RESEARCH REPORT

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Equitable Congestion Pricing

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16. Abstract Congestion pricing can be an equitable policy strategy. This project consisted of a review of case studies of existing and planned congestion pricing strategies in North America (Vancouver, Seattle, and New York) and elsewhere (Singapore, London, Stockholm, and Gothenberg). The analysis shows that the most equitable congestion pricing systems include 1) a meaningful community-engagement processes to help policymakers identify equitable priorities; 2) pricing structures that strike a balance between efficiency and equity, while encouraging multi-modal travel; 3) clear plans for investing CP revenues to equalize the costs and benefits of congestion relief; and lastly, 4) a comprehensive data reporting plan to ensure equity goals are achieved. This project was developed to support the San Francisco County Transportation Authority in its efforts to conduct the Downtown Congestion Project.		

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Disclaimer

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Glossary

ALS	Area Licensing Scheme
CP	congestion pricing
ERP	Electronic Road Pricing
ERP2	next generation Electronic Road Pricing system
EV	electric vehicle
HOV	high occupancy vehicle
LCCS	London Congestion Charge Scheme
LTA	Land Transport Authority (of Singapore)
NYC	New York City
SFCTA	San Francisco County Transportation Authority
TfL	Transport for London
TNC	transportation network company
ULEZ	ultra low-emission zone
VMT	vehicle miles traveled

Executive Summary

Executive Summary

Congestion pricing (CP) can be an equitable policy strategy. However, policy makers need more information about the specific strategies that can make a CP system more equitable. This analysis highlights early experiences with CP in North America in Vancouver, Seattle, and New York City highlighting where these cities are taking steps to build an equitable CP system. The bulk of this analysis, however, focuses on examples of long-standing CP systems in Singapore, London, Stockholm, and Gothenberg. For each international case study, we highlight how the CP system operates and report on its effectiveness metrics such as traffic relief and transit ridership gains. We also assess whether the CP system included a COVID-19 pandemic response. Our analysis includes the following sections for each case study:

- **Process equity.** The community-engagement approach for each case study reveals the equitability of the process for creating each CP system, and for instituting updates or changes. We find that among the U.S. examples (although they are still in the development phases) there appears to be a stronger emphasis on equitable community engagement. Seattle has proposed a robust engagement strategy, that targets engagement of disenfranchised communities. Among the CP administering governments outside of North America, there were efforts to solicit community input, in meetings and through survey data collection, but these tended to be focused on geographic representation, and there were no explicit efforts to target low-income individuals or specific racial populations.
- **Practice equity.** This section investigates what policies and practices promoted the equitability of the CP system itself. The analysis determines that Singapore and London removed various discounts or exemptions for vehicles over time to improve system efficiency. Targeted exemptions based on income were never a part of any of the non-North American CP systems examined, but almost all provide exemptions or discounts to disabled populations. Income-based exemptions were considered for Seattle, New York, and Vancouver. Many cities included transit pass discounts as an accompanying policy to CP.
- **Outcome equity.** This section evaluates the system's "big picture" impacts on equity. Reinvestment of revenues is shown to be the most powerful equalizing force. According to the research literature on the equitability of European CP systems, revenues reinvested into public transit ensure long-term fairness. However, in places where transit networks are less robust, low-income people and other vulnerable groups may be more likely to be adversely impacted by a congestion charge even if revenues are reinvested to benefit those groups.

This analysis concludes that an equitable CP system begins with a **meaningful community-engagement process**. The CP system should then be designed with pricing structures **that strike a balance between efficiency and equity**. Discounting should encourage multi-modal transportation and use of transit. Discounts for CP zone residents or electric vehicles will likely continue to decrease CP efficiency (i.e., the number of people and goods that can travel through a network in a given time, with minimal congestion). The CP system should also include a **clear plan for investing CP revenues in equitable, community-driven solutions to problems of transportation access and affordability**. Finally, **a comprehensive and transparent data reporting strategy** will enable researchers and planners to assess overall outcomes of CP systems and ensure that progress towards equity objectives can be tracked and monitored on an ongoing basis.

Contents

1. Introduction

Policymakers and regulators will have many difficult tasks ahead to address the fallout from the 2020 pandemic. Among them will be mitigating an anticipated spike in demand for single-occupant driving. Pricing policies can be a very effective tool for reducing vehicle miles traveled (VMT), traffic congestion, and emissions, while generating revenue for transportation investments. (See Appendix A. Road Pricing vs. Congestion Pricing for more about types of road pricing.)

However, the potentially regressive nature of road pricing and congestion pricing (CP) systems presents challenges for policymakers and practitioners. San Francisco, among other major California cities, struggles with a widening wealth gap. Disparate access to transit, jobs, education, and health facilities also contributes to an unlevel playing field among SF Bay Area residents. There is concern that additional regressive policies will further exacerbate inequities. Such concern makes it difficult for policymakers to publicly support road pricing and congestion pricing. Policymakers will need clear guidance to develop transportation pricing policies that are effective, politically feasible, and (importantly) equitable.

This issue paper intends to support the San Francisco County Transportation Authority (SFCTA) in its efforts to conduct the Downtown Congestion Project. Within, we identify case studies and examples that may help SFCTA develop a CP system that meets the needs of the SF Bay Area. An analysis of the literature on CP identifies the following as key elements of a successful and equitable CP system:

Meaningful community-engagement processes. Sustained community engagement (iterated periodically) can help policymakers identify priorities for road-pricing strategies (*1*), develop and revise downtown zone discounts that meet community needs, and decide how to best spend CP revenue (*2*). SFCTA is undertaking a community-engagement process and has convened a policy advisory committee. This committee will need to find new strategies to engage the public during and after the pandemic.

Pricing structures that strike a balance between efficiency and equity. Careful review of discounts should ensure that efficiency goals can be achieved. *Efficiency* of a transportation network means increasing the number of people and goods that can travel through a network (on all modes) in such a way that mitigates traffic congestion. CP systems in other countries often provide steeper discounts for transit and rarely subsidize driving. These international examples show that discounts for residents in the CP zone or for electric vehicles tend to inhibit efficiency of CP systems. Electric vehicle (EV) discounts also tend to disproportionately benefit higher-income households. If considered, EV discounts can include a sunset period to avoid long-term efficiency losses while motivating shorter-term increases in EV uptake.

Clear plan for investing CP revenues. Research points to transit investments as the true equalizing force of a CP system. Each of the case-study cities included in this review used CP revenues to invest in rail and bus networks. In 2010, San Francisco's transportation priorities included additional transit, transit-fare assistance, street beautification, street resurfacing, bicycle-pedestrian improvements, and parking enforcement. These priorities will likely need to be updated to incorporate newly available strategies that can ease last-mile transit and promote neighborhood connectivity (e.g., microtransit, ridehailing, and automated shuttles).

Comprehensive and transparent data reporting. A critical element of a successful and equitable CP system is comprehensive data reporting. Disaggregated data is most useful for assessing equity impacts (including timestamped, geolocated data on vehicle routes (*3*)). However, this type of data collection likely requires a trusted third-party datastorage strategy to preserve user privacy. If a third party is not feasible (or there is not sufficient funding to support one), then aggregated data reporting on usage by rate type coupled with periodic surveys of users will suffice.

To date, at least six prominent international cities—Singapore, London, Milan, Oslo, Stockholm, and Gothenburg (Sweden)—have implemented CP in the form of zone-based or cordon charging. At least three U.S. and Canadian cities are actively working on CP schemes. This paper briefly describes the CP schemes in progress in the United States and Canada. The bulk of the paper is devoted to a more in-depth evaluation of the international cities that have already implemented CP. We focus on Singapore, London, Stockholm, and Gothenburg, excluding Milan and Oslo due to lack of adequate information for comparison. Throughout, we highlight key takeaways that could inform development of a CP system for San Francisco.

2. CP Systems in Development in the United States and Canada

2.1 Vancouver

San Francisco has good company among U.S. and Canadian cities in envisioning an equitable and multi-modal CP system. Vancouver, Canada is actively considering a CP system. Vancouver (city population of 631,486; metro area population of 2.4 million) determined that around 20% of net CP revenues, or between $170–345 million CAN ($128–$260 million USD) annually would need to be returned to low-income households through rebates, transit pass discounts, or other measures in order to reach the City's outlined equity goals (*2*). This conclusion was reached by a Mobility Pricing Independent Commission that aimed to represent the city's diverse neighborhoods. Vancouver also held a fairly robust public-engagement effort called "It's time" around the possibility of a CP scheme. The effort included three workshops, a series of stakeholder meetings, and development of online engagement tools (*4*).

2.2 Seattle

The City of Seattle (city population of 747,300 (*5*); metro area population of 4.2 million (*6*)) is also exploring CP (*7*) by taking a phased approach. In 2019, the first phase included the City Council passing the Mayor's "FareShare Plan" and taxing Uber and Lyft rides (*8*). The plan requires minimum compensation for Uber and Lyft drivers (plus benefits and expense reimbursements). The fare-share taxes include a $0.51 tax per ride for Uber and Lyft to support affordable housing near transit, $56 million investments to fully fund the Center City Connector streetcar, and the establishment of an independent and non-profit Driver Resolution Center (*8*).

