or school tickets to be 1/3 higher to almost three times higher than the adult elasticities. The child/school elasticities were in the range of –0.41 (Warwickshire) to –0.44 (Montreal) (Mayworm, Lago and McEnroe, 1980).

Transit Use Frequency

There has been a tendency in the transit industry to discount the importance of infrequent transit riders. Historically, discounted fares have been aimed primarily at riders who use transit practically every weekday, if not more. With the advent of "deep discounting" proposals, more attention has been focused on using fare prepayment with discounts as a marketing device and reward system not only for everyday riders, but also for less frequent riders. This is the result, in part, of market analyses identifying the scope of infrequent riding. In Dayton, Ohio, for example, 1992 surveys showed that riders using transit three times per week or less accounted for 31 percent of all trips and 75 percent of all customers. In Louisville, Kentucky, it was determined that in 1993 riders using transit too infrequently to make good use of a monthly pass accounted for 60 percent of all transit trips and constituted 90 percent of individual customers (Oram and Schwenk, 1994).

Tables 12-26 and 12-27 provide transit use frequency statistics for nine cities, from surveys made in the 1997–1998 period. The frequencies are quantified as percentages of transit trips in Table 12-26, and percentages of people (customers) in Table 12-27. Looking only at regular route operations, transit use frequencies of three times per week or less range from 13.8 percent of all bus trips in Kenosha, Wisconsin, to 28.4 percent of bus trips (35.1 percent of LRT trips) in Portland, Oregon. That corresponds to 34.7 percent of all Kenosha bus customers and 60.1 percent of Portland bus customers (69.2 percent of Portland LRT customers) (McCollom Management Consulting, Inc., 1999). The substantial variation indicates that the same fare system modification applied in different cities can produce sharply divergent outcomes. Clearly, each market segment needs to be examined in the context of local data to properly anticipate fare change implications.

Table 12-26 Frequency of Transit Use (Percent of Transit Trips Made)

System - Mode	7 Days per Week	6 Days per Week	5 Days per Week	4 Days per Week	3 Days per Week	2 Days per Week	1 Day per Week	1–2 Times per Month	Total	First Time Rider
Austin - Regular	24.7%	15.4%	33.7%	7.4%	4.8%	5.4%	4.1%	4.5%	100%	2.2%
- University	11.5	14.6	57.3	5.0	4.8	3.5	2.2	1.1	100.0	1.3
Buffalo - Bus	17.0	12.9	44.7	5.4	6.0	5.2	3.3	5.5	100.0	1.6
- Light Rail	18.8	11.6	44.3	5.9	5.1	4.4	2.7	7.1	99.9	2.4
Chicago - Bus	23.1	15.1	39.0	5.6	5.3	3.6	1.9	6.3	99.9	2.6
- Subway/El	13.2	14.3	51.8	4.4	4.3	3.9	2.8	5.3	100.0	2.2
Grand Rapids	7.7	19.5	43.4	7.2	7.1	6.1	4.5	4.6	100.1	1.6
Kenosha	10.3	17.0	52.2	6.8	5.0	3.3	2.1	3.4	100.1	1.1
Lincoln	0.0	12.4	48.1	9.6	10.6	6.2	7.0	6.1	100.0	1.8
Pittsburgh - Bus	13.9	12.8	49.2	5.8	5.6	4.5	3.6	4.6	100.0	1.3
- Light Rail	6.6	8.8	57.6	4.3	5.3	4.0	4.2	9.1	99.9	2.9
Portland - Bus	17.2	9.1	38.3	7.1	7.3	6.6	4.7	9.8	100.1	6.7
- Light Rail	15.7	7.8	35.3	6.0	6.8	7.0	6.2	15.1	99.9	7.7
Sacramento - Bus	15.0	6.5	45.8	7.6	7.0	6.6	4.2	7.3	100.0	2.0
- Light Rail	15.8	7.4	45.6	7.5	6.1	6.0	4.5	7.0	99.9	3.0

Source: McCollom Management Consulting, Inc. (1999).

Table 12-27 Frequency of Transit Use (Percent of Persons/Customers)

System - Mode	7 Days per Week	6 Days per Week	5 Days per Week	4 Days per Week	3 Days per Week	2 Days per Week	1 Day per Week	1–2 Times per Month	Total	First Time Rider
Austin - Regular	12.8%	9.3%	24.4%	6.7%	5.8%	9.7%	14.8%	16.6%	100%	2.2%
- University	7.0	10.4	48.8	5.3	6.8	7.5	9.5	4.8	100.0	1.3
Buffalo - Bus	8.6	7.6	31.6	4.8	7.1	9.2	11.8	19.2	100.0	1.6
- Light Rail	9.4	6.8	30.9	5.2	5.9	7.7	9.5	24.7	100.0	2.4
Chicago - Bus	12.3	9.4	29.1	5.2	6.6	6.6	7.1	23.7	100.0	2.6
- Subway/El	6.9	8.8	38.0	4.0	5.3	7.1	10.4	19.6	100.0	2.2
Grand Rapids	3.4	8.5	22.7	4.7	6.1	7.9	11.8	34.8	100.0	1.6
Kenosha	5.8	11.3	41.4	6.8	6.6	6.5	8.3	13.3	100.0	1.1
Lincoln	0.0	4.4	20.7	5.2	7.6	6.7	15.0	40.5	100.0	1.8
Pittsburgh - Bus	7.2	7.7	35.5	5.3	6.8	8.0	13.1	16.5	100.0	1.3
- Light Rail	3.0	4.6	35.9	3.4	5.5	6.3	13.0	28.4	100.0	2.9
Portland - Bus	7.3	4.5	22.8	5.3	7.2	9.9	14.1	28.9	100.0	6.7
- Light Rail	5.7	33.3	18.0	3.9	5.8	8.9	15.8	38.7	100.0	7.7
Sacramento - Bus	6.8	3.4	29.2	6.0	7.5	10.5	13.4	23.3	100.0	2.0
- Light Rail	7.3	4.0	29.3	6.0	6.6	9.7	14.6	22.4	100.0	3.0

