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Just pricing: the distributional effects of congestion pricing and sales taxes

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Abstract Those who oppose tolls and other forms of road pricing argue that low-income, urban residents will suffer if they must pay to use congested freeways. This contention, however, fails to consider (1) how much low-income residents already pay for transportation in taxes and fees, or (2) how much residents would pay for highway infrastructure under an alternative revenue-generating scheme, such as a sales tax. This paper compares the cost burden of a value-priced road, State Route 91 (SR91) in Orange County, California with the cost burden under Orange County's local option transportation sales tax, Measure M. We find that although the sales tax spreads the costs of transportation facilities across a large number of people inside and outside Orange County, it redistributes about $3 million (USD) in revenues from less affluent residents to those with higher incomes. The entire Measure M program redistributes an estimated $26 million from low-income residents to the more affluent. Low-income drivers as individuals save substantially if they do not have to pay tolls, but as a group low-income residents, on average, pay more out-of-pocket with sales taxes.

Keywords Sales taxes · Congestion pricing · Equity · Justice

Introduction

Proposals to impose new charges for roadway use are often criticized as unfair to those with lower incomes (Giuliano 1992, 1994; Sorenson and Taylor 2005). While economists have long advocated congestion or value-pricing as an efficient way to alleviate congestion, skeptics have questioned whether such charges will disproportionately burden impoverished drivers (Small 1992; Vickrey 1994).

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These concerns over the fairness of road pricing implicitly suggest that existing transportation finance methods are fair or just, or at least are more so than pricing. In the US, the road system—and indeed much of the surface transportation system—is financed primarily through gas taxes, vehicle registration fees, and sales taxes, all of which affect the poor (Dill et al. 1999). While the fuel tax is regressive with respect to income, it is progressive with respect to highway use because those who drive more and who drive larger, heavier vehicles tend to use more fuel and, hence, pay more in taxes. In contrast, local option sales taxes for transportation, which have increased significantly over the past two decades compared to fuel tax revenues, are regressive with respect to both income and transportation system use because payments are largely unrelated to driving (Goldstein et al. 2001). Thus, the relevant question is not whether congestion pricing is regressive in the abstract, but whether pricing methods are more or less regressive than other means of paying for transport infrastructure and maintenance. This paper examines that question.

The question takes on enormous significance given several trends in mobility and urbanization. Inflation-adjusted government revenues for transportation in the US increasingly lag growth in vehicle travel (Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation 2006). In the decades ahead, local, state, and regional governments will face difficult choices over how to accommodate increasing travel, particularly in large and rapidly growing metropolitan areas. Three factors combine to make it difficult for fuel taxes to keep up with expanding expenditures: increasing vehicle fuel efficiency, the fact that per-gallon fuel tax revenues do not increase with inflation, and increasing transportation program commitments (Brown 2001; Taylor 1995). Between 1996 and 2004, for example, the ratio of transportation user fee revenues (from all sources) to total highway expenditures declined from 0.93:1 to 0.88:1 (Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation 2006). How policy-makers choose to supplement and/or replace the eroding gas tax in upcoming decades will affect equity, environmental, and mobility goals.

Background

We begin by defining several key concepts. Cost burden is the amount paid by an individual, household, or group. Progressivity means that the ratio of the tax burden to income increases with income; regressivity is the opposite. In most tax incidence research, the concepts of progressivity or regressivity typically relate to income, while in transportation they usually pertain to the costs imposed or the benefits received from transportation services, policies, or taxes. The way we have defined equity reflects a standard approach in public finance that assumes justice or equity concerns the distribution of costs and benefits between groups and among individuals.

Road pricing refers to the practice of charging varying fees for facility use, depending on the marginal costs (delay of others, damage to roadbeds, emissions, etc.) imposed by facility users. There are many options for implementing road pricing. Congestion pricing levies fees on users that vary in relation to facility demand. The fees are set to prompt at least some drivers to travel on a different route, at another time, on a different mode, or to forego a trip entirely in order to reduce delay and increase vehicle throughput. Congestion pricing works by shifting peak-hour, peak-direction trips that drivers value less than their marginal social cost. By internalizing delay, pollution, road damage, etc. costs, road pricing raises the concern that less affluent drivers will be unfairly burdened or "priced off the road" (Cohen 1987).

In contrast, value-priced facilities impose congestion charges on only part of a multiple-lane facility, giving drivers the option of paying to use uncongested toll lanes or remaining in the unpriced lanes. Many of these facilities, called high-occupancy/toll, or HOT, lanes, allow carpoolers to use the priced lane for free or at a reduced rate. Some argue that value-priced facilities, like California State Route 91 (SR91) in Orange County, are consistent with equity goals, because drivers always have the option to remain in the free lane rather than pay into the uncongested lane (Richardson and Bae 1998). Others are not so sanguine, arguing that such facilities allow the rich to buy their way out of congestion, leaving the poor stuck in traffic (Bullard and Johnson 1997; Giuliano 1994; Wachs 1994).

So far, the data on SR91 dispute the idea that only the wealthy use the facility, but it is clear that higher incomes do influence facility usage to some degree. Along with income, the decision to obtain the transponder needed to access SR91 varies with education, language skills, and gender, with women more likely to sign up than men (Parkany 1999). Sullivan and subsequent research find that few people use the SR91 priced facilities every day. About one-third of the corridor travelers from households with incomes below $40,000 use the lanes at least occasionally, compared to about two-thirds of travelers from households with incomes over $100,000 (Sullivan and El Harake 1998).