Seattle's Phase 1 focused on increasing mobility options by investing in transit. Phase 2 will focus on identifying cordon boundaries and additional fees for for-hire vehicles entering the city. During this phase, Seattle will also work through a multi-step community-engagement process, guided by the City's racial equity toolkit (*9*) strategy (Figure 1), to explore several possible options. These include a congestion fee for downtown access, discounts for low-income people, and off-peak discounts.

Figure 1. City of Seattle's process to assess equity impacts using their Racial Equity Toolkit (Source: City of Seattle (*9*))

Seattle has proposed evaluating the following discounts for its CP program to ensure equity for low-income households:

- Exemptions for people with disabilities.
- No tolls during off-peak hours.
- Transit discounts.

Subsidized bike- and car-share memberships or rides (*7*).

The City of Seattle is considering CP as one approach to support a more equitable transportation system, decrease traffic, and reduce climate pollution. The in-person engagement efforts scheduled for Phase 2 of Seattle's CP strategy are delayed due to repercussions from COVID-19 and social-justice demonstrations. The City is working to reimagine these community-outreach efforts. Seattle's Phase 3 will focus on implementing a congestion charge, first on trucks and then on light-duty vehicles. Phase 3 was originally proposed for 2020 but faces delays.

2.3 New York City

New York City (NYC; city population of 8.34 million (*10*); metro area population of 19.26 million (*11*)) is also working on phasing in CP. The City received state approval for a CP tolling system for a cordon in mid- and lower Manhattan (Figure 2). NYC has since moved a first phase forward, charging for-hire vehicle drivers for access to the CP area. The City is currently charging $2.50 for non-shared trips in taxicabs, $2.75 for non-shared trips in for-hire vehicles (including limousines and green taxis), and $0.75 for shared rides in any type of vehicle (*12*).

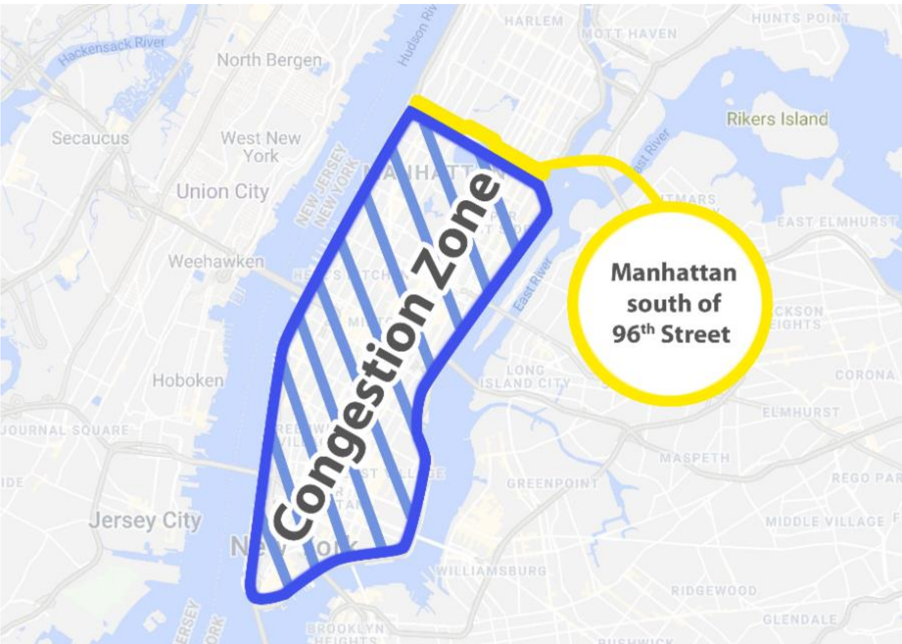

Figure 2. New York City's Congestion Zone (Source: NYC Taxi and Limousine Commission (*12*))

An appointed Traffic Mobility Review Board is required to announce the fee-rate structures for future phases of the CP program by December 31, 2020. Structures will include a set of credits and exemptions (*13*). While the CP rates have not yet been announced, there is no indication that the Board plans to grant direct discounts for low-income drivers entering the Manhattan cordon. This aligns with findings from a 2017 study by the nonprofit Community Service Society that aimed to "debunk the myth that congestion pricing would disproportionately impact the working poor" (*14*). The study found that only 4% of "outer-borough working residents" commute to the cordon zone.

Discounts for the NYC CP system have been proposed for emergency vehicles and differently abled people. There has also been debate about discounts for residents. For low-income populations, focus has been on investing in transit to enable equitable access to the cordon zone. While the NYC CP system is well under development, it is unclear when the system is likely to be put into practice. Approval from the Federal Highway Safety Authority (FHWA) is needed for full implementation of NYC's CP system. There is speculation that this approval process could delay implementation beyond the planned 2021 implementation timeline (*15*).

3. International Examples of Established CP Systems

This section presents in-depth case studies of established CP systems in Singapore, London, Stockholm, and Gothenburg.[1] Our analysis highlights impacts of these CP systems on low-income households. Where sufficient data are available, we also assess impacts of these CP on other underserved populations (e.g., people with disabilities, seniors, and racial/ethnic minorities)

Each case study comprises the following components:

- **Introduction.** Includes relevant demographic/population data, an explanation of how the CP system in question works, and an assessment of how effective the system has been (as indicated by metrics such as traffic relief and transit ridership gains).
- **Pandemic response.** Describes how the COVID-19 pandemic has affected the CP system.
- **Process equity.** Examines (i) whether development of the CP system included a robust community-engagement process, (ii) whether equitable outcomes were considered in the program's initial design, and (iii) whether any special efforts were made to involve historically disadvantaged populations in the CP development process (*16*).
- **Practice equity.** Examines policies and practices established to promote the equitability of the CP system. Special attention is given to whether the CP system included any pricing discounts for certain populations.
- **Outcome equity.** Considers the system's "big picture" impacts on equity. For instance, did the system deliver benefits that improved the welfare of disadvantaged communities or groups?

Appendix C discusses in detail different definitions of equity and how these affect assessments of equity.

3.1 Singapore

City population: 5.7 million
Population density: 12,586/square mile
Share of Population Using Transit for commute (during peak hours): 67% (*17*)

3.1.1 Introduction to CP in Singapore

Plagued by bumper-to-bumper traffic in the early 1970s, the island city-state of Singapore implemented the world's first major CP system in 1975. This "Area Licensing Scheme (ALS)" encircled Singapore's downtown area. ALS originally charged a flat fee for vehicles entering the most heavily trafficked part of downtown, the "Restricted Zone (RZ)", during peak commute times. Initially, ALS required private vehicles entering the Restricted Zone to display a prepaid paper permit

[1] Milan and Oslo also have established CP systems, but have not made available data needed for detailed assessment of equity effects in these cities. Appendix B provides information on the CP systems in Milan and Oslo.

through their windshields. At the time of ALS implementation, parking costs within the zone increased 25–33%, with the most expensive parking in the densest part of the city (*18*).

Singapore also developed an extensive 10,000 space park-and-ride and shuttle system that originally cost USD $13/month (in 1974 dollars) for both parking and bus service. The paper CP permit system at that time cost USD $26/month or USD $1.30/day (*18*). The paper system was later upgraded to an overhead electronic monitoring system that relies on in-unit transponders required for all vehicles entering the Restricted Zone. ALS evolved over time to include a variable fee structure with charges that depend on cordon entry location, direction of travel, time of day, and vehicle type (*19*). The current system is referred to as the Electronic Road Pricing (ERP) system. It is recognized as the world's most sophisticated CP system to date. The costs of the current system vary per gantry ranging from $1 Singapore dollar to $6. Singapore has not made significant increases to these costs for over a decade, maximum rates were $5 in 2007, despite increases to income over this period. (For context, the median monthly income in 2019 in Singapore is USD$ 2,039 (*20*).)

The Singaporean Ministry of Transport is now planning for "the next-generation ERP system (ERP2)," an updated version of the ERP that will accommodate distance-based pricing. The Ministry claims that ERP2 "…will be more equitable than the current system, which charges all motorists the same amount regardless of the distance they travel on the congested road" (*17*). The vision is for ERP2 to replace physical gantries—overhead structures containing the sensors that communicate with in-vehicle transponders—with a GPS-based system that will enable accurate distance-based pricing (*21*). The switch from ERP to ERP2 was originally scheduled for 2020 but has been delayed for an unknown time—likely 1 or 2 years—due to the COVID-19 pandemic and other factors (*22*).

3.1.2 Singapore: Pandemic response

The Singaporean government closed the ERP system on April 6, 2020 in response to the COVID-19 pandemic. The system was originally slated to reopen on June 28, 2020, but reopening has since been further delayed (*23*). The system will eventually re-open with a revised fee-rate structure informed by pandemic-related changes in travel patterns (*24*).

