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Considering Fare-Free Transit in the Context of Research on Transit Service and Pricing: A Research Synthesis

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16. Abstract

In this report, we examine both the substantial research literature on transit pricing and use and literature on free- and reduced fare (FAR) programs. In general, we find that FAR programs can take many forms, and the idea of "fare-free" transit is far from a one-size-fits-all proposition. Second, while reducing or eliminating fares does indeed increase ridership, all else equal, transit research has consistently found that riders tend to be more service elastic than fare elastic. In other words, they tend to respond more to service improvements than price reductions, which means that, at the margin, money "spent" on fare-free programs (in the form of foregone revenues) may attract fewer riders than if that money were put toward improving service. And third, the social equity dimensions of fare-free transit are many, ranging from considering the share of fare-free benefits that flow to higher-income riders to the potential racial equity benefits of reduced fare enforcement policing on transit.

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Executive Summary

Executive Summary

While the COVID-19 pandemic has wreaked havoc on public transit systems around the globe, it has precipitated something of a watershed moment for free- and reduced-fare (FAR) programs. The pandemic demonstrated that FAR programs can work if the funding and political will are there, and in the nation's second largest metropolitan area LA Metro launched what was in many respects the biggest experiment in FAR programs the U.S. has ever seen. While viscerally attractive, FAR programs entail costs to transit systems in addition to offering benefits to riders. These cost and benefit tradeoffs raise important public policy issues. Among these are the availability and sustainability of funding to underwrite FAR programs, how riders perceive the relative benefits of fare reductions (or elimination) versus service improvements, the operational benefits of faster passenger boarding, the potential equity benefits of reduced fare enforcement, the presence of antisocial behavior on transit and whether FAR programs may exacerbate those behaviors, and the extent to which FAR programs detract from transit agencies' ability to achieve state-mandated farebox recovery requirements.

Against this backdrop, we examine both the substantial research literature on transit pricing and use, as well as the smaller and generally newer literature on FAR programs. We summarize the current state of research, consider its policy implications for FAR programs, and identify major research needs. In general, we find that FAR programs can take many forms, and the idea of "fare-free" transit is far from a one-size-fits-all proposition. Second, while reducing or eliminating fares does indeed increase ridership, all else equal, transit research has consistently found that riders tend to be more service elastic than fare elastic. In other words, they tend to respond more to service improvements than price reductions, which means that, at the margin, money "spent" on fare-free programs (in the form of foregone revenues) may attract fewer riders than if that money were put toward improving service. And third, the social equity dimensions of fare-free transit are many, ranging from considering the share of fare-free benefits that flow to higher-income riders to the potential racial equity benefits of reduced fare enforcement policing on transit.

With respect to public policy, free- and reduced-fare programs do have potential to attract riders and increase equity, but they are far from a one-size-fits-all proposition. With respect to fare-free transit, the cost (in foregone fare revenue) is lower on systems that already recover a relatively small share of their operating costs out of the farebox. Such systems tend to operate in less transit-friendly environments and carry larger shares of lower income and mobility disadvantaged riders. On systems with higher farebox recover rates, especially those serving large downtowns, the opportunity cost of fare-free programs is much higher, and such systems tend (though they do not always) carry proportionally larger shares of non-poor riders. On these latter systems, targeted fare-reduction programs aimed at particular rider groups (low-income, students, etc.) are a less costly way of directing fare reductions for those riders who need them most. But in either case, the costs and benefits of FAR programs should be weighed against the costs and benefits of improving service quality.

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Introduction: What's the right price for public transit?

Debates over transit fare policy are almost as old as public transit itself. Patrons agitate for lower fares. Lower-income carless patrons, who frequently constitute the core transit user demographic, and their advocates often argue for lower fares on equity grounds. Higher-income patrons who are likely to own a vehicle may advocate for lower fares so that the monetary costs of their transit travel fall below the cost of parking at their destination; otherwise, such patrons would be likely to drive instead (NASEM, 2004). Conversely, transit operators are likely to argue for higher fares to at least mitigate, if not completely cover, the costs of providing service. While public transit systems dating from prior to the Second World War typically have private, for-profit origins, public ownership of almost all transit systems in the U.S. today has complicated decisions about fare policies because it raises questions about the appropriate role of pricing strategies in allocating publicly owned goods and services. Ultimately, because policy "is negotiated, not formulated," (Jones, 1985, p. vii), agreements among various interested parties, once settled, are seldom revisited, resulting in fare structures that have changed only modestly over the past century.

Proponents of lower and higher fares historically reached a detente in the form of flat-rate fares that increase only in the face of fiscal crises (Civic Research Bureau, 1936; Cudahy, 1990; Miller, 1941). During the first half of the last century, when nearly all public transit systems were privately owned but publicly regulated, local politicians often sought to curry electoral favor among voters (many of whom were also transit riders) by keeping fares low and by being perceived as willing to punish the often unpopular "traction companies" for overcharging for fares and under-delivering on service quality and quantity (Bottles 1987). Keeping fares low (often a nickel) amid rising costs may have been popular with voters but tended to exacerbate service quality and financial instability problems for private transit companies expected to improve and expand service on fixed, flat fare revenues alone (Jones 1985).

Ultimately, the flat fare policies— alongside routes that stretched further and further into expanding auto-oriented suburbs, passenger demand increasingly concentrated in peak hours and peak directions, and a legacy of rising real labor costs (Jones, 1985)— combined in the first third of the 20th century to create structural problems that plague transit finance to the present day. For example, to this day, most transit agencies charge some version of a flat fare, which varies neither by time nor distance of travel.

While total transit boardings (at least prior to the COVID-19 pandemic) remained relatively flat over the past half-century, the population, vehicle travel, and transit investment have all grown. As a result, transit's share of overall travel and the share of its capital and operating costs covered by fares have both eroded over time. Transit agencies are constrained in their ability to raise fares to match costs, in no small part because the elected officials who sit on transit governing boards are often loath to raise prices or shift away from flat fares.

Most U.S. transit systems 2+ years into the pandemic are struggling to find stability as overall rider demand remains at about half of pre-pandemic levels, with ridership into and out of downtowns and other major activity centers remaining particularly depressed (Speroni, Taylor, & Hwang, 2022). This is on top of ongoing longer-term trends in metropolitan growth on the auto-oriented suburban fringe that is difficult to serve effectively with traditional fixed-route, fixed-schedule transit (Schouten, Blumenberg, & Taylor, 2021). With respect to transit fare payment systems, innovation is occurring, albeit slowly. Technological innovations such as "open-loop" systems enabling payment via credit card and/or mobile devices are improving the flexibility of fare payment for riders and agencies alike. However, institutional inertia on the part of transit agencies, regulations, tradition, and contractual guarantees between transit agencies and fare media companies often combine to deter innovations in fare policy that could make it easier for riders to pay fares and could allow transit prices to better reflect the costs of providing transit service (Yoh, Taylor, & Gahbauer, 2015).

Many analysts have argued for fares to vary with distance traveled and time of day to better reflect the highly variable costs of transit service provision on both efficiency and equity grounds. Variable fares can be efficient if they allow fares to track the cost of serving particular trips. These costs differ across trips according to factors such as trip length, travel mode, direction, and time of day. For example, the industry-standard "flat" fares that do not vary by distance traveled or time of day mean that long-distance riders (who tend to be higher income) pay less per mile than short-distance riders (who tend to be lower income). Variables fares can be equitable to the extent that socially vulnerable groups including low-income and non-white transit users tend to consume less expensive-to-serve trips. In addition to taking shorter trips on average, they also tend to ride lower-cost modes (like buses instead of trains) and take more trips at less-expensive-to-serve off-peak times. Variable fares can thus help prevent socially vulnerable riders from subsidizing the fares of more advantaged groups. Even so, transit riders – outside of downtown commuters in the oldest, largest cities – are disproportionately low-income, so that U.S. is overwhelmingly a social service for groups unable to afford or otherwise access private automobility.

