FARE POLICIES AND PRICING STRATEGIES FOR THE CAPITAL METRO TRANSIT SYSTEM

by

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ABSTRACT

Fare policies and pricing strategies in public transportation systems have important implications on ridership and revenue generation, as well as on the public's perception of the system's equity and cost effectiveness. This study presents a framework for the identification, analysis and evaluation of alternative pricing strategies and fare-related policies, and its application to the Capital Metropolitan Transportation Authority system in the Austin, Texas area. A taxonomy of available fare differentiation schemes is presented, along with a summary of experience with selected schemes in North American transit systems. An extensive review of fare elasticities reported in the literature is presented, with special focus on those associated with free fare experiments. Also discussed are available values for the elasticity of demand for service attributes. A range of elasticities is thus developed for use in the analysis of alternative fare strategies. Several scenarios are analyzed for the Capital Metro system and estimates are developed for the range of ridership and revenue impacts. It is found that, in general, service-related improvements are likely to be more effective than fare reduction or elimination in attracting ridership. Targeted (to particular socio-economic groups or geographic areas) fare reduction or elimination programs are generally more cost-effective than across-the-board fare cuts. Based on the experience of other localities and on the analysis presented in the report, it does not appear desirable to totally eliminate fares in the Capital Metro system; a possible exception would be as a promotional measure in connection with major service restructuring.

Operational and fare payment aspects of the Capital Metro/University of Texas Shuttle system merger are identified, and proposed strategies are analyzed. In particular, two fare policies are considered for possible implementation in the overlapping service areas. The first is a no-fare policy, which is relatively simple to implement, but suffers from possible overcrowding, perceived inconsistency and inequity, as well as additional cost due to lost revenue and increased service requirements. The second policy is an honor system with pre-payment, which has the advantages of perceived consistency and equity, the ability to control abuse, and the contribution to stimulating transaction-free riding through pre-payment systemwide. The primary drawback is the initial effort required for implementation.

In addition, fare structures and eligibility requirements for the Special Transit Services (STS) are addressed, in light of information obtained from a survey of several providers. The results of this survey indicate that the Capital Metro fare policy and eligibility requirements are consistent with the other transit agencies.

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CHAPTER 1: INTRODUCTION

1.1. MOTIVATION AND PROBLEM DEFINITION

During the past few decades, public transportation ridership has been declining in the United States, while the cost of providing services has been increasing. Many transit agencies, including the Capital Metropolitan Transportation Authority (Capital Metro) in Austin, Texas, have become interested in finding innovative methods to increase ridership without significantly increasing costs.

Capital Metro, like many other public transit agencies, charges an essentially flat fare on its fixed-route bus system. Exceptions include limited fare differentiation on the basis of type of service (higher fares for express service, where available), and certain types of riders (students, mobility impaired, and senior citizens). Several agencies, with encouragement from the Urban Mass Transportation Administration (UMTA), have adopted a greater degree of fare differentiation, such as on the basis of time-of-day, trip distance, cost of service or means of payment. Arguments have been made for such differentiation by several consultants and researchers. Experimentation with the complete or partial elimination of fares has also taken place in some agencies.

Fare policies and pricing strategies are generally aimed at striking a balance between four principal considerations: 1) revenue generation and cost-effectiveness, 2) marketing, 3) equity, and 4) ease of administration. Different circumstances in terms of funding structure, economic and political attitudes, and system penetration are generally reflected in different relative importance being accorded to the above four considerations. It is therefore not surprising to find that no pricing strategy or fare structure is considered to be appropriate for all transit systems, and that decisions in this regard must be reached only after careful assessment of the above considerations for a particular context.

This degree of context specificity would suggest the existence and availability of generally accepted and widely adopted methodologies for analyzing the relative impacts of a particular strategy in a given environment. However, such is not the case, as evidenced by the wide spectrum of approaches used in practice. These range from back-of-the-envelope approaches based on aggregate elasticities borrowed from other cities, to elaborate procedures involving several mathematical models with extensive input data requirements. Therefore, it is usually necessary to structure an appropriate analysis and impact prediction methodology for the needs of a particular system and problem.

The purpose of this study is to develop information and procedures that would be used to design and recommend a strategy for fares and pricing issues for Capital Metro. The strategy should recognize the competing considerations involved in this problem, and should be based on a systematic assessment of its impacts in terms of these considerations. Information on these impacts was obtained from a variety of sources, including the experience of other systems as well as through the use of appropriate methodological tools developed for the purpose of this study and applied specifically to the Capital Metro system. Specifically, the study has identified the principal alternative pricing schemes available, synthesized experience available in other systems with regard to non-standard fare policies, developed a methodological framework for the evaluation of the impacts of particular pricing and service improvement schemes, and applied the methodology to the Capital Metro area in order to assess the relative desirability of these alternatives.

This study is one component of the comprehensive review of Capital Metro services and service strategies underway during 1988. Results will be considered in connection with the Five-Year Service Plan Update process.

1.2. OBJECTIVES

The objectives of this study are to:

(1) Perform a systematic assessment of the impacts of alternative fare structures and pricing schemes on ridership, revenue generation, cost recovery, equity, and the ease of fare collection and administration. The alternative schemes are defined in terms of the amount of the fares and its variation by 1) type of service, 2) time-of-day, 3) distance, 4) type of passengers, and 5) means of payment (collection). This objective involves the following two sub-objectives:

1.a. Synthesize comparative information and experience on non-standard fare structures in other systems;

1.b. Develop a methodology for the assessment of the impact of alternative schemes.

(2) Specialize the results of the first objective to the Capital Metro transit system, with particular attention to the following cases:

2.a. No fare, systemwide and for designated zones (e.g. downtown);

2.b. Alternative transfer and pass policies.

(3) Analyze the fare policy aspects and resulting operational implications of the Capital Metro/University of Texas Shuttle system merger.

(4) Review fare and eligibility policies for Special Transit Services (STS) as they relate to those of the regular fixed-route service.

1.3. OVERVIEW

The next chapter summarizes the various types of differentiated fare structures, along with their underlying logic, likely impacts on ridership and revenue, and applicable case studies. Fare strategies are defined on the basis of differentiation: geographic, temporal, type of user and type of service. The chapter also discusses fare-related programs which may be used in conjunction with any of the above differentiated fare strategies.

The third chapter defines and explains elasticities in terms of their importance in estimating ridership impacts of fare and service changes. A compilation of reported fare and service elasticities is presented, and the significance of their relative magnitudes is discussed. Particular emphasis is placed on the elasticities associated with free fare experiments. A summary of the impacts observed in connection with these experiments is also presented.

Chapter Four presents the methodological framework developed for this study to undertake the analysis and evaluation of alternative fare strategies and programs. The methodology is applied to estimate the ridership and revenue impacts of various fare strategies and service improvements. The principal fare scenarios addressed include: 1) systemwide fare increase or decrease, 2) free off-peak for senior citizens, 3) free off-peak systemwide, and 4) geographically delineated free fare zones. In addition, the effectiveness of improving service is compared to that of reducing or eliminating fares. The service improvements addressed include increased vehicle miles and reduced travel time.

The fifth chapter presents an analysis of the implications associated with the Capital Metro/University of Texas shuttle system merger. Specifically, the fare policy alternatives (no-fare vs. honor system with pre-payment) and service considerations are presented with respect to the equity, cost, and ease of implementation of each.

Chapter Six presents the responses to a telephone survey of fare structures utilized by various transit systems for their STS services.

The final chapter presents a summary of the results presented in this report as well as possible areas of further research.

CHAPTER 2: A REVIEW OF TRANSIT FARE STRUCTURES, PRICING STRATEGIES AND PAYMENT PROGRAMS

2.1. INTRODUCTION

Several types of fare structures and strategies are available to public transportation providers to achieve one or more objectives that relate to four principal considerations: impact on ridership, revenues, equity, and ease/cost of administration. Many transit systems, including Capital Metro, are increasingly interested in fare strategies and programs as a potential mechanism to enhance ridership (and thus overall mobility in the service area) rather than viewing them exclusively as sources of revenue. This interest is motivated by the broader goals of public transportation in urban areas.

A desirable fare structure should be clear, equitable, efficient, easy to understand, and simple to implement and administer. It should minimize the risk of losing potential patrons by avoiding a proliferation of fare options. Many transit agencies use flat fares because they are easy to administer, and easy for riders to understand. Several ways have been suggested to make differentiated fare structures easier for everyone: automated fare collection using magnetically encoded cards, the honor system, and multi-ride passes (Daskin, 1983). Other considerations are efficiency and equity. An efficient fare is one in which riders pay an amount related to the marginal cost of providing the service they receive. Equity can be defined from different perspectives. A narrow definition is that an equitable fare structure is one in which riders pay in proportion to the benefits they receive. A broader definition would recognize the socio-demographics of a particular service area and attempt to reflect public policy goals aimed at particular segments of the population.

This chapter presents an overview of the principal types of fare structures and programs in operation or proposed in various transit systems in North America. A taxonomy of differentiated fare structures is defined according to the basis of differentiation: geographic, temporal, type of user and type of service. Included with the description of each category are its underlying logic, likely impacts on ridership, and applicable case studies reported in the published literature. Next, the chapter discusses various fare-related programs, particularly merchant coupon incentives, passes and other pre-payment plans, as well as total or partial free-fare programs, and the ways that these can be implemented with the other types of differentiated fares.

2.2. DIFFERENTIATED FARE STRUCTURES

As noted above, four bases of fare differentiation can be identified: geographic, temporal, user type, and service type. These are discussed in turn hereafter.

2.2.1. Geographic Differentiation

A commonly used type of fare differentiation is a geographic one, where the fare for a trip depends, directly or indirectly, on the origin and destination of that trip. The most commonly used form of geographic differentiation is a distance-based structure, whereby a rider pays more for longer trips than shorter ones. It is generally argued in the context of North American cities that equity across income and racial lines is increased by distance-based structures, relative to flat fares, which many consider to be regressive. The reason is that the cost per mile (to a rider) is less on a long trip than on a shorter one, and lower-income groups tend to make more short trips than higher-income groups, resulting in a higher cost to the lower-income group, who are additionally more likely to be captive to transit. With zonal charges, the cost per mile can be approximately the same, regardless of trip length. These fares are also more efficient and effective than flat fares.

While the above features are often used to justify geographically-differentiated fares, the primary purpose for their consideration by transit properties is to increase revenue, especially over the past eight years as federal operating subsidies have been phased out. However, going from a flat fare to a geographically-differentiated one will negatively affect ridership, unless the minimum fare is reduced. The ridership impacts would depend on the existing distribution of long versus short trips. There may be some substitution of longer trips by less costly shorter ones, as well as some possible loss of longer trips to the system.

Zonal fare schemes are usually accompanied by the provision of passengers with maps indicating where the zone boundaries are located. The more challenging problem is determining how to collect the additional fare: should everyone pay at the boundary, pay when leaving, or should the transit agency distribute color-coded tickets? Fare collection can be facilitated by pre-payment plans and through automation.

One type of geographic fare differentiation is to have zones that are shaped as concentric rings, usually around the CBD. With this method the driver would charge the passenger an additional amount each time the bus crosses a concentric ring boundary. This method encourages circumferential travel. In cities with radially oriented peak period commuting, this configuration would be more beneficial to the off-peak rider (Daskin, 1983).

Another type of geographic fare differentiation is "wedge-shaped" zones, or zones shaped like pie sections. The driver would charge an additional fare when the bus crosses sector boundaries. This method encourages radial travel and is therefore more advantageous to the peak rider (Daskin, 1983).

Grid shaped zones are essentially a combination of concentric zones and wedge-shaped zones. An additional fare is charged when the bus crosses a "rectangular" zone boundary. This method is more likely to equalize cost per mile than either of the above (Daskin, 1983).

The final type of geographic fare differentiation is origin-destination specific. That is, the fare is charged on the basis of the origin and destination of the passenger. Because a driver cannot keep track of where each person gets on and off, expensive fare collection machines (such as those used for the Washington D. C. Metro and BART systems) would be required. A flat cost per mile could be charged, or the fare could depend on the "attractiveness" of the origin and/or destination of the trip, such as major tourist attractions. This level of detail in differentiation is rarely used in connection with bus transit systems.

A partial list of cities which use zonal fares, alone or in combination with time-of-day, are: Baltimore, Boston, Buffalo, Cincinnati, Dallas, Detroit, Hartford, Houston (park and ride routes only), Indianapolis, Kansas City, Los Angelos, Minneapolis, Pittsburgh, Portland, San Antonio, Seattle, and St. Louis (Tri-Met, 1987).

2.2.2. Temporal Differentiation

2.2.2.1. Types

There are several types of temporally differentiated fare structures including time-of-day, day of week, and season of year. The primary reason agencies may use temporal differentiation is to increase ridership at times when the marginal cost of serving these trips is minimal due to the availability of under-utilized capacity. Time-of-day differentiated fares usually involve lower off-peak fares. Peak riders are generally less sensitive to fare changes than off-peak riders (Lago, Mayworm & McEnroe, 1981). Also, additional peak riders may require an increased number of buses on the route, whereas additional off-peak riders can usually be accommodated on the existing under-utilized buses. Finally, since off-peak trips are generally shorter than peak trips, the cost per mile tends to be equalized. To the extent that lower income riders tend to account for a higher proportion of the off-peak trips than of the peak trips, time-of-day fares would be more equitable. Temporal fare differentiation could therefore increase equity, ridership, and possibly revenues, especially if combined with a geographic fare structure (Daskin, 1983).

To implement a differentiation between peak and off-peak fares, the agencies may reduce off-peak fares, raise peak fares, raise peak and reduce off-peak fares, raise peak fares more than they raise off-peak (differential fare increase), or lower off-peak fares more than peak (differential fare decrease). As of 1983, there were no cases of an agency instituting a differential fare decrease, or of an agency raising peak while lowering off-peak fares. One of the reasons for which transit agencies have instituted time-of-day differentials has been to try to shift some of the peak ridership to the off-peak. However, experience to date suggests that such shifts do not occur to any significant degree, though some systems instituting reductions of off-peak fares have seen an increase in the fraction of the total ridership during the off-peak. However, the extent of this increase that is attributable to shifts from the peak versus new trips to the transit system is not well documented. Generally, off-peak fare reductions have resulted in somewhat greater utilization of off-peak capacity, though the evidence is mixed and the impact appears to be system-specific (Cervero, 1985).

Thirty-two transit agencies introduced time-of-day differentials between 1970 and 1983. Of the 32, 12 were subsequently discontinued, although two of those 12 were later reinstated. The differentials ranged from 5¢ to 35¢ for systems with time-of-day differentials only and as high as $1.30 for systems which have zonal and time-of-day differentials, with an average of about 15¢. The most common discount structure is the midday discount. The largest ridership increase was the result of a midday fare discount. Overall, the most successful programs were the ones which had an aggressive marketing program and used "run direction" rather than "exact time" to determine which fare was in effect. "Run direction" refers to changing the fare charged at the next end of route, rather than at the specific times of day at which the higher fares go into effect. That is, if the off-peak is 9:00 a.m. -3:00 p.m., the bus driver would not suddenly charge the higher fare at exactly 3:00. People who got on at 3:01 might feel it is unfair that they have to pay more for the same ride as someone who got on just two minutes earlier, especially if the bus is running a little late. Instead the bus driver would wait until the end of the route, where the bus turns around, to start charging the higher fare. This way, everyone on this specific bus will be paying the same fare. Of course, when the fare is supposed to go to a lower value, then the driver would start charging the lower fare at the beginning of the route immediately preceding the beginning of the lower fare period (in other words, no one should have to pay more than the advertised rate applicable at a given time of the day). (Cervero, 1985).

Larger transit agencies have used wide peak time bands (6-7 hours), usually 6-9 a.m. and 3-6 p.m. The time band for most midday discount periods is 5-6 hours around lunchtime. The wide peak bands tend to minimize the revenue losses but discourage ridership from switching to off-peak. A narrow peak time band tends to generate less revenue and cause more fare disputes at fare change times. Most transit managers have been satisfied with the time-of-day structure and plan to continue it. The general public seems to be indifferent to the structure. The most frequent citizen complaint has been about the length of the peak period, which some find too long to allow them to take advantage of the lower off-peak fares. However, it appears that many cities that discontinued off-peak discounts did not encounter much public resistance, primarily because many off-peak riders tend to qualify for other types of discounts, such as senior citizens (Cervero, 1985).

Reducing off-peak fares tends to reduce revenue and increase off-peak ridership, as some peak riders might switch, and a few "new people" might ride during the off-peak. A study of seven cities which raised peak fares indicated that this type of fare strategy tends to increase revenue and cause a decrease in peak ridership of about 10% on average. The decrease resulted from some patrons switching to off-peak, while others stopped riding altogether. The percentage differential, or peak surcharges, of the seven cities were as follows: Chapel Hill (20%), Minneapolis (20), Sacramento (17), Seattle (17), St. Louis (17), Tacoma (50), and Washington Metrobus (7) (Cervero, 1985).

In addition to time-of-day differentiation, day of week differentiation has also been tried, especially in the form of lower weekend fares. Experience with this suggests that lower weekend fares tend to increase ridership but decrease revenue, unless subsidized by the private sector (Kirby, 1982). Lowering fares during certain seasons (e.g. Christmas) can increase revenue and ridership if implemented "correctly," which according to Cervero (1985) means that the agency should advertise the program extensively to the target group of potential users.

Time-of-day differentiation is considered to be more efficient than day of week or seasonal differentiation. The average cost of instituting day of week differentials is probably higher than time-of-day. There are however several cities which charge lower weekend fares. An evaluation of Cincinnati's low weekend fare structure is given in Oram (1987). Seasonal fare differentials are appropriate in resort areas when there are great cost increases during the tourist season (Cervero, 1985). Transit agencies may also offer holiday shoppers a discounted fare (Guenthner, et. al.,1985). In Allentown, Pennsylvania, the transit agency offered a holidays shopper's pass during the

1984 Christmas season. The pass allowed the user to make an unlimited number of rides during the off-peak for a six week period for $5.00. Many new riders were attracted to the system during this promotion, and they were retained after the promotion ended. Thus revenue and ridership increased (Oram, 1987).

An extensive reference which details 32 case studies of temporally differentiated pricing is in the report by Cervero (1984) A summary of some of these examples is shown in Table 1, and the example of Akron, Ohio is briefly discussed below.

2.2.2.2. Akron, Ohio Example

In 1972, Akron instituted a time-of-day fare structure in order to increase off-peak and overall ridership and to fill midday buses. At that time, the flat fare of 40¢ was reduced to a base fare of 35¢, and midday (Monday - Friday, 10:00 AM-2:00 PM) fare of 25¢. In 1979, all fares were increased by 5¢. In 1981, concern over federal operating subsidy cuts caused the agency to increase all fares to 50¢. In 1982, management determined that the flat fares had resulted in a large ridership decline; as a result, they raised the base fare to 55¢, and did not change the midday fare. The base fare was raised 5¢ again in January 1983. The resulting base fare was 60¢ while the midday fare remained at 50¢. The systemwide ridership increased by 16.7% from 1972 to 1973. This increase was not due to the new fare structure alone because the number of bus miles increased by over 20% in the same year. Therefore, the ridership effects of time-of-day fares cannot be separated; the best estimate is that ridership increased by 5% or 6% (a fare elasticity of -0.4). The ridership in 1972 and 1973 was lower than in 1971; therefore, it is possible that a portion of the 1972-73 increase consisted of riders returning to transit. Revenue did increase during that time, but not sufficiently to offset the cost of providing the additional route miles of service (Cervero, 1984).

2.2.3. Type of User

The third basis for fare differentiation is the type of user, such as charging lower fares for senior citizens, mobility impaired, students, unemployed, low-income persons, military/veterans, etc. The first three are the most commonly used, but the others can also increase ridership in addition to contributing to broader societal objectives. Albany, New York and Nashville, Tennessee have reported successful programs in which the unemployed were offered a discount. These programs

Table 1. Summary of Time-of-Day Fare Programs

TRANSIT PROPERTY	TYPE OF FARE CHANGE	DESIGNATED PEAK/OFF-PEAK	GENERAL RIDERSHIP IMPACTS (CONTROLLING FOR AVG. FARE & LEVEL OF SERVICE)	EXISTENCE IN 1983?
Akron, OH	non-midday surcharge	10:00am-2:00pm (op)	decrease	NO
Allentown, PA	off-peak discount	10:00am-3:00pm (op)	decrease	YES
Baltimore, MD	differential increase	6:00-9:00am, 3:00-6:00pm (p)	decrease	NO
Boston, MA	off-peak discount	10:00am-1:00pm (op)	decrease	NO
Burlington, VT	midday discount	9:15am-3:15pm (op)	increase	YES
Chapel Hill, NC	peak surcharge	6:30-9:30am, 3:00-6:00pm (p)	increase	YES
Cincinnati, OH	differential increase	6:00-9:00am, 3:00-6:00pm (p)	increase	YES
Columbus, OH	midday discount	9:30am-3:00pm (op)	increase	YES
Denver, CO	differential increase	6:00-9:00am, 3:00-6:00pm (p)	little or uncertain	YES
Erie, PA	midday discount	10:00am-2:00pm (op)	increase	YES
Louisville, KY	off-peak discount	6:30-8:30am, 3:30-5:30pm (p)	little or uncertain	YES
Minneapolis, MN	peak surcharge	6:00-9:00am, 3:30-6:30pm (p)	little or uncertain	YES
Orange Co., CA	differential increase	6:00-9:00am, 3:00-6:00pm (p)	little or uncertain	YES
Sacramento, CA	peak surcharge	6:30-9:00am, 3:30-6:00pm (p)	little or uncertain	YES
Salt Lake City, UT	differential increase	6:30-8:30am, 3:30-5:30pm (p)	increase	YES
Seattle, WA	peak surcharge	6:00-8:45am, 3:15-6:00pm (p)	little or uncertain	YES
Tacoma, WA	peak surcharge	5:00-9:00am, 4:00-6:00pm (p)	increase	YES
Wilmington, DE	differential increase	9:00am-3:00pm (op)	decrease	YES

(op) = designated off-peak hours
(p) = designated peak hours

Source: Cervero (1985)

in principle increase equity because the benefiting group of people usually have lower incomes. This may increase the accessibility of job interviews, enhance the likelihood of obtaining a job, and thus be on the unemployment roll for a shorter period of time. Arlington County, Virginia government offers a discount to low-income households because they prefer to directly subsidize the individual rider rather than the transit operator. The transit agency may offer a discount to the military/veterans in recognition of service to the country (Oram, 1987).

One way that a transit company could determine eligibility for programs such as low fares for the unemployed and low income would be to apply the criteria used by other appropriate agencies, such as the Texas Unemployment Commission and the various welfare agencies. The low fare could be a part of the "benefits" distributed by these agencies. The level of funding would have to be a transit board decision based on how important they consider this service to be to the community, and their assessment of the community's desire and willingness to pay for such service.

2.2.4. Service Differentiated Fares

Fares may also be differentiated on the basis of type or level of service. If transit service attributes compete relatively well with other available modes of transportation, riders could be charged a higher fare than if their trips are served poorly compared to other modes. A premium fare may be charged for express service, park and ride routes, and/or special events (concerts, football games, etc.) (Daskin, 1983). Some of the cities which charge more for park and ride (or express) services include: Austin, Baltimore, Cleveland, Detroit, Houston, Kansas City, Miami, Milwaukee, Minneapolis, Phoenix, St. Louis, San Antonio, San Diego, and San Jose. In addition, such differentiation is viewed as being more equitable, since the fares that premium service users are charged better reflect the relatively greater benefit that these riders receive.

On the other hand, rather than surcharges for premium services, discounts may be offered on services to encourage usage and to possibly achieve other non-transportation objectives. For example, discounted or even free-fares can be charged for downtown circulators as part of efforts to revitalize downtown areas or to reduce automobile congestion. General discussions in the economics and public policy literatures have addressed the broad concept of the philosophical underpinnings and economic rationale for and/or against various forms of welfare. In the transport domain, particularly the STS arena, there does not appear to be anyone who has specifically implemented cost-based fares for STS.

Transfers can also be placed in the "service type" category. It is widely accepted in the industry and in users' expectations that transit operators should not charge for transfers. The logic for this is that transfers are an inconvenience imposed on the customer, who needs a transfer only because the system does not have routes that service her/his destination directly. A transfer fee is then a "double taxation" because of the inconvenience of added travel time and added cost (Daskin, 1983).

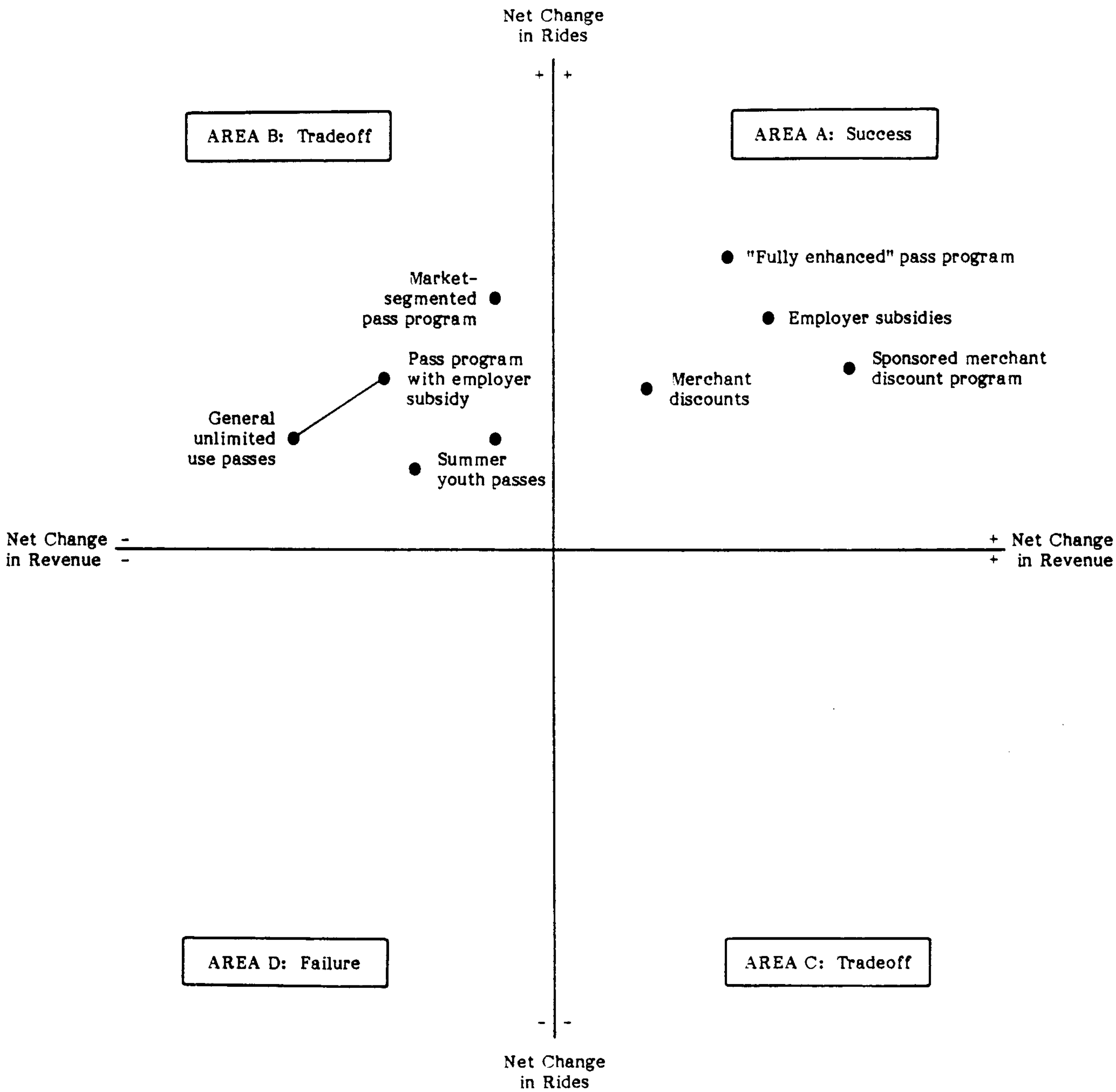
2.3. SPECIAL FARE-RELATED PROGRAMS

This section reviews fare-related initiatives that have been used primarily as marketing instruments, to encourage ridership offering merchant incentives, by "rewarding" frequent users (through discounted passes or books) or to enhance the convenience of transit usage by eliminating transactions otherwise necessary every time that a user makes a trip. To the extent that such plans offer different fares to the participants, they can be viewed as another form of fare differentiation on the basis of type of user (the one who elects to participate in the plan). However, to the extent that eligibility to participate may be restricted to certain types of users, or their applicability may be limited to certain service types or times of day, or the fees charged may depend on the service or user type, these plans may be used in connection with any of the bases for fare differentiation identified in the previous section. Also included in this discussion are free fares, which can be viewed as a special case of fare differentiation that can be used in connection with any of the bases identified above.

Figure 1 presents a summary of the relative ridership and revenue impacts of the programs presented in this section. It indicates that programs which incorporate merchant discounts (sponsored or otherwise) or employer subsidies may increase ridership and revenue. On the other hand, passes which are not subsidized by outside companies tend to increase ridership while decreasing revenues.

2.3.1. Merchant Incentive Coupons

Merchant discounts are a unique form of incentive offered to passengers to promote ridership. Usually these programs offer retail savings to pass or token buyers, although the coupons may be offered to all riders, regardless of payment method. The discounts may also be used to promote a new or special service. The transit agency's revenue effects depend on the level of financial support from merchants. When merchant incentive programs are financially sponsored be the merchants or other interested parties the ridership and revenue increases are greater (see Figure 1). An example is a local radio station in Bridgeport which sponsors a merchant



Source: Oram, 1987

Figure 1. Relative Impacts of Various Fare-Related Programs on Ridership and Revenue

discount program such that their trade contribution is greater than the direct cost of the program. For more information about the programs used in Bridgeport, Seattle, Portland, Syracuse, Washington D. C., and Philadelphia, see Oram (1987).

A local example in August, 1988 was Capital Metro's shuttle service between several parking areas and AquaFest at a cost of 50¢ round trip. The Southland Corporation, which operates the 7-11 chain of convenience stores, provided each passenger with a coupon good for "Buy-one-get-one-free" Super Big Gulp (a large soft drink which regularly costs 89¢). There were 95,928 one-way trips on Capital Metro for the duration (10 days) of AquaFest. A representative of the Southland Corporation believed the promotion was worthwhile and considered it a goodwill gesture*. There was no way to determine how many coupons were redeemed because the same coupons were used in other promotions. The representative also indicated that his company would be willing to participate in similar incentive programs in the future, and would recommend this type of promotion to other companies. It should also be noted that the shuttle service and coupon offer were very well advertised.

Capital Metro later offered a shuttle service for Freedom Festival (Labor Day, 1988). This second promotion was different in several respects. First, the service was advertised for only a few days; second, the shuttle ran only to one parking facility (Barton Creek Square Mall); and third, the coupon offer did not accompany this service. The estimated one-way ridership this time was 17,000 passengers.

2.3.2. Passes and Fare Prepayment

Passes and prepayment plans can simplify the implementation of any of the above structures. They can be sold on the basis of usual trip length, location of trip (downtown, park and ride, one zone, etc.), time-of-day, day of week, season, age, mobility, etc. One of the primary drawbacks of differentiated fare structures is that they are more difficult to implement and understand. An agency with an elaborate fare structure could influence ridership positively by making passes available so that customers may better understand what prices they must pay at different times and/or locations. Riders would not have to figure out what fare to pay at the farebox, nor would they have to worry about exact change; in addition, they could pay with checks. However, the transit authority may see a decrease in revenues because pass users may make more than the break-even number of trips. However, this would be offset by

*Per conversation with Mr. Bob McKinnely, market manager at the Southland Corporation.

interest on pre-paid passes and by a decrease in operating costs due to reduced dwell times and reduced cash handling costs (Daskin, 1983).

One problem with passes, however, is that they tend to be used by only a fraction of the people who could benefit from them. The high front-end cost of the pass, usually required at the beginning of the month, may deter many low-income riders with unsteady income from purchasing the pass. Unfortunately, these constitute the group of people who might benefit the most from the passes. One way to help reduce this problem is to sell weekly passes. The lower front-end cost makes them more attractive to lower income riders. Furthermore, if a weekly pass is lost, the rider's monetary loss would be less than it would have been if a monthly pass were lost (Oram, 1987). The transit agency in Bridgeport, Connecticut initiated the "Fare Cutter Card" to help increase pass sales to low-income riders. The users purchase lower priced monthly passes which require an additional 25¢ each time they board the bus. The user still receives the discount benefits of a pass (if used more than the break-even number of trips), but pays a lower front-end cost. Norfolk, Virginia offers a similar program (Oram, et. al., 1983). However, this method loses an attractive feature of passes, namely that they eliminate the need for a monetary transaction on every trip.

Setting the price of the passes is a very important consideration. If they are priced above a 35 trip break-even cost (commuter level), only persons who make regular off-peak trips would benefit. If the passes are priced too low, however, great revenue losses result. Riders who buy passes tend to be sensitive to the price. Promotional cost reductions can increase sales to existing riders, although they are not likely to generate many new riders (Oram, 1987).

A study of eleven cities (Los Angeles, Philadelphia, St. Paul, Seattle, Cincinnati, Portland, Norfolk, Sacramento, Richmond, Wilmington, and Tucson) reported the average costs for prepayment plans shown in Table 2.

Some ways to reduce the costs of prepayment plans include:

- courier or certified mail delivery instead of transit staff delivery for small sales outlets when there is a short distance between outlets, and

- prompt collection of money so that the agency may maximize the amount of interest they get from having the money earlier.

The largest single cost of prepayment plans is the sales commission charged at larger companies. Instead, the agency should use a network of sales outlets that do not charge a commission (Mayworm and Lago, 1984).