3.1.3 Singapore: Process equity

The Singaporean Ministry of Transport has not historically targeted (and does not currently target) CP-related outreach towards any specific income or racial group (*25*). The Ministry does conduct an annual customer-satisfaction survey for the general public. The Singaporean Land Transport Authority (LTA) also conducts periodic public-consultation exercises. The LTA recently evaluated the equitability of policies related to Certificate of Entitlement (i.e., vehicle registration). For the evaluation, the LTA conducted focus groups to determine whether and how to reclassify vehicles and to reevaluate policies for people who own multiple cars. The evaluation led the LTA to report that land constraints prevent everyone in Singapore from owning a car, and that "individuals who own more than one car deprive others of the opportunity to own a car, given the limited number of Certificates of Entitlement available" (*26*). This feedback will be integrated into upcoming plans for Certificate of Entitlement reform. The Singaporean government also plans to establish a new "Community Link" program, that will include a network of four "social service hubs" that will provide social services targeted to families at low-income multi-family housing developments (*27*).

3.1.4 Singapore: Practice equity

Neither the original ALS nor the current ERP schemes feature exemptions or discounts for specific populations of drivers, riders, or residents. The ERP does exempt certain vehicles from paying CP fees. Initially, exemptions were granted to vehicles carrying four or more passengers (HOV 4+), motorcycles, buses, vehicles carrying commercial goods (e.g., delivery trucks), police vehicles, and taxis (*28*). Today's ERP system only exempts ambulances, fire engines, police vehicles, Singapore Civil Defense Force vehicles, and vehicles being towed by another vehicle (*29*).

Singapore's public-transit system includes a variety of discounts for "Adults, Children, Students, Senior Citizens, National Servicemen, Persons with Disabilities and Workfare Income Supplement recipients" (*30*). Some of these discounts offer unlimited transit use during off-peak hours. Broad discounts are available for high-frequency use during off-peak hours.

ERP revenues contribute to Singapore's general fund. While this means that there is no direct link between ERP revenues and transportation investments, many significant transit improvements have been made since the original ALS system was implemented. Singapore has implemented bus rapid transit, an extensive light-rail system, and a deluxe bus service. Singapore has also invested in affordable housing near the Restricted Zone.

3.1.5 Singapore: Outcome equity

While Singapore's CP system is widely considered a success, it has not always been favorably received across the board. A 1978 survey conducted shortly after the ALS was implemented found that 44.1% of travelers reported longer travel times than they did before the ALS. Cyclists, bus passengers, and residents within the Restricted Zone judged the ALS as favorable, while car drivers and passengers judged the ALS as mildly unfavorable. As a group, middle-income travelers felt that they were adversely affected by the ALS (*28*). An analysis of this survey (published in 1988) concluded that residents outside the Restricted Zone had neutral to negative views of the ALS at the time of implementation while cyclists, bus passengers, and residents living within the Restricted Zone held positive views (*31*). These early data suggest that CP systems may have short-term adverse effects on those individuals who cannot easily afford to pay CP fees. A switch to transit may cost those individuals time if they are unable to commute at less-desirable times, when fees are lower. This analysis also suggests that CP systems may also adversely impact those encountering increased congestion on roads that bypass CP zones.

On the other hand, after some initial increase in crowding following implementation of CP, transit riders in Singapore eventually began to enjoy better service as CP funds were used to expand and improve public transportation. Similarly, vehicles with four or more passengers, motorcyclists, and pedestrians—groups that collectively constituted 52% of trips to the restricted zone before the ALS was implemented—enjoyed a significant increase in travel benefits. Survey data show that the shift from cars to buses was fairly uniform across income groups. Among residents who switched to busses a total of 25% of low-income residents switched to busses. This analysis also suggests that trip times were not disproportionately affected (positively or negatively) for any particular income group (*31*).

There have been several shifts in Singapore's Gini coefficient—a measure of national income inequality—over the lifetime of Singapore's CP system. Singapore's Gini coefficient increased in the 1980s and peaked in 2007. More recently, the Gini coefficient fell from 0.48 in 2007 to 0.43 in 2014 and 0.38 in 2019, which shows a trend towards equitability (*32*, *33*). Trends in the coefficient cannot be causally linked to the implementation or evolution of Singapore's CP system.

3.2 London

City population: 9.1 million (*34*)
Population density: 3,542/square mile (*35*)
Transit ridership during peak hours: 2 million/month (*36*)
Gini coefficient (2017): 0.43 (*37*)

3.2.1 Introduction to CP in London

The London Congestion Charge Scheme (LCCS) was implemented in February 2003 and began at £5 ($8.15 in 2003 USD). The LCCS CP scheme covers an area of roughly 22 square miles of central London (*38*). LCCS charges £15 ($19.05 in 2020 USD) daily for vehicles entering and operating within the zone between 7:00 AM and 10:00 PM (*39*). The toll is enforced digitally through Automatic Number Plate Recognition technology. Drivers pay to register their Vehicle Registration Number (VRN) on a database, and the Automatic Number Plate Recognition uses cameras to read a vehicle's number plate as it enters, leaves, or drives within the charging zone (*40*). Travelers may pay the charge before or by midnight on the day of travel by phone, text message, online, or by mail (*40*). The stated objectives of the LCCS are to reduce traffic congestion, reduce travel times, improve bus services, and encourage public transit use over personal motor vehicles (*41*).

3.2.2 London: Pandemic response

Transport for London (TfL) suspended the LCCS for seven weeks to respond to the COVID-19 pandemic. In mid-May 2020, TfL reinstated the charge (then priced at £11.50) but provided reimbursements for healthcare and home workers (*42*). To avoid a spike in driving amid anticipated anxiety about using public transit, after June 22 London Mayor Sadiq Khan increased the LCCS fee to £15, extending the fee hours to 10:00 PM (from 6:00PM) every day (previously the charge excluded weekends), and closed applications for new in-zone resident discounts (*43*). TfL is currently collecting public comments on the changes that will be reviewed before deciding whether or not to make the changes permanent (*44*).

3.2.3 London: Process equity

In 2000, former London Mayor Ken Livingstone ran for election on a platform promoting a CP system. The public was initially skeptical of any CP system, though public approval has increased with time. Although London's mayors since 2003 have been committed to gaining public support, none passed any CP decisions to a referendum. Each have listened to skeptics and remained committed to CP as an effective—although not always popular—strategy. At the time of implementation, LCCS critics suggested that a congestion charge would disproportionately impact poorer motorists, arguing that a flat fee was a regressive "tax on the poor" (*41*). The TfL, at the direction of the mayor, conducted a robust public-engagement effort to respond to this and other concerns. They did conduct two "public consultations" or large sample surveys of the city neighborhoods, and they distributed 3 million leaflets to each London household twice (*45*).

Pre-implementation, the City hosted an 18-month consultation period to solicit public feedback on the proposed congestion charge (*46*). One report stated the following:

> Formal and informal public consultations were conducted throughout the development of the scheme, with feedback reports subsequently made public. Media campaigns explained the operation and implications of the scheme. A clear vision and delivery plan for the scheme helped to raise confidence in the long-term financial benefits, both in terms of the expected revenue generation and the cost savings as

a result of reduced congestion, all of which helped to justify the initial costs (£162 million) [USD $213 million]. (*47*)

The Center for Public Impact gave the LCCS a favorable “strong” rating for “stakeholder engagement” (*48*). However, the Center for Public Impact measures stakeholder engagement based on involvement of public officials and institutions (e.g., London’s mayor, TfL, the London Assembly, the national government, and local policymakers), not on involvement of non-governmental stakeholders. According to the Greater London Act of 1999, London’s mayor has substantial control over the City’s transportation policies without any mandated public oversight or requirement of public consultation (*49*). That said, TfL and London’s mayor have clearly engaged in extensive public outreach (*50*).

In 2005, during the discussion regarding a proposed expansion of the congestion zone, 75% of public survey respondents and 80% of businesses opposed expanding the congestion zone. However, some who held this position were not strongly opposed. According to this same survey “47% of general public and 52% of businesses thought it was unimportant” (*45*). In the end, a lack of widespread public support was not considered a barrier to moving the expansion forward.

TfL did continue to listen and maintain open channels of communication with London area residents about the successes and failures of the LCCS. For example, when TfL wanted to modify the LCCS in 2017 to impose a harsher penalty on vehicles failing to pay the congestion fee, it embarked on a two-month consultation process to allow the public an opportunity to provide feedback on the proposed changes. Public consultation involved meetings with stakeholders (e.g., trade organizations, environmental groups), a survey fielded to Londoners, and a traditional public-comment period. In total, TfL collected feedback from over 7,000 stakeholders and members of the general public. A majority of respondents rated the consultation process as “good” or “acceptable” (*51*).

3.2.4 London: Practice equity

The LCCS does not offer income-based discounts but does offer a wide variety of other discounts serving different purposes. Wheelchair-accessible, private-hire vehicles are automatically exempt from LCCS charges. Also excluded from fees are licensed taxis, motorcycles, bicycles, registered buses, and emergency service vehicles (*40*). Residents within the LCCS CP zone are eligible for a 90% fee discount but must apply and pay a £10 annual registration fee to qualify (*40*). Other discounts are available for Blue Badge holders (i.e., those who qualify for disability parking) and certain clean-air vehicles (*52*, *53*).

In the immediate wake of LCCS implementation (between 2003 and 2006), Central London saw a 26% decline in congestion (*48*). From 2002 to 2014, the number of private cars entering the LCCS CP zone decreased by 39%. Yet in 2017, London’s Transport Committee acknowledged that conditions on the ground were rapidly worsening, noting that as “traffic speeds have gone down, journey times have increased. Excessive bus waiting times have gone up, leading to a fall in ridership” (*54*). Transit delays have somewhat soured the public towards LCCS, especially as private for-hire vehicles (i.e., transportation network companies (TNCs)) have flooded London’s streets. London saw increased public-transit ridership after the LCCS was implemented, but these gains have been partially offset by the rapid increase in TNCs on roads in Central London (*55*). By one estimate, over 18,000 different private for-hire vehicles traverse the CP zone each day (*56*).

In addition to LCCS discounts, London also established an Ultra Low Emission Zone (ULEZ) in April 2019 (*57*). The ULEZ was implemented with the primary goal of reducing pollution in central London, especially for pollution plaguing more vulnerable communities (*58*). Vehicles that don’t meet certain emissions standards are required to pay £12.50 daily, in addition to the standard LCCS charge, in order to enter the ULEZ. A temporary exemption for hybrid electric cars will sunset in 2021, and an exemption for full battery-electric vehicles will sunset in 2025 (*59*). The ULEZ fee is in effect 24 hours a day, seven days a week, including holidays (*60*). Since ULEZ was introduced, Central London has seen exhaust NOx (nitrogen oxides) and roadside NO_2 emissions drop by up to 45% (*57*). Another major success of the program has been a rise in cycling in the city. The number of cycling journeys has increased by 66% since the LCCS was introduced (*40*).

3.2.5 London: Outcome equity

Direct analyses of LCCS impacts on low-income, minority, and other underserved groups are limited. At the time of implementation, London's priorities for the LCCS were to reduce traffic and vehicle emissions. The City has since shifted its focus, in part, to identifying progressive and regressive aspects of the program. For instance, TfL fielded a survey to low-income families and people with disabilities in 2008 and found that these vulnerable populations had more difficulty affording LCCS fees (50%) than the general population (30%) but were just as likely to alter their travel behavior to make fewer trips in response to the charge (*61*).

One clear equity benefit of the LCCS is London's commitment to reinvest program revenues into its public-transit network, which disproportionately benefits lower-income Londoners (*62*). By law, net revenues from the LCCS must be spent on transportation improvements such as increased bus service, more bus lanes, advanced technology for out-of-bus ticket sales, and efforts to curb vehicular travel into the zone (*63*). TfL reported net revenues of £155.9 million (USD $203.2 million) for the 2017–18 fiscal year, which were reinvested in network maintenance and enhancements (*63*, *64*). However, due to the large costs of transit service provision in London, the LCCS can fund only a relatively small portion of expenses (*65*).

For road users to benefit from CP, the cost of the CP fee levied must be less than the benefit gained. Benefits can be measured in terms of the road user's "value of travel time," which assesses a value per unit of time based on income. However, it should first be noted that this calculation does not capture externalities. It also assumes that cost of time correlates to income. This latter assumption may be inherently inequitable, because people with higher incomes are more likely to receive annual salaries rather than hourly wages and have more flexibility with respect to when they must arrive at work.

Nevertheless, evaluations such as these still provide an illustrative method for quantifying how many people will choose to drive in more expensive conditions. One such analysis estimated that in 2003, when the charge was £5, the minimum income a car commuter would require to benefit from the LCCS' original fee was £1,400 per week (or an annual salary of just under £75,000). This meant that almost no one would generate a net benefit from paying the charge (*66*). The median gross weekly earnings in 2003 were £578.8/week for men and £460.7/week for women (*67*), pointing to additional inequities based on gender, and indicating that the majority of the population would not garner a value of travel time benefit from paying the charge. The LCCS fee increased from £5 to £8 in late 2005 and has risen several times since then. The early research suggested that realizing net benefits from the £8 charge would require car commuters to make an annual salary of roughly £122,000. While there is considerable debate over the appropriate way to measure the value of time, TfL assumes a uniform value of time regardless of traffic conditions. TfL argued that the two key issues for equity are: (i) who is affected by the charge, and (ii) how revenues are used. Neither issue could be addressed by simply examining the monetary value of time (*68*).

3.3 Stockholm

City population: 1.5 million (*69*) (and 2.4 million in the metropolitan area) (*70*)
Population density (in Stockholm City): 4,862/km (*69*)
Transit ridership during peak hours: 47% of the metro population (*69*)
Gini coefficient: 0.314 (*71*)

3.3.1 Introduction to CP in Stockholm

Stockholm is the third major city in the world to adopt CP to reduce traffic congestion. The City's CP program is one of the most successful pricing schemes of its kind. Stockholm's charging scheme is an electronic, variable time-of-day, cordon-based charge that is active between 6:30 AM and 6:30 PM every weekday, with pricing peaks during morning and evening rush hours. The area of the toll zone is around 35 square kilometers (22 square miles) (*72*). Stockholm's CP system began as a well-executed pilot program in 2005. The CP system was implemented in conjunction with other transit improvements, including enhanced bus service through new routes, new buses, improvements to rail lines and existing bus lines, and improvements to park-and-ride sites.

The CP system has been successful in reducing congestion in its cordon zone. During the 2005 pilot period, weekday traffic fell by approximately 22%, transit ridership increased by 6%, and carbon emissions fell a full 40% compared to the previous year. Although there could have been other factors effecting emissions reductions, the CP charge was the largest identifiable emission-reducing factor in the region during this time. The program moved from pilot to full implementation in 2006 (*73*).

3.3.2 Stockholm: Pandemic response

Sweden did not mandate lockdowns or restrict travel or economic activity during the pandemic. The Stockholm CP system remained in operation during the 2020 pandemic. In fact, new increased rates that took effect in January 2020 remain in effect (*72*).

3.3.3 Stockholm: Process equity

The debate over CP in Stockholm started in the 1970s. Prior to the CP pilot, Stockholm's residents overwhelmingly opposed CP by a margin of two to one, expressing concerns primarily about geographic equity. Specifically, residents worried that inner-city residents and employees would be unfairly burdened by an expense that would not be levied elsewhere (*68*). Yet by the end of the CP trial, two out of every three residents were in favor of implementing CP permanently. More than two-thirds of Stockholm voters were in favor of extending the CP program after the trial period was over (*73*, *74*).

3.3.4 Stockholm: Practice equity

Stockholm's CP program does not offer income-based discounts or exemptions based on any other sociodemographic characteristics. Exemptions are granted for persons with disability parking passes. Emergency vehicles, buses, motorcycles, and military vehicles are also exempt. Low-emission vehicles were originally exempt, but the exemption was later eliminated. Traffic to and from one of Stockholm's outlying areas, Ludingö, is also exempt on the condition that the traffic passes through the congestion zone within 30 minutes (*75*). This is because Ludingö is an island that has its only access to the mainland through the area affected by the congestion tax.

Stockholm's main approach to mitigating regressive effects of CP is reinvesting revenues back into the transportation network, with a portion of the funds specifically dedicated to public-transit improvements. During the CP pilot period, 200 additional buses were put into operation (*73*). Over the years since, revenues have supported extensions of the metro into Stockholm's suburban ring. Future plans for CP revenues include building a new subway line as well as three new stations (*76*).

3.3.5 Stockholm: Outcome equity

Multiple studies have investigated the welfare effects of CP in Stockholm. A 2014 meta-analysis of four of these studies found no regressive effects of CP in Stockholm, assuming that revenues are invested into transit operation. The study actually concluded that if this assumption holds, then the CP system actually has progressive effects (*77*). Other analyses show that men, the wealthy, and those living in Central Stockholm are most affected by the CP, while the revenue spending on public transport is most beneficial to women and lower-income individuals (*68*). Health impacts also have been documented. In a study of childhood asthma in Stockholm, researchers found a 16% reduction in hospital visits during the pilot period as well as a 50% reduction in asthma-related hospital visits among asthmatic children in the zone compared to asthmatic children outside of the zone (*78*).

3.4 Gothenburg

City population: 579,281 (*79*)
Population density (in Stockholm City): 1,293/km² (2019) (*80*)
Transit ridership in peak hours: N/A
Gini coefficient (2009): 0.324 (*81*)

3.4.1 Introduction to CP in Gothenburg

Given the success of the Stockholm CP system, the Swedish Transportation Agency and the Swedish Transport Administration were inspired to expand CP to other cities. The agencies, in partnership with Gothenburg's Urban Transportation Administration, began with Gothenburg (*82*). Gothenburg is considerably more car-dependent than Stockholm but also far less populous. Gothenburg's jobs are more geographically dispersed than Stockholm, meaning that commuters relied more on cars before the charge was implemented in 2013 (*83*). Gothenburg's stated goals for the program are threefold: (i) raise revenues to reinvest in transportation infrastructure, (ii) reduce congestion, and (iii) decrease vehicle emissions and improve air quality (*84*).

Like Stockholm, Gothenburg's current program is a time-of-day fee (between SEK 9 to SEK 22; roughly equivalent to USD $1 to USD $2.35) charged for vehicles entering and exiting the city cordon. The charge is not applied at night, on the weekends, during public holidays, or in the month of July, when many people take a vacation (*85*). Gothenburg also features a "single charge rule," meaning that vehicles that pass through several tolling stations within the same hour are only charged once at the highest rate applicable (*86*). Gothenburg's system uses the same technology as the Stockholm system (i.e., the Automatic Number Plate Recognition System), comparing a vehicle's license plate to the national registry to determine the vehicle owner, who is the party responsible for paying the fee (*85*). The maximum a vehicle can be charged per day is SEK 600 (approximately USD $60), with a fine of SEK 500 (approximately USD $50) for unpaid fees (*85*).

In practice, Gothenburg's congestion charge has been a success, suggesting that cordon-based charges can work in smaller cities as well as very large cities. One estimate found that congestion in the region declined by roughly 12% when the charge was active. Commuting by car fell by 9% and public transit ridership increased by 24% after CP implementation (*83*). Air quality improved by 5% in the heart of Gothenburg after CP implementation (*87*). Additionally, West and Börjesson (2020) found that "the congestion charge scheme is socially beneficial, generating a net surplus of €20 million per year" (*88*). Gothenburg has also been able to recoup the money invested in its system at a faster rate than in Stockholm, likely owing to the fact that the Swedish Transportation Agency had already developed the legal and regulatory infrastructure needed to implement CP (*89*). These outcomes suggest that Gothenburg's congestion charge has been successful in all three of its stated goals, though equitable transportation outcomes were not among those goals.

3.4.2 Gothenburg: Pandemic response

The Gothenberg CP system has remained in operation during the 2020 pandemic (*86*). Sweden did not impose a formal government lock down, but Gothenburg lowered parking costs in the central city to encourage commerce in the downtown shopping district.

3.4.3 Gothenburg: Process equity

Support for the CP has always been lower in Gothenburg than in Stockholm. Pre-implementation, support for the CP was at just over 30% in spring 2013. This initial disapproval was attributed to Gothenburg's greater reliance on personal-use automobiles. By 2014, support had increased to close to 55% (*83*). Public support declined slightly in late 2014 after Gothenburg raised its CP fee (*90*). Lower support may also be attributed to the way that CP revenues are spent. Rather than reinvesting in public transport to benefit low-income groups, Gothenburg's revenues are earmarked for a rail tunnel that will benefit commuters who live further from the cordon zone (*91*). Additionally, Gothenburg's charge is promoted as a type of taxation, despite its operation as a fee (*92*).

3.4.4 Gothenburg: Practice equity

Gothenburg's congestion charge includes minimal exemptions. There are no discounts for residents or low-income populations, and low-emissions vehicles are not exempt from the fee (*93*). As of 2018, Gothenburg exempts charges in Backa, a suburb of Gothenburg, with the intent to minimize inconvenience for Backa residents in opposition to the CP system, and to avoid through-traffic in the Backa region. The exemption applies only to drivers staying within Backa and not those driving through the area, which was a deal brokered to appease residents opposed to the CP system (*92*). Other exemptions exist for emergency vehicles, emergency mobile cranes, high-tonnage buses, motor bikes, mopeds, diplomatic vehicles, military vehicles, and cars registered to disabled individuals (*94*).

3.4.5 Gothenburg: Outcome equity

Despite success in achieving its three stated goals, Gothenburg has failed to achieve significant equitable outcomes as a result of its CP system. One report observed that "Most residents in Gothenburg suffer a net loss from the charges, and because the distribution of the direct effects of the charges are regressive, the spending of the revenue is decisive for the total effect on equity" (*90*). A modeling exercise estimated that there are significant inequities in gains associated with the CP (Figure 3) (*95*).

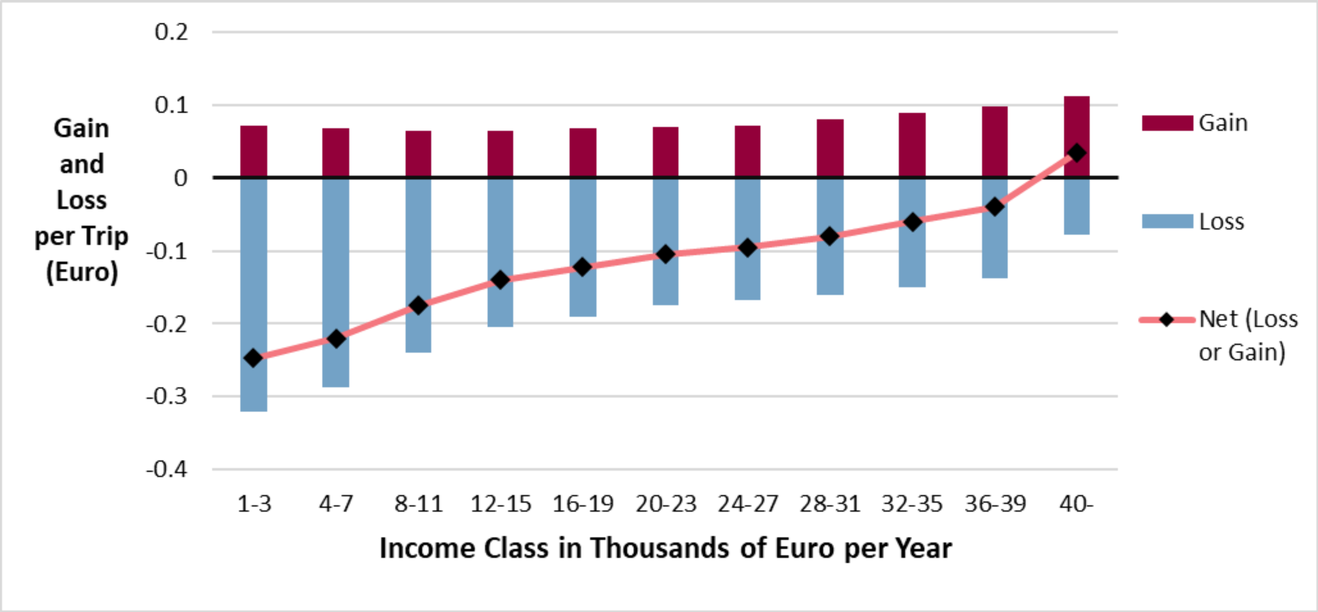

Figure 3. Income effects of the Gothenberg CP System: Gains and losses per trip by income class for car commuters (Source: West, Jens, and Maria Börjesson 2020 (*88*))

Notably, this modeling exercise found that Gothenburg's system is more regressive than Stockholm's, concluding that all but the highest-income drivers in Gothenburg lost more than they gained from the congestion charge due to the charge's regressivity (*95*). The researchers attributed this in part to the fact that the fee's revenues have not been reinvested in public transportation, which would improve transit equity for low-income riders. These researchers also found that though women and men cross the cordon at equal rates, men are more likely to have access to an exempt company car than women. As a result, women suffer, on average, greater losses from CP than their male counterparts (*95*). Additionally, there are noticeable differences in the distribution of net loss vs. gain by age. The net losses are similar across all age groups with slightly smaller losses among the 36–50 group (*95*). Lastly, the researchers found that residents living immediately outside the cordon zone pay the most in fees while residents to the north and west of the cordon suffer the greatest net losses; in these areas the mean income is low. Meanwhile, residents inside the cordon zone are least impacted by the charge since they take fewer charged trips overall (*95*).

4. Analysis of Cases Studies

This section synthesizes key insights from the case studies introduced in Sections 1 and 2. In particular, this section identifies elements of existing or proposed CP programs that are worth exploring for a CP system in San Francisco. On the demand side, our analysis focuses on variable fees for different income groups, spending allowances for targeted populations, and permits for residents living inside a cordon, among others. On the supply side, the focus is on how communities can ensure that investments are targeted towards disadvantaged communities so as to help level the playing field in a durable way.

4.1 A Key Trade-off: Efficiency vs. Discounts

Equity and efficiency are two of the most important principles to balance in any CP system (*96*). The term efficiency was historically used by traffic engineers to justify a push for faster network travel speeds for private autos. The engineers-of-yore sought to improve roadway efficiency by expanding supply of road miles (widening avenues and highways) to allow for ever-increasing demand. But, it is now known that this push for ever-expanding roadway supply only induces demand, and only temporarily improves efficiency. Here we apply a more modern definition of transportation efficiency. Improving the efficiency of a transportation network means increasing the number of people and goods that can travel through a network (on all modes) in such a way that mitigates traffic congestion. Achieving a more efficient network can include strategies that flatten peak travel demand by encouraging people to travel at alternate travel times, not travel at all, or switch from single-occupant vehicles to alternative modes that can move more passengers per vehicle mile traveled (e.g., subways, buses, carpools).

Researchers examining the Stockholm CP system found that the more efficient CP systems could be the least equitable (on the demand side) (*97*). They attributed this trade-off to the uneven distribution of workplaces and residential areas and the geographic separation of low- and high-income groups. Researchers argued that balancing equity and efficiency will be a challenge for any city where the workplaces are located away from affordable housing (*97*).

A second major factor in the trade-off between efficiency and equity is the level of discounts and types of exemptions that are granted to specific populations (e.g., residents, low-income families) and methods of transport (e.g., electric vehicles). If too many discounts and exemptions are granted, the CP system becomes less efficient. But without targeted exemptions based on income, the CP system can be less equitable for the most vulnerable populations. Reinvestment of revenues is an equalizing force, but one that tips the scales in favor of revenue generation over a large number of discounts.

London's congestion charge, for example, did not offer discounts based on income specifically but did offer multiple exemptions and discounts—for motorcycles, emergency vehicles, public transport vehicles with 9 or more seats, licensed taxis and mini-cabs, military vehicles, vehicles used by disabled persons, alternative fuel vehicles, vehicles registered to residents within the charging zone, and private for-hire vehicles.

This was a large number of exemptions, and over time the number of vehicles within exempt categories grew. Between 2013 and 2017, London's private for-hire vehicle registrations rose by 75%. Until 2019 these vehicles (i.e., those driven by ridehailing drivers) were also exempt from the charge (*55*). As the number of CP-exempt vehicles grew, London experienced substantial rises in congestion and travel times within and around the cordon, as well as a reduction in transit ridership.

That is, London's pursuit of transportation equity (via exemptions and discounters) rendered its CP scheme less efficient and thus less effective.

Another illustrative example is Singapore, which offers no population-specific exemptions but does offer limited exemptions for specific vehicle-types (e.g., emergency vehicles) (*29*). Singapore's system is often hailed as a global example for reducing traffic congestion and improving air quality in the city, leading observers to call it a particularly efficient system (*98*). However, the lack of direct exemptions and discounts for more vulnerable populations (e.g., low-income residents, seniors) has led some to conclude that the Singapore system has room to grow in terms of transportation equity.

The Singaporean government does provide substantial discounts for use on public transit, including for low-income workers. This strategy may be an effective way to circumvent the CP tradeoff between efficiency and equity. San Francisco already provides a transit-pass discount for low-income residents. It is possible that further expanding the discount program to include disabled populations is a good starting place. Further analysis for providing free transit service could be needed to identify what discounts can be offered to either very-low, low-, and middle-income people, such that discounts can aid those who need them without threatening the efficiency of a CP system.

The key takeaway is that the trade-off between efficiency and equity is a tough one that all transportation departments must deal with in CP planning. As demonstrated below, agencies may offset some inequities through reinvestments in public transit systems, though some programs may not generate enough revenue to make such reinvestments meaningful. The decision of whether to emphasize efficiency or equity must be made locally and in concert with community stakeholders.

4.2 The Demand Side of Transportation Equity

4.2.1 Vehicle-Specific Discounts and Exemptions

Discounts for Taxis and Ridehailing Services (London, Singapore)

Stockholm and Gothenburg do not exempt (and have never exempted) for-hire vehicles from CP charges. London and Singapore both had CP exemptions or discounts for taxis and ridehailing companies at one point, but those exemptions/discounts are no longer in place. When London's pricing scheme was first implemented in 2003, TNCs and private for-hire taxis were included in the list of discounts and exemptions. As observed above, this may have contributed to a substantial rise in the number of for-hire vehicles in London. The City eliminated this exemption in April 2019, but the number of for-hire vehicles still remains high—perhaps indicating residual effects from the exemption. Between 2013 and 2017, private for-hire vehicle registrations rose by more than 75%. During this time congestion increased and bus ridership decreased. Although additional factors likely contributed to these outcomes, the rise in TNC availability is a partial explanation. This case highlights the importance of flexible infrastructure that can handle new entrants to the CP system to identify where efficiency losses can be addressed.

Charging taxis and TNCs for CP zone access is important for minimizing congestion in city centers and encouraging public transit over vehicle travel. However, it is important to recognize the equity effects of such charges on taxi and TNC drivers. In San Francisco, 69% of taxi drivers are over 60 years old, and many are struggling to pay down their investments on taxi medallions due to reduced taxi demand following the introduction of ridehailing (*99*, *100*). Glassdoor estimates $3,681.58 as the average monthly base pay (including bonuses) for Uber drivers in the San Francisco Area (*101*). However, a report from JP Morgan Chase found that TNC drivers working full-time in 2018 in San Francisco could expect to make an average of $1,508 per month, well below the poverty line for a head of household supporting a 4-person family in California (*102*, *103*). This range reflects the fact that ridehailing drivers' earnings vary considerably based on factors such as driving during different times and in different areas, as well as variability in the costs of driving. Both taxi and TNC drivers work to independently optimize their earnings by choosing when and where they drive, so thoughtful policies should take care to ensure fees do not represent a wage tax for drivers, and that fees are the responsibility of consumers.

Discounts for High-Occupancy Vehicles (Singapore)

The only city in this report that has offered a CP discount or exemption for personally-owned high-occupancy vehicles (HOVs) at any time is Singapore. Singapore has since removed that exemption, though it is unclear whether that was due to enforceability concerns, efficiency, and/or financial reasons. California has had mixed success with HOV lanes for freeways. HOV lanes have been shown to neither encourage carpooling nor reduce congestion (*104*). Therefore, it is possible that HOVs may have a net negative effect on the efficiency of a CP system. More analysis is needed to identify what types of occupancy discounts could result in net benefits for San Francisco. It is possible that discounting rates for commercial for-hire vehicle rides that offer pooled service options would have different effects than HOV lanes do, because price signals will be more apparent for consumers.

Discounts for Electric and Other Clean-Air Vehicles (London, Stockholm)[2]

Congestion pricing can be an effective complement to other measures intended to encourage development and adoption of lower-emission vehicles and electric vehicles (EVs). Offering discounts or exemptions for EVs entering a CP zone creates an additional incentive for those who regularly access the zone to go electric. However, there are two important caveats. First, while the growing number of used EVs entering the market is improving EV affordability (*105*), up-front costs of purchasing EVs remain more difficult for lower-income households to finance. A blanket EV discount may therefore disproportionately benefit higher-income households, which have easier access to EVs. This challenge can be addressed by restricting EV discounts to lower-income households, or having a clear sunset period for the discount to take effect.

Second, as the market share of EVs increases, a CP discount for EVs will reduce the effectiveness of the CP scheme over time (because a greater share of drivers will be exempt and hence no longer have a disincentive to drive in CP zones). To account for this, Stockholm built a sunset for EV discounts into its CP plan before that plan was implemented. Similarly, London was required to later revisit and change its EV discounts. If San Francisco decides to incorporate an EV discount into its CP scheme, it would be well advised to consider a similar sunset provision.

Among the case studies evaluated in this report, there appears to be a shift away from discounts for EVs and toward an additional charge for less-efficient vehicles. London introduced an ultra low-emission zone (ULEZ) in 2019 such that vehicles that do not meet certain emissions standards are required to pay £12.50 in addition to the congestion charge (*106*). The ULEZ fee stacks on top of CP fees and is in effect 24 hours a day, 7 days a week. Since the ULEZ fee was introduced in April 2019, Central London has seen a 20% reduction in emissions, with 9,400 fewer cars entering the ULEZ each day (*107*). The primary goal of the ULEZ is to reduce air pollution. While more research is necessary to estimate the effects of a ULEZ on low-income populations, it is possible that lower-income individuals are disproportionately burdened by a fee that has a

[2] Stockholm no longer offers discounts for low-emissions vehicles.

greater impact on older, higher-polluting vehicles.[3] While this trend towards "pollution charging" may improve a transportation system's capacity to achieve its efficiency and emissions goals, it must also be weighed against potential regressive effects.

4.2.2 Population-Specific Discounts and Exemptions

Discounts for Residents (London, Gothenburg)

London offers a discount to residents within its CP zone. Both Stockholm and Gothenburg exempt residents within specific suburbs of those cities, but residents of the CP zone are not exempt upon reentering. New York similarly is not proposing charges for residents traveling within its CP zone (although there is a possible discount proposed for in-zone residents earning under $60,000), but higher-income residents would pay for reentry into the zone. The justification is that residents of a CP zone receive benefits such as decreased traffic, reduced collisions, and improved air quality. Moreover, CP zones are generally desirable areas with abundant amenities. Subsidizing zone access for residents would be inequitable if not means tested, because the CP would compound existing desirability factors, and could therefore result in rising costs for housing within the CP zone. Research in London supports this premise, indicating that housing prices within the CP zone increased compared to similar neighborhoods outside of the CZ. This research concluded that "homeowners pay to avoid traffic so as to reduce commuting time, to enjoy better air quality and less traffic noise, and to travel on safer roads" (*108*).

