Commission Briefing Paper 5A-05

Evaluation of Fares as a Transportation Revenue Source

Prepared by: Rand Corporation
Date: January 12, 2007

Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on transit fares as a transportation revenue source and transit fare policy. Specifically, this paper explains the importance of fare structures in relation to the revenue that fares can produce. This paper describes different fare structures in use, discusses the relative strengths and weaknesses of each structure, and asserts the importance of choosing an optimal fare structure, given the current and future financial conditions of transit.

Background and Key Findings

- **Revenue from transit fares accounts for approximately one-third of all operating expenses. This number has been decreasing over time.** Increases in operating and capital expenses, increased suburbanization of jobs and housing, and declines in percent of travelers using transit have combined to erode farebox recovery rates.
- **Transit fares have the ability to attract or repel riders depending on the level at which they are set.** Fare reductions can boost ridership but can also reduce revenue and increase subsidies. Fare increases may increase revenues per rider, but ultimately may price many riders out of public transit use.
- **Flat fares although less complicated to implement have been found to be inefficient, inequitable, and ineffective.** Flat fares promote the cross-subsidization of more-expensive-to-provide transit services at the expense of riders who typically are disproportionately poorer, non-white, and have no choice but to use public transit. These potentially alienated transit dependents are more likely to support low marginal cost services and are an important segment of transit ridership.
- **Variable fares although more complicated than traditional flat fare structures can increase system efficiency, equity, and effectiveness.** Variable fares, while requiring initial capital investments, offer greater revenue generating potential, are economically more efficient than flat fare structures. Additionally the same technology used to process tickets under a variable fare structure can also help prevent fare evasion. They also encourage aligning fares more closely with the marginal cost of transit and therefore encourage the use of less expensive routes, at less expensive times of the day.
- **Deep-discount group-pass programs often yield higher revenue per boarding than systemwide averages or higher total revenues from target markets with the program than without it.** Many deep-discounting programs target choice riders who use transit at

low marginal costs and at off-peak times. While deep-discounting programs price fares at lower prices, they still increase average system revenue per boarding.

- **Smart cards offer many benefits to transit patrons and providers alike.** Smart cards allow for easier implementation of more complicated variable fare structures, improve boarding times, and decrease fare evasion. Smart cards can also easily collect travel data for use by transit providers to improve scheduling and other operation and planning. Smart cards promote cross-mode, and cross-provider transfers and interoperability.
- **If the goal of transit planners is to maximize revenue generation, a variable fare structure can improve upon revenues generated under a flat fare structure.** Given the path of ridership and revenues, and the advancements and availability in key technologies, transit operators can consider shifting from flat fares to variable fares in order to bolster revenues. It should be noted that this shift will likely not yield dramatic increases in revenues, but will nonetheless provide modest revenue gains. Not only can revenue generation be enhanced under variable fare structures, but transit operators can provide more efficient and equitable service. Where appropriate, smart cards and deep discounting programs can also yield increases in revenue at minimal cost.

Introduction

Transit fares are an integral part of transit policy and an important and arguably underutilized source of revenue. Revenue received from transit fares account for approximately one-third of all US transit operating expenses. The remaining two-thirds are covered by federal (17 percent), state (18 percent), and local funding (33 percent) (Federal Transit Administration 2007). The fare revenue share has been shrinking over the past 50 years and shows no sign of deviation from this course. Transit fares have the ability to attract or repel riders depending on the level at which they are set, the ease with which they are paid, and the degree of complication associated with calculating what they are. The following discussion will begin by presenting a historical perspective on transit fare policy, its implementation, and the role that fares have played in funding transit. Next, multiple fare instruments and structures will be discussed and critiqued. Finally, recommendations will be made to utilize fares to better support transit and increase transit's overall sustainability.