Table 2. Average Unit Costs for Selected Prepayment Plans

	Cost ($1981)	
Instrument	per instrument	per trip
annual pass (one plan)	8.91	0.018
semester pass (one plan)	2.96	0.019
monthly pass (nine plans)	0.69	0.014
weekly pass (two plans)	0.46	0.035
ticket book (20 trip) (two plans)	0.55	0.028
ticket book (10 trip) (six plans)	0.53	0.053
token (20 each) (three plans)	0.83	0.038

Source: Mayworm and Lago (1984)

One potential benefit of passes that does not appear to have been identified in the published literature or tried anywhere is the ability to develop and maintain a mailing list of pass-holding riders. Most agencies sell the passes without keeping a record of the buyers. However, maintaining such information could provide a mechanism for minimizing the loss of riders to the system and perhaps increasing the convenience of obtaining such passes on a regular basis through the mail.

If the employer subsidizes the cost of the pass, savings may accrue to both the employer and the employee. The employer saves if the cost of subsidized parking is greater than the cost of subsidized passes, and the employee saves on the cost of the transit ride. It is generally believed that large numbers of new riders are not likely to be attracted by the implementation of passes. Rather, pass users are likely to make more off-peak trips (Daskin, 1983). However, public awareness of pass availability is usually very limited. Seasoned riders are typically the most cognizant of their existence. Examples of areas with employer subsidized passes are examined in Bullard (1988) [Austin, Dallas, Denver, Fort Worth, Houston, and Seattle], and Ziering (1983) [Southeast Pennsylvania]. One type of employer subsidy is the "matched discount." The transit agency sells discounted passes to the employer only if the employer matches or increases the discount when selling the pass to the employee. Passes introduced through employer-sponsored programs are likely to attract new riders to the system, due to increased awareness of passes and their benefits. Therefore employer subsidized passes generally increase ridership and revenue (see Figure 1).

This method is used in Baltimore, Boston, Bridgeport, Dallas, Denver, Des Moines, Hartford, Philadelphia, Seattle, and others (Oram, 1987).

A transit agency considering implementation or expansion of an employer subsidized pass program should weigh the benefits and costs to all involved. Enumeration of benefits and costs follows.

Employer benefits:

- inexpensive/popular employee benefit which may help recruit new employees
- less expensive subsidies for passes than for parking, especially in the CBD
- reduced employee parking requirements allowing more parking for clients/customers
- improved employee performance because employee may be under less stress from not having to fight traffic
- increased budget flexibility, i.e. can change amount of subsidy, while parking costs are fixed for a long term
- environmental concerns such as fuel savings
- improved public image of company
- pass subsidy is a tax deduction
- employer distribution (regardless of subsidy) allows the employee a more convenient method to purchase the passes.

Employer costs:

- subsidy as primary cost
- administration costs (approximately 1-3 days/month of clerical time).

Employee benefits:

- more convenient, especially when the pass price is deducted from the payroll
- reduces the number of "break-even" trips required to pay for the pass
- larger subsidies tend to result in larger employee pass usage

Employee costs:

- remaining cost of pass.

Transit agency benefits:

- additional ridership
- increased operational efficiency due to reduced boarding times
- increased public support of transit

- additional interest from money received in advance
- fewer farebox repairs/less time to count cash.

Transit agency costs:

- operational cost may increase if many more passes are sold
- revenue lost from existing cash riders making "free" trips
- if ridership increases significantly, more buses (drivers, fuel, etc.) may be required to maintain the same level of service.

The honor system may be used when all trips require a pass or ticket. Tickets, like passes may be purchased in advance or, unlike typical passes, could be purchased on-board the transit vehicle(from a dispenser). Riders could also buy multi-ride tickets at sales outlets, then validate them when boarding the vehicle. Each passenger is responsible for having a valid ticket or pass for the current trip. On-board inspectors periodically check the tickets and passes and fine passengers in violation. The honor system may provide many of the following advantages to bus systems (Daskin, 1983):

- decreased vehicle-hours due to reduced dwell time (transactions are eliminated which allows utilization of all doors)
- improved service reliability
- increased revenues from fines collected from passengers with invalid tickets (though this should not be viewed as a revenue generation strategy)
- increased passenger convenience
- reduced driver workload and stress
- improved security (due to the reduced amount of cash on the vehicle)
- increased equity of fare structure may be accomplished because more complex fare structure may be introduced with limited passenger confusion (i.e. the passenger does not have to try to determine the appropriate fare while boarding the bus because the ticket or pass has already been purchased).

A more complete discussion of the honor system is presented in Chapter 6, in connection with the operation of the University of Texas shuttle routes by Capital Metro.

2.3.3. Free Fares

Free fares can be used for the whole transit system, only in certain geographically-defined portions and time periods, or for certain types of services or users. Some existing examples of free fares are: for the elderly, for the mobility impaired, for students, and for the military; in the downtown area; during the off-peak;

and even a completely free fare system. Most existing free fares are in restricted zones. Free fare zones have generally increased ridership, especially when accompanied by a good information program, although they have required additional subsidies. It has been noted that the greater the number of hours of operation, the greater the ridership impact (Kirby 1982).

In Denver and Trenton, system wide off-peak free fares were used for one year as UMTA-funded demonstration projects. While these two cities differ in several respects, and there were different circumstances before and during the demonstrations (one city had just raised the fares before the experiment), some of the results were similar for the two cities. For example, ridership increased to the point that overcrowding caused a marked deterioration of the level of service. There were long delays at the bus stops and driver morale decreased. Ridership of the target groups (transit disadvantaged such as the poor, elderly, and mobility impaired) did not increase significantly. Overall automobile use did not decrease substantially (Spear and Doxsey, 1981). Other references on the Denver and Trenton experiments include Studenmund and Conner (1982); Doxsey and Spear (1981); and Studenmund, et. al. (1979). A free fare experiment during the off-peak only in Salt Lake City, Utah is reported in Train (1981). The accumulated experience from these experiments is discussed in greater detail in the next chapter, and several free fare strategies are analyzed in Chapter 3.

2.4. CONCLUSIONS

The fare structures and fare-related programs discussed above could increase ridership and/or revenues. The methods which have increased ridership with no reduction in revenue have usually required some form of private sector support, such as merchant supported free fare zones, specially funded low fare for the unemployed, "fully enhanced" (employer sales and subsidies, short-term discounts, and merchant discounts) pass program, employer subsidized passes, merchant discount passes, and sponsored merchant discount pass programs. However, it may be possible to increase both ridership and revenues by improving and restructuring the service provided, as illustrated in subsequent chapters. Methods that usually increase ridership but decrease revenues are: fare free zones, low fares for the unemployed market-segmented pass programs, summer youth passes, and general unlimited use passes. Low weekend fares seem to have the largest impact on ridership, although revenues tend to decrease (Oram, 1987).

It is unfortunate that virtually none of the available references appear to have addressed fare structures and programs from the standpoint of the rider's perceptions and convenience. No serious serious surveys or experiments appear to have been conducted to study how well users and potential users might understand different fare structures or programs, and what their preferences might be regarding how fares ought to be collected.

Another important note is that considerable agreement exists among those that have seriously addressed fare and pricing strategies from the perspective of enhancing ridership that the potential of such strategies alone is rather limited. Most available evidence from elasticities obtained from calibrated demand models indicates that level of service attributes are more important than fares in evaluating the desirability of transit alternatives, as discussed in the next chapter. Inconvenient service will not attract many choice riders, even if free. On the other hand, convenient service will attract riders, even when it costs more, as evidenced by higher fares for premium services in many cities. It is therefore somewhat misleading to discuss the effect of fares without considering the corresponding level of service. Considerable caution and judgement should therefore be exercised in interpreting the experience reported by other areas on the effectiveness of various fare structures and programs.

CHAPTER 3: ELASTICITIES

3.1. INTRODUCTION

This chapter presents a review and discussion of the sensitivity of transit ridership to fare changes, based on research results and observations in transit systems in North America. The principal concept for capturing this sensitivity is that of elasticities. The first section of the paper will review this concept, and discuss some general issues associated with the measurement and subsequent interpretation of elasticities. The second section summarizes available findings on the values of fare elasticities in various systems, and their systematic dependence on the characteristics of the population as well as of the transit system itself. Of particular interest are elasticities associated with free fare demonstration projects, which are summarized in section three. Elasticities with respect to service characteristics and trip quality attributes are presented in section four. Finally, the market segments are defined for analysis purposes in section five, followed by concluding comments.

3.2. CONCEPTUAL BACKGROUND

3.2.1. Definition

Elasticities capture the sensitivity or response of demand to changes in the values of the attributes or characteristics of the transportation system. Because the principal attribute of interest in this study is the fare, the focus of this discussion is on fare elasticities. The fare elasticity of demand, or ridership, can be defined as the percent change in ridership in response to a one percent change in fare. The mathematical definition of elasticity is given in reference to a demand function, which expresses the dependence of ridership on fare, as well as on other pertinent attributes, primarily level of service characteristics (such as frequency of service, travel times and reliability). Thus, given the demand function shown in Figure 2, the *point* elasticity (so called because it is defined at a particular point along the demand curve) is given by:

point elasticity: $\varepsilon_0 = \frac{\partial F}{\partial F} \cdot \frac{F_0}{V_0}$

In this equation, F_0 is the prevailing fare, V_0 the corresponding ridership, and $\partial V / \partial F$ the partial derivative of the demand function with respect to the fare variable.

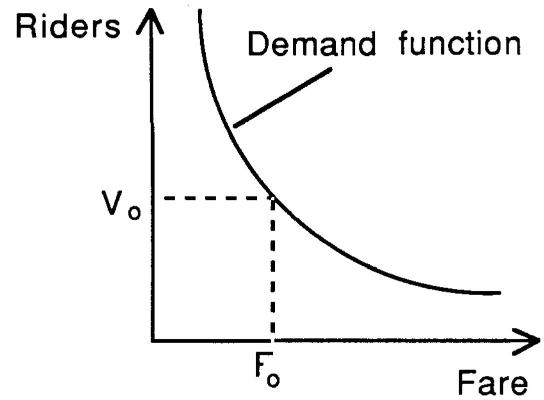


Figure 2. Definition of Point Elasticity

When data on ridership before and after a fare change are available (see Figure 3), but the demand function is not known, one can calculate the *arc* elasticity as follows (V_0 is the ridership before the change, V_1 after the change; F_0 and F_1 are the corresponding fares):

arc elasticity:

$$\varepsilon_{arc} = \frac{\Delta F}{\Delta F} \cdot \frac{F_0}{V_0} = \frac{(V_1 - V_0)/V_0}{(F_1 - F_0)/F_0} \iff \frac{\text{\% change in ridership}}{\text{\% change in fare}}$$

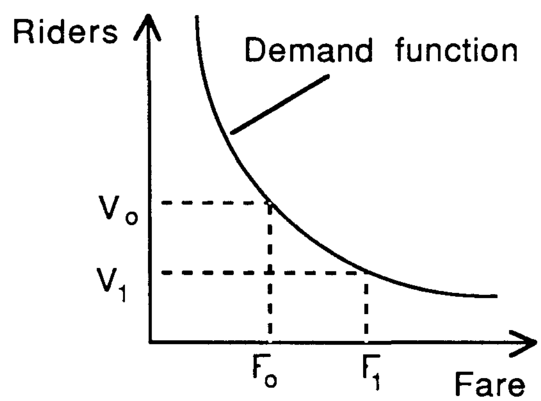


Figure 3. Definition of Arc Elasticity

The arc elasticity can thus be interpreted as the *% change in ridership per 1% change in fare*, so when the ridership is known before and after a fare change, we can simply divide the percent change in ridership by the percent change in fare to calculate the corresponding arc elasticity. If an elasticity is equal to -0.3, then a 3% loss in ridership would result from a 10% increase in fare.

In some cases, particularly when the fare or ridership change is large, a so-called *midpoint* elasticity is computed, by dividing the change by the average of the before and after values, i.e. the "midpoint" value of the change:

midpoint elasticity: $$\varepsilon_{\text{midpoint}} = \frac{(V_1 - V_0)/(V_1 + V_0)}{(F_1 - F_0)/(F_1 + F_0)}$$

The absolute value of the elasticity indicates whether the demand is elastic or inelastic to fare. When the absolute value is less than one (i.e., the elasticities between +1 and -1), the demand is said to be "inelastic" with respect to fare changes. In this case, an increase in fare will cause an increase in revenues. Even though there is a decrease in ridership, it is a lower percentage than the increase in fare, such that the additional fare collected from the remaining riders still results in a net increase in revenues. Similarly, a decrease in fare will cause a decrease in revenue. However, when the absolute value of the elasticity is greater than one, the demand is said to be "elastic" with respect to fare changes. In this case, an increase in fares will cause a decrease in revenues, whereas a decrease in fares will cause an increase in revenues. In the special case of the absolute value of an elasticity being equal to one, the demand is said to be "unit elastic" with respect to fare changes. That is, the revenues will remain constant regardless of whether the fare is increased or decreased. The evidence collected over many years and from many different systems has firmly established that the demand for transit is inelastic with respect to fares. In other words, a decrease in fares will never generate enough additional riders to compensate for the lost revenues.

3.2.2. Basis for Estimation

The magnitude and practical implications of calculated elasticities depend on the manner in which they were estimated and the source of information or data on which they are based.

There are two principal sources for determining elasticities: 1) travel demand models, and 2) actual experiments or implemented changes, i.e. before and after studies.

Elasticities based on models use the mathematical definition of "point elasticity" given earlier. Before and after studies allow us to calculate arc or midpoint elasticities.

Two types of models can be distinguished for the purpose of estimating elasticities:

- The most common are cross-sectional models, which are developed and estimated based on a cross-section of the population, at a given time. A typical example would be a mode choice model based on a home interview survey conducted in a particular week. The elasticity can be calculated from the coefficients of the cost or fare variable in the utility function in the commonly used logit mode choice model.
- In some cases the elasticity may be based on time-series models, which are developed and calibrated using a sequence of observations taken at different time periods. However, these observations are typically not obtained under controlled conditions, and thus may not be able to separate the effect of the variable of interest (fare in this case), to the same extent as before and after studies.

In addition to the distinction between model-based elasticities and those derived by experimental or quasi-experimental methods, it is useful to distinguish between static versus dynamic approaches to estimate elasticities. A static approach does not involve observations over time, e.g. cross-sectional mode choice models. On the other hand, a dynamic approach can be either model-based or experimental (or quasi-experimental) and is characterized by observations of actual changes over time. Elasticities based on a dynamic approach provide a more appropriate and desirable basis for forecasting the effect of changes in fares (or other attributes). Elasticities derived from a static approach are not based on observations of actual changes and responses thereto, and are therefore more questionable as a basis for forecasting the response to fare changes. To illustrate the effect of the estimation approach on the magnitude of the resulting elasticities, the table below gives the average and standard deviation of elasticities based on different approaches from a variety of cities in North America.

Source	Avg. elasticity ± standard deviation
Dynamic;	
before and after experiments	-0.28 ± 0.16 (67 cases)
Time-Series models	-0.42 ± 0.24 (28 cases)
Static; cross-sectional models	-0.53 ± 0.35 (28 cases)

Source: Lago, Mayworm & McEnroe (1981)

Several points can be noted in connection with the above table:

a. The well-known Simpson Curtin rule (established in the 1950's and 1960's as an industry rule of thumb) states that transit ridership elasticity with respect to fare is approximately -0.3, which is remarkably close to the average elasticities for the "before and after" cases (itself based on data over the last several decades). This implies that -0.3 is probably still a reasonable estimate for the fare elasticity when no other information is available.

b. The source and estimation approach appears to have a systematic effect on the resulting elasticities. For instance, the average magnitude of elasticities obtained from cross-sectional models is approximately twice that obtained from experiments or quasi-experiments. In other words, elasticities based on static models will tend to overpredict the ridership impact of a given fare change by about a factor of two.

c. The implication of the above is that if a mode choice model is calibrated for a given area, the elasticities based on that model ought to be divided by a factor of two in order to provide a realistic basis to study the effect of fare policies.

Another important distinction in the source of data on which elasticities might be based is between revealed preference and stated preference data. Revealed preference data generally consist of observations of actual behavior, from which tripmakers' preferences can be inferred. On the other hand, stated preference data consist of responses to questions on what a tripmaker might do if some hypothetical changes were to be implemented, or if some new service were to be offered. Research has established that what individuals say they might do and what they actually do are not always the same. Nevertheless, stated preference data may be the only practical approach available to assess what user response might be prior to the development and/or introduction of major service changes and new policies for which no historical record is available. Most of the elasticities available in the literature (and discussed in this report) are based on revealed preferences, or observations of actual behavior, using either static or dynamic approaches. However, the past few years have seen increased selective use of stated preference methods in the transit industry, e.g., in a recent study conducted by the Chicago Transit Authority (LaBell, 1988), as well as in several systems in the U.K. and the Netherlands. Such careful and properly controlled use of stated preference methods may be the only practical approach available to gain insight into user preferences and predict responses to innovative fare policies and fare-related programs.

3.2.3. Asymmetries in response to fare increases vs. decreases

Some studies have revealed asymmetries in ridership response to fare changes. These arise because ridership responds differently to a fare increase than to a fare decrease. A fare decrease is not as likely to attract as many new riders as a fare increase of the same magnitude is to lose riders. This is reflected in the absolute value of the elasticity of ridership with respect to a fare decrease being smaller than that corresponding to an increase. There are several possible explanations for this phenomenon. One is that fare decreases may not be sufficient to compensate for the perceived inconvenience of transit service by non-riders (especially staunch non-riders). Another is due to information diffusion and awareness considerations: current riders immediately become aware of fare increases, thereby possibly seeking alternative modes, whereas information about fare decreases may not spread adequately to non-riders to induce them to ride.

Shown in the table below is a summary of elasticities with respect to an increase as well as to a decrease in two of the very few cities where such information is available for both increases and decreases. In addition, average elasticities for increases versus decreases are also reported.

Elasticity

City	Fare Decrease	Fare Increase
Atlanta	-0.18 (1972)	-0.60 (1971)
Madison		2 - 3 times larger than that for a fare decrease

Action	Average Elasticity ± Standard Deviation
Fare Increase	-0.34 ± 0.11 (14 cases)*
Fare Decrease	-0.37 ± 0.11 (9 cases)*

Source: Lago, Mayworm & McEnroe (1981)

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*The fare increase value is an average of : Cincinnati (1957), San Francisco (1952), Chicago (1957 & 1970), Atlanta (1963 & 1971), Cleveland (1973), York (1948), Jacksonville (1970), Springfield (1949), Portland (1958), Hartford (1958), and 2 value from Boston (1955). The fare decrease value is an average of Atlanta (1972), Seattle (1973), Cincinnati (1973), Kent (1967), Richmond (1973), and 2 values from St. Louis (1973) and San Diego (1972).

Note that when values are averaged, erroneous interpretations may result. For instance, data from the two cities where elasticities are available for both increase and decrease clearly indicate that the elasticity with respect to fare increase is about 3 times greater than that for a decrease. However, the average values taken over many cities indicate essentially equal values. The reason is that these averages are taken over different cities and different years in each case. Therefore, no proper basis exists for comparing the average values.

In the next section, some general trends in reported values of elasticities are discussed. In particular, the sensitivity of different market segments, defined on the basis of time of travel, trip purpose, trip length, route type and income, are examined. Unfortunately, much of the reported data does not differentiate between elasticities estimated from cross-sectional (static) models and those based on experimental or quasi-experimental methods. Nevertheless, the resulting patterns and insights are valuable for purposes of the Capital Metro fare study.

3.3. ELASTICITIES FOR VARIOUS MARKET SEGMENTS

3.3.1. Time of Day

Time Period	Average Elasticity ± Standard Deviation
Peak	-0.17 ± 0.09 (5 cases)
Off-Peak	-0.40 ± 0.26 (5 cases)
All Hours	-0.29 ± 0.19 (5 cases)

Source: Lago, Mayworm & McEnroe (1981)

Peak ridership is much less elastic with respect to fares than off-peak ridership. Most peak trips are work trips, i.e. required, whereas off-peak trips tend to be more discretionary in nature, such as shopping and recreational trips. Therefore a fare change is likely to have a greater effect on off-peak trips.

3.3.2. Trip Purpose

Trip Purpose	Average Elasticity ± Standard Deviation
Work	-0.10 ± 0.04 (6 cases)
School	-0.19 (1 case)
Shop	-0.23 ± 0.06 (5 cases)

Source: Lago, Mayworm & McEnroe (1981)

As expected, work trips exhibit the least elasticity with respect to fares. Though based on only one case, school trips appear to be slightly more elastic than work trips, even though the school trip is in principle not optional to the student. However, students and their families may arrange for alternative transportation involving other members of the household or neighbors. The shopping trip is the most discretionary, and therefore would have the highest elasticity.

3.3.3. Transit Mode

Transit Mode	Average Elasticity ± Standard Deviation
Bus	-0.35 ± 0.14 (12 cases)
Rapid Rail	-0.17 ± 0.05 (10 cases)
Commuter Rail	-0.31 (1 case)

Source: Lago, Mayworm & McEnroe (1981)

For systems where more than one transit modal alternative is available, e.g., bus and rail, reported elasticities exhibit higher values for bus trips. Note that there is only one case for the commuter rail elasticity, so this value may not be representative. This data is not directly applicable to the Capital Metro service area since only bus service is available. However, it might suggest that ridership on the "premium" services (e.g., express buses) may be less elastic to fare changes (read increases) than regular service. This is corroborated by the next set of results for different route types.

3.3.4. Route Type

Route Type	Average Elasticity ± Standard Deviation
Radial arterial (routes)	-0.09 ± 0.02 (3 cases)
Intrasuburban (routes)	-0.31 ± 0.05 (3 cases)
System-wide (all routes)	-0.24 ± 0.08 (3 cases)
(The 3 cases are: Bus, Rapid Rail and Commuter Rail in London, [1977])	
CBD oriented (routes)	-0.40 ± 0.04 (3 cases)
Non-CBD oriented (routes)	-0.62 ± 0.09 (3 cases)
System-wide (all routes)	-0.55 ± 0.08 (3 cases)

(2 of these cases are: San Diego, peak [1972 - 1975] and Minneapolis/St. Paul, peak [1976].)

Intra-CBD (routes)	-0.52 ± 0.11 (4 cases)

(The 4 cases are: Portland, all hours [34 months, before 1980]; Albany, off-peak [6 months, before 1979]; Seattle, all hours [10 months, before 1980]; and Knoxville, all hours [18 months, before 1980].)

System-wide (all routes)	-0.43 ± 0.08 (3 cases)

(The 3 cases are: Portland, all hours [34 months, before 1980]; Albany, off-peak [6 months, before 1979]; and Seattle, all hours [10 months, before 1980].)

Source: Lago, Mayworm & McEnroe (1981)

The radial trip often corresponds to a CBD work trip and would therefore be less elastic than the intrasuburban trip. Intrasuburban trips could be more evenly divided between work or shopping purposes. Even if it is a work trip, it would be sensitive to fares because suburban offices generally do not have the parking limitations associated with CBD destinations. The system-wide average would, of course, be somewhere in between. For the same reason, one would expect the CBD oriented trip to be less elastic than the non-CBD trip, as reflected in the above table. The intra-CBD trip would be more elastic than the average trip because it tends to be a short trip, competes with walking and may be given up altogether.

3.3.5. Trip Length

Trip Length	Average Elasticity ± Standard Deviation
London: Bus	
• trips less than 1 mile	-0.55 (1 case)
• trips between 1 and 3 miles	-0.29 (1 case)
London: Rapid Rail	
• trips between 1 and 3 miles	-0.25 (1 case)
• trips greater than 3 miles	-0.60 (1 case)

Source: Lago, Mayworm & McEnroe (1981)

In general, short trips are more elastic than long trips. The bus is competing against walking (a free, but sometimes inconvenient alternative) for the short trips. A reason the opposite appears true for the case of London rapid rail is that the more circuitous surface street layout, compared to the directness of the rail system, may actually be masking the true length of a trip by competing modes.

3.3.6. City Size

City Size	Average Elasticity ± Standard Deviation
Populations greater than 1 million	-0.24 ± 0.10 (19 cases)
Populations 500,000 to 1 million	-0.30 ± 0.12 (11 cases)
Populations less than 500,000	-0.35 ± 0.12 (14 cases)

Source: Lago, Mayworm & McEnroe (1981)

As one would expect, cities with larger populations exhibit lower elasticities than smaller cities. In general, larger cities have more traffic congestion and less parking (and hence more expensive).

3.4. ELASTICITIES ASSOCIATED WITH FREE-FARE DEMONSTRATIONS

This section summarizes available findings regarding the response of different ridership groups to partial or total free fare experiments conducted in Denver, Trenton, Portland and Seattle. It should be noted in connection with the reported values that elasticities can be a misleading indicator of tripmaker response to such experiments. Elasticities are calculated relative to existing ridership levels before the introduction of the free fares, and do not as such capture information of the relative size of the potential market of non-users. In addition, because the demonstration projects in question may have involved simultaneous major service increases or improvements, the measured response cannot be attributed solely to the fare element of the changes.

Fare Change to Fare-Free	Average Elasticity ± Standard Deviation
Within CBD only	-0.52 ± 0.11 (4 cases)
(3 of these cases are: Portland, Albany, and Knoxville)	
System-wide	-0.30 ± 0.17 (6 cases)
(5 of these cases are: Madison; Auburn; Rome, Italy; Denver; & Trenton)	

Source: Lago, Mayworm & McEnroe (1981)

The elasticity associated with fare-free travel in the CBD only is generally higher than that for systemwide free travel. This parallels the earlier finding that intra-CBD trips are more elastic than the average system trip. For many intra-CBD trips, walking is a viable alternative, which competes with transit. The higher elasticity of these trips is the result of individuals choosing to ride for free rather than walk. It is noteworthy that the average systemwide elasticity associated with a change to free-fare is virtually identical to the average fare elasticity calculated from less extreme fare changes. As such, it suggests that no significant additional impact on ridership can be attributed to free fares beyond that associated with the reduction in the monetary amount of the fare.

Given the objectives of the present study, a more detailed examination of elasticities associated with free fares is useful. The following income-based elasticities were derived from the free fare demonstrations in Trenton and Denver:

Household Income (1978 $)	Denver's Off-Peak Elasticity	Trenton's Off-Peak Elasticity
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: Lago, Mayworm & McEnroe (1981)

When two other cases (unknown, and not stated whether free fare or not) are included the following average elasticities are obtained:

Income Group	Average Elasticity ± Standard Deviation
Less than $5,000	-0.19 ± 0.10 (2 cases)
$5,000 to $14,999	-0.25 ± 0.11 (4 cases)
More than $15,000	-0.28 ± 0.13 (4 cases)

Source: Lago, Mayworm & McEnroe (1981)

Given the large standard deviations associated with the above values, it is not clear that the apparent numerical differences in the average values are really significant, especially since they are based on so few cases. For instance, the results in Denver and Trenton do not suggest any consistent trend. Note that the elasticities given for Denver and Trenton are for off-peak trips and are therefore more likely to be discretionary. Surprisingly, the impact of the free fares on the low-income ridership in Trenton is relatively low. The following elasticities for various trip purposes were determined from the Trenton demonstration:

Trip Purpose	Off-Peak Fare Elasticity
Work	-0.11
School	-0.19
Shop	-0.25
Medical	-0.32
Recreation	-0.37
Social	-0.25
Other	-0.19
Aggregate Value	-0.19

Source: Lago, Mayworm & McEnroe (1981)

As expected, the work trip is the least elastic, while recreational trips are the most elastic. Note, however, that the work trip is probably not well represented among off-peak trips.

The fare elasticities by age group were also determined in the Denver and Trenton free fare demonstrations. These are reported below:

Age Group	Denver	Trenton	Average Elasticity ± Std. Dev.
1 to 16 years	-0.32	-0.31	-0.32 ± 0.01
17 to 24 years	-0.30	-0.24	-0.27 ± 0.03
25 to 44 years	-0.28	-0.08	-0.18 ± 0.10
45 to 64 years	-0.18	-0.12	-0.15 ± 0.03
65 and more years	-0.16	-0.12	-0.14 ± 0.02

Source: Lago, Mayworm & McEnroe (1981)

In general, older riders tend to be less elastic to fares, with respect to either increases or decreases, than younger riders. One explanation is that older persons may already be in the "transit habit," and because the very old are less likely to drive and in some cases may be transit-dependent, whereas non-riders may be more reluctant to experiment. Furthermore, in the free fare demonstrations, older riders may have been discouraged from further use of the system by the higher level of crowdedness and discomfort induced by large numbers of teenagers (the group with the largest response to the free fare).

Available examples of free fare elasticities for different cities are shown below followed by a discussion of the corresponding schemes and related findings:

Location	Elasticity
Portland's Fareless Square	≈ -7.2 to -8.0 (CBD area only)
Seattle's Magic Carpet	-2.0 (CBD area only)
Denver's Off-Peak Demonstration	-0.52 (off-peak)
	-0.32 (overall)
Trenton's Off-Peak Demonstration	-0.46 (off-peak)

Sources: Colman (1979a); Colman (1979b); Donnelly, Ong, and Gelb (1980); Spear and Doxsey (1981).

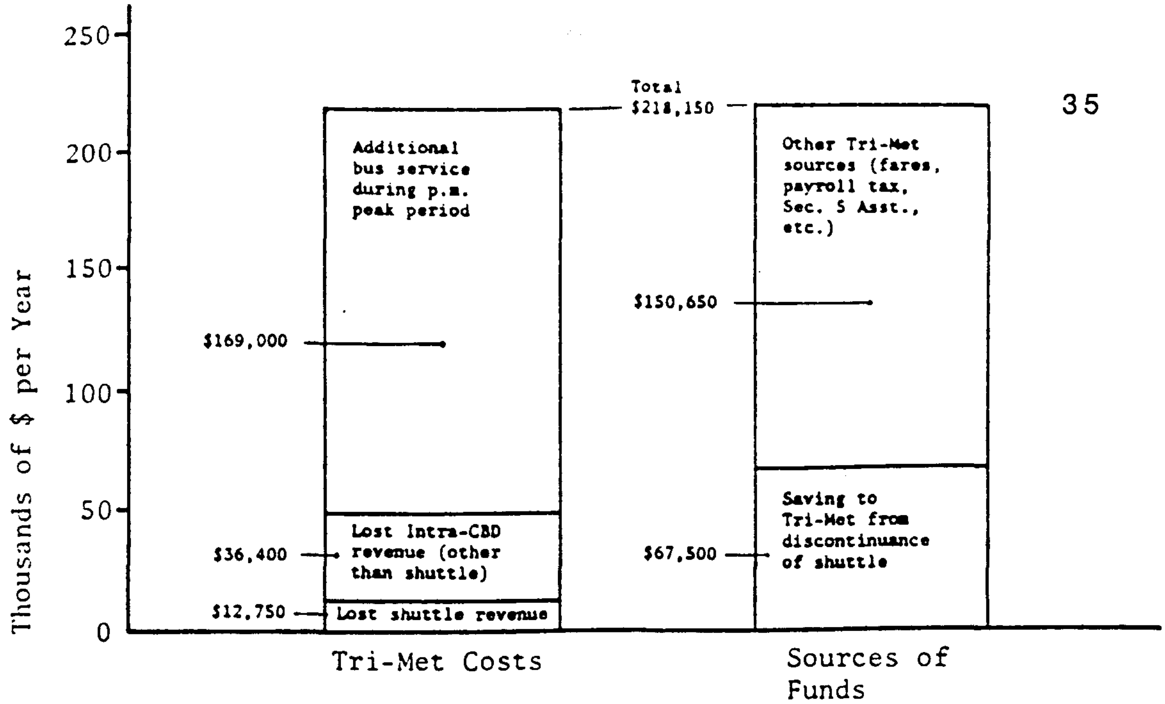
Some pertinent information regarding the above cases is summarized hereafter.

Portland's Fareless Square *(Source: Colman,1979a):*

- Begun in January 1975, over an area of 280 square blocks.
  Expanded in 1977 to an area of 350 square blocks, which includes offices, retail establishments, high rise condominiums/apartments, an urban renewal area and Portland State University.
- All bus trips within the CBD are free during all hours, seven days per week. In the CBD, passengers may board and exit the bus from the front or rear door. When the passengers board outside the CBD, they pay as they get on the bus. If going through the zone, they ask for transfers when boarding and return them when getting off (so that the driver knows they have paid). When transferring buses in the CBD to an eventual destination outside the CBD, the transfer is returned when getting off the second bus. Any applicable zone fees will be paid at that time. When the passengers get on the bus in the CBD and ride beyond the Fareless Square boundary, they pay all fares and transfers when getting off the bus. If a transfer is needed to another non-CBD bus, it is requested when getting off the bus. Outside the CBD, only the front door of the bus is used for boarding and alighting.
- Ridership on the downtown shuttle was estimated to be between 900 and 1000 trips per day before the introduction of the Fareless Square promotion. A ridership survey in November, 1977 indicated 8200 trips per day in the Fareless

Square. This yields an elasticity of between -7.2 and -8.0. ((8200-1000)/1000 = 7.2% increase in ridership with a 100% decrease in fare, for an elasticity of 7.2%/-100% = -7.2). Two factors contribute to this distorted and misleadingly high value: 1) service coverage was significantly increased in the zone, and 2) the initial level was quite low, thereby yielding rather high relative increases.

- The "Shop Hop" operated in the CBD prior to the Fareless Square. This service charged 10¢ per ride. Two buses operated at 10 minute headways from 10 a.m. to 4 p.m. Monday - Friday on only two streets.
- Between 1975 and 1977, overall Tri-Met service was increased by 17%, thereby precluding the attribution of the observed ridership exclusively to the free fare.
- 4% of the trips in Portland are made by transit; 28% of the CBD trips are transit trips.
- When the Fareless Square began, the 35/75¢ zone charge was changed to a 35¢ flat fare, and monthly passes were introduced. In September 1978, a 45/65¢ zone charge was put into effect.
- Fareless Square start-up costs: $5300 for a rider's contest to name the free fare zone; $5900 for promotion in January and February 1975 (art production, printing, etc.); and $910 for 200 signs.
- The free service costs Tri-Met $218,000 per year (0.4% of their operating budget), which are paid out of the regular operating budget (there is no special funding for the service). Thirty additional vehicle hours per day were required during the P.M. peak (0.6% of the "current" service). [See chart in Fig. 4 "Estimated Costs and Operating Results of Fareless Square, FY 1978/79"]
- Two-thirds of the new trips were made between 9 a.m. and 4 p.m.
- An increase in boarding speed was noticed due to the elimination of fare collection. However, this may have been offset overall by the increase in the number of passengers and the pay-on-exit system. No estimates of the net effect are available.
- A slight though probably insignificant increase in retail sales was noted.
- Riders in the Fareless Square appear to have a slightly higher average income than the average Tri-Met passenger.