Source: McCollom Management Consulting, Inc. (1999).

RELATED INFORMATION AND IMPACTS

Sources of New and Lost Ridership

New transit rides are almost always attracted when fare levels are reduced or fares are eliminated. The rides come from two sources:

- Existing riders who decide to take more trips, and
- New riders who either divert from other modes such as the automobile, or did not make the trip before the fare reduction.

Three studies suggest that new transit trips tend to be made more in off-peak periods for nonwork purposes than in peak periods for commuting purposes, and conversely, that off-peak and non-work trips are most likely to be lost when fares are raised. In May 1988, the Topeka Metropolitan Transit Authority offered a promotional month of free bus service in Topeka, Kansas. As discussed with respect to “Free Transit,” ridership increased 83 percent on weekdays, 153 percent on Saturdays, and 156 percent on the downtown circulator route (Topeka Metropolitan Transit Authority, 1988). These results are at the least very suggestive that much of the ridership increase occurred in off-peak hours for non-work purposes.

Before-and-after surveys were conducted to assess the impacts of the July 1980 fare increase implemented by Mercer Metro in Trenton, New Jersey. The increase involved raising the base fare from $0.40 to $0.50 for travel during all periods. The survey found that a larger percentage of people making non-commuting trips reduced their transit trip making than did people making commuting trips. The percentages are listed in Table 12-28 (Day, 1985). This response also occurred in Los Angeles after the 1980 fare increase, covered in the case study, "July 1980 Los Angeles Fare Increase" (Attanucci, Vozzolo, and Burns, 1982).

Table 12-28 Effects of Fare Increase on Trip Frequency by Trip Purpose in Trenton

Type of Trip	Decreased Trip Frequency	No Change	Increased Trip Frequency
Commutation	16.1%	83.8%	0.0%
Non-Commutation	23.0%	71.2%	5.8%

Note: Values shown are percent of survey respondents.

Source: Day (1985).

Before-and-after surveys taken to assess impacts of a 1975 bus and subway fare increase in New York City examined mode shifts. Although 20 percent of respondents predicted they would make changes in their journey to work travel, only 14.6 percent actually did. Alternative work trip travel modes for those who did stop using transit were 34 percent drive alone, 12 percent carpool, 23 percent walk, 14 percent bus (as an alternative to the subway), and 17 percent taxi, bicycle and other. For off-peak travel, 34 percent reduced their number of transit trips, and 4 percent discontinued use altogether. Of those who reduced their transit trips, 60 percent reported making fewer total trips and 49 percent stated they had shifted some off-peak trip making to auto (Obinani, 1977).

Studies of fare reductions made in combination with service increases in Atlanta and Los Angeles show diversion from the automobile ranging from 64 percent of new riders in Atlanta to 80 percent of new riders in Los Angeles. The full range of prior modes of travel is shown in Table 12-29. Note that these data are for new riders, not new rides, at least in the case of Atlanta. Additional rides made by existing riders constituted 9 percent of the patronage increase in Atlanta (Bates, 1974; Weary, Kenan and Eoff, 1974).

Table 12-29 Prior Mode for New Riders—Fare Reduction and Service Improvement

	Prior Mode					
Location	Auto Driver	Auto Passenger	Walk	Other	Trip Not Made	Source
Atlanta	42%	22%	4%	10%	22%	Bates (1974)
Los Angeles	59%	21%	—	10%	10%	Weary, Kenan, and Eoff (1974)

Studies of free fare demonstrations during off-peak periods in Denver and Trenton show distinct differences in the percentage of new rides that were diverted from the automobile—46 percent of the Denver new rides and 16 percent of the Trenton new rides. This is quite likely due to socio-economic and structural differences between the two cities: Denver, a new, western city with a diverse economy, and Trenton, an old eastern city with a historically industrial base. The full range of prior mode findings is displayed in Table 12-30, along with similar data for the Seattle implementation of fare-free travel within the CBD only. In that case, the focus on intra-CBD trips produces a quite different pattern of prior modes, a pattern representative of short-distance travel with the walk mode dominant.

Table 12-30 Prior Mode for New Trips—Fare-Free Demonstrations

	Prior Mode				
Location	Auto	Walk	Other	Trip Not Made	Source
Denver	46%	—	22%	32%	De Leuw, Cather and Co. (1979a).
Trenton	16%	23%	16%	45%	De Leuw, Cather and Co. (1979b).
Seattle CBD	12%	47%	3%	38%	Colman (1979).