Nonetheless, as countries around the world have implemented different types of congestion and value pricing schemes in recent years, mounting evidence suggests that individuals vary significantly in their willingness to seek out the benefits or avoid the costs of a congestion/value-priced facility. Further, the effects of any pricing scheme depend on the geospatial distribution of travelers, the transportation network characteristics, and the configuration of potential destinations (Giuliano 1994; Arnott et al. 1994; Glazer and Niskanen 2000; Harvey 1992; Kalmanje and Kockelman 2004; Santos 2004; Santos and Roley 2004; Yang and Zhang 2002). Second, while decisions to opt onto a value-priced facility can vary systematically by driver and household characteristics, such choices also vary significantly for the same individual or household day-by-day and even trip-by-trip during the same day (Small and Gómez-Ibáñez 1999; Small et al. 2005; Sullivan 2002; Sullivan and El Harake 1998). The value of uncongested travel, therefore, reflects both the public and private resources available to individual drivers at a given time. In one exemplary study, women were found to be far more likely than men to engage in more expensive congestion delay mitigation measures, such as buying cell phones, and those with low incomes were less able to employ these mitigating technologies to make up for time lost sitting in traffic (Mokhtarian and Raney 1997).

Tolls are, therefore, traded off against the consequences of late or delayed arrival as well as the monetary and time resources available to the household. Different public or private resources also influence a driver's ability to shift the cost of the toll onto others, such as employers or customers, or to move to alternative roads or modes. For example, many moved to public transit (newly improved by both faster speeds due to congestion reductions and with the additional revenues from tolls) when London's center city cordon congestion toll was introduced in February 2003 (Santos 2004; Small 2004). How a toll affects travel choice and household expenditures depends on a complex array of factors; it is not a simple story of rich and poor.

In contrast, economists agree that even with exemptions for necessities and some "backward shifting" of the cost burden onto producers, sales taxes are income regressive (Fullterton and Lim-Rogers 1993; Baum 1991; Gentry and Ladd 1994; Santi 1994). A sales tax is a consumption tax applied as a percentage of pre-tax expenditure. The burden of sales taxes can in theory be shifted forward onto consumers, backwards onto producers, or even onto the laborers who produce the taxed goods. The net effect of a tax payment depends not only on the tax rate or payment, but also on the supply and demand effects the tax produces (Due and Mikesell 1994). As a result, there may be no strong a priori basis for assuming how much of a sales tax consumers will pay (Fullterton and Lim-Rogers 1993; Derrick and Scott 1998).

Even so, many empirical analyses of tax incidence assume that sales taxes are shifted 100 percent, or more, onto consumers (Besley and Rosen 1998). In a widely cited 1996 study, Poterba (1996) found evidence for complete forward shifting and even *over*-shifting because prices rose more than the cost of the tax. Another study conducted in Maryland found that even though assuming complete forward shifting overstates the overall regressivity of the sales tax by failing to consider the effect of business-to-business transactions, the forward-shifting assumption does accurately reflect sales tax incidence among consumers (Derrick and Scott 1998). As a result, we assume forward shifting.

Case study

How much do different households pay in sales taxes compared to congestion or value pricing? This is a central, but surprisingly unexamined, question in transportation finance. To estimate an answer we examine the SR91 HOT lanes project in Southern California. The priced section of SR91 is in the median of a 10-mile stretch of the congested freeway that links job-rich Orange County in southeastern metropolitan Los Angeles with the housing-rich “Inland Empire” in western San Bernardino and Riverside Counties to the northeast. The revenues generated by SR91 to cover both debt service and operating costs in 2003 were $34.7 million USD and $39 million USD in 2004–2005 (Orange County Transportation Authority 2007). For the purposes of comparison, we use $34 million in 2003 dollars as the revenue target to be raised either through a local option transportation sales tax or through tolls.

The base sales tax rate in California is 7.25%; of that, one percent of the levy is dedicated to counties and cities for transportation and other local infrastructure needs. In addition to the base rate, the voters of Orange County approved Measure M in 1990, which added a half-cent to the sales tax specifically earmarked for transportation, bringing the local sales tax rate to 7.75%. We thus ask the hypothetical: what if $34 million in revenues from SR91 tolls were generated by Measure M revenues rather than by value pricing?

Sales taxes

To compare the payments of sales taxes and congestion tolls by households, consumer expenditures are summed to estimate the cost burden on representative consumers at various income levels. For the sales tax, a consumer expenditure model is estimated using the Bureau of Labor Statistics’ Consumer Expenditure Survey (CES) data for 2002. California, like many states, exempts basic necessities like groceries, medicine, and so on from the sales tax. Our variable of taxable expenditures T_i is constructed by applying a factor of one to all expenditures *(X)* in taxable categories (*k*) reported in the Consumer Expenditure Survey and 0 to all nontaxable expenditure categories:

$$\mathbf{T} = \begin{bmatrix} X_1^1 & \cdots & X_1^k \\ \vdots & & \vdots \\ X_i^1 & \cdots & X_i^k \end{bmatrix} \times \mathrm{t}$$

where $t = 0$ if k is taxable, 2nd $t = 1$, if k is nontaxable.

The total taxable expenditure for each consumer is then summed across categories, creating $T_i = \sum_{1}^{k} X_i$ as the dependent variable in the expenditure models.

In addition to these exemptions, not every consumer purchases every category of taxable good, either due to preferences (such as bicyclists who do not purchase gasoline), item durability, or other issues. Such zero values in our analysis are important as some residents do not use the SR91, just as some consumers do not purchase clothing, during a given time period. So-called "double hurdle" models of consumer expenditure reflect first the probability of purchase, and then the amount purchased. The probability of goods purchase (P_j) is estimated using the familiar logit form, while a separate model of expenditure levels, $E(T)$, is estimated using OLS regression. Both stages use socioeconomic factors to predict consumption.