However, proposals for variable fares have garnered little traction among transit managers and their governing boards, who often worry that changing fares may be even less popular with riders than raising them (Yoh, Taylor, & Gahbauer, 2015). In addition, variable fares were also difficult to implement from a technological standpoint for most agencies until recently. As a result, much fare experimentation has centered on "fare-free" or reduced fare programs (Bleich, 2020; Saphores, Shah, & Khatun, 2020; Walker, 2022). Free- and reduced-fare (FAR) programs have most commonly been targeted at specific groups of transit riders, like students or seniors. When fare-free policies have been adopted system-wide, it has often been by relatively low-ridership, low-farebox-recovery[1] systems for which the costs of fare collection may exceed the fare revenues generated. Special purpose systems, such as university shuttle buses or systems primarily geared toward economic development such as downtown streetcar circulators, may also not charge fares at all.

FAR programs can help improve transit system performance. FAR programs may reduce the costs of collecting fares and improve vehicle dwell times at stations by reducing time delays resulting from fare collection. Boarding

[1] Farebox recovery refers to the percentage of operating and maintenance (but not capital, such as for buses and other equipment) costs that are covered by passenger fares. Farebox recovery rates range from five to 50 percent on most transit systems.

times per passenger on fare-free systems may be between three and 10 times less than boarding times on the same type of vehicle when passengers pay with cash or card (Tirachini, 2013). In more recent fare free transit experiments, LA Metro's elimination of fare collection during the peak of the COVID-10 pandemic reduced boarding times by 10 percent (Walker, 2022). Eliminating fares also reduced dwell times by 20 percent during Boston's ongoing fare-free pilot (McArthur, 2022). Completely eliminating fares may be especially convenient for non-regular users, who will experience fewer barriers to occasionally using the system caused by not being familiar with different routes and fare media. Discount programs of any magnitude, however, reduce the amount of fare revenues collected, in some cases entirely.

FAR strategies address equity concerns related to the absolute affordability of transit for low-income patrons but also raise questions about the equity and effectiveness of eliminating fares for higher-income patrons. These riders have little need for financial assistance and tend to take more expensive-to-serve trips on more expensive-to-operate modes. At the same time, they constitute only a small minority of transit users outside of New York City, San Francisco, Washington, DC, Boston, and few other of large cities. The actual extent to which high-income travelers will be motivated to ride or ride more frequently due to free or discounted fares is likely to be small, if not negligible, on most transit systems.

As a special case of flat fares, fare-free policies limit the ability of operators to charge different fares based on trip costs rather than traveler characteristics. Even so, FAR programs are increasingly being touted by transit advocates, many practitioners, and some scholars in recognition of the important social service role played by transit in providing mobility to those unable to afford or otherwise access private mobility, such as older adults who may face both physical and financial barriers to automobile use (Shin, 2021). Advocates have also proposed fare-free policies as a strategy to reduce racially biased fare enforcement, as fare payment is disproportionately likely to be enforced on Black riders (ACT-LA, et al., 2021; Groover, 2019). In recognition of these disparities, transit agencies in Cleveland and Portland have been sued on grounds of racial discrimination in fare enforcement (Zipper, 2019). And during the COVID-19 pandemic many transit systems experimented with fare-free policies as a public health strategy to reduce the need for physical contact between riders and fare collection equipment as well as to facilitate rear-door boarding, which reduces physical contact among riders and drivers. While there are several formal analyses of specific FAR programs that almost exclusively examine ridership and fare revenue impacts (Dai, Liu, & Li, 2021; Metaxatos, 2013) much of this work lacks theoretical or conceptual framing and empirical guidelines for holistically evaluating the overall success of FAR programs in terms of both achieving program goals as well as in improving the performance and financial position of the implementing transit agency.

What does previous transit pricing research tell us about fare-free proposals?

In this section, we summarize key bodies of literature related to and informing research on fare-free transit. We begin by describing the social and transportation functions served by transit. We follow by discussing transit pricing, factors that influence transit fare policies, and different fare structures. We emphasize the characteristics of, and current literature related to, FAR programs. We then discuss elasticities of demand for transit, including reasonable parameter estimates. We conclude the literature review by summarizing the current state of relevant literature and research needs related to FAR programs.

Transit: What it does and who uses it

Public transit in the U.S. typically serves two key markets: travelers who, because of age, income, or ability, lack access to private cars, trucks, or motorcycles, and commuters traveling into and out of downtowns and other major activity centers where parking is scarce and/or expensive. Transit thus both serves as a transportation social service and enables large agglomerations of activity (central business districts, universities, etc.) to thrive (Garrett & Taylor, 1999). People who do not have access to a vehicle are disproportionately likely to be low-income, non-white, and/or an immigrant, while those traveling to major activity centers tend to have higher incomes, are more often white, and are less likely to be immigrants. The demographics of transit users are in this way closely linked to the two functions served by transit.

Because transit use is so heavily concentrated among commuters and transit dependents, ridership and subsequent cost patterns are heavily influenced by the needs and behaviors of these two ridership segments. Changes in the travel needs and transit use of these two groups will consequently have a disproportionate effect on transit ridership patterns and resulting financial performance.

Relationship of transit prices to costs and benefits of transit service

Transit fares are the price charged for transit service. In competitive markets, prices reflect the equilibrium of individuals' demand and firms' costs (Nicholson, 1998). In the (noncompetitive) transit market, transit fares do not fully reflect the costs of providing service incurred by a transit agency. One reason for this is that not all of the costs of providing transit service accrue to the agency providing the service, nor are all of the benefits of transit enjoyed only by riders. External costs and benefits, or externalities, occur "whenever the activities of one economic agent affect the activities of another agent in ways that are not reflected in market transactions" (Nicholson, 1998, p.730). In other words, the costs and benefits of externalities accrue to parties other than those that take a particular action. For example, transit service may enable private firms to locate in dense areas that benefit from agglomeration economies that serve to increase the firms' productivity. Transit riders do not directly benefit from this agglomeration effect, although it may lead to increased employment and income for riders over the long run. Because externalized costs and benefits accrue to parties other than the transit agency and its riders, they will tend to be excluded from transit's cost-benefit calculations unless steps are taken to *internalize* those costs and benefits (pp.736-737). Internal costs, by contrast, are borne directly by agencies providing transit service and internal benefits (such as getting to work or school on time) are enjoyed directly by riders.

Beyond the question of external and internal costs, transit agencies typically depend entirely on taxpayer subsidies to build subway and light rail lines and purchase vehicles and equipment. This is because many subsidy programs, particularly federal transit subsidy programs, strongly favor capital over operating expenditures. So, while capital costs are an internal cost directly related to service provision, such costs are almost always excluded from farebox recovery calculations, which typically divide fare revenues collected by operating and maintenance costs. While a century ago transit fares covered both operating and capital costs on most transit systems, today they typically cover none of the capital costs and from five to 50 percent of operating and maintenance costs.

Why do fares fall so far short of covering the costs of providing transit costs? With the move from the private to public sector, the public goals and aspirations for public transit – to provide mobility for those without, to encourage travel by means other than driving in order to reduce congestion and emissions, and so on – have tended to grow over time. As a result, transit agencies do not always value cost recovery as a primary, or even a supplementary, goal of fare policy. Agencies may set fares to achieve other goals, such as to attract more riders (e.g., Li et al., 2021). Other common motivations for the public subsidy of transit include improving the transportation access experienced by community residents, improving the quality and effectiveness of transit service offered, and contributing to economic development of transit service areas (Taylor & Morris, 2014). Agencies that benefit from dedicated sales taxes and other local revenue tools that require voter approval to be enacted may be motivated to structure their fares to at least be perceived by voters as contributing to the achievement of goals of interest to those voters such as congestion relief or environmental benefits (Börjesson et al., 2015; Manville & Cummins, 2014). As a result, fare policies structured by agencies to help achieve these goals may not necessarily charge higher fares for more expensive to serve trips.

Even agencies that attempt to structure fares to better match costs may be stymied by incomplete or incorrect cost information. Virtually no transit operators develop fully allocated cost-allocation models for their services and as a result are unable to precisely calculate the marginal costs of different operational and managerial decisions. FAR programs exacerbate these accounting difficulties, because due to different FAR programs the average paid per trip or passenger is not the same as the posted "sticker price" of transit fares.