"Trips Not Made" (previously), as in Tables 12-29 and 12-30, may reflect either changes in destination choice or in trip frequency, with trip frequency in this case not referring to transit travel per se, but rather to travel by any mode.

The variation of these results suggests there may be explanatory factors affecting the sources of new ridership, particularly the percentages of trips not previously made and automobile-diverted trips. These factors probably include type of fare change, time of day, level of transit service provided, transit mode, population of the service area, and socio-economic characteristics, factors that have been shown also to affect the values of relevant fare elasticities. In any case, aside from the Trenton experience, the data suggest that driving an auto is the alternate mode choice of about one-third to one-half of the riders who shift to and from transit in response to systemwide fare changes.

Impacts on Revenues and Costs

The paramount finding of this review of fare and pricing changes is that nearly all the observed values of fare elasticities fall in the range between zero and –1.0 or, in economic terms, that rider response to fare changes is *inelastic.* This has two important implications for fare policy planning:

- An increase in transit fare levels should be expected to result in some ridership loss, but will provide increased fare revenues. Therefore, if a transit system wants to increase total fare revenues, it should increase fare levels.

- A reduction in transit fare levels will nearly always generate more ridership, but will also result in lowered fare revenues. Therefore, if a transit system reduces fare levels to increase ridership, success can be reasonably assured, but at a cost of revenue reduction.

Fare revenues at many transit systems cover between 25 and 35 percent of operating costs. While fare policy is important, its role in increasing transit revenues has been limited because of the significant ridership losses that must be incurred to generate large revenue increases. For example, fare levels would have to be raised 25 percent across all fare categories to increase the fare recovery from 35 percent to 40 percent at the average bus fare elasticity of –0.40. This would result in loss of 8.5 percent of transit riders, an impact few agencies would wish to choose.

As discussed in the "Changes in Pricing Relationships" section, a key objective of the deep discounting approach is to minimize ridership losses when seeking to increase revenues. It is hoped that targeting larger fare increases to users with low fare sensitivities/elasticities will result in smaller losses of riders than would result from imposing a uniform fare increase on all riders.

The cost of lost revenues in a fare reduction, which in the case of a citywide free fare can range from substantial to huge for all but the smallest of operations, is of crucial importance. On the other hand, operating cost increases associated with reducing fares are likely to be limited, at least for medium to small size cities where scheduling is based more on policy than demand. The experience with fare increases and decreases suggests that much of the ridership change occurs during off-peak periods. It is during these periods that transit systems have a significant excess of passenger carrying capacity on the streets. In the previously cited case of a promotional month of free bus service in Topeka, despite a near doubling of ridership, only one bus had to be added to address problems of overcrowding (Topeka Metropolitan Transit Authority, 1988).

Larger cities, however, are likely to have some services operating near capacity, with scheduling based on demand, and the cost of adding needed service might well be significant. Yet, New York City, at the other extreme from Topeka, provides what is in fact a remarkably inconclusive example. As described earlier, with implementation of electronic fare media essentially complete in 1998 for both bus and subway, MTA New York City Transit had for the first time instituted systemwide free transfers between bus and subway, a multi-ride stored fare prepayment discount, and unlimited-ride passes. Comparing September 1998 year-to-date with the same for September 1996, subway trips were up 6.6 and 11.5 percent on weekdays and weekends, and bus passenger trips were up 26.0 and 27.2 percent on weekdays and weekends, respectively. AM peak subway service increases were not deemed possible. Peak bus requirements increased by 16.5 percent, from approximately 3,090 to 3,600, partly due to the ridership increases and partly because of longer processing times for the electronic fare media. Revenues were down 4.0 percent, while the farebox recovery ratio changed from 75.9 to 71.0 percent (Tucker, 1999). This implies an operating cost increase so minor—2 to 3 percent—that it could be explained either by the very focused service enhancements that were indeed provided, or simply inflation, or it may be that the true costs of resolving overloads had not yet surfaced as of 1999.

Impacts on VMT, Energy and Environment

Transit ridership in most urban areas represents less than three percent of all trips region-wide. Under these conditions, with rider response to fare changes being inelastic, fare changes by themselves will have very little impact on regional vehicle miles of travel (VMT). The corresponding impact on energy consumption will be minuscule, and air quality impacts nearly as minor. Even in very large cities, the regional impact would be small. It is when fare changes are implemented in conjunction with other strategies, and particularly when focused on congested areas with good transit service such as downtowns, universities, and major urban employment concentrations, that the effect on traffic and environment takes on more relevancy.

Fare decreases in conjunction with transit service increases have a synergistic effect to the extent that while both divert a measure of travel to transit from the automobile, service increases tend to produce an excess of capacity that can absorb additional riders attracted by reduced fares. Transit productivity losses can thus be minimized, or productivity may even be enhanced (Pratt and Shapiro, 1976). A classic example was produced by a trial three-month 25¢ flat fare in Los Angeles County in the mid 1970s. The principal transit operator, the Southern California Rapid Transit District, expanded service concurrently with the fare reduction, increasing bus miles operated by 9 percent. With the help of the fare reduction, the passengers per bus mile productivity actually grew, from 2.62 to 2.75 (Weary, Kenan and Eoff, 1974).