Discounts for People with Disabilities (London, Stockholm, Gothenburg)

London, Stockholm, and Gothenburg offer discounts for people with disabilities, vehicles registered to those with disabilities, or for-hire vehicles transporting people with disabilities. While we did not encounter any specific equity analyses of the impact of CP on individuals with disabilities, we tentatively suggest that such discounts are likely beneficial for equitable transportation and that the number of discounts allowed is likely not a large burden on the charging system.

Discounts for Low-Income Populations (no implemented case study cities, considered in Vancouver, Seattle)

Of the several long-standing CP schemes in place today, none offers a direct discount for low-income households. One way to evaluate how this impacts people with different incomes is shown in a study of London in 2005. The authors of that study argued that for users to benefit from the congestion charge, its price must be less than the user's value of time based on income (although this calculation does not account for externalities). In 2005, less than 10% of London area residents would yield a net benefit from paying the £5 original charge. Researchers estimated that to benefit from the (then proposed) increased £8 charge, a car commuter would need to make an annual salary of roughly £122,000 (*66*). London area median gross earnings were £28,904 in 2005. The charge was increased several times, and the updated charges continued to far exceed the contemporaneous median income. As of 2018 the charge was £11.5 representing a 43% increase compared to 2006, while gross earnings only increased 25% during this same period (£38,272 in 2018) (*109*). In 2020 the charge once again increased to £15, with the addition of an additional ULEZ fee added in 2019, based on vehicle emissions. During none of these increases did London implement accommodations for low-income people.

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[3] For a case study on the link between income, vehicle age, and vehicle emissions, we refer you to https://journals.sagepub.com/doi/pdf/10.3141/1815-06?casa_token=hg6laoih1voaaaaa:q-vmaxutwcppsans9shevevtjnwigapocmz4x9h9opmzpfendonigitmj5qztopu-rgcbztu5qexfw.: Miller TL, Davis WT, Reed GD, Doraiswamy P, Tang A. Effect of County-Level Income on Vehicle Age Distribution and Emissions. Transportation Research Record. 2002;1815(1):47-53. doi:10.3141/1815-06.

Further research is needed to understand mitigation strategies that would directly reduce the burden of CP fees for low-income individuals. In assessing how much low-, middle-, and high- households might spend under different CP systems, Vancouver determined that upper-income households would pay a higher absolute-dollar figure but that low-income households would pay a higher percentage of their income. To achieve their stated goal of ensuring that everyone paid the same proportion of their income as the high-income households paid, Vancouver officials determined that around 20% of the CP program's net revenues (between CAN $170–345 million annually) would need to be returned to low-income households through rebates, discounts, and other measures (*2*).

Similarly, Seattle established its Transportation Equity Program in 2017 with the desired goal of providing "Safe, environmentally sustainable, accessible, and affordable transportation options that support communities of color, low-income communities, immigrant refugee communities of color, people with disabilities, people experiencing homelessness or housing insecurity, LGBTQ (lesbian, gay, bisexual, transgender and queer) people, women and girls, youth and seniors" (*110*). The Seattle Transportation Equity Program allocates up to $2 million annually to support equity programs, including subsidized transit passes, youth transit passes, partial rebates for vehicle licensing fees, discounted car-share memberships, and ongoing community consultation. Seattle officials have considered implementing a congestion charge to increase the revenue available to this equity program. The City is also considering direct income-based discounts.

Equity and Flat Rates Versus Variable Fees (all case study cities)

London charges a flat fee (£15 daily) from 7:00 AM to 10:00 PM. Singapore, Stockholm, and Gothenburg each charge a variable fee that changes based on the time of day, entry/exit cordon locations, and the direction of travel. Though a variable pricing system may require more sophisticated technology, variable fees are typically more equitable because low-income households tend to travel shorter distances during off-peak hours and flat rates favor longer-distance travelers traveling during peak hours. Analysts identify pay-as-you drive insurance as more equitable than flat monthly rates, because miles driven correlate to risks accumulated. Flat rates tend to subsidize higher mileage drivers, who tend to be higher-income (*111*). Transit ridership in Los Angeles was shown to demonstrate similar trends. Researchers found that flat-rate fees are the least equitable types of fees for Angelenos, due to the fact that low-income riders are more likely to take transit for shorter trips during off-peak hours, thereby they pay higher per mile costs and would benefit from a mileage based system (*112*). Theoretically, these lessons could apply to a CP system as well: more variable time-of-day and/or distance based rate structures will likely yield more equitable outcomes.

4.3 The Supply Side of Transportation Equity

4.3.1 Reinvestment of Revenues (all case study cities)

Using revenues to lower taxes has been found to benefit wealthier drivers. For example, replacing a gas tax with a congestion charge, or providing other tax breaks in exchange for a congestion charge, would benefit wealthier people (*68*). There is an overwhelming consensus that CP revenues should be reinvested into public transit and targeted to ensure that low-income communities and communities of color are well-served with high-quality transit.

In Stockholm, additional public transit service was added four months before the congestion toll was initiated, reducing headways and adding service. This allowed travelers to adjust their schedules prior to the fee's implementation and contributed to high ultimate favorability of CP. In contrast, in Gothenburg, where CP revenues were mainly spent on a rail tunnel, public acceptance of the CP program has been much lower (*113*). London allocates most of its CP revenues to enhance bus service, including through increased service, longer bus lanes, introduction of out-of-bus ticket sales (instead of on-bus sales) to reduce waiting time at stops, enhanced route supervision, and introduction of quality incentive contracts (*114*). Although Singapore's revenues are directed toward a general fund, considerable resources are spent on transit and (unique among cities with CP programs) affordable housing located near major transit hubs (*61*).

There are, however, some caveats to the reinvestment of revenues into public transit programs. Even prior to the implementation of CP, the use of public transit in the above case studies was relatively high. For example, prior to the implementation of CP in Stockholm, 60–65% of all motorized trips to the city center were made on transit. During rush hour, that figure rose to 80% (*77*). Prior to London's CP scheme, 83% of travelers arrived in Central London using public transit. Although increasing public transport mode share was a goal of the London CP system, this already high transit mode share prior to CP implementation suggests that the goal of reinvestment was primarily to fund an already extensive and well-utilized public transit network. The majority of the population was not driving, so could not make a mode switch, but the incentives from the congestion charging to encourage more transit ridership resulted in an upward cycle that encourages ever-more transit ridership.

In places where transit networks are less robust, low-income people and other vulnerable groups may be adversely impacted by the congestion charge even if revenues are reinvested to benefit those groups—i.e., the reinvestment benefits may not outweigh the CP costs. Theoretically, as CP revenues help expand transit systems, this calculus will change over time. It is worth noting that bus network investments may yield more "bang per buck" compared to rail, although more analysis is needed to assess this further for San Francisco under current market conditions. Before any CP system is implemented, it will be important for San Francisco to identify strategies for underserved communities who already face inequitable transit access, so that planners will have a better sense of where targeted investments may do the most good.

4.4 Data Reporting

A critical element of a successful and equitable CP system is transparent data reporting. In evaluating the available data and existing literature, there is a deficit of information on the sociodemographic nature of the users of existing CP systems. Providing a robust data collection apparatus will be essential to ensure that equitability of access can be tracked and analyzed on an ongoing basis. Disaggregated data would be most useful. Such data should include geolocated, timestamped information on vehicle route polylines (i.e., combined route segments), costs paid, and vehicle types for all ride-trip periods (*3*). A third party may be best suited to securely hold such data and provide structured access for states, cities, and researchers. If a trusted third-party cannot be identified (or funded), then only aggregated data should be shared.

5. Conclusion

There is a large body of research on the topic of CP, but there is relatively little on how to ensure that CP systems are both effective and equitable. This issue paper seeks to help to fill this gap. The COVID-19 pandemic will mark a turning point for many aspects of the global economy. Mitigating an anticipated spike in demand for single-occupant driving is critical. The challenge for transportation planners will be to ensure that this shock does not exacerbate mobility inequities. This analysis concludes that an equitable CP system begins with a **meaningful community-engagement process**. The CP system should then be designed with pricing structures **that strike a balance between efficiency and equity**. Discounting should encourage multi-modal transportation and use of transit. Discounts for CP zone residents or electric vehicles will likely continue to inhibit CP efficiency. The CP system should also include a **clear plan for investing CP revenues in equitable, community-driven solutions**. Finally, **a comprehensive and transparent data reporting strategy** will ensure that progress towards equity objectives can be tracked and monitored on an ongoing basis.

APPENDICES

Appendix A. Road Pricing vs. Congestion Pricing

In practice, it is important to keep in mind the distinction between road pricing and the more specific congestion pricing. Road pricing (e.g., variably priced lanes and per-mile fees) does not price congestion specifically, though one outcome of road-pricing programs may be reduced congestion. Instead, road-pricing programs allow road users to bypass traffic while leaving unpriced lanes congested. The intent of road-pricing schemes is to provide a benefit to drivers who are willing to pay to avoid congestion, not to minimize the congestion overall.