Historical Perspective

At the beginning of transit's history in the mid-19th century in the United States fares were flat. High density land use patterns and the centralized nature of land use led to relatively uniform trip lengths and highly differentiated fares were not needed to reflect the cost of serving passengers. As cities expanded and streetcar suburbs began to grow, longer distances brought differentiated pricing based either on distance or zones. In addition to the driver, streetcars employed a second transit operator who received payment, made change, and handed out tickets to patrons. This was the norm until the 1930's and 1940's when single person operation became widespread. Exact fare policies were implemented broadly during the 1960s and 1970s, as drivers' unions and management responded to robberies and attacks on bus drivers for their change funds (Sterm 1997). This policy at the same time simplified the operator's duties, reducing the potential for confusion and disputes, and reducing back office accounting costs.

With declining ridership in the 1960s and 1970s transit service became highly subsidized with the passage of the Urban Mass Transportation Act. In 1974, operating subsidies were added to the various Federal assistance programs for transit with a 50 percent matching ratio from the combination of fare box, state and local sources (Wachs 1989). In order to curtail ever-increasing subsidization, federal assistance has been restrained over the years. Given the need for additional revenue some agencies turned to fare increases. Historically, however fare increases have led to declines in ridership in favor of the private automobile further lowering revenue (Rubin 2000).

Farebox Recovery: Past, Present, and Future

The farebox recovery ratio of a transportation system is the proportion of the amount of revenue generated through fares as a fraction of the cost of its total operating expenses. Most systems are not self-supporting, and very few lines of service within a system even approach independent sustainability. Transit agencies in the United States have historically experienced loss of market share and low levels of farebox recovery. This decline has occurred despite higher average fares and limited federal subsidies. Since recovery rates do not address annualized capital costs, and recovery rates have hovered in the 33 percent range for at least 20 years, it can be assumed that transit fares will not in the foreseeable future cover very much of capital costs, but that they could probably recover a larger share of operating costs by strategic changes in the way fares are charged and in fare levels.

Flat Fares versus Variable Fares

Most transit providers in the United States use a flat fare structure to collect passenger revenues. The chief characteristic of a flat fare system is that every passenger pays the same base fare (with some exceptions for the elderly, disabled, and others) regardless of the time of day, distance, or direction traveled. The chief benefit of this structure is its simplicity both in collection and payment; riders always know that they pay the same amount. Further, drivers never have to make change nor monitor when a passenger exits to prevent evasion. However, this simplicity is accompanied by revenue losses and trade-offs in equity and efficiency that will be described below.

The opposite of a flat fare structure is a "variable fare structure". A variable fare structure is pricing method where the fare paid is dependant on one or more factors of a rider's journey. There are many variations of variable-based fare structures currently in use. These include a time-based structure where riders pay more to use transit during congested times such as 'rush hour', distance-based fares where the fare that a rider pays varies with the distance traveled, or zone-based fare which increases as a rider enters and exits demarcated zones, rings, or cordons around an area. While variable fares are a more complicated fare policy to administer they are more equitable and efficient than their flat counterparts.

The Cost of Supplying Transit

The cost of providing public transit is not uniform. The type of mode used, trip length, time of travel, and direction of travel, all affect the cost of supplying transit. Studies have shown that providing peak period (e.g. rush hour) and peak direction (e.g. following typical commuting patterns) service is significantly more costly than off-peak service (Parody, Lovely et al. 1990; Taylor, Garrett et al. 2000). Since more people use transit during peak times and in peak directions, this fact may appear counterintuitive. In order to provide enough vehicles for all times of the day, transit providers must have a large enough fleet to handle peak crowds. These vehicles typically sit unused for a large part of the day and on weekends. Additionally, there are significant labor costs associated with peaking. Labor is the single biggest operating cost in public transit. Because labor contracts limit or prohibit split-shifts or part-time shifts, many drivers' time is underutilized (Wachs 1989). It is not uncommon for drivers to sit idle during non-peak time as a result of the problem of peaking (Cervero 1980).

Given the problem of peaking, when transit managers set fares at a uniform level, they are assuming away the different costs that make up a route or service and averaging them into one simple fare. This is inefficient because riders who only travel during peak times, in peak directions, and for longer distances are paying a disproportionately lower share of fare and eroding a transit operator's overall revenue. The problem of peaking will be discussed in more detail in subsequent sections.