Synergy or no, fare reductions remain an expensive way to conserve energy, if that is the only objective (Pratt and Shapiro, 1976), and the same could be said of air quality enhancement. More commonly today, however, environmental objectives are multiple and may be joined by economic factors as well. Key objectives now typically include traffic mitigation, along with parking needs reduction, and the focus is often more site-specific.

Fare reductions in tandem with other strategies have proved effective in such multi-objective situations. It is with a mix of service improvements, and either fare reductions or institutional unlimited travel pass partnerships, that small city operations in a university environment have as much as tripled ridership and seen parking space demand reductions of consequence (see Chapter 10, "Bus Routing and Coverage," under "Response by Type of Service and Strategy"—"Service Changes with Fare Changes," and also "Related Information and Impacts"—"Impacts on Traffic Volumes and VMT"). Similarly, it is with a combination of unlimited travel pass partnerships and other alternative TDM measures, that the University of Washington and Seattle area hospitals and employers of many types achieved single occupant vehicle use reductions in the 1990s such as those documented in Table 12-16. Multi-objective impacts of transit pricing actions as a component of TDM programs are further explored—with data extending into the early 2000s—in Chapter 19, "Employer and Institutional TDM Strategies."

ADDITIONAL RESOURCES

Patronage Impacts of Changes in Transit Fares and Services, UMTA/USDOT Report Number RR135-1 (Mayworm, Largo and McEnroe, 1980) and a report of the International Collaborative Study of the Factors Affecting Public Transport Patronage, *The Demand for Public Transport* (Webster and Bly, 1980) are excellent sources of observed and estimated fare elasticity values at both the aggregate and market segment levels of detail, along with interpretation and guidance in their use. Newly available as of this chapter's publication is *The demand for public transport: a practical guide,* which "has re-examined the evidence from [Webster and Bly, 1980] . . . and has extended the coverage from that of the 1980 study . . ." (Balcombe et al, 2004). A periodically updated source that includes fare elasticities along with references and leads to more information is the "Transportation Elasticities" compendium maintained on the www.vtpi.org website (Victoria Transport Policy Institute, 2003).

Consumer-Based Transit Pricing at the Chicago Transit Authority, UMTA/USDOT Report Number DOT-T-92-19 (Multisystems, 1991); *Transit Fare Prepayment: A Guide for Transit Managers,* UMTA/USDOT Report Number RR125-8 (Mayworm and Lago, 1983); and *Implementation Experience with Deep Discount Fares,* FTA/USDOT Report Number FTA-MA-26-0006-94-2 (Oram and Schwenk, 1994) provide useful information on fare policy planning, preferably used in conjunction with each other rather than in isolation.

CASE STUDIES

Introduction of a Monthly Pass in Atlanta

Situation. The Metropolitan Atlanta Rapid Transit Authority (MARTA) operates bus and heavy rail transit (HRT) service in metropolitan Atlanta including Fulton and DeKalb Counties. Prior to 1979, the MARTA operation was bus-only, and fares had been held low during this phase in a contract with the voters. The fare structure was based on cash fares and did not offer the option of a monthly pass. MARTA had a universal system of free transfers.

Actions. On March 1, 1979, MARTA introduced the TransCard to offset the simultaneous 67 percent increase in flat fare from $0.15 to $0. 25 charged in Fulton and DeKalb counties. The price of the TransCard was set at $10, for a breakeven level of 20 round trips (40 one-way trips) per month. The TransCard offered three potential advantages to riders: 1) cost savings to riders making more than 20 round trips per month, 2) transfer convenience in not having to obtain a transfer slip or transfer card when transferring, and 3) cash convenience in not having to carry exact fare.

Rail service on the East line began July 1, 1979, and on the West line on September 8. The TransCard could be used as a flash pass to board a bus and as a fare card to pass through the rail station turnstiles.

Analysis. The investigation was funded by a demonstration grant from the Service and Methods Demonstration Program of the Urban Mass Transportation Administration. As part of the demonstration, the effects of introducing the pass were evaluated for the bus system before the rail service was started. The evaluation examined the following: 1) socioeconomic and transit ridership characteristics of pass buyers, and 2) ridership and revenue consequences of a system wide fare increase with pass introduction.

In the analysis, TransCard and cash users were weighted separately by the inverse of weekly transit trip frequency, to remove over-representation in the sample of individuals with high transit trip frequencies. Therefore, the information presented describes the characteristics of individual transit users (customers) rather than transit boarders.

Results. In general, TransCard users were likely to have the socioeconomic and ridership characteristics most often associated with frequent users of transit. Compared to cash users, TransCard users:

- had lower incomes (mean of $10,521, compared to $12,007),
- were less likely to have an automobile available (34 percent compared to 48 percent), and
- made more bus trips than cash users made—3.0 more one-way work trips and 1.3 more oneway non-work trips per week.

Cost savings appeared to be important to pass purchasers. About 95 percent of TransCard users made the same as or more than the breakeven number of trips per week. There was a strong relationship between the number of trips taken per week to and from work and whether an individual purchased a TransCard.

The purchase of the pass appeared to encourage users to make more transit trips. Individuals who purchased a TransCard increased their transit usage, which was already higher than average, by 1.6 trips per week compared to the before TransCard condition. In contrast, those individuals who continued to use transit and pay cash after the fare increase and introduction of TransCard did not change their transit trip frequency.

