Statistical Assessment of Public Opinion Toward Conversion of General-Purpose Lanes to High-Occupancy Vehicle Lanes

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Converting general-purpose lanes to high-occupancy vehicle (HOV) lanes is a policy that has been meticulously avoided since the public outcry opposing the lane conversion projects of the 1970s. Now that HOV lanes are firmly established in many metropolitan areas one has to wonder if public sentiments toward such lane conversions have changed. Public opinion of an HOV lane conversion recently completed in the Seattle metropolitan area is assessed. A series of multinomial logit and ordered probit models are estimated to isolate factors that determine commuters' attitudes toward various HOV policies (including lane conversion). The results show that although lane conversions are still strongly opposed by a substantial portion of the population, the intense public resistance encountered in the 1970s appears to be waning. Most of the survey respondents were either neutral or in favor of lane conversion projects.

High-occupancy vehicle (HOV) lanes have become one of the mainstays of urban traffic congestion mitigation in the United States. Although their effectiveness is sometimes questioned by the public, numerous research studies have shown apparent operational, safety, and benefit–cost advantages of HOV facilities. These studies have formed the basis for the continued expansion of HOV lane systems throughout North America.

Two methods have been widely used to provide HOV lanes: (a) constructing new lanes and (b) restriping an existing roadway by reducing lane or shoulder widths to accommodate the addition of an HOV lane. A third method, creating an HOV lane by taking (or converting) an existing general-purpose lane, has considerable potential from a cost reduction perspective. However, this is one approach that the HOV lobby has purposely avoided so as not to arouse public resistance to HOV lane implementation. The concern relating to possible public backlash against converting general-purpose lanes to HOV lanes is well founded. During the early stages of HOV lane implementation (in the 1970s) two infamous projects converted lanes of general traffic to create HOV lanes: (a) the Santa Monica Freeway project in Los Angeles (21.0 km of the inside lane of a four- or five-lane freeway was converted to a three-plus-passenger HOV lane), and (b) the Southeast Expressway project in Boston (13.3 km of a three-lane freeway was converted to a three-plus-passenger HOV lane). Analyses of the impacts of these projects showed that they were generally successful: HOV travel times improved, mode shifts from single-occupant vehicle to carpool or bus were observed, and good levels of safety were found in both cases (*1–3*). Despite these seemingly positive analyses, both the Santa Monica Freeway and Southeast Expressway HOV lanes were terminated after 5 and 6 months of operation, respectively, because of negative public opinion. The lesson seemed clear: in terms of HOV lane viability, operational impacts take a distant back seat to public opinion.

Since the lane conversion attempts of the 1970s the public has had nearly 20 years to warm up to HOV lane projects that have added HOV lanes through either construction or restriping. A natural question to ask is whether or not public opinion toward HOV lanes has swayed sufficiently so that lane conversions are now considered a tolerable policy. In fact, a number of researchers have begun addressing this question (*4,5*). The intent of the study described here was to evaluate public opinion toward a recent HOV lane conversion in the Seattle metropolitan area. It is hoped that the findings can provide valuable information with regard to the current status of public opinion toward lane conversions.

The paper begins with a description of the lane conversion area and the conversion implementation strategy. That section is followed by a discussion of the public opinion survey and sampling procedures. Public opinion is then statistically evaluated by estimating a series of multinomial logit and ordered probit models that address the types of comments that the survey respondents provided and their attitudes toward various HOV policies (including lane conversion). Finally, the implications of the findings are discussed and concluding comments are made.

DESCRIPTION OF STUDY AREA AND IMPLEMENTATION STRATEGY

The Seattle-area HOV lane conversion was made on Interstate 90 near a rapidly growing suburban area (Issaquah, Washington). Interstate 90 is one of two primary east–west routes in the Seattle area. On I-90 three lanes enter and exit Seattle. The limitation to three lanes was the result of a number-of-lanes restriction (i.e., a cap on capacity expansion) that was approved in the 1970s. Specifically, this restriction allowed no more than three lanes of traffic in each direction to cross the I-90 floating bridge that links Seattle with its eastern suburbs. However, east of this floating bridge (toward the suburbs) I-90 included a fourth lane in each direction. During the morning peak period the westbound commute (i.e., into Seattle) encountered considerable delay and queuing at the point where I-90 went from four to three lanes. It was reasoned that converting this fourth general-purpose lane to an HOV lane would ease the delay and queuing at this location; fewer vehicles would be required to merge because travel in the HOV lane would be restricted to carpools, vanpools, and buses. This condition made the fourth lane a strong candidate for conversion because it provided the potential for some immediate operational improvements as well as the usual

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HOV lane attributes (e.g., reduced travel times for HOVs, modal shifts, and so on).

Before deciding on a lane conversion the Washington State Department of Transportation (WSDOT) attempted to gain public support for the project. Representatives from local jurisdictions were informed about the project and asked to provide feedback. Public open houses were held, and motorists and local citizens were informed of the project and allowed to voice their concerns in an open forum. On the basis of the input received from both jurisdictional representatives and concerned citizens, a decision was made to pursue the lane conversion.

The new HOV lane was created by using two approaches; about 4 km of HOV lane was created by narrowing existing lanes and restriping the roadway, and another 6 km was created by converting an existing lane. Operation of the 10-km HOV lane was operational in November 1993. The lane is open to vehicles with two or more occupants and is restricted to such vehicles at all times of the day.