Without a clear understanding of how their cost inputs relate to service outputs, and how this relationship varies across modes, time of the day, day of the week, location, or distance, transit managers have little basis to use fare policy to match prices to costs in order to equalize subsidies across trips, riders, or modes (Yoh, Taylor, & Gahbauer, 2015). Without accurate and precise cost data, and a way to systematically relate these data to service outputs or consumption, fares charged will be unlikely to reflect in ways that might, for example, encourage riders to consume more inexpensive-to-provide trips and be more judicious in their consumption of expensive-to-provide trips. And since lower income riders are more likely to consume the former, and higher income riders the latter, the opportunity to use pricing to increase both efficiency and one important form of equity is lost (Yoh, Taylor, & Gahbauer, 2015).

Fare structures

Fare structures are formally set by transit agencies, but the effective fare paid by riders will depend on policy in conjunction with fare enforcement and any other subsidies that riders may be receiving. These subsidies may be provided directly by transit agencies, by a third-party (such as an employer, school, or social service provider), or through group fare purchase programs. This highlights the distinction between transit system fare policies and user-side subsidies for transit use. Both can be classified as FAR programs, but the underlying mechanisms are fundamentally different. *Policies*, as implemented in fare policies, operate by regulating the sticker price of transit use. *Subsidies* operate by effectively increasing the financial resources available to some or all riders for paying fares. Table 1 compares the two types of FAR programs. Both types of FAR program exist in addition to general subsidies on transit use that mean that even baseline fares involve some level of subsidy from the public.

Table 1. Distinguishing FAR Policies from Subsidies

	Policies	**Subsidies**
Examples	Discounted fares for seniors and riders with disabilities; Free rides on holidays; Discounted off-peak travel; Free rides for students and veterans; Free transfers; Discounted multi-ride passes	Transit agency distributes preloaded fare cards; Third party purchases fare tickets and distributes them directly to riders; Service provider provides riders with funds to purchase fares
Distinguishing features	Operate by reducing the sticker price of transit use. Fare discounts are provided through fare structures	Operate by increasing resources available to transit users to put towards transit; Budget supports produce effective fare discounts
Advantages	Many FAR policies require minimal resources to implement; Many policies will not require identifying and recruiting eligible transit riders, which should result in increasing the number of eligible transit users who benefit from different FAR policies;	Reduces the cost of transit use for recipients without reducing the revenues collected by transit agencies; Subsidies may thus potentially reduce the opportunity cost of improving transit affordability relative to FAR policies; FAR subsidies may be preferred for all the general theoretical reasons why

	Policies	**Subsidies**
	This does not necessarily hold for FAR policies, such as low-income fare eligibility, which may require a verification and enrollment process; Does not require funding to purchase subsidies; Reduces marginal cost of adding new riders	user-side subsidies are preferred by economists over price controls; Subsidies increase supply over the medium- and long-term by increasing demand, while binding price controls will tend to interfere in the adjustment of supply to match changes in demand spurred by reduced prices (Chunyan, Funing, & Jun, 2013; Davis & Kilian, 2011).
Disadvantages	Discounted fares reduce revenues, which in the long run may lead to reduced service quality and require new revenues; they are likely to limit the ability of transit agencies to have fare levels track costs	Requires resources to identify eligible recipients; The ability of transit agencies to shape user travel patterns using fare policy is limited when someone besides the user pays for their fares; Some entity must provide funding for the subsidies; Potentially wasted funds if subsidies are purchased but not used

FAR policies and subsidies can both decrease the financial burden of transit use for riders. FAR policies (such as fare structures that provide discounts to students) are generally straightforward to implement but may reduce the ability of transit agencies to match fare levels to the costs of serving particular trips. Transit agencies that implement FAR policies may experience declines in fare revenues as a result, which could potentially lead to cuts in service or, short of that, fewer service improvements. In contrast, FAR subsidies (such as transit agency-funded distribution of preloaded fare cards) require (often 3rd party) funding and are likely to require additional expenditure of resources in identifying eligible recipients. Third-party subsidies, however, do not require transit agencies to forego fare revenues the same way that FAR policies do. Interested agencies may choose to use part of those revenues to fund subsidy programs. Whether a policy or subsidy is more appropriate for a particular transit agency will depend upon the specific circumstances, including the agency's funding situation and the outcomes it hopes to achieve. In general, subsidies will require more resources to implement but may reduce the opportunity costs of FAR programs.

Flat fares vs differentiated fares

Under a flat-rate fare policy, patrons pay a pre-specified amount per trip, regardless of time-of-day, trip length, or travel mode (Cervero, 1980; Stern, 1997). While distance-based fares (usually levied in terms of geographic fare zones) were much more common (albeit not the norm) prior to the 1970s, they increased driver/conductor conflicts with passengers (such as by traveling into another zone without paying for it and being required to leave the bus or streetcar), which made them unpopular with drivers/conductors. Flat fares originated in the horsecar era, when trip distances averaged little over 3 miles, so there was little difference in length between “long” and “short” trips (Jones, 1985, p.30). Service agreements between transit agencies and municipalities generally guaranteed flat fares, by 1910 (p.35), and flat fares remain common today, their popularity buoyed by their longevity, simplicity, and potential to reduce conflict between transit riders and staff.

In addition to better matching prices to the costs of providing various types of transit service, fare structures that charge different amounts for different types of trips enable demand management as well. By charging more for expensive-to-provide trips (say a longer peak-hour, peak-direction trip on rail) and less for inexpensive-to-provide trips (say a ten block mid-day bus trip) transit passengers can be encouraged to shift their riding patterns in ways that reduce the marginal costs of service provision. Transit agencies can in this way use fare structures to help reallocate demand for service to enable more efficient use of labor and rolling stock. These fare structures also reduce the marginal cost of adding riders, which improves the cost-efficiency and cost-effectiveness of service (Taylor, Garrett, & Iseki, 2000).

Fares may be differentiated along the lines of trip characteristics such as time of day, distance, and direction. Distinctions between peak and off-peak travel are particularly important, because peak period passenger volumes largely determine labor needs and have a big effect on capital costs by determining vehicle and infrastructure needs as well. As discussed above, flat fare structures will tend to overprice short trips and underprice longer trips relative to the costs of serving those trips (Rosenthal, 2017). Brown (2018) explores the per-mile transit fares paid by lower-income and higher-income transit users in LA. She finds that low-income transit riders tend to take shorter trips than higher-income riders, to use local-travel oriented transit modes such as local bus rather than longer-distance modes such as commuter rail, and to be more likely to travel during off-conventional peak periods than higher-income patrons. As a result of these factors, under flat fare structures, lower-income riders tend to pay higher per-mile transit fares than do higher-income riders. Thus, fare structures that vary by distance, time-of-day, or mode will tend to be fairer across many dimensions of equity than flat fares, but may still be themselves inequitable. Brown concludes that, based on riders’ ability to pay, the benefits riders receive from transit trips, and the costs of providing service, the most equitable fare structure would be a non-capped distance-based fare structure that also varies by time of day. Nuworsoo, Golub, and Deakin (2009) similarly find that flat fares are among the most inequitable of fare structures because low-income, younger, and non-Hispanic white riders tend to make more trips and make more transfers than wealthier riders.

However, in contrast to, for example, the pricing of air travel, it is far less common for transit operators to set different rates for different trips based on trip length, direction, or time of day (Brown, 2018; Cervero, 1985; Markowitz, 1985). More common than differential pricing based on *trip* characteristics, however, is differential pricing based on *traveler* characteristics (Kraus & Yoshida, 2002) such as age, disability, or status as a student (Cervero, 1980). Fare policies may in this way indirectly consider patrons’ different abilities to pay. In other words, fares are more likely to be set based at least in part on traveler characteristics than they are to be based on the variable costs of providing different kinds of trips (Bond, 2003).

As with fare structures that vary based on trip characteristics, fare structures that vary based on rider characteristics may be more equitable than undifferentiated flat fares but do not necessarily eliminate all equity issues (Brown, 2018). Common categories of riders toward whom FAR programs are aimed include seniors and people with disabilities, students, public employees, veterans, and low-income people.

Seniors and people with disabilities

Operators receiving federal funds are required to provide discounted fares for seniors and people with disabilities. To receive federal funding from the Federal Transit Administration, operators "may not charge more than half of the peak fare for fixed route transit during off-peak hours for seniors, people with disabilities, and Medicare cardholders" (FTA, n.d.a). Subsidies for seniors and people with disabilities are potentially equitable to the extent that they ensure ongoing mobility for two potentially vulnerable populations. However, such subsidies may not be justified on income equity grounds, because neither seniors nor the disabled are necessarily low-income. Even with federal requirements for discounts, seniors and people with disabilities may be prevented from using transit due to physical or cognitive limitations, particularly in conjunction with inadequate pedestrian and transit infrastructure (Rosenbloom, 2003).