TransCard users were more likely to increase the number of non-work trips than the number of work trips made by transit. Two-thirds of the new trips made by TransCard users were made for non-work purposes. Since TransCard users were already frequent users of transit for commuter work trips, they had less opportunity to make even more work trips after buying a TransCard.

Automobile ownership was a factor in the number of new trips made. The number of new transit trips made per week for work was higher for those who had access to an automobile (0.7 new trips per week) than for those who did not (0.5 new trips per week). The reason proposed for this was that those who did not have access to an automobile already had a high frequency for work trips while those with access to an automobile had room to increase the frequency. In contrast, those who did not have access to an automobile had a higher mean change in number of non-work bus trips per week (about 1.2) than those who had access to an automobile (about 0.8).

The most common reason for purchasing a TransCard was to save money, followed by convenience (See Table 12-13). The first reason for buying a pass varied by income categories. As income increased, "save money" declined in importance from about 60 percent for less than $5,000 annual income to about 40 percent for greater than $25,000, the highest income group. Meanwhile, the frequency of "convenience" as the first reason increased from about 25 percent for the less than $5,000 income group to about 45 percent for income greater than $25,000.

More . . . To assess ridership and revenue impacts, annualized revenues for the five-month period prior to and the four-month period after the fare increase were compared. Because MARTA rail was not yet in service during the chosen study period, the before and after revenue figures were not confounded by introduction of the HRT service.

Transit revenues increased by about 58 percent due to the system-wide fare increase. The revenues attributable to cash-pay individuals increased by 61.7 percent, reflecting the 66.7 percent increase in fares and the 2.5 percent decrease in the number of cash-paying users. The revenues from individuals who became TransCard users increased by only 36 percent.

The number of individuals using the TransCard after its introduction was 17,000. The number of bus riders paying by cash was calculated at 117,164. Whatever new bus riders there were are subsumed in these numbers. Also, 2,960 individuals were calculated to have discontinued using the bus immediately after the fare increase. Because TransCard users increased their transit trip frequency, and thanks to some number of new bus riders, the number of linked trips on the system increased by 290 per week after the fare increase. Further detail on before and after revenue, individual transit users, and linked trips per week is provided in Table 12-31.

Table 12-31 Changes in Revenue, Number of Transit Users, and Linked Trips

Fare Type After	Before	After	Percent of After Amount	Absolute Change	Percent Change
	Revenue per Month				
TransCard	$124,600	$170,000	13.6%	$45,400	+36.4%
Cash	$665,913	$1,077,070	86.4%	$411,156	+61.7%
Total	$790,513	$1,247,070	100.0%	$456,556	+57.8%
	Individual Transit Users				
TransCard	17,000	17,000	12.7%	0	0.0%
Cash	120,124	117,164	87.3%	–2,960	–2.5%
Total	137,124	134,164	100.0%	–2,960	–2.2%
	Linked Trips per Week				
TransCard	197,710	225,420	17.8%	27,710	+14.0%
Cash	1,065,494	1,038,074	82.2%	–27,420	–2.6%
Total	1,263,204	1,263,494	100.0%	290	<0.1%

Notes: Adjusted for seasonality and effects of gasoline price increases. No apparent adjustments for impacts of reduced availability of gasoline in mid-1979.

Cash payers who became TransCard buyers are set equal to TransCard buyers.

Source: Parody, T. A., *Atlanta Integrated Fare Collection: Demonstration Report.* Prepared for the Urban Mass Transportation Administration. Charles River Associates, Boston, MA (1982).

London Transport Fare Elasticities and Travelcard Impact

Situation. London Transport (LT) operates London's extensive bus and "Underground" HRT network. Commuter rail service in the area, operated by British Rail, is also substantial. The LT Planning Department maintains an extensive data base and research effort. In 1993, the department released a report on LT bus and Underground traffic trends between 1971 and 1990 that provides a unique quantitative understanding of the interplay of fares in a multi-modal urban transit system. It presents estimated demand elasticities and also estimates of the impact of LT's monthly pass (Travelcard) on revenue and demand.

Analysis. The LT Planning Department developed semi-logarithmic time series models for both bus and Underground utilizing ridership data in four-week increments between 1971 and 1990. Fare levels were computed as averages by mode and adjusted for inflation by deflating on the basis of personal income. Passenger demand was deflated by population growth. Comparable period data for other factors found to influence ridership were included by utilizing the factors as variables in one or both of the bus and Underground models. These factors included transit service levels (run miles for each mode), employment, retail sales, tourism, auto ownership, and various one-time events.

Results. The analysis provides estimates of fare elasticities from two primary perspectives:

- Conditional Fare Elasticity. This elasticity describes the change in demand level with respect to price if the fares of all modes (bus, Underground, British Rail) all change by the same proportion. This is often viewed as the "normal" elasticity and is the type of elasticity generally cited in this Handbook.

- Own Mode Elasticity. This elasticity provides the change in demand level with respect to price if only the fare for the mode in question (e.g., bus) changes while the fares for the remaining modes (e.g., Underground, British Rail) remain constant. This is not cross-elasticity, but rather the net effect of the "normal" elasticity and all of the applicable cross-elasticities (e.g., bus/Underground and bus/British Rail) under the assumption of unchanged fares for the other modes.