Source: TRI-MET

Figure 4.
ESTIMATED COSTS AND OPERATING RESULTS OF FARELESS SQUARE, FY 1978/79

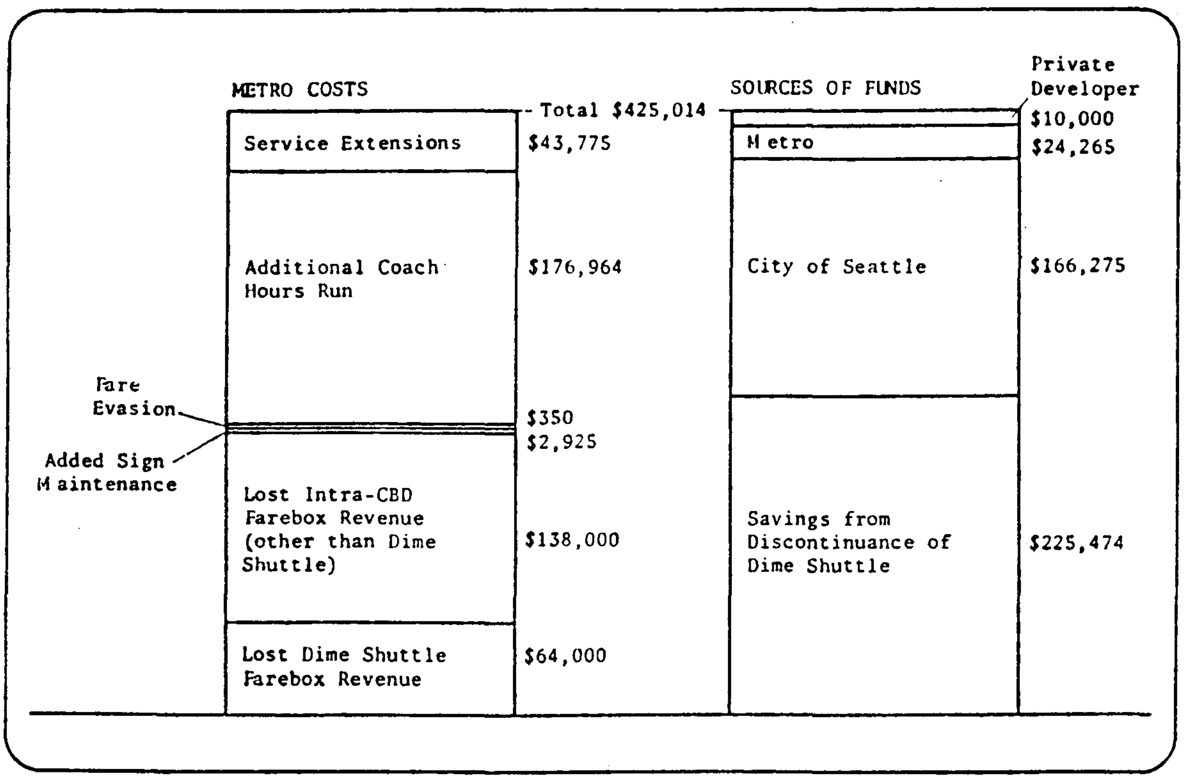


Figure 5.
MAGIC CARPET COSTS ESTIMATED BY METRO FOR 1978

Source: METRO Transit Planning Department

Seattle's Magic Carpet *(Source, Colman, 1979b):*

- Began in 1973 in a 1/2 square mile area of the CBD, consisting mostly of retail, tourist and office centers, it has been expanded twice (1974 & 1978) to an area of 2/3 square mile. In 1974, four bus stops were added. In 1978, urban renewal and some residential areas were added to the free fare zone including most of the Regrade residential area. Previously, a downtown shuttle system charging 10¢ per ride and called the Dime Shuttle provided service with 5 minute headways between 10 a.m. and 3 p.m., Monday - Friday.
- Intra-CBD ridership increased from 4100 to 12,250 trips per day. This represents an elasticity of -2.0. However, as noted, this cannot be interpreted as a fare elasticity since service coverage and other service attributes changed as well.
- Most new trips are made between 11 a.m. and 2 p.m. Of the people who made these trips before, most had walked (45%) or ridden the bus (41%).
- Previous riders appear to have increased the frequency of their use.
- Seattle uses a similar pay-when-exit system as in Portland.
- Boarding time was reduced by about 20% in the CBD, though longer deboarding times were noted outside the CBD during the peak hours.
- Riders in the free-fare zone appear to have a slightly higher average income than the average passenger on the system as a whole.
- The City of Seattle paid from its general fund for most of the incremental costs of the free fare service. [See chart, in Fig. 5, of "Magic Carpet Estimated by Metro for 1978"]

Denver's Free Off-Peak Demonstration *(Source: Donnelly, Ong, and Gelb, 1980; and Studenmund, Swan and Connor,1979):*

- The demonstration took place between February 1978 and January 1979. It was begun as "Transit Awareness Month" in February 1978, and was subsequently extended several times until the local and federal agreement to make it a one-year demonstration project. Its primary purpose was to reduce the massive air pollution problems that the city was facing at the time. All buses on all routes were free, except between 7 and 9 a.m. and 4 and 6 p.m., Monday - Friday. The morning peak was redefined on May 1, 1978, to 6-8 a.m.
- The average off-peak fare prior to the demonstration had been 25¢, while the peak fare remained 50¢. [See Table 3 for fare structures before, during and after the demonstration.]

- Because of a lack of pre-implementation data, the "before" data came from surveys (i.e. stated usage) rather than being observed, and is therefore of questionable reliability.
- A large number of new motor coaches were put into service in early 1978. Major route restructuring was also implemented during the demonstration, which limits one's ability to separate and assess the effect of the fare elimination.
- Relatively large increases in weekday off-peak ridership (50%), Saturday ridership (50%), and Sunday ridership (100%) were observed.
- Approximately 34.3 million trips were made during the demonstration (about 8.2 million more than projected without the free off-peak, or ≈31% increase). This is approximately 118,500 trips per weekday (about 26,000 more than without the free off-peak, or ≈28% increase).
- 70% of the weekly trips during the demonstration were made during the off-peak.
- The bus mode share of the intra-regional trips was 2.4% before the demonstration and 3.1% during the demonstration.
- For CBD trips, the bus carried less than 9% before the demonstration, and ≈11% during.
- The ridership gain was rapid: 85% of the maximum impact was attained shortly after the first month.
- Five months after the reinstatement of the 25¢ off-peak fare, the ridership was an estimated 7% higher than if there had not been the demonstration. However, it should be noted that when the free fares were discontinued, tokens and passes were promoted more heavily in order to dampen the ridership loss due to the termination of the demonstration.
- Attitude surveys indicated that passengers became more negative about overcrowding, late buses and security problems. A significant number of users switched to the peak or stopped bus use entirely.
- Approximately one-half of the nearly $7 million needed to fund the project for one year came from a Federal UMTA grant.
- RTD experienced a 40% reduction in fare revenues, or 6% of the total operating budget.
- Additional bus service (about a 1% increase) was added to help ease the overcrowding problems.
- 60% of the metropolitan area residents never used the free service.

Table 3.

DENVER RTD FARE SCHEDULES: 1977, JANUARY 1978, AND 1979 AFTER FREE FARE

Type of Service	1977 Peak	1977 Off-Peak	January, 1978[a] Peak	January, 1978[a] Off-Peak	1977 & 1978 Monthly Pass	1979, After Free-Fare[a] Peak	1979, After Free-Fare[a] Off-Peak	1979, After Free-Fare[a] Monthly Pass
Local								
Regular	$.35	$.25	$ .50	$ .25	$15.00	$ .50	$ .25	$15.00
E&H[b]	.25	.15	.50	.25	12.50	.50	free-.10[c]	12.00
Students	.20	.20	.50	.25	12.50	.50	.25	12.00
Express								
Regular	.50	.50	.75	.75	25.00	.75	-	25.00
E&H	.40	.40	.75	.25	22.50	.75	.25[d]	22.50
Students	.35	.35	.75	.25	22.50	.75		22.50
Circulator								
Regular	.25	.25	.25	.25	7.50	.25	.25	7.50
E&H	.15	.15	.25	.25	5.00	.25	free-.10[c]	5.00
Students	.20	.20	.25	.25	5.00	.25	.25	5.00
Transfer[e]	.05	.05	free	free		free	free	
Intercity								
Medium Distance	-	-	1.00	1.00	32.00	.75-1.00	.75-1.00	35.00
Long Distance	-	-	1.25	1.25	40.00	1.25	1.25	40.00
E&H	-	-	.50	.50	28.00-35.00	1.75-1.25	free-.50[c]	35.00[f]

[a]The off-peak free-fare program began February 1, 1978 and continued through January 31, 1979.

[b]Elderly (over 65 years) and handicapped.

[c]Elderly ride free during off-peak hours; handicapped persons ride at reduced fares.

[d]Express buses do not serve off-peak hours. Should elderly or handicapped persons board an express bus completing a run after the peak period has ended, they receive their off-peak reduction.

[e]Transfers are free since 1978; patrons transferring from a lower to a higher grade of service, however, are required to pay the difference in fares.

[f]Reduced monthly pass rate is also available to students.

- Researchers have concluded that free fare can be effective as a short-term marketing instrument, though reduced or low fares during the off-peak may produce similar results.

Trenton's Free Off-Peak Demonstration (*Sources: Knight, 1978; Spear and Doxsey, 1981; and Studenmund, Swan and Connor, 1979):*

- The population of Trenton, New Jersey was decreasing at a rate of almost one percent per year at the time of the demonstration. The population was around 104,000. Most of the population was low-income, elderly and/or carless. Mercer County was approximately twice the size of Trenton and was growing at that time. Most of the residents of the county were fairly affluent.
- One objective of the demonstration, aside from learning more about free fares, was to help revitalize Trenton's CBD.
- The demonstration was from March 1978 - February 1979.
- All trips on all buses within Mercer County, New Jersey were free (a few routes to special locations outside the county were not included in the demonstration) during the off-peak. The off-peak was defined as all day Sunday and holidays, and from 10 a.m. to 2 p.m. and after 6 p.m. Monday - Saturday.
- Most off-peak trips charged a fee of 15¢, with transfers charging an additional 5¢, before the demonstration. The longest intracounty trips charged fares of 20¢ and 25¢ during the off-peak. The peak fares remained at 30¢, 40¢, and 50¢, respectively.
- It is claimed that extensive planning before the demonstration produced relatively reliable "before" data. Several surveys were conducted before and during the demonstration, including phone and on-board surveys, as well as interviews with patrons in a major shopping mall.
- In order to maintain better experimental control, no other major service changes were made at the time.
- The demonstration was funded by a $500,000 grant from UMTA. The total cost was estimated to potentially reach $750,000 not including evaluation.
- Off-peak weekday ridership increased an average of 56% during the demonstration. This impact is lower than the one observed in the Denver demonstration. Some possible reasons include the simultaneous service improvements in Denver, shorter off-peak period in Trenton, and the lower pre-demonstration fare in Trenton.

In summary, the free fare demonstrations have yielded mixed results. On one hand, there have been increases in ridership on the affected portions of the system and during the affected times of the day (or day of the week); on the other hand, these increases were either unsustained, did not achieve the broader societal role of transit of attracting auto driver trips (instead picking up mostly otherwise walking trips), or not exclusively due to fare elimination per se. The mixed record nevertheless points to the fact that free fares can be most effective as a promotional device for major service improvements. The successful demonstrations were accompanied by such service coverage or quality changes. This leads to a fundamental question facing a transit operator contemplating fare reductions as an inducement to ridership: what is the relative impact on ridership of fare changes compared to that of service improvements. This is especially important because all available evidence indicates that ridership is inelastic to fares, in that decreasing fares will always lead to losses in revenues. Had these lost revenues been invested instead in service improvements, would the impact be greater or smaller than that of the fare decrease?

The next section attempts to provide an answer to this question by reviewing available evidence on the elasticity of transit ridership with respect to changes in the level of service characteristics.

3.5. ELASTICITIES WITH RESPECT TO SERVICE CHANGES

This section reviews available elasticities with respect to changes in overall supply (vehicle-miles of service), route characteristics (headway for frequency), as well as individual trip attributes (total trip time, in-vehicle travel time, walk time, transfer time and number of transfers).

3.5.1. Overall Supply

Overall supply is measured in terms of vehicle miles of service, which could represent changes in coverage (spatial and temporal), routing or frequency (or any combination thereof). Below is a summary of reported demand elasticities with respect to vehicle miles.

Vehicle-miles	Elasticity ± Standard Deviation
Bus (quasi-experimental)	
All hours	+0.63 ± 0.24 (3 cases)
Bus (non-experimental)	
Peak	+0.33 ± 0.18 (3 cases)
Off-peak	+0.63 ± 0.11 (3 cases)
All hours	+0.69 ± 0.31 (17 cases)
Rapid Rail (non-experimental)	
Peak	+0.10 (1 case)
Off-peak	+0.25 (1 case)
All hours	+0.55 (1 case)

Source: Meyer and Miller (1984)

These elasticities are of course positive since more vehicle-miles represent an improvement to the system, which would be expected to increase ridership. The average of the reported elasticities for the peak trips is less than for the off-peak trips (approximately one-half the value). Note that the peak average is based only on 3 cases, and has a rather high associated variability (as measured by the reported standard deviation). Furthermore, to the extent that the peak values are based on non-experimental methods (i.e., inferred from static models), their reliability and validity are dubious because vehicle miles is not a commonly used explanatory variable in travel demand models, and the model specification is likely to have included variables that correlate with it (so that its effect may not be properly captured by the associated coefficient value in the estimated model).

An interesting aspect of the data presented in the above table is that the average elasticities based on quasi-experimental approaches are about equal to those based on non-experimental approaches, unlike the fare elasticities discussed earlier. More importantly, this value is about twice as large as the elasticity with respect to fares, meaning that a 1% increase in supply results on average in twice as much ridership increase than a 1% fare reduction.

3.5.2. Route Characteristics

Headway	Average Elasticity ± Standard Deviation
Bus (quasi-experimental)	
Peak	-0.37 ± 0.19 (3 cases)
Off-peak	-0.46 ± 0.26 (9 cases)
All hours	-0.47 ± 0.21 (7 cases)
Commuter rail (quasi-experimental)	
Peak	-0.38 ± 0.16 (5 cases)
Off-peak	-0.65 ± 0.19 (5 cases)
All hours	-0.47 ± 0.14 (5 cases)
Commuter rail (non-experimental)	-0.47 ± 0.11 (4 cases)

Source: Meyer and Miller (1984)

As one would expect, the headway elasticity is negative, indicating a loss of ridership in response to longer headways (which imply longer waiting times). The headway elasticities are also somewhat lower for the peak trips, though there is no indication of whether the values are based on increases or decreases in headway. The smaller elasticities may reflect either an already well-served market segment (peak work trips), or a less flexible group of commuters. There appears to be no significant difference between the elasticities for bus and commuter rail, regardless of method of calculation, with the exception of off-peak trips (which exhibit a rather higher degree of variability).

3.5.3. Individual Trip Attributes

These elasticities are with respect to the attributes of individual trips rather than those of a route or of the system. As such, these values come closer to capturing the riders' preferences and attitudes towards the service as it affects the quality of particular trips. These elasticities are based almost exclusively on non-experimental approaches, relying primarily on discrete choice models of individual mode choice behavior, usually calibrated using a cross-section of tripmakers.

The first attribute considered is the total travel time for a trip, which includes the walking and waiting times in addition to the in-vehicle travel time.

Total Travel Time	Average Elasticity ± Standard Deviation
Bus (non-experimental)	
Peak	-1.03 ± 0.13 (2 cases)
Off-peak	-0.92 ± 0.37 (2 cases)
Bus and rapid rail (non-experimental)	
Off-peak	-0.59 (1 case)

Source: Meyer and Miller (1984)

The elasticities reported indicate that riders are more sensitive to total travel time than to comparable percent changes in any other feature. The absolute values of the travel time elasticities may actually exceed 1, indicating that a percentage point improvement in total travel time induces more than a 1% increase in ridership.

Next, the in-vehicle component of the total travel time is considered.

In-Vehicle Time	Average Elasticity ± Standard Deviation
Bus (quasi-experimental)	
Peak	-0.29 ± 0.13 (9 cases)
Off-peak	-0.83 (1 case)
Bus (non-experimental)	
Peak	-0.68 ± 0.32 (7 cases)
Off-peak	-0.12 (1 case)
Rapid rail (non-experimental)	
Peak	-0.70 ± 0.10 (2 cases)
Bus and rapid rail (non-experimental)	
Peak	-0.30 ± 0.10 (2 cases)
All hours	-0.27 (1 case)
Commuter rail (non-experimental)	
All hours	-0.59 ± 0.28 (9 cases)

Source: Meyer and Miller (1984)

As expected, riders are less sensitive to improvements in in-vehicle travel time than they are to total travel time. In-vehicle travel time is generally much better tolerated than waiting time. The limited number of cases make any general conclusions regarding the differences between peak and off-peak, bus and rail, or non- and quasi-experimental calculation methods difficult. The values are nevertheless relatively high, especially when compared to the fare elasticities.

In the case of walk-time, the person's reaction is greater during the peak hours. This may be because people traveling during the peak have less flexibility in their schedules and are therefore more sensitive to changes in this attribute. However, it is not appropriate to generalize on the basis of just one case.

Transfer-time	Average Elasticity ± Standard Deviation
Bus and rapid rail (non-experimental)	
Peak	-0.40 ± 0.18 (3 cases)
Number-of-transfers	
Bus (non-experimental)	
Off-peak	-0.59 (1 case)

Source: Meyer and Miller (1984)

The above values indicate that travelers appear to be more sensitive to relative changes in the number of transfers than in the transfer time. However, such information is difficult to obtain because it has not been adequately addressed in past studies.

In general, it appears that riders are less sensitive to fare changes than to changes in the level of service provided by the transit system. While fare changes do affect ridership, a transit agency would realize a larger impact by improving service. This issue is addressed further in the next chapter.

3.6. DEFINITION OF MARKET SEGMENTS

The above fare elasticities can be used to explore the ridership impacts of alternative fare changes and policies in connection with appropriately defined market segments. At this stage, a detailed set of market segments has been defined for this purpose. These are intended primarily to provide a conceptual framework for the analysis. However, it should be noted that the data is not presently available to support such fine differentiation across segments. The market segments are defined on the following criteria:

a. Service Type: regular fixed route service, Park & Ride, 'Dillo and STS
b. Socio-Demographic Characteristics: students, senior citizens, mobility-impaired and "regular" (the latter corresponding to those that currently pay full fare, whereas the first three receive half-price discounts).

c. Transit Status: riders who possess a valid driver's licence and have access to a car (choice rider); riders who have a valid driver's licence, but no access to a car; and riders who do not have a valid driver's licence (captive riders).
d. Pass Usage: Pass, no pass
e. Time-of-Day: Peak, off-peak
f. Trip Length: Long trip, short trip.

Figure 6 lists all the combinations for each service type in this study. An explanation of the rationale for including or excluding certain categories is presented hereafter for each service type.

Regular Fixed Route Service For "regular" and mobility impaired riders, all combinations of the levels of factors c-f above are considered. Because students' trips do not exhibit the concentrated patterns of commuters, time-of-day is not considered for that group. Pass usage is also not considered for students because they do not receive the one-half price discount for passes (as they do with cash fares), and student passes were phased out upon the acquisition by Capital Metro of the Laidlaw-operated UT Shuttle Bus System. Therefore, the only market segments considered for student trips, on regular routes, are defined on the basis of captive status and trip length. Time-of-day is also not considered for senior citizen trips. However, all other combinations will be considered for senior citizens' trips on regular routes.

Park & Ride Routes The majority of the service provided by the Park & Ride routes takes place during the peak hours, and corresponds to long trips. Therefore, only one level of each of the trip length and time-of-day factors are considered. All combinations of the levels of captive status and pass usage are considered for all user types of Park & Ride, with the exception that pass usage is not included for students (for the same reasons mentioned earlier).

'Dillo Most of these trips are short, therefore only this level is considered for the trip length factor. Because all riders currently pay the same fare, 'Dillo riders are not partitioned on the basis of socio-demographics. All possible combinations of captive status, pass usage, and time-of-day are considered.

The above segmentation is deliberately very detailed in order to provide a flexible basis for analysis and evaluation. The classes defined can be easily aggregated into classes compatible with the available data and the purposes of any particular analysis.

3.7. CONCLUDING COMMENTS

The elasticities reviewed in this report provide a distillation of the transit industry's experience. However, several important cautionary comments must be kept in mind when trying to interpret this data:

1) There is considerable variability across systems and over time in the reported elasticities; this is compounded by the differences in the sources for and the manner in which the elasticities were computed. Therefore, extreme caution must be exercised in trying to apply the results locally.

2) The elasticities reported are in most cases aggregate measures for a whole system or portions thereof. The documented variation of the elasticities across market segments and service types further suggests that it is dangerous to take such aggregate values and apply them to very specific localized proposals.

3) Fare decreases will never attract sufficient riders to compensate for the loss in revenues. In subsequent analysis, described in the next chapter, we examine cost trade-offs between alternative actions for a given ridership impact, and compare such actions and policies on the basis of subsidy per additional rider.

4) Major limitations in using transferred fare elasticities for policy analysis are that issues of service quality are ignored (i.e., the same response to fare changes is predicted regardless of whether the service is convenient or not), and that no provision is made for the effect of information dissemination and promotional activities. Both of these factors can be critical in the Capital Metro situation.

5) Information on user response is critically needed at the local level for future Capital Metro planning activities. Such information could be obtained using stated preference approaches (successfully tried elsewhere) and possibly small-scale targeted experimentation.

Nevertheless, in the absence of locally collected data, the elasticities reviewed in this chapter provide a starting point for the analysis and evaluation of alternative fare-related strategies and programs. However, keeping in mind the above limitations, it is essential to perform sensitivity analysis with respect to the values of these elasticities. For this reason, a range of reported values is considered for each market segment in the evaluation procedure discussed in the next chapter.

REGULAR ROUTES

FULL FARE
LNC-P-PK-ST
LNC-P-PK-LT
LNC-P-OPK-ST
LNC-P-OPK-LT
LNC-NP-PK-ST
LNC-NP-PK-LT
LNC-NP-OPK-ST
LNC-NP-OPK-LT
LC-P-PK-ST
LC-P-PK-LT
LC-P-OPK-ST
LC-P-OPK-LT
LC-NP-PK-ST
LC-NP-PK-LT
LC-NP-OPK-ST
LC-NP-OPK-LT
NL-P-PK-ST
NL-P-PK-LT
NL-P-OPK-ST
NL-P-OPK-LT
NL-NP-PK-ST
NL-NP-PK-LT
NL-NP-OPK-ST
NL-NP-OPK-LT

1/2 FARE--STUDENTS
LNC-ST
LNC-LT
LC-ST
LC-LT
NL-ST
NL-LT

LEGEND
LNC=LICENSED/NO CAR
LC=LICENSED/CAR
NL=NO LICENSE

P=PASS
NP=NO PASS

PK=PEAK
OPK=OFF-PEAK

LT=LONG TRIP
ST=SHORT TRIP

1/2 FARE--SENIOR CITIZENS
LNC-P-ST
LNC-P-LT
LNC-NP-ST
LNC-NP-LT
LC-P-ST
LC-P-LT
LC-NP-ST
LC-NP-LT
NL-P-ST
NL-P-LT
NL-NP-ST
NL-NP-LT

1/2 FARE--MOBILITY IMPAIRED
LNC-P-PK-ST
LNC-P-PK-LT
LNC-P-OPK-ST
LNC-P-OPK-LT
LNC-NP-PK-ST
LNC-NP-PK-LT
LNC-NP-OPK-ST
LNC-NP-OPK-LT
LC-P-PK-ST
LC-P-PK-LT
LC-P-OPK-ST
LC-P-OPK-LT
LC-NP-PK-ST
LC-NP-PK-LT
LC-NP-OPK-ST
LC-NP-OPK-LT
NL-P-PK-ST
NL-P-PK-LT
NL-P-OPK-ST
NL-P-OPK-LT
NL-NP-PK-ST
NL-NP-PK-LT
NL-NP-OPK-ST
NL-NP-OPK-LT

PARK AND RIDE

FULL FARE
LNC-P
LNC-NP
LC-P
LC-NP
NL-P
NL-NP

1/2 FARE--STUDENTS
LNC
LC
NL

1/2 FARE--SENIOR CITIZENS
LNC-P
LNC-NP
LC-P
LC-NP
NL-P
NL-NP

1/2 FARE--MOBILITY IMPAIRED
LNC-P
LNC-NP
LC-P
LC-NP
NL-P
NL-NP

'DILLO
LNC-P-PK
LNC-P-OPK
LNC-NP-PK
LNC-NP-OPK
LC-P-PK
LC-P-OPK
LC-NP-PK
LC-NP-OPK
NL-P-PK
NL-P-OPK
NL-NP-PK
NL-NP-OPK

Figure 6. Market Segments

CHAPTER 4: EVALUATION OF FARE POLICY ALTERNATIVES

4.1. INTRODUCTION

This chapter presents the application of an evaluation framework based on market-specific elasticities, presented in the previous chapter, to the analysis of several alternative fare scenarios for the Capital Metro service area, in terms of their impact on ridership and revenues. The scenarios include: 1) systemwide fare increase or decrease (including systemwide free fare), in order to illustrate the overall sensitivity to fare changes, 2) free off-peak for senior citizens, 3) free off-peak systemwide, and 4) geographically delineated free-fare zones. In addition, a comparison of the relative impacts of increased vehicle-miles (and other service characteristics) to those of lower fares is performed. The methodology, assumptions and results of each of these scenarios are discussed in detail hereafter.

4.2. SYSTEMWIDE FARE CHANGES

This analysis illustrates the change in ridership and revenue that would result from a uniformly applied fare increase or decrease. The impacts are calculated for changes in 10% (of the current fare) increments up to a 50% increase, and decreases down to 100%. Note that the computed values were intended to generate the overall *trend* in ridership response to fare changes, rather than to evaluate this response for the specific levels considered. The elasticity values used for a given market segment were slightly higher (in general) for fare increases than for fare decreases; in addition, a separate free fare scenario was tested using elasticities derived from actual free fare experiments.

The ridership on regular fixed routes and on Park and Ride routes are divided into the following four primary market segments: 1) "full-fare" riders (i.e. those who pay the full cash fare, or pay the full price of a pass); 2) students; 3) senior citizens; and 4) the mobility impaired. Primary market segments 2, 3, and 4 are considered "half-fare" whether they pay cash or use a pass. The ridership on the 'Dillo is not divided into the above primary market segments because all passengers pay the same fare. The four primary market segments (and the 'Dillo ridership) are further divided into more specific segments defined on the basis of all appropriate combinations of the levels of the following factors: captive status (i.e. licence/car, licence/no car, and no licence), pass usage, trip length, and time of travel (i.e. peak vs. off-peak). These are summarized in Table 4. (See Chapter 3 for a more detailed explanation of the

Table 4. Market Segments and Associated Elasticity Ranges.

MARKET SEGMENTS	ELAS.- INCREASE			ELAS.-DECREASE			ELAS.-FREE FARE		
Regular Routes									
FULL FARE	Lower	Middle	Higher	Lower	Middle	Higher	Lower	Middle	Higher
LC-NP-PK-ST	-0.09	-0.35	-0.60	-0.09	-0.32	-0.55	-0.05	-0.35	-0.64
LC-NP-PK-LT	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
LC-NP-OPK-ST	-0.18	-0.41	-0.63	-0.18	-0.41	-0.63	-0.08	-0.36	-0.64
LC-NP-OPK-LT	-0.12	-0.38	-0.63	-0.12	-0.38	-0.63	-0.08	-0.36	-0.64
LNC-NP-PK-ST	-0.09	-0.35	-0.60	-0.09	-0.32	-0.55	-0.05	-0.35	-0.64
LNC-NP-PK-LT	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
LNC-NP-OPK-ST	-0.18	-0.40	-0.62	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
LNC-NP-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
NL-NP-PK-ST	-0.09	-0.35	-0.60	-0.09	-0.32	-0.55	-0.05	-0.35	-0.64
NL-NP-PK-LT	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
NL-NP-OPK-ST	-0.18	-0.40	-0.62	-0.18	-0.40	-0.62	-0.08	-0.36	-0.64
NL-NP-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
LC-P-PK-ST	-0.09	-0.35	-0.60	-0.09	-0.32	-0.55	-0.05	-0.35	-0.64
LC-P-PK-LT	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
LC-P-OPK-ST	-0.18	-0.41	-0.63	-0.18	-0.41	-0.63	-0.08	-0.36	-0.64
LC-P-OPK-LT	-0.12	-0.38	-0.63	-0.12	-0.38	-0.63	-0.08	-0.36	-0.64
LNC-P-PK-ST	-0.09	-0.35	-0.60	-0.09	-0.32	-0.55	-0.05	-0.35	-0.64
LNC-P-PK-LT	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
LNC-P-OPK-ST	-0.18	-0.40	-0.62	-0.18	-0.40	-0.62	-0.08	-0.36	-0.64
LNC-P-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
NL-P-PK-ST	-0.09	-0.35	-0.60	-0.09	-0.32	-0.55	-0.05	-0.35	-0.64
NL-P-PK-LT	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
NL-P-OPK-ST	-0.18	-0.40	-0.62	-0.18	-0.40	-0.62	-0.08	-0.36	-0.64
NL-P-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
1/2 FARE--STUDENTS									
LNC-ST	-0.05	-0.33	-0.60	-0.05	-0.30	-0.55	-0.08	-0.36	-0.64
LNC-LT	-0.05	-0.33	-0.60	-0.05	-0.27	-0.48	-0.08	-0.36	-0.64
LC-ST	-0.05	-0.33	-0.60	-0.05	-0.30	-0.55	-0.08	-0.36	-0.64
LC-LT	-0.05	-0.33	-0.60	-0.05	-0.27	-0.48	-0.08	-0.36	-0.64
NL-ST	-0.05	-0.33	-0.60	-0.05	-0.30	-0.55	-0.08	-0.36	-0.64
NL-LT	-0.05	-0.33	-0.60	-0.05	-0.27	-0.48	-0.08	-0.36	-0.64
1/2 FARE--SENIOR CITIZENS									
LC-NP-ST	-0.23	-0.42	-0.60	-0.18	-0.38	-0.58	-0.08	-0.36	-0.64
LC-NP-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LNC-NP-ST	-0.23	-0.42	-0.60	-0.18	-0.38	-0.58	-0.08	-0.36	-0.64
LNC-NP-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
NL-NP-ST	-0.23	-0.42	-0.60	-0.18	-0.38	-0.58	-0.08	-0.36	-0.64
NL-NP-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LC-P-ST	-0.23	-0.42	-0.60	-0.18	-0.38	-0.58	-0.08	-0.36	-0.64
LC-P-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LNC-P-ST	-0.23	-0.42	-0.60	-0.18	-0.38	-0.58	-0.08	-0.36	-0.64
LNC-P-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
NL-P-ST	-0.23	-0.42	-0.60	-0.18	-0.38	-0.58	-0.08	-0.36	-0.64
NL-P-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64

Table 4. Market Segments and Associated Elasticity Ranges (ctd.).

1/2 FARE--MOBILITY IMPAIRED									
LC-NP-PK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.64
LC-NP-PK-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
LC-NP-OPK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
LC-NP-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
LNC-NP-PK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.64
LNC-NP-PK-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
LNC-NP-OPK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
LNC-NP-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
NL-NP-PK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.64
NL-NP-PK-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
NL-NP-OPK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
NL-NP-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
LC-P-PK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.64
LC-P-PK-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
LC-P-OPK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
LC-P-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
LNC-P-PK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.64
LNC-P-PK-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
LNC-P-OPK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
LNC-P-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
NL-P-PK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.64
NL-P-PK-LT	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
NL-P-OPK-ST	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.36	-0.64
NL-P-OPK-LT	-0.12	-0.36	-0.60	-0.12	-0.33	-0.54	-0.08	-0.36	-0.64
PARK AND RIDE									
FULL FARE									
LC-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
LNC-NP	-0.12	-0.36	-0.60	-0.12	-0.35	-0.57	-0.05	-0.35	-0.64
NL-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.05	-0.35	-0.64
LC-P	-0.09	-0.35	-0.60	-0.09	-0.33	-0.57	-0.05	-0.35	-0.64
LNC-P	-0.09	-0.35	-0.60	-0.09	-0.29	-0.48	-0.05	-0.35	-0.64
NL-P	-0.09	-0.35	-0.60	-0.09	-0.33	-0.57	-0.05	-0.35	-0.64
1/2 FARE--STUDENTS									
LNC	-0.05	-0.33	-0.60	-0.05	-0.27	-0.48	-0.08	-0.36	-0.64
LC	-0.05	-0.33	-0.60	-0.05	-0.27	-0.48	-0.08	-0.36	-0.64
NL	-0.05	-0.33	-0.60	-0.05	-0.27	-0.48	-0.08	-0.36	-0.64
1/2 FARE--SENIOR CITIZENS									
LC-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LNC-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
NL-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LC-P	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LNC-P	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
NL-P	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64

Table 4. Market Segments and Associated Elasticity Ranges (ctd.).

1/2 FARE--MOBILITY IMPAIRED									
LC-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LNC-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
NL-NP	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LC-P	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
LNC-P	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
NL-P	-0.12	-0.36	-0.60	-0.12	-0.30	-0.48	-0.08	-0.36	-0.64
'DILLO									
LC-NP-PK	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.65
LC-NP-OPK	-0.18	-0.41	-0.63	-0.18	-0.41	-0.63	-0.08	-0.42	-0.75
LNC-NP-PK	-0.14	-0.37	-0.60	-0.14	-0.35	-0.55	-0.05	-0.35	-0.65
LNC-NP-OPK	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.42	-0.75
NL-NP-PK	-0.13	-0.37	-0.60	-0.13	-0.34	-0.55	-0.05	-0.35	-0.65
NL-NP-OPK	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.42	-0.75
LC-P-PK	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.05	-0.35	-0.65
LC-P-OPK	-0.18	-0.41	-0.63	-0.18	-0.41	-0.63	-0.08	-0.42	-0.75
LNC-P-PK	-0.14	-0.37	-0.60	-0.14	-0.35	-0.55	-0.05	-0.35	-0.65
LNC-P-OPK	-0.18	-0.39	-0.60	-0.18	-0.37	-0.55	-0.08	-0.42	-0.75
NL-P-PK	-0.13	-0.37	-0.60	-0.13	-0.34	-0.55	-0.05	-0.35	-0.65
NL-P-OPK	-0.17	-0.39	-0.60	-0.17	-0.36	-0.55	-0.08	-0.42	-0.75

LEGEND

LNC=LICENSED-NO CAR	PK=PEAK	P=PASS	ST=SHORT TRIP
LC=LICENSED-CAR	OPK=OFF-PEAK	NP=NO PASS	LT=LONG TRIP
NL=NO LICENSE			

combinations of the specific market segments corresponding to each of the above primary segments.)

"Current", or base-case, ridership figures are representative of conditions preceding the September merger with the UT-shuttle system. Farebox data from one week in June was used to estimate the percentages of the primary market segments. It is assumed that the percentage of riders who are "full-fare," students, or senior citizens/mobility impaired remain relatively constant over the year. The percentage of riders using transfers or passes is also obtained from the farebox data and assumed to remain constant over the year. Sensitivity analyses have shown that the results are relatively robust with regard to small departures from these assumptions.

The methodology presented in this chapter treats senior citizens and the mobility impaired as separate market segments, although the farebox counts do not distinguish between these groups. Information from a Capital Metro market survey (Nu-Stats, 1988) was used to determine the relative proportions of the two groups.

In the farebox data base, "full-fare" refers to full *cash* price; in the segmentations presented in this report, "full-fare" refers to full *cash or pass* price. Pass users are coded in the farebox as one category whether the pass is a half-fare or full-fare pass. The proportion of pass usage that is "full-" or "half-fare" is assumed to be the same as that for pass sales. The pass sales reports for February-May, 1988, indicate an average of 36% half-fare passes and 64% full-fare passes. The percentage of pass users who transfer is assumed to be the same as that for cash users.

The current, or base-case, ridership value used in the analysis is the number of "linked revenue person-trips," which is equivalent to the total boardings (from the reports) less the number of transfers (cash and pass) and non-revenue trips. The number of transfers are subtracted because the transferring passenger is simply continuing the original trip, and most available model-derived elasticities are applicable to such complete linked trips, rather than to undifferentiated boardings. The number of non-revenue passengers is subtracted from the total boardings because ridership frequency of this group would not be influenced by fare changes. The resulting base case ridership and revenue are as follows:

	Average Weekday		Weekend	
Route Type	Ridership	Revenue ($)	Ridership	Revenue ($)
Regular	22,600	9,700	17,200	7,410
'Dillo	2,220	555	300	75
Park & Ride	950	845	77	70

The large sample of fare elasticities reported in the literature, and reviewed in Chapter 3, was synthesized, and ranges of elasticities were individually assigned to all appropriate market segments. Reported elasticities were obtained from demand models (and would apply to a fare decrease or increase), before and after studies of fare decreases, before and after studies of fare increases, and UMTA (Urban Mass Transportation Administration) free fare demonstrations. The high and low ends of a range of applicable elasticities were determined for each specific market segment. The upper and lower bounds on the likely ridership and revenue impacts of contemplated fare changes could then be estimated. When the high end of the elasticity spectrum is used, the ridership impact is, by definition, greatest. As an illustration, when the high elasticity is applied to a fare increase, the largest decrease in ridership is obtained. Similarly, using the high elasticity in connection with a fare decrease would lead to a larger increase in ridership than when a low elasticity is used. Note that the high values correspond to the highest reported anywhere, and tend as such to be rather extreme and highly unlikely for the Capital Metro service area.

Unfortunately, this range is often quite large, as the results presented in this chapter illustrate, and may not be very helpful for policy-making purposes, other than to highlight the need for Austin-specific data. It is helpful to therefore consider less extreme, possibly more representative values towards the middle of the range of elasticities. The middle elasticity for each segment was obtained by averaging the corresponding high and low values. The resulting middle values appear to be towards the higher end of the spectrum encountered for U.S. properties that can be considered comparable to Austin. Therefore, actual values for Austin are likely to be in the lower to middle range of elasticities. Table 4 summarizes the upper and lower ends of the elasticity ranges associated with each market segment, as well as the middle values.

The corresponding revenue impacts are also evaluated. The current revenue is based on all "full-fare" (cash and pass) riders paying 50¢ on regular bus routes and $1.00 on Park and Ride routes, and "half-fare" (cash and pass) riders paying 25¢ on regular routes and 50¢ on Park and Ride routes. Everyone pays 25¢ on the 'Dillo. This analysis assumes that pass holders, on average, use their passes so as to "break-even." This assumption seems to be valid, on average, because the base-case revenue calculated by this method is very close to the reported revenue generated by the farebox and pass sales. In this analysis, the current revenue is $63,100 per week or $265,000 per month (based on 4.2 weeks per month), while the budget report for June, 1988 (the current ridership is based primarily on June data) indicates total farebox and pass sale revenues of $264,858.

For a given fare elasticity ε_k associated with market segment k, the new ridership resulting from a fare decrease (or increase) is determined by the following equation:

$$V_k' = V_{0k} (1 + \varepsilon_k \Delta f_k / f_{0k})$$

where:

V_k' = new ridership

V_{0k} = current ridership

ε_k = fare elasticity

Δf_k = change in fare (negative for fare decrease, positive for fare increase)

f_{0k} = current fare

The total ridership systemwide or for a primary market segment is then obtained by aggregating or summing the ridership in the corresponding specific market segments.

Figures 7-15 show the estimated ridership for each market segment as well as the total revenue that would result from each increment of fare change. For example, Fig. 1 plots this information for regular fixed routes on an average weekday assuming the low elasticities.

Figures 16-18 depict the total (Regular, 'Dillo and Park and Ride) ridership and revenue that would result from the incremental fare changes.

Figures 19 and 20 show the average weekday ridership, by market segment, for the systemwide fare scenario, under the "free fare experiments" elasticities. Figure 21 depicts the total average weekday ridership, by type of service, for the same scenario. Figure 22 presents similar information as Figure 19 for weekend ridership. The corresponding revenue for all the free fare cases is zero.

Table 5 summarizes the ranges of marginal subsidies per new passenger associated with the systemwide fare decrease and free fare scenarios. This subsidy is calculated by dividing the additional cost by the number of riders (more specifically, the number of linked revenue trips, as previously defined). The additional cost considered in this calculation consists exclusively of the revenues lost because of the lower fares. It does *not* include the cost of providing additional service to accommodate overcrowding that would develop along certain routes at certain times of the day, especially under the middle and high elasticity scenarios. The estimation of such cost requires a more

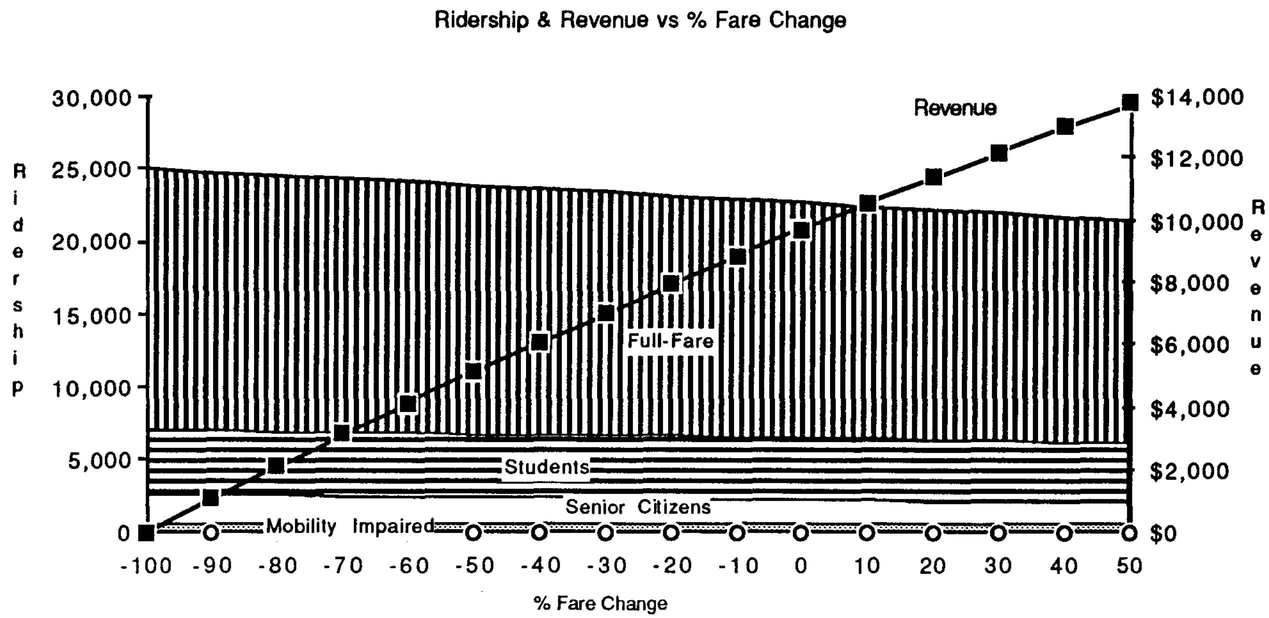


Figure 7. Average Weekday Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Regular Routes, under the Low Fare Elasticities.

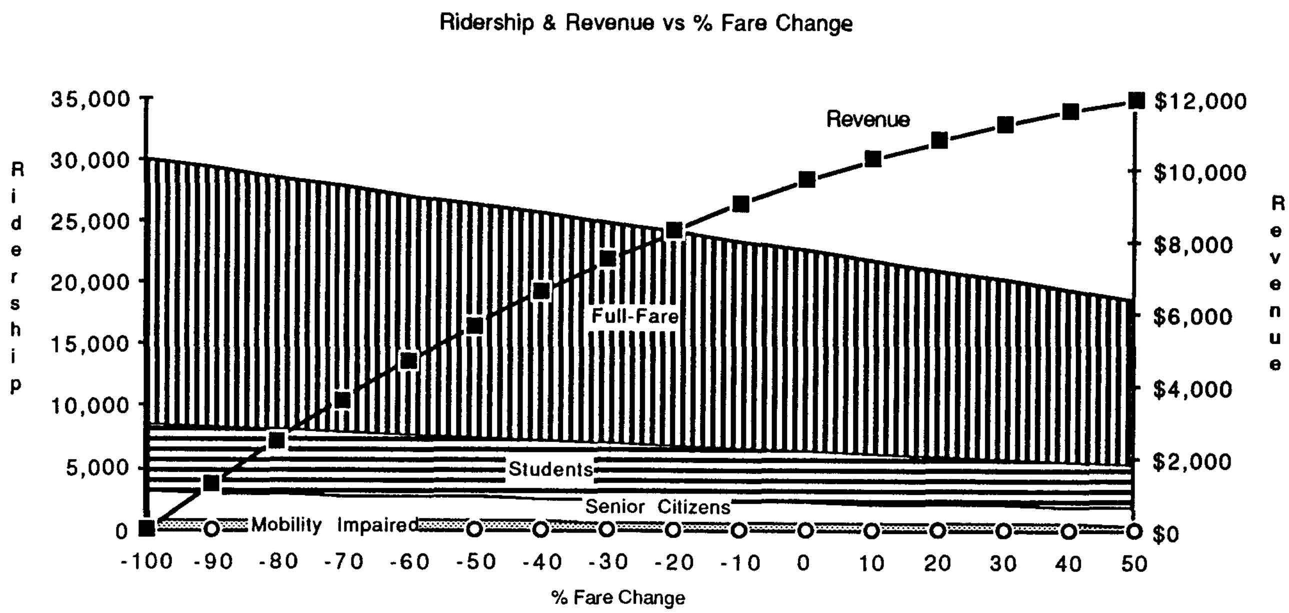


Figure 8. Average Weekday Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Regular Routes, under the Middle Fare Elasticities.

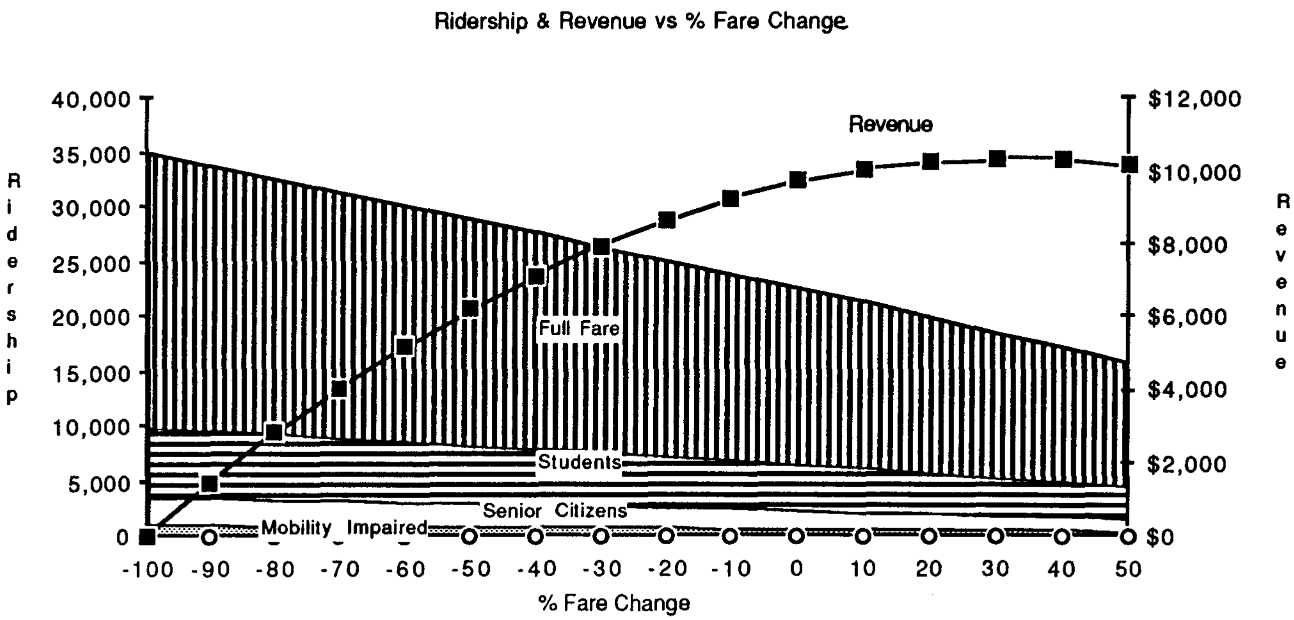


Figure 9. Average Weekday Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Regular Routes, under the High Fare Elasticities.

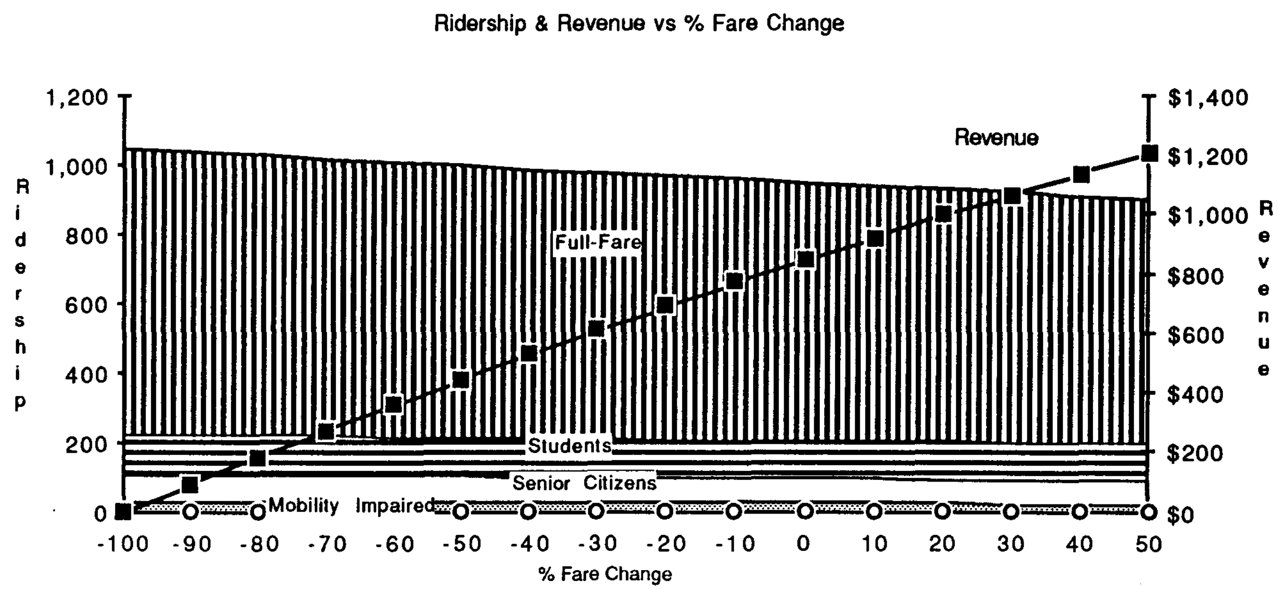


Figure 10. Average Weekday Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Park and Ride Routes, under the Low Fare Elasticities.

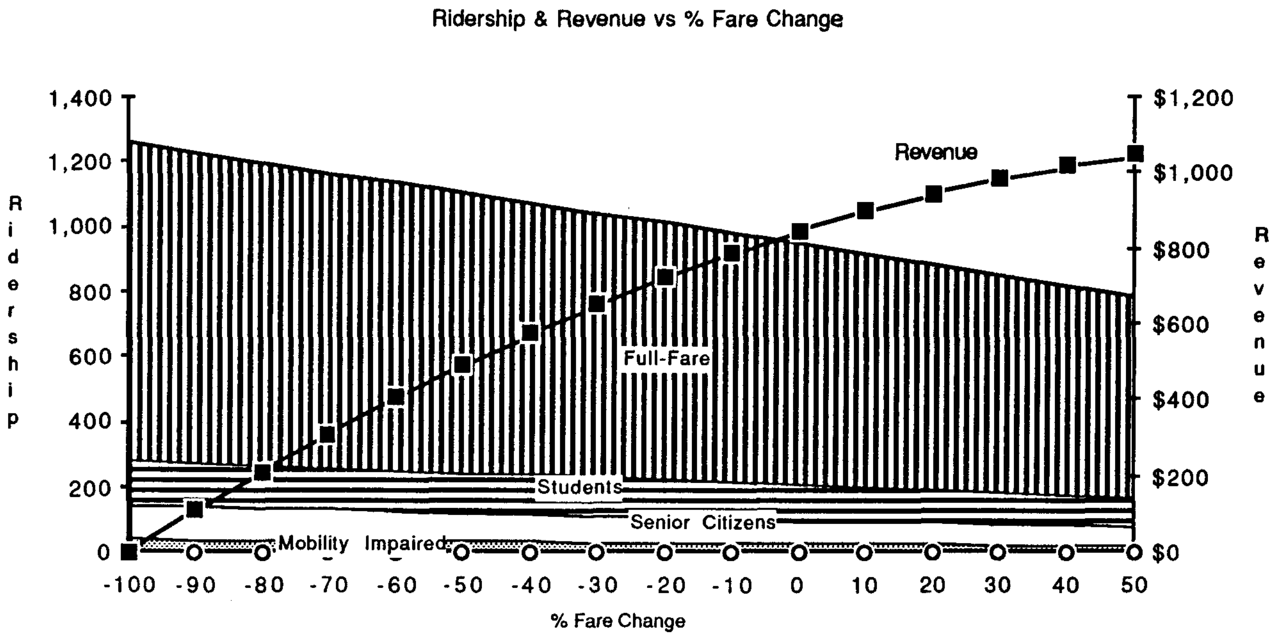


Figure 11. Average Weekday Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Park and Ride Routes, under the Middle Fare Elasticities.

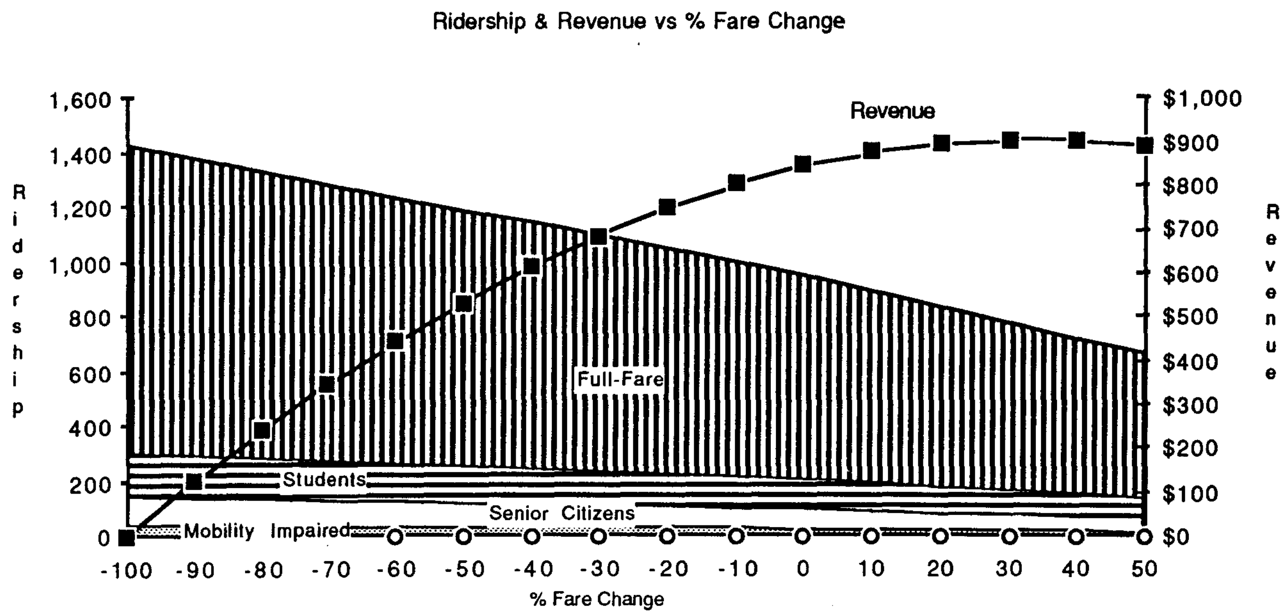


Figure 12. Average Weekday Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Park and Ride Routes, under the High Fare Elasticities.

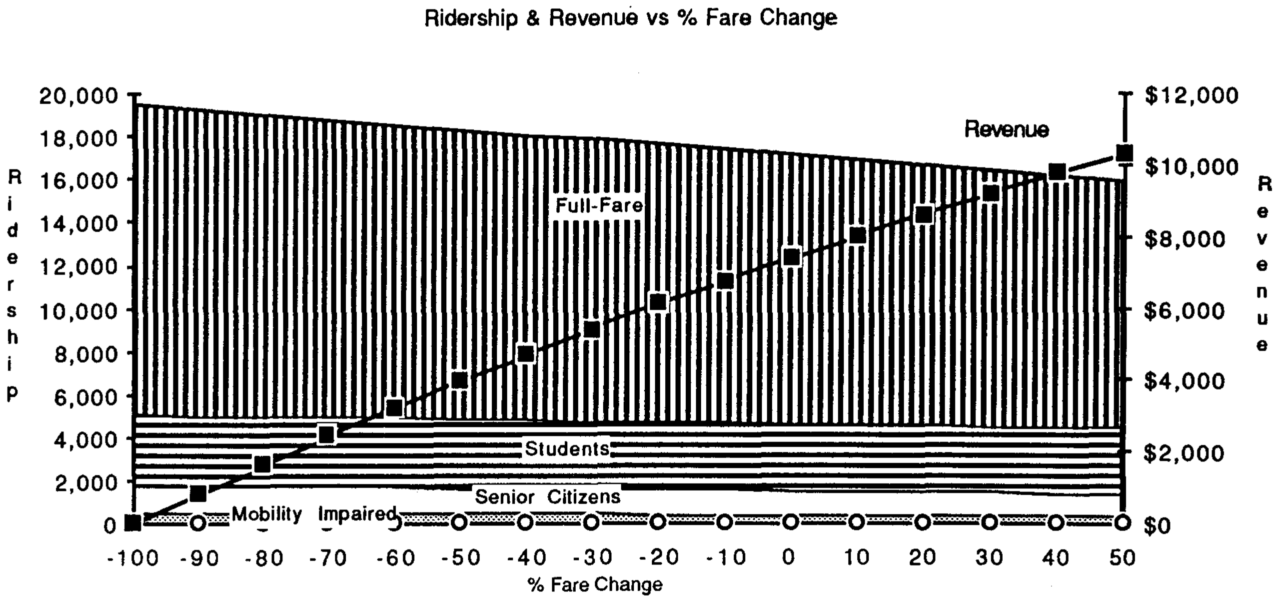


Figure 13. Weekend Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Regular Routes, under the Low Fare Elasticities.

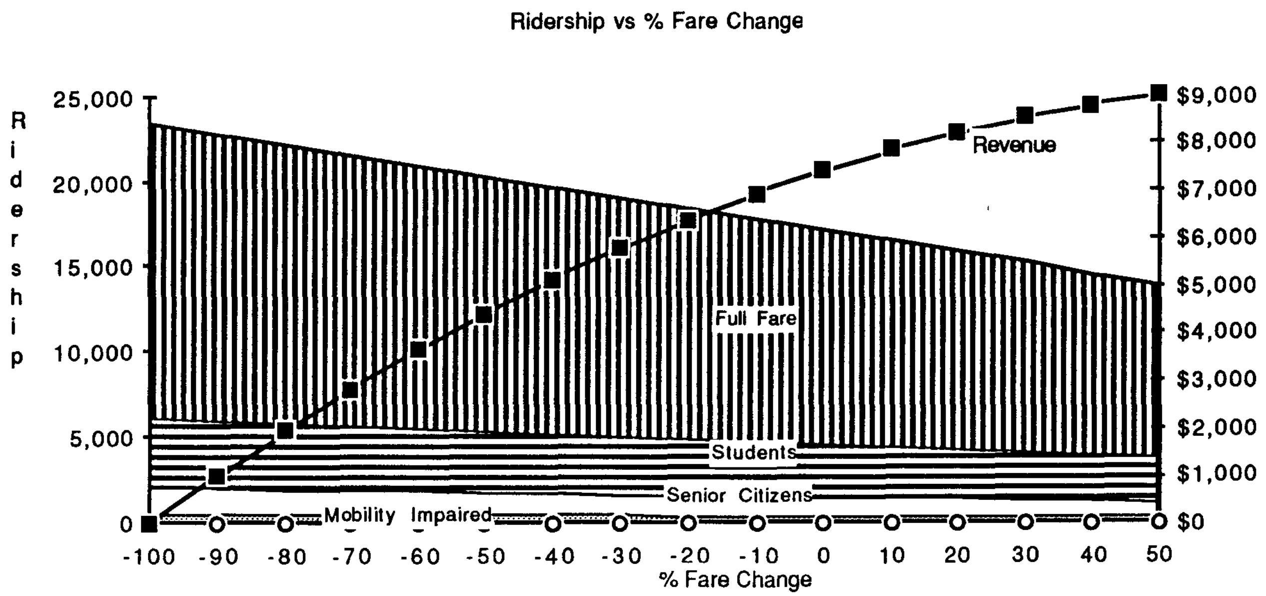


Figure 14. Weekend Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Regular Routes, under the Middle Fare Elasticities.

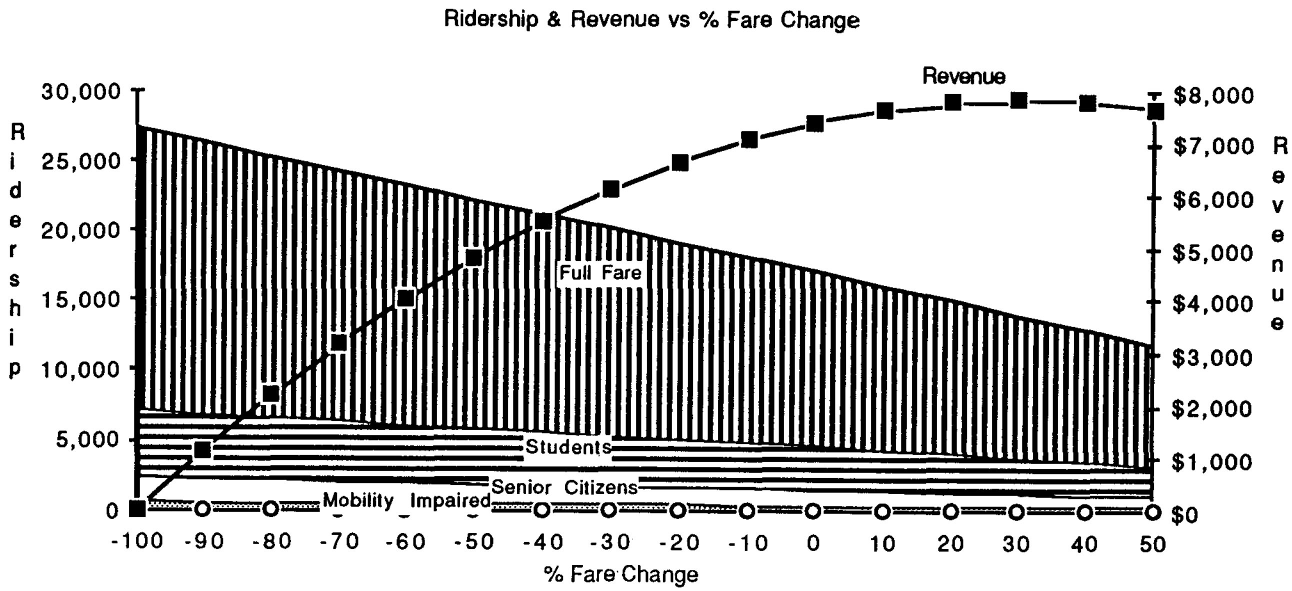


Figure 15. Weekend Ridership, by Market Segment, and Total Revenue vs. Percent Fare Change for Regular Routes, under the High Fare Elasticities.

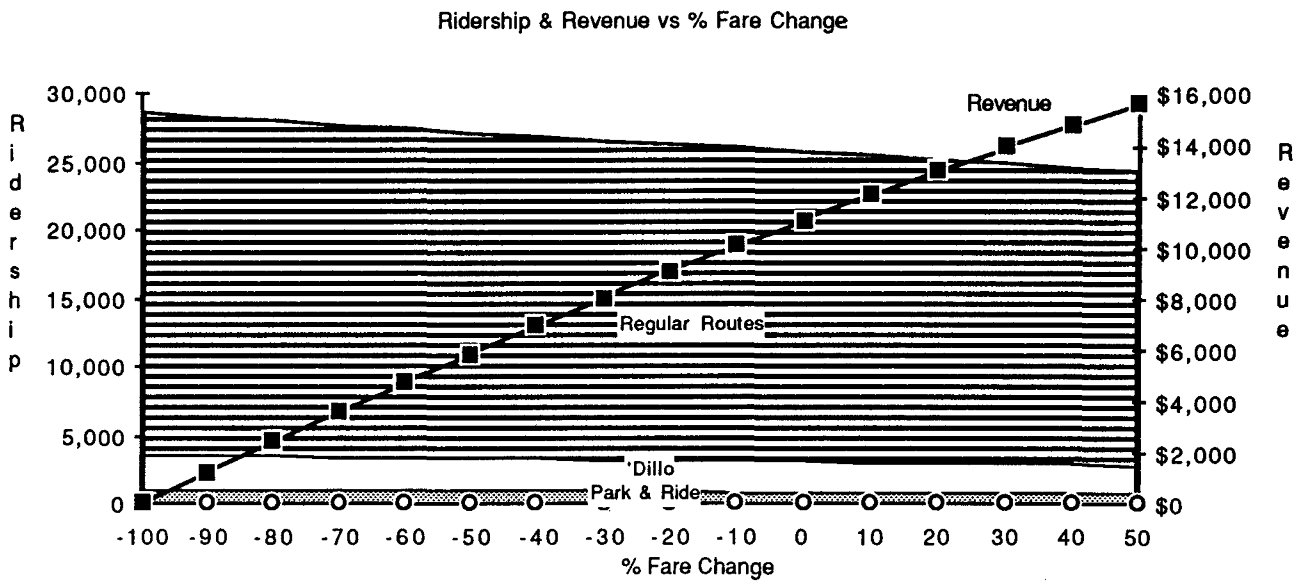


Figure 16. Average Weekday Ridership, by Route Type, and Total Revenue vs. Percent Fare Change under the Low Fare Elasticities

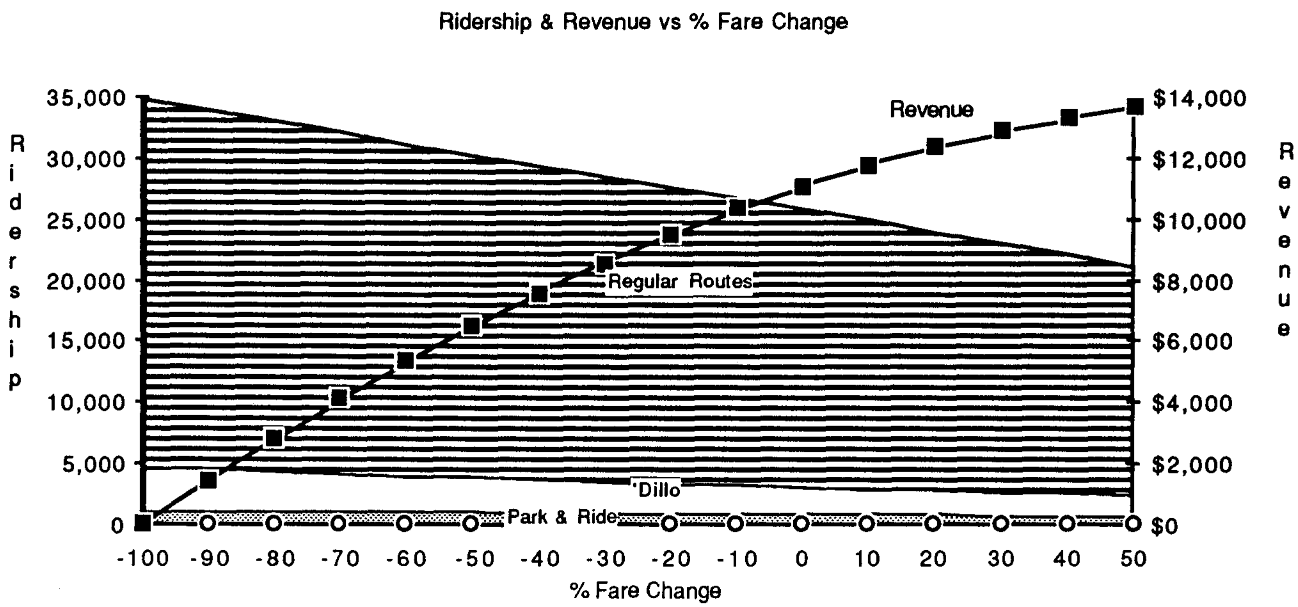


Figure 17. Average Weekday Ridership, by Route Type, and Total Revenue vs. Percent Fare Change under the Middle Fare Elasticities

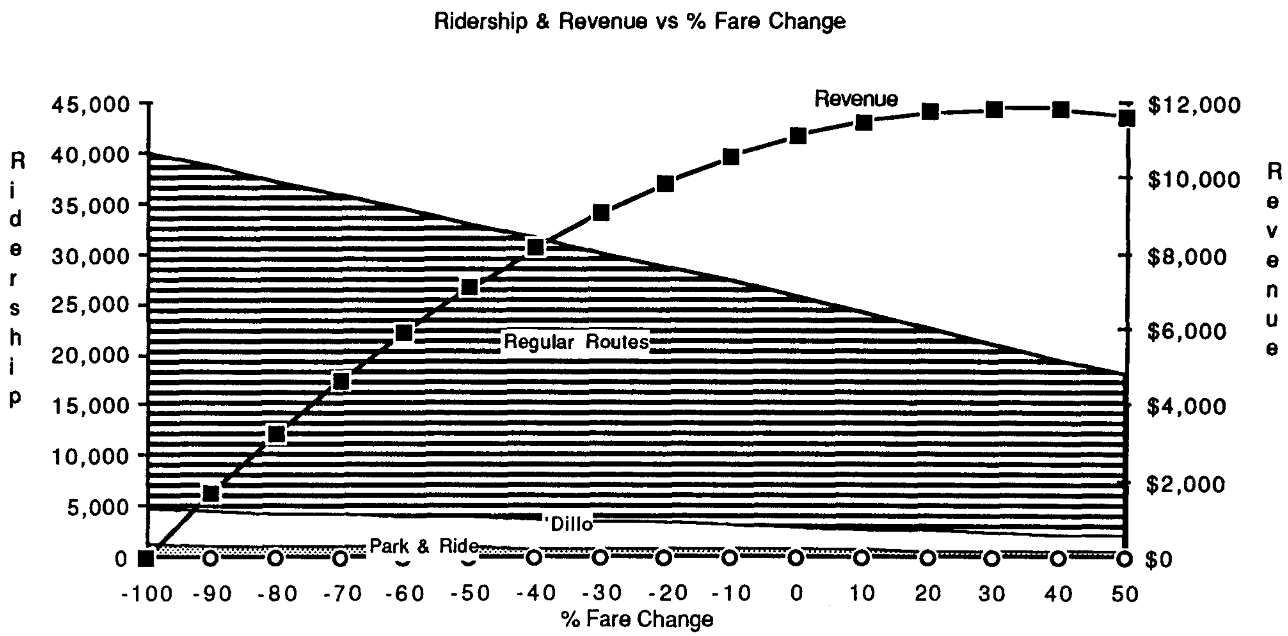


Figure 18. Average Weekday Ridership, by Route Type, and Total Revenue vs. Percent Fare Change under the High Fare Elasticities.

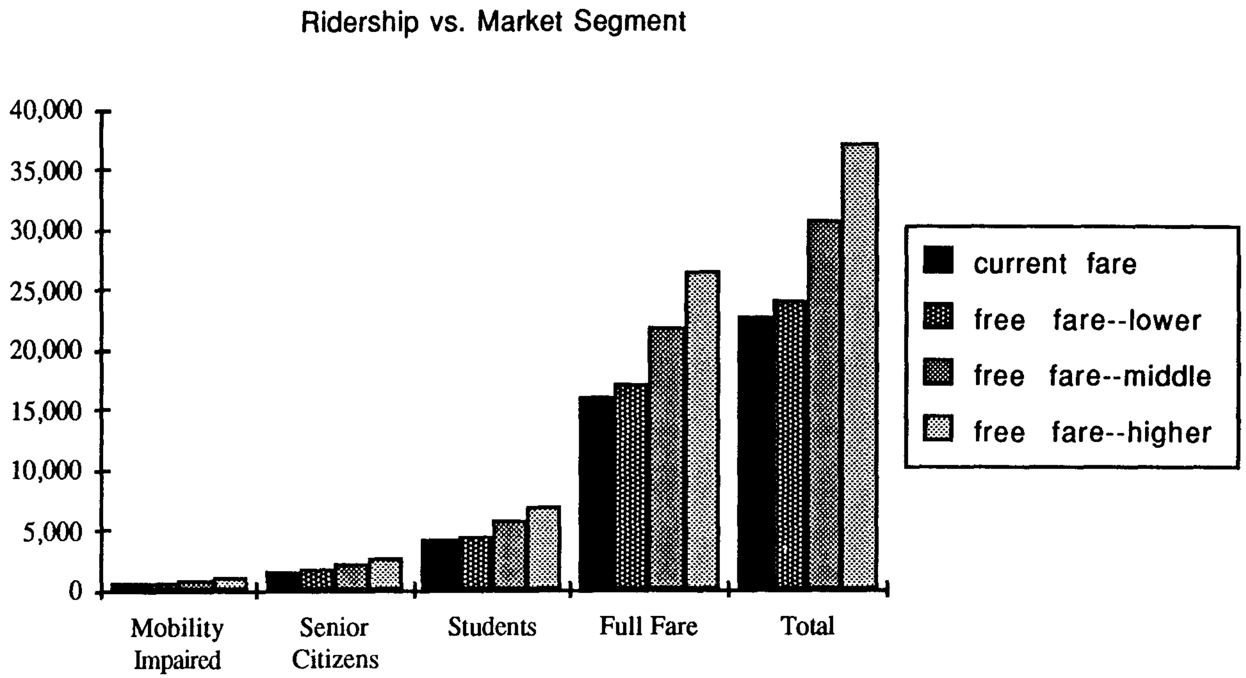


Figure 19. Average Weekday Regular Route Ridership, by Market Segment, for Current Fare and Free Fare under Low, Middle and High Free Fare Elasticities.

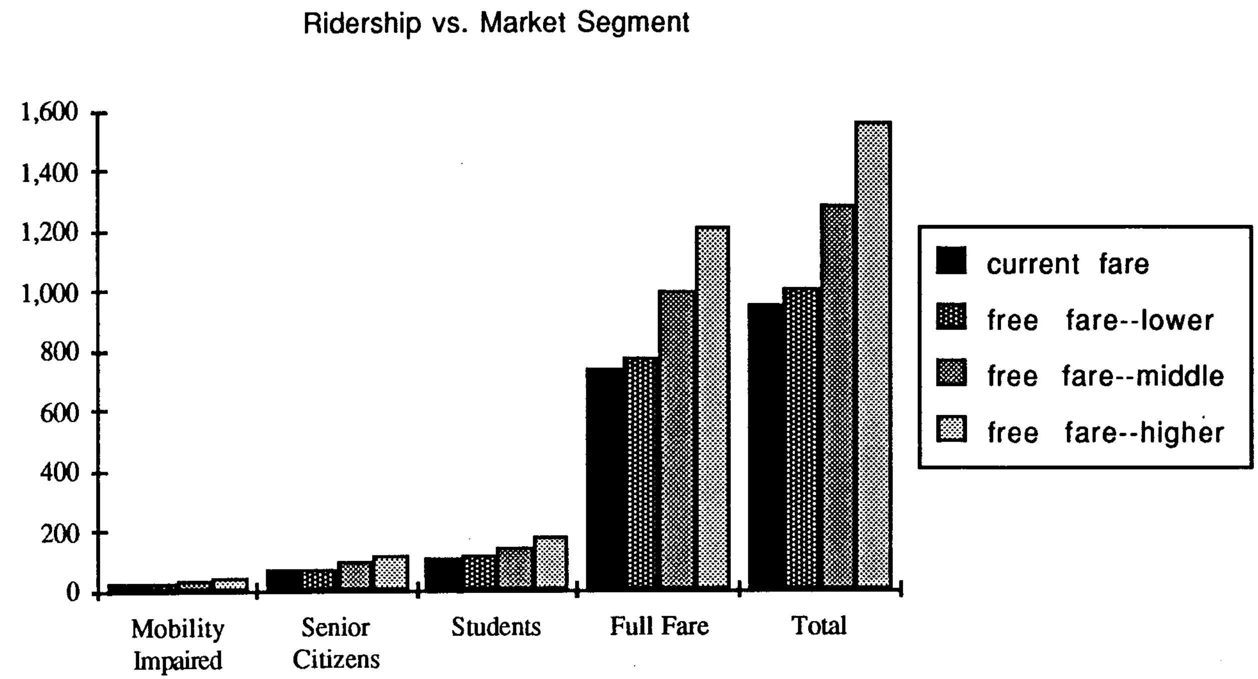


Figure 20. Average Weekday Park and Ride Ridership, by Market Segment, for Current Fare and Free Fare under Low, Middle and High Free Fare Elasticities.

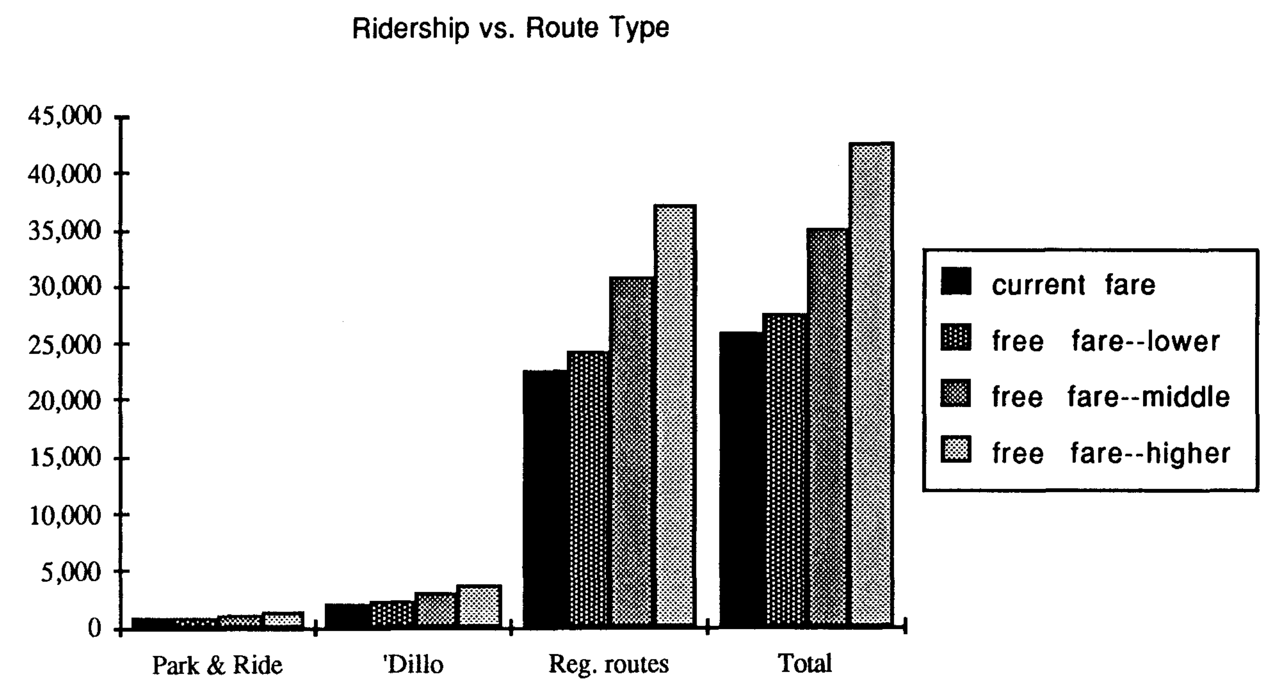


Figure 21. Systemwide Average Weekday Ridership, by Route Type, for Current Fare and Free Fare under Low, Middle and High Free Fare Elasticities.

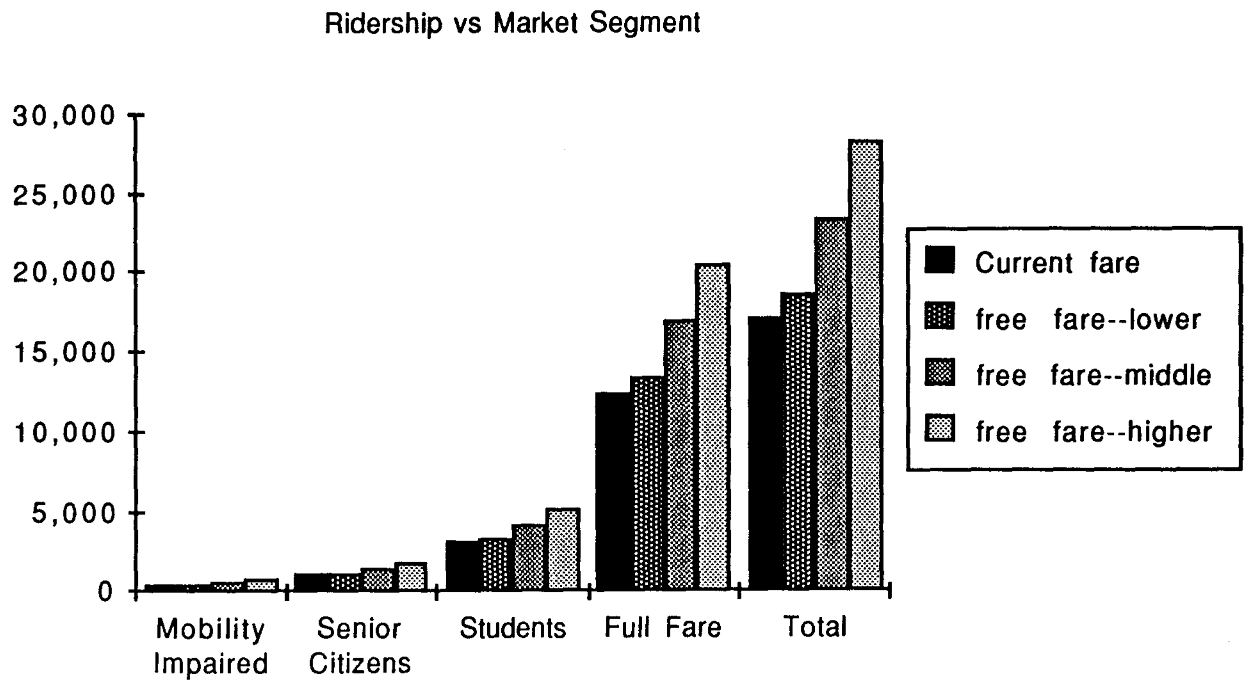


Figure 22. Weekend Regular Route Ridership, by Market Segment, for Current Fare and Free Fare under Low, Middle and High Free Fare Elasticities.

Table 5. Range of Marginal Subsidy per New Rider for Systemwide Fare Increase and Free Fare for the Three Elasticity Levels.

		Fare Decrease	Free Fare
		(Δ cost/Δ passenger gained)	
Regular Routes			
Avg. Wkday	(lower)	$3.62-$4.02	$6.52
	(middle)	0.92- 1.31	1.21
	(higher)	0.39- 0.78	0.67
Weekend	(lower)	2.95- 3.17	5.54
	(middle)	0.83- 1.19	1.21
	(higher)	0.35- 0.73	0.68
'Dillo			
Avg.Wkday	(lower)	1.22- 1.45	4.14
	(middle)	0.20- 0.44	0.67
	(higher)	0.21- 0.44	0.36
Park & Ride			
Avg. Wkday	(lower)	7.93-11.07	15.67
	(middle)	1.96- 2.75	2.56
	(higher)	.94- 1.75	1.39

detailed perspective which is outside the scope of the present analysis. Therefore, the subsidy estimates should be considered as minimum values, with the likelihood of serious underestimation increasing for higher elasticity values. The results in Table 5 illustrate that the cost-effectiveness of fare decreases as a means of inducing ridership is critically dependent on the underlying fare elasticities. It should be stressed further that the high elasticity case is a highly unlikely one for Austin, and is provided here only for illustrative purposes, so as to obtain an absolute upper bound on the potential ridership impact. As noted earlier, the Austin situation can be reasonably expected to lie somewhere between the low and the middle elasticity values.

4.3. FARE-FREE DURING THE OFF-PEAK

This analysis uses the base-case ridership and revenue values from the above scenario, in connection with the free-fare elasticities, which are applied only to the off-peak market segments. No other fare changes were assumed. The free off-peak period is considered to be between 9:00 A.M. and 3:00 P.M., after 6:00 P.M. until the end of the day's service, and all day Saturday and Sunday.

Figure 23 compares the estimated ridership before and after the free off-peak strategy is implemented, assuming an elasticity in the middle of the range. This comparison is made for average weekday, Saturday and Sunday. The corresponding revenue loss would be 32.3% ($11,100 to $7,510) for an average weekday, and 100% for Saturday ($5,280 to $0) and Sunday ($2,290 to $0). The resulting marginal subsidies are as follows:

$1.13/new passenger on an average weekday

$1.19/new passenger on Saturday, and

$1.20/new passenger on Sunday.

The average marginal subsidy is $1.15/new passenger for the week. Similar analyses were conducted for the lower and higher ends of the elasticity spectrum, resulting in an average marginal subsidy of $5.21/new passenger (low elasticity) and $0.64/new passenger (very high elasticity) for the week.

4.4. FREE OFF-PEAK FOR SENIOR CITIZENS

An estimate of the increase in senior citizen and overall ridership under the scenario where senior citizens may ride free during the off-peak would provide an interesting test of the estimation process and an opportunity to calibrate the elasticities to the local context. Because Capital Metro has adopted such a policy as of November 1, 1988, it would be useful to compare the estimated ridership increases with the actual

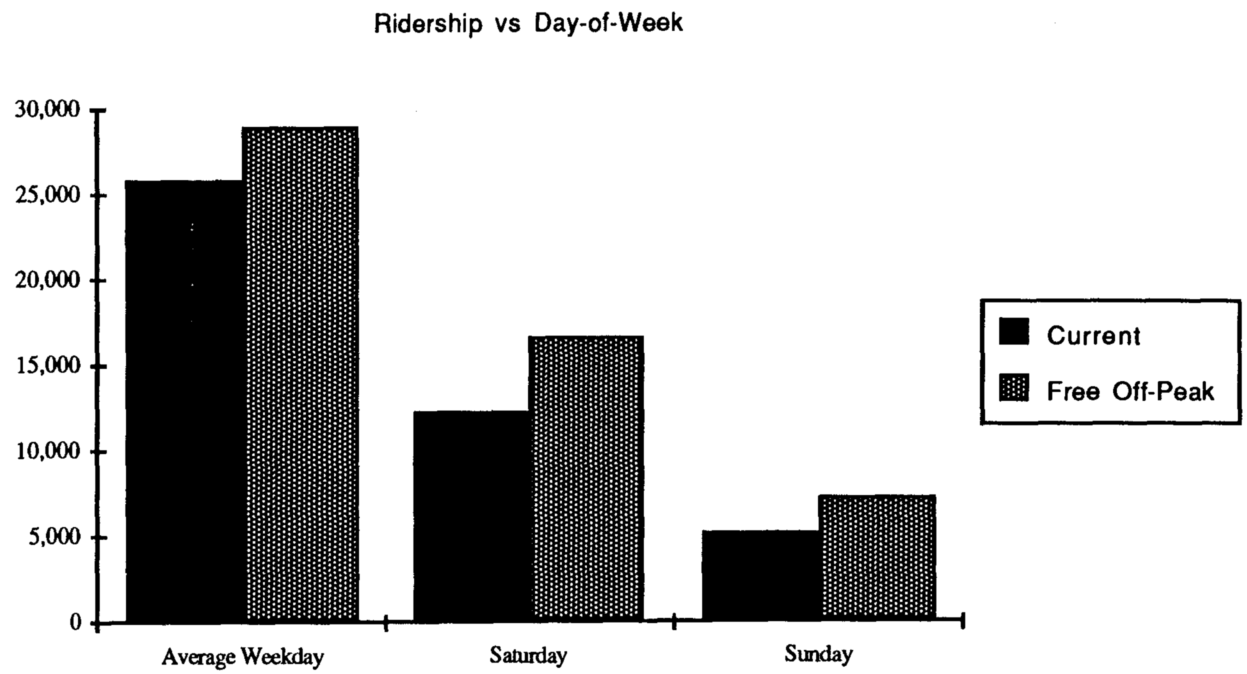


Figure 23. Systemwide Ridership, by Day-of-Week, before and after Implementing Off-Peak Free Fares.

eventual increases. Unfortunately, the latter will be difficult to determine due to the lack of adequate observed "before data," as senior citizens and mobility impaired riders were not separated in the farebox counts prior to this program. Capital Metro planners have estimated this increase at approximately 30%.

The same base-case ridership and revenue values as those described above, as well as the "free-fare" elasticities are used in this analysis. No fare change was assumed for any other market segment. In addition, this analysis did not consider the ridership impacts on the 'Dillo. The number of senior citizens who ride the 'Dillo is relatively small compared to the total who ride the regular routes and Park and Ride routes.

Figure 24 compares the estimated senior citizen ridership before and after the free off-peak for senior citizens strategy is implemented, assuming an elasticity in the middle of the range. This is shown for average weekday, Saturday and Sunday. Figure 25 presents the corresponding total ridership under these scenarios. Figures 26 and 27 presents similar comparisons for the estimated revenue. The resulting marginal subsidies are as follows:

$0.69/new passenger on an average weekday

$0.70/new passenger on Saturday, and

$0.69/new passenger on Sunday.

The average marginal subsidy is $0.69/new passenger for the week. Similar analyses were conducted for the lower and higher ends of the elasticity spectrum, resulting in an average marginal subsidy of $3.08 new passenger (low elasticity) and $0.39/new passenger (very high elasticity) for the week.

4.5. FREE ZONES

This analysis illustrates the application of the fare impact assessment methodology to geographically-based fare strategies. In particular, we consider the scenario of a central zone where no fares would be charged for trips originating and ending in that zone. Three alternative geographic definitions of such a free zone are considered (see map in Fig. 28):

1) the CBD only,
2) the CBD, UT, Zilker Park, and Barton Springs area, and
3) the area from Oltorf (on the South) to 38-1/2 (North), and Exposition (West) to Airport/Pleasant Valley (East).

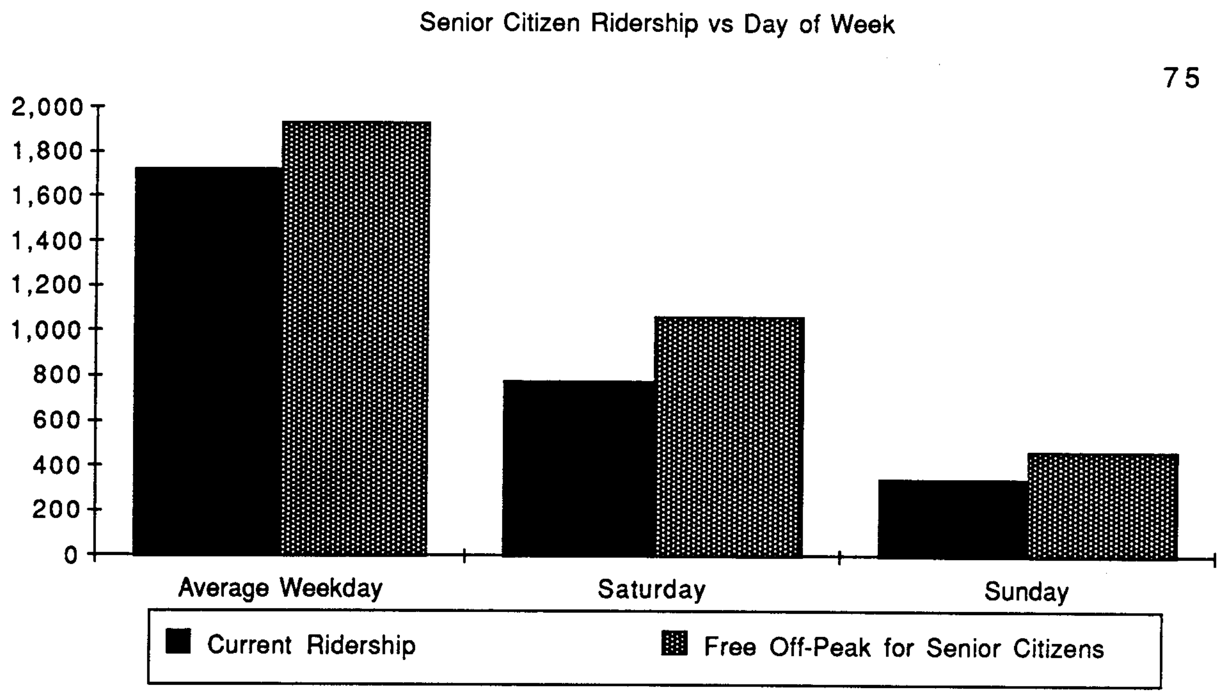


Figure 24. Senior Citizen Ridership, by Day-of-Week, Before and After Implementing Free Off-Peak Free Fares for Senior Citizens

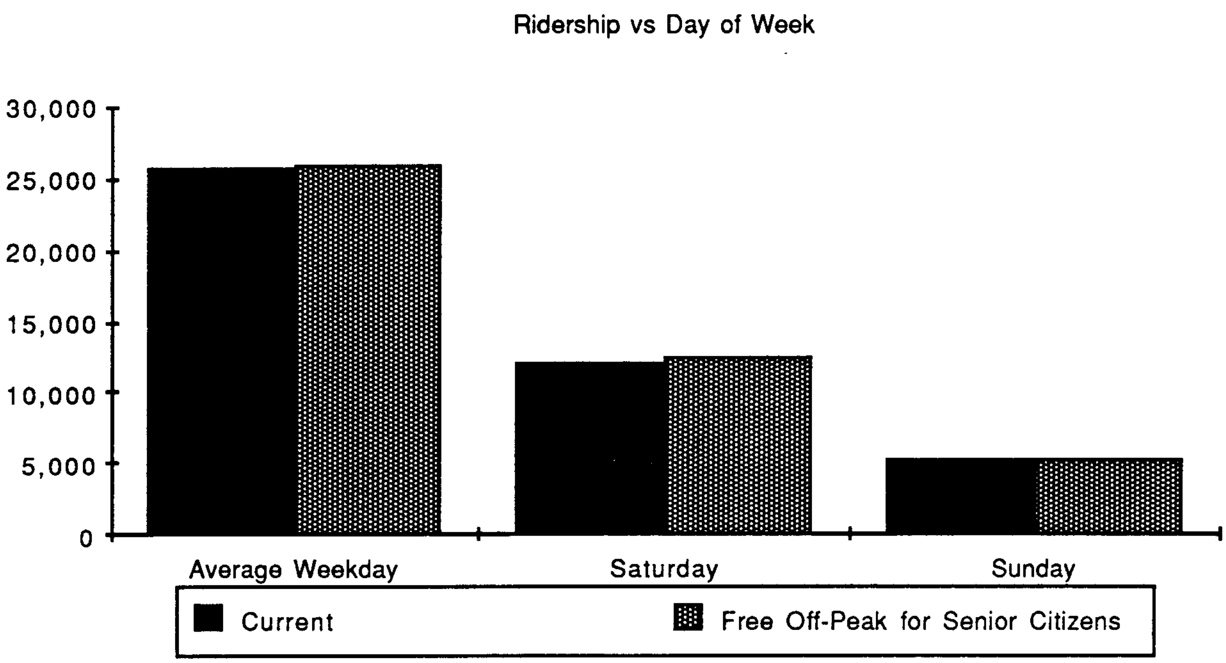


Figure 25. Systemwide Ridership, by Day-of-Week, Before and After Implementing Free Off-Peak Free Fares for Senior Citizens

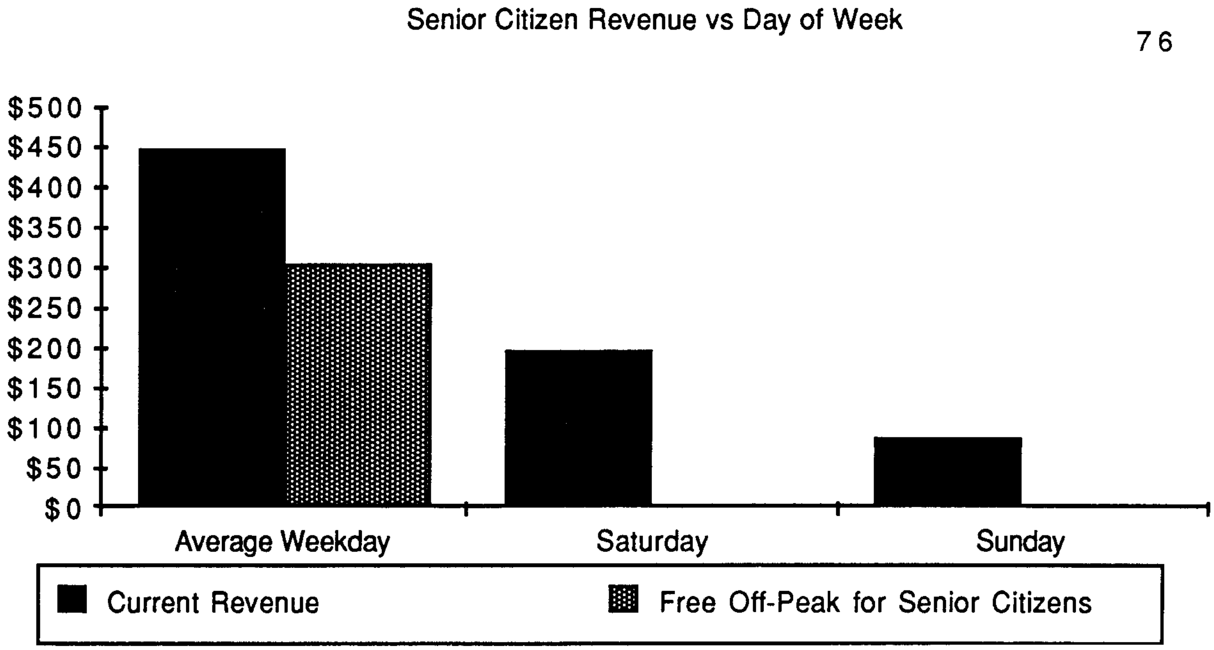


Figure 26. Senior Citizen Revenue, by Day-of-Week, Before and After Implementing Free Off-Peak Free Fares for Senior Citizens

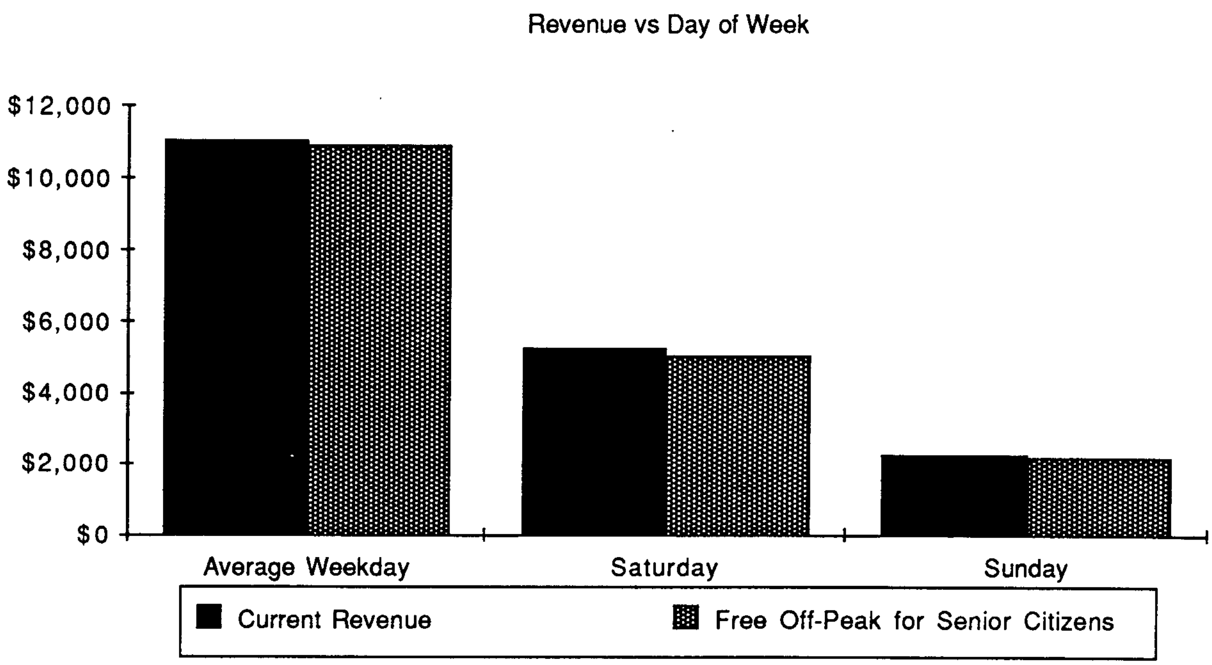


Figure 27. Systemwide Revenue, by Day-of-Week, Before and After Implementing Free Off-Peak Free Fares for Senior Citizens

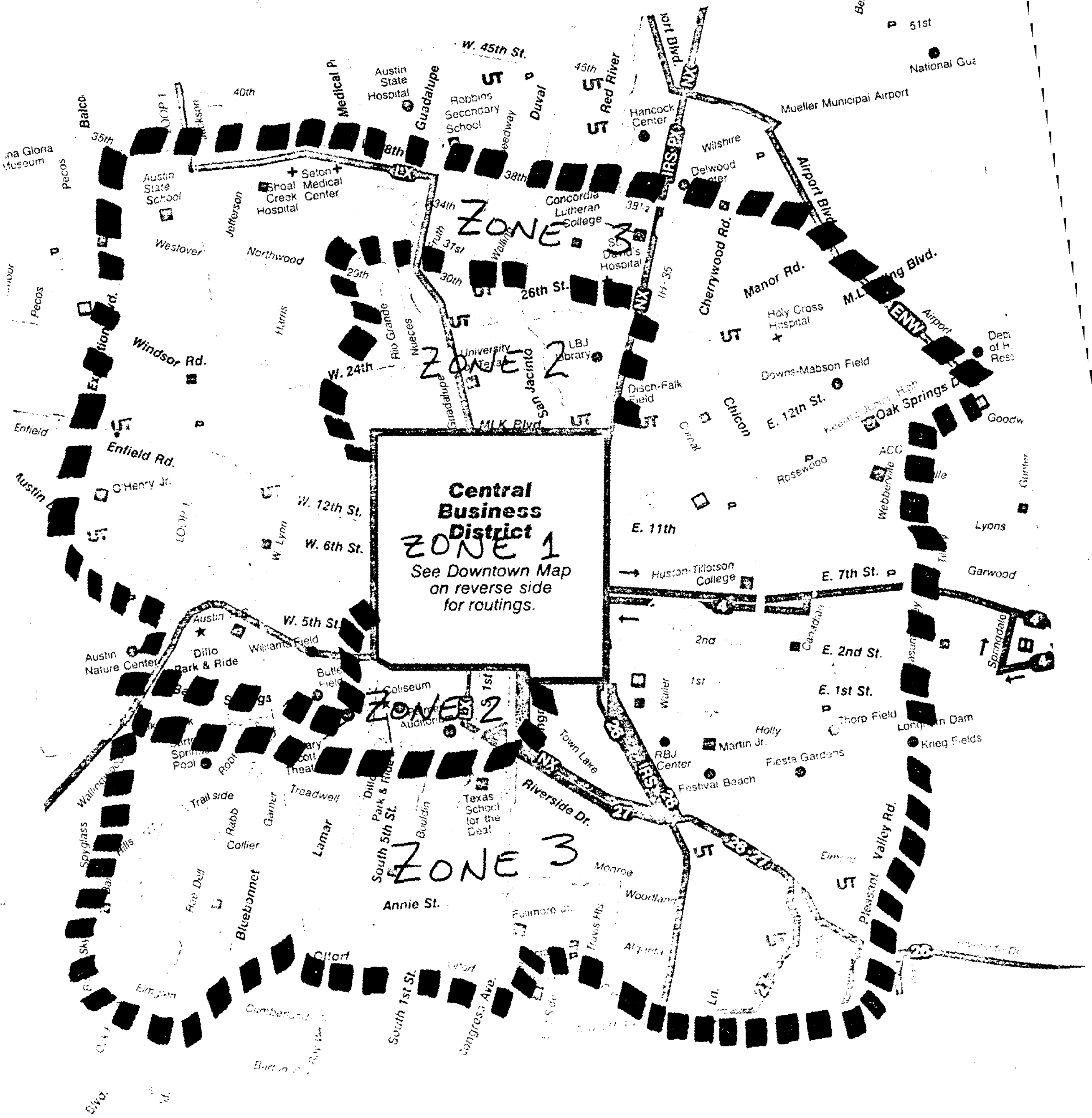


Figure 28. Free Zone Alternatives

The boundaries for alternative 1 were selected to include only the CBD. Alternative 2 includes all of alternative 1, the UT area, Palmer Auditorium, and Zilker Park. These "tourist" areas were included to aid Austin visitors. Alternative 3 was selected as a somewhat large area that still allows simple implementation. Care was taken to avoid having routes that cross into (or out of) the free zone several times. For simplicity, all 'Dillo routes are assumed to be free in all three alternatives. Because Park and Ride routes offer a premium service, the free zones do not apply to them. Furthermore, they do not serve trips with both ends in the free zone.

The three zone alternatives were analyzed with and without those Capital Metro routes which duplicate, in part, the University of Texas (UT) shuttle routes and serve the campus area. These would be routes 5 and 15. Routes 9, 21, and 26 also duplicate UT-Shuttle routes, but are not included because they do not serve the UT campus. (Route 26 does go past campus as route 5, but travels via the CBD, not express on Interstate 35 as the UT shuttle does.) Under the recent Capital Metro/UT shuttle system merger, all shuttle routes must be open to the general public, with no cash fare required (though not excluding pre-payment). Because students could use routes 5 and 15 as well as the designated shuttles, it would be reasonable to extend the free portion of these routes to the point where they diverge from the shuttle routes. The free zones are also analyzed without those routes in the event that the Capital Metro route structure is revised to eliminate the duplication.

In this analysis, the same base-case ridership and revenue values were used to maintain consistency with the above three studies. However, because of August route restructuring, more recent data (October 4, 1988) was utilized to determine the percentage of the total ridership that is on each route group (as it exists after August, 1988). The farebox data was used to obtain the respective fractions of full- and half-fare patrons, in order to calculate the average fare, per route. The average fare, for the purposes of this analysis, is the total revenue divided by the number of linked revenue-trips for each route. This value ranged from 36.4¢ to 44.2¢. For the route groups which were affected by the restructuring, an estimated value of 40.3¢ was used (calculated in a manner that preserves the overall average fare of 42.8¢ per linked revenue trip).

To analyze the free fare zone concept, it is necessary to estimate the fraction of trips on each route that take place within the free zone. In the absence of route-level origin-destination data, some reasonable simplifying assumptions were made to estimate the needed fractions. In particular, it is assumed that boardings are uniformly distributed along a given route. Similarly, a passenger getting on at a particular point is equally likely to get off at any subsequent point along that route. Under these assumptions, the proportion of riders whose trip is entirely within the free zone can be calculated. The details of the derivation are given in Appendix A.1.

An average elasticity of -0.50, based on "free CBD only" elasticities reported in the literature, is applied to the above proportion of riders to determine the new ridership and revenue for alternative 1. The reported average systemwide free fare elasticity is approximately -0.35; therefore, as the area of the free zone increases, the (absolute value of the) fare elasticity decrease. For alternative 2, an elasticity of -0.45 was used; for alternative 3, which covers the largest area of the three, an elasticity of -0.40 was assumed. Note that this last value falls between the systemwide and the CBD-only free fare elasticities, the rationale being that alternative 3 is, larger than the CBD but smaller than the whole system service area.

In order to implement a free central zone system, Capital Metro could follow the examples of Portland, Oregon and Seattle, Washington. Passengers traveling toward the free zone pay their fare upon boarding the bus. On routes leaving the free zone, passengers pay as they exit the bus. Thus, when passengers board (or alight) in the free zone, they may use either the front or rear door because no fare needs to be paid. The utilization of both doors also contributes to decreased boarding/alighting times, which offset the increased time required by the greater number of passengers that might be expected to ride the bus. When a passenger traveling toward the free zone (paying on entrance) wishes to travel beyond the free zone (paying on exit), a transfer is requested upon boarding, and is to be returned to the driver upon exit as proof of fare payment. Similarly, a passenger who boards the bus outside the free zone and wishes to transfer to another bus in the CBD will request a transfer upon boarding the first bus but will return it to the driver of the *second* bus, when getting off outside the CBD. A sign or cover could be placed over the farebox while in the free zone to remind regular passengers and inform new riders that no fare is required to board the bus. Seattle and Portland have found that this system works well, and there is very little passenger confusion.

In the Capital Metro system, Route 21 could cause a potential implementation difficulty in connection with alternatives 1 and 2. Because it is a "loop route", it is difficult to determine when the passenger is travelling toward the free zone or away from it. Two possible solutions are: 1) Issue the passenger some type of card which indicates boarding location, to be returned to the driver upon exit. If the entire trip was in the free zone, no fare is paid; otherwise, the regular fare is paid. 2) Make all of route 21 free, as in alternative 3.

Figure 29 shows the current ridership as well as the resulting ridership for each alternative (including routes that overlap UT shuttle routes) for each route type as well as systemwide. Figure 30 shows the corresponding revenue. Because all 'Dillo and no Park and Ride routes are included, the revenue for the 'Dillo is zero for the three alternatives, whereas the revenue remains constant (at the current value) for Park and Ride under all three alternatives. Very similar graphs are obtained when the routes overlapping the UT shuttle routes are excluded.

The marginal subsidies per new rider are shown below for each alternative:

Alternative 1 $0.56/new passenger

Alternative 2 $0.60/new passenger

Alternative 3 $0.82/new passenger

These figures are not significantly affected by the inclusion or exclusion of the routes that duplicate the UT Shuttle.

The above results are intended primarily to illustrate the application of the methodology to specific scenarios in the study area. With the methodology now in place, alternative geographic definitions of the free zone, as well as different strategies with spatial and temporal elements can be analyzed.

4.6. COMPARATIVE EVALUATION OF SERVICE IMPROVEMENTS AND FARE DECREASE

In Chapter 3, reported elasticities with respect to service changes were reviewed along with those corresponding to fare changes. The elasticities associated with service quality attributes, such as frequency of service, travel time, and number of transfers, are in all cases greater in magnitude than those associated with fare changes. In other words, a 10% improvement in travel time is likely to result in a greater percent increase in ridership than a 10% fare reduction. However, in order to properly evaluate the relative effectiveness of various improvements, it is necessary to translate them into a common basis of comparison. This can be accomplished by examining the relative impact on ridership of a given dollar amount, invested alternatively in a particular improvement in service and in subsidizing a fare decrease, respectively. Many experts agree that $1000, for example, spent on service improvements may increase ridership to a greater extent than $1000 lost as result of a fare decrease.

4.6.1. Increasing Vehicle Miles

While translating a given fare decrease into an overall revenue loss is straightforward, estimating the costs of service changes is somewhat more elaborate, requiring the use of cost allocation formulas. Because the Capital Metro costs for vehicle

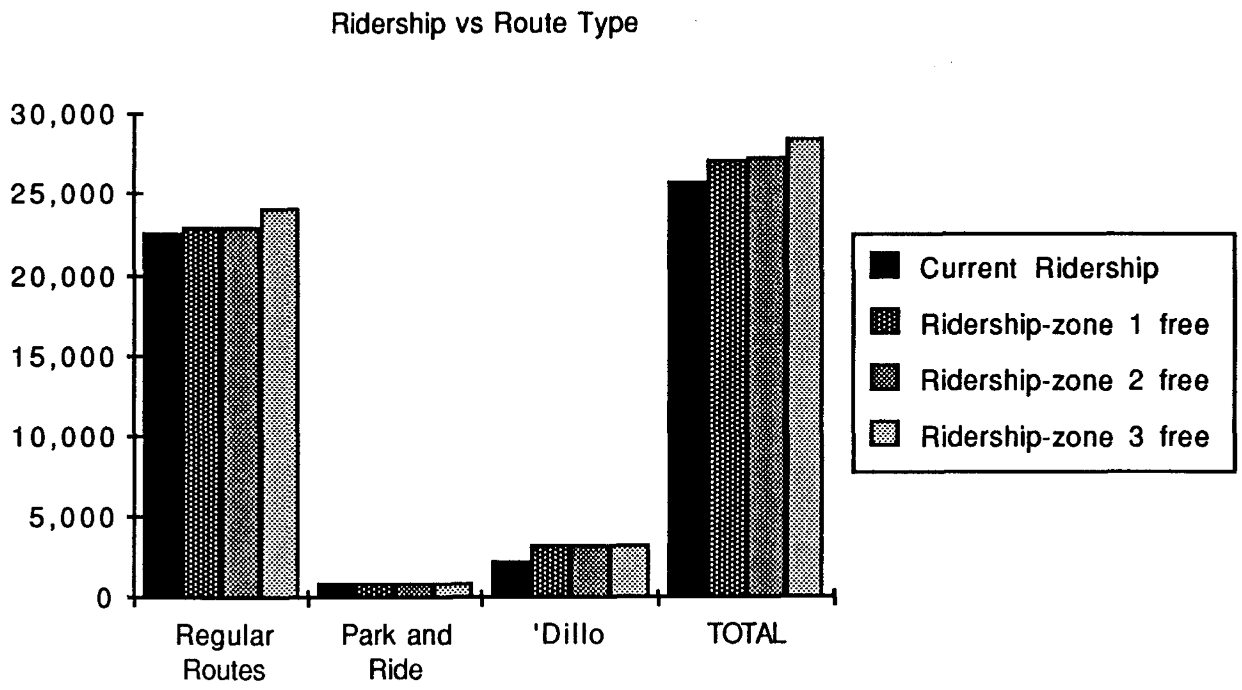


Figure 29. Average Weekday Ridership, by Route Type, for Each Free Zone Alternative.

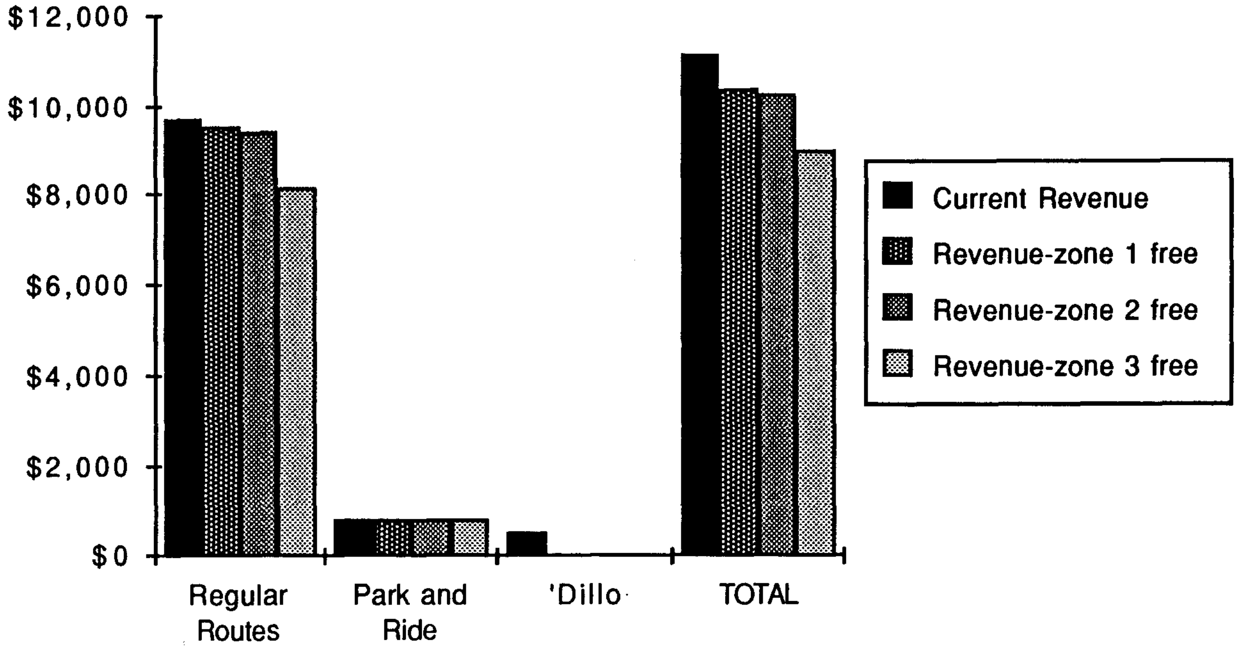


Figure 30. Average Weekday Revenue, by Route Type, for Each Free Zone Alternative.

miles and vehicle hours are readily available, service improvements in the form of vehicle-mile increases were analyzed first. An elasticity of 0.69 is used to quantify ridership response to vehicle mile increase. A range of fare elasticities (from -0.05 to -0.35) was tested to determine at which point fare changes would result in a similar ridership impact as increased vehicle miles.

This analysis is used to determine the ridership impact of an expenditure, ranging from $0 to $10,000 per day (in $1,000 increments), to subsidize a systemwide fare decrease, versus spending the same amount on an increase in the vehicle miles of service. The net cost involved in reducing fares is simply the lost revenue. However, the net cost for increasing vehicle miles includes the direct cost per additional vehicle mile as well as the indirect cost per additional vehicle hour, and is partially offset by the increased revenue generated by the new ridership (the average fare per rider is assumed to remain constant). The two formulas for new ridership are as follows (see appendices A.2 and A.3 for derivations):

Ridership resulting from increasing vehicle miles:

$$V' = \frac{NC}{[(VM_o/\mathcal{E}*V_o) * (C_{vm} + C_{vh}/S_{avg}) - R_o/V_o]} + V_o$$

where:

V' = new ridership

NC = net cost

VM_o = current vehicle miles

$\mathcal{E}$ = vehicle miles elasticity (a value of 0.69 is used here based on reported data

V_o = current ridership (or volume)

C_{vm} = cost per vehicle mile

C_{vh} = cost per vehicle hour

S_{avg} = average vehicle speed

R_o = current revenue

Ridership resulting from decreasing fares:

$$V' = \frac{(1/\varepsilon - 1) - \sqrt{(1 - 1/\varepsilon)^2 - 4 * (NC/R_0 - 1)/\varepsilon}}{2/(V_0 * \varepsilon)}$$

where:

V' = new ridership

ε = fare elasticity (ranges from -0.05 to -0.35)

NC = net cost

R_0 = current revenue

V_0 = current ridership (volume)

It should be noted of course that indiscriminate increase in vehicle-miles can be just as misguided as across-the-board reductions in fare. Indeed, recent experience in the Capital Metro area has indicated that a reduction of up to 12 percent in total vehicle-miles of service has not had any significant ridership impacts. This was largely due to the nature of the vehicle-miles that were eliminated: carefully selected, well-targeted unproductive service. It should therefore be stressed that the level of detail in this particular analysis is rather coarse, and it does not recognize the specific factors that must be taken into into account when fine-tuning a particular system. The purpose of this analysis is to illustrate the kind of trade-offs present in considering appropriate fare structures and pricing strategies, and to demonstrate that the latter should be addressed in connection with service considerations. Nevertheless, recognizing the above concerns, three scenarios of service improvements are analyzed:

1) Across-the-board systemwide increase in vehicle-miles; in other words, the analysis is performed at the aggregate systemwide level.

2) Targeted service improvement: only a portion of the system is targeted to receive the total increase in vehicle-miles.

3) Redeployment of existing vehicle-miles, with no additional cost. It is assumed that the top ten routes in the system receive a given percent increase in vehicle-miles, which are redeployed from the remaining routes. It is intended for illustrative purposes only, as additional considerations must be taken into account before recommendations on specific routes can be made. Such recommendations are outside the scope of this particular study.

Figure 31 depicts the estimated ridership resulting from a given net dollar investment in either increased vehicle miles systemwide, or in subsidizing a decrease in fares (with the same cost), for a range of assumed fare elasticities. (Note that the net cost for increasing vehicle miles includes the amount spent on increased service *less* the revenue increase.) The plots in this figure indicate that the superiority of one strategy over the other (in terms of greater ridership impact for a given investment) depends on the magnitude of the underlying fare elasticity. If the absolute value of the latter is less than about 0.15, then the increased vehicle-miles strategy would be more effective than a fare decrease. The marginal subsidy per new rider for the vehicle-miles increase remains constant at $2.61 net/new passenger across the total net cost levels considered.

Figure 32 presents similar information as Figure 30, except that now the increase in vehicle-miles is targeted to five among the more productive route groups in the system (1/13/40, 2/10, 3/17/25, 6, and 7/27). The resulting subsidy (of $1.68/new passenger) is, as expected, considerably less than for the untargeted case, illustrating the potential of carefully selected service improvements to increase ridership.

Figure 33 presents the results of the redeployment of service strategy, from less productive to more productive portions of the system. The figure plots the new ridership under this strategy on the routes targeted for the increased vehicle-miles as well as on the "other" routes (with decreased vehicle miles), against the percentage of the total vehicle-miles that are redeployed. The 10 targeted route groups include the five mentioned earlier, as well as: 4/18, 5/26, 8, 12/20, 15/16/39. Note that because there is an increase in ridership with no additional funds spent on the redeployment, there is actually an increase in revenue. In other words, this strategy leads to increased ridership and revenue at the same time.

For comparison purposes, Table 6 shows the systemwide decrease in fares (assuming a fare elasticity $\varepsilon = -0.20$) required to achieve the same ridership obtained from a given percent of redeployed vehicle miles, and the corresponding revenue implications. (Note: the "% revenue increase" is not identical to the "% ridership increase" because the average fare is different for the routes which had increased ridership and the ones which had decreased ridership.)

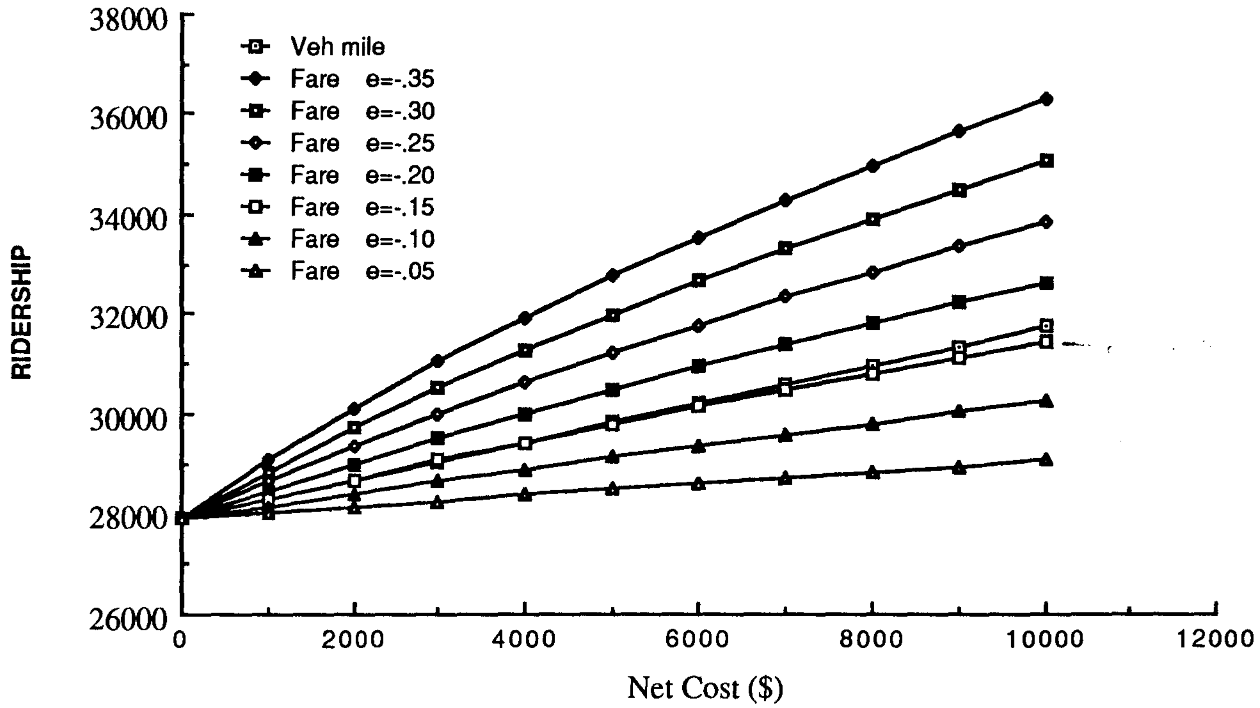


Figure 31. Average Weekday Systemwide Ridership vs. Net Cost of Aggregate Vehicle Mile Increase and Net Cost of Systemwide Fare Decrease under a Range of Fare Elasticities.

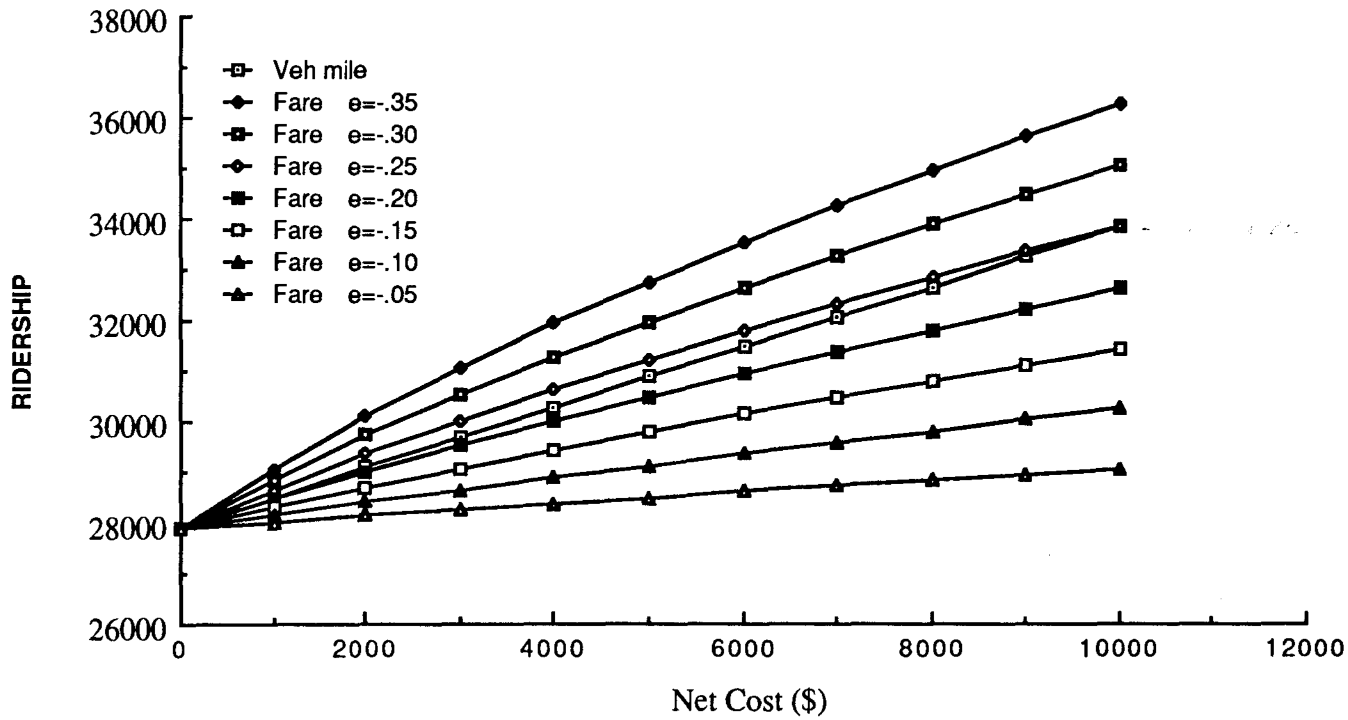


Figure 32. Average Weekday Systemwide Ridership vs. Net Cost of Targeted Vehicle Mile Increase and Net Cost of Systemwide Fare Decrease under a Range of Fare Elasticities.

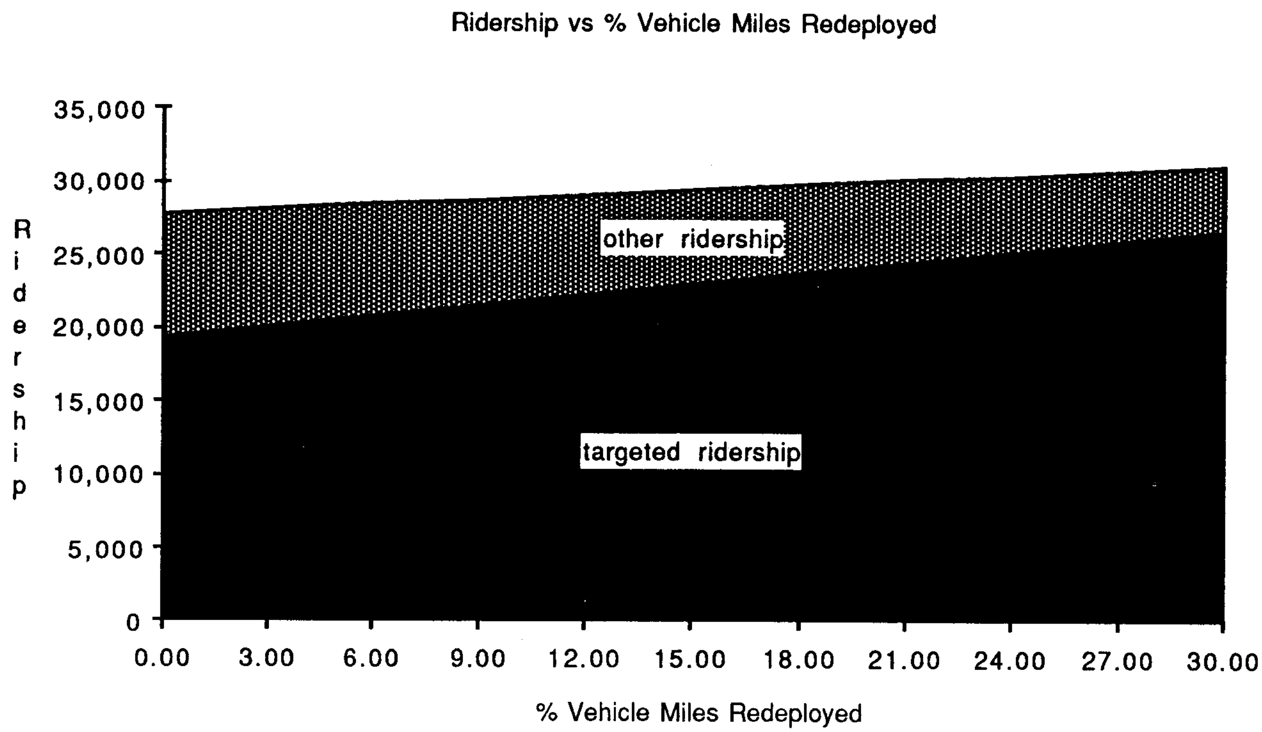


Figure 33. Average Weekday Systemwide Ridership vs. Percent of Targeted Route Vehicle Miles Redeployed from Other Routes.

% v-miles redeployed	% ridership increase	% revenue increase	% fare decrease	% revenue decrease
3	1.16	1.17	6.3	5.1
6	2.31	2.34	12.5	10.3
9	3.47	3.51	18.7	15.7
12	4.63	4.68	25.0	21.2
15	5.79	5.84	31.2	26.9
18	6.94	7.01	37.5	32.8
21	8.10	8.18	43.7	38.8
24	9.26	9.35	50.0	45.0
27	10.42	10.52	56.2	51.3
30	11.57	11.69	62.5	57.8

Table 6. Percent Fare Decrease Needed to Achieve Same Ridership Impact as Given Percent of System Vehicle-Miles Redeployed.

4.6.2. Decreasing Total Travel Time

The largest service improvement elasticity is for total travel time during the peak hours (-1.03). Therefore, large ridership gains may result from relatively small reductions in total travel time. Calculating the costs of reducing total travel time is very complex. Total travel time includes wait-time, in-vehicle time, and transfers. Wait-time can be reduced by increased vehicle miles (i.e. higher frequency). In-vehicle time can be reduced by increasing speed or restructuring routes to make them more direct. The number of transfers could be reduced and the remaining transfers can be timed to minimize the wait. Some of these techniques require additional service, while others do not. Therefore, a general analysis estimating the cost of given percentages of reduced total travel time is not presented.

It is, however, possible to illustrate the ridership and revenue impacts that result from a given percentage increase in systemwide total travel time using the following relationship:

$$V\% = \varepsilon_{TTT} * TTT\%$$

Where:

V% = Percent change (increase) in ridership

ε_{TTT} = Total Travel Time elasticity = -1.03

TTT% = Percent change (decrease) in total travel time (value is negative).

The percentage fare and revenue decrease required to achieve the same ridership impacts are shown in the following table (assuming a fare elasticity of -0.20):

% total travel time decrease	% ridership increase (=% revenue increase)	% fare decrease	% revenue decrease
5	5.2	25.8	21.9
10	10.3	51.5	46.5
15	15.5	77.3	73.7
20	20.6	n.f.*	
25	25.8	n.f.*	
30	30.9	n.f.*	

* not feasible, as the fare decrease implied by the elasticity value would exceed 100% (which would be equivalent to actually paying the passenger to ride).

As noted earlier, it may be possible to reduce total travel time at no or relatively little additional cost to the transit agency, through restructuring routes to reduce transfers and make trips more direct. For instance, if it were possible to reduce total travel time by, say, 15% through such fine tuning of services, the above table indicates that a 15.5% increase in ridership and revenue would result. To obtain a ridership increase of this magnitude through fares would require a 77.3% fare reduction and thus a 73.7% revenue decrease. Clearly, it would be more cost-effective to increase ridership through service improvements than through fare reductions.

4.7. SUMMARY AND CONCLUSIONS

This chapter has illustrated the application of an approach based on borrowed elasticities for various market segments to the evaluation of alternative fare policies in the Capital Metro area. In interpreting the results, it must be kept in mind that:

1) The elasticities used are not based on any local data; reported values in other cities exhibit considerable variability. For this reason, we used a range of values to illustrate the sensitivity of the results to the assumed elasticities.

2) The analysis is aggregate in nature, and does not capture details of particular routes.

Regarding the first item above, it is our belief that fare elasticities in Austin are likely to be closer to the -0.15 ~ -0.20 range, which corresponds to the lower-middle end of the spectrum. This is based on comparisons with situations judged to possess similar characteristics as Austin, taking into account the manner in which the reported elasticities have been derived. The transit system in Austin has been around for some time in its present form, and it is unlikely that the present fare structure is seriously deterring a sufficient number of potential riders, whose trips can be served at competitive levels of service, to justify a high fare elasticity. Furthermore, there is evidence from other cities to indicate that elasticities for fare decreases are smaller than for increases. This would place the maximum systemwide potential impact of fare elimination at about 20 to 25%.

Table 7 presents a summary of the impact of the various strategies considered in this report under the high, low and middle fare elasticity values. Each strategy is summarized in terms of three principal criteria: its maximum impact on ridership (total potential number of new trips), the associated cost (revenue loss), as well as the marginal subsidy per new rider, which is a cost-effectiveness measure.

The analysis of the various strategies presented in this report indicate that some potential exists for increasing ridership by reducing and/or eliminating fares. However, this potential is limited, with only relatively small increases possible through fare-related strategies. The cost per new rider is highly dependent on the underlying fare elasticity, as shown in Table 7. In general, targeted fare strategies, especially to specific geographic areas and time periods, as well as to particular socio-economic groups, are more cost-effective than universal indiscriminate reductions.

More importantly, greater impact on ridership can be achieved through service improvements. The most effective demonstrations reviewed are those where promotional fare programs were accompanied by major improvements in service coverage and/or quality. Elasticities associated with service quality attributes in most transit systems are known to be significantly larger than those associated with fares. The comparative analysis presented in this report illustrated how a meaningful basis of comparison can be established between fare decreases and service improvements. The results clearly illustrate that service changes can provide a more cost-effective approach to increasing ridership. The results also illustrate the importance of carefully targeting these improvements to areas where the potential impact is greatest.

Table 7: Summary of Ridership and Revenue Impacts of Various Fare Strategies

	Maximum Impact New Riders		Total Cost ($)		Marginal Subsidy Per New Rider	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Low Fare Elasticity						
Systemwide Free Fare	1,680	1,400	11,100	7,570	6.62	5.39
Free Off-Peak	700	1,400	3,590	7,570	5.14	5.39
Free Off-Peak/Seniors	45	90	140	280	3.06	3.14
Middle Fare Elasticity						
Systemwide Free Fare	9,160	6,340	11,100	7,570	1.21	1.19
Free Off-Peak	3,180	6,340	3,590	7,570	1.13	1.19
Free Off-Peak Seniors	210	410	140	280	0.69	0.70
Free Zones:						
Alternative 1	1,340		750		0.56	
Alternative 2	1,440		860		0.60	
Alternative 3	2,560		2,100		0.82	
Very High Fare Elasticity						
Systemwide Free Fare	15,000	11,280	11,100	7,570	0.74	0.67
Free Off-Peak	5,660	11,280	3,590	7,570	0.63	0.67
Free Off-Peak/Seniors	370	720	140	280	0.39	0.39
Independent of Fare Elasticity						
Redeployed	1,620 †		0($650 profit)		0.00	
Targeted	5,950*		10,000*		1.68	
Systemwide Service Increase	3,840*		10,000*		2.61	

†The ridership increase depends on percent redeployed (see Fig. 33); number given here is for 15% redeployed.

*These figures depend on the amount to be invested (see Figs. 31 and 32); amounts shown here are for illustrative purposes.

Furthermore, *it should be noted that the benefits of service improvements are not limited to more trips, but also include better quality trips for new as well as existing riders. Trips induced by lower fares alone provide no benefits to existing trips.*

Other important considerations in the evaluation of a free-fare policy include: the nature of the attracted trips, the extent to which consistent with the agency's mission, overcrowding on certain portions of the system, vandalism, potential safety issues, degradation of perceived image, possible turn-off of choice (i.e., non-captive) customers, and low driver morale (reported in the Denver experiment). These were discussed in more detail in Chapter 3.

Based on the results presented in this chapter, as well as the analysis and synthesis of the findings of the study, the recommendations of the study team are as follows:

1) The basic fare structure presently adopted by Capital Metro on its regular fixed routes, park-and-ride, and 'Dillo System is generally adequate and does not warrant major revision. The 50¢ base fare is among the lowest in the nation (see Table 8, and is a simple fare to communicate and process. The lower fares to the selected groups are also appropriate and fair, and contribute to the agency's broader mission.

2) Pre-payment plans, such as passes, should be encouraged and more heavily promoted as a means of eliminating transactions associated with riding, encouraging habitual loyal ridership, providing discounts to regular volume users.

3) Transfers should remain free. Transfers are an inconvenience imposed on the rider by a route structure that does not allow for direct service for a substantial fraction of all trips. This is the case in the Capital Metro service area where some transferring is built in by design in the partially implemented time-transfer plan. However, in light of driver difficulty in enforcing some of the provisions of the present transfer system, we recommend that an alternative mechanism for the transfers be developed and adopted. More importantly, the reported difficulties would significantly diminish if the present route numbering and pairing system is simplified. Regarding the transfer passes, one suggestion to simplify the drivers' task in handling and checking transfers is as follows: each day, only transfers of a particular color, or marked with a particular symbol or letter, would be valid. This color (letter or symbol) would not be known until the beginning of the day, thereby preventing fraudulent use. This would eliminate the waste associated with transfers that can be used by the agency on one day only, and would save drivers'

Table 8. Survey of Fixed Route Transit Fares as of August 1, 1986

	UNITED STATES		CANADA	
Number in Sample with Fares of:	Number of Reporting Systems	Percent	Number of Reporting Systems	Percent
.00	1	0.4%	0	0.0%
.10	1	0.4%	0	0.0%
.15	0	0.0%	0	0.0%
.20	0	0.0%	0	0.0%
.25	12	4.3%	0	0.0%
.30	1	0.4%	0	0.0%
.35	9	3.2%	0	0.0%
.40	10	3.6%	0	0.0%
.45	1	0.4%	0	0.0%
.50	72	25.9%	0	0.0%
.55	7	2.5%	0	0.0%
.60	60	21.6%	0	0.0%
.65	9	3.2%	0	0.0%
.68	0	0.0%	1	12.5%
.70	9	3.2%	0	0.0%
.75	50	18.0%	0	0.0%
.80	7	2.5%	0	0.0%
.85	8	2.9%	1	12.5%
.90	3	1.1%	0	0.0%
.95	1	0.4%	1	12.5%
1.00	15	5.4%	3	37.5%
1.10	0	0.0%	1	12.5%
1.15	0	0.0%	1	12.5%
1.20	0	0.0%	0	0.0%
1.25	1	0.4%	0	0.0%
1.50	1	0.4%	0	0.0%
Total	278	100.0%	8	100.0%

Note: Table summarizes basic adult cash fares for fixed-route service, weekday base period not including zone fares, transfer charges or premiums. Each reporting system counted only once. For multi-mode systems with different fares for modes, the motor bus fare is used. Systems not operating fixed-route service are not included.

Source: American Public Transit Association; "Transit Fare Summary: Fare Structures in Effect on August 1, 1986" time otherwise necessary to check the date on every transfer. Furthermore, the route number would be pre-printed in large print on each transfer, allowing easy checking by drivers for "legal" transfers. Ideally, each transfer pass would also have pre-printed on it a time of expiration, so the driver would only have to hand the transfer to the passenger. For convenience and simplicity, these would be at the following times: 10 a.m., 1 p.m., 4 p.m. 7 p.m., and end of service; if a rider desiring to transfer would have less than two hours left on the next expiration, then a later one would be issued. For example, if the next expiration is 10:00 a.m., and the present time is 9:15 a.m., then the passenger is automatically given the transfer that is valid until 1:00 p.m. The driver would have packets of the preprinted transfers to use. When it is time to change to a later expiration, the driver would simply reach for the next packet. Alternatively, the present tear-away format could be retained, though it would add to the required driver transactions.

4) The findings of this study do not support the introduction of large-scale free fare programs at this time. In most free-fare demonstration projects, the impacts have fallen short of expectations. The reported increases proved ephemeral, were not sustained throughout the demonstration, and were in most cases virtually completely reversed upon reinstatement of the regular fares. The increases were generally not consistent with the mandates of the sponsoring agencies, as those additional trips were diverted in large part from short walking trips. In addition to the mixed results achieved elsewhere, and the limited systemwide potential, it would be premature to implement such free fare programs in the Capital Metro area before the recommendations of the service plan update have been developed and implemented. In other words, free fares should not be used as a panacea to avoid improving the route structure and the directness and quality of service. If free transportation is judged to be a desirable political and social objective by the community, then it would be better to time the implementation of such a wish in connection with major route restructuring and service improvement. However, our perception of the political environment in which this and other transit systems must operate is one of fiscal conservatism and business-like accountability, which does not appear to be consistent with what will undoubtedly be viewed as a give-away.

5) With regard to the targeting of special socio-economic groups with fare-related programs, such actions are appropriate as long as they are consistent with the agency's mandate and its broader social objectives. Such targeted programs are generally more cost-effective than uniform measures, and can contribute to the formation of a steady and loyal ridership base for the service.

Another important set of fare-related questions arise in connection with the merger of the University of Texas Shuttle System and Capital Metro. These questions also have important operational ramifications. In particular, a policy is needed regarding how non-UT students should be charged for using the shuttle routes. The principal issues associated with this problem are identified in the next chapter. Alternative solutions are proposed and evaluated accordingly.

CHAPTER 5: FARE POLICY ASPECTS OF THE MERGER WITH THE UNIVERSITY OF TEXAS SHUTTLE SYSTEM

5.1. INTRODUCTION

In the Spring of 1988, Capital Metro signed an agreement with the University of Texas to manage the operations of the Shuttle system. The two systems have several overlapping routes, indicating potential for more efficient and effective service through integration of the route systems. By allowing the UT students to ride the regular Capital Metro routes at no additional charge (service is paid for as part of the student services fees) and Austin residents to ride the shuttle routes, major route duplication could be reduced or eliminated. This chapter addresses some of the fare policy and associated operational aspects of this merger.

The Capital Metro/UT Shuttle agreement offers many opportunities and provides unique operational challenges. The principal overall challenge is to integrate the presently separate services in a manner that is cost-effective and consistent with Capital Metro's objectives, and at the same time maintains the level of service requirements of the shuttle system. This goal has important and thorny fare policy aspects. Specifically, how should the general public (i.e. non-UT students) be charged for riding on the UT Shuttle buses? This question has contractual, financial, operational and policy dimensions. The purpose of this chapter is to discuss the principal considerations associated with this issue, identify and analyze the principal options available to Capital Metro, and provide recommendations in this regard.

5.2. DEFINITION OF FARE POLICY ALTERNATIVES

The principal contractual stipulations that affect the kind of fare policy adopted for the shuttle-designated portions of the transit system are:

1. Shuttle buses must be open to the general public in order to meet federal requirements associated with the acquisition of new buses.

2. Boarding and alighting the shuttle buses must take place using two doors simultaneously.

3. Shuttle route drivers will not collect cash fares or require presentation of university ID cards in order to avoid possible associated delays; this effectively precludes drivers from engaging in transactions that might contribute to delay.

In light of the above constraints, the following two alternative fare policies for treating non-UT students on the shuttle routes appear feasible:

1. No fare required;

2. Honor system, with proof of fare pre-payment or of eligibility to be presented by the rider upon request.

The first option is simpler in terms of implementation, as it requires no transactions and no enforcement. Because the rider is not paying a fare, no transfers will be issued by the driver. Riders who need to continue on another non-shuttle route must pay (or otherwise demonstrate eligibility) at the beginning of the second leg of their trip.

The second option requires the resolution of several policy questions and the specification of some operational details before it can be implemented. In particular, two aspects of the option must be addressed: 1) the method of fare pre-payment, and 2) the type and extent of enforcement. Regarding the first, note that only pre-payment is considered because of the difficulty and confusion associated with on-board transactions, in light of the UT contract stipulations. The following can be accepted as proof of pre-payment or eligibility:

- Valid transfer pass from applicable non-shuttle routes (on which rider would have paid the applicable fare).

- UT-student ID card with the appropriate sticker verifying fee payment.

- UT-staff ID card with appropriate sticker verifying payment of shuttle bus fee.

- Valid ID card for senior citizens traveling during the off-peak (under the recently introduced plan). Similarly, any group granted free riding privileges would have to present applicable proof of eligibility.

- Valid Capital Metro pass. In this regard, it would be worthwhile to give serious consideration to two new pass categories:

a. Daily pass, valid on UT Shuttle service only (including some overlapping Capital Metro routes, as described later), but allowing transfer privilege to applicable regular Capital Metro fixed routes at applicable legitimate transfer points. The main purpose of this pass is to provide an opportunity for the occasional "semi-spontaneous" non-student rider to have access to the service on particular days. It is still not as convenient to the occasional rider as paying a fare on board. This can be compensated for by wide availability at convenience stores and similar outlets. At some point in the future, self-service automated dispensing machines may be considered. The recommended price for such a pass is two times the regular fare (or $1.00 per weekday under the present fare structure). In the interest of consistency, a weekend pass could be sold for the same price as a weekday pass, but would allow travel on both Saturday and Sunday. The same reductions as in the present fare structure can be applied to the price of this pass (i.e. half fare for students and seniors). Because no transactions will be required on board, the pass allows unlimited travel on the day on which it is valid, which must be shown on the pass. This can be accomplished at the point of sale, by simply stamping the date (of valid use) on the card upon payment. Such passes need not be purchased every day, as the user can have the option to buy one or more passes several days in advance (say for a period not to exceed two weeks).

b. Monthly (and longer) pass: a holder of a Capital Metro regular route or systemwide pass would also be allowed to ride the UT Shuttle service. The additional category proposed here is to have a monthly pass valid only on UT Shuttle service (and transfer therefrom onto applicable routes, as above). The recommended price would reflect a small discount relative to the regular Capital Metro pass, placing it in the $15-18 range per month.

Regarding the issues of the type and extent of enforcement, random checking by official inspectors is suggested, as drivers cannot perform this function on a regular basis. However, drivers should be given the prerogative to perform such checking whenever necessary. In particular, this would provide them with a mechanism to deal with situations where they detect obvious abuse. The extent of enforcement under a random checking strategy can range from virtually none to enforcement at all times. The former is not effective, whereas the second is not economical. Somewhere in between may lie a cost-effective level of checking. In a recent APTA workshop report, a level of 25% of all riders is quoted as the recommended minimum level believed to be necessary in order to have a low evasion rate in US systems. In addition to checking, the manner in which violators are handled is considered to be as (if not more) important as the rate of checking in terms of the effect on the evasion rate. In particular, cooperation with court officials is necessary in order to uphold the charges and collect the fines. In what follows, a cost-effectiveness analysis of the level of enforcement is presented for the Capital Metro/UT Shuttle situation. However, before doing so, it is necessary to specify how the fare policy interacts with the manner in which regular Capital Metro bus service is provided in those areas served totally or partially by the UT Shuttle routes.

5.3. SERVICE CONSIDERATIONS IN FARE POLICIES

In the first year of implementation of the agreement with the University, the two systems have been merely juxtaposed, with no changes in either, and no attempt to rationalize Capital Metro service or otherwise integrate the two systems. However, this is only a transitional stage, and some changes can be expected over time so as to realize the potential operating economies offered by the merger, and enhance the mobility of the area residents. Under either scenario (i.e. change vs. no change), situations will be encountered where a particular Capital Metro route overlaps over some significant portion with a UT Shuttle route. The two alternative fare policies described above must be specified with regard to the following four cases, corresponding to the type of trip by origin and destination:

a. The passenger boards in the portion of the route that precedes the UT Shuttle overlap, and gets off either before or in the UT Shuttle portion. In this case, the passenger is required to deposit the applicable fare in the farebox upon boarding, or otherwise demonstrate eligibility to ride. In this respect, the procedure is no different than on present Capital Metro routes. Under the free UT Shuttle fare policy, nothing else needs to be done. Under the second fare policy alternative (honor system with pre-payment), the passenger should be furnished with some form of receipt (essentially a transfer pass, with limited time validity), which could be used to prove payment if subjected to a check while in the UT Shuttle portion. It is also suggested that the daily pass discussed earlier be honored on such trips.

b. The passenger boards in the portion of the route that precedes the UT Shuttle overlap, but gets off beyond it. These trips should be treated identically to those under case a, with the exception that, under the free fare policy, the passenger needs to be furnished with the same type of receipt as mentioned above in connection with the honor system. This receipt will serve as proof of payment upon exiting from the bus. It is necessary for compatibility with case d below.

c. The passenger boards and gets off in the UT Shuttle portion. If the no fare policy is adopted on Shuttle routes, no fare should be required on the overlapping Capital Metro regular route portions, primarily for the perceived consistency and equity of the policy. Under the second fare policy option, the passenger would be expected to possess one of the above-mentioned proofs of pre-payment or eligibility.

d. The passenger gets off beyond the UT Shuttle portion. Regardless of origin, everyone getting off beyond the Shuttle route would be required to either deposit the applicable cash fare or show proof of eligibility (or of prior payment). Thus riders having originated prior to the Shuttle portion would be in possession of the above mentioned receipt to acknowledge payment. The two alternative policies would be identical in how these trips are treated. It is suggested that, under the second policy, Shuttle day passes be honored for these trips as well.

Both policies can thus be implemented relatively simply and consistently for those situations that might arise in the merged system. The only possible loophole in the above scheme occurs under the second fare policy (honor system). In particular, passengers who board in the UT portion with the intention of getting off beyond that portion will not be required to have a proof of payment, since they have the option to deposit a cash fare upon leaving the bus. None of these trips can evade payment or proof of eligibility since checking by the driver will take place as on present Capital Metro routes (except at the end rather than at the beginning of the trip). However, riders boarding in the Shuttle portion with the intention of getting off in that (Shuttle) portion could claim, if subjected to inspections, that their destinations are beyond that portion (and thus that they will pay upon exit). The inspector could hold such individuals to their claim by not letting them get off until after the Shuttle zone. However, this is where the honor feature of the system should be invoked; the inspector should simply "believe" the rider's claim. Even if it is a lie, the analysis, presented below, of the costs and benefits of enforcement, suggests that the cost of this possible loophole to Capital Metro (and thus to taxpayers) is much less than the cost of enforcing it.

In the merged system, there will be four types of trips affected by the fare policies under consideration:

1) those that can only be served by the Shuttle service;

2) those that can only be served by non-shuttle Capital Metro routes which overlap over some portion with the Shuttle service;

3) those that can be served by either type of service; and

4) those that involve transfer to or from at least one of the above three.

A fifth type, consisting of those trips that can only be served by non-shuttle Capital Metro routes that do not overlap Shuttle routes, is not of concern to this discussion, other than serving as a base of reference against which to measure the relative perceived consistency and equity of the system.

Trips of the first type are easily covered by the two fare policies described above. Such service will be accessible to all; however, under the honor system, a potential new or occasional rider faces the impediment of being required to have the necessary pass proving pre-payment. This is an issue in virtually any pre-payment system with buses. However, this should not significantly deter riders, especially if well advertised and the outlets for selling such passes are conveniently located. Promotional activities could distribute trial day passes in selected target areas to get potential customers to know about the service. Furthermore, it should be noted that trips in this category are likely to benefit from an exceptional level of service and convenience, which may well overcome the initial hurdle.

Trips in the second category are handled as described above, under each of the two policies. Essentially, nothing of significance will change for current Capital Metro riders. If they are prepared to pay a fare, they will continue to do so, though in some cases at the end of the trip. They will need to keep the receipt given to them by the driver in the cases identified earlier. If they are pass holders, they can continue using their passes. However, it will be necessary to properly train the bus drivers so as to correctly implement the fare policy.

The third category of trips may be the most confusing. Users can be expected to board the next bus to arrive, regardless of whether it is designated as Shuttle or not. Under the no fare policy, no confusion should result because no transaction would be necessary on either service. Under the honor system, matters are somewhat more complicated, because of the need to show proof of pre-payment if requested. If non-Shuttle service remains offered on such routes after service integration has been phased in, then a question of concern is whether or not to allow individuals to pay a cash fare in the farebox upon boarding (because this would not be designated as shuttle service, the two-door boarding and no-fare collection stipulations would not apply), or to require pre-payment as well. The answer to this question depends in part on the extent to which such duplicative service is continued. From a user standpoint, the advantages of the day (or longer) passes should be evident, as the patient user is likely to witness several shuttle buses come by before the desired Capital Metro bus. Thus the value of the passes is a substantially higher level of service in terms of reduced wait times and enhanced convenience. Therefore, with proper information dissemination and promotion by the agency, the passes should prevail along these routes. However, to the extent that the buses would be already equipped with a farebox, and riders have to use the front door to board, cash payment could still be accepted along with other acceptable proofs of eligibility, including day and shuttle-only passes.

The fourth category of trips involves transfers to or from a shuttle-only route or a Capital Metro route that partially duplicates shuttle service. Under the no-fare policy alternative, no special arrangements are required when the transfer is *to* a trip in the first or third categories above. When it is in the second category, a valid transfer pass would be necessary. When transfer is made *from* a trip in either categories one or three, the second leg of the trip would have to meet whatever fare requirements apply on that trip, because no transfer passes are granted to such users under the no-fare policy. The usual transfer rules, with the same instruments used elsewhere in the system, will apply when the transfer is from a trip in category two.

Under the honor system policy, valid transfer passes granted on the preceding leg of the trip will be honored as proof of payment when transferring *to* a trip in any of the above three categories. For transfers *from* trips (in any category), the day passes will be honored as acceptable transfer instruments, as discussed earlier.

5.4. COST-EFFECTIVENESS OF ENFORCEMENT OF HONOR SYSTEM

This section presents a simple analysis of the cost-effectiveness of enforcement associated with the honor system described above, and the implications for the extent of enforcement recommended for the Capital Metro situation. Essentially, the comparison involves the cost of implementing a successful honor system against the benefits that might be expected. Estimates of the (minimum) anticipated costs are presented next, followed by (maximum) anticipated benefits, in the form of retained revenues. These estimates take the present situation as a point of reference; thus benefits consist of revenues presently collected that may be retained as a result of enforcement, and costs correspond to the additional cost of enforcement, as explained hereafter.

5.4.1. Costs of Honor System

The primary costs involved in the daily operation of the honor system are the wages and benefits of the checkers or inspectors responsible for enforcement. A wage estimate of $9 per hour + 30% fringe benefits was assumed, as per Capital Metro staff. Of course, the cost of these checkers per day would depend on the extent of enforcement adopted in the system. Let p denote the percent of the total applicable revenue hours that are checked. Laidlaw currently operates a total of approximately 740 "revenue" hours per day. Thus the daily cost of enforcement at a level of p percent of revenue hours is about $87p per day. For example, if p is equal to only 1%, the cost would be $87 per day; at 10%, it would be $870 per day, and at 25%, $2175 per day. Practically, one full-time checker is required to cover about 1% of the total revenue-hours. Note that the effectiveness of enforcement for a given level p can vary depending on how the revenue hours are selected. By proper targeting, and recognizing the peaking present in the time-of-day distribution of ridership, a higher fraction of all users can be reached for the same level p.

In order to have a more direct comparison with the revenue estimates presented next, one enforcement scenario would be to deploy the checkers only on those shuttle routes that overlap present Capital Metro service, i.e. on the approximately 335 revenue hours provided on the RR, IF, MS, ER, and SR shuttle routes. In this case, if q denotes the percent of revenue hours on those routes that are checked, the daily cost of enforcement would be about $40q per day, i.e. $40 per day for 1% enforcement, $400 per day for 10%, and $1000 per day for 25%.

Note that the effectiveness of such enforcement is known to depend on the penalties imposed on violators, and the diligence with which such penalties are collected.

Furthermore, opportunities must usually be provided for violators to appeal their fines. It is therefore clear that potentially substantial monetary costs will be incurred for administrative purposes in addition to the cost of checkers. No attempt is made to provide estimates of these costs in this analysis. An initial guess would be that these would be about equal to the cost of the checkers.

5.4.2. Benefits of Honor System

The primary monetary benefits of the honor system relative to a no-enforcement policy are the fares that would otherwise go uncollected. An upper bound on such "lost" revenue, relative to the present situation, is presented in this section. Such lost revenue is the result of regular-route Capital Metro riders switching to the shuttle system. The only source of lost revenue is from cash passengers whose trip could be served equally well by a regular Capital Metro bus or a shuttle bus. That is, only present Capital Metro passengers whose origin *and* destination are also served by the shuttle could switch. The only passengers in this category are those along the Capital Metro routes which partially overlap shuttle routes, namely: 5/26 (IF), 7/27 (SR), 9 (ER), 15/16/39 (RR), and 21 (MS). To estimate the fraction of potential switchers, it is assumed that boardings are uniformly distributed along a given route, and that a passenger is equally likely to get off at any point beyond the boarding point along that route. These assumptions are identical to those made in the analysis of the Free Zone alternatives presented in chapter 3. Using the expressions derived for that analysis, the *maximum* percentage of passengers on each route who could switch to a shuttle was calculated. This is considered a maximum because a possibly large percentage of non-UT students whose trip could be served by either system are believed to be already riding the shuttle buses.

By applying the percentages of potential switchers to the ridership and revenue data from October 4 and October 12, the maximum number of revenue trips switching to the shuttle is estimated to be approximately 100 (or about 0.25% of total fixed-route boardings). This translates to approximately $43 per day in "lost revenue" (or about 0.50% of daily revenue). Note that when present pass users, transfer users, senior citizens (during the off-peak), and other non-revenue passengers switch to the shuttle, no revenue is lost.

The above results indicate that only a token level of enforcement (less than 1% of the present shuttle revenue-hours) can be justified from a cost-effectiveness standpoint. However, the effectiveness of such enforcement can be greatly enhanced by careful targeting, high visibility, heavy signing aboard the buses to provide reminders to riders, and similar techniques. Because the analysis is relative to the present revenues taken in by the agency, potential income from new riders, or from passengers presently not paying on the shuttle, is not included. No ready basis exists for projecting this income. However, it is not expected to affect the conclusion that enforcement beyond a token level would not be cost-effective, especially in light of the conservative assumptions underlying the cost estimates.

5.5. ADDITIONAL CONSIDERATIONS

5.5.1. User Confusion

Some degree of confusion, at least initially, is unavoidable whenever users have a choice between two similar but different services running side by side. Neither fare policy discussed in this report can totally eliminate this element, though both proposals strive to reduce it. A detailed discussion of what users contemplating different types of trips would encounter under the two policies was presented earlier. Under both alternatives, there would not be major departures from the present situation for most current Capital Metro users. However, the most effective solution to the possible confusion issue is clear and widely disseminated information. It is essential that bus stops be clearly signed, displaying information on both the route itself, as well as the fare structure. In particular, under the honor system, clear warnings to potential evaders should be prominently displayed, in addition to information on where the passes contemplated under the pre-payment program can be obtained. Such information should also be placed on the buses themselves. Generally, Shuttle and shuttle-overlap routes should provide an excellent opportunity for introducing and testing better information, signage and other passenger amenities.

5.5.2. Time Delays

The pre-payment requirement of the honor system policy alleviates the issue of potential time delays associated with individual transactions. In this regard, both policies are transaction-free. Depending on how the two present systems are integrated, the requirement to show proof of payment or eligibility for regular route (with shuttle overlap) passengers getting off beyond the shuttle portion may contribute to some increase in dwell times at those stops. However, this would likely be compensated by the time savings upon boarding, and might be partially offset by the greater use of pre-payment methods on these routes.

5.5.3. Additional Peak Service

One aspect, common to both fare policies, that has not been addressed is the additional service that may be required to meet the additional demand placed on already crowded shuttle routes at certain times of the day. Note first that the peak times for the shuttle are closely related to the scheduling of classes at UT, and do not necessarily coincide with the peak for the general public. Furthermore, one of the objectives of Capital Metro is to increase its productive ridership to better serve the mobility needs of the service area. As such, additional ridership-driven service would be a desirable development, and is likely to perform better than the overall Capital Metro system in terms of cost per rider.

The cost of such additional service depends on how effectively the two systems are integrated, and how thoroughly the opportunities to achieve the potential economies made possible by the merger are exploited. It is beyond the scope of the present study to develop such service integration plans. On the basis of the present combined flows on both the Shuttle routes and the Capital Metro routes that would be affected, it does not appear that additional service should be necessary; on the contrary, opportunities are likely to be present for rationalizing present Capital Metro service, thereby reducing overall costs. However, the need for additional service at certain times of the day should not be ruled out at some point in the future. The demand pattern for such service is likely to be of the type that can be most effectively served by innovative operating strategies that are usually possible in high demand corridors. The honor system would be preferable to the no-fare policy in terms of the possibility of recovering some of the costs of providing the service.

5.5.4. Abuse

Related to the above issue is the potential danger of unproductive "joyride" trips, possibly by individuals prone to vandalism and loud behavior, under the no-fare policy. Such trips have been observed in some of the free-fare demonstration projects, as discussed in chapters 2 and 3. It is not evident that such behavior will also occur in Austin. However, the honor system with pre-payment policy provides a ready mechanism that can be exercised by the driver to deal with such situations. Therefore the honor system would be preferable to the no-fare policy in terms of ensuring that the available capacity is utilized to serve productive trips and legitimate transportation needs.

5.5.5. Other Aspects of Enforcement

As discussed earlier, one of the principal problems associated with the honor system is enforcement. In Austin, it may be somewhat difficult to obtain cooperation from police and judges. Negative public reaction may result if Capital Metro is perceived as being too tough in its enforcement. On the other hand, lax enforcement may lead to loss of credibility and a rise in the evasion rate. The analysis presented above suggests that a high rate of enforcement is not cost-effective. Heavy-handed enforcement is certainly not desirable from a community relations perspective, nor warranted by the potential revenues that may result.

5.5.6. Perceived Consistency and Equity

The questions of internal consistency and equity can be approached from a diversity of perspectives that do not always lead to the same conclusion. A case can be made for either proposed policy in this regard. Internal consistency refers to the treatment of similar situations in a similar way, in a manner that does not contradict the general policy. Equity refers to the "fair" treatment of different socio-demographic groups and geographic sectors of the service area. Consistency and equity are interrelated in that the consistent application of a given policy is generally perceived as being equitable. Yet equity considerations have sometimes led to "exceptions" to the consistent application of certain policies. A philosophical and legalistic discussion of these issues is beyond the scope of this report.

Practically, the discussion of equity must consider: 1) the value of the service received by different groups, and 2) the relative costs of providing this service. As is the case with most vague concepts, attempts to provide a precise quantitative basis for assessing the equity of a particular system or policy often lead to inconsistent conclusions depending on which criterion is used. However, the honor system will generally be *perceived* by the general public as being more consistent with the fare policy prevalent in the rest of the Capital Metro system, and therefore as more equitable than the no-fare alternative . This perception is not necessarily grounded in fact. The answers to some of these questions depend to a large extent on how the Shuttle service is integrated within the overall Capital Metro system, and the resulting cost implications.

If no additional service is provided by Capital Metro along the Shuttle routes, it would not be inequitable to allow the general public to ride these buses for free. While riders whose trips can be served by these routes would be receiving a benefit that exceeds that received by other users (who, by virtue of living in a different geographic sector, would not have as much use for the service), the marginal subsidy per rider would be zero (because the costs of the shuttle service are primarily paid for by UT student fees). If the Shuttle is viewed as a separate subsystem paid for by UT students, it seems reasonable for the students to allow the general public to ride for free on that system in exchange for free riding privileges on the public system. This would not be inequitable towards those who live in different sections of town, as they would not have lost any service, and they would have access to the Shuttle routes should they choose to ride them.

The situation would be more complicated if Capital Metro were to provide additional capacity along these routes to serve the additional load generated by the general public. In this case, equity may suggest charging the regular fare for this service; however, consistency along that particular route would require charging a comparable fare for a comparable ride. The same type of inconsistency would arise if parallel and separate Capital Metro service is provided, requiring payment of a fare comparable to the rest of the system, at the same time that the shuttle service is open and free to the public.

The main point of the above discussion is to illustrate the complexity of the equity issue. The answer is not clear cut, and arguments can be constructed in favor and/or against either of the two alternatives. As noted, the honor system with pre-payment policy appears to be less objectionable than the no-fare policy in this regard.

5.6. CONCLUSION

This chapter has described two alternative fare policies for possible implementation in connection with the UT Shuttle routes in the context of an integrated public transit system. The first is a no-fare policy over the Shuttle routes as well as on overlapping portions of regular Capital Metro routes. The second is an honor system with fare pre-payment; it requires the introduction of a day pass that would be valid on Shuttle routes, on regular Capital Metro routes that overlap the Shuttle routes (with pass validity not limited to the overlapping portions), and as a transfer pass onto applicable routes at applicable points. Both policies provide for essentially transaction-free riding over the UT Shuttle routes or portions of regular fixed routes that overlap the shuttle routes. Both policies have some attractive characteristics as well as some negative aspects, which were detailed and contrasted in this report. The operational details of how the two policies might be implemented in a merged system were described, along with the various situations facing potential riders. A major determining factor of the relative desirability of the two policy alternatives is the extent of service integration between the UT Shuttle routes and the Capital Metro system.

The principal advantages of the no-fare policy are its relative simplicity and ease of implementation. Its principal negative aspects include: 1) possible abuse in terms of trips that do not serve legitimate transportation needs, 2) overcrowding in light of the previous point, 3) perceived inconsistency and inequity, and 4) cost due to lost revenues and possible additional service to comply with contractual requirements.

The principal advantages of the honor system with pre-payment relative to the no-fare policy include: 1) its perceived consistency and equity, 2) the ability to control abuse and its negative implications, and 3) its possible contribution to increased fare pre-payment systemwide. Its principal relative negative aspects include the added effort required for implementation. From a financial cost-effectiveness standpoint, it appears that the cost of implementing and *strictly* enforcing the "honor" element on the UT shuttle routes is likely to far exceed the monetary benefit that it might generate. It would be preferable to redirect the necessary resources for such enforcement to promote pre-payment programs, such as passes and arrangements with large employers, as means of achieving true transaction-free riding. Only a token level of enforcement, not exceeding 1% of all Shuttle route-miles, can be justified from a cost-effectiveness standpoint. Proper information and careful targeting of the checking effort could increase the effectiveness of such token enforcement beyond its relative share of the total shuttle route-miles.

Based on the above discussion, it appears that internal consistency and perceived equity tend to favor a system where fares are required for the general public on the Shuttle and shuttle-overlap routes. Given the clear operational constraints imposed by the contract with UT, pre-payment of such fares will be required.† A detailed scheme for a policy of pre-payment under an honor system has been described in this report, including the specification of how the policy could be implemented under the various operational situations that might be present in a merged system with different degrees of integration. As noted, only a token level of clever enforcement should be instituted. Essentially, Capital Metro should be willing to forgo all revenues that might be generated by this scheme, at least under the present demand and service situation. As the two systems are further integrated, and substantial new ridership is attracted, this policy may become more attractive from a revenue standpoint.

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† To the extent that buses providing shuttle service will require fareboxes for operation along the non-shuttle portions, uninformed spontaneous riders who carry exact change could be allowed to deposit 50¢ in the farebox on an honor basis. However, clear information should be provided on the buses and at the stops to direct riders towards using the pass system.

CHAPTER 6: SPECIAL TRANSIT SERVICES

6.1. INTRODUCTION

Because little is available in the published literature on the fare structures followed by agencies operating STS-type services, we conducted a phone survey of eight transit companies: Orange County Transit District, Southwest Ohio Regional Transportation (Cincinnati), Metropolitan Transit Authority of Harris County (Houston), Denver Regional Transit District, Akron Metropolitan Regional Transit Authority, Utah Transit Authority (Salt Lake City), Dallas Area Rapid Transit, and San Mateo County Transit District.

The primary purpose of this survey is to determine how other cities operate and set fares for their STS services. Specifically, we were interested in how the STS fare related to the regular bus fare structure, and whether the fare for the special service related to the cost of providing it. Other concerns included ridership eligibility requirements, the implementation of these requirements (e.g., identification when boarding the vehicle or making the reservation), and the fare charged other people accompanying the "eligible patron." We sought data on what percentage of the trips were "shared ride," if available. We also inquired about types of vehicles used (i.e. vans or taxis), and whether the transit company operates the service or contracts it out. If an outside company was used, information was sought on the financial arrangements by which the transit company reimburses the contractor. If both the transit company and outside company operated the service, information was sought on the kind of operational coordination that determines who picks up which patron. Also of interest was the extent to which the transit agency worked with specific agencies such as hospitals and other social service agencies, and the financial arrangements pertaining thereto. Finally, we inquired about the sources of funding for the STS service. In this chapter, a summary of the results is first presented, followed by the individual responses form each system. Also included is the questionnaire used to guide the phone interviews.

6.2. SUMMARY OF RESULTS:

• The eligibility requirements range from the very liberal case of Orange County, California where everyone may ride the demand responsive service, to the more extreme case of San Mateo, California where the service is limited to persons physically unable to ride the regular bus or to drive a car. Requirements in other districts include physical or mental disability, senior citizen status (minimum age varies, but generally between 62 and 67). One city (Denver) allows senior citizens only if they are work volunteers, while another city (Akron) allows persons age 62 to 64 only if they are on a limited income, and all persons over 65.

• About the same number of companies require the patron to show an ID when boarding the vehicle, as maintain a computer list so that only eligible persons may make a reservation. One transit agency (San Mateo) issues the reservation phone number only to eligible patrons.

• Almost every transit district utilizes some combination of their own vans or contracted vans and taxis. Orange County has 4 contracted companies which use vans; Cincinnati uses vans from a contracted company; Houston uses a combination of transit vans and a contracted company's vans; Denver uses a combination of transit and contracted company's vans; Akron and Dallas use a combination of transit vans and contracted vans and taxis; Salt Lake City contracts with four companies which use vans and buses; and, finally, San Mateo uses transit vans only.

• A variety of methods are used for reimbursing the contracted companies:

1) Hourly Basis: Orange County pays the contracted companies between $17.47 and $18.60/hour, while Denver pays $25/revenue hour;

2) Trip Basis: Akron pays $4.65/passenger trip (less the 50¢ passenger fare)--similar to Austin; when a patron use contracted taxis in Houston, the patron pays the first $1.00, the transit company pays for up to the next $8.00, and the patron pays the remainder of the taxi fare; similarly in Dallas, the passenger pays for the first $1.00 of the contracted taxi fare, while the transit company pays for up to the next 9 miles, and the passenger pays for any amount over that;

3) Hourly and Distance Basis: Cincinnati reimburses the contracted company on a per mile and per hour basis.

4) Cost Basis: Salt Lake City reimburses the contracted company their actual expenses.

• The STS fare per one-direction trip ranges from 35¢ in Denver to $1.00 (and possibly more) in Houston and Dallas. Other fares include: 50¢ (Akron, and the one of four Salt Lake County regions in Salt Lake City), 60¢ (Cincinnati and San Mateo) and 75¢ (other three regions in Salt Lake County).

By comparison, most surveyed systems have a rather complicated fare structure for regularly-scheduled service (non-STS-type). These are presented in connection with the individual responses. In general, the STS fares are not identical to the corresponding fares on the regular routes, though they are within no more than 25¢ of each other. Some systems (e.g., Denver) charge less on STS than on regular routes, some charge about the same (Akron), while most seem to charge more for STS.

• There are various policies for the fare that an accompanying passenger must pay on the STS vehicle. Cincinnati allows up to two companions or aides to travel with the eligible passenger, provided enough space is available, and they pay the same STS fare of 60¢. Houston allows one attendant, who travels free, to accompany the eligible patron. Denver's policy is similar to Austin's in that if the passenger requires an aide, the latter travels free; but if a friend (not required) travels with the eligible passenger, the friend pays the STS fare of 35¢. One slight difference is that if the eligible passenger is confined to a wheelchair, the companion may in all cases travel free. The policy in Akron allows a friend or aide to ride with the eligible passenger, but must pay the regular bus (not STS) fare. Salt Lake City allows the passenger to have an escort who pays the regular STS fare of 50¢ or 75¢. In Dallas, the escort may ride for 50¢ (compared to $1.00 for the eligible passenger). Finally, in San Mateo, escorts (required or not) pay the regular STS fare of 60¢.

• The cost of providing the STS service ranges from $8.28 to $12.00 per passenger-trip in the responding agencies that have cost information available on this basis. Akron estimates their cost at $5.00/passenger. The Orange County dial-a-ride has a cost-to-revenue ratio of approximately 15%. Other agencies apparently did not have any estimates of this quantity.

• All systems operate on a shared ride basis whenever possible.

• Most of the transit agencies do not work with social agencies or hospitals. The exceptions are Akron and San Mateo. Akron's transit agency works with The Blind Society, Cerebral Palsy Foundation, Foster Grandparents and several other agencies. Passengers pay the regular STS fare (no group discount). They also have a contract with a summer youth group, which is billed monthly by the transit agency. San Mateo provides regularly scheduled periodic trips for several social agencies, primarily for medical purposes.

• Most of the STS services are funded through two or more of the following: local, state, and/or federal grants; local and/or state taxes; property taxes; and/or sales taxes.

The information obtained is presented hereafter for each system individually.

Orange Co. Transit District
Orange County, California
(713) 739-4000

Everyone in the area is eligible to use the dial-a-ride service vans; it is not restricted to senior citizens and/or the mobility impaired. The service operates in four districts and is contracted to four different companies. Each of the four companies uses vans which are owned by the transit district. The contracted company supplies the drivers and performs all related activities. The individual rider calls one telephone number, regardless of origin or destination, about 45 minutes before the desired departure time, and the service is provided by the appropriate contractor.

The mobility impaired and senior citizens pay 80¢/zone, whereas the general public pays $1.60/zone. Groups may travel together if there is a common origin and/or destination; each group member then pays 80¢/zone, regardless of the fare category that the individual is in. The corresponding fare structure on the regular bus route is: regular fare of 80¢, all day; senior citizens pay 40¢ during the peak hours (6-9 a.m., 3-6 p.m.) and 10¢ off-peak; the mobility impaired pay 80¢ during the peak hours and 40¢ off-peak. 100% of the dial-a-ride service is shared ride. The transit company pays the contracted companies $17.47-$18.60 per hour. The revenue/cost ratio of providing this service is approximately 15%. There are no contracts with special groups or agencies. The dial-a-ride service is funded through UMTA funds, Section 15, and local matching funds.

Southwest Ohio Regional Transportation
Cincinnati, Ohio
(513) 632-7581

Ridership on the STS type service is limited to persons who are unable to ride the regular fixed route bus service because of some physical disability. Such persons must have an eligibility application approved by a physician. The transit agency then issues eligible riders identification cards which must be shown upon boarding a vehicle. The transit company contracts with an outside company that uses vans for the specialized service. The contracted service is reimbursed on a per mile and per hour basis. Contractors are also reimbursed for their capital costs, computer time costs, vehicles, and radios.

The fare for a trip on the STS vehicle is 60¢; the patron purchases a book of 10 tickets for $6.00 and turns in one ticket on each ride. Eligible riders may take up to two companions or aides with them, provided that space is available. The companions also pay 60¢ each. The corresponding regular bus fare structure is: regular bus: 65¢ peak hours (6-9 a.m., 3-6 p.m.), 50¢ off-peak + 10¢/zone all day; express bus is 75¢ peak + 10¢/zone, and 60¢ off-peak + 10¢/zone; the weekend fare is 35¢; senior citizens (≥ 65 years old) and the mobility impaired pay 30¢; students with a pass pay 20¢. The average ridership on the STS vehicles is about 3 passengers/vehicle hour. The average cost of providing the service is $9.25 - $9.50/passenger-trip. There are no contracts with special groups or agencies. The STS services are funded through an earnings tax, UMTA operating money, state and local income tax, and fares. The fares constitute approximately 3.5% of the total Metro budget.

Metropolitan Transit Authority of Harris County
Houston, Texas
(713) 739-4000

Persons who are unable to ride the regular bus because of a physical or mental disability may ride the "Metro Lift." To be eligible for the service, the person must have an application signed by a physician. Transit agency vans and an outside company's taxis are used to provide this service. Patrons making reservations 1 to 6 days in advance will ride on a transit van and pay a flat fare of $1.00; Patrons making reservations at the last minute will ride on a taxi, in which case the rider pays the first $1.00 of the fare and any amount over $9.00, with the transit company paying up to $8.00. The customer may be accompanied by one attendant who rides free. The regular bus fare structure is: 60¢ (will increase to 65 or 70¢ in September 1988); students, senior citizens and the mobility impaired pay 25¢ with an appropriate ID. 100% of the trips on the Metro Lift are shared rides. The Metro cost of providing the service is $8.28/trip and there are approximately 1.94 passengers/revenue hour. There are no contracts with special groups or social service agencies. Metro is funded through a local 1% sales tax, and the total Metro Lift service represents slightly more than 3% of the Metro operating budget.

Regional Transit District
Denver, Colorado
(303) 628-9000

Persons who are work volunteers over age 67, are unable to access the regular bus, or are permanently disabled are eligible to ride the "Handyride" service. All Handyride vehicles are wheelchair accessible. Riders do not need to show an ID. The "Handyride" service utilizes both transit company vans and a contracted company's vans. The vehicle used for a specific trip is based on the trip made; i.e.: if the trip is between Boulder and Denver, then the contracted company's van is used on a demand responsive basis; fixed route trips are made on the transit company's van. RTD is in charge of reservations and scheduling of the trips.

The fare is 35¢ each direction. If the patron is confined to a wheelchair and requires an aide, the aide rides free; if a non-required friend rides with the patron, the friend pays 35¢ each direction. The fare structure on the regular bus is: students (age 6 to 19, and in college), mobility impaired (with physician statement), and senior citizens over 65 years of age pay 10¢ during the off-peak (if they have an appropriate ID), and the regular fare during the peak; local bus fare is 75¢ during the peak and 50¢ during the off-peak; the express service (only offered during the peak hours) fare is $1.25; the regional service (between Denver and Boulder) fare is $2.00. A monthly pass for regular local service costs $25.00, $18.00 for students, senior citizens, and mobility impaired; for regular express service, a monthly pass costs $42.50, and $26.00 for students, senior citizens, and mobility impaired; finally, a regular regional pass costs $68.00, $44.00 for students, senior citizens, and mobility impaired. The percentage of Handyride trips that are shared is not known. RTD pays the contracted company $25/revenue hour. The service is funded by UMTA grants and local taxes.

Metropolitan Regional Transit Authority
Akron, Ohio
(216) 726-0341

Persons 62 to 64 years of age <u>and</u> on a limited income or pension, over 65 (no other restrictions), or who are disabled (physician certificate) are eligible to ride the STS type service. Eligible persons are issued an identification card by the transit agency, and a computer list is maintained of their Social Security Numbers. The ID card must be shown when boarding a regular bus. STS vehicles consist of 6 wheelchair accessible transit vans, as well as the taxis and vans owned by two contracted companies. (The vans are used for group trips.) The patron can make reservations at least 24 hours in advance, or ride on a subscription basis.

The patron pays 50¢ per trip regardless of vehicle type. A "non-eligible" person riding with an eligible person pays the regular bus fare: 50¢ between 10 a.m. and 2 p.m., 65¢ at all other times; students pay 40¢; children under 6 years of age ride free. Senior citizens and the mobility impaired pay 30¢ on the regular bus routes. Over 60% of the STS type trips are shared ride. The contracted companies are each paid $4.65 per passenger trip (less the 50¢ passenger fare). The average cost to the transit company for providing the service is $5.00/passenger. The transit agency works with many social agencies (such as the Blind Society, Cerebral Palsy Foundation, Foster Grandparents, etc.) in which the passenger pays when boarding (no discount). They also have an agreement with a summer youth program in which the transit agency bills the program on a monthly basis. The STS service is funded as follows: federal subsidy (41.3%), state taxes (12.9%), other taxes (0.4%), Metro property tax (33.1%), and fares (12.3%).

Utah Transit Authority
Salt Lake City, Utah
(801) 287-4636

Persons who are physically unable to use the regular bus system are eligible to ride the STS type service. The eligible riders do not need to show an ID to ride the service because a computerized listing is maintained. The transit agency contracts four outside companies which use vans and buses. Three out of the four companies are private and non-profit. Each company operates in a different region and is responsible for its own scheduling. The company operating in Salt Lake County charges 50¢ per trip, whereas the other companies charge 75¢ per trip. An escort may ride with the patron and pay the same fare. The regular bus fare structure is: 50¢ all day (peak/off-peak fare was eliminated in order to simplify the fare structure) except for the mobility impaired, and senior citizens who pay 25¢ all day. The special service is a regularly scheduled system with route deviation. The agency tries to cluster trips in the area of the route, therefore, all trips are of the shared ride nature. The companies are reimbursed based on their actual expenses. The service provided in Salt Lake County is new, and projected to cost about $12.00/trip. The existing service in the other counties costs approximately $8 to $9 per trip. There are no contracts with special groups or agencies. The service is funded by: local options (0.25% tax is about 60% of the funding), federal funds (15%), and the remaining from fares, advertising, and miscellaneous funds.

Dallas Area Rapid Transit
Dallas, Texas
(214) 828-6800

Persons who are mobility impaired to the extent that they are unable to ride the regular bus (includes mental retardation or anyone who requires an aide) are eligible for the STS type service. The patron must show an ID when boarding the bus. Transit company vans and contracted company's taxis and vans are used to provide the service. The patron pays $1.00 each way on the transit vans; if riding in a cab, the passenger pays $1.00, the transit company pays for remainder up to 9 miles, and the passenger pays for any amount over 9 miles. Someone riding with an eligible patron pays 50¢. The regular bus fare structure is:

Zone 1 into CBD (no park and ride available): $27/month or 75¢ each direction;
Zone 2 into CBD (includes park and ride): $54/month or $1.50 each direction;
Zone 3 into CBD (includes park and ride): $63/month or $1.75 each direction;
Zone 4 into CBD (includes park and ride): $81/month or $2.25 each direction;
If travel is all within one zone, the fare is 75¢;
In the northern zones, the first additional zone is free, while remaining zones are 75¢ each;
In the southern zones, all additional zones are 75¢;
Senior citizens pay 15¢/trip, regardless of trip length, or $5 for a monthly pass;
Mobility impaired pay 35¢/trip, regardless of trip length, or $9/month;
Students (5 - 12 years old) may purchase a 20-trip punch card for $7 or a 40-trip punch card for $14;
Students (13 - 18 years old, and still in high school) may purchase a $2 photo ID which allows them to board the bus for 35¢;
Shuttle trips (through the CBD, along Oakline Dr., etc.) are 35¢/trip.

San Mateo County Transit District
San Mateo, California
(415) 872-6748

Persons who are certified by their doctors as unable to drive a car or are unable to ride the regular transit bus are eligible to ride the paratransit vans. They are issued a card which has the reservation phone number on the back. This is the only place where the number is listed. Therefore, in principle,only persons with this card may make reservations on the paratransit vans. These vans are owned by the transit company, but are operated by a contracted company. Persons making medical trips have priority and may make reservations up to 20 days in advance. Reservations for trips to the bank, welfare office and shopping may be made 2 days in advance. Recreational trip reservations may be made only one day in advance, but due to the large number of medical trips, recreational trips are non-existent.

The fare to ride "Readywheels" is 60¢. Group trips may be scheduled and cost what the contractor charges. If the person wishes to have an escort, required or not, the escort pays the same 60¢ fare. Trips are scheduled on a shared ride basis when possible. Each van services a different area so that more trips may be grouped together; however, efforts are made to avoid grouping too many trips that would result in someone riding in the van for long periods of time (say 1-1/2 hours), especially since many of the riders are frail. The contracted company charges the transit district approximately $14/hour. The average cost of providing this service is approximately $10/trip. The transit district works with several social service agencies and adult health care facilities. These are usually in the form of periodic trips (i.e. once per week) for medical purposes. In most cases, the individual pays when boarding the van, but there are different financial arrangements for different agencies. The fare structure for the regular bus routes is: adults pay 50¢, senior citizens (65 years and older) and mobility impaired (with transit issued photo ID indicating user is impaired) pay 15¢, and teenagers under age 18 pay 25¢. On designated express routes, senior citizens and mobility impaired pay full fare during the peak. Readywheels is funded through state and federal sources.

6.3. SAMPLE QUESTIONNAIRE

1. What are the ridership eligibility requirements for this service?

   ____

2. Do riders need to show some sort of ID?

   When do they show it? ______________________________

   ____

   Where do they get it? ______________________________

   ____

3. What types of vehicles are used:

   ________ Transit Van

   ________ Small Transit bus

   ________ Outside company taxi

   ________ Outside company vans

   ________ Other: ______________________________

   ____

4. If an outside company is contracted, what type of arrangement do you have, i. e. how much do you reimburse them? ______________________________

   How is scheduling handled? ______________________________

   ____

   ____

How do you determine which vehicle will pick up a patron? ______________

5. How much is the fare (does it differ by vehicle type)? ______________

6. What is done about people who ride with the "eligible patrons", i.e.: Who may ride? ______________

How much do they pay? ______________

7. What is the regular bus fare, by category? ______________

8. Do you operate on a shared ride basis? ______________

9. If so, do you have any data that you can share with us on the percentage of shared rides? ______________
cost of providing service as compared to passenger fare? ______________

10. Do you work with other companies/agencies such as hospitals and social agencies? ______________

11. If so, what are the financial arrangements? ______________

12. How are your STS services funded? ______________________________

____

____

CHAPTER 7: CONCLUSIONS

7.1. SUMMARY

The purpose of this report was to identify and evaluate various pricing strategies and fare-related programs for the Capital Metro system in terms of their relative ability to enhance ridership in a cost-effective manner.

Of the strategies considered, the ones which increased ridership with no reduction in revenue usually required some form of private sector support, namely, merchant supported free fare zones, specially funded low fare for the unemployed, employer subsidized passes, merchant discount passes, and/or sponsored merchant discount pass programs. Methods that usually increase ridership but decrease revenues are: (non-sponsored) fare free zones, low fares for the unemployed, market-segmented pass programs, summer youth passes, and general unlimited use passes. However, it may be possible to increase both ridership and revenues by improving and restructuring the service provided.

The evaluation of the ridership and revenue impacts of the service improvement and fare strategies considered in this study for the Capital Metro system was based on "borrowed" elasticities, because values specific to the study were not available. For this reason, a rather wide range of possible elasticities was considered for each market segment, and separate impacts were evaluated for low, medium and very high values of the elasticities. The Austin values of fare elasticities are likely to be in the -0.15 to -0.20 range, which is the lower to middle end of the spectrum. The consideration of a range of elasticities recognizes and underscores that the accuracy of the estimated impacts of a particular fare strategy depends on the assumed underlying elasticities.

Table 9 presents a summary of the impact of the various fare and service improvements strategies considered in this report under the very high, low and middle fare elasticity values. Each strategy is summarized in terms of three principal criteria: its maximum impact on ridership (total potential number of new trips), the associated cost (revenue loss), as well as the marginal subsidy per new rider, which is a cost-effectiveness measure. The table illustrates that riders are more likely to be attracted to the system through service improvements than through fare decreases. Service improvements also tend to require a lower subsidy; in particular, redeploying vehicle miles does not increase total costs to the transit agency, while increasing revenue (due to the increased ridership). The fare is not likely to be a deterrent to a significant number of potential riders; the fare currently charged by Capital Metro is

Table 9: Summary of Ridership and Revenue Impacts of Various Fare Strategies

	Maximum Impact New Riders		Total Cost ($)		Marginal Subsidy Per New Rider	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Low Fare Elasticity						
Systemwide Free Fare	1,680	1,400	11,100	7,570	6.62	5.39
Free Off-Peak	700	1,400	3,590	7,570	5.14	5.39
Free Off-Peak/Seniors	45	90	140	280	3.06	3.14
Middle Fare Elasticity						
Systemwide Free Fare	9,160	6,340	11,100	7,570	1.21	1.19
Free Off-Peak	3,180	6,340	3,590	7,570	1.13	1.19
Free Off-Peak Seniors	210	410	140	280	0.69	0.70
Free Zones:						
Alternative 1	1,340		750		0.56	
Alternative 2	1,440		860		0.60	
Alternative 3	2,560		2,100		0.82	
Very High Fare Elasticity						
Systemwide Free Fare	15,000	11,280	11,100	7,570	0.74	0.67
Free Off-Peak	5,660	11,280	3,590	7,570	0.63	0.67
Free Off-Peak/Seniors	370	720	140	280	0.39	0.39
Independent of Fare Elasticity						
Redeployed	1,620†		0($650 profit)		0.00	
Targeted	5,950*		10,000*		1.68	
Systemwide Service Increase	3,840*		10,000*		2.61	

†The ridership increase depends on percent redeployed (see Fig. 33); number given here is for 15% redeployed.

*These figures depend on the amount to be invested (see Figs. 31 and 32); amounts shown here are for illustrative purposes.

among the lowest in the nation. The results also illustrate the importance of carefully targeting these improvements to areas where the potential impact is greatest. Furthermore, *it should be noted that the benefits of service improvements are not limited to more trips, but also include better quality trips for new as well as existing riders. Trips induced by lower fares alone provide no benefits to existing trips.*

In contrast, systemwide free fares are generally very costly. Most free-fare demonstration projects appear to have fallen short of expectations, achieving only temporary increases which were not sustained through the demonstration. Problems have been reported with vandalism and overcrowding on certain portions of the system that ultimately led to a loss of non-captive riders, as discussed in Chapter 3. If this type of plan is desired, it should accompany extensive service improvements or some other type of significant change, as a means of promoting and attracting attention to the changes. Free fares targeted to specific socio-economic groups are generally more cost effective than the systemwide alternative, and may also contribute to the formation of a steady and loyal ridership base for the service.

The fare-related strategy that is worthy of serious consideration and active promotion is pre-payment. Plans such as passes make the transit trip more convenient, as well as decrease the number of on-board transactions (decreasing dwell times), and provide a discount to regular riders. These plans should be promoted more aggressively, especially in connection with large employers, possibly the form of employer subsidized passes.

In the case of the UT Shuttle routes, the study identified two alternative fare policies for possible implementation in the context of an integrated public transit system. The first is a no-fare policy over the Shuttle routes as well as on overlapping portions of regular Capital Metro routes. The second is an honor system with fare pre-payment; it requires the introduction of a day pass that would be valid on Shuttle routes, on regular Capital Metro routes that overlap the Shuttle routes (with pass validity not limited to the overlapping portions), and as a transfer pass onto applicable routes at applicable points. Both policies provide for essentially transaction-free riding over the UT Shuttle routes or portions of regular fixed routes that overlap the shuttle routes. Both policies have some attractive characteristics as well as some negative aspects.

Principal advantages of the no-fare policy are its relative simplicity and ease of implementation. Its principal negative aspects include: 1) possible abuse in terms of trips that do not serve legitimate transportation needs, 2) overcrowding in light of the previous point, 3) perceived inconsistency and inequity, and 4) cost in terms of lost revenues and possible additional service to comply with contractual requirements.

Principal advantages of the honor system with pre-payment relative to the no-fare policy include: 1) its perceived consistency and equity, 2) the ability to control abuse and its negative implications, and 3) its possible contribution to increased fare pre-payment systemwide. Principal relative negative aspects of the honor system include the added effort required for implementation. From a financial cost-effectiveness standpoint, it appears that the cost of implementing and *strictly* enforcing the "honor" element on the UT shuttle routes is likely to far exceed the monetary benefit that it might generate. It would be preferable to redirect the necessary resources for such enforcement to promote pre-payment programs, such as passes and arrangements with large employers, as means of achieving true transaction-free riding. Only a token level of enforcement, not exceeding 1% of all Shuttle route-miles, can be justified from a cost-effectiveness standpoint. Proper information and careful targeting of the checking effort could increase the effectiveness of such token enforcement beyond its relative share of the total shuttle route-miles.

At this stage, it appears that internal consistency and perceived equity tend to favor a system where fares are required for the general public on the Shuttle and shuttle-overlap routes. Given the clear operational constraints imposed by the contract with UT, pre-payment of such fares will be required.

Finally, a survey of eight transit agencies with STS-type services indicates that the Capital Metro STS fare strategy is adequate. The Capital Metro policy regarding ridership eligibility are also consistent with the other transit agencies' policies.

7.2. AREAS FOR FURTHER STUDY

The analysis and discussion presented in this report suggest several areas that can benefit from additional study, and contribute to the development of better fare policies and programs in the future. Perhaps the most important is to address the absence of a reliable basis of local information on the sensitivity of residents of the study area to fares as well as to service attributes. While obtaining such information might be considered impossible without actual fare experimentation in the system, it should be noted that encouraging successes have been reported with the use of relatively affordable *stated preference* techniques for this purpose. Obtaining such information should be a high priority for Capital Metro.

A related area would be to monitor any changes contemplated and implemented by Capital Metro so as to better calibrate the methodological approach used in this study, as well as to extract as much information for planning purposes from such implemented changes.

One aspect of the analysis presented in Chapter 4, namely the relative effectiveness of service improvements versus fare changes, is worthy of extension to include a wider array of service improvements. However, this requires a more elaborate cost analysis methodology that would provide the costs of various service improvements, such as decreased number of transfers and improved service reliability.

APPENDICES

A.1 DERIVATION OF PROPORTION OF PASSENGERS WHOSE TRIP WOULD BE COMPLETELY WITHIN THE FREE ZONE:

The general expression for the proportion of riders whose trip would be completely within the free zone is given by the following expression:

$$N = p(F_{off} \mid F_{on}) * p(F_{on}) \qquad (1)$$

where:

N = percentage of riders on a specific route group whose complete trip would be in the free zone

$p(F_{off}|F_{on})$ = conditional probability of a passenger deboarding in the free zone (F_{off}) *given* that passenger got on the bus in the free zone (F_{on}); i.e. the proportion of all passengers who board in the free zone on that route who will also deboard in the free zone

$p(F_{on})$ = probability that a given passenger will board the bus in the free zone (F_{on}); i.e. the proportion of all passengers along a route group who board in the free zone.

The assumption of uniform ridership distribution makes evaluation of this last term rather simple, as it is taken as the ratio of the length of route group in the free zone to the total length of route group):

$$p(F_{on}) = F/T \qquad (2)$$

where F and T are defined below.

A schematic drawing will help explain the formula for $p(F_{off}|F_{on})$:

________"L"______|__"F"___|______"R"_________

"L" = the length of the route "left" of the free zone

"F" = the length of the route in the free zone

"R" = the length of the route "right" of the free zone

"T" = the total length of route

The uniform distribution assumption implies that one-half of the passengers will be travelling "left" and the other one-half will travel "right." If a passenger boards at the "right" border of the free zone and travel "right," there is a probability of zero of deboarding within the free zone. If a passenger boards at the "left" border of the free zone and travels "right," the probability of deboarding within the free zone is: F/(F+R). To determine the "expected" probability of a randomly selected passenger who boards in the free zone also deboarding in the free zone, a midpoint value was used. Therefore:

$$p(F_{off} \mid F_{on} \text{ and travelling "right"}) = (F/2)/ [(F/2) + R]$$

Similarly, for a passenger traveling "left":

$$p(F_{off} \mid F_{on} \text{ and travelling "left"}) = (F/2)/ [(F/2) + L]$$

Therefore:

$$p(F_{off} \mid F_{on}) = (1/2) * [p(F_{off} \mid F_{on} \text{ and travelling "right"}) + p(F_{off} \mid F_{on} \text{ and travelling "left"})]$$

$$=(1/2)*\{(F/2)/[(F/2) + R]+(F/2)/[(F/2) + L] \qquad (3)$$

Combining (2) and (3):

$$p(F_{off} \mid F_{on}) * p(F_{on}) = (1/2)*\{(F/2)/[(F/2)+R]+(F/2)/[(F/2)+L] * (F/T)$$

or:

$$N = p(F_{off} \mid F_{on}) * p(F_{on}) = \frac{(F/2)^2}{T} *\left[\frac{1}{[F/2 + L} + \frac{1}{F/2 + R}\right]$$

A.2 DERIVATION OF NEW RIDERSHIP GENERATED FROM INCREASING VEHICLE MILES:

The net cost for increasing vehicle miles is given by the following general expression:

$$NC = C_{vm} * \Delta VM + C_{vh} * \Delta VH - \Delta R \qquad (1)$$

where:

NC = net cost
C_{vm} = cost per vehicle mile
ΔVM = increase in vehicle miles
C_{vh} = cost per vehicle hour
ΔVH = increase in vehicle hours
ΔR = increase in revenue

This general equation should be altered to determine new ridership in terms of known values. The formulas necessary for this alteration are given below:

$$\varepsilon = \frac{(V'-V_o)/V_o}{(VM'-VM_o)/VM_o}$$

where:

ε = vehicle miles elasticity
V_o = current ridership
V' = new ridership
VM_o = original vehicle miles
VM' = new vehicle miles ($\Delta VM = VM' - VM_o$)

rewriting:

$$\Delta VM = \frac{(V' - V_0) * VM_0}{V_o * \varepsilon} \qquad (2)$$

Also,

$$\Delta VH = \Delta\ VM/S_{avg} = [(V' - V_o) * VM_o]/(V_o * \varepsilon * S_{age}) \quad (3)$$

where:

S_{avg} = average speed (miles per hour)

finally:

$$\Delta R = (V' - V_o) * R_o/V_o \quad (4)$$

where:

R_o = current revenue

Substituting (2), (3) and (4) into (1):

$$NC = C_{vm} * (V' - V_o) * VM_o/V_o * \varepsilon + (C_{vh} *(V' - V_o) * VM_o)/(V_o * \varepsilon * S_{avg}) - (V'-V_o)*R_o/V_o$$

Solving for V':

$$V' = \frac{NC}{[(VM_o/\varepsilon*V_o) * (C_{vm} + C_{vh}/S_{avg}) - R_o/V_o]} + V_o$$

A.3 DERIVATION OF NEW RIDERSHIP GENERATED BY DECREASING FARES:

The net cost for decreasing fares is given by the following general expression:

$$NC = V_o * f_o - V' * f' \qquad (1)$$

where:

NC = net cost
V_o = current ridership
V' = new ridership
f_o = current fare
f' = new fare

Other necessary formulas:

$$f_o = R_o/V_o \qquad (2)$$

where:

R_o = current revenue
V_o = current ridership

$$\varepsilon = \frac{(V' - V_0)/V_0}{(f' - f_0)/f_0} \qquad (3)$$

where:

ε = fare elasticity

Substituting (2) into (3), and rewriting:

$$f' = R_o/V_o + (V' - V_o) * R_o/(V_o^2 * \varepsilon) \qquad (4)$$

Substituting (2) and (4) into (1):

$$NC = V_o * R_o/V_o - V' * [R_o/V_o + (V' - V_o) * R_o/(V_o^2 * \varepsilon)]$$

Rewriting:

$$(V')^2 * R_o/(V_o^2 * \varepsilon) + V' * [R_o/V_o - V_o * R_o/(V_o^2 * \varepsilon)] + (NC - R_o) = 0$$

Simplifying (multiply both sides by V_O/R_O):

$$(V')^2/(V_O * \varepsilon) + V' * (1 - 1/\varepsilon) + (V_O * NC/R_O - V_O) = 0$$

This formula is now in the form of the quadratic equation:

$$ax^2 + bx + c = 0,$$

such that:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

where:

$x = V'$

$a = 1/(V_O * \varepsilon)$

$b = 1 - 1/\varepsilon$

$c = V_O * NC/R_O - V_O$

or:

$$V' = \frac{-(1 - 1/\varepsilon) \pm \sqrt{((1 - 1/\varepsilon)^2 - 4 * [1/(V_0 * \varepsilon)] * [V_0 * NC/R_0 - V_0]}}{2 * [1/(V_0 * \varepsilon)]}$$

To determine if the radical should be added or subtracted, the V' was evaluated for NC = 0. When the radical was subtracted, $V' = V_O$.

Simplifying:

$$V' = \frac{(1/\varepsilon - 1) - \sqrt{(1 - 1/\varepsilon)^2 - 4 * (NC/R_0 - 1)/\varepsilon}}{2/(V_0 * \varepsilon)}$$

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