Students

Major transit agencies currently considering or that have recently implemented FAR programs for students include Los Angeles Metro (LA Metro, n.d.) and Dallas Area Rapid Transit (WFAA Dallas, 2022b). Motivations for providing free- and reduced-fares to students include indirectly increasing funding for school transportation; backfilling for limited or absent yellow school bus service; increasing student attendance; increasing freedom and mobility for students; decreasing citations, arrests, and court referrals for teen fare evasion; increasing disposable income available to low-income families; decreasing traffic and congestion; and decreasing injuries (Gase et al., 2014). University-and college-affiliated fare-free transit services function to reduce demand for parking, increase student access to campus, serve as recruitment and retention tools for students, and reduce the costs of higher education (Brown, Hess, & Shoup, 2001)

One example of a successful university-affiliated FAR subsidy program is BruinGo at UCLA. Initiated in the early 2000s and still in existence albeit in modified form as of Spring 2022, BruinGo is funded from student fees, one of several transit subsidy programs funded from different sets of student fees at the university. Early on, BruinGo allowed students and employees of UCLA to board Santa Monica Big Blue Buses for free on presentation of their UCLA student ID card. It increased transit use among program enrollees and reduced automobile commuting to campus, particularly among students living in areas with the most frequent Big Blue Bus service (Boyd, Chow, Johnson, & Smith, 2003). Commuting to campus by bus increased by 56 percent during BruinGO's first year, while driving alone fell by 20 percent (Brown, Hess, & Shoup, 2003). The program proved so successful that parking demand, and parking revenues used to finance it, fell and the university instituted a "co-payment" that turned BruinGo into a reduced fare program. BruinGo is an "opt-in" (non-universal) program, meaning that the population of students who do not use transit are not forced to contribute mandatory fees towards the program's functioning and upkeep. Currently, the BruinGo program offers reduced-fare trips on Santa Monica's Big Blue Bus routes as well as Culver CityBus routes. One programmatic difference between earlier years of BruinGo and current years is that students currently do not use their university-issued ID card as a transit fare pass. Rather, students are eligible to purchase pre-loaded TAP cards. TAP cards can be used to pay fares to 26 different municipal transit systems across Los Angeles County (TAP, n.d.).

When, like BruinGo, free-fare programs are funded out of mandatory student fees, there will be a welfare transfer from students who do not use the passes or use them very little to students who use the passes more frequently. In practice, this means a welfare transfer to students who live within the transit commute shed of campus and make use of the transit pass, and from students who live too far from campus to make transit practicable and students who live on or near enough to campus to walk and bike (Butler & Sweet, 2020). Free transit passes for high school students have been shown to reduce absence rates, particularly, and ironically, for students who live within walking distance of schools (Wexler et al., 2021).

Funded by local government agencies and nonprofits, a free-fare program for low-income students was implemented on AC Transit in the Eastbay of the San Francisco Bay Area because in the AC Transit service area, schools charge students to use school buses. This is a financial burden on families. In addition, students without after school transportation are unable to participate in extracurricular activities. In this case, then, a FAR program served to reduce disparities in students' ability to access educational resources (McDonald, Librera, & Deakin, 2004).

Public employees

Transit operators sometimes provide free fares to public employees (e.g., City of Eugene, Oregon, n.d.). In at least one case, a transit agency has implemented free fares for federal employees to assist those employees and their families through the financial difficulties attending a government shutdown, when many are not getting paid although in at least one case free fares for federal employees was linked to a federal government shutdown (Caltrain, 2019). Most agencies offer free fares to their employees, either formally (SFMTA, 2020b) or informally.

Veterans

Free or reduced fares are frequently offered to veterans. Examples include Houston, Texas (Metropolitan Transit Authority of Harris County, n.d.), San Mateo County, California's SamTrans (SamTrans, n.d.), and Pasco County, Florida's GOPASCO (Pasco County, Florida, n.d.).

Low-income riders

Operators frequently either set lower rates for low-income riders or subsidize transit passes for low-income riders, the effect of which is to reduce the price paid per trip from the rider's perspective. Subsidies for low-income riders may also be available through third-party service providers, like social service agencies.

It is particularly important to consider the welfare impact of fare policies on low-income riders both because low-income riders constitute a large and consistent component of transit ridership but also because low-income people almost by definition have fewer financial resources than other people.

As discussed above, Brown (2018) finds that lower-income riders tend to take shorter trips, use less capital-intensive modes, and travel during less congested travel periods than higher-income riders. In other words, the "typical" transit trip for a low-income rider is less expensive for the operator to serve than the typical transit trip for a higher-income rider. Discounts for low-income riders can thus be considered to be a rough mechanism for adjusting the prices of different trip types to reflect the varying costs of serving those trips.

Fare reductions for low-income riders may be justified at least in part because transit is an essential service for those largely low-income individuals who are unable to afford or otherwise access private automobility. This is the primary reason why poor people tend to locate in inner-city and inner-ring suburban neighborhoods with the best transit service (Glaeser, Kahn, & Rappaport, 2008). More self-interestedly, transit operators should also care because low-income individuals who cannot afford the costs of transit may engage in strategies to avoid fare payment (Perrota, 2017).

Rider characteristics such as age, disability status, and veteran status are relatively straightforward to verify in the context of fare policies; these riders may face additional barriers and documentation needs when attempting to access other transportation resources such as paratransit service. Transit agency personnel selling fares, monitoring fare payment, and/or operating vehicles can easily verify if riders are eligible for FAR programs based on physical appearance, asserted need, or commonly available government identification on the same day as the rider takes a trip. However, transit agencies independently verifying that a rider's income is low enough to qualify for low-income FAR programs can involve elaborate application and assessment processes (e.g., LA Metro, 2021; SFMTA, 2020a; TriMet, 2022). In such cases, riders typically need to submit their applications and have it approved far enough ahead of their trip to allow time for their application to be processed. More recently, however, some transit systems have sought to simplify the process of qualifying for free- or reduced-fares by accepting means-testing both other government programs, such as school lunch programs for younger riders, lifeline utility rates, unemployment insurance, and so on. LA Metro's new LIFE low-income fare program, for example, accepts almost any government means-tested certification to qualify (LA Metro, 2021).

Fare structures may also charge different prices depending on a particular trip's relation to other trips. Transfers within systems, between specific modes within systems, or, less frequently, between systems, are often free or reduced, for example. Reduced-fare or free transfers will tend to reduce per-mile fares paid to the extent that transfers enable longer trips.

Deep discount group fares take advantage of economies of scale to reduce effective transit fares. These kinds of trips are less expensive because they are purchased in bulk. Deep discount group fares typically provide discounts of 40 to 94 percent off the price of individual monthly passes (Nuworsoo, 2011). They are commonly associated with and covered by third parties, such as educational systems and employers. Universal deep discount group fare programs are those for which all members of the group purchasing the fares are enrolled and prohibited from opting out. Universal coverage is key from the perspective of the transit operator, because it means that many enrollees will take fewer trips than they pay for and many, perhaps even most, may take no trips at all. Universal deep discount fare programs tend to be more financially viable for transit operators, because like subscribers to Netflix or other streaming services, relatively small payments for a very large base of potential riders (most of who may not ride at all) can significantly increase revenues relative to costs, while attracting at least some new riders who would not otherwise have ridden absent the FAR program. Unlike traditional monthly passes, universal coverage programs do not suffer from the problem of adverse selection that leads to the heaviest transit users being the most likely to enroll in opt-in transit pass programs. This self-selection process can make non-universal (opt-in) programs financially unviable (Zolnik, 2007). As a result of universal coverage, by contrast, universal deep discount group programs tend to generate higher revenues per boarding than systemwide averages and higher total revenues from target markets. Employer-based programs are especially likely to return high net revenues to operators (Nuworsoo, 2011).