Table 12-32 presents the short-to-medium term fare elasticities that were estimated at the 1990 LT fare levels. They are defined as measuring the total impact of a fare change that occurs within a year of the change. The fare elasticities for bus were much larger than those for the Underground, twice as large in the case of the "normal" elasticities. The own mode elasticities were substantially larger than the conditional elasticities. This reflects the shifting of riders to or from competing transit modes that would take place if the fares for the competing modes were to remain constant.

Table 12-32 Estimated London Transport Fare Elasticities

Elasticity Type	Elasticity (95% Confidence Interval)	Explanation
LT Bus		
Own Mode	–0.62 (±0.04)	Change in demand level if only the bus fare changes within the multi-modal system.
Conditional ("Normal")	–0.35 (±0.06)	Change in demand level if bus, Underground, and British Rail fares all change by the same proportion.
Underground		
Own Mode	–0.43 (±0.05)	Change in demand level if only Underground fare changes within the multi-modal system.
Conditional ("Normal")	–0.17 (±0.06)	Change in demand level if Underground, bus, and British Rail fares all change by the same proportion

The analysis indicated that the lag in response to bus and Underground fare changes differed. For buses, it was estimated that four-sixths of the total impact of a fare change occurs immediately, and one-sixth within a year of the change, with the final sixth occurring over a longer time period. For the Underground, no longer term effects were detected in addition to the immediate effects of the fare change. The limitations of available data may have influenced this finding, or it may reflect the ready availability of British Rail commuter service as a competing mode.

More . . . The LT Planning Department included in the model variables related to introduction of London Transport's Travelcard—a pass good on both buses and the Underground. Travelcard introduction was associated with certain other fare structure changes and with a change in the overall fare level. The average bus fare paid fell by 19 percent, and the average Underground fare paid fell by 28 percent. The fare level effects were separated from the fare structure effects, including the Travelcard, with the results illustrated in Table 12-33.

Table 12-33 Estimated Impact of Travelcard and Associated Fare Changes

Stimulus	Effect on Bus		Effect on Underground	
	Revenue	Passenger Miles	Revenue	Passenger Miles
Change in Fare Level	–11%	+10%	–17%	+15%
Change in Fare Structure	+4%	+20%	+16%	+33%
Total Impact	–7%	+30%	–1%	+48%

Note: "Change in Fare Structure" includes Travelcard and associated fare *structure* changes.

The change in fare level produced a predictable increase in travel, which must be viewed in the context of London's traditional distance based fare system, balanced by a loss in revenue. What is notable about these results is the positive effect of the new fare *structure,* including Travelcard, not attributable to the change in fare level. On the Underground, the positive effect nearly canceled out the revenue loss from the 28 percent reduction in average fare. The effect was more muted on the bus system, which may have resulted from the fact that a bus pass was already in existence.

The models were also used to estimate elasticities to service (miles) and personal income for bus and the Underground. The service elasticities had a relatively large confidence interval that was taken to suggest that it is difficult to model the relationship between service levels and passenger demand without being able to take into account the uneven impact of changes in time and location. The results were 0.18 ±0.12 for bus and 0.08 ±0.06 for the Underground. A positive relationship was estimated between Underground ridership and personal income, suggesting that usage increases with income. No significant income relationship could be developed for bus; however, auto ownership was significant and associated with decreased bus usage.

Source. London Transport, "London Transport Traffic Trends 1971–90," *Research Report R273* (February, 1993) • Certain interpretations added by Handbook authors.

CBD Fare-Free Zones in Seattle, Washington, and Portland, Oregon

Situation. In 1973, Metro, the Seattle bus operator, served a metropolitan population of 1.4 million, carrying 168,000 fare paying trips a day, 4 percent of all trips made in the region. Metro carried 35 percent of all peak hour trips to the CBD. An estimated 70,000 persons were employed in the downtown. A “Dime Shuttle,” a 10¢ downtown circulator service, traversed the CBD and carried 58 percent of all intra-CBD bus trips.

The situation in 1975 in Portland was roughly equivalent, but with a smaller ridership base. TriMet, the Portland bus operator, served a metropolitan population of about 1.2 million and a downtown employment of 68,000, carrying 96,000 linked trips per weekday. A 10:00 AM to 4:00 PM downtown “Shop Hop” circulator service with 10 minute headways and a 10¢ fare carried about 55 percent of intra-CBD bus trips.

Actions. Beginning in September 1973, a 105 block area of the Seattle CBD encompassing the primary tourist, retail, and office centers was designated a zone that is today known as the ride free area. All intra-zone trips carried by Metro were free for all hours of the day. (The ride free area was subsequently expanded and later reduced again, and a 7:00 PM free fare cut-off has been imposed.) Fares for trips between the ride free area and external locations are collected at the external end of the trip either during boarding or departure.

In Portland, a downtown area of approximately one square mile or 280 blocks was designated to be the fare-free “Fareless Square” area. Implementation was in January 1975, concurrently with elimination of zone fares systemwide (producing a flat fare system), introduction of a monthly transit pass providing substantial savings for frequent riders, and an increase in bus service. The Fareless Square area was expanded in July 1977 to 350 square blocks, bringing coverage to Portland State University. The free fare applied during all operating hours. Fare collection was initially similar to Seattle’s, but has been altered several times.