Types of Road- and Congestion-Pricing Schemes

The four most common types of road and congestion pricing are (1) variably priced lanes, (2) variable tolls on entire roadways, (3) zone-based or cordon charges, and (4) area-wide or system-wide charges.

Variably priced lanes, also called high-occupancy toll (HOT) lanes, are separate lanes on highways that drivers must pay a toll to use. Toll fees may be fixed or dynamic. A HOT lane will typically be installed by either adding a new lane to a roadway or by modifying an existing high-occupancy vehicle (HOV) lane to accommodate HOT lane travelers (*115*).

Variable tolls on entire roadways similarly charge drivers a fee for road use. Unlike HOT lanes, these charges apply to entire roadways or bridges (rather than separate lanes) and are never set at a fixed rate (*115*). Instead, pricing varies by time of day and day of week. Variable tolls on entire roadways are usually implemented on roadways or bridges that are currently free or feature a flat toll (*115*).

Zone-based or cordon charges impose “either variable or fixed charges to drive within or into a congested area” (*115*). Today, cordon charges are mainly used to relieve congestion in dense urban spaces, especially city centers (*115*). Similar to HOT lanes, implementing zone-based charges often requires building new infrastructure around existing road networks to establish the boundaries of a given zone.

Area-wide or system-wide charges are a road-segment specific form of congestion pricing (*115*). Different from zone-based charges, area-wide charges are “per-mile charges on all roads within an area or on a roadway network that may vary by level of congestion” (*115*). An area-wide pricing program may not require the same border infrastructure as a zone-based one, but it does require significant investment to monitor the vehicle miles traveled by all motorists in a designated area.

Appendix B. Congestion Pricing in Milan and Oslo

Milan’s pollution pricing

Milan’s pricing scheme was introduced in 2008. The scheme was initially implemented as a pollution charge called “Ecopass,” where road users were charged for their vehicle’s relative level of pollution. The Ecopass was replaced with the congestion charge called “Area C” under a trial period in 2012. This new charge was permanently implemented in April of 2013. Under the Area C scheme, gasoline and diesel vehicles are prohibited from accessing the target area. Studies indicate that Ecopass and Area C have contributed to significant improvements in congestion, air quality, and public transport ridership and speed. These notable findings are largely unaccompanied by insights regarding the equity effects of these policies.

Oslo's repayment plan

Oslo's pricing scheme was not initially introduced with the purpose of demand management. The toll was implemented to recover the costs of replacing major highways around the central business district and improvements to transit. After the projects were paid off, the pricing plan was left in place for demand management purposes and to raise revenue for further transport projects. The toll applies every day, at all times. As a result, some studies do not consider Oslo's pricing strategy to be a congestion charge. As with data on Milan's pricing system, data or reports on the equity effects of Oslo's pricing scheme are limited.

Appendix C. Defining Equity

Conceptualizing equity is a difficult task because equity can be measured along many different dimensions for different populations. For reference, key terms and concepts with respect to equity in transportation are included here. Numerous government agencies, nonprofits, and academic institutions have explored the theoretical and practical notions of equity as it relates to road pricing and transportation systems. We have provided a summary of these resources in Table 2 below.

How equity is measured depends on how it is defined. Noted economist Amartya Sen once argued that equity is multidimensional, including dimensions of justice, rights, treatment of equals, capability, opportunities, resources, wealth, primary goods, income, welfare, and utility (*116*). Further, different measures of equity and of success may be important to different people. A public-safety department will care more about equitable justice than a university admissions office, which prioritizes equity in opportunities. It is therefore insufficient and even inappropriate to measure equity along a single dimension or population.

For the purposes of this paper, equity is most easily understood as the degree of fairness by which costs and benefits are distributed among members of society. Equitability is generally considered a question of degree rather than an absolute; that is, a policy is more or less equitable (rather than asserting that it is or isn't equitable). To this end, the many dimensions of equity in congestion pricing may be divided into two broad categories—equity in process and equity in outcome (*2*).

Dimensions of Equity

Equity in process considers the extent to which all members of a community are engaged in decision-making and planning processes. For example, Seattle has done extensive work developing a strategy to engage the public in the planning of a CP scheme, specifically around how to ensure that minority populations are intentionally included in the conversation. San Francisco has already made strides to improve process equity, such as convening a Policy Advisory Committee to ensure input from community members and underserved residents (*117*).

Equity in outcome can be qualified along a number of dimensions. There are many dimensions of outcome-based equity. These include vertical or income-based equity; spatial or territorial equity; temporal, longitudinal or generational equity; market equity; and social equity. In its planning process, the SFCTA has emphasized its focus on vertical equity, or the extent to which individuals from different classes are treated similarly, and spatial/territorial equity, or the extent to which costs and benefits are distributed equally across geographic space.[4]

Vertical Equity

In 2016, San Francisco was found to have the sixth-worst income inequality among major U.S. cities, with a poverty rate at around 12% of residents (*118*, *119*). According to the U.S. Department of Transportation, transportation costs consume a substantial amount of the average American household budget, after healthcare, housing, and food expenditures (*120*). The bulk of these costs go toward the maintenance of personal vehicles, though low-income individuals face the steepest barriers to car ownership. Non-ownership is especially disadvantageous for low-income workers in the labor market, as regular automobile access has significant consequences for job retention and earnings potential (*121*). By one estimate, having one car per adult in a household improves a family's net income by $2,258 per year for those in poverty. The burden of high-cost transportation is further compounded for low-income drivers. Specifically, low-income households in some regions live farther from their jobs and face longer commute times than higher-income households (*122*). Given these setbacks, the role of CP in addressing transit inequities for low-income households is of paramount importance in regions where this trend exists.

Spatial or Territorial Equity

The SF Bay Area has a long history of racial and ethnic segregation. In Oakland and the East Bay, strategic decisions by local government officials (e.g., redlining, job decentralization) have made minority communities disproportionately reliant on transportation infrastructure, both in terms of public-transit ridership and use of high-traffic conveyance routes (*123*). This inequity means that any CP decisions must be made with due consideration for the transportation burdens uniquely faced by communities of color.

The Bay Area is also famously suburbanized, meaning that more residents live outside the city center—but within the bounds of the metropolitan statistical area—than live in the City center itself. Numerous scholars have pointed to San Francisco's early transportation policies (e.g., ferry networks, trolley systems) and overreliance on single-family homes as key contributors to the City's suburbanization (*124*). This metropolitan "sprawl" has led to longer commutes for most Bay Area residents and has forced many to switch from public transit to single-occupancy vehicles (*125*).

Congestion is exacerbated further by inbound commuters. One estimate by the American Community Survey suggests that San Francisco's population grows by over 160,000 people during normal business hours, many of whom are commuting in from surrounding San Mateo, Alameda, and Contra Costa Counties (*126*, *127*). Thus, any CP program implemented by the City must also account for the differential impacts a road-use fee will have on the mobility of its residents and its large commuter pool.

Populations of Interest

In addition to how equity is conceptualized, it is necessary to determine whom equity considerations are meant to benefit. Disadvantaged populations vary by city and country, meaning that equitable congestion programs will vary by place, space, and time. At a minimum, CP analyses should look to protect (or reduce harm to) low-income groups and people of color.

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[4] The SFCTA's goals are consistent with the three forms of transportation equity the FHWA promotes: equity in income, geography, and modality.

Additional populations may be of interest depending on the city in question and the granularity of data available. Many of the studies reviewed in the sections above on Outcome Equity (3.1.5, 3.2.5, 3.3.5, 3.4.5) focus primarily on the impacts of congestion pricing for low-income families, failing to also account for other underserved populations. Data or recommendations for other disadvantaged populations are included as available, but their limited availability speak to a need for additional research.

Women and families with young children

Gendered transportation disparities abound, often overlapping other societal disparities (like the wage gap) and compounding intersectional disparities (meaning that women of color are at an even greater disadvantage in access to affordable and reliable transportation). In short, women are more likely to use transit, run multiple family errands in a single trip, and face transit-related harassment (*128*). Women are also more likely to “chain-trip” than men, running family errands like stopping at daycare or the grocery on their commute home (*129*). When transportation surveys define “trip” as a single journey, they obscure gender-related transit data, making it difficult to account for the unique travel needs of women commuters.

Elderly

It is projected that by 2040, more than 1 in 5 Americans will be aged 65 or older (*130*). Access to transit is important for older people, who “age out” of driving or have fixed incomes on which financing personal car ownership may be difficult. Yet transit can be challenging for the elderly to navigate and is often unreliable or insufficient for many trips. For those seniors who rely on access to the SF downtown zone there may be strategies to provide alternative or subsidized access to health or human services in the zone. Efforts to undertake specialized outreach at such facilities in the downtown zone will help to identify targeted solutions. The CP could generate revenues that can help improve access for older people, but equitable policy could also mitigate direct negative effects on vulnerable populations.

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