The results of the logit model are shown in the first column of Table 1. The second column of Table 1 displays the results of the second stage of the expenditure model. Even though the OLS model shows a comparatively low overall fit, with an adjusted R-square of 0.1932, the model is significant at 0.05, and the variables demonstrate the expected signs, relative magnitudes, and significance levels. As expected, income shows a strong, positive relation to expenditures; the more people make, the more they spend on both taxable and nontaxable goods. But, as expected, taxable expenditures as a percentage of income falls as incomes rise. A dummy variable for mortgage-holding homeowners demonstrates a strong, positive relationship with taxable expenditures.

Table 1 Consumer expenditures models

	Logit P_j		Taxable expenditures	
	Beta	Std. Error	Beta	Std. Error
Intercept	3.455***	0.1481	1556***	79.4
After tax income	0.0004586***	0.0000396	0.002917***	0.00634
Small city	−0.029050*	0.0117	−367.7 003212***	66.99
Western region	1.115***	0.1670	532.4***	69.11
Northeast region	0.478**	0.07799	406.1***	77.89
Midwest region	0.8091***	0.1455	358.02***	69.43
Mortgage	0.908***	0.1819	371.5***	71.5
Renter dummy	−0.2193*	0.1266	−542.60***	74.22
Children	0.009164	0.08106	154.7***	32.88
Retirement age	0.3908***	−0.08057	−377.02***	45.9
African American	0.0172***	0.04040	−374.2	354.3
Latino	−0.7285***	0.1750	−372.22**	121.5
Asian	0.1130	0.3941	−201.8	173.7
Single mother	−0.4568	0.3857	−688.03***	207.6
Single father	0.1717	0.2075	525.1	579.2
Children 2–15	−0.7318**	0.2796	279.9**	101.4
Children over 15	0.6329	0.3879	364.2***	102.4
Income * Asian	−0.2673*	0.00012	−6188.04**	2515.3
Inc * African American	0.00006088	0.00003795	−9885.06	6748.3
Inc * Latino	0.00001435	0.0000194	−6960.30**	2515.97

Source: Consumer Expenditure Survey, model results by the authors. * = significance at 0.1; ** = significance at 0.05; *** = significance at 0.01

Being single tends to decrease the amount of taxable outlays, although not uniformly. An interaction term between dummy variables for single motherhood and fatherhood show that neither of these significantly affects the likelihood of purchase, but single motherhood does decrease the amount of taxable expenditure. An interaction term between the dummy variable denoting single motherhood and income shows a strong, positive association, so that as incomes rise among single mothers, they are more likely than other groups to consume taxable goods and services. This makes sense, as many taxable services, like prepared food consumed away from home, are useful time savers for a single parent (Paulin and Lee 2002).

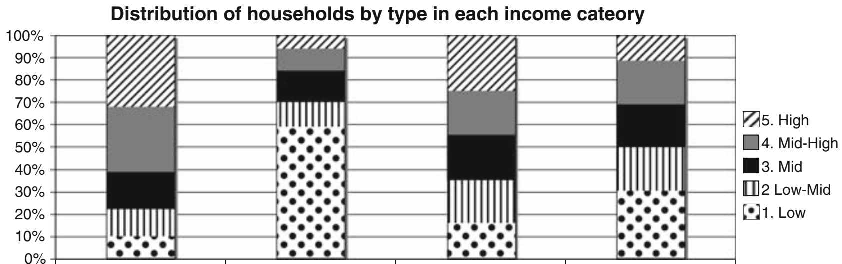
The findings with regard to race and ethnicity are mixed, in previous studies (Paulin 1998). Latino and Asian respondents consistently spend less on taxable goods than either their white (the base case) or African American counterparts. This is true even when interacted against income, suggesting that, even at higher income levels, Latino and Asian households tend to spend less on taxable goods than comparable white households. The coefficients are similar for African American households, but the estimates are not significant, perhaps due to the smaller sample size.

Finally, family status does not appear to affect the probability that a household will make taxable expenditures (in the logit model), but the number of children in a household and their ages do. And the more children, the higher the taxable and total outlays a household makes. Also, families with older children (over the age of 15) spend significantly more on taxable items than do those who have young children (under age two). Families with children aged two to fifteen also spend more than those with young children, and households with at least one retired person spend significantly less on taxable goods.

The model results collectively suggest that, in constructing estimates of representative consumers in Orange County from this national sample, there are good reasons to differentiate by income level, gender, ethnicity, family type, and parental status. However, it becomes too cumbersome to stratify by all these variables, as well as by number and ages of children. So to balance our model results with the demands of parsimony, we stratify our estimates by family type (which includes sex of householder) and income. Although average incomes in Orange County are higher than the rest of the US (and higher than most of California), there are working class and lower-income households as well. It is particularly important to distinguish consumer expenditure units by sex because a disproportionate number of women head lower income households; the concentration of women in lower income households is shown in Fig. 1.

To estimate the total outlay of taxable expenditures by household category, the predicted probability of purchase estimated in the first stage is multiplied by the OLS estimate to derive an average predicted expenditure, $E[T]$, which is weighted by P_j, the probability of purchase. Table 2 shows the expected expenditure for each stratum, the yearly tax payments that result from a half-cent sales tax, and, in the last column, these payments as a percentage of the median income for the category. While total sales tax payments increase with income for each household type, the percentage of income spent on taxable expenditures is inversely related to income, demonstrating that the sales tax is indeed regressive with respect to income.