Reasons for instituting Seattle’s ride free area included encouragement to redevelop Pioneer Square, a historic section; improving Metro’s image with a high visibility, low cost program; speeding passenger loading and unloading along the few major streets in the downtown; and the proposal’s popularity with the business community. The impetus in Portland was heavily related to the early 1970s transportation control strategy intended to help Portland meet federal and state air quality requirements.

Analysis. Data for analysis of the Seattle program were obtained from two passenger surveys, one performed during July 1973, before inception of the ride free area, and the other performed in May 1974, eight months after implementation. The surveys identified ridership levels, trip purposes, and in the 1974 survey, prior travel behavior. An additional trip purpose survey in 1977 eliminated some ambiguities contained in the 1974 survey.

Evaluation of Portland’s program made use of a May 1975 post-implementation survey similar to Seattle’s “after” survey, plus a November 1977 ridership survey. In addition, a time-series analysis of transit ridership in Portland between 1971 and 1982 has contributed information on systemwide response. The simultaneous implementation of Fareless Square, major fare changes, and additional bus service makes determination of causality difficult.

Results. Seattle’s 1973 survey revealed that 4,100 intra-CBD trips per day were carried by the dime shuttle and other Metro buses. Institution of the ride free area resulted in 12,250 intra-CBD trips per day on Metro buses, a 200 percent increase. Approximately 65 percent of the trips were found to be taken between 11:00 AM and 2:00 PM, 49 percent during the normal 12:00 to 1:00 PM lunch hour. Of ride free area trips, 5 percent were destined for home, 39 percent for work, 1 percent for school, 15 percent for entertainment, 16 percent for personal business, and 24 percent for shopping. Of the 12,250 trips per day taken in 1974, 25 percent would not have been made prior to implementation of the ride free area, 31 percent would have been made by walking, 19 percent by the Dime Shuttle, 15 percent by other buses, 8 percent by auto, and 2 percent by taxi or other means. A survey of 642 downtown employees determined that 7 percent of the downtown work force, 4,900 persons, used bus service outside of the ride free area more often than before because of the free CBD service, representing perhaps a 1,000 to 2,000 daily transit trip increase.

In the Portland CBD, only 900 trips per day were carried by the "Shop Hop" circulator and other TriMet buses before Fareless Square. After 34 months of free transit in the CBD, and 4 months after including Portland State University, approximately 8,200 riders were getting on and off in the Fareless Square area each weekday. Of these free rides, 8 percent were made in the morning peak period (7:00 to 9:00 AM), 65 percent were made during midday (9:00 AM to 4:00 PM), and 22 percent were made in the evening peak (4:00 to 7:00 PM). Some 48 percent of the trips were work related, thought to be primarily trips to work from shopping, recreation or other activities. Other major trip purposes included 18 percent to shopping, 15 percent school related, and 13 percent social or recreational. As best can be estimated, it appears that the number of intra-Fareless Square trips has remained relatively constant over the years.

More . . . In 1978, the cost of Seattle's ride free area in revenue foregone was somewhat more than twice the cost of the Dime Shuttle had been and represented slightly less than 1 percent of Metro's total operating budget. An estimated 900 vehicle trips per day, 2 percent of all intra-CBD traffic, were eliminated from the street system due to mode shift to free bus travel. Most of these trips were made during the midday. An additional 25 bus hours of service were provided during the noon and PM peaks to handle the increased loads, mostly by routing already existing bus lines through the ride free area. It was estimated that the ride free program accounted for 2.5 to 5 million dollars in annual retail sales in the downtown, approximately 1 percent of total annual retail sales, and six to twelve times the program cost. Effects on VMT, fuel consumption and pollutant emissions were minor, though it was estimated, without confirmation, that the carbon dioxide standard was exceeded four fewer days per year because of the ride free area.

As noted above, evaluation of Portland's Fareless Square was hampered by simultaneous implementation of several major changes. In the May 1975 ridership survey, which was distributed only to riders boarding in the CBD, 42 percent of the respondents indicated they had increased their use of TriMet. Of these, 27 percent credited Fareless Square. The monthly pass was credited by 35 percent; the flat fare, 19 percent; and the increased service, 19 percent. The time series analysis results produced an estimate that 5,100 riders per weekday, representing over 5 percent of total system ridership, had been attracted by the various actions in combination. In Portland, the positive incentive of fare-free service was seen as offsetting other transportation disincentives, including the CBD parking ceiling and transit mall road use restrictions implemented at about the same time.

In the 1980s, consideration was given to eliminating Seattle's fare-free area when the downtown business community withdrew from supporting a substantial portion of the cost. However, a study showed that the operational savings produced by not collecting fares at downtown bus stops—including related traffic engineering considerations—more than outweighed the loss of revenue. Recent King County Metro ridership wholly within the fare-free area is estimated at 7,600,000 trips annually, which should be roughly 25,000 per weekday. In 1990, fare evasion attributable to Portland's Fareless Square was estimated at 1.9 percent of system revenues. A move to terminate the free fare was withdrawn in the face of public outcry. Both Seattle's and Portland's fare-free areas have seen their 25th anniversaries.

Sources. Colman, S. B., *Case Studies in Reduced Fare Transit: Seattle's Magic Carpet.* Prepared for the Urban Mass Transportation Administration. De Leuw, Cather and Company, San Francisco, CA (April, 1979). • Charles River Associates, "Building Transit Ridership: An Exploration of Transit's Market Share and the Public Policies That Influence It." *TCRP Report 27,* Transportation Research Board, Washington, DC (1997). • Glascock, G., King County Metro, Seattle, WA. Telephone interview (February 25, 1999).