Revenue Production Potential

Variable fare structures can help optimize fare revenue production. Under a flat fare structure, riders who are more likely to take short and off-peak transit trips are discouraged from riding since their fares are relatively more expensive on a per-mile basis then their counterparts. Since shorter trips tend to be on routes that are relatively less costly to serve, the already-pervasive peaking problem is exacerbated (Cervero and Wachs 1982). This can effectively price certain riders out of the market, thus lowering ridership, and effectively lower net revenues for a transit provider, further eroding the already diminishing farebox recovery rate. Instead a variable fare structure sets fares closer to or at least scaled to, the marginal cost to provide transit service. Then, riders who tend to use transit in cheaper non-peak times and directions are therefore encouraged to ride more often, and riders at the peak are encouraged to change the times at which they make some of their trips. At the same time, riders, who under a flat fare structure received greater subsidies for using more expensive services, are now required to cover a greater share of their marginal cost, thus increasing revenue.

Equity

A flat fare structure is less equitable than a variable fare structure (Cervero 1980; Cervero 1981). Flat fares charge an average calculated systemwide price to ride transit, whether the rider is traveling 2- or 20-miles. Riders who travel these short distances at non-peak times and non-peak directions tend to subsidize other riders. These subsidizing riders are more often than not female, non-white, either very young or very old, and poor. As a result, under a flat fare system, these riders pay more on a per-mile basis then their typically male, white, and more affluent commuting counterparts. Under a variable pricing system where fares are based on the relative cost of supplying service, discretionary riders are not cross-subsidized nearly as much by transit dependents (Luhrsen and Taylor 2003).

Economic Efficiency

Overall, flat fares are less economically efficient then variable-based fares. Economic efficiency refers to a policy's use of limited resources. As mentioned previously, because flat fares disproportionately burden transit dependents they also tend to discourage shorter trips which are relatively less costly to provide. At the same time the converse is true. Flat fares are in effect, a cross-subsidization of discretionary riders by transit-dependents. Because discretionary riders tend to travel longer distances on less frequently used modes, flat fares promote relatively more expensive services, routes, and modes. Similarly, since transit dependents tend to make more non-work related trips and more non-rush hour work trips, flat fares exacerbate the phenomenon of peaking further leading to economic inefficiency. For those systems where fares are identical across different modes of transit, flat fares also promote use of more expensive to provide services such as commuter rail and express buses over local buses.

Cost Efficiency

Cost efficiency refers to the relative costs to administer a given policy or fare structure. One of the chief benefits of a flat fare structure is the relative simplicity of operation over a variable fare structure. There are three main cost components associated with administering a fare structure, equipment, labor, and management costs. Equipment costs include the cost of the fare machines, ticket printing machines, and turnstiles when applicable. Under a flat fare structure, less equipment, technology and capital costs are needed. Buses require traditional fare collection machines which simply register if a patron has paid the flat fare. In a flat fare structure, a turnstile is not necessary although it can help lower fare evasion. Under a variable fare structure however, on buses, a fare box must be able to calculate the time of day, direction of service, zones entered and exited, and may even have to be equipped to process electronic fare cards. These added requirements require additional capital expenditures. Similarly, fare collection and ticket printing machines must be able to collect different cash allocations and print fare cards with different amounts of money. Further while with a flat fare system, electronic turnstiles are not necessary, in a variable fare structure, electronic turnstiles that can scan fare cards, calculate the appropriate fare paid, and subtract it from a patron's card are a necessity. These additional expenses have significant capital costs associated.

On buses in the United States, a flat fare is almost exclusively collected by the driver. The additional time associated with collecting the same fare for every patron is somewhat negligible relative to a variable fare structure. The driver does not have to think about different rates or ask a patron about there planned destination, calculate the fare accordingly, and then monitor that the rider exits at their stated destination. Under a variable fare structure however, there is significantly more labor required to collect fares. With variable fares, a different fare is calculated for every rider depending on any or all of the following: time of day, direction of travel, zones entered, and mode used. The collection of these fares requires more labor, either by slowing down the progress of a vehicle so that the driver can calculate and process a fare, or by having a ticket taker on board to handle the process.