Total expenditures are a better predictor of taxable expenditures than income for several reasons. Reporting in the CES is lower for income than total expenditures, due to retired consumers spending from savings and inconsistent reporting of income among the respondents with very little income. Unfortunately, the US Census reports incomes and not expenditures, so in order to apply the results of the expenditure models to Orange County residents, we are limited to the admittedly imperfect income data rather than the likely more accurate expenditure data. But because income performs so poorly in taxable



	Married couples	Single Mothers	Single Fathers	Nonfamily households
5. High	170,561	11,169	7,316	29,696
4. Mid-High	154,070	18,606	5,809	51,427
3. Mid	89,390	26,434	5,902	50,601
2 Low-Mid	64,437	20,859	5,638	50,098
1. Low	54,857	110,850	4,768	80,420

Household type

Fig. 1 Distribution of income groups and households by household type, Orange County. *Source*: Data compiled by the authors from the US Census, STF File 3

expenditure models for the 1st income group reported in the CES, we treat the median reported expenditure as the expected expenditures for this income group only, rather than using the model estimates.

In order to approximate the total contributions to sales tax revenues by Orange County residents, we assume the expected taxable expenditures, $E[T]$, for each representative consumer apply to each family type f in each income group d in Orange County. The expected expenditure is multiplied by the number N of families in each family type f in each income group d:

$$\overline{\mathbf{T}} = \begin{bmatrix} E[T]_1^1 \\ \vdots \\ E[T]_{10}^f \end{bmatrix} \times \left[N_1^1 \cdots N_d^f \right]$$

Each individual element in the resulting matrix $\overline{\mathbf{T}}$ is the total contribution of any one family type in any income group. The total tax contribution of any income group is the sum across all family types and all households, and summed across all income groups for a total tax revenue prediction. When checked against the total taxable sales of Orange County, which run to just under \$45 billion USD, the total Measure M revenue is about \$240 million. Non-residents of Orange County pay a sizable portion of this figure, of course, just as Orange County residents make taxable expenditures outside of their home county. Orange County is home to Disneyland, beaches, and major retail, sports, and entertainment centers, which combined attracted nearly 25.3 million visitors in 2003, adding an estimated \$161 million USD to the county's local sales tax receipts. Business transactions also contribute to the total sales tax take. Thus, our model predicts the Orange County household sector's share of total sales tax receipts at a little less than half of total sales tax receipts, with travelers, external residents, and businesses making up the rest.

Toll expenditures

Because there is a sample of revealed toll payment behavior from the SR91 facility, there was no need to estimate expected toll revenues. Instead, data from a survey of

Table 2 Predicted taxable expenditures

Group	Family households				Non-family households			
	Median income	$E[T]$ (s)	Tax	Percent of income	Median income	$E[T]$	Tax	Percent of income
Single women								
1	$0	$2,764	$13.82		$648	$1,708	$17.08	2.64%
2	7,595	3,088	15.44	0.20%	7,536	1,228	12.28	0.16
3	12,500	3,708	18.54	0.15	12,310	2,014	20.15	0.16
4	17,000	4,064	20.32	0.12	17,388	3,088	30.88	0.18
5	24,600	4,856	24.28	0.10	24,000	4,212	42.12	0.18
6	34,000	6,576	32.88	0.10	34,100	6,636	66.36	0.19
7	43,932	8,676	43.38	0.10	44,158	7,116	71.16	0.16
8	56,000	9,132	45.66	0.08	58,000	9,272	92.72	0.16
9	79,888	9,580	47.9	0.06	81,779	10,728	107.28	0.13
10	113,669	16,648	83.24	0.07	128,285	16,340	163.4	0.13
Single men								
1	0	4,332	43.32		540	2,508	25.08	4.64
2	7,968	4,024	40.24	0.51	7,300	1,720	17.2	0.24
3	12,000	5,600	56	0.47	12,060	2,440	24.4	0.20
4	17,540	3,648	36.48	0.21	17,000	3,080	30.8	0.18
5	24,000	4,428	44.28	0.18	24,555	3,602	36.028	0.15
6	34,668	5,672	56.72	0.16	34,056	5,356	53.56	0.16
7	43,833	6,052	60.52	0.14	44,420	7,328	73.28	0.16
8	58,928	9,344	93.44	0.16	59,000	9,532	95.32	0.16
9	78,000	10,120	101.2	0.13	81,394	11,712	117.12	0.14
10	115,080	10,604	106.04	0.09	130,000	15,888	158.88	0.12
Married couple								
1	0	5,380	53.8		0	4,404	44.04	
2	7,896	4,580	45.8	0.58	7,900	3,832	38.32	0.49
3	12,948	3,432	34.32	0.27	13,015	2,847	28.47	0.22
4	17,462	3,408	34.08	0.20	17,838	2,956	29.56	0.17
5	24,500	4,716	47.16	0.19	24,211	4,260	42.6	0.18
6	35,000	6,100	61.00	0.17	34,736	6,110	61.00	0.18
7	44,567	7,724	77.24	0.17	44,833	11,896	118.96	0.27
8	59,066	9,824	98.24	0.17	54,850	11,840	118.4	0.22
9	82,000	11,840	118.4	0.14	82,714	16,460	164.6	0.20
10	129,300	16,460	164.6	0.13	131,300	22,572	225.72	0.17

Source: Data compiled by the authors from the CES data. Sensitivity analyses for the expected values are available from the authors

SR91 users collected in the fall of 1999 report toll payments and timing by basic household characteristics, such as income and the presence of children in the household.[1] The demographic and use data for the SR91 survey come from a spatially and

[1] These data are available from the California Polytechnic and State University at: http://ceenve3.civeng.calpoly.edu/sullivan/sr91/Survey_downloads.html

Table 3 Estimated contributions by each of five income groups to SR91 Express Lanes costs under two finance method and no sales tax exporting