July 1980 Los Angeles Fare Increase

Situation. The Southern California Rapid Transit District (SCRTD) in 1980 provided fixed-route bus service to the urbanized southern portion of Los Angeles County and contiguous urban areas. As of that summer, the SCRTD served 8 million people and covered 2,300 square miles. With 1,200,000 average weekday unlinked trips on 224 local and express routes, the SCRTD was the third-largest transit system in the country and the largest all-bus transit property. During the quarter immediately preceding the July 1980 fare increase, system revenues accounted for 37 percent of the total annual budget of $300 million. In the 1970 census, 5.4 percent of workers in Los Angeles County reported using transit for work trips.

The typical SCRTD rider had the following characteristics:

- Low Income: Greater than 75 percent of users had household incomes less than $15,000.
- Working Age: Two-thirds of riders were between 21 and 62 years of age.
- No Car Available: About 60 percent cited lack of car availability as the main reason for riding the bus.
- Work Commuters: About half of the trips were made to and from work. The five hours covered by morning and afternoon peak periods accounted for 43 percent of transit trips.

Many SCRTD riders transferred from one bus route to another to complete their trips. An estimated 11 percent of SCRTD passengers made multiple transfers and 23 to 38 percent made a single transfer.

Actions. SCRTD implemented a fare increase that covered all aspects of the fare structure—cash fares, transfers, monthly passes, and special user (e.g., seniors, students) discounts. The average fare increase was 27.3 percent, not evenly distributed across fare categories. The most notable change was the shift from a 5-cent transfer with an unlimited number of uses to a 20-cent transfer with only one use allowed.

Analysis. A federally sponsored evaluation was conducted of the fare increase using ridership and revenue counts and a telephone survey of riders. System ridership estimates were made using average fare factors, based on a quarterly random sample of trips. Ridership changes were not evaluated with respect to either seasonal patterns or recent ridership trends, which had been generally upward. The telephone survey was conducted in February 1981 using names and phone numbers obtained from an on-board survey conducted in early July 1980 on "representative" bus routes. Respondents successfully interviewed represented 13.6 percent of the surveys originally distributed. There was a 7 month lag between obtaining the sample and completing the interviews. This lag and the small proportion of interviews were of concern.

Results. Based on a comparison of ridership in the months of March 1980 and March 1981, the average fare increase of 27.3 percent in July 1980 was accompanied by a ridership decrease of 1.9 percent. There was a substantial and stable increase in revenue of 24.5 percent. The increases in revenue by fare category from March 1980 to March 1981 were 10.7 percent at the fare box, 31.3 percent in pre-paid tickets, and 57.2 percent in monthly passes.

The general trend from 1978 to 1980 had been toward increasing the attractiveness of monthly passes for longer-distance or frequently-transferring passengers. Monthly pass sales increased substantially after the fare restructuring. Two-thirds of the new revenue generated by the fare increase was in the form of new pass sales. The shift from a 5-cent transfer with an unlimited number of uses to a 20-cent transfer with only one use in July 1980 had a large effect. Newly attracted pass purchases consisted mainly of previous cash-pay customers who made frequent transfers. The substantial increase in transfer price was mitigated by the possibility of switching to a monthly pass.

Between March 1980 and March 1981, the transfers received as a percentage of total boardings dropped from 21 to 12 percent, and the number of express and/or regular monthly pass boardings as a percentage of the total increased from 20 to 30 percent. The percentage of total pass boardings (including senior, handicapped, and student passes) increased from 39 to 55 percent during the same time period.

More . . . Analysis of the retrospective survey panel's responses indicated that a substantial number of travelers are entering and leaving the pool of regular transit users and making drastic changes to their individual trip frequencies for reasons unrelated to transit fare policy. Respondents reporting no change in transit trip making over a 9 month period represented 60 percent of the panel. The number increasing their frequency of transit use was barely less than the number decreasing their use or ceasing to ride. Only one in ten reporting decreased frequency or cessation of riding attributed their change to the fare increase. Even taking into account inferred motives, it appears that the travel changes reported by the survey panel had more to do with normal turnover than the fare increase.

A higher percentage of those riders who discontinued use of the transit service outright were ones who made work trips. These riders tended to be choice riders with an automobile available for the trip and having moderate to high incomes, greater than $20,000. A higher proportion of these former riders had paid cash fares than other riders. The transit-dependent (such as the elderly, those with low incomes, and/or zero cars available) were less likely to discontinue use, since fewer alternative modes were available to them.

Those who continued making work trips via transit did not exhibit sensitivity to the price increase, and in fact increased their frequency of ridership. Those who continued making nonwork-related trips via transit were apparently more sensitive to the price increase and decreased their frequency of ridership. The net effect was an impact on transit riding that was more pronounced for nonwork purposes than for work purposes.

Source. Attanucci, J., Vozzolo, D., and Burns, I., *Evaluation of the July 1980 SCRTD, Southern California Rapid Transit District, Los Angeles Fare Increase.* Prepared for the Transportation Systems Center. Multisystems, Inc., Cambridge, MA (1982).

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ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation