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EQUITY OF EVOLVING TRANSPORTATION FINANCE MECHANISMS

**The Empirical Research on the Social Equity of Gas Taxes,  
Emissions Fees, and Congestion Charges**

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# The Empirical Research on the Social Equity of Gas Taxes, Emissions Fees, and Congestion Charges

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This manuscript summarizes the empirical research on the effects of transport user charges and taxes on low-income households. In the first section, I describe how finance fits into two emerging fields of equity research: social exclusion and environmental justice. These two fields inform why researchers should be concerned with finance and pricing beyond basic tax fairness principles from public finance. After that discussion, I assemble the empirical estimates from the research and draw some lessons both for policy and analysis. General gas and emissions charges are expected to cost low-income households about 0.2 percent of their annual income, without tax shifting. High-occupancy toll (HOT) lanes—a premium transport service—are expected to cost roughly the same, while comparatively high, comprehensive tolling schemes designed for vehicle miles traveled (VMT) reduction have estimated out-of-pocket costs at about 5 percent of household income for lower income households. Studies that consider benefits as well as costs tend to tell a different story: some toll schemes are beneficial to low-income households both in terms of congestion relief and air quality benefits. The manuscript ends with a critique of the methodology and concepts, including a conceptual frame for multi-level, geographic analysis and for broadening the scope of finance equity.

## INTRODUCTION

Change is clearly afoot in transportation finance. Environmentalists commonly reject the idea that cheap automobility is good for economic growth, impoverished Americans or urban environments; many argue that there should be a ‘green tax shift’ that lightens personal income taxes in favor of taxes that penalize polluters and encourage pro-environmental behavior. Previous US and European leaders have pressed user charges for roadways—formerly assumed to be a political dead-end—under the rubric of privatization and revenue enhancement after seemingly successful experiments with cordon tolling in London and Stockholm (1). How socially equitable or responsible any of these changes in transportation finance would be, however, remains a significant topic of debate both in scholarly and practitioner circles (2–6).

This manuscript examines the previous research to do three major things:

1. To place the research on tax incidence within the larger scope of equity research in transportation;
2. To summarize the data, methods and estimates for how much income groups pay under different revenue instruments; and
3. To identify places where the research currently overlooks significant distributional issues related to finance.

The theory of transport finance equity tends to draw from traditional conceptions of horizontal and vertical equity from public finance. However, transportation taxes and fees affect both social inclusion and environmental justice, two emerging fields of social justice research. In the first part of this manuscript, I describe how charging, or contrastingly, *not* charging, for mobility services affects both environmental justice and social inclusion in the way that it affects the distribution of opportunities on the one hand and environmental costs on the other.

In the second section of the manuscript, I set aside the larger theoretical discussion in favor of summarizing the empirical studies of transportation taxes, fees and charges. Empirical studies have converged on a basic range of estimates for how much different income groups pay, even though the studies involve significant variations in method, data, and assumptions. Low-income drivers pay, on average, somewhere between 0.1 to 0.5 percent of household income for most proposed taxes and fees as they are spread across a large tax base of drivers. Fairly high, comprehensive tolling schemes which affect a smaller subset of drivers are expected to take a higher percentage, as much as 2 percent of household income for those with under \$25,000 a year. Yet low-income drivers are expected to be a small portion of premium transportation service users in most metropolitan regions. All of these outcomes depend on the geographic context and the choices available to low-income motorists, as some toll applications have been found to be progressive, depending on the geographic context and the implementation (6, 7).

In general, the variation in empirical estimates tends not to reflect major differences in study quality or methodology. While some studies are more comprehensive and detailed than others, studies tend to use similar data, defensible methods, and reasonable assumptions. The three key methodological differences concern whether the study (*a*) accounts for shifting (most do not); (*b*) considers geographic context and supply/quality of alternative modes; and (*c*) measures impacts in terms of drivers or entire tax bases. Even with these differences, most variation derives from differences in policy instrument design and revenue usage. There are no easy answers in the research for those looking to justify simplistic, one-note policy stances such as “if we price the freeway, the poor will suffer.”

While studies of tax incidence have been informative, the research focuses on money costs and low-income motorists. This focus directs the policy discussion away from many salient distributional issues. In transportation finance, we routinely hear that congestion pricing will “price poor drivers off the road,” but we almost never encounter comparable discussions of the extent to which drivers or transit riders are, in the absence of explicit monetary prices for driving, “delayed off the road” or “delayed off the bus” or “polluted into purchasing an air filter or taking an additional sick day.” The focus on low-income motorists has caused research and policy to ignore rising transit fares in major metropolitan regions, the distribution of the externalities associated with road transport, the potential effects on low-wage workers in freight transport, and the inequities that may result in other policy realms from the failure to “pay as we go” for transportation services.

## **DISTRIBUTIVE JUSTICE RESEARCH IN TRANSPORTATION FINANCE**

Most of the research in transportation and social welfare concerns distributional outcomes: the question of who gets what. The research on distributive social justice in transportation occurs primarily in three fields: social exclusion, environmental justice, and the major topic of this manuscript, tax incidence. The research on social exclusion addresses the extent to which

mobility limitations—either physical or financial—affect the distribution of individuals' access to social and economic opportunity. Because taxes and user charges can raise the costs of gasoline or transit fares, they can create (or lower) financial barriers to mobility, and by extension, to social inclusion (8). The research on social inclusion in the United States is perhaps best represented by the large literature on spatial mismatch.

Environmental justice research and activism have raised awareness about the distributive consequences—particularly for impoverished communities of color within metropolitan regions—of the external costs from transportation-related pollutants (9–16). Other types of external costs, like noise and pedestrian crashes, have also been shown to be higher in low-income communities than in more affluent neighborhoods (9). These costs can be measured by additional sick days or expenditures on items and services like air conditioning or air filters. Because of these types of costs, the social equity question arises from *failing* to expect motorists, low and high-income alike, to consider the external costs of their choices, and thus enabling travel over and above a social optimum in a way that decreases the welfare of others.

The tax incidence research, by contrast, asks how much individuals and groups pay under different finance methods relative to other groups. This research examines the regressivity or progressivity of tax payments and revenue allocations (17). Regressive taxes or fees ask low-income individuals to sacrifice a comparatively larger percentage of their resources to pay for taxes (usually measured in income) than is required of those with higher incomes. Progressive taxes, like a graduated income tax, take an increasing percentage of income as income increases overall. These definitions are inverted in the case of tax allocations rather than costs. Incidence research tends to ask a very different question than social inclusion research: do socially marginalized groups, particularly class minorities, pay a disproportionate amount of their income for a tax? Most taxes, save for the graduated income tax, are regressive in terms of out-of-pocket costs. It is possible for a tax to be regressive, while revenue distribution may be progressive, so that low-income individuals may pay-in disproportionately *and* benefit disproportionately. It is important to maintain the distinction between social exclusion and tax incidence because regressivity and progressivity are general measures of tax fairness, not proxies for whether mobility is affordable overall. Gas taxes have been found to be regressive, in general, but with an out-of-pocket cost estimate of \$180 a year per household per car, the Federal gas tax is hardly a prohibitive sum.<sup>1</sup>

However, tax and finance structures affect relative prices among modes and thus can influence both the overall affordability of mobility—the social inclusion concern—and the amount/type of driving going on—the environmental justice concern. The policy goals surrounding all of these issues can and do conflict, depending on the context and the policy design. Among the most significant equity concerns over congestion pricing is that low-income motorists will have to forego trips. With tolls, mobility on congested roadways would become less affordable, creating a barrier to social inclusion for low-income motorists and their families. But by protecting low-income motorists from financial barriers to mobility by refusing to charge any drivers at all, policy may burden communities with excess emissions and surface traffic. The results from the environmental justice research suggest that these costs are distributed unequally as well, so that by not pricing trips off the road, policy burdens low-income communities.

Though most of the studies in tax incidence examine the distribution of the out-of-pocket costs associated with pricing, the best studies acknowledge the role that prices play in altering

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<sup>1</sup> It is important to remember that this is not the total operating expense associated with gasoline or with mobility, or even the total transport tax burden, which would include state and local taxes, registration fees, and tolls.

the distribution of both mobility overall and the external costs associated with that mobility. Unfortunately, there are very few empirical studies that take such a comprehensive view; instead, the preponderance of the research looks at out-of-pocket costs alone. It is to these studies that I now turn.

## **EMPIRICAL STUDIES OF TAX AND TOLL INCIDENCE**

From the existing research, I assemble roughly 50 studies on the incidence of gas and energy taxes, emissions fees, vehicle registration charges, user charges, and transit fares. As I discuss in the conclusions, there are virtually no studies on transit fares. The research is for the most part dominated by forecasting and estimation studies designed to look for the effects of policy changes rather than empirical elasticities of behavioral changes.

### **Data and Methodologies**

A summary of the data used in tax incidence appears in [Table 1](#). Most transportation studies are estimates based on representative household profiles constructed from

1. General household expenditure survey data (18, 19) or
2. Travel demand data either generalized from a national travel survey (20) or regional travel surveys (6, 21–23).

A few studies use revealed preference survey data from either existing or proposed facilities or stated preference information from proposed policy changes (18, 24–25). Other studies use zone-based models to derive representative consumers.

In these studies, researchers have generally had to limit the strata by which they study cost and benefit incidence. Consumption studies that do break out potential user populations by income tend not to stratify by other characteristics associated with social exclusion. This problem reflects data limitations: few regional travel surveys stratify samples to represent user groups in each mode, such as ethnicity by driving status, within income groups (three strata). The major Federal travel-related datasets (National Household (Personal) Travel Survey, American Community Survey) do collect sufficiently large samples but those may not generalize well to regions.

Two English studies stand out as a means to address these limits. A methodology called the “Pop-Gen method” was developed and applied in Leeds as a means to use small-scale area statistics available from the central population census. The method uses the existing distribution of particular population characteristics, notably those associated with disadvantage like age, disability, language, etc., to construct Monte Carlo simulations. The simulations bootstrap a distribution of the most likely travelers from particular zones (39). The representative travelers are then assigned to likely links, including the priced roadways, according to a standard traffic assignment algorithm. The method offers the opportunity to examine comparatively disaggregate spatial effects and dimensions of social exclusion with statistical robustness. However, it also entails the standard problems with small-number and small-area statistics.

**TABLE 1 Data Sources for Transportation Finance/Pricing Equity Studies**

| <b>Data</b>                             | <b>Source</b>                       | <b>Studies</b>  | <b>Methods</b>                                      |
|---|-------------------------------------|-----------------|---|
| National Personal Transportation Survey | Federal Highway Administration (26) | (20, 27, 28)    | Demand system estimation                            |
| Consumer Expenditure Survey             | Bureau of Labor Statistics (29)     | (18, 19)        | Choice models, household account methods            |
| Emissions data                          | California Air Resources Board (35) | (19, 28)        | Regression  |
| Studies of existing facilities          | SR91, I-15, London                  | (18, 19, 30-34) | Choice models                                       |
| Region-wide Traffic data                |                                     |                 |   |
| Paris                                   |                                     | (36)            | Choice models                                       |
| Washington, DC                          |                                     | (37)            | Zone models   |
| Stockholm                               |                                     | (38)            | Zone Models   |
| San Francisco                           |                                     | (22)            | Choice models                                       |
| Leeds, Bristol                          |                                     | (6,21)          | Pop-Gen, Aggregate zonal models, interview analysis |

There are also unique opportunities to collect original data. A second study used focus groups and interviews to discuss the potential effects of a proposed user charge in Bristol (24). The resulting manuscript reported the challenges that elders perceived from increased trip costs. As with interview studies, this method allows for gathering in-depth, original data on how individuals view the probable effects of policy changes given their contexts and needs, including traffic spillovers and their ability to pay or substitute less-expensive modes (39). However, the method shares the same limitations common to all stated preference methods: what individuals imagine their responses would be to a hypothetical change may not be what they actually do. Respondents may not have experience with the tax or policy change they are discussing.

### **Estimates of Gas Tax Cost Burden by Income Strata**

In general, studies that estimate incidence tend to do so for different variants of the same type of finance charge: studies will examine cordon tolls of different sizes, at different toll levels, or with different revenue allocation schemes rather than testing really different instruments, such as a sales tax against a traditional on-system charge. Table 2 summarizes the findings from studies on existing taxes and user fees. This is not a comprehensive listing of all the studies. Those listed are recent, and they represent those analyses where the estimates could be either reported or imputed to three groups: low, medium, and high incomes.<sup>2</sup>

<sup>2</sup> Studies vary in how they divide income strata. Some studies group by population distributions at various income levels and draw four groups, five groups, or ten groups. Other studies use equal income increments, regardless of the populations in each stratum. For studies with ten strata, for example, I combined the estimates for the first three, the middle four, and the last three, and I use the same general approach for five strata studies. Clearly, aggregating the studies introduces additional error, and I do not want to overstate what we can conclude. However, it is really difficult to draw lessons from the studies unless we can put them together. So I tolerate the potential error to look for patterns in the findings we have so far.



**TABLE 2 Percentage of Income Paid/Gained with Registration Fees and Gas Taxes**

| Study                         | Finance Mechanism  | Considers Revenue or Benefits? | Percentage of income or expenditure |                  |                      |
|-------------------------------|--|--------------------------------|-------------------------------------|------------------|----------------------|
|                               |  |                                | Rough Income Group                  |                  |                      |
|                               |  |                                | Low incomes (<\$25K)                | Medium incomes   | High incomes (100K+) |
| <b>Registration fees</b>      |  |                                |                                     |                  |                      |
| Dill et al. (1999) (27)       | Vehicle registration graduated by income                         | No                             | -1.7 %                              | -0.59 %          | -0.10 %              |
| Walls and Hanson* (1999) (28) | Existing vehicle registration fee                                | No                             | -0.44 to -0.57                      | -0.68 to -0.55   | -0.53 to -0.46       |
| <b>Gas taxes</b>              |  |                                |                                     |                  |                      |
| Bento et al. (2005)** (20)    | 30-cent gas tax increase, all households, tax-based recycling    | Yes                            | -0.103                              | -0.108 to -0.098 | -0.092               |
|                               | 30-cent gas tax increase, car owners, tax-based recycling        | Yes                            | -0.110                              | -0.110 to -0.098 | -0.092               |
|                               | 30-cent gas tax increase, no-car households, tax-based recycling | Yes                            | -0.084                              | -0.089 to -0.099 | -0.091               |
| Devarajan et al. (1980) (41)  | 50 percent gas tax increase with 6 percent rebate                | Yes                            | +0.01 to +0.03                      | -0.06 to -0.04   | +0.01 to +0.21       |
|                               | 50 percent gas tax increase                                      | No                             | -0.55 to -0.125                     | -0.34 to -1.15   | -0.16 to -0.73       |

\*Percentage of lifetime income rather than annual income

\*\*Equivalent variation, using reported income as a benchmark

A cursory review of these results confirms that transportation finance tools are regressive in terms of out-of-pocket costs. Graduating vehicle registration fees by emissions tends to increase how much lower income drivers pay. Both studies on registration fees use data for California, and they find that the cost burden of the registration fee averages about 0.56 percent of household income per year across all income groups—a comparatively small amount at existing tax levels.

Like registration fees, gas taxes are common, but I did not find a baseline study of incidence that would work for comparison. The two gas tax studies reported here are not measures of existing taxes. They are analyses of policy changes. They have multiple policy designs, and they find that gas taxes can be somewhat less regressive than other tools, but that the total burden from the gas tax can be high depending on the design of the tax and revenue scheme. Revenue “recycling” concerns the use of tax revenues to either lower other taxes or to provide rebates on the tax in question (40). Recycling based on gas tax payments was found to be less regressive than recycling based on income. One study found an inverted U-shaped distribution, with middle-income groups paying a higher percentage than either high or low-income groups, and this effect was pronounced enough that it redistributed resources to high- and low-incomes from middle income groups (41).

## Motor Vehicle Emissions Fees

Emissions fees have not had widespread implementation in the US, so the research here tends to analyze policy changes. These studies use data from the California Air Resources Board. According to the results of the two studies summarized in [Table 3](#), VMT-based fees based on emissions are less expensive for low-income drivers than registration fees based on emissions. With the former, drivers do not pay out a lump-sum penalty for their polluting behavior, which allows them to adjust their behavior in response to the emissions fees. Again, whether the analysis includes revenue benefits or reductions in other taxes paid makes a much bigger difference to the estimate than do differing modeling methods.

The 1999 and 2005 studies highlighted here are consistent in the amounts paid out by income. Again, these two studies both use California data. In terms of total out-of-pocket burdens, the fees are again regressive, but they are a small portion of either annual expenditures or lifetime income in any group. The most paid under any policy design by low-income households occurs with an emissions-based registration fee—0.70 percent of lifetime income. The annual expenditures are a bit easier to interpret: the emissions fees from West (2005) (19) would cost low-income families somewhere between \$162 and \$65 per year.

**TABLE 3 Percentage of Income Paid/Gained with Emissions Fees**

| Study                          | Finance Mechanism  | Considers Revenue or Benefits? | Percentage of income or expenditure |                 |                      |
|--------------------------------|--|--------------------------------|-------------------------------------|-----------------|----------------------|
|                                |  |                                | Rough Income Group                  |                 |                      |
|                                |  |                                | Low incomes (<\$25K)                | Medium incomes  | High incomes (100K+) |
| West (2005)* (19)              | Vehicle emissions fee, approximately 0.006 per mile (all groups) | No                             | -0.33% to -0.34                     | -0.28% to -0.35 | -0.13% to -0.19      |
|                                | Vehicle emissions, approximately 0.006 per mile (vehicle owners) | No                             | -0.55 to -0.65                      | -0.42% to -0.27 | -0.20 to -0.14       |
|                                | Uniform VMT tax, roughly the same level (all groups)             | No                             | -0.26 to -0.28                      | -0.27 to -0.30  | -0.15 to -0.22       |
|                                | Uniform VMT tax, roughly the same level (vehicle owners)         | No                             | -0.46 to -0.54                      | -0.27 to -0.41  | -0.16 to -0.17       |
| Walls and Hanson** (1999) (28) | Emissions fee per \$50.72 g/mile                                 | No                             | -0.52 to -0.66                      | -0.56 to -0.58  | -0.37 to -0.39       |
|                                | Emission-based registration fee                                  | No                             | -0.70 to -0.71                      | -0.51 to -0.66  | -0.33 to -0.38       |
|                                | VMT-based fee of \$0.94 a mile                                   | No                             | -0.42 to -0.56                      | -0.60 to -0.62  | -0.41 to -0.44       |

\*Percentage of expenditures rather than income.

\*\*Percentage of lifetime income rather than annual income

## Voluntary and Comprehensive Toll Schemes

Just like emissions fees, toll schemes are not widely implemented, though there are a few examples. Thus, the studies here are mix of modeling estimates and those that use existing facilities.

[Table 4](#) summarizes the findings from recent studies on HOT lanes, congestion charges, and cordon tolls. I did not find any studies that measured the incidence of basic highway tolls, such as those commonly used in states like Oklahoma.

Again, the charges are broadly regressive, and again, the variance in the findings depends much less on differences in methodology or data than on policy design and the distribution of revenues. The studies range here from taking as much as 2 percent of income from low-income motorists to actually redistributing income to the lowest income group with higher public transit expenditures, benefits from congestion and air pollution reduction. Although tolls and HOT lanes have a reputation for being regressive, low-income motorists appear to pay very little for priced links, largely because most schemes only apply to selected links under HOT lane proposals. When the tolls are comparatively high and mandatory, the income sacrificed obviously becomes greater.

Though there is some debate about whether HOT lane usage is truly voluntary given the potential for very high congestion levels on free lanes, their use is still discretionary and most equity analyses agree that HOT lanes are not as regressive as the popular moniker “Lexus Lane” would suggest (42). HOT lanes were found to provide social welfare gains to all income levels in Washington DC (37). This analysis compared HOT lanes with more comprehensive tolling methods and found that HOT lanes provided almost as much congestion relief at a much lower social cost than the more comprehensive tolling schemes. Each income group is expected to gain by a minor amount, as the toll payments do not allow much consumer surplus. Higher income groups gain very little under these schemes largely due to the spatial distribution of higher income commuters in DC. Higher income groups occupy central city as well as suburban locations well served by public transit or unpriced surface roads.

A panel survey of SR91 users showed that low-income individuals paid very little, because the SR91 serves fairly affluent areas (43). The DC HOT lane, by contrast, would affect some suburban, low-income commuters from Maryland, though even then the benefits they receive in congestion reduction outweigh their out-of-pocket costs. Who benefits from pricing strategies, and who pays, depends on the distribution of low-income residents throughout regions relative to the priced links and the comprehensiveness of the pricing strategy.

Among all the studies, the highest HOT-lane payment is about 5 percent of income, for those at medium incomes on the SR91 who use the facility five days a week during the very highest cost hours morning and evening. Opting to move the trip off peak and wait out traffic brings the payment down to the levels predicted by other HOT lane studies, which is less than 0.5 percent of annual income.

If the toll is low enough, or if low-income people are transit users, the incidence even of involuntary tolls can be progressive, as in Stockholm. Even without revenue factored in, the Stockholm charges were progressive, and with public transit, both the out-of-pocket payments and net benefits were found to be progressive.

Higher toll levels and more comprehensive pricing schemes tend, obviously, to raise payments for all income levels. These are summarized in [Table 5](#). Though higher and more comprehensive than voluntary tolls, the estimated incidence is not that much higher than

**TABLE 4 Percentage of Income Paid/Gained with HOT Lanes and Low Tolls**

| Study                                | Finance Mechanism   | Considers Revenue or Benefits? | Percentage of income or expenditure |                  |                      |
|--------------------------------------|---|--------------------------------|-------------------------------------|------------------|----------------------|
|                                      |   |                                | Rough Income Group                  |                  |                      |
|                                      |   |                                | Low-incomes (<\$25K)                | Medium-incomes   | High incomes (100K+) |
| <b>Lower-cost tolls</b>              |   |                                |                                     |                  |                      |
| Safirova et al. (2003) (37)          | Washington DC, HOT lane (\$0.20/mile)   | Yes                            | +0.038                              | +0.037 to +0.050 | +0.042               |
| Schweitzer and Taylor (2008)* ‡ (18) | SR91 HOT lanes, graduated by time of day (\$3.60/trip peak, \$1.65 off-peak) (single women, peak user)                | No                             | 0*                                  | -1.20 to -5.24   | -0.54 to -0.84       |
|                                      | SR91 HOT lanes, graduated by time of day (\$3.60/trip peak, \$1.65 off-peak) (single women, heavy off-peak user)      | No                             | 0*                                  | -0.23 to -1.24   | -0.16 to -0.08       |
|                                      | SR91 HOT lanes, graduated by time of day (\$3.60/trip peak, \$1.65 off-peak) (single women, infrequent, peak user)    | No                             | 0*                                  | -0.05 to -0.43   | -0.3 to +0.01        |
|                                      | SR91 HOT lanes, graduated by time of day (\$3.60/trip peak, \$1.65 off-peak) (single women, infrequent off-peak user) | No                             | 0*                                  | -0.02 to -0.12   | -0.02 to -0.04       |
| Eliasson (2006) (38)                 | Cordon toll—Stockholm, \$2.07 peak, \$1.38 off peak   | No                             | -0.14                               | -0.13            | -0.16                |
|                                      | Cordon toll—Stockholm, \$2.07 peak, \$1.38 off peak, lump sum rebate  | Yes                            | +0.28                               | +0.38            | +0.01                |
|                                      | Cordon toll—Stockholm, \$2.07 peak, \$1.38 public transit allocation  | Yes                            | +0.35                               | +0.04            | +0.02                |
|                                      | Cordon toll—Stockholm, \$2.07 peak, \$1.38, tax relief  | Yes                            | +0.035                              | +0.042           | +0.083               |
| Bureau et al. (2008) (44)            | Zone \$1.00 motorists (Paris)   | No                             | -0.48                               | -0.24            | -0.135               |
|                                      | Zone \$1.00 all commuters   | No                             | -0.12                               | -0.08            | -0.06                |
|                                      | Zone \$2.44m motorists  | No                             | -1.06                               | -0.56            | -0.32                |
|                                      | Zone \$2.44m all commuters  | No                             | -0.25                               | -0.19            | -0.16                |

\*based on reported usage of an existing facility

‡Estimated toll payments minus small savings from sales tax payments as a percentage of income

**TABLE 5 Percentage of Income Paid/Gained with Relatively High-Priced Toll Schemes**

| Study                              | Finance Mechanism   | Considers Revenue or Benefits? | Percentage of income or expenditure |                |                      |
|------------------------------------|---|--------------------------------|-------------------------------------|----------------|----------------------|
|                                    |   |                                | Rough Income Group                  |                |                      |
|                                    |   |                                | Low-incomes (<\$25K)                | Medium-incomes | High incomes (100K+) |
| <b>High tolls</b>                  |   |                                |                                     |                |                      |
| Bureau et al. (2008) (44)          | Zone \$3.67 motorists (Paris)                                 | No                             | -1.49                               | -0.82          | -0.48                |
|                                    | Zone \$3.67 all commuters                                     | No                             | -0.35                               | -0.27          | -0.22                |
|                                    | Zone \$6.13 motorists   | No                             | -2.08                               | -1.25          | -0.75                |
|                                    | Zone \$6.13 all commuters                                     | No                             | -0.48                               | -0.41          | -0.35                |
| Nakamura and Kockelman (2002) (22) | Rationing toll—\$5 (San Francisco)                            | No                             | -0.13                               | -0.15 to ~ 0   | -0.05 to +0.14       |
|                                    | Rationed toll—BPR \$10  | No                             | -0.05 to -0.25                      | -0.07 to -0.33 | -0.36 to ~0          |
| Safirova et al. (2004) (37)        | Limited pricing, just HOV lanes (\$0.22/mile) (Washington DC) | Yes                            | -0.22                               | -0.06 to -0.11 | +0.005               |
|                                    | Comprehensive pricing, all lanes (\$0.22/mile)                | Yes                            | -0.46                               | -0.23          | -0.039               |

voluntary usage. The highest burden of 2.08 percent for low-income motorists is estimated for a relatively high, zone-based toll of over \$6 in Paris, specifically designed to reduce auto travel by 20 percent (44). When all commuters are factored in, the percentage falls to less than 0.5 percent of income a year. Rationing tolls on the San Francisco–Oakland Bay Bridge, and more comprehensive pricing measures for DC, fall within a lower cost range (22).

### Methodological Lessons

Almost all the possible effects on low-income households reflect differences in regional geography. Travel demand depends on the spatial distribution of modes, their substitutes, human settlement patterns, and destinations. Given differences in regional geography, policy analyses may not generalize from one region to another (45–47). Table 6 lays out how finance tools relate to these geographic and individual differences. Multi-level policy analysis is perhaps the best way to capture the effects associated with changes in taxes and fees within a given region.

#### *Level 1: Neighborhood Effects*

Individuals' ability to substitute less expensive modes or destinations in response to higher gas taxes, tolls, or transit fares depends in part on the geographic supply of alternatives. The only way to avoid the gas tax in some places is to stay home more or arrange for rides, at least in the short term. Some urban residents, by contrast, have plenty of choices other than driving. In turn, whether groups benefit or lose overall from a tax change depends on the revenue allocation, which also depends on geography. Income and ethnic groups correlate with neighborhoods

**TABLE 6 Multiple Layers of Analysis in Social Welfare Studies**

|   | <b>Traits and variables</b>   |
|---|---|
| <b>Geographic Variation—Level 1</b>                                   |   |
| Mode supply   | Availability and quality of substitute modes, such as walking or transit  |
| Destination/activity supply   | Availability and quality of substitute destinations   |
| Tax base socioeconomic characteristics                                | Tax base via scheme type, such as cordon tolls, area tolls, or service areas  |
| Geographic distribution of the congestion and pollution externalities | The socio-spatial distribution of the external costs that finance tools may address/alleviate   |
| <b>Individual Variation &amp; Interactions—Level 2</b>                |   |
| Race, ethnicity and culture   | Socio-cultural networks, mores, and institutions, racism and discrimination in social and economic activities                               |
| Employment, education   | Type of work, flexibility and timing of work travel demand, ability to shift costs to employers or travel to alternative times/destinations |
| Income and wealth   | Income elasticity of both time and money; ability to absorb or shift time, out-of-pocket, or risk costs                                     |
| Gender  | Distribution and timing of paid and non-paid work activities  |
| Age   | Timing and flexibility of activity, different ways of relating to different modes, different income concerns                                |
| Parenting and care giving   | Distribution and timing of care giving activities; ways in which these interact with other variables  |

within regions. Studies that seek to measure intra-metropolitan variability by neighborhood find major differences in incidence, social inclusion, and environmental justice from place to place (6).

### *Level 2: Individual Effects*

Within different metropolitan geographies and neighborhoods, individuals differ in how they are able to respond to price and service quality changes induced by taxes and user charges. Research shows that ethnicity, physical wellness, and gender affect travel demand, and that these factors may diversify the range of effects that price changes can have (48–51). Income, of course, is one of the major factors influencing demand in response to taxes and user charges. Just as geography affects the supply of potential substitutes and the distribution of external costs, income can affect individuals' ability to afford substitutes, and these variables most likely interact. Depending on cost levels, individuals can make short-term substitutions—such as leaving work early or changing hours, opting for shorter trips to more proximate destinations, or taking fewer trips. People can also make longer-term substitutions among modes, residences, or different engine technologies. Individuals can employ multiple strategies, by scaling back on car usage and adopting transit for some trips, or by swapping out a gas-guzzling car for a thriftier one, as with the popular 2009 “Cash for Clunkers” program.

Studies of congestion pricing show that geographic effects are significant in toll incidence. Given these findings, geographic factors also probably influence the incidence of gas

taxes and emissions fees as well. Yet, multi-scale analyses that capture both neighborhood and individual effects are rare.

### *Political and Administrative Differences*

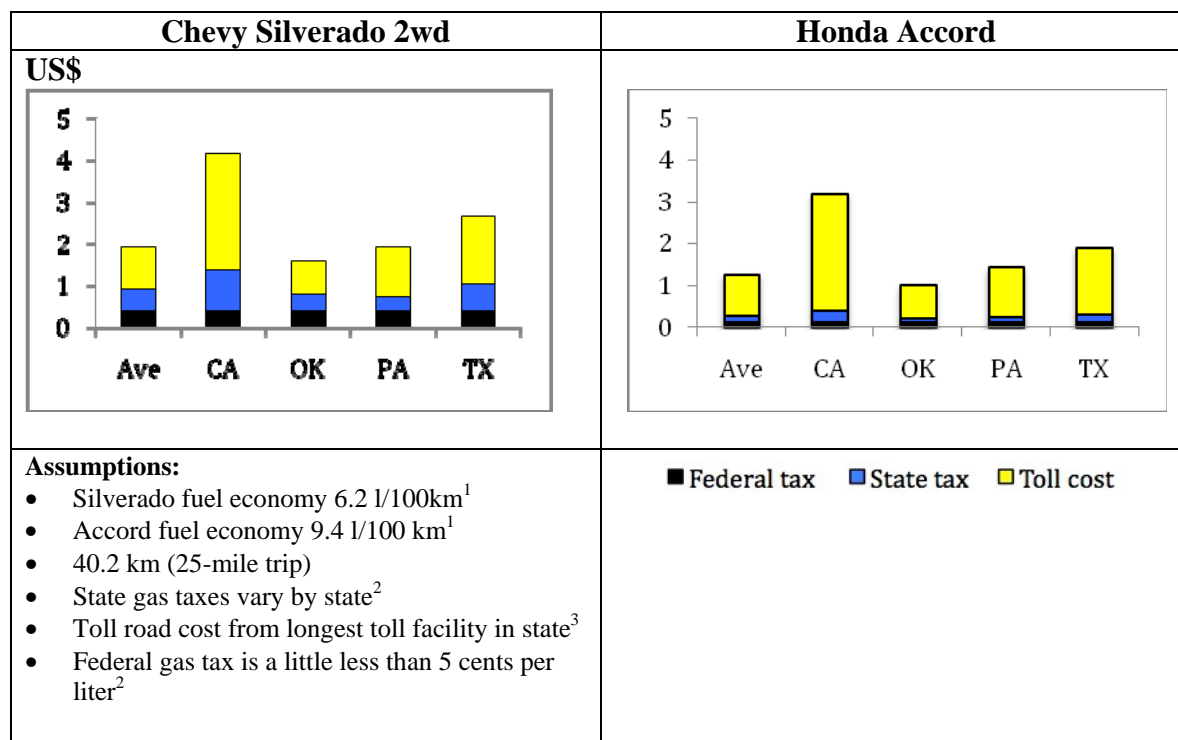
Political geography matters as well. Different jurisdictions have different baseline tax conditions. States and localities vary in how and how much they tax lower income groups. [Figure 1](#) displays the estimated taxes and fees associated with driving (a) a Chevy Silverado pick-up or (b) a Honda Accord coupe in four states, and a national average. California toll roads tend to be more costly per kilometer compared to other states, and California has a much more limited number of tolled miles compared to the other states. Remember that these are general highway tolls, not congestion charges, so that the California toll system includes facilities like the Beaver Valley Expressway but not Orange County's SR91.

The black area of the bar charts in [Figure 1](#) shows the amount of federal gas tax paid for a 40-km trip with the different fuel economies associated with the two vehicles. The federal tax does not vary by state, so the Accord and Silverado drivers pay the same amount per liter for federal taxes in each state, though the Silverado driver uses more gas and therefore pays more than the Accord driver.

One of the key points in [Figure 1](#) concerns the difference in state gas taxes and tolls. Tolls (the yellow) are a costly part of the 40-km trip, but a comparison between Oklahoma and California shows the difference that baseline tax and toll conditions can make on what drivers ultimately pay. In Oklahoma, state gas taxes are low—about a nickel per liter—whereas the average for all 50 states is about 7 cents per liter. California gas taxes are high, and Californians also pay sales tax on gasoline, so that the American Petroleum Institute estimates that gas taxes run roughly 13 cents per liter.

California has few highway tolls: it has five tolled highways which account for about 120 miles of the state system. Most Silverado drivers in California pay just the state and federal gas taxes—the blue and black, which amount to \$1.35 in taxes for the 40 km trip, unless they are on one of the few tolled facilities. Oklahoma has many tolled highway facilities; it has 10 different turnpikes with just under 1,000 centerline miles. Off those tolled facilities, Oklahoma Silverado drivers only pay about 80 cents in taxes for the same 40 km trip for which California Silverado drivers pay about \$1.35 in taxes. On tolled facilities in Oklahoma, drivers pay about \$1.45 for the trip. Thus Oklahoma uses tolls rather than gas taxes, whereas California relies on gas taxes rather than tolls. But the tax and toll bills for both states fall within a dime of each other, though their finance mechanisms vary quite a bit. The comparison also shows what happens if you add a toll to a state where the taxes are already relatively high: those Silverado drivers on tolled facilities in California pay a lot more than those subject to tolls in Oklahoma.

Comparing the Silverado and the Accord drivers allows us to see the different driver incentives built in to highway tolls versus gas taxes. The Accord driver saves a lot of money in Federal and state gas taxes in California. What costs the California Silverado drivers \$1.35 in taxes only costs the Accord driver about \$0.40. This driver saves on the total fuel bill and saves nearly 30 percent in taxes. This is where it gets interesting. The Accord driver in Oklahoma, with its reliance on tolls rather than gas taxes, pays about 21 cents when the Silverado drivers pay 80 cents, saving a little less than 27 percent on taxes in Oklahoma. This 27 percent is compared to the 30 percent savings in California. Highway tolls do not reward fuel efficiency the way gas taxes do, and thus drivers face different incentives in different places.



<sup>1</sup>These are for 2010 model year; Chevrolet Silverado C15, 2-wheel drive; Honda Accord Coupe. The data on fuel economy are from the U.S. Environmental Protection Agency ([www.fueleconomy.gov](http://www.fueleconomy.gov); accessed November 31, 2009).

<sup>2</sup>Data from the American Petroleum Institute (<http://www.api.org/statistics/fueltaxes/>; Accessed November 15, 2009). The API is an industry-sponsored research organization, but the data are relatively uncontroversial and regularly updated.

<sup>3</sup>Data are from The Oklahoma Turnpike Authority (Pikepass: <http://www.pikepass.com/>; Accessed November 31, 2009); the California Department of Transportation maintains links to the turnpike authorities in California, including FastTrak (<http://www.dot.ca.gov/hq/traffops/trucks/ops-guide/tolls.htm>; Accessed November 15, 2009); The Texas Department of Transportation (<http://www.texasollways.com/>; Accessed November 15, 2009); the Pennsylvania Turnpike (<http://www.paturnpike.com/>; Accessed November 15, 2009).

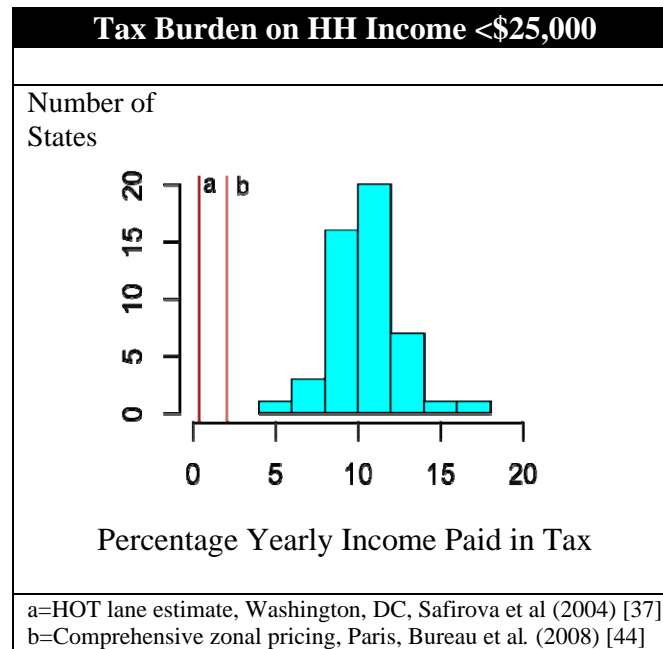
**FIGURE 1 An example of state tax and toll structure variance.**

These comparisons are also germane to a jurisdiction's entire tax structure. The estimated total tax burden—for everything from sales taxes to property taxes, etc.—varies by state and locality because these all have different tax policies. Some localities have higher property taxation, others shift a greater burden on to sales taxes, and still others design tax policy to make both sales and income taxes as progressive as possible. These policy differences all change the outcomes for low-income drivers and transit users.

Figure 2 shows the distribution (by frequency) of the total tax burdens for all fifty states illustrated against the estimated out-of-pocket cost burdens with new high (line b) and low (line a) tolls. The total tax burden figures are calculated from models estimated by the Institute on Taxation and Economic Policy (ITEP).<sup>3</sup> These estimates include property taxes, sales and excise taxes, and income taxes (52). The ITEP uses five major models to construct its total tax burden figures: a personal income tax model, a consumption tax model, a property tax model, a corporate tax income model, and a local tax model. From the brief description of the models that

<sup>3</sup> The ITEP is a tax advocacy organization, and these numbers should be viewed with some caution even though the models appear to be reasonable out-of-pocket estimates.





**FIGURE 2 Proposed tolls as a percentage of total tax burden for low-income households in the U.S. (SOURCE: ITEP (2003) (52); distributions calculated by the author.)**

appear in the report, these are accounting rather than behavioral models. Nonetheless, they serve to illustrate the differences in policy context. These are not welfare calculations, as they do not factor in revenue allocations to programs that affect different income groups, nor do they account for tax shifting—a potentially major source of error in these studies (53–55). Nonetheless, they serve to illustrate how large the total tax burden is relative to the estimates from transport studies, and how much the existing tax burden varies according to state.

In most states, low-income households pay around 9 to 12 percent of their annual income in existing taxes. However, the estimates range from as low as 5 percent to as high as 17 percent.

New transportation fees would occur within these different state tax regimes. Line (a) in Figure 2 shows one possible estimate of the annual household income spent on a HOT lane proposal (DC-area). The HOT lane would add roughly 0.5 percent to the existing burden for lower-income households with drivers. That means that among the lower-tax states, the 0.5 percent for households would move their total burden from around 9 percent to 9.5 percent. In higher tax states, the 0.5 percent added with a metropolitan HOT lane system would push the total tax burden to 17.5 percent—but, again, only for drivers. Line (b) shows a cost burden estimate from the comprehensive, zone-based toll estimated for Paris from Table 5 of roughly 2 percent of household income for motorists. In this case, the total burden would increase by about 2 percent, thus moving the total estimated burden—the state burden plus new metropolitan tolls charges—from 5 percent to 7 percent of household income in states where the tax burden is low, and up to 19 percent from 17 percent in places where the estimated tax burden on low-income households is high. In most states, the burden on low-income drivers would move from about 10 percent to about 12 percent for a relatively high, zone-based toll and from about 10 to 10.5 for a HOT lane proposal.

## OMISSIONS FROM INCIDENCE STUDIES

Because this manuscript synthesizes research results, it reflects numerous biases and limitations apparent in contemporary policy analysis and studies of social equity. As such, it is important to consider the scope of the research; it may be that the most significant issues for social equity lie outside the field's existing data and dominant focus. This discussion examines whether research is asking the right equity questions in the right way.

### Benefits and External Costs

Based on the review, the studies that both account for cost and benefit distribution and include both motorists and non-motorists as user groups tend to find that gas taxes, emissions fees, and tolls are less regressive than they appear in cost-only, motorist-only studies. Because so much of the popular and political discussion has centered on the idea that transport policy may “price or tax poor drivers off the road,” the research has responded primarily to that concern. This focus leads to two different but significant sources of bias in the social welfare calculations of existing studies: a) the systematic under-counting of changes in service quality resulting from finance changes and b) failures to evaluate the distribution of external cost burdens.

The benefits of service quality improvements or mobility service differentiation to travelers are seldom estimated for roadway studies, though the benefits are apparent in theory (56). When these effects are measured, the differences among groups have been startling (57–59), with estimates of the value of travel-time reliability for women being nearly twice that of men in one study (60). Among studies that calculate the benefits of congestion relief to low income groups, it is not common to differentiate travel time values in line with reliability experiments. Rather, congestion reduction benefits are assumed to be a function of hourly wages rather than estimated as a demand function.

So far, equity studies have tended not to grapple with this level of complexity for congestion charging or fuel taxation. The ones that have are extremely insightful because they enlighten whether impoverished and socially excluded individuals can really substitute between different modes and services—a key aspect of both sustainability and finance equity (49, 50, 61). One idea for making road use charges or gas tax increases less onerous is to put the revenue into public transit, so that those who have trouble affording a road charge have a ready, less expensive substitute (62, 63). Research suggests, however, that simply providing more mainstream services—like mass transit—may not benefit older, fixed-income motorists, even if it might work for younger people. Using transit can require more physical exertion and time costs than driving alone, even with good sidewalks and street life (49–51).

A recent focus group study on road user charges in Bristol, UK reveals the essence of the tradeoff. By most commonly accepted measures of transit accessibility and service quality, Bristol's transit has both good frequency and high geographic coverage. Nonetheless, elderly women and men in the focus groups noted that the transit system configuration did not effectively support travel to either their social networks or their trips to vital social services, like medical care (24). None of the services offered by transit agencies, including paratransit, were spatially or temporally flexible enough to meet their needs well, so that they used expensive taxis or rides from friends or family. Respondents reported being much less likely to ask for rides if they knew it would cost their friends and family a user charge. The result was that, when faced with a road user charge, many reported that they were more likely to forego trips entirely than to

shift modes, even where transit and walking access are ostensibly good. There are reasons to believe the same might be true for low-income parents or other groups who have relatively high mobility demands.

Pricing congested roadways may be more likely to cause low-income motorists to forego trips, opt out of activities, or take money from other needed family expenditures rather than shift to transit, at least in the short term (64). By not factoring in roadway service quality improvements or the level/timing of transit quality improvements, equity analyses tend not to help us understand how individuals of different income groups value or react to service quality improvements vis-à-vis price changes. This is a problem particularly for transit, where planning research has emphasized the possibility of increasing social inclusion through transit service improvements, but where a recent review of the research finds uneven evidence on demand responses to improvements in in-vehicle time, waiting environment quality, reliability, and pre-trip information (65).

Tax incidence research has also not factored in the distribution of the cost burdens associated with transport externalities and defensive expenditures—how people manage the costs of transport externalities, such as buying an air filter to avoid airborne pollutants or using a nanny service to deal with unreliable travel times (66). What little research exists on congestion adaptations suggests that income affects the ability to pay for the purchase of time-saving services, like prepared meals or lawn care to make up for time lost in traffic (67–70).

Early studies of the London congestion charge, which is a cordon toll that runs currently about US\$11 (71), predicted that the air quality benefits of restricting auto trips would be both positive and progressively distributed (72). Subsequent analyses have found the predictions to be correct, in that the reductions in emissions from motor vehicles after the cordon charge have been both sizable and steeply progressive in their distribution of air quality benefits (73, 74). A study of the potential effects of pricing on eight English towns showed a sizable variance in the distribution of out-of-pocket cost by income among the different towns: in some towns, tolls were progressively distributed by income while in others they were regressive, due primarily to differing levels of suburbanization among low-income households (75). Without exception, however, the distribution of the air quality benefits of congestion pricing was progressive in each of the eight towns. This same author finds that the overall benefits of congestion reduction in London allow even low-income motorists to benefit more than they pay in tolls (23, 76). These findings are echoed by an in-depth study of the potential for congestion charges to positively affect air quality in Leeds, UK (77).

A natural experiment before, during, and after the 1996 Olympic games in Atlanta found that short-term traffic reductions, from traffic suppression rather than building transit, reduced the incidence of asthma, particularly in poorer neighborhoods (78). Though not an equity study *per se*, a recent evaluation of four different congestion charging methods for the city of Copenhagen found that the greatest benefits from the scheme accrued from reducing traffic fatalities (by redirecting vehicle trips to safer routes and by eliminating vehicle trips) and through reducing noise, with air quality benefits much lower and regressive in the case of a small cordon (79). Such findings are not always consistent: an English study found the air quality benefits to be minor compared to the congestion reductions (76), while other studies have found that increasing the gasoline tax can have positive benefits for safety and other external costs that have distributive consequences by income (80).

In sum, the research has undercounted both the potential costs and benefits associated with (a) shifting to transit, (b) congestion relief and (c) the external environmental costs of motor

transport. These types of costs and benefits, again, are likely to vary by region; the common environmental justice finding that impoverished people have lower air quality is not uniformly true across metropolitan regions or across pollutants (81, 82). It may be that the congestion benefits of pricing trips off the road accrue to higher income groups, while at the same time the air quality and noise reduction benefits accrue to the most socially disadvantaged within the region. Or the opposite may occur. Again, geography matters to the outcomes.

Depending on the size of these effects, they can sway how regressive or progressive the revenue instrument is, or how much low-income groups have to pay. These issues influence what the toll and taxation levels should be in the first place for there to be overall welfare gains at all. Hitting the proper price or taxation levels in markets with non-traded or bundled externalities is difficult precisely because the available information is insufficient to set a proper tax or toll. A recent study nicely illustrates this point. It compared the outcomes from under taxing gasoline in the US with overtaxing it in the UK to show that social welfare erodes in both circumstances (83).

### **Transit Fares**

The research primarily covers three revenue instruments: gas taxes, road user charges (cordon tolls, area tolls, HOT lanes, congestion charges and basic tolling), and green taxes. There is much less research on the latter two than the former, and this imbalance does not necessarily reflect the relative significance or usage of policy tools. Some methods of revenue generation, like congestion pricing, have generated both scholarly and public debate disproportionate to the tool's relatively limited implementation, while others, like transit fares, have generated much less scrutiny and debate. This represents a potential mismatch between the level of analytical scrutiny and the policy relevance of different finance instruments, and in how much those instruments are likely to affect truly impoverished residents.

An example of two very different user fees and services may illustrate the point. Transit fares are universally applied in US regions, and if the research on value pricing experiments is any indicator, transit is far more likely to be patronized by low-income urban residents and people of color than HOT lanes (84–87). However, research on the equity of the out-of-pocket costs associated with HOT lane usage—an upgrade service for motorists on select facilities—has generated a far greater number of recent studies than transit fares. Transit is, by comparison to auto ownership and usage, a much cheaper mode out-of-pocket, though local transit is usually slower, and it currently offers fewer potential employment and residential access options than cars (88, 89). Transit's lower price relative to the automobile, while good for consumers, does not mean that transit fares are in and of themselves affordable, especially given the higher average out-of-pocket, time, or risk (uncertainty of arrival times) costs associated with transit use (90, 91). Many of the equity concerns raised about HOT lanes also apply to transit fares, albeit at a different level of socio-economic differentiation. HOT lanes are a premium service that wealthy motorists can afford more readily than the poor; on the transit side, flat fare structures and highly differentiated service quality for commuter rail in affluent suburbs systematically benefit the affluent among transit riders more so than other riders (92–94). The high up-front costs of purchasing a transit pass, like that of purchasing a HOT-lane transponder, are easier for comparatively higher-income transit patrons, who then enjoy discounts and conveniences for transfers and trip chaining (95).

Putting some numbers on the example further illustrates the point. A patron of Orange County's SR91 HOT lanes pays on average \$1600 a year in user fees if they use the facility 8 times a week during the very highest morning and afternoon peak charges; if they use the lane for only 6 trips a week and move to an hour off peak in either direction, they can reduce that amount to only about \$800 a year (96). Peak-period, peak-direction freeway commuters are more likely than commuters in general to come from middle- and upper-income households; as such, the lowest income users who regularly commute in the SR91 Express Lanes come from households with average annual incomes of about \$40,000 (43). Someone who buys a regular monthly pass for Los Angeles County-wide transit service pays \$744 a year; a region-wide pass costs \$881 a year—about the same as the HOT lane charges (97). A monthly pass for the New York MTA costs over \$1,000 a year (98). Local bus and subway services for Boston MBTA patrons are about \$720 a year, and commuter rail passes range in price from \$720 to \$3000 a year (99). These costs can increase if a patron is unable to pay out in lump sums for monthly passes; what costs monthly pass riders \$744 a year in Los Angeles costs weekly pass purchasers \$884. These are not small charges when the poverty line sits at \$18,000 for a family of three in the US; the cost of a NY MTA pass runs at 0.06 percent of total income there—higher than some gas tax and toll schemes (100).

For transit patrons so poor that owning a car is a out of the question, let alone driving one in a HOT lane—the fact that transit is less costly than autos tells us little about how mobility costs contribute to social exclusion in general. Researchers have been more preoccupied with comparing the relative merits of various modes for low-income residents than with measuring whether any mode, given the rising costs of metropolitan residency, is affordable at all. It may be that having to pay out-of-pocket for transit marks a much more pressing issue for social exclusion than whether some who currently use cars might have to use them less, take transit for some trips instead of their cars, or enjoy less HOT lane usage than richer motorists.

## **Freight**

The second problem with the scope of empirical research on transportation finance equity concerns its narrow focus on surface passenger travel to the exclusion of freight. This reflects the larger bias in the research on passenger travel, where the out-of-pocket costs of travel are widely recognized and where indirect costs, like time costs and congestion externalities, receive little attention in the debate. Virtually every equity concern that applies to low-income drivers, for example, applies as well to truck owner-operators who depend on transport for their livelihoods, as well as small business owners who rely on shipping. The small body of research on voluntary adoption of green technologies among truckers finds a clear difference between fleet trucker and owner operators, with owner operators falling into comparatively lower income levels (101). The tendency of the research to ignore potential service-quality improvements or differentiation, noted above, may be a particularly important issue for freight (102). Yet, we have very little information on how taxes, user charges, service quality difference, or external costs affect individuals employed within freight sectors.

## **Budgets, Political Economy, and Shifting Costs Off-System**

While mobility experts have developed a large literature surrounding the effects that access and mobility have on social life, inclusion, and opportunity, these experts have not asked: *who pays*

*for transportation services if the system users do not?* Transport infrastructure has for decades had dedicated funding. Because investment in transportation infrastructure has only partially relied on the general budgetary process, transport researchers tend to frame the social equity of budgetary tradeoffs as choices within the sector—the hardy perennial being highways versus transit—rather than as choices between investments in mobility versus investments in other social goods like education.

Again, an example may help. California’s well-publicized \$24-billion budget deficit and standoff occurred mere months after California voters approved nearly \$10 billion in obligations for its high-speed rail project. In the end, California’s budgetary crisis was resolved with no tax increases, but with deep cuts to social programs and prisons. One round of cuts took over \$6 billion from K-12 public schools, and \$1.3 billion from the state’s medical program for impoverished Californians, including a million children. Additional cuts removed another \$80 million from child welfare programs, which was later reinstated (103). The state went *overnight* from being among the most generous providers of social support to being among the worst (104).

Our traditional boundaries in equity analysis in transportation would have us view \$10 billion in new bond obligations for one rail project concurrent with a \$7 billion cut in programs for children as separate finance issues, but obligation bonds and existing programs both draw on the state’s fiscal capacity. While high-speed rail will generate fare revenue that should help to retire the bond debt, these are expected future revenues. The state has to finance the capital costs of getting the service up and running before any operating revenue is realized.

Our equity analyses do not account for what happens if transport system users do not pay their way at the same time that they demand higher service volumes and qualities. With infrastructure and services priced low for all users to ostensibly keep things affordable for low-income groups, there is little to discipline the growth in demand for new and better mobility services relative to other goods. That demand can displace fiscal capacity for other public programs and services, which is what has happened in transportation finance over the past three decades as resistance to gas tax increases has aligned with increased demands for public transit investment, environmental mitigation, and ever-growing vehicle miles of travel. It is not as though these demands for additional and higher quality mobility services are a bad thing—they reflect higher affluence and the valuing of environmental goods, and a vibrant economy—but these demands are nonetheless not cost-free. Contrast, for example, what might have been possible had an increase in the gas tax in California or a carbon tax on motor fuels occurred a decade ago—or even five years ago—to become a dedicated revenue stream for high-speed rail investment to lower the up-front borrowing needed for the project. Instead, the obligations are now added to the state’s burgeoning general bond obligations at a time when the state cannot meet its existing program budgets and bond issuers are scrutinizing the state’s borrowing credibility in the light of 13 percent unemployment.

It is in these kinds of counterfactual analyses that perhaps our greatest gaps occur in equity analysis, for they transcend what we currently measure and our understanding of finance. We can focus on the nickels, dimes, and dollars at the household level as a part of the equity question, but there are also equity questions at the macro-budgetary level—how much the state has to spend to borrow for building projects may have steep consequences both for total project costs and the financial burdens associated with new projects. We seldom ask these kinds of questions, and in our failure to do so, there may be consequences for each of the three major aspects of social equity in environmental justice, tax incidence, and social inclusion.

## CONCLUSIONS

This has been a wide-ranging review of the tax incidence research in transport. Distributive policy analysis in transport is still fairly new, and thus opportunities for significant research and policy innovation remain. Throughout, I have stressed the connections between finance and prices, prices and social exclusion, and prices and environmental costs. By changing the price structure of mobility services, transportation finance has potential to change both how affordable the system is and how much pollution it generates. The result: the transport finance influences multiple policy arenas and issues related to social justice.

Of the many issues I raise throughout, I wish to highlight here three major takeaway points. First is that the estimates here fall at about 0.5 percent of income for households under \$25,000 for gas taxes, emissions fees, and some limited implementation HOT lane proposals. For fairly comprehensive, high-cost tolls, the estimates go as high as 2 percent for low-income drivers. While the effects of specific implementations vary by context, as I will discuss later on, the major choice among policy instruments—the gas tax, emission taxes, or facility pricing—concerns the tax base across which system costs are spread. The gas tax, emission taxes, and VMT-charges apply to all motorists, and as a result the burdens on any given household are low compared to what would happen to those same households if they routinely use facilities that were to become subject to pricing. Given the pressing social and environmental concerns associated with driving, spreading the costs of driving across ever larger tax bases—through methods like the sales tax, for example—is the wrong direction for policy to go, except for sales taxes dedicated specifically to services like transit where users are expected to come from lower income strata. At the same time, steep increases in charges for congestion relief or VMT reduction do raise potential barriers to affordable mobility, even with transit provision. In prior decades when congestion was less of an issue, spreading the costs across motorists enabled greater mobility among low-income households. However, current levels of urbanization mean that this strategy for keeping costs low will not work indefinitely as congestion worsens on the road and, in time, on transit systems.

While it may seem farfetched now to discuss congestion on most US transit systems, continued metropolitan population growth portends that congestion on all systems in the long term—road, sidewalk, and transit—will be an increasing problem. Without pricing, nothing disciplines demand *except* congestion (time costs). Residents will have to deal with one type of cost or another, and existing research suggests that it is incorrect to simply assume that lower income drivers would rather experience delays than pay to avoid them, even with rising costs. Service differentiation, both on road and on transit, may be valuable to some members of lower income groups; however, we do not have enough information on travel demand by income or other strata, such as race or parental status, to be able to generalize how vulnerable groups respond to service changes and price changes. In addition to concerns over service quality on transit, fares on some of the more heavily patronized transit systems around the world suggest that those concerned about equity in transportation finance can no longer assume—as we used to be able to do—that transit fares are affordable or will stay that way indefinitely, particularly for transit's most deeply impoverished riders.

Outcomes for low-income urban residents further depend on geography and policy context. Urban geography determines the baseline conditions for the availability of substitute modes and destinations and the spatial distribution of different social groups. The political geography matters as well. The review of the research shows that total, un-shifted tax burdens

for low-income households range from low burdens—about five percent of income—to very high burdens, at 17 percent. Given this range, the addition of higher taxes and fees in transport occur across different baseline tax conditions. Given these differences, research that engages policy in this field in multi-level spatial analysis would provide better insights for new finance tools, as would policy analyses that consider total tax burdens.

Just as transport taxes are seldom treated as part of the total tax burden, few equity studies have quantified the distribution of the benefits that may accrue to low-income communities with lower environmental costs that accrue from higher mobility costs—i.e., by reducing the overall number of trips and idling. Studies from the London congestion pricing policy are hopeful, with air quality benefits promising to be sizable and progressively distributed to London's less affluent communities. Other studies show higher benefits to lower income groups via lowering traffic deaths, noise levels, and congestion. These types of benefits tend to be treated as endogenous in equity studies.

Another potential area of valuable future research would examine the incidence of taxes and fees in the freight sector. Studies that address the effect of higher taxes and fees mostly demonstrate that many in the freight industry stand to gain from HOT lane proposals because these would decrease labor expenses and improve reliability. However, these studies tend not to look at the freight sector in terms of a disaggregate labor force with many different levels of economic and institutional power. Expecting truckers to shift off-peak or steeply pricing freight—as a recent congestion pricing proposal in New York planned to do—might have a much greater impact on owner-operators who have lower incomes and operate on fairly slim margins, than on the larger fleet trucking companies who can spread the cost of doing business in a priced area across larger markets. Research has touched on these issues, but differences here have not been quantified by workers' income classes. It would be useful to have that information for markets like Los Angeles, New York, and Chicago, where pricing and fees are likely to go up and which have significant employment in the freight sector.

Finally, I have questioned whether, in the light of growing budgetary scarcity, failing to have transportation system users pay their own way results in the expansion of the sector and its services, and crowds out other (perhaps less democratically palatable) services like social welfare programs. As transportation revenues fall short of demands for service volume and quality, resources have to come from somewhere. This condition suggests that, depending on which way the general budgetary process goes, money for mobility may impact groups who are more vulnerable than low-income motorists and transit users, such as impoverished children.

## REFERENCES

1. Hensher DA, Puckett SM. Road user charging: The global relevance of recent developments in the United Kingdom. *Transport Policy*. 2005 Sep ;12(5):377-383.
2. Brown J. Reconsidering the Gas Tax: Paying for What You Get. Access. 2001 ;1910-15.
3. Taylor B, Norton A. Paying for Transportation: What's a Fair Price? *Journal of Planning Literature*. 2009 ;24(1):22-36.
4. Levinson D. Equity Effects of Road Pricing: A Review. *Transport Reviews*. 2010 ; 30(1):33-57. Available from: <http://nexus.umn.edu/Papers/TransportEquityReviewPaper.pdf>
5. Rosenbloom S. The Equity Implications of Financing the Nation's Surface Transportation System. *TR News*. 2009, Number 261, March-April, pp. 3-9



6. Santos G, Roley L. Distributional impacts of road pricing: The truth behind the myth. *Transportation*. 2004 ;3121-42.
7. Kalmanje S, Kockelman KM. Credit-based congestion pricing: Travel, land value and welfare impacts. *Transportation Research Record*. 2004 ;186:445-53.
8. Lucas K. Locating transport as a social policy problem. In: *Running on Empty: Transport, Social Exclusion, and Environmental Justice*, The Policy Press, Bristol. 2004. pp. 7-14.
9. Schweitzer L, Valenzuela Jr A. Environmental Justice and Transportation: The Claims and the Evidence. *Journal of Planning Literature*. 2004 ;18(4):383-398.
10. Schweitzer L, Stephenson M. Right Answers, Wrong Questions: Environmental Justice as Urban Research. *Urban Studies*. 2007 ;44(2):319-350.
11. Houston D, Wu J, Ong P, Winer A. Proximity of Licensed Childcare to Near-Roadway Vehicle Pollution. *American Journal of Public Health*. 2004 ;96(9):1611-1617.
12. Houston D, Wu J, Ong P, Winer A. Structural disparities of urban traffic in southern California: Implications for vehicle related-air pollution exposure in minority and high-poverty neighborhoods. *Journal of Urban Affairs*. 2004 ;26(5):565-592.
13. Jerrett M, Finkelstein M. Geographies of risk in studies linking chronic air pollution exposure to health outcomes. *Journal of Toxicology and Environmental Health, Part A*. 2005 ;68:1207-1242.
14. Jerrett M, Burnett RT, Kanaroglou P, Eyles J, Finkelstein N, Giovis C, et al. A GIS-environmental justice analysis of particulate air pollution in Hamilton, Canada. *Environment and Planning A*. 2001 ;33(6):955-973.
15. Loh P, Sugerman-Brozán J, Wiggins S, Noiles D, Archibald C. From asthma to AirBeat: Community-driven monitoring of fine particles and black carbon in Roxbury, Massachusetts. *Environmental Health Perspectives*. 2002 ;110(Suppl. 2):297-301.
16. Marshall JD. Environmental inequality: Air pollution exposures in California's South Coast Air Basin. *Atmos. Environ*. 2008 7;42(21):5499-5503.
17. Due JF, Mikesell JC. *Sales Taxation*. Washington, DC: Urban Institute; 1994.
18. Schweitzer, L and Taylor, B. "Just Pricing: Equity and the Future of Road Finance." *Transportation* 2008 (85)6: 797-812. Available Online: 10.1007/s11116-008-9165-9.
19. West SE. Equity Implications of Vehicle Emissions Taxes. *Journal of Transport Economics and Policy*. 2005 Jan ;39(1): 1-24.
20. Bento AM, Goulder LH, Henry E, Jacobsen MR, von Haefen HR. Distributional and Efficiency Impacts of Gasoline Taxes: An Econometrically Based Multi-Market Study. *The American Economic Review*. 2005 May ;95(2):282-287.
21. Bonsall P, Kelly C. Road user charging and social exclusion: The impact of congestion charges on at-risk groups. *Transport Policy*. 2005 Sep ;12(5):406-418.
22. Nakamura K, Kockelman KM. Congestion pricing and roadspace rationing: an application to the San Francisco Bay Bridge corridor. *Transportation Research Part A: Policy and Practice*. 2002 Jun ;36(5):403-417.
23. Santos G, Bhakar J. The impact of the London congestion charging scheme on the generalised cost of car commuters to the city of London from a value of travel time savings perspective. *Transport Policy*. 2006 Jan ;13(1):22-33.
24. Rajé F. The impact of transport on social exclusion processes with specific emphasis on road user charging. *Transport Policy*. 2003 Oct ;10(4):321-338.
25. Tilahun N, Levinson D. Unexpected Delay and the Cost of Lateness on I-394 High Occupancy/Toll Lanes. In: *Travel Demand Management and Road User Pricing: Success, Failure and Feasibility*, eds. Saleh and Sammer. Hants, UK: Ashgate Publishers; 2009. p. 173-184.
26. National Household Travel Survey (NHTS) - Policy Information - FHWA [Internet]. [cited 2009 Aug 5] Available from: <http://www.fhwa.dot.gov/policy/ohpi/nhts/index.cfm>
27. Dill J, Goldstein T, Wachs M. California vehicles fees: Incidence and equity. *Journal of Transportation and Statistics*. 1999 ;2(2):133-148.

28. Walls M, Hanson J. Distributional aspects of an environmental tax shift: The Case of motor vehicle emissions taxes. *National Tax Journal*. 1999 ;52(1):53-65.
29. Consumer Expenditure Survey [Internet]. [cited 2009 Aug 6] Available from: <http://www.bls.gov/cex/>
30. Brownstone D, Ghosh A, Golob T, Kazimi C, Van Amelsfort D. Drivers' willingness-to-pay to reduce travel time: evidence from the San Diego I-15 congestion pricing project. *Transportation Research Part A: Policy and Practice*. 2003 ;37(4):373-387.
31. Lam TC, Small KA. The value of time and reliability: measurement from a value pricing experiment. *Transportation Research Part E: Logistics and Transportation Review*. 2001 ;37(2-3):231-251.
32. Steimetz SS, Brownstone D. Estimating commuters' "value of time" with noisy data: a multiple imputation approach. *Transportation Research Part B: Methodological*. 2005 Dec ;39(10):865-889.
33. Brownstone D, Small KA. Valuing time and reliability: assessing the evidence from road pricing demonstrations. *Transportation Research Part A: Policy and Practice*. 2005 May ;39(4):279-293.
34. Li J. Explaining high-occupancy-toll lane use. *Transportation Research Part D: Transport and Environment*. 2001 Jan ;6(1):61-74.
35. Background Information: Emissions Inventory Data [Internet]. [cited 2009 Aug 6] Available from: <http://www.arb.ca.gov/ei/emissiondata.htm>
36. Bureau B, Glachant M. Distributional effects of road pricing: Assessment of nine scenarios for Paris. *Transportation Research Part A: Policy and Practice*. 2008 Aug ;42(7):994-1007.
37. Safirova E, Gillingham K, Parry I, Nelson P, Harrington W, Mason D. Welfare and distributional effects of road pricing schemes for metropolitan Washington, DC. *Research in Transportation Economics*. 2004 ;9(1): 179-206.
38. Eliasson J, Mattsson L. Equity effects of congestion pricing: Quantitative methodology and a case study for Stockholm. *Transportation Research Part A: Policy and Practice*. 2006 Aug ;40(7):602-620.
39. Gardenshire AD. Economic and sociodemographic influence on autolessness: are missing variables skewing results? *Transportation Research Record*. 1999 ;670:13-16.
40. Metcalf GE. A distributional analysis of green tax reforms.(Statistical Data Included) [Internet]. 1999 12; Available from: [http://find.galegroup.com.libproxy.usc.edu/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=AONE&docId=A58459725&source=gale&srcprod=AONE&userGroupName=usocal\\_main&version=1.0](http://find.galegroup.com.libproxy.usc.edu/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=AONE&docId=A58459725&source=gale&srcprod=AONE&userGroupName=usocal_main&version=1.0)
41. Devarajan S, Fullerton D, Musgrave R. Estimating the distribution of tax burdens. *Journal of Public Economics*. 1980 ;13:155-182.
42. Richardson HW, Bae CC. The equity impacts of road congestion pricing. In: *Road Pricing, Traffic Congestion, and the Environment: Issues of Efficiency and Social Feasibility*. Cheltenham: Edward Elgar; 1998. p. 247-262.
43. Mastako K, Rilett LR, Sullivan EC. Commuter behavior on California State Route 91--After introducing variable-toll express lanes. *Transportation Research Record*. 1998 ;1649: 47-54.
44. Bureau B, Glachant M. Distributional effects of road pricing: Assessment of nine scenarios for Paris. *Transportation Research Part A: Policy and Practice*. 2008 Aug;42(7):994-1007.
45. Giuliano G. Where is the 'Region' in Regional Transportation Planning. In: *Up Against the Sprawl: Public Policy and the (Re)Making of Southern California*. Minneapolis, MN: University of Minnesota Press; 2004. p. 151-160.
46. Giuliano G. Equity and fairness considerations of congestion pricing. In: *Curbing Gridlock*. Washington, DC: Transportation Research Board, National Academy Press; 1994. p. 250-279.
47. Peters JR, Gordon C. Results not guaranteed: A tale of road pricing in New York and London. *Journal of Urban Technology*, 16(1):113-131, 2009.
48. Rosenbloom S, Burns E. Why working women drive alone: Implications for travel demand management programs. *Transportation Research Record*. 1994 ;1459:39-45.
49. Rosenbloom S. Sustainability and automobility among the elderly: An international assessment. *Transportation*. 2001 ;28(4):375-408.

50. Rosenbloom S. Transit Markets of the Future: The Challenge of Change. Federal Transit Administration; 1998.
51. Rosenbloom S. Women's travel at various stages of their lives. In: Full Circles: Geographies of Women Over the Life Course. London: Routledge; 1993. p. 208-242.
52. Institute on Taxation and Economic Policy. Who Pays? A Distributional Analysis of the tax Systems in All 50 States [Internet]. 2003 ;[cited 2009 Aug 15] Available from: <http://www.itepnet.org/whopays.htm>
53. West SE. 2009. The Incidence of Public Finance Schemes. Macalester College, St. Paul, Minnesota, October.
54. Derrick FW, Scott CE. Sales tax equity: Who bears the burden? *The Quarterly Review of Economics and Finance*. 1998 Summer ;38(2):227-237.
55. Poterba J. Retail price reactions to changes in state and local sales taxes. *National Tax Journal*. 1996 ;27(Fall):169-179.
56. Small KA, Yan J. The Value of "Value Pricing" of Roads: Second-Best Pricing and Product Differentiation. *Journal of Urban Economics*. 2001 Mar ;49(2):310-336.
57. Brownstone D, Ghosh A, Golob T, Kazimi C, Van Amelsfort D. Drivers' willingness-to-pay to reduce travel time: evidence from the San Diego I-15 congestion pricing project. *Transportation Research Part A: Policy and Practice*. 2003 ;37(4):373-387.
58. Lam TC, Small KA. The value of time and reliability: measurement from a value pricing experiment. *Transportation Research Part E: Logistics and Transportation Review*. 2001 ;37(2-3):231-251.
59. Steimetz SS, Brownstone D. Estimating commuters' "value of time" with noisy data: a multiple imputation approach. *Transportation Research Part B: Methodological*. 2005 Dec ;39(10):865-889.
60. Brownstone D, Small KA. Valuing time and reliability: assessing the evidence from road pricing demonstrations. *Transportation Research Part A: Policy and Practice*. 2005 May ;39(4):279-293.
61. Crane R, Schweitzer L. Sustainability, transport, and the built environment. *Built Environment*. 2003 ;29(3):238-252.
62. Small KA. Using the revenues from congestion pricing. *Transportation*. 1992 Dec ;19(4):359-381.
63. Parry I, Bento AMR. Estimating the welfare effect of congestion taxes: the critical importance of other distortions within the transport system. *Journal of Urban Economics*. 2002 ;51(2):339-365.
64. Levine J, Garb Y. Congestion pricing's conditional promise: promotion of accessibility or mobility? *Transport Policy*. 2002 Jul ;9(3):179-188.
65. Paulley N, Balcombe R, Mackett R, Titheridge H, Preston J, Wardman M. The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transport Policy*. 2006 Jul ;13(4):295-306.
66. Light T. Optimal Highway Design and User Welfare under Value Pricing. *Journal of Urban Economics*. 2009 ;66(2):116-124.
67. Cao X, Mokhtarian PL. How do individuals adapt their personal travel? A conceptual exploration of the consideration of travel-related strategies. *Transport Policy*. 2005 May ;12(3):199-206.
68. Clay MJ, Mokhtarian PL. Personal travel management: the adoption and consideration of travel-related strategies. *Transportation Planning and Technology*. 2004 ;27(3):181-209.
69. Mokhtarian P, Raney E. Behavioral response to congestion: identifying patterns and socio-economic differences in adoption. *Transport Policy*. 1997 ;4(3):147-160.
70. Salomon I, Mokhtarian PL. Coping with congestion: Understanding the gap between policy assumptions and behavior. *Transportation Research Part D: Transport and Environment*. 1997 Jun ;2(2):107-123.
71. Home | Transport for London [Internet]. [cited 2009 Aug 5] Available from: <http://www.tfl.gov.uk/>
72. Beevers SD, Carslaw DC. The impact of congestion charging on vehicle emissions in London. *Atmospheric Environment*. 2005 Jan ;39(1):1-5.
73. Atkinson RW, Barratt B, Armstrong B, Anderson HR, Beevers SD, Mudway IS, Green D, Derwent RG, Wilkinson P, Tonne C, Kelly FJ. The impact of the congestion charging scheme on ambient air pollution concentrations in London. *Atmospheric Environment*. 2009 ;43(34):5493-5500.

74. Tonne C, Beevers S, Armstrong B, Kelly F, Wilkinson P. Air pollution and mortality benefits of the London Congestion Charge: spatial and socioeconomic inequalities. *Occupational and Environmental Medicine*. 2008 Sep ;65(9):620-627.
75. Santos G. Urban Congestion Charging: A Second-Best Alternative. *Journal of Transport Economics and Policy*. 2004 Sep ;38(3):345-369.
76. Santos G. Preliminary results of the London congestion charging scheme. *Public Works Management and Policy*. 2004 ;9(2):164-181.
77. Mitchell G. Forecasting environmental equity: Air quality responses to road user charging in Leeds, UK. *Journal of Environmental Management*. 2005 Nov ;77(3):212-226.
78. Friedman MS, Powell KE, Hutwagner L, Graham LM, Teague WG. Impact of changes in transportation and commuting behaviors during the 1996 summer Olympic Games in Atlanta on air quality and childhood asthma. *Journal of the American Medical Association*. 2001 ;285(7):897-905.
79. Rich J, Nielsen OA. A socio-economic assessment of proposed road user charging schemes in Copenhagen. *Transport Policy*. 2007 Jul ;14(4):330-345.
80. Leigh JP, Geraghty EM. High gasoline prices and mortality from motor vehicle crashes and air pollution. *Journal of Occupational and Environmental Medicine*. 2008 Mar ;50(3):249-54.
81. Liu F. Urban ozone plumes and population distribution by income and race: A case study of New York and Philadelphia. *Journal of the Air and Waste Management Association*. 1996 ;46:201-215.
82. Marshall JD, Nethery E, Brauer M. Within-urban variability in ambient air pollution: Comparison of estimation methods. *Atmospheric Environment*. 2008 ;42(6):1359-1369.
83. Parry IWH, Small KA. Does Britain or the United States Have the Right Gasoline Tax? *American Economic Review*. 2005 Sep ;95(4):1276-1289.
84. Garrett M, Taylor BD. Reconsidering Social Equity in Public Transit. *Berkeley Planning Journal*. 1999 ;13:6-27.
85. Garrett M. *The Struggle for Transit Justice: Race, Space, and Social Equity in Los Angeles*. Ph.D. dissertation, University of California, Los Angeles, Department of Urban Planning, 2006.
86. Gardenshire A, Sermons MW. Understanding Automobile Ownership Behavior of Low-Income Households: How Behavioral Differences May Influence Transportation Policy. In *Personal Travel, the Long and the Short of It*. National Academy Press; 2002.
87. Dahlgren J. High-occupancy/toll lanes: where should they be implemented? *Transportation Research Part A*. 2002 ;36:239-255.
88. Center for Neighborhood Technology, Surface Transportation Project. Driven to Spend [Internet]. 2005. Available from: <http://www.transact.org/report.asp?id=236>
89. Ong P. Work and automobile ownership among welfare recipients. *Social Work Research*. 1996 ;20(4):255-262.
90. Ong P, Blumenberg E. Job access, commute, and travel behavior among welfare recipients. *Urban Studies*. 1998 ;35(1):77-93.
91. Blumenberg E. Engendering Effective Planning: Spatial Mismatch, Low-Income Women, and Transportation Policy. *Journal of the American Planning Association*. 2004 ;70(3):269-281.
92. Cervero R. Transit pricing research: A review and a synthesis. *Transportation*. 1990 ;17:117-139.
93. Grengs J. Community-based planning as a source of political change--the transit equity of Los Angeles Bus Riders' Union. *Journal of the American Planning Association*. 2002 ;68(2):168-178.
94. Brown J. Race, class, gender, and public transportation planning: Lessons from the Bus Rider's Union. *Critical Planning Journal*. 1998 ;Spring:3-20.
95. Nuworsoo C, Golub A, Deakin E. Analyzing equity impacts of transit fare changes: Case study of Alameda-Contra Costa Transit, California. *Evaluation and Program Planning*. 2009 ;32(4):360-368.
96. Express Lanes - Toll Schedules [Internet]. [cited 2009 Aug 4] Available from: <http://www.91expresslanes.com/tollschedules.asp>
97. Prepaid Passes & Tokens [Internet]. [cited 2009 Aug 4] Available from: [http://www.metro.net/riding\\_metro/riders\\_guide/paying\\_fare-02.htm](http://www.metro.net/riding_metro/riders_guide/paying_fare-02.htm)
98. MTA Fares Information [Internet]. [cited 2009 Aug 4] Available from: <http://www.mta.info/mta/09/>

99. MBTA.com > Information on Fares and Passes [Internet]. [cited 2009 Aug 4] Available from: [http://www.mbta.com/fares\\_and\\_passes/passes/](http://www.mbta.com/fares_and_passes/passes/)
100. Health and Human Services. 2009 Federal Poverty Guidelines [Internet]. [cited 2009 Aug 4] Available from: <http://aspe.hhs.gov/poverty/09poverty.shtml>
101. Schweitzer L, Brodrick C, Spivey SE. Truck driver environmental and energy attitudes – an exploratory analysis. *Transportation Research Part D: Transport and Environment*, 2008 May ;13(3):141-150.
102. Kawamura K. Perceived Benefits of Congestion Pricing for Trucks. *Transportation Research Record*. 2003 ;1833:59-65.
103. Christian Science Monitor. California budget cuts deep into healthcare, schools | csmonitor.com [Internet]. [cited 2009 Aug 6] Available from: <http://features.csmonitor.com/politics/2009/07/21/california-budget-cuts-deep-into-healthcare-schools/>
104. MSNBC.com Calif. gov cuts more, signs budget - Life- msnbc.com [Internet]. [cited 2009 Aug 6] Available from: [http://www.msnbc.msn.com/id/32190224/ns/us\\_news-life/](http://www.msnbc.msn.com/id/32190224/ns/us_news-life/)