Group	Median income	Sales taxes	Tolls	Gain or Loss	Loss/Gain per family
1 Low	$7,126	$3,353,241	$0.00	−$3,353,242	−66.60
2 Low-Mid	22,221	1,789,375	3,906,577	2,117,202	36.72
3 Mid	40,902	3,977,632	7,345,369	3,367,737	42.47
4 Mid-high	67,427	10,798,820	12,731,744	1,932,924	14.60
5 High	180,830	14,080,930	10,006,040	−4,074,890	−27.46

Source: Data compiled by the authors from the CES and SR91 data

demographically representative sample of SR91 tollway users and a subsample of those who do not use the tollway. Users come from around the region, though primarily from Orange and adjacent Riverside Counties. Unfortunately, the SR91 survey did not ask about ethnicity, or separate out single from other parents. If the sample of 1,788 respondents is representative of all facility users and nonusers, we can treat each income group's relative contribution to the total take derived from the users in the sample to total SR91 revenue of $34 million USD. This means we assume that there is no sales tax exporting for the moment; we will come back to that assumption. The sample data from SR91 report incomes in six categories, which required us to collapse both the sales tax and SR91 households into five income groups and distribute households accordingly. Because the lowest income group has no respondents among SR91 users, the three lowest groups from the CES estimates are collected into one group at the lowest income level.

The resulting distributions of revenues under the two schemas—the voluntary toll payments by users of the SR91 facility and the involuntary payments of sales taxes—are shown in Table 3. According to this analysis, households in the lowest income group contribute little to SR91 toll revenue because the sample shows that members of this group seldom use the facility, and when they do they are more likely than those in higher income categories to do so during less congested time periods with lower tolls. As a group, however, they contribute over $3 million USD in Orange County sales tax revenues. Their contribution, along with a sales tax contribution of over $4 million from the highest income group, is redistributed to households in the middle groups, who fare much better under a general sales tax than under a tolling scheme, because they are the heaviest users of the facility.

Household-level price incentives

In addition to examining the relative transfer of toll and sales tax payments among lower to higher income groups under the two pricing schemes, it is also important to examine how the different revenue instruments affect the price and incentive structure for representative consumers. To do so, we constructed 140 representative consumer types based on income and SR91 use patterns. Table 4 lays out the SR91 use profiles for heavy, moderate, and infrequent users of the facility whose use occurs during peak and non-peak hours. We assume that those traveling during peak hours do so because they cannot avoid it.

Table 4 Estimated annual SR91 costs paid by representative users

	Peak period			Off-peak user		
	Heavy	Moderate	Infrequent	Heavy	Moderate	Infrequent
Toll	$3.60	$3.60	$3.60	$1.65	$1.65	$1.65
Times per week	5	3	1	5	3	1
Number of weeks	40	30	20	45	35	20
Yearly cost	$720	$324	$72	$371.25	$173.25	$33

Source: Toll levels from SR91 documentation, other numbers are the authors' assumptions and calculations

The 140 types are single-mother families and married-couple families from each income group by use profiles. The savings that a family of SR91 tollway users would derive if the facility had been financed by local option sales tax revenues is simply the total yearly toll less the yearly sales tax paid (from Table 2). We assume that if the facility were financed with sales tax revenues, it would operate with uncongested conditions, at least in the near term, because of the substantial increase in free lane capacity (50%, from 4 to 6 lanes in each direction). Those benefits, of course, would dwindle as the lanes recongest in the absence of pricing or another means to ration road use.

The results for representative household types are shown in Table 5. Just as the sales tax burden is regressive with respect to income, the savings from *not paying* congestion tolls are progressively distributed, but this is only true among drivers who use the facility. Because drivers in the very lowest income groups seldom use the facility, their savings are negligible. Yet, frequent tollway users benefit substantially as individuals from shifting the costs of the facility onto others via the sales tax. These savings can be as high as $700 a year for heavy users. The relative gains for heavy users in the lower (but not lowest) income groups are especially large. The gains to moderate users of the facility are much smaller, but (at around $300 per expenditure unit per year) still sizeable. Our calculations here assume that drivers are all going to pay the same amount. If policy-makers are worried about low-income, peak-period commuters paying tolls, it is possible to provide discounted "lifeline" pricing by income or to provide credits to lower-income commuters.

Who would lose in a shift from tolls to sales tax finance? Middle- and higher-income infrequent users of SR91 and the very large pool of residents, businesses, and tourists in Orange County who do not travel on or directly benefit from the SR91 facility. The magnitude of the increased cost burden to the losers under a sales tax (from $5 to $80, depending on the individual consumer unit) is much smaller than the gains to the regular users of SR91 because the absolute number of sales-tax-paying losers is so much larger. But in relative terms, the biggest losers under sales tax finance would be the large number of sales-tax-paying lower-income households in Orange County whose members do not make use of SR91.

Given that sales taxes are subject to export, our expected contributions for Orange County residents to the sales tax may go down by as much as half for this facility due to the presence of significant retail and tourist outlets in the region. But it is important to realize that though sales taxes may be exported, shopping and tourist visitors to Orange County are likely to be, on the whole, less affluent than most residents of Orange County, because residents of neighboring jurisdictions in Los Angles, Riverside, and San Bernardino Counties are markedly less affluent than those living in Orange County. The

Table 5 Estimated savings from sales tax finance of SR91 versus congestion tolls by representative household type, no sales tax exporting or shifting

Income groups	Peak period user						Off-peak user						Nonusers	
	Heavy		Moderate		Infrequent		Heavy		Moderate		Infrequent			
Single women														
1	$0.00	0.00%	$0.00	0.00%	0.00	0.00%	$0.00	0.00%	$0.00	0.00%	$0.00	0.00%	−$13.82	0.00%
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−46.88	−0.62
3	701.46	5.61	305.46	2.44	53.46	0.43	352.71	2.82	154.71	1.24	14.46	0.12	−18.54	−0.15
4	699.68	4.12	303.68	1.79	51.68	0.30	350.93	2.06	152.93	0.90	12.68	0.07	−20.32	−0.12
5	695.72	2.83	299.72	1.22	47.72	0.19	346.97	1.41	148.97	0.61	8.72	0.04	−24.28	−0.10
6	687.12	2.02	291.12	0.86	39.12	0.12	338.37	1.00	140.37	0.41	0.12	0.00	−32.88	−0.10
7	676.62	1.54	280.62	0.64	28.62	0.07	327.87	0.75	129.87	0.30	−10.38	−0.02	−43.38	−0.10
8	674.34	1.20	278.34	0.50	26.34	0.05	325.59	0.58	127.59	0.23	−12.66	−0.02	−45.66	−0.08
9	672.1	0.84	276.1	0.35	24.1	0.03	323.35	0.40	125.35	0.16	−14.9	−0.02	−47.9	−0.06
10	636.76	0.56	240.76	0.21	−11.24	−0.01	288.01	0.25	90.01	0.08	−50.24	−0.04	−83.24	−0.07
Married couples														
1	$0.00	0.00%	$0.00	0.00%	0.00	0.00%	$0.00	0.00%	$0.00	0.00%	$0.00	0.00%	−26.9	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−22.9	−0.29
3	702.84	5.43	306.84	2.37	54.84	0.42	354.09	2.73	156.09	1.21	15.84	0.12	−17.16	−0.13
4	702.96	4.03	306.96	1.76	54.96	0.31	354.21	2.03	156.21	0.89	15.96	0.09	−17.04	−0.10
5	696.42	2.84	300.42	1.23	48.42	0.20	347.67	1.42	149.67	0.61	9.42	0.04	−23.58	−0.10
6	689.5	1.97	293.5	0.84	41.5	0.12	340.75	0.97	142.75	0.41	2.5	0.01	−30.5	−0.09
7	681.38	1.53	285.38	0.64	33.38	0.07	332.63	0.75	134.63	0.30	−5.62	−0.01	−38.62	−0.09
8	670.88	1.14	274.88	0.47	22.88	0.04	322.13	0.55	124.13	0.21	−16.12	−0.03	−49.12	−0.08
9	660.8	0.81	264.8	0.32	12.8	0.02	312.05	0.38	114.05	0.14	−26.2	−0.03	−59.2	−0.07
10	637.7	0.49	241.7	0.19	−10.3	−0.01	288.95	0.22	90.95	0.07	−49.3	−0.04	−82.3	−0.06

Source: Data imputed by the author from CES, Census, and SR91 survey data fact that a tax may be exported does not lessen the tax's potential regressivity—it may, in fact, worsen it.[2]

However, our point has been to show that the equity of revenue-generating instruments has to be understood relative to alternatives. By shifting taxes for infrastructure development onto visitors and onto nondrivers, the relative savings drivers get when they are not paying a toll go up. Thus, heavy peak users cost savings grow to $800 with exporting.

Conclusions

Are tolls regressive? According to this and many previous analyses, yes. But for transport policy, whether tolls are regressive fails to fully address the justice and fairness issues that arise in financing road use. Whenever members of lower income groups pay for services, they may be expected to pay a greater share of their income than do the wealthy. Strictly speaking, public transit fares are regressive. The fact that congestion tolls are regressive in the abstract reflects only one aspect of the distributional justice issues facing transportation and taxation. The real issues are comparative: are congestion tolls more or less regressive than other tax or price strategies? We endeavored to answer this question in part by comparing who pays under a value-priced high-occupancy/toll facility in Orange County, California with the most rapidly growing new form of transportation finance in the US: the local option sales tax. Our example is particularly relevant, given the rise in both sales tax proposals and congestion/value pricing projects around the US.

In sum, we find that shifting from value pricing to local transportation sales tax finance entails two cost burden transfers: (1) from low and high-income households to middle-income households and (2) from regular users of the road facility to people who rarely or never use it—with higher-income non-users bearing the largest added burden in absolute terms, and lower-income non-users in relative terms. So in comparison to transportation sales taxes, the value-priced HOT lane facility examined here is progressive with respect to income among lower income households (income groups 1, 2, and 3), and regressive with respect to income among higher income households (income groups 4 and 5). The savings from toll avoidance is similarly progressive for all income classes. It is possible to understand why, in situations such as New York City's proposed $8 a day toll (over $1,500 a year on the low end for most commuters with *no* option to remain in free lanes), people become concerned about the costs facing low-income drivers.

The estimates developed for this analysis illustrate the trade-offs involved in turning to general sales taxes in order to finance infrastructure. The sales tax, because it is paid by virtually everyone, spreads the costs of infrastructure across a broad base of consumers. It costs each family comparatively little, but these burdens are regressively distributed. In

[2] Without more information on the demographics of individuals traveling to Orange County to purchase sales or services, we can only infer a few, limited things. Orange County residents as a group are among the most affluent people in the US. It is likely that visitors to Orange County are on average less affluent at the mid to higher income levels than Orange County residents. Visitors may also be, on average, more affluent than the mid to low-income residents of Orange County. Thus, if we were to relax the geographic constraints of the cost estimations, it is likely that the tax incidence would be more regressive than our constrained estimates at the group level for the whole body of consumers paying into the county coffers—including those outside of Orange County. However, the burden for individual low-income households within Orange County lessens because of the cross-payments from outsiders. That much is evident because the tax base increases. This story would be different in a jurisdiction with a smaller retail base than Orange County or in a place where the jurisdiction levying the tax is on average less affluent than its visitors. Again, context matters.

comparison to higher-income groups, low-income households pay the highest proportion of their income on sales taxes; we find in our geographically constrained estimation that households in the lowest income group would contribute over $3 million out of the $34 million in SR91 revenues were these monies to come from sales taxes rather than tolls. With exporting, the amount paid by all income classes go down significantly, but the relative regressivity of the tax instrument worsens, depending on the mix of shoppers and tourists visiting the County.

While the income regressivity of sales taxes is an issue, it becomes an even greater concern when one notes how much sales tax revenues, when spent on transportation projects that primarily benefit individual users of an improved facility, redistribute cost burdens from users to non-users. In this case, the heaviest users of SR91's priced lanes—who are the largest beneficiaries of the time savings it provides—are disproportionately from middle- and upper-middle income households both inside and outside of Orange County. While it is beyond the scope of this paper to compare such benefits in detail, we can say that if Orange County's Measure M had financed the SR91 facility, the added capacity would have lowered the direct time and money costs of peak-hour, peak-direction trips on SR91 in the short term, but resulted in higher aggregate levels of person- and vehicle delay in the longer term if congestion re-occurs. From a regional planning perspective, funding freeway capacity with the sales tax is a pro-auto/pro-driving policy that taxes all residents, the rich and (disproportionately) the poor, to provide benefits to a smaller group of drivers and their passengers.

These problems are especially a concern if the environmental, energy, safety, and congestion externalities associated with driving are also regressively distributed (Schweitzer and Valenzuela Jr. 2004). If these externalities are, in fact, regressively distributed, then the Measure M transportation sales tax, if used on road projects, would disproportionately tax poorer residents to subsidize an activity whose externalities (such as noise and freeway-adjacent particulate emissions) harm them.

The larger policy question concerns whether drivers at any income level should be given cost savings for behaviors that exert significant environmental and social costs. Concern over a subset of drivers—those with low-incomes on freeways—means that all drivers, rich, middle-income, and poor alike, avoid paying the marginal social costs of their driving. At the same time, governments throughout at the US at the federal, state, and local levels have adopted policies that attempt to discourage driving and demand for freeway capacity. Policy and planning responses to rising metropolitan congestion have included supply strategies (adding road and transit capacity, increase transit services) and demand-side strategies (shifting land use patterns to encourage more walking and transit use). None of these have proven effective responses to waxing metropolitan traffic congestion. Rather than pricing freeway driving well below its marginal social costs because tolls might burden impoverished drivers, targeted policies such as discounts to low-income families can help ease the cost burdens for families who face high costs. It is similarly possible to use toll revenues to improve lower-cost public transit alternatives to commuting in congestion or paying tolls and to provide revenues to local communities (Gómez-Ibáñez 1992; Small 1992; King et al. 2007).

While regressive and counter to Smart Growth and other sprawl-reduction policies, transportation sales taxes are just as clearly popular politically while congestion tolls are not (Giuliano 1992; Gómez-Ibáñez 1992). The substantial majority of families that would pay more via sales tax finance than with tolls are able to spread the costs of sales taxes throughout the entire year, paying a little at a time at points of purchase over hundreds of transactions rather than making bigger payments for a transponder and monthly toll bills.

Sales taxes are also easy for cities and counties to collect, and, as we have discussed, jurisdictions are able to export part of the tax burden onto people from other places—the famous desire cleverly described by the comedy troupe Monty Python to “tax foreigners living abroad.” But the sales tax’s transactional ease and its disassociation from driving also help to reduce the perceived cost of vehicle use, particularly for high marginal social cost peak-hour, peak-direction metropolitan highway trips. As a matter of policy, we cannot expect individual drivers to make socially or environmentally desirable decisions about their driving behavior if such costs are hidden to this extent, and if financing methods explicitly shield them from even perceiving the costs of their choices.

Over the long term, the spatial arrangement of jobs and housing in metropolitan regions results from a complex set of social, economic, and regulatory factors (Boarnet and Crane 2001). Our paper does not address the broader questions of urban form, housing choices, and the costs that these can impose on commuters, or the benefits that impoverished commuters may receive from congestion reduction or added capacity. These are important subjects for future research. The problems with the transportation sales tax we have outlined here may not be generalizable to sales tax revenues used to finance other infrastructure and services, such as affordable housing. For example, if the sales tax-funded transit services for riders who come disproportionately from low-income households, the sales tax could transfer resources towards lower-income households. As others have shown, toll revenues spent on public transit can help make their ultimate effect less regressive and, in some cases, progressive; the same may be true of sales taxes used to fund public transit operations or fare subsidies.

Using sales taxes to fund roadways creates substantial savings to drivers by shifting some of the costs of driving from drivers to consumers at large, and in the process disproportionately favors the more affluent at the expense of the impoverished. Others have shown such transfers to be inefficient; we argue it is inequitable as well. The operational and environmental arguments for marginal social cost road pricing are many, and this analysis suggests that the social equity arguments against it are weak.

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References

Arnott, R., de Palma, A., Lindsey, R.: The welfare effects of congestion tolls with heterogeneous commuters. J. Transport Econ. Pol. **28**, 139–161 (1994)

Baum, D.N.: Economic effects of including services in the sales tax base: an applied general equilibrium analysis. Public Financ. Quart. **19.2**, 166–192 (1991)

Besley, T.J., Rosen, H.: Vertical externalities in tax setting: evidence from gasoline and cigarettes. J. Public Econ. **70**, 383–398 (1998)

Boarnet, M., Crane, R.: (2001) Travel by Design. Oxford University Press, Oxford (2001)

Brown, J.: Reconsidering the gas tax: paying for what you get. Access **19**, 10–15 (2001)

Bullard, R.D., Johnson, G.S.: Introduction. In: Bullard, R., Johnson, G. (eds.) Just Transportation, pp. 1–6. Island Press, Gabriola Island, BC (1997)