In terms of management costs, both for buses and rail, implementing a flat fare pricing system requires fewer outlays then a variable fare structure. Instead of determining many tiers of prices for various directions of travel, times of day, and zones entered, a transit provider need only calculate one blunt average price for an entire system. Similarly, since a variable fare structure requires certain automated equipment, changes to variable pricing require additional reprogramming to equipment.

Likelihood of Evasion

The relative likelihood of evasion associated with each fare structure has as much to do with exogenous transit conditions such as the type of mode or type of fare collecting system as it does with intrinsic characteristics associated with a given fare structure. For example, on buses with a flat fare system there is little likelihood of evasion because each rider must enter past the driver. On buses with a variable fare structure however, drivers are required to remember where riders embark and or disembark. Because of the difficulty involved with this task, the likelihood of evasion is increased under a variable fare structure on buses.

On non-bus modes such as commuter rail, or other rail-based modes, likelihood of evasion is in part a function of the fare-taking infrastructure and in part a function of the fare structure. That is, for rail systems with an automated entry and exit fare turnstile systems like Metro in Washington, DC, without actually physically cheating the system by jumping over the turnstile, the likelihood of evasion is relatively low. Each passenger must enter and exit via electronic turnstiles that read a fare card and charge the appropriate fare regardless of what type of fare structure is in place.

With honor-based enforcement systems such as the one in use at MTA in Los Angeles, riders are beholden to truthfully purchase tickets and therefore the likelihood of evasion increases. Without electronic turnstiles in place riders are less likely to pay to ride a rail system regardless of the fare structure, unless a severe enough evasion penalty is in place. Under flat fares, a random monitoring system makes the likelihood of evasion higher. Under a variable system, the same holds true. This time however, the only aspect of a rider's trip that can be verified is the direction, time of day, and original or final destination. Therefore, gaming can occur not only by completely neglecting to pay a fare but also paying a significantly lower fare and claiming that a rider exits a system earlier than planned.

Essentially then, the likelihood of evasion on buses is increased under a variable fare system unless a significant labor cost is added to the bus operation. As for rail transit, the likelihood of evasion is marginally increased under a variable fare system, unless electronic turnstiles are in place, or high penalties for evasion are enforced.

Technical Feasibility

Establishing either a flat fare structure, variable fare structure, or a hybrid of the two is technically feasible. Both types of system are already in use in many systems and across many modes. The technology exists for traditional flat fare bus systems as well as distance- or more readily used zone-based bus routes. On rail, Metro in Washington, DC already incorporates distance and time of day-based fare in their fare structure. Adding additional variables to the fare calculations such as direction of travel, or service line used what simply involving reprogramming the automated fare collection and ticket generation machines and their corresponding electronic turnstiles. In flat fare rail systems without turnstiles such as MTA in Los Angeles, additional equipment would have to be purchased and installed, but the equipment already exists and the technical feasibility is still very high.

Deep Discounting

One form of alternative ticketing method is "deep discounting." Deep discounting is similar to the monthly transit passes commonly used in public transit. Deep discounting differs from traditional monthly passes in that deep discounting allows unlimited use, and can be issued for varying lengths of time, often longer than a month. It also covers all members of a group, for example, all students and employees at a University, and it charges very low fares per use relative to other forms of transit fares. Deep discounting is typically paid for by an employer or other organizing body such as a university.

Deep discounting follows from the idea that given significant revenue losses, transit providers have typically had two response, service improvements and expansions and fare reductions. Research has shown however that fare reduction yields greater ridership and lower operating deficits. Further, one of the goals of some deep discounting programs is that they target routes where capacity is under utilized and therefore any increase in ridership, regardless of the discounted fare, would represent an increase in revenue at a minimal marginal cost (Nuworsoo 2004).

One example of a deep discounting program is the ClassPass at the University of California, Berkeley. The class pass was paid for by the University ($1.3 million per year) and allowed students to ride AC Transit for free. After implementation of the ClassPass program, surveys in 1997 and 2000 found an 8.4 percent increase in annual student ridership (Nuworsoo 2004). This increase yielded AC Transit net additional revenues of $40,600 per month without any additional service changes. Basically the additional revenue came from previously unused excess capacity. Another deep discounting example is the ECO Pass program, also in conjunction with AC Transit but this time for City of Berkeley employees. About 120 employees used AC Transit for work before the program. With the program, the city paid AC Transit $6,650 (for 1,330 city employees at $5 each) for each month (Nuworsoo 2004). This translated to a calculated revenue increase of $4,240 a month, approximately 175 percent more than without the program, a net annual revenue increase of approximately $50,880 from the program. Once again in this case, AC Transit made no changes in service to accommodate the employee population and incurred no additional costs.

Despite the success of several deep discounting programs, many transit managers fear that adopting such programs would raise alarms about the perception of inequity associated with giving certain groups a discounted fare. Despite concerns, case study analyses have found that deep discounting passes produce up to three times the revenue per boarding then the system-wide average without deep discounting. Further research suggests that "deep discount group pass may be an instrument for increasing operating revenues and hence system efficiency. Everything else being equal, the more revenue that is raised, the less society might need to subsidize operations (Nuworsoo 2004)."

Smart Cards

Smart cards are a credit card-sized fare media that riders use to pay for fares. Smart cards are capable of data storage and transmission. Smart cards are typically rechargeable and often contactless, meaning that cards only have to be a certain distance from a proximity detector to register an entrance or exit from a system. They are intended to offer many benefits both to patrons and transit providers, however they do require more capital costs initially then traditional fare card systems.

One of the prime benefits of smart cards is their interoperability. Some systems are limited to one service provider or mode only. Other systems however not only work on all of a provider's various modes (bus, rail, and parking) but are also compatible with several transit operators within a region, such as the San Francisco Bay Area TransLink card that works with AC Transit and Golden Gate Transit. TransLink is slated to also work with BART, Caltrain, and MUNI in the near future. By simplifying the transfer process between multiple modes and transit providers, riders can use one fare card across multiple systems and boost overall ridership.

Smart cards also have the potential to improve transit operations and planning. Smart cards make implementing variable fare structure less complicated and allow for greater fare accountability. Smart cards can also reduce boarding times for riders and improve individuals and transit providers' queuing-associated inefficiencies. Smart cards can also reduce the percent of revenue lost as a result of evasion. Further, the data captured and transmitted by smart cards can, at no additional effort to a rider, be transmitted to a service provider and be used for better planning of service.

However despite the potential benefits associated with smart cards they do require significant capital expenditures and have therefore led some transit planner to drag their feet about adoption. In a recent survey, nearly a third of transit agencies surveyed were either not considering or had rejected the smart card adoption. Further investigation found that those agencies that either did not consider smart cards or rejected the system, tended to have the lowest revenues of the operators surveyed (Iseki, Yoh et al. 2006). The low revenues and in turn low ridership likely did not justify the initial investment despite the potential future benefits.

Conclusions

Transit fare policy is an integral part of transit planning and operations. Transit fares not only affect direct revenue generation, but fares also send signals to patrons and consequently affect ridership levels and types of costs services used which have indirect effects on revenue. Fares also have important equity implications. Flat fares are used on most bus systems and many rail systems. These fares while easier to implement have led to suboptimal revenue generation. They have also led to ineffective and inequitable transit service. Variable fares, while more complicated to implement, price transit more accurately, maximize revenue, and are more equitable than flat fares. Flat fares encourage the use of expensive services like express buses and commuter rail as opposed to less expensive services like local buses. Typically transit dependents are more likely to use less expensive services because they make more off-peak, local, and non-commuting trips. Flat fares lead to the problem of peaking which increases operating costs, while variable fare structures increase revenue and encourage the use of cheaper-to-provide transit service. Flat fares further encourage cross-subsidization of richer, typically non-white populations by poorer groups. Thus there are several advantages if service providers switch from flat fare structures to variable fare structures where appropriate.

In addition, fare tools such as deep discounting programs and smart cards have been found to offer significant benefits. Deep discounting programs can increase net revenue per boarding and encourage off-peak ridership among such key market segments as students and commuters. Smart cards, can decrease boarding times and therefore decrease transit delays. Smart cards also promote mode and system transfers and provide operators with key operations and planning data. Smart cards and discounting programs also provide transit managers with revenues at the beginning of a month or time period, and allow for greater investment and planning options.