Types of free and reduced fare transit

In the U.S., support for FAR programs first emerged in the 1960s, when downtown business interests threatened by suburbanization of consumers advocated for fare-free transit to improve the ability of workers and customers to reach their businesses (Delheim & Prince, 2018). As detailed in Table 1 above, contemporary FAR programs can be divided into two types. One type reduces fares directly through policies set by transit operators. The other type effectively reduces fare burdens through fare subsidies. Subsidies can be provided through operators, government programs, or third parties.

Keblowski (2020) presents a typology of fare-free programs. The first type are free-fare programs that apply to the majority of routes and services within a given transit network, which are available to most of the system's riders for most of the time, and that are available for a period of time spanning at least 12 months are full programs. The second type are partial free-fare programs that do not last at least 12 months, are implemented for specific yet regularly occurring periods of time, apply to specific areas or modes or routes, or apply to specific groups of users.

Short-term FAR programs may be implemented to incentivize the use of new or revamped transit services. The entire Dallas Area Rapid Transit system, for example, eliminated fares from January 20 - February 6, 2022, and reduced the costs of fares purchased through the agency's contactless payment system by half from February 7 through February 21. The goal of these fare reductions was to incentivize riders to try the system's revamped bus network, which had been redesigned to expand peak-hour frequency, increase the number of direct routes, and expand service hours (WFAA Dallas, 2022a).

Motivations for FAR programs frequently revolve around increasing transit ridership, which is a concern of virtually every transit operator coming out of the COVID-19 pandemic. One of the oldest FAR programs in the U.S. was the use of discounted multi-fare ticket books that "commuted" down the cost of an individual trip for regular transit riders (and which spawned the term "commuter" to describe those traveling to and from work). The goal with these commuted fares was to stimulate "the riding habit" among non-transit-users (Jones, 1985). Transit agencies, scholars, and taxpayers are likely to be interested in ensuring ridership is high enough to optimize both the efficiency (cost/service output) and efficacy (riders/service output) of transit service. Transit agencies, regional planning bodies, and many transportation and environmental activists are often motivated to increase ridership in order to reduce the environmental impact of the most common alternative to riding: driving. Other FAR program advocates may also be focused primarily on reducing the environmental impacts of driving and/or on increasing the ability of socially vulnerable groups to access transit in order to reduce their costs of travel (Štraub & Jaroš, 2019).

Differing motivations for free- and reduced-fare programs may manifest spatially. For example, free- and reduced-fare programs in the United States are more likely to be motivated by the pursuit of cost minimization and maintaining a budgetary incentive for efficient transit management than are programs in Europe (Keblowski, 2020). FAR programs may also be implemented in pursuit of broad political goals, such as when politicians advocate for reduced or eliminated fares to attract the attention and favor of voters, rather than to solve any particular economic, environmental, or social problems such as congestion, emissions, or transportation access (Carr & Hesse, 2020; Hess, 2017).

The travel behavior effects of free- and reduced-fare programs

The literature on FAR programs in practice generally finds that such programs increase ridership. The extent of ridership change is in line with the broader transit pricing literature and depends on the relevant elasticities of demand for transit, which is jointly determined by the characteristics and needs of the traveler and the quality and extent of the transit service, mediated by the fare or change in fare. Reduced or free fares may be particularly effective at increasing ridership during (generally less-expensive-to-serve) off-peak travel times (Bull, Muñoz, & Silva, 2021), because peak-hour, peak-direction travel is likely to be more inelastic than off-peak travel. Peak travel tends to be more inelastic because there tends to be a higher share of commuters in peak periods and such travelers tend to have less control over the time or direction of travel; they also tend to have higher incomes (and, hence, less price sensitivity) than those who ride transit for other trip purposes. In general, commuters, such as 9-5 office workers, have a great deal of life "fixity" in the time and location of their paid work. That is, commuters are more likely to have a reduced level of autonomy over the exact progress of their day and are thus less inclined than others whose time is more flexibly structured to make behavioral changes in response to changed incentives (Kim et al., 2017), such as reduced transit fares.

FAR programs with fares that vary by time of day can incentivize travelers with low levels of life or trip fixity to, for example, take transit trips at times outside the peak to take advantage of off-peak fare discounts. This might, at least in the short run, reduce passenger demand and vehicle crowding during peak hours. This could, in turn, lower operating costs because, as noted earlier, transit agencies must scale their labor and rolling stock to serve peak-hour demand, which means that the marginal cost of peak-period service is considerably greater than the marginal cost of, for example, midday service. In the short run, then, using price incentives to shift some rider demand outside of peak-periods could reduce operating expenses even as the total number of riders served increases. Conversely, FAR programs that reduce the costs of travel during the peak, such as a blanket discount irrespective of time, distance, or direction, may increase already taxed peak-hour demand and increase labor and rolling stock needs in the process. Such peaking concerns, however, have eased considerably during the protracted period of depressed demand during the COVID-19 pandemic.

FAR programs may incentivize a change to transit from other modes, including walking and cycling, in addition to driving (Carr & Hesse, 2020). They may decrease driving among those attracted to transit (Oldridge, 2012), which is a common policy rationale for subsidizing public transit broadly, and for promulgating FAR programs in particular. However, at least one study (Carr & Hesse, 2020) suggests that FAR programs are more likely to draw new riders from walkers and bikers, than from drivers. Travelers who, for example, switch from a long walk to work or school, to riding low- or no-fare transit may well be better off as a result of such shifts, but the effects on driving, traffic, and emissions are likely negligible.

The research to date has not been able to differentiate the ridership effects of FAR programs in encouraging current transit users to ride more versus encouraging new travelers to begin riding. Additional trips generated by existing riders and trips generated by new riders have different cost implications because existing riders may have previously been paying higher fares. Without disaggregate ridership data, analysts can only guess at the cost implications of the ridership generated by FAR programs. They are also unable to evaluate whether FAR programs intended to attract new riders onto transit are successful. Some research has addressed links between automobile use and free- and reduced-fair programs (Brown, Hess, & Shoup, 2003; Katzev & Bachman, 1982; Shin, 2021), but we are aware of no research that addresses linkages between FAR programs and longer-term decisions about residential location, vehicle ownership, or employment.

Much of the existing research on transit fare policy focuses on analyzing the extent to which one-time changes in fare levels affect ridership. This body of literature has generally found, consistent with both logic and the more general transit pricing literature, that one-time fare increases tend to decrease ridership, while one-time fare reductions tend to increase ridership (Bull, Muñoz, & Silva, 2021; Ma, Masoud, & Idris, 2017; Nahmias-Biran, Sharaby, & Shiftan, 2014; Nuworsoo, Golub, & Deakin, 2009; Wang et al., 2017). On the other hand, empirical analyses of the effects of fare policy changes over time within agencies and research on how fare policies at different agencies compare over time are both notable gaps in the current research literature.

Perhaps the most intractable policy issue associated with FAR programs relates to whether and to what extent FAR programs, if not counterbalanced by rigorous enforcement of codes of conduct, increase the presence of individuals actively engaging in antisocial behavior such as use of illicit substances, failure to maintain acceptable hygiene standards, and generally failing to engage others respectfully on transit. These individuals may also be unhoused and looking to transit systems for shelter. This issue has received significant media attention but the extent to which eliminating fares actually increases the presence of unhoused individuals on transit is unknown, with at least some researchers finding no statistical link between fare policies and the presence of unhoused riders (Wasserman, Loukaitou-Sideris, Ding, & Caro, 2022). Unhoused individuals have as much a right to navigate the city as everyone else, and transit frequently acts as an important way to fill holes in the existing social safety net. At the same time, reasonable people can disagree as to whether it is wise or desirable to try to ask transit systems to fulfill a social safety function that is only loosely related to transportation and that may actively degrade the experience of using transit for other users. It also remains that middle-class consumers with access to vehicles will opt not to use transit if the presence of antisocial behavior on transit is excessive (Loukaitou-Sideris et al., 2020; Loukaitou-Sideris et al., 2021). Still, issues associated with the presence of unhoused individuals, or at least the perception of those issues, are going to affect transit operations for the foreseeable future, so agencies must craft some kind of response. Sorting through the competing interests involved in relation to unhoused individuals and other individuals engaging in antisocial behavior on transit is one of the major unresolved policy challenges related to FAR programs.

Elasticity of demand for transit

The extent to which travelers ride more or less in response to fare or service changes is captured in the price elasticity of demand for transit. The price elasticity of demand for different goods or services captures the responsiveness of quantity demanded to changes in price. It measures changes along the demand curve and is calculated by dividing the percentage change in quantity demanded by the percent change in price (*Principles of economics,* 2016, p.145). Elasticities are likely to be higher over longer periods of time, because over longer periods of time people have greater ability to change their behavior in response to changing incentives (p.156). Empirically, the “long-run” is a period of time long enough that a household or firm may consider all of its factors of production to be variable. Over shorter periods of time, households and firms are constrained in their ability to substitute different factors of production (p.283).

Whether positive or negative, an elasticity greater than 1.0 is considered “elastic,” meaning in the case of fares, that a 10 percent change in fares would elicit a greater than a 10 percent change in ridership. Conversely, an elasticity below 1.0 (again whether + or -) is considered “inelastic,” meaning that a 10 percent change in fares will elicit less than a 10 percent change in ridership. Again, with fares the relationship to ridership is negative (as fares go up, ridership goes down, and vice versa) and, in most cases, inelastic. But whether elastic or inelastic in absolute terms, so values closer to 0 are less elastic (so an elasticity of - 0.20 is relatively more inelastic than one of - 0.40, even though both are inelastic in absolute terms).

In the context of public transit, the price elasticity of demand is not the only relevant elasticity to consider. Elasticities may also be calculated with respect to changes in service provision, such as the frequency of buses or trains. Service elasticities measure how transit ridership is affected by service quality. Commonly used measures of service characteristics include convenience, frequency, speed, and comfort. Similarly, to other types of elasticities, service elasticities are calculated by dividing the percentage change in quantity of transit demanded by percent change in different service characteristics. Service elasticities tend to be positive, indicating that increases in service quality tend to be associated with increased ridership (Litman, 2021).

Further, both price and service elasticities may be evaluated with respect to income. Income elasticity of demand measures how demand for transit is affected by a traveler's income. It is calculated by dividing the percentage change in quantity of transit demanded by percent change in individual or household income. Because transit is, in economists' parlance, an "inferior good," income elasticity of demand will tend to be negative such that an increase in income will tend to reduce demand for transit. If transit were a "normal good," by contrast, demand for transit would be positive and tend to increase with income. We now summarize several academic studies that have examined transit fare elasticities. Note that the studies vary in the extent to which participants are divided into sub-groups (such as by traveler income, gender, or age) when calculating elasticities. Some studies produce only a single overall elasticity estimate, while others produce different estimates for different categories of riders or trips. Analysts who use elasticities to estimate the ridership impacts of fare changes should be careful to note that most of the factors influencing transit use fall outside the control of transit agencies. Fare levels and service characteristics (i.e., factors within agencies' control) together explain only about a quarter of observed variation in transit use across metropolitan areas (Taylor et al., 2009). Major factors outside of agencies' control include the built environment, parking availability, traffic congestion levels, and the national and local economy.

The conventional rule of thumb for transit fare elasticities is the Simpson-Curtin rule, which holds that the price elasticity of demand for transit is approximately -0.33, meaning that a 10 percent increase in fares will likely result in a 3.3 percent decline in ridership. The Simpson-Curtin rule was derived from studies of 77 cities over a 20-year period over a half-century ago and is frequently the only basis on which calculations of transit ridership are made (Curtin, 1968, as cited in Manski, 1979).

An early literature review focused on transit pricing research comes from Cervero (1990). Cervero summarizes the state of transit pricing literature, noting that transit riders are relatively insensitive to fare levels, fare structures, and fare payment methods. He finds that riders are approximately twice as sensitive to changes in travel time as to changes in fares. Cervero notes that higher costs of private vehicle ownership and use (or so-called "cross-elasticities") would do substantially more to increase ridership than would lower fares. He also argues that flat fares are inequitable and penalize short-distance and off-peak travelers. He concludes that free fare programs have proven to attract new riders onto transit, but at significant per passenger cost.

Another early review comes from Oum, Waters, and Yong (1992). They summarize the results of 12 different studies that present estimates of price elasticity of demand for transit. Elasticities generally range from -0.78 to -0.01, although one study estimates a range of estimates with magnitudes as high as -1.32. The 12 studies generally agree that elasticity estimates ranging from -0.4 to -0.2 are reasonable. Oum, Waters, and Yong note that factors such as time horizon, the degree of rider/data aggregation, and the functional specification of the demand model all substantively impact model results.

A somewhat more recent analysis of transit price elasticity of demand scholarship is represented by Petitte (2001), who estimates fare elasticities for Washington, D.C.'s Metro service. The estimated fare elasticities are -0.34 and -0.38, respectively, using systemwide and station-level data and assuming a monocentric city structure by controlling for distance to the city center. Larger fare elasticities (in the range of -0.52 to -0.56) are estimated when the author drops an assumption that all commuters commute to a single central city station (in other words, when the author drops the assumption of a monocentric city structure).

Similarly, Paulley et al. (2006) calculate fare elasticities of demand for transit in Great Britain. For buses, they calculate elasticities of -0.4 in the short run, -0.56 in the medium run, and -1.0 in the long run. For metro rail, they calculate elasticities of -0.3 in the short run and -0.6 in the long run. Finally, for suburban rail they calculate a fare elasticity of -0.6 in the short run. Paulley et al. note that fare elasticities tend to increase over time and that travelers tend to have higher values of time for commuting travel than for leisure travel. They also find that trip distances tend to increase with income (which means that, were the DC Metro to have flat fares, then would be more income regressive than the current distance-based fares) and note that vehicle ownership has a significant dampening effect on transit demand.

A meta-regression analysis comes from Holmgren (2007), who calculates a short-run fare elasticity in the United States of -0.62 when service is treated as endogenous (i.e., determined in part by demand), a practice which he recommends. Holmgren finds that the "rule of thumb" Simpson-Curtin rule elasticity of -0.33 holds when service is treated exogenously (i.e., is not affected by demand). Based on his findings, he recommends that transit demand models include variables measuring car ownership, the price of motor fuel, fares, passenger income, and at least some transit service characteristics.

Graham et al. (2009) calculate price elasticities of demand for metros in 22 urban areas in Europe. They calculate fare elasticities of -0.05 in the short-run and -0.33 in the long run. They also calculate service elasticities of 0.07 in the short-run and 0.51 in the long-run. Finally, they calculate income elasticities of 0.03 in the short-run and 0.18 in the long-run. Graham et al. find a small positive income elasticity, indicating that metros are perceived as normal goods. They also calculate service elasticities that are larger (relatively more elastic) than fare elasticities, which implies that travelers would, all else equal, tend to prefer service improvements over fare reductions.

In contrast to the many studies finding higher service than fare elasticities, Chen et al. (2011) estimate a short-run fare elasticity of -0.40 and long-run fare elasticity of -0.80, but a short-run service elasticity of 0.13 and a long-term service elasticity of 0.27. Notably, Chen et al. identify an asymmetry in ridership responses, such that fare increases tend to reduce ridership more than fare decreases increase ridership – which has important implications for FAR programs. Similarly, with respect to cross-elasticities, they find that increases in gasoline prices increase ridership more than decreases in gasoline prices decrease ridership.

Deb and Filippini (2013) calculate elasticities of demand for public buses in India and find riders to be more service than fare elastic. They calculate fare elasticities of -0.37 in the short-run and -0.52 in the long-run; income elasticities of -0.03 in the short-run and -0.04 in the long-run; and service elasticities of 0.68 in the short-run and 0.96 in the long-run. Based on their findings, Deb and Filippini conclude that the role of fares in determining ridership is limited because fare elasticities are so inelastic. They also emphasize the role of factors outside transit operators' control in determining ridership, chief among these being demographic factors.

Schimek (2015) estimates transit fare and service elasticities for 198 U.S. operators from 1991 to 2012. He calculates a short-run fare elasticity of -0.34 and a long-run elasticity of -0.66. Schimek finds that long-term behavioral impacts are largely observable within 18 to 36 months and that demand elasticities tend to be smaller in magnitude in larger urban areas (-0.48) than in urban areas with fewer than 1 million residents (-0.73). Ridership in areas with fares that are initially lower will be more sensitive to changes in fares than will ridership in areas where fares are initially high. In other words, demand is more price elastic when fares are initially lower. Schimek concludes that both urban area size and initial fare levels should be considered when selecting appropriate fare elasticities.

Miller and Savage (2017) do not calculate elasticities per se but do relate changes in rail ridership in Chicago in response to fare increases in different years to neighborhood characteristics. Of the four incidents of fare increases, Miller and Savage find that ridership decreased more in poor neighborhoods than in wealthier neighborhoods once, ridership decreased less in poor neighborhoods than in wealthier neighborhoods once, and in two cases ridership changes do not have a consistent relationship with neighborhood income. They attribute the ambiguities in their findings to the reality that low-income transit-dependents are both more price sensitive and less likely to have alternatives to transit use than higher-income transit users. Miller and Savage estimate elasticities of demand that differ across income groups. Lower-income riders, despite being less able to afford any given fare level, may ultimately be less price-sensitive to transit fares because they have fewer travel alternatives, so the relative benefits of transit to such riders are much higher than they would be if those riders had reliable alternative travel means available to them.

Wang et al. (2018) estimate fare elasticity of demand for rail in Beijing using data on ridership after an increase in fares. They calculate weekday elasticities of -0.26 overall, -0.16 for the morning peak, and -0.21 for the evening peak. They find that shorter trips are more elastic. They also find that weekend traffic is much more elastic than weekday traffic. Wang et al. find that fare changes affected overall demand more than travel distances. They find that passenger sensitivity to fares is highest for weekend passengers, followed by passengers in the evening weekday peak. Weekday morning peak hour passengers display little sensitivity to fare changes. They find that effects of fare changes can be captured at the station level because different stations serve different types of land uses or generate trips with distinct purposes at different times. They conclude that increased fares can increase revenues and shift modest amounts of travel to walking and cycling but this effect is not so large as to mitigate the effects of peak-period crowding. They also find that stated preference surveys overstate passengers' responses to fare increases.

Li, Kasraian, and Shalaby (2020) calculate demand elasticities for transit using data from Canadian transit operators. They calculate a short-run fare elasticity of -0.24 and a long-run elasticity of -1.1. They find that demand elasticity with respect to service levels is more inelastic in the short run (0.28) than in the long run (1.3). They also find that ridership responded more to an increase in transit service supply than a decrease.

Davis (2021) calculates short-run price elasticities of -0.32 to -0.23 for rail transit in three Mexican cities. Davis also finds that baseline ridership increased after a 60-day fare holiday in one of the study cities.

Finally, Sianturi, Nasrudin, and Yudhistira (2022) estimate an overall fare elasticity of -0.074 for rail rapid transit in Jakarta and find that off-peak travel is more price elastic than travel during the peak. They find that off-peak demand is more responsive to fare changes than peak demand.

Major findings from these studies are summarized in Table 2. Table 3 following Table 2 summarizes the ridership effects of fare changes on higher- and lower-income riders.

Table 2. Summary of Findings from Transit Price, Service, and Income Elasticity Studies.

Major finding	Sources
Traveler responses to fares tend to be relatively more elastic over the long term because, given more time, people are more able to change their travel behaviors and factors influencing their travel behaviors in response to price changes.	Paulley et al. (2006); Graham et al. (2009); Chen et al. (2011); Deb and Filippini (2013); Schimek (2015); Li, Kasraian, and Shalaby (2020)
Travelers's responses to price changes tend to be inelastic, so changes in fares produce less than proportionate change in ridership – whether the fares are increased or decreased.	Curtin, 1968, as cited in Manski, 1979; Oum, Waters, and Yong (1992); Petitte (2001); Paulley et al. (2006); Holmgren (2007); Graham et al. (2009); Chen et al. (2011); Deb and Filippini (2013); Schimek (2015); Wang et al. (2018); Li, Kasraian, and Shalaby (2020); Davis (2021); Sianturi, Nasrudin, and Yudhistira (2022)
Discretionary and off-peak travel tends to be more elastic than nondiscretionary and peak-period travel.	Paulley et al. (2006); Wang et al. (2018); Sianturi, Nasrudin, and Yudhistira (2022)
Different elasticities also apply to different transit modes. Bus ridership may be less elastic than rail ridership to the extent that buses disproportionately serve nondiscretionary trips by low-income riders and trips by essential workers who are likely to work nonstandard hours not typically well served by rail. At the same time, rail typically offers service that is faster, more direct, or otherwise superior to the service provided by bus. This may serve to reduce the magnitude of fare elasticities for rail.	Paulley et al. (2006); Miller and Savage (2017)
Riders tend to be more service elastic than fare elastic, which would suggest that, all else equal, riders would tend to take proportionately more trips in response to a dollar spent to improve service than in response to that same dollar being used to reduce fares. Passengers are thus likely to respond more to service improvements than to fare reductions, all else equal. The effects of fare increases and fare decreases may also not be	Graham et al. (2009); Chen et al. (2011); Deb and Filippini (2013); Schimek (2015); Li, Kasraian, and Shalaby (2020)

symmetric. That is, a given fare increase may drive away more riders than an identically sized fare decrease would be expected to attract riders.	

Table 3. Travel Mode Substitution Opportunities May Explain Why Higher- and Lower-Income Travelers Tend to Respond Differently To Transit Fare Changes

	Fare increases	**Fare decreases**
Higher income riders	May have a ***more elastic*** response because they can easily switch to driving rather than pay higher fares	May have a ***more inelastic*** response because the price of transit is not what keeps them from riding
Lower income riders	May have a ***more inelastic*** response because they few options other than to pay the higher fare and ride	May have a ***more elastic*** response because their price sensitivity discourages discretionary trips

There is thus a significant literature focused on fare, income, and service elasticities that provides insights into the workings of FAR programs. There is also, however, a body of literature focused directly on FAR programs. Similarly, to the literature on transit elasticities, the bulk of literature analyzing FAR programs has focused on empirical evaluations of the effects of FAR programs on transit ridership. These have generally found that FAR programs increase ridership to a degree consistent with the more general literature on transit pricing (Bull, Muñoz, & Silva, 2021). This implies that much of the empirical literature focused on elasticities can indeed be applied to estimate the ridership impacts of FAR programs.

Saphores et al. (2020) reviewed FAR programs across California. They interviewed 59 transit agencies, representing 55 percent of unlinked passenger trips in the state. They found that the most common target of FAR programs were students, followed by seniors (the latter of which generally also serve the disabled, likely reflecting the influence of federal requirements). They identified only 13 FAR programs focused on low-income transit users and 11 employer-based programs. Overall, FAR programs increase ridership but raise concerns about the effect of programs on farebox recovery as well as the overall financial health of transit agencies. FAR programs funded through student fees and employer-funded programs tend to have fewer deleterious effects on farebox ratios. Saphores et al. conclude that FAR programs can play a pivotal role in increasing ridership but will be more effective if used in combination with strategies such as road pricing of private vehicle use. They also find that California's current farebox requirements constitute a substantive barrier to the expansion of FAR programs in the state. Saphores et al. argue that FAR programs should be designed to draw riders out of cars rather than competing with walking or cycling. They also argue that improving transit service quality is as important as reducing fares and that the number of FAR programs aimed at students, unemployed people, veterans, the elderly, and people with disabilities should be increased. They advocate for straightforward eligibility requirements for FAR programs so that potential recipients are not deterred. Finally, Saphores et al. argue for the creation of pilot studies geared toward measuring the travel behavior effects of FAR programs, free publicly available guidelines for FAR programs, and a clearinghouse of successful programs so that transit agencies can learn from their peers.

As demonstrated in Saphores et al. (2020), one type of FAR program that is well-represented in the literature is deep discount fare programs, such as those for students, which leverage bulk purchases by a third party (such as a school district or employer) into lower per-trip fares for riders (e.g., Brown, Hess, & Shoup, 2001; Nuworsoo, 2011). Deep discount fare programs are so common because they solve the problem of FAR programs acquiring a stable source of funding to remain viable over the long term.

A related body of research focuses more generally on how FAR programs are funded. Hess (2017), for example, explores fare-free transit in Talinn, Estonia. He focuses on the central role in funding the city's FAR program played by windfall income taxes collected from new city residents. Moving into the future, this funding source is uncertain at best, raising questions about the long-term viability of the city's FAR program.

