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Guardrails on Priced Lanes: Protecting Equity While Promoting Efficiency

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16. Abstract

Can congestion pricing be implemented in a way that protects vulnerable residents of California? This report examines that question from two perspectives. First, we empirically estimate the size of the vulnerable population likely to be impacted if congestion pricing were introduced on California's urban freeways. Our estimates suggest that 13% of households, as a result of their low-incomes and current travel habits, might be unduly burdened by a freeway tolling program in California. Second, we consider ways to mitigate these burdens. In particular, we compare freeway use to use of other metered network infrastructure, like electricity grids or water systems. We suggest that assistance programs from these utilities provide a useful model for protecting low-income drivers from road prices, and further note that policymakers would be less constrained in progressively redistributing congestion toll revenue than they would be in redistributing utility revenue.

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Introduction

Fairness is one of the largest and most common concerns that arises when governments or advocates propose road congestion pricing. This report examines the fairness of congestion pricing, using California as an example. Our particular interest is not just in pricing's potential equity implications (although we attempt to measure those), but is rather in policies governments can design to accompany, or embed in, pricing to mitigate its potentially unfair outcomes. We focus on California's six largest metropolitan statistical areas (MSAs), where congestion pricing is most likely to be enacted: Los Angeles, San Francisco, the Inland Empire, San Jose, San Diego, and Sacramento.

Understanding the equity impacts of pricing requires answering five overarching questions. First, who will be exposed to congestion pricing (i.e., who will pay the tolls)? Second, what share of this exposed group is also vulnerable (that is, low-income), and thus likely to have trouble paying? Third, how easily can this exposed and vulnerable group change their behavior to avoid or reduce the toll (for instance, by carpooling or taking transit)? Fourth, to what extent will tolling *improve* the welfare of vulnerable people, including members of the jointly exposed and vulnerable group (for instance, by improving air quality or transit service)? Fifth and most important from a policy perspective, can congestion pricing be designed in a way to mitigate the harm it might otherwise impose on vulnerable households?

Answering these questions is difficult, because doing so is necessarily hypothetical. A reasonable way to estimate a policy's impact in any given place is to examine that policy's impact in other, similar places. With pricing in California, this approach is hard, because neither California nor places like it have fully priced their roads. California does have some freeway segments with so-called High Occupancy/Toll (HOT) lanes, where one or two lanes are congestion-priced while other lanes remain free. One example is State Route 91 in Orange County. Even HOT lanes are uncommon, however, and while they can potentially play a role in transitioning to a future of fully priced roads (a point we return to later) they offer little insight into the equity impacts of fully priced roads.

The places where roads *are* fully priced, meanwhile, and thus more closely resemble canonical congestion pricing programs, do not resemble California. The world's most-established and longest-running congestion pricing programs operate in Singapore, London, and Stockholm. These places, compared to metropolitan California, are denser, have better transit (including more extensive rail) and lower levels of vehicle ownership. Pricing in these places, as a result, falls disproportionately on the minority of largely affluent people who drive. The typical resident, and certainly the typical lower-income resident, pays congestion tolls only rarely. Across the United States, in contrast, including in California, most low-income people drive, even in urban areas.

Compared to the U.S., moreover, places with congestion pricing programs also have strong national-level social safety nets, which can cushion the impact of market-priced local services. High prices for local collective goods are less of a burden for low-income people when progressive taxation covers large household costs like health care or child care. In the United States, in contrast, national-level redistribution is smaller. In this context, holding down the price of local services becomes a more important aspect of the safety net. We can see this dynamic at work looking at transit fares. A one-day pass to ride the Los Angeles Metro costs $7. A day pass for the London Tube is the equivalent of over $19.

For all these reasons, existing pricing programs offer little help drawing conclusions about the equity impacts of pricing in California. In light of these limitations, we try to answer the first four of the five questions posed above by first estimating the relative burden that congestion tolls would place on different groups in California's six largest MSAs. The upshot of this exercise is that congestion pricing, because it involves a regressive toll levied on all drivers, does have the potential to create equity problems. Our estimates suggest that 13% of households, as a result of their low-incomes and current travel habits, might be unduly burdened by a freeway tolling program in California.

From there we turn to the fifth question: What can governments do to mitigate this impact? To answer this question we step back, and consider congestion pricing's potential equity burden in the context of other services, and in particular of other priced network infrastructure. Roads are network infrastructure, and while neither California nor the United States has a system of completely, or even largely, tolled roads, in most metropolitan areas most *other* network infrastructure — water, electricity, heating fuel — *is* metered, often almost completely so. Metering these networks creates equity problems similar to those that could be created by priced roads: It conditions access to vital infrastructure, for which there is no substitute, on ability to pay. Utilities do mostly manage this equity problem: They have policies that protect low-income consumers and ensure that pricing does not deny them access. Some of these policies can be models for congestion pricing. So too, for that matter, could existing assistance programs for other essential goods, like food and housing. The 13% of California households that we estimate are vulnerable to harm from tolls is not dissimilar to the proportion of California residents eligible for food assistance in 2019 (14%). It is also notably smaller than the share of California residents that qualify for utility assistance; low-income California households consume slightly less electricity than higher-income households, on average, but between 25% and 30% of all residential electricity in California is sold to low-income producers at discounted rates (Borenstein et al. 2021).

Neither food nor utility assistance is perfect, of course; too many people who need both routinely go unassisted. But some of the imperfections in these programs arise from a combination of three disadvantages that road pricing would not face. First, in the case of utility assistance, the amount of revenue available for redistribution is constrained by the need to produce the service itself. Much of the money paid to electric utilities, for example, must go to producing and delivering electricity. This is not true of roads. The road, unlike a kilowatt hour of electricity, does not need to be produced anew for each additional user. More revenue, as a result, can be devoted to assistance.[1]

Second, pricing a road network, unlike pricing utilities, can and should be done at a geographic scale that supersedes income segregation. Many utilities, particularly water systems, for historical reasons conform to municipal (or smaller) boundaries, which means that water systems in poorer cities have a disproportionately low-income revenue base. This small base, in turn, forecloses the possibility of substantial ratepayer assistance (Pierce, Chow and DeShazo 2020). A problem of this sort is less likely to occur with priced roads, and especially priced freeways, because freeway networks serve entire labor markets, and the typical tollpayer, as we will demonstrate, will not be low-income.

[1] This constraint faced by utilities is particularly large for electric utilities in California, where rates are high in part because they finance not just generation and transmission but a variety of programs (such as energy efficiency and fire mitigation) unrelated to producing and delivering electricity. As a result of these obligations, a utility that charged the socially "correct" rate for electricity would not be able to cover its costs. Strictly speaking, then, the price of electricity in California is inefficiently *high* (Borenstein et al. 2021). None of this would apply to roads.

Third, many existing redistribution programs involve grafting a mechanism for public assistance onto an already-established private market. The SNAP (food stamp) program involves the government trying to remedy the deficient buying power of some people who participate in the enormous private market for food. Unemployment insurance helps people who lose jobs in a long-standing and overwhelmingly private labor market.

Congestion pricing, in contrast, basically does not exist. There is no established market in road space, nor is one likely to arise unless the government creates it. These circumstances offer an opportunity for holistic market design: Both the market and its redistribution mechanism can be jointly created (e.g., Roth 2018). Congestion pricing can be *introduced* with a mechanism in place to protect the most vulnerable drivers.

The rest of this report is organized as follows. Section 2 outlines our methods and data. Section 3 is our results, which describe the socioeconomic characteristics of households in the six study MSAs and discuss what we know about their travel behavior. The takeaway here is twofold. First, most tolls would be paid by higher-income households; the affluent do most driving, so to the extent pricing "targets" a socioeconomic group, that group is higher-income people. But second, some low-income households would undeniably be exposed to congestion pricing, and these tolls would, as a matter of sheer arithmetic, impose a larger burden on those households.

Section 4 examines the travel behavior and job accessibility of these low-income households by accounting for costs imposed on these households under the status quo of free roads. Our results suggest that some of the costs of congestion pricing that fall on low-income people *as a group* would be mitigated by some of the benefits of less congestion, such as faster transit trips and less air pollution. Congestion pricing, however, offers a good example of the shortcomings of group-based approaches to equity. Even if pricing has some progressive effects (and it almost certainly does) many *individual* low-income households could be burdened by tolls, which means that redistributing some of the toll revenue, or otherwise protecting low-income households, would be essential to the fairness of any pricing program. Section 5 discusses different approaches to implement equitable pricing.