Overall, transit fare policy is an integral part of the transit planning process. Given the trajectory of riders and fares, and the advancements and availability in key technology, transit operators are now better able to convert from flat fares to variable fares and to institute smart cards and deep discounting programs that will benefit both transit providers and users.

References

Cervero, R. (1980). Efficiency and Equity: Implications of Transit Fare Policies, University of California, Los Angeles.

Cervero, R. (1981). "Flat Versus Differentiated Transit Pricing: What's a Fair Fare?" Transportation(10): 211-232.

Cervero, R. and M. Wachs (1982). "An Answer to the transit Crisis: The Case for Distance-Based Fares." Journal of Contemporary Studies **Spring**: 59-70.

Federal Transit Administration (2007). "National Transit Database."

Iseki, H., A. Yoh, et al. (2006). Survey on Status of Smart Card Fare Collection Systems Among U.S. Transit Agencies, Institute of Transportation Studies, University of California, Los Angeles.

Luhrsen, K. F. and B. D. Taylor (2003). "The High Cost of Flat Fares: An Examination of Ridership Demographics and Fare Policy at the Los Angeles MTA."

Nuworsoo, C. (2004). Deep Discount Group Pass Programs as Instruments for Increasing Transit Revenue and Ridership?, University of California, Berkeley. **Ph.D.**

Parody, T. E., M. E. Lovely, et al. (1990). "Net Cost of Peak and Off-Peak Transit Trips Taken Nationwide by Mode." Transportation Research Record **1266**: 139-145.

Rubin, T. A. (2000). "Environmental justice and transportation decisions—The Los Angeles experience." Transportation Research Board Annual Meeting, Washington, DC.

Sterm, R. (1997). Synthesis of Transit Practice 26: Bus Transit Fare Collection Practices. Transit Cooperative Research Program. Washington, DC, Transportation Research Board, National Research Council.

Taylor, B. D., M. Garrett, et al. (2000). "Measuring Cost Variability in the Provision of Transit Service." Transportation Research Record(1735): 101-112.

Wachs, M. (1989). "US Transit Subsidy Policy: In Need of Reform." Science **244**(4912): 1545.

CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS on PAPER 5A-05

One reviewer commented as follows:

- Among transit modes, cost recovery ratios can vary significantly from the 33 percent average that is stated. Typically, rail transit (subways, commuter rail) will recover much higher shares. Rail transit fares are usually higher than bus fares, and operating costs per passenger for rail are much lower, given the greater number of passengers per operator on rail transit.
- Transit fares are inelastic. That means if the objective is more revenue, fares should be raised, despite the resulting reduction in ridership. But maximizing transit revenue is not the objective. To a certain extent, maximizing peak transit ridership is the objective in order to compensate for externalities induced by subsidization of auto trips. To get clean air and reduce congestion, transit peak fares are not typically set to cover transit peak marginal costs as if transit were a private company operating in a perfectly functioning market. Focusing exclusively on higher peak period transit fares simply chases customers back to their peak period automobiles.
- The paper does not mention federal and state transit tax incentive programs that provide the equivalent of sharply reduced fares. At the federal level, employers can deduct up to $110 per month per employee as a business expense and employees can receive that amount tax free. This program spurs increased transit ridership and revenues.
- Smartcards do offer more convenience for customers and can reduce cash-handling expenses for transit systems. But the lack of interoperability is a severe handicap. Many transit systems have encountered frustrating delays and serious cost consequences as competing vendors refuse to permit systems to be integrated into regional networks.
- Any fare system, whether flat or variable, can experience fare evasion problems. For example, if transfers are allowed, it is common practice among fare evaders to pass transfers from persons on the bus back to those waiting to board. Also, transfers can be re-used long after their expiration if bus drivers are not vigilant.
- The paper does not mention free-fare zones. These are a beneficial example of flat fares. Again, the objective of such zones is to boost access to commercial activities, reduce congestion and improve air quality. There is no need to insist that transit fares match transit marginal operating costs in this case.