Cohen, Y.: Commuter welfare under peak-period congestion tolls: who gains and who loses? Int. J. Transport Econ. **14.3**, 239–266 (1987)

Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance.: The Fuel Tax and Alternatives for Transportation Funding. Transportation Research Board, Washington DC (2006)

Derrick, F.W., Scott, C.E.: Sales tax equity: who bears the burden? Q. Rev. Econ. Finance **38. 2**, 227–237 (1998)

Dill, J., Goldstein, T., Wachs, M.: California vehicles fees: incidence and equity. J. Transport Stat. **2. 2**, 133–148 (1999)

Due J.F., Mikesell J.C.: (1994) Sales Taxation. Washington, DC, Urban Institute

Fullterton, D., Lim-Rogers, D.: Who Bears the Lifetime Tax Burden. Washington, DC (1993)

Gentry, W.M., Ladd, H.F.: State tax structure and multiple policy objectives. Natl. Tax J. **47.4**, 747–769 (1994)

Giuliano, G.: An assessment of the political acceptability of congestion pricing. Transportation **19.4**, 335–358 (1992)

Giuliano, G.: Equity and fairness considerations of congestion pricing. In: Curbing Gridlock, pp. 250–279. Transportation Research Board, National Academy Press, Washington, DC (1994)

Glazer, A., Niskanen, E.: Which consumers benefit from congestion tolls? J. Transport Econ. Pol. **34**, 43–54 (2000)

Goldstein, T., Corbett, S., Wachs, M.: Local option transportation taxes in the United States: Issues and trends. Berkeley, CA (2001)

Gómez-Ibáñez, J.A.: The political economy of congestion charges. Transport. Q. **46.3**, 343–360 (1992)

Harvey, G.W.: Transportation pricing and travel behavior. In: Curbing Gridlock, pp. 89–119. Transportation Research Board, National Academy Press, Washington, DC (1992)

Kalmanje, S., Kockelman, K.M.: Credit-based congestion pricing: travel, land value and welfare impacts. Transport. Res. Rec. **1864**, 45–53 (2004)

King, D., Manville, M., Shoup, D.: The political calculus of congestion pricing. Transport Pol. **14**, 111–123 (2007)

Mokhtarian, P., Raney, E.: Behavioral response to congestion: identifying patterns and socio-economic differences in adoption. Transport Pol. **4. 3**, 147–160 (1997)

Orange County Transportation Authority: 91 Express Lanes Fast Facts (2007). URL: http://centerline.octa.net/pdf/91.pdf

Parkany, E.: Can hot lanes encourage carpooling? A case study of carpooling behavior on the 91 express lanes. Transport. Res. Board Rec. **1682**, 46–54 (1999)

Paulin, G.D.: A growing market: expenditures by Hispanic consumers. Monthly Labor Rev. March, 3–21 (1998)

Paulin, G.D., Lee, Y.G.: Expenditures of single parents: how does gender figure in? Monthly Labor Rev. July, 16–37 (2002)

Poterba, J.: Retail price reactions to changes in state and local sales taxes. Natl. Tax J. 27(Fall), 169–179 (1996)

Richardson, H.W., Bae, C.-H.: The equity impacts of road congestion pricing. In: Button, K. Verhoef, E. (eds.) Road Pricing, Traffic Congestion, and the Environment: Issues of Efficiency and Social Feasibility, pp. 247–262. Edward Elgar, Cheltenham (1998)

Santi, L.: Estimates of the state sales and use tax on Arkansas households, 1989–1995. Arkansas Bus. Econ. Rev. **27**(1), 10–18 (1994)

Santos, G.: Preliminary results of the London congestion charging scheme. Public Works Manage. Pol. **9.2**, 164–181 (2004)

Santos, G., Roley, L.: Distributional impacts of road pricing: the truth behind the myth. Transportation **31**, 21–42 (2004)

Schweitzer, L, Valenzuela, A., Jr.: Environmental justice and transportation: the claims and the evidence. J. Plann. Literature **18.4**, 383–398 (2004)

Small, K.: Urban Transportation Economics. Harwood Academic Publishers, New York (1992)

Small, K.A.: Unnoticed lessons from London: road pricing and public transit. Access **26**, 10–15 (2004)

Small, K.A., Gómez-Ibáñez, J.A.: Urban transportation. In: Chesire, P., Mills, E. (eds.) Handbook of Regional and Urban Economics, pp. 1936–1999. North-Holland, New York (1999)

Small, K.A., Winston, C., Yan, J.: Uncovering the distribution of motorists' preferences for travel time and reliability. Econometrica **73. 4**, 1367–1377 (2005)

Sorenson, P., Taylor, B.: Review and Synthesis of Road-Use Metering and Charging Systems. The National Academies Press, Washington, DC (2005)

Sullivan, E.: State Route 91 value-priced express lanes: updated observations. Transport. Res. Rec. **1812**, 37–42 (2002)

Sullivan, E., El Harake, J.: The CA Route 91 toll lanes—Impacts and other observations. Transport. Res. Rec. **1649**, 55–62 (1998)

Taylor, B.: Public perceptions, fiscal realities, and freeway planning: the California case. J. Am. Plann. Assoc. **61.1**, 43–56 (1995)

Vickrey, W.S.: Marginal cost pricing. In: Arnott, R. (ed.) Public Economics: Selected Papers by William, pp. 198–215. Cambridge University Press, Cambridge (1994)

Wachs, M.: Will congestion pricing ever be adopted? Access **4**, 15–19 (1994)

Yang, H., Zhang, X.: Multi-class toll design problem with social and spatial equity constraints. J. Transport. Eng. **128. 5**, 420–28 (2002)

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