A smaller body of literature focuses on motivations for FAR programs (e.g., Kębłowski, 2020). Common motivations for FAR programs include improving the efficiency of transit operations, improving the environmental sustainability of transportation networks, and improving the social equity of transit operations. Another body of literature focuses on the political economy of FAR programs (e.g., Carr & Hesse, 2020). FAR programs can be dominated by political considerations and be implemented primarily to support populist political goals and metropolitan image-building rather than to improve transit service.

Finally, bodies of literature with contributions from both scholars and practitioners has emerged since the start of the COVID-19 pandemic focusing on fare-free programs as a public health strategy (e.g., Kamga & Eickemeyer, 2021) and as a tool to aid in the recovery of transit ridership in the wake of the pandemic (e.g., Barone, n.d.). The ability of FAR programs to act as a public health strategy is primarily linked to how FAR programs eliminate the need for fare payment and therefore reduce physical contact between riders and fare collection equipment and close contact between riders and vehicle operators. Many transit agencies implemented fare-free transit (or, in many cases, stopped enforcing fare paying without formally going fare-free) for some amount of time during the height of the COVID-19 pandemic to take advantage of reduced viral transmission linked to fare collection. Others implemented or continued FAR programs to increase ridership in the wake of lower baseline ridership post-COVID. Most transit operators that eliminated fares to either reduce viral spread or increase ridership have since reinstated fares.

Amidst this flurry of research, there is precious little work examining how FAR programs affect transit system finances. Unlike much of the existing transit pricing literature, analyses related to FAR programs have generally not attempted to empirically link FAR program benefits to the financial costs incurred by agencies that implement them. How have existing transit agency resources been re-allocated to implementation of FAR programs? What are the opportunity costs associated with the implementation of FAR programs? Another research need relates to FAR programs in the COVID-19 era. Has people's willingness to use transit in the wake of COVID-19 changed so much that the ability of FAR programs to increase ridership has been affected, positively or negatively?

Research on transit fare elasticities finds, as theory would suggest, that fare and ridership levels are negatively related, and that the effects are relatively inelastic. But most of this research has examined the effects of fare increases on transit use (e.g., Wang et al., 2017), as examples of fare decreases have historically been much rarer. In particular, existing research has so far yet to address the extent to which increased ridership comes from new riders or the extent to which increased ridership is generated from existing riders taking additional trips. Decomposing the ridership effects of FAR programs into ridership generated from existing riders and ridership generated from new transit riders is important because existing riders were likely paying higher fares before the FAR program, while new riders were not. Each additional trip taken by an existing rider must account for the trips that rider had been previously taking and paying for. New riders may also potentially become full fare paying riders in the future if they develop a sufficient transit riding habit, which is the motivation behind many short-term FAR programs.

Conclusion

In this report, we summarize the current state of the research literature relevant to FAR programs, emphasizing the applicability of transit pricing research to FAR programs. We begin by discussing transit as a service and the relationship of transit prices to costs and benefits of transit service. We describe different possible fare structures, emphasizing the differences between flat versus differentiated fares, noting that fare-free is a special case of a flat fare. We identify major rider categories towards which FAR programs are frequently aimed, including seniors and people with disabilities, students, public employees, veterans, and low-income transit riders. We then describe different types of FAR programs, distinguishing between FAR subsidies and FAR policies; we also distinguish between FAR programs that cover all parts of a transit system versus FAR programs that cover only a portion as well as short-term versus long-term FAR programs. We outline common motivations for FAR programs, including increasing transit ridership, increasing environmental sustainability, and improving various dimensions of social equity. We describe how the extant literature generally finds that FAR programs increase ridership, but that FAR programs can influence different types of transit trips differently. In particular, riders may be more willing and able to adjust their off-peak travel behavior than their peak-period travel behavior in response to changes in the price for transit. We summarize the results of multiple studies that calculated price, income, and service elasticities for transit demand. We follow this by describing the current state of literature on FAR programs. We describe the results of Saphores et al. (2020), which provided a comprehensive review of FAR programs in California at the time. We describe deep discount group fare programs as a particularly important subclass of FAR programs and describe how literature on FAR programs frequently focuses on funding and motivations. We describe a body of literature that has emerged since the start of the COVID-19 pandemic focused on FAR programs as a health strategy and as a strategy to increase baseline ridership, which is currently still significantly under ridership levels before the pandemic. We conclude by discussing research needs related to programs, including comprehensive analyses of the effects of FAR programs on transit system finances as well as decomposing the marginal ridership effects of FAR programs into ridership generated by existing riders and ridership generated by new riders, a distinction which has important financial implications for transit agencies.

Our analysis points to several policy issues related to FAR programs.

First, FAR programs are likely to increase ridership — if sustainable funding for the FAR program can be generated. Identifying sustainable funding is the first and fundamental challenge of FAR programs. Ridership impacts are likely to be more pronounced on systems with relatively high fares, and less on systems with already low fares. Similarly, transit systems with higher proportions of low-income riders are likely to see a more elastic response to FAR programs.

Second, the net fiscal impact of FAR programs on transit agency finances is generally unknown to implementing agencies, particularly with respect to increased costs that may be occasioned by increased rider demand. Fully understanding how FAR programs influence agency finances is a major research challenge but one that is worth undertaking. Without such information, recommendations about the wisdom of implementing FAR programs can be tenuous at best.

Third, in California, state-level farebox recovery requirements present a major barrier to the further expansion of FAR programs. FAR programs would almost certainly be much more common than they are now if transit agencies were not bound by minimum farebox recovery requirements, as are transit agencies that receive finding under California's Transportation Development Act (TDA). Eliminating or relaxing farebox recovery requirements would represent a significant move away from a user fee-funded transit system and towards a transit system that functions more like a utility, a baseline level of access to which is expected for every community member. From this perspective, FAR programs constitute a key mechanism enabling some level of transit access for all.

Fourth, the vast majority of literature on transit use that compares fare elasticities with service elasticities finds that service elasticities are greater than fare elasticities. This is strong evidence that, *ceteris paribus*, service improvements are likely to be a more effective use of resources than fare reductions, even for low-income riders. At the same time, agencies should actively invest in resources to improve the ability of those for whom fare levels constitute a substantive barrier to transit use.

Fifth, FAR programs may generate a host of societal benefits to the extent that they decrease vehicle use. These benefits include reducing vehicle miles traveled (VMT) and associated greenhouse gas emissions. Mode shift is likely to be modest, however, particularly if fare discounts are not coupled with strategies to price driving to reflect its social costs. And, again, it may be that increased spending on transit service improvements may occasion more of these benefits than FAR programs.

Sixth, by reducing the financial barriers to transit access, FAR programs may risk increasing the presence of individuals actively engaging in antisocial behavior such as active, in-vehicle use of illicit substances, failure to maintain acceptable hygiene standards, and/or generally failing to engage others respectfully while riding on transit. This issue will likely only intensify as transit agencies continue to experiment with FAR programs while crises in housing affordability and social service provision continue to fester due to lack of political consensus to enact necessary reforms. At least some transit agencies, however, such as LA Metro, San Francisco's BART, and Philadelphia's SEPTA are responding to these challenges by dedicating funding to (1) "transit ambassador" programs designed to improve the experience of riding transit and (2) increasing agencies' ability to reach out to unhoused individuals and other vulnerable rider groups. As another example, some agencies have created FAR subsidies particularly for unhoused riders. They are distributed through homeless service providers or departments of homeless services. These generate the benefits of providing mobility for some of the most in-need travelers, reducing enforcement encounters, and getting unhoused people connected to housing and services at the site from which they receive the pass (Loukaitou-Sideris et al., 2021).

Finally, free- and reduced-fare programs do have potential to attract riders and increase equity, but they are far from a one-size-fits-all proposition. With respect to fare-free transit, the cost (in foregone fare revenue) is lower on systems that already recover a relatively small share of their operating costs out of the farebox. Such systems tend to operate in less transit-friendly environments and carry larger shares of lower income and mobility disadvantaged riders. On systems with higher farebox recover rates, especially those serving large downtowns, the opportunity cost of fare-free programs is much higher, and such systems tend (though they do not always) carry proportionally larger shares of non-poor riders. On these latter systems, targeted fare-reduction programs aimed at particular rider groups (low-income, students, etc.) are a less costly way of directing fare reductions for those riders who need them most. But in either case, the costs and benefits of FAR programs should be weighed against the costs and benefits of improving service quality.

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