We introduce two caveats before moving on. First, we are not making a normative argument about the broader fairness of congestion pricing. Discussions of that sort can be found in Manville (2018) and Manville and Goldman (2018). Second, we are neither attempting, nor claiming, to create a system of redistribution where congestion pricing makes no one worse off. While such an outcome might be theoretically possible, and the literature on revenue recycling discusses it, we see it as neither practically feasible nor politically necessary.[2] Metered water and electricity have net winners and losers, and so too does the status quo of unpriced roads. These plain facts suggest that a policy regime needn't make everyone whole to be accepted and endure. Efforts to change the status quo, moreover, (for example, to price the roads) are more likely to succeed when they *concentrate* benefits, which attracts political champions, not when they distribute costs and benefits equally and net them out to zero (Olson 1965; King et al. 2007). We thus leave the goal of everyone being held harmless to the side. We accept that some people in a congestion-priced world will be worse off than they had been in a world of free roads. Our goal is to protect *vulnerable* people in such a world.

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[2] Sallee (2019) makes a strong argument that, contra the literature, Pareto-efficient pricing is actually impossible.

Methods and Data

Measuring Pricing's Equity Costs

Congestion pricing raises fairness concerns because many people in the U.S. need cars, and some have little choice but to regularly drive at busy times. Some of this driving, for some people, could be replaced by transit use. In much of the United States, however, public transportation is infrequent and inadequate. Thus many people, at least some of the time, would need to pay congestion tolls. While higher-income households can likely afford those tolls, lower-income households might struggle to do so.

Our first two exercises, therefore, are to measure exposure and vulnerability. Exposure, again, is traveling in a way that makes a household likely to pay a toll. Vulnerability reflects a household income status suggesting that this toll would be burdensome.

While many households would be regularly exposed to congestion pricing, not all would. Congestion pricing can take a number of forms, and exposure will vary, in part, based on the form the government chooses. Measuring exposure to a pricing program thus first requires describing the program itself. For the purposes of this report, we assume a program where only freeways are priced, and only in large MSAs where congestion is severe. We further assume that the tolls would be dynamic, making driving more expensive when and where demand was most intense. While the tolls would not necessarily change in real time, they would vary across hours (e.g., higher tolls at 8 a.m. than 6 a.m.). The rate-setting would be governed by performance metrics — for instance, the government might charge the lowest toll that keeps traffic moving at between 45 mph and 55 mph — and the tolls would be collected through transponders mounted in each vehicle.[3]

We assume, in short, that California would adopt a pricing model similar to the one that exists in Singapore, where prices on the network are calibrated to demand (Christiansen 2006). We do not consider a London-style cordon charge, where authorities charge a flat rate to enter a downtown area. Nor do we consider a vehicle miles traveled (VMT) charge, which charges drivers for each mile traveled, regardless of whether that mile is driven in congestion or how severe the congestion is. Cordon and VMT charges are viable policy instruments, but they are different policy instruments, with different aims, than freeway congestion charges. Particularly in urban California, a disproportionate share of both VMT and delay occur on the freeways, and charging for freeways is logistically easier. Freeways have limited access and, unlike city streets, they are explicitly designed only to move one mode, which reduces potential problems that can arise if congestion charging increases vehicle speeds.

If we assume that freeways would be congestion priced at peak periods, then households driving during peak periods on congested freeways would be exposed. Measuring exposure thus involves estimating the share of households fitting that description. Measuring vulnerability involves taking those households and determining how many of them fall under commonly accepted thresholds of socioeconomic disadvantage.

We estimate both exposure and vulnerability using weighted responses from the 2017 National Household Travel Survey (NHTS). The NHTS is conducted by the Federal Highway Administration, and records the details of daily

[3] This is standard; most systems also rely on backup systems (usually cameras) for vehicles without transponders.

non-commercial travel by all modes, including characteristics of trips taken, the people traveling, their households, and their vehicles. The sample size for California (just over 26,000 households) is too small to permit analysis at the neighborhood level, but does let us analyze travel in MSAs.

We consider a household exposed to congestion pricing if, on a given travel day, any of its members take a peak period driving trip on a congested freeway. We operationalize this as follows:

- Drive: A trip is a drive trip if it uses a personal automobile.
- Peak Period: A trip occurs at peak period if any part of it occurs between 5:30 a.m. and 9:30 a.m. or between 3:00 p.m. and 7:00 p.m.
- In Congestion: The NHTS does not provide congestion data, so we use speed as a proxy. We consider any trip whose average speed is below 45 mph to be congested. We calculate average speed by dividing a trip's time into its roadway travel distance. This definition errs on the inclusive side: It will likely include some slow trips that did not occur in congestion, and thus artificially expand the population exposed to tolls.
- Freeway: The NHTS does not indicate if a trip used a freeway. We use trip distance as a rough proxy for freeway use. We assume that trips of over 3 miles occur at least in part on a freeway. This definition will, like the definition of congestion above, err on the inclusive side. It will leave out trips of 3 miles or less that do use freeways, but will also capture trips of 3 miles or more that do not.[4]

While the different components of our definition contain potential error (e.g., erroneously counting some slow-speed trips as congestion, or some longer non-freeway trips as freeway), some of that error will be reduced as the components are combined. For example, some slow-speed trips, or long surface-street trips, will occur outside peak hours, and be dropped. Similarly, some slow speed trips will not exceed 3 miles, and vice versa, and will be dropped. In total, the likely direction of error will be to expand rather than reduce our exposure estimates, which is preferable given our desire to fully capture the harm from pricing.[5]

One potential component of exposure that we examined, but ultimately did not use, was trip purpose. Arguably, a discretionary trip constitutes less exposure than a necessary one: Trips to stores or restaurants might be easier to reroute, or to make at different times, than trips to work or school. When we tabulate trips by purpose in the NHTS, however, the result suggests that only 63% of households took a vehicle trip for a non-discretionary purpose (work, school, child care, health care, or religious activity) on a given day. That proportion struck us as implausibly low, and did not change notably if we removed people aged 65 or older, so we dropped trip purpose as an exposure criterion. We thus consider any trip that meets the three criteria above as exposed — thus erring again on the inclusive side.

Not everyone who is exposed is vulnerable. We measure vulnerability by income: A traveler is vulnerable if their household income is below 200% of the federal poverty level. This definition is also relatively inclusive. Many

[4] The 2009 NHTS did record whether a vehicle trip used a freeway. Plotting that variable against trip distance suggests that our 3-mile distance threshold is very inclusive. Nationwide in 2009, about 20% of 3-mile trips used a freeway. By comparison, 75% of 20-mile trips did. Our variable is thus designed to minimize false negatives (recording people as not being on the freeway when they actually are) rather than false positives.

[5] One area where our method may be conservative: We do not consider trip chains. It is possible that two trips of less than 3 miles are part of a tour that exceeds 3 miles (and occurs in part on the freeway). If this is so, we will miss a freeway trip and undercount exposure. In our judgment, this potential bias is likely counterbalanced by our inclusiveness along other dimensions.

federal social safety programs use 150% of the poverty level as an eligibility threshold. Two hundred percent of poverty is a standard definition of low-income in the utility sector, however, and is appropriate in high-cost areas like urban California (it also, again, lets us err on the inclusive side). We use the NHTS responses on household income and household size responses to determine a household's poverty status, based on 2017 federal poverty guidelines.[6]

Not every exposed household — vulnerable or not — is equally exposed. The procedure above establishes exposure as a binary, in that households are exposed or not, but the toll burden can vary considerably within the exposed category itself. Some exposed drivers will spend more time in congestion, or will drive in more severe congestion, and confront a larger total toll payment as a result. Recall that because we are analyzing a congestion charge, and not a VMT charge, the total amount of *miles* driven by a household is not, by itself, a good metric of exposure to tolling. What matters is the amount of driving that occurs in congested conditions, and the intensity of that congestion. We do not have a perfect way to estimate these, but we approximate it with weighted trip-level NHTS data, which let us estimate the average number of exposed miles each household drives daily.

A complicating factor is that tolling can itself reduce exposure, by inducing some drivers to not travel in congested conditions. Indeed, that is the point of the toll. If households can change the time, mode, or route of a trip relatively costlessly, then pricing can deliver a social benefit (less congestion) without imposing a high private cost. Electric utilities increasingly employ a similar logic to justify time of day electricity pricing: They assume that most residential customers can shift relatively easily their use of major appliances to periods when demand is lower, and will do so in response to a price signal. Similarly, if multiple exposed households can combine and carpool for some tolled trips, their exposure might not change but their costs could fall, since they can share the charges. One aspect of measuring exposure, then, involves estimating the extent to which people could *easily* change travel behavior — use a different time, route, or mode — to avoid the toll.

Unfortunately, existing data cannot reliably tell us if a household could easily complete a trip at a different time or by a different route. For simplicity, we assume that households cannot. That assumption is unrealistic — certainly *some* households would be able to easily adjust for some trips — but it is unrealistic in a way that expands the equity impact from congestion pricing.

Existing data also offer little insight as to how easily households could change modes. Non-driving modes are easier in urban rather than suburban or rural area, and the NHTS does offer information on these designations — noting if households live in "rural", "small town", "suburb", "second city", or "urban" settings. But such aggregate characteristics can be misleading. Downtown San Francisco and downtown Fresno are both urban. One offers an abundance of non-driving options; the other does not.

Substitution to transit is arguably the easiest adjustment to predict. For the 50 largest MSAs in the U.S., the University of Minnesota's Accessibility Observatory has compiled data that estimate, at the census tract level, the transit and auto accessibility in the United States. The closer these two numbers are, the more likely a driver can substitute a transit trip for an auto trip. We use these data for Los Angeles and San Francisco. Outside of those places, the quantity and quality of public transportation service is low, making it difficult to replace vehicle trips with transit. Bicycling in California, similarly, often lacks infrastructure. Walking is more feasible — sidewalks are

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[6] There are of course other measures of vulnerability, such as being a member of a traditionally disadvantaged racial or ethnic group, but the primary equity concern with pricing is that people will not be able to pay.

common — but walking is an unlikely substitute for freeway trips of at least 3 miles. We thus assume that no trips can be switched to biking or walking. This assumption may also be unrealistic, in that some households could change destinations in response to tolling (e.g., walking to a close restaurant rather than driving to one farther away) but for simplicity we adopt it.

Finally, available data cannot tell us how easy it would be for households to start carpooling. NHTS data do show the share of exposed miles that are currently driven with non-household members, which we consider a reasonable proxy for current carpooling. A carpool that exists before pricing is costless to form once pricing begins. We assume, again erring on the inclusive side, that additional carpools would be too costly to create.

Measuring Pricing's Equity Benefits

Our primary concern is with how congestion pricing might adversely affect equity. But pricing could also increase, rather than decrease, overall fairness. This positive outcome could occur through two primary pathways. The first pathway is by reducing air pollution. Throughout the world, congestion pricing has been shown to reduce roadway air pollution, and air pollution in turn is a source of costly public health problems (e.g., Currie and Walker 2011). Roadway air pollution often disproportionately affects low-income people, both because they are more likely to live on or near busy roads, and because they may be more likely to have underlying health conditions that make them more vulnerable to complications arising from pollution exposure. We roughly estimate the prevalence of this benefit by estimating the prevalence of poverty near freeways. We use the U.S. Major Highways layer package from ESRI to determine the location of freeways in Los Angeles and San Francisco (we consider any “limited access” road a freeway) and then match that to block-group poverty data from the 2014-2019 American Community Survey (ACS).

The second pathway by which congestion pricing can improve equity is through improved transit service. Pricing can make transit faster — and in some cases this speed may also set in motion a virtuous circle of higher ridership and lower fares (Small 2005). Public transportation is used disproportionately, and in some California MSAs primarily, by very low-income people (Taylor and Morris 2012; Manville et al. 2021). Improvements in transit, then, are likely to be progressive. We use route schedules published by each respective transit agency to compare p.m. peak hour freeway trip times to early a.m. trip times. We located transit schedules published before March 2020 (when COVID-19 impacts changed travel times) for all relevant transit agencies except the San Francisco Municipal Transit Agency and the Santa Clara Valley Transit Authority.

Results

Vulnerability

Table 1, drawn from NHTS data, shows that 11% of all households in our six study MSAs have incomes below the federal poverty level (below FPL), and an additional 16% of households have incomes above the FPL but below 200% of the FPL (100%-200% FPL). The table also shows that people of color are disproportionately represented among low-income households. Seventy-five percent of below FPL households have a non-white survey respondent, compared to just 48% of higher-income households. The lowest-income households have a substantially lower rate of vehicle ownership than higher-income households (97% of households at 200% FPL have a vehicle, compared to 76% of households below the poverty line). Nevertheless, three-quarters of the lowest-income households have at least one car. Lastly and perhaps unsurprisingly, lower-income households are much more likely to report that travel represents a financial burden.

Table 1. Income Levels in Six Study MSAs

	Below FPL	100%-200% FPL	Above 200% FPL
Household Income Levels in Six Study MSAs	11%	16%	73%
Share of Households with Non-White Respondent	75%	62%	48%
Share of Households that Own a Vehicle	76%	84%	97%
Share of Households that “Agree” or “Strongly Agree” that Travel is a Financial Burden	65%	61%	40%

In summary, 27% of households in these six MSAs are vulnerable, and of those more than eight in 10 have automobiles. Given that being car-free in California is rarely voluntary, moreover, we should also assume that many and perhaps most of the car-free households do aspire to vehicle ownership (Brown 2017; King et al. 2020). Were this preference to be satisfied, their likelihood of toll exposure would rise.

Exposure

Figure 1 shows the share of households that would be exposed to congestion pricing based on income. Low-income households are less likely to be exposed than higher-income households. Roughly half of households below FPL, and of households at 100%-200% FPL, would be exposed to pricing, compared to 68% of higher-income households.

Figure 1. Household Pricing Exposure by Income

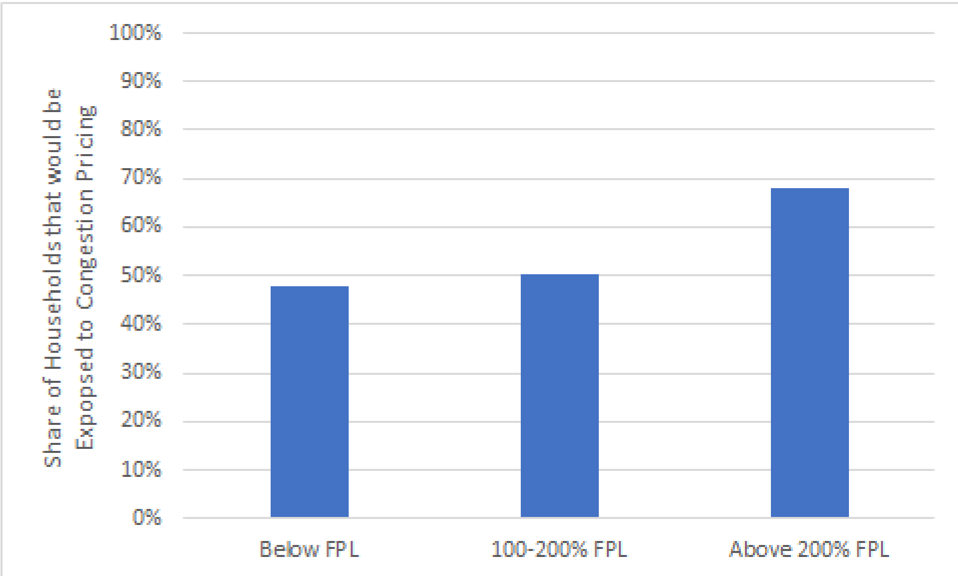

Figure 2 breaks this down further, into joint categories of income and exposure. The primary takeaway is that while 27% of households in the six study MSAs are low-income, only 13% are both low-income and exposed. These households comprise our “exposed and vulnerable” category. The figure also shows, indirectly, that the exposed and vulnerable are 21% of the total households exposed to congestion pricing. Most households that would pay tolls are not vulnerable, but vulnerable households account for a nontrivial share of exposure.

Figure 2. Income and Pricing Exposure

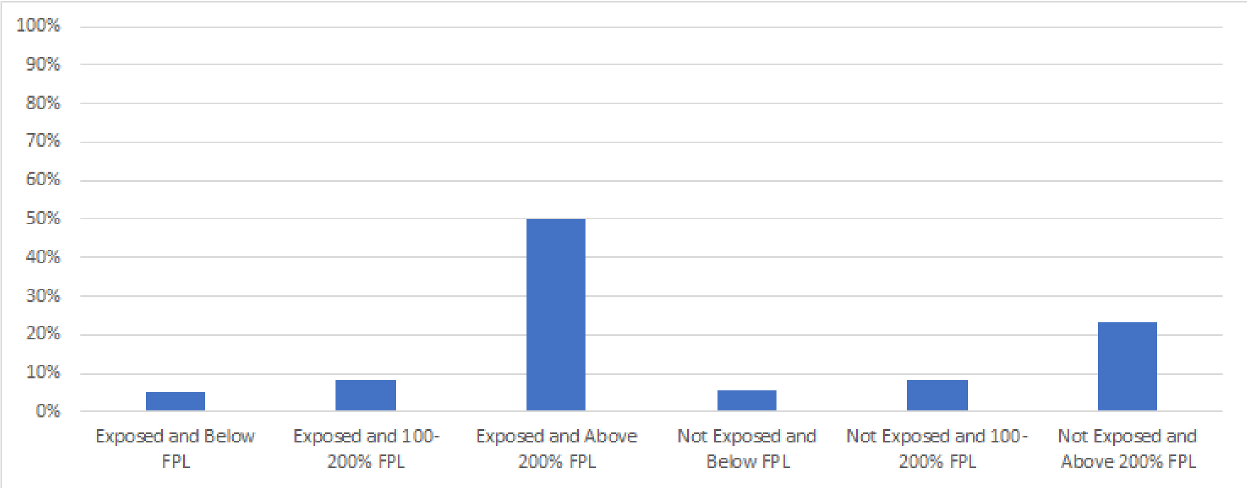

Table 2 shows that the jointly exposed and vulnerable are not the most vulnerable group of people in society. The vulnerable and *not* exposed, along many dimensions, are more socioeconomically disadvantaged. This finding is not surprising: Driving requires access to a vehicle, and the very poorest households have difficulty acquiring and keeping vehicles. The cost of driving also rises with driving's quantity, so more exposure, all else equal, suggests more income (more driving means more ability to pay for gas, maintenance, etc.). The income, in turn, suggests exposure, because income often implies employment, which means commuting. We see all these patterns in Table 2. Within the category of vulnerability, households exposed to tolls are between nine and 10 times more likely to own a vehicle as households not exposed. They also travel far more, both in cars and otherwise, have substantially higher incomes, and are more than twice as likely to have a household member who is employed. This analysis does not suggest that low-income exposure to tolls is not a problem, only to highlight that the slight majority of vulnerable people who are not exposed are substantially more disadvantaged than those who are.

Table 2. Household Demographics by Poverty Status

	Vulnerable and Exposed		Vulnerable, Not Exposed	
Poverty Level	**0-100%**	**101%-200%**	**0-100%**	**101%-200%**
Median Income	$13,891	$30,572	$8,323	$23,224
Zero-Vehicle Households	5.5%	2.7%	41.1%	28.5%
White Head of Household	22.1%	33.9%	27.4%	41.6%
Employed	83.1%	81.3%	38.5%	40.7%
Daily Household PMT (miles)	72.2	132.1	13.9	13.6
Daily Household VMT (miles)	53.9	70.2	8	9.1
HS Diploma	96.5%	96.3%	84.0%	90.6%

Employed = at least one HH member is employed
HS Diploma = at least one HH member has a high school diploma
PMT = person miles traveled (total travel)
VMT = vehicle miles traveled

Figure 3, also drawn from the NHTS, plots the average daily exposed miles for the average household in each exposed group. Exposed miles are, again, not a perfect proxy for the amount of toll a household would pay, because they do not capture the potential variance in congestion that might occur from place to place (e.g., a mile of congestion on the 405 freeway in Los Angeles might require a larger toll to clear than a mile on a freeway outside Fresno). In general, however, households driving 10 miles a day in congestion should pay more in tolls than households driving only 5 miles.

We see that households below the poverty level drive an average of 36 exposed miles per day, which is notably less than the 51 exposed miles for higher-income households. The gap closes dramatically, however, when we examine households between 100% and 200% of the poverty level, who drive almost as many exposed miles as more affluent households. Thus while the most vulnerable users spend notably less time in congestion than exposed drivers overall, most *of* the vulnerable drivers do not. And of course, the very low incomes of households below poverty suggests that any given toll will impose a larger burden on them.

Figure 3. Average Daily Exposed Miles Driven by Household

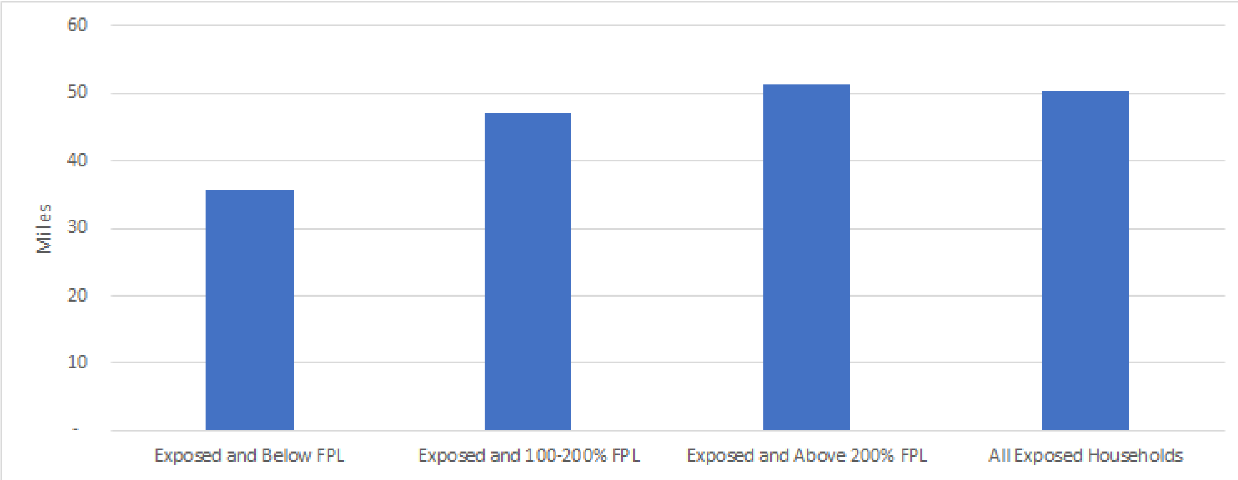

Figure 4 shows that, compared to higher-income households, jointly exposed and vulnerable households are more likely to carpool when they are in congestion. About 23%[7] of these jointly exposed and vulnerable households share at least some of their exposed miles with non-household members, and compared to higher-income households, they share a greater proportion of their exposed miles.[8] The difference, however, is not large, ranging from 32% of exposed miles carpooling for households below poverty, to 24% for higher-income households. More important is that 75% of vulnerable households do *not* share exposed miles, and over seven in 10 congested miles for low-income households are *not* miles spent carpooling. So the vast majority of exposure is not shared. As we mentioned above, it is of course possible that some households could and would form carpools in response to a toll, but these carpooling efforts would start from a low base.

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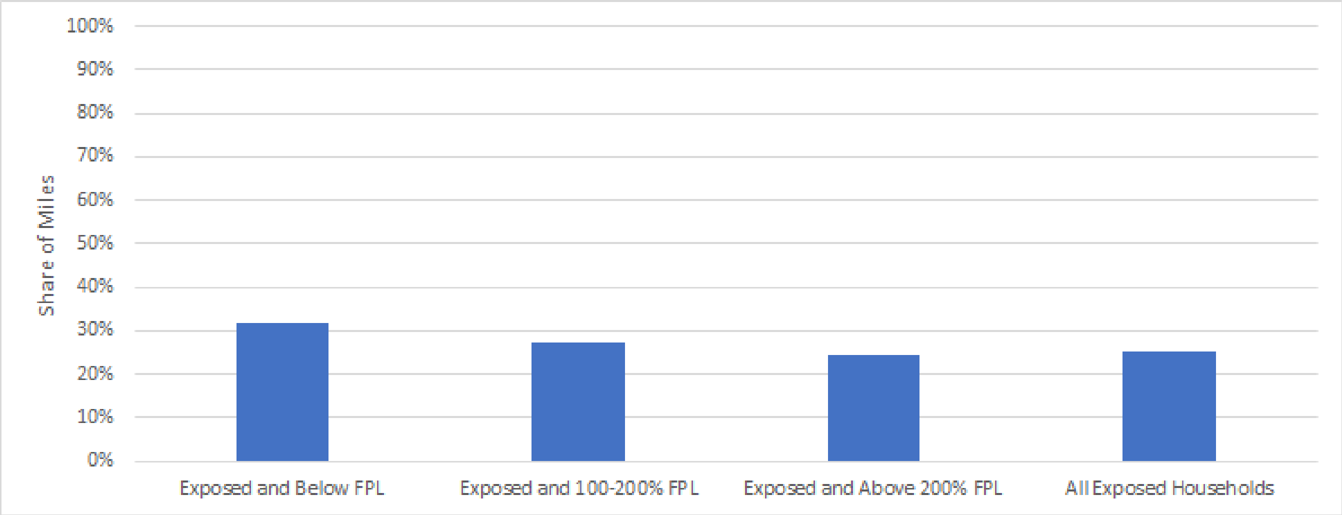
[7] We tabulate this proportion from the NHTS, but it is not shown in the figure.

[8] The average number of daily exposed household miles might seem high. However, the Federal Highway Administration reports that the average U.S. driver drives 37 miles per day, and the average U.S. household has more than one driver. Our use of means rather than medians also nudges numbers up; some households report very high daily VMT, and this biases estimates upward.

Figure 4. Share of Exposed Miles Driven with Non-Household Members



Although we do not show this in a figure, the majority (over 60%) of exposed and vulnerable households live in urban areas.[9] About 35% are in suburbs, and a very small share are in rural areas. These latter households presumably face little congestion. The urban households can presumably replace vehicle trips with transit more easily than suburban households. The accessibility data from the University of Minnesota, however, suggest that even in dense, transit-rich parts of California such a switch would likely impose a severe accessibility penalty. Table 3 compares a.m. peak-hour accessibility to jobs in Los Angeles and San Francisco by car and transit, and broken down by neighborhood poverty level. Even in the highest-poverty neighborhoods (which tend also to be the densest), automobile access dwarfs transit access (in Los Angeles by over an order of magnitude, and in San Francisco by a factor of five).

[9] We tabulate this by combining the NHTS "small town" and "rural" designations and the "second city" and "suburb" designations

Table 3. Job Accessibility by Neighborhood Poverty

Metropolitan Statistical Area	Neighborhood Poverty	Average Jobs Accessible by 45-Minute Transit Trip in AM Peak Hour	Average Jobs Accessible by 45-Minute Driving Trip in AM Peak Hour
Los Angeles	Most impoverished 10% of block groups	283,293 jobs	3,252,602 jobs
	Other 90% of block groups	136,825 jobs	2,723,181 jobs
San Francisco	Most impoverished 10% of block groups	358,316 jobs	1,536,449 jobs
	Other 90% of block groups	203,287 jobs	1,416,964 jobs

This access disparity does not mean that no peak period freeway auto trips in the six study MSAs could costlessly switch to transit. Nevertheless, based on these results, we assume for our analysis that such switching would be nonexistent.

Doing so lets us emphasize, again, the inclusive nature of our estimates. By our calculation 13% of the MSA households are both exposed and vulnerable, and 21% of those exposed are vulnerable. There is good reason to think these figures are high. Some of the trips we count as congested probably are not. Some auto trips could be replaced, by some people, with transit, biking or walking, and some new carpools could be formed. Some trips, similarly, could be completed easily by traveling at another time or another route, or choosing a similar but closer destination. These adjustments could move some vulnerable households entirely out of the exposed category, and could lower the toll payments of others. Because we have no good way to estimate these adjustments, however, we keep our larger, inclusive figure.

Equity Benefits of Pricing

Congestion pricing is an efficiency policy. As we have discussed, that efficiency, because it is achieved with regressive charges, could come at the expense of equity. There are two ways, however, that pricing might advance equity. The first is that pricing, by reducing freeway congestion, would also reduce near-freeway air pollution, and the health impacts that accompany it (Curry and Walker 2011). Disparities in exposure to near-freeway air pollution tend to be most stark in older American cities, where lower-income people are significantly more likely than others to live within 1,000 feet of a freeway (e.g., Manville and Goldman 2017). In urban California, income disparities in freeway proximity are not quite as large, as Table 4 shows using ACS data on the Los Angeles and San Francisco MSA. The poverty rate within 1,000 feet of a freeway is about one percentage point higher than the rate outside 1,000 feet. The benefits of cleaner air near the freeway are likely to still be progressive, however, because lower-income people are more likely to live in substandard housing with higher indoor-outdoor ratios, which allows more pollution in, and because lower income people are more likely to have other health conditions that air pollution exposure could complicate (Gaffney et al. 2021).[10]

Table 4. Households' Freeway Proximity by Poverty Level

MSA	Freeway Proximity	Income Below Federal Poverty Level
Los Angeles	Within 1,000 Feet of a Freeway	15.1%
	Greater than 1,000 Feet from a Freeway	13.8%
San Francisco	Within 1,000 Feet of a Freeway	10.0%
	Greater than 1,000 Feet from a Freeway	8.9%

Table 5 illustrates the second way that freeway pricing could be progressive: It could improve transit performance. Congestion on freeways delays any vehicle on those freeways, transit vehicles included. Most vehicles on freeways are not transit vehicles, of course, and most transit vehicles do not use freeways, so the benefits here should not be overstated. (For example: six LA Metro bus routes run almost entirely on the freeway; these routes represent 5% of the 112 routes Metro offers). Nevertheless, transit agencies in all of the six study

[10] Air pollution can lower rents, so it is possible that pricing, by reducing pollution, would make rents rise slightly. Little empirical evidence examines this idea, however: Most air pollution models examine sale values of property, not rents. See Chay and Greenstone (2005).

MSAs do run bus routes on freeways, and freeway congestion slows these buses down. Some of these buses run in protected lanes (carpool lanes or dedicated busways) but most do not. Many near-freeway bus routes, moreover, are slowed by spillover traffic that occurs because freeways are overloaded. (A number of bus routes, for example, travel on Sepulveda Boulevard in Los Angeles, a traffic-choked arterial parallel to the 405 freeway). Freeways with less congestion would speed up buses both on and near them, and buses are used disproportionately by low-income households. The fall 2019 Los Angeles Metro rider survey shows that the median household income of Metro bus riders was $17,975, compared to a countywide median household income of $72,977 (LA Metro 2019; U.S. Census Bureau 2019).

Table 5 estimates the potential travel time gains from congestion pricing, by comparing the scheduled travel times for p.m. peak-hour freeway bus trips to the scheduled times for early a.m. trips on those same routes. (Trips during the p.m. peak are the most congested daily trips, while early a.m. trips have little or no congestion). We analyze only the share of trips occurring on freeways, and show the ratio between the p.m. peak-hour and early a.m. trip durations for the largest transit operators in each metropolitan area. On average, traffic slows freeway-using buses by 23% in the six study MSAs. Congestion pricing may not reclaim all that difference, but could notably improve speed and reliability for riders, who are (again) disproportionately low-income, and may also speed up routes on nearby arterials.

Table 5. Transit Slowdown due to Traffic

MSA	Transit Provider	PM:AM Travel Time Ratio	Percentage of Time Spent in Congestion in Peak Hour
Los Angeles	Los Angeles County Metropolitan Transportation Authority	1.31	31%
Inland Empire	Omnitrans	1.28	28%
San Francisco	Municipal Transit Agency	1.21	21%
San Jose	Santa Clara Valley Transportation Authority	1.25	25%
San Diego	San Diego Metropolitan Transit System	1.26	26%
Sacramento	Sacramento Regional Transit District	1.07	7%
Simple Average		**1.23**	**23%**

Pricing can, in summary, have some progressive effects. But progressivity is not harm reduction. The presence of a progressive effect does not undo the damage of a regressive effect, at least not from the perspective of those hurt by the regressivity. A bus that runs faster does not help a low-income driver forced to pay a toll. Thus while the potentially progressive effects of pricing should not be discounted, they do not warrant ignoring the damage that could arise from its regressivity, which still must be mitigated. We turn to this issue next.

Protecting Low-Income Drivers

How should governments protect low-income drivers from tolls? Existing transportation policy offers little guidance. Because roads are generally free in the U.S., the few transportation programs oriented around redistribution usually have different goals, and take different forms, than the sort of relief that might be required by tolling. Subsidies to help low-income people buy cars, for example, address a large disparity in U.S. transportation access, but vehicle acquisition is a one-time capital purchase, whereas a road toll is an ongoing operating expenditure. Programs that assist with vehicle purchases, moreover, also suffer from small amounts of funding relative to need. Assistance offered to households to acquire a vehicle is usually offered via discretionary rather than entitlement programs. These programs are first-come, first serve, and often over-subscribed. They tend to use limited dollars to channel large benefits to relatively few beneficiaries, and leave many eligible households unassisted (Sheldon and Dua 2019).

An important difference between programs that help people buy cars and programs that help people afford tolls is that the former have no obvious revenue source, and the latter do. Tolls create a potential equity problem, but also create — through revenue — the solution to that potential problem. Raising revenue is not congestion pricing's goal, but any congestion pricing program will, as a byproduct of reducing congestion, raise a considerable amount of revenue.[11] The revenue can be used to help people whom pricing might harm. The revenue available, moreover, should be largely commensurate with the harm. One concern about congestion prices is that they can be dynamic, which means that, as they rise and fall, the burden they place on affordability can change. The revenue, however, will change with the burden. If tolls rise, more people might find themselves burdened, but more revenue should also be available for redistribution. The relevant question, then, is not where to find the money (often, one of the largest questions surrounding redistribution programs) but instead how best to use it.

More broadly, the equity problem pricing presents is serious but not unique: Low-income people are regularly exposed to market or near-market prices for essential goods (food, electricity, water, etc.). The primary approach to addressing this issue is some form of direct monetary assistance. The SNAP program is a model of this approach; low-income households are not exempted from food prices, but instead given an effective cash transfer that helps them participate in the private market. Arguably, congestion-priced roads would be less akin to private, competitive markets like food, and more like regulated monopoly markets such as utilities. In this regard, the income-support programs employed by utilities could become models adopted in some form for road pricing.

Utility assistance programs, like SNAP, are flawed; many have low enrollment, offer insufficient benefits, and can be cumbersome to apply for and administer (Herd and Moynihan 2018). Their basic premise, however, is sound: In situations where a price signal is necessary to efficiently allocate use of a vital good, but where that price might present problems for some users, some of the payments made by most users can be used to subsidize consumption by vulnerable people.

[11] See Manville and Wachs (2018) for a rundown of operating costs and expenses in major pricing programs. All operate in the black.

Moreover, assisting low-income drivers in congestion-pricing programs may also be easier than delivering utility assistance, for a few reasons. One reason, alluded to in the introduction, is that some existing utilities, because their service area maps almost directly onto the boundaries of low-income cities, have high proportions of households in need. In such circumstances, redistribution is difficult: When the majority in a group needs assistance, there is no obvious reservoir of revenue from which that assistance can be drawn. Even in situations where some redistribution might be feasible, moreover, many utilities must contend with incomplete, aging (and sometimes out-of-date) metering and pricing methods. Neither of these circumstances would apply if freeways were priced. Freeways cover entire labor markets, including the rich and the poor, and because pricing is new presumably the metering methods would also be new, and up to the task of tracking use.

A further point is that utilities, compared to road agencies, operate under different and stricter logistical and legal constraints, and have more intrinsic demands on their revenue. Utility pricing is governed, by both necessity and law, by a "cost-causation" or "benefit" principle: The price of a good or service should reflect the cost of delivering that service to a particular class of user or customer (Beecher 2020). Logistically, the cost causation principle is understandable: If utilities do *not* follow this principle, they cannot produce the service, or at least not reliably produce it for long periods. An electric utility that does not charge users for electricity will not be able to produce and distribute electricity, unless it is somehow subsidized from another source.

On one level, the cost causation principle is fair: If households want to use a scarce resource, and particularly one that has substantial negative externalities for the environment, they should pay for it. Carrying the cost causation principle to its literal end, however, means that low-income households could spend more on utilities than what is commonly considered "affordable" based on their income level (Meehan et al. 2020).

An obvious implication of this concern is that utilities should *not* carry the principle to its literal end, but utilities are sometimes prevented by law from departing from cost causation. The cost causation principle has been enshrined in utility pricing practice and in California is mandated by statutes like Proposition 218, which applies to public-owned utilities. Laws of this sort prevent cross-subsidies on the basis of household income: A publicly owned electric or water utility cannot, for example, charge a lower rate to a lower-income household and make up the lost revenue by charging a higher-rate to a higher-income household. Privately owned utilities have more leeway, and in California private utilities run programs — CARE and FERA — that offer discounts on the bills of lower-income households. CARE, for instance, gives qualifying households a 30% to 35% reduction in their electricity bill, and a 20% reduction on their natural gas bill. Even privately owned utilities, however, are constrained by cost-causation, which often manifests in their negotiated revenue requirements.[12]

The upshot here is that many utilities, when they try to account for affordability, cannot do so by offering some people lower prices, and the amount of monetary relief they do offer is limited by the other demands on their revenue (Pierce et al. 2021; Brown et al. 2020). Even the CARE program bumps against these constraints: Utilities must raise the rates of the state's other electric customers to cover the program's costs (Borenstein et al. 2021). Broadly, utilities try to address affordability through four means: efficiency programs (helping people find ways to use less, and thus be charged less), low prices for basic consumption (such as tiered rates, described below), income-based assistance programs, and crisis relief (preventing utility shutoffs when a household falls

[12] The term "revenue requirement" is used to describe the amount of revenue a utility needs to recover its costs and realize an authorized rate of return. The level of revenue requirement, and its components, are typically highly scrutinized and negotiated between a utility, a public utilities commission, a ratepayer advocate and other intervening parties.

behind on payments). The breadth and depth of implementation of these strategies varies greatly across utilities (Pierce et al. 2020; Brown et al. 2020).

For our purposes, two points are salient. First, three of these approaches are reasonably analogous to approaches that could be used with congestion pricing (the exception is crisis relief — there is no easy analogy between road pricing and a situation where a household has its water or electricity completely turned off). Second, congestion pricing programs need not be constrained in the way other utility assistance programs are. A key difference between roads and other network infrastructure is that road providers do not need to physically produce anything for each new user (Manville and Pinski 2021), so there is no obvious demand on congestion pricing revenue beyond the cost of administration. This cost varies, but in Singapore (the closest analogy to what we consider here) it amounts to about 25% of revenue. Because the risk of being unable to produce the good is basically nonexistent, moreover, road agencies are unlikely to be subject to legal constraints like Proposition 218 or other revenue requirements.

In what follows, we discuss four potential equity guardrails that governments could consider when rolling out congestion pricing: subsidizing transit, offering lower rates to lower income people, offering payment assistance to lower-income people, and introducing pricing lane-by-lane.

Subsidizing Transit

Perhaps the most common proposal for making congestion pricing fair is dedicating some of the toll revenue to transit. The logic behind this proposal is that drivers as a group are disproportionately affluent, while transit riders as a group are disproportionately poor. Transferring money from drivers to transit riders is therefore progressive. The problem with this logic, again, is that it confuses progressivity with harm reduction. Helping a transit rider may be progressive, but it does not help the traveler that pricing harms — the low-income person who for whatever reason *cannot* use transit. Low-income people are not interchangeable, so help to one does not offset harm to another.

To be sure, in some situations dedicating revenue to transit could improve service to the point where a low-income driver could easily switch to transit and avoid a toll. But this outcome is far from certain. Using toll revenue to finance transit is progressive because drivers are an on-average higher-income group and riders are an on-average lower-income one. The within-group variance in income for both groups is high, however, so spending on transit could help higher- rather than lower-income people (Manville and Goldman 2018). Using toll revenue to improve transit could deliver a better ride to a high-earning person who has long used commuter rail, for instance, rather than make it feasible for a lower-income driver to change modes. Even if the latter outcome occurs, allowing some drivers to switch easily to transit, it will likely take time, and in the interim the low-income drivers will be harmed by tolls.[13]

[13] When such a change does occur, using toll revenue to support transit can be considered analogous to electric and water utilities promoting conservation, and thus helping low-income consumers by making it easier for them to reduce consumption.

Overall, while we see nothing wrong with using toll revenue to fund transit, we do not consider it a step that mitigates pricing's potential harms.

Lower Prices for Lower Incomes

A second option is to hold prices down for lower-income drivers. At the extreme, a pricing program could exempt low-income drivers from tolls. The notion of making an essential good or service affordable by keeping it free is intuitively appealing. It also has the benefit, at least superficially, of simplicity. But making a service free for a group, if that group is large enough, risks undermining the supply of the service for everyone. The entire premise of congestion pricing, after all, is that when roads are unpriced urban areas are prone to shortages of them. If enough people qualify for payment exemptions, that good becomes prone again to overuse, and can paradoxically become *less* accessible. We see this most evidently in some urban areas of low- and middle-income countries, where introducing a charge for utilities helps low-income households get better service, whereas making services "free" has led to less equitable outcomes, degrading service quality for all (Burgess et al. 2020).

A related problem is that blanket exemptions for specific people are prone to abuse: People will try to fraudulently acquire them, and people who acquire them legitimately might share them with others or sell them on secondary markets. Disabled parking placards offer a prominent example of this problem. Placards are ostensibly reserved for people with disabilities, to protect them from parking pricing. The placards, however, are often distributed to people without disabilities, and even many placards initially distributed to people with disabilities often end up in the hands of nondisabled people, either through illegal trades or just being passed around (for instance, everyone in a household using the placard assigned to the elderly family member (Manville and Williams 2013)).

Misuse of exemptions can at best undermine confidence in income-protection programs, and at worst undermine pricing itself, if the misuse is heavy enough to generate shortages. The latter can occur if exemptions are easy to get, as is the case with parking placards, which do seem to undermine efforts at pricing the curb (Manville and Williams 2011; SFMTA 2014; Chatman and Manville 2017; Manville and Pinski 2021). It can also occur if the exempt group suddenly grows substantially. London, for example, exempted taxis from its cordon charge in 2003, which seemed like a reasonable decision given that the size of the taxi fleet was strictly regulated. The rise of ride-hailing services, however — unforeseen when the exemptions were approved but ubiquitous 10 years later — led the number of exempt vehicles to skyrocket, and reduced the cordon charge's effectiveness (Badstuber 2018).

In lieu of exemptions, governments can use tiered pricing to protect low-income consumers. With tiered pricing, a service provider charges more per unit of consumption as consumption increases. The first few units of consumption are very inexpensive, the next set slightly more expensive, and so on. Tiered pricing is common in utility provision — nearly ubiquitous among energy providers and increasingly common with water in California (Allaire and Dinar 2022). In part, tiered pricing's appeal lies in its ability to address affordability while still adhering to cost-causation principles and rules. Charging more for every user as use increases can conserve resources (by discouraging high levels of use) and advance equity goals (if household income and consumption are positively correlated, then in practice lower income households will pay a lower rate for a larger share of their consumption). The low initial price is often called a "lifeline rate", based on the idea that the first tier keeps some necessary amount of consumption affordable.

For most utilities, the primary problem with tiered pricing as an equity strategy is that variance in income does not fully explain variance in consumption (Cook 2020). Some high-income households consume relatively little, and some low-income households, for different reasons, end up consuming more. Tiered pricing thus risks delivering a low rate to some households that do not need it, while leaving some burdens on low-income households unmitigated.

The same problem would likely exist if tiered prices were used to mitigate congestion tolls. A larger and additional complication, however, would arise from ambiguity around the unit of purchase. With electricity, the intuition behind tiered pricing is straightforward: Consumers buy kilowatt hours of electricity, the utility charges the low lifeline rate for first kilowatt hours consumed in each billing period, and then a higher rate for kilowatt hours purchased thereafter. If governments in California were considering basic road charging, such as a per-mile fee (a VMT charge) this logic would translate nicely. The first block of miles a household drove would be charged at a lifeline rate, and additional miles at a higher rate. Because lower-income households drive less, on average, than higher-income households, a tiered rate could let a greater share of a low-income household's miles be purchased at a lifeline rate.

The problem posed by congestion tolls is that it is less obvious what the buyer is purchasing. Prices may be charged per congested mile, but because the price is determined largely by the level of congestion, any two congestion-charged miles a driver purchases may have very different social costs. If the rate structure does not account for this complexity, a tiered program could backfire, and undermine pricing's efficiency goals. One could imagine, for instance, that with tiered prices early in each month a large number of people would face an artificially low rate to travel on the 405 freeway in Los Angeles at rush hour. Given the fixed quantity of the 405 at rush hour, this situation could create congestion. While this problem may not be insurmountable, it is a complication, and one that is less relevant to utilities that can increase supply when necessary.

Direct Assistance to Lower-Income Drivers

A common argument in microeconomics is that when some people have trouble affording efficiently priced goods, the best solution is not to depart from the efficient price but to instead give people who can't afford it money. If a congestion charge represents a correct or almost-correct price to use the road (in that it ensures that road space won't suffer shortages), then governments worried that some drivers will not be able to afford that price should help them pay it, rather than try to lower it. An analogy here would be SNAP, or the Section 8 housing voucher program. Participants in these programs do not pay lower prices for vital goods, but instead receive government assistance to help them pay market prices.

At least conceptually, such a program, if applied to congestion pricing, could be simple. Suppose all the freeways in Los Angeles County were congestion-charged, with the charges being collected primarily via in-vehicle transponders. Every month, each household in the county below a certain income threshold (for instance, 200% of the poverty level) would get some cash, regardless of whether they used the freeway. The cash could be delivered via a bankcard (as SNAP is) and paid for out of the toll revenue. Recipients could use the cash for anything, including but not limited to traveling on priced roads.

Such a program would offer two advantages: It would be non-paternalistic and neutral with respect to mode. Distributing a certain amount of cash each month allows low-income families to decide for themselves how best to allocate their money, and avoids the common problem of conditioning program assistance on the behavior the program seeks to reduce — in this case driving at high-demand times when the risk of congestion is high. If a low-income household has no choice but to drive at busy times, the income support helps offset the burden of doing so. If, however, the household can figure out a way to make that trip by bus, foot or bicycle, it does not forfeit the assistance; instead, it just has more cash to use for other purposes. The cash helps cover the cost of driving at peak hours, but also gives that behavior a tangible opportunity cost (a household that drives at peak hours eats into its cash), and thus directly rewards substitution away from it.

In being non-paternalistic, moreover, a cash transfer program reduces concerns about fraud. Suppose that instead of distributing cash each month the government gave low-income households special toll transponders exempting them from prices. An obvious concern with such a program would be that these special transponders would be passed around, or even traded on a black market. The special transponder would deliver no help to low-income people who do not drive, and might end up being an illicit windfall for many non-poor households that do drive. A cash distribution each month, however, is finite. If a low-income household wanted to share some of its cash with a neighbor, nothing would stop such an action. But because it is cash, and finite, it runs out. One person using it means someone else has less. The problem of an exemption credential circulating and undermining pricing would thus be avoided.

A cash transfer program is conceptually simple, but would likely face obstacles in becoming a reality. Certainly, it is an expensive approach. Given the multibillion-dollar estimates of pricing's revenue streams in California (see Manville and Goldman 2018 for a discussion), and the aforementioned lack of intrinsic demands on that revenue, a large program could likely be supported fiscally. The price tag may, however, cause elected officials to balk, especially if other interests are vying for revenue, as they likely will be.

A logistical challenge is that for a program of this sort to work optimally, it would probably require the cooperation of the state's Franchise Tax Board (FTB), the state agency with information on everyone's income. FTB data could be used to determine eligibility, and ideally it could be used to automatically opt eligible households in. The FTB is not generally involved in social service programs, however, and because congestion charges are not legally taxes, it would also probably not be involved in collecting toll revenue. The obstacles here should not be insurmountable, but they also should not be minimized. We consider this the ideal method for protecting low-income travelers, but we acknowledge that cooperation between state bureaucracies, along with a heretofore unseen taste for redistribution, would be essential in making it work.[14]

If direct, automatic opt-in redistribution from the state is impossible, there are two alternatives to consider. First, low-income households could apply to the agency that oversees tolling, and that agency could verify their income and get them signed up for assistance. So, again, supposing that freeways in Los Angeles County were priced, applicants could submit paperwork to the county, and then begin receiving monthly payments. A disadvantage of this approach is that it pushes some costs onto the applicants — they need to know the program exists, and navigate the process of signing up — and this would inevitably lead to some qualified households being excluded (Herd and Moynihan 2018). An advantage is that the county is the level at which human services are

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[14] If the FTB were willing to be involved, another possible equity program could involve lower-income households receiving rebates through the tax code on their toll payments, with some of those rebates exceeding their payments--in much the same way low-income workers receive rebates through the Earned Income Tax Credit.

administered and distributed, so once people are signed up there would be an existing framework for giving aid.[15] A pricing-protection program could piggyback, for example, on the existing apparatus for distributing SNAP. Indeed, eligibility for SNAP, or for similar programs (utility assistance, or housing subsidies), could be treated as automatic eligibility for tolling assistance.

The other, most-restrictive alternative would be to have low-income people sign up for pre-loaded toll transponders. These transponders would *not* exempt anyone from prices, but would instead be electronically credited at the beginning of each month with a certain amount of money. A program based on pre-loaded transponders presupposes the availability of such a device. Transponders pre-loaded with credit have seen little use in the U.S., but they do exist, and have been used, for example, in South Africa to provide pre-paid water utility service (Von Schnitzler 2008).[16] The advantage of this sort of program, compared to the more universal program described above, would be its administrative simplicity; the government would not need to consider low-income people who did not drive on priced roads. This approach, however, would also mean the program would lose its neutrality with respect to mode, and would on the margin favor driving. People who chose to ride transit or walk would not get program benefits from doing so. This program would also, compared to the automatic opt-in, have more barriers. Low-income people would need to apply for the program.

An approach that probably should *not* be pursued is a local revenue return program. Some programs address affordability concerns by having the state redistribute money not to individual households, but instead to local agencies, in the hope that these agencies can identify and assist vulnerable users in their jurisdictions. Such programs are popular with elected officials, but they offer little assurance that revenue will reach the people who need it, and present a real risk that revenue will instead be diverted. Creating new, middle-man recipients, furthermore, risks creating new political players that can distort the program's purpose in the future.

One issue we have not discussed is the actual level of benefit that vulnerable households might need, and how precisely that benefit should be structured. One could imagine a circuit-breaker style program that imposed a simple upper limit on expenditures or limited expenditures relative to vulnerability (e.g., did not allow toll payments to rise above a certain percentage of household income), a program that estimated average monthly toll payments for a region and redistributed enough to complete a certain amount of travel (for instance, 20 peak-hour trips per month) or even a program that just sought to deliver the most generous subsidy possible given the revenue available. There is probably no single correct answer here: What constitutes "affordability" is an inherently normative judgment where people can reasonably disagree. We see a wide variety of definitions and approaches in income-support programs for housing, water, and energy sectors (Cook 2020; Pierce et al. 2020). Our point in the discussion above is simply that — whatever the benefit level — delivering that benefit is feasible with congestion pricing.

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[15] This is another difference between assistance for priced roads and utility assistance. Utilities have no way to verify income, or experience doing so. In many cases, as a result, utility assistance is determined based on a declaration by the customer that their income is low. A county has a better existing infrastructure for checking income. If a driver declares themselves low-income, the county should be able to quickly verify if he or she is also signed up for SNAP or other benefits. Verification of this sort would not eliminate all problems of determining eligibility, but would reduce them.

[16] A related consideration is that transponders themselves might be expensive, but toll agencies could offer them at a discount to lower-income households. LA Metro, for example, already does this for its HOT lanes. If a transponder requires connection to a bank, that could present a problem for unbanked households, but this problem can be avoided by using transponders that load with debit cards, rather than requiring credit cards or checking accounts.

Gradual (Lane-by-Lane) Congestion Pricing

A final approach to addressing equity, one first proposed by Klein and Fielding (1997), and elaborated on since (formally by Hall (2018, 2020) and informally by Manville (2021)) involves introducing pricing lane-by-lane. For the same reason there is no real analogy between utility crisis relief and congestion charging, there is no applicable analogy from a technical or equity perspective to this type of gradual pricing for utility customers. With other utilities, every household has its own piece of the infrastructure — a single or shared meter — and that piece constitutes its point of access to the service. With freeways, in contrast, the privately controlled equipment that accesses the system is an automobile. The freeway doesn't come to the house; the household uses a car to access the freeway.

This distinction matters. It could be difficult, for example, to gradually introduce water or electric meters in a manner that users considered fair. Every house or building has its own meter, so gradually introducing meters would mean a period of charging some households for all their consumption of a service while charging other households nothing to consume exactly the same good. Gradually pricing the freeway network, in contrast, treats all users of that freeway the same. No household is singled out, and involuntarily charged before others for using the same facility. This fact opens up an opportunity to have a transition period, where priced roads exist literally side-by-side with free roads.

Many urban areas in California (and elsewhere) already have some HOT Lanes. One way to introduce pricing with equity in mind is to slowly expand these programs. We will again use Los Angeles as an example. Right now, there are HOT lanes on two Los Angeles freeways. Los Angeles could begin congestion pricing by converting the HOT lanes entirely to toll lanes (i.e., carpools would not be free anymore) and also by converting two free lanes on every other freeway to congestion-priced lanes. Doing so would create a congestion-priced network, but would also leave, on the entire network, at least two and three or more lanes free.

In this situation anyone willing to pay for a faster ride could do so — and some of the revenue could be used to help the lowest-income drivers afford tolls — while anyone unwilling to pay would still have free lanes to choose from. Those in the free lanes, moreover, would see a demonstration of pricing in action.

The key is that after a period of time (maybe a year, maybe 18 months) the government could convert a third lane to priced management. After another year, it could convert the fourth lane. Full congestion pricing could thus be slowly rolled out, over the better part of five years. As more of the road became priced, there would be fewer free options, but there would also be more revenue available to help offset the burden for lower-income drivers.

More people, furthermore, would have time to prepare. New expenses are more burdensome when they are sudden, especially for those with low incomes. Time, however, allows for learning, coping and substitution. A yearslong rollout lets many people adjust in myriad ways. People who were planning to move anyway can locate closer to their jobs. Carpools and transit routes can be experimented with. When families need new cars, they can choose to spend slightly less, and buy a car with a lower price tag and better fuel efficiency, and in so doing reserve some of their previously allocated transportation budget away from the capital cost of a car and toward the operating cost of tolls (Manville 2021).

Importantly, the lane-by-lane approach does not preclude other strategies. A lane-by-lane system could still offer redistribution, for example, but the revenue base would be lower, so the redistribution would be less generous while some lanes remained unpriced. At the same time, however, the redistribution would presumably be less necessary, since drivers could still drive the exact same route in free lanes.

Conclusion

Congestion charges are regressive user fees, and as such present a potential equity problem for low-income road users. We estimate the size of this group of users in metropolitan California and consider ways to assist them. The group is large (about 13% of the study population) but not inordinately large compared to populations that qualify for assistance for other essential services, such as food or energy. The fact that priced roads would not need to reserve some revenue for production, moreover, suggests that ample revenue would be available to protect low-income users.

Our analysis, then, suggests that congestion pricing can be introduced in a manner consistent with concerns about equity and fairness. In this report we have reviewed, at a broad level, different approaches for doing so. The textbook approach, which we endorse, is to price freeway lanes according to demand (a performance price) but use a portion of the toll revenue to assist the low-income people who those prices might burden. The optimal way to deliver this assistance is via a cash transfer that every person below a certain income threshold is automatically opted into. Such an approach would protect low-income travelers while being neutral with respect to mode: It would provide assistance to people who drove at peak times, but it would not *condition* assistance on doing so. To the extent administrative obstacles make such a program infeasible, we recommend either a program that opts people in at the county level, perhaps by piggybacking on existing social service programs, or using a narrower program that distributes pre-loaded toll transponders to low-income drivers.

Any of these approaches, moreover, can be paired with a program that gradually introduces pricing, leaving some lanes free as others become priced, and thereby preserving a free option while transitioning toward pricing.

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