SURVEY APPROACH

The objective of the survey was twofold: (a) to determine the impact of the lane conversion on commuting behavior including mode, route, and departure time choices and (2) to study commuters' attitudes toward HOV lanes in general and lane conversions in particular. To achieve this objective a carefully constructed survey was designed. The survey was partitioned into three sections. The first section dealt with questions relating to the commute trip. Questions in this section focused on changes (before versus after the HOV lane conversion) in usual mode, route, and departure time. Questions relating to consumers' daily variations in mode, route, and departure times were asked as well. The second section gathered information on commuters' attitudes toward HOV lanes and lane conversion. The third and final section collected socioeconomic information on the commuter and the commuter's household.

The survey was distributed to commuters observed to be traveling in the lane-conversion area. License plate numbers were gathered during the morning commute over a 3-day period in June 1994 (roughly 7 months after the lane conversion). By using the Washington State Department of Motor Vehicles files, the license plate numbers were matched with the addresses of the registered vehicle owners and questionnaires were sent out in late June. In all, surveys were sent out to 1,325 commuters, and 322 responded (a response rate of 24.3 percent). Summary statistics for this sample are presented in Table 1.

Table 1 shows some interesting results with regard to commuters' socioeconomics. For example, roughly 62 percent of the respondents were male. This is a reasonable response because a higher percentage of males is expected in the morning commute. Another interesting finding was the high level of education (more than 16 years) and the high annual household income (more than $75,000). Although Seattle's eastern suburbs are relatively affluent, the $75,000 figure is on the high side. One possible explanation for this finding is that certain socioeconomic groups may have been more likely to respond to the survey. Our subsequent statistical analysis addresses this possibility.

In terms of commuting mode, about 77 percent list single-occupant vehicles (SOVs) as their usual mode of travel. It is also interesting that more than 70 percent of the commuters have used HOV lanes in the Seattle area during peak periods of travel at least once (Table 1). This suggests reasonable familiarity with the HOV system and its potential benefits in terms of saving travel time. Table 1 also shows that the usual mode of HOV lane travel is the two-person carpool, as expected. However, more than 2 percent of the commuters admit to HOV lane violations (i.e., listing SOV as the usual mode of HOV lane travel; Table 1). Given that Seattle-area HOV lane violation rates are very close to this figure, this admission shows an unexpected candor among survey respondents.

In terms of being qualified for HOV lane use and choosing not to use them, the most common reasons were "all traffic moves fast enough" and "slower than regular lanes." Less than 10 percent listed HOV lane safety as a reason for not using HOV lanes. Although this is a comparatively low figure, it shows that the HOV lane safety issue is still a fairly serious concern among some travelers (Table 1). Finally, the frequency of HOV lane usage on commuters' past five commutes (i.e., after the lane conversion) is given in Table 1. This shows some tendency toward regular mode switching (i.e., values in the range of 1 to 4 are more than 10 percent of the total) or not using the HOV lane when they are qualified to do so.

The survey also showed that the commuters in this corridor actively seek alternative route and departure times to shorten their commutes, with more than 30 percent indicating that they changed their route or departure times at least once in the past five commutes in an attempt to avoid traffic congestion. In terms of long-term changes, Table 1 shows that more than 35 percent of the commuters changed their usual departure times for work after the HOV lane conversion and more than 21 percent changed their usual routes. However, only 2.1 percent attributed these changes to the HOV lane conversion. Thus, the effect of the HOV lane conversion on route and departure time choice does not seem to be perceived by commuters to be significant. If this is the case, it indicates that the HOV lanes are not having a large impact on the well-being commuters derive from existing route and departure time choices [see the reports by Mannering and Hamed (6) and Small (7) for discussions of the impacts of HOV lanes on commuter welfare]. This important matter will be explored in forthcoming sections.

The HOV lane conversion appears to have had little impact on commuters' mode choice. Nine SOV users became carpool or vanpool users, and one became a bus user. However, five carpool or vanpool users became SOV users and two bus users became SOV users. Statistically, the HOV lane conversion had no significant impact on mode choice. Some caution should be exercised in interpreting these findings because the survey approach disproportionately samples SOV users (i.e., because it is based only on the vehicles observed to be traveling in the study area).

Commuters' opinions toward HOV lanes and HOV lane conversions also revealed some interesting findings. First, 47 percent believe that HOV lanes do not help save time for all commuters, and 41 percent do (Table 1). This suggests some lingering doubts as to the effectiveness of HOV lanes. This doubt is underscored by the 69 percent of respondents who believe that HOV lanes are not being adequately used. In fairness, it is possible that some of this negativity is an outgrowth of the fact that Seattle's HOV lane system is not yet complete. This could be a major source of HOV lane underutilization and a subsequent reduction in perceived effectiveness.

There also seems to be general public support for HOV lanes. Table 1 shows that only 36 percent of the survey's respondents believe that HOV lanes should be converted to general-purpose lanes. In terms of lane conversion, public opinion is negative, with 45 percent disagreeing (39 percent agreeing) that regular lanes should be converted. However, it is important to note that although

TABLE 1 Sample Summary Statistics (Averages Unless Otherwise Noted)

Sex (% male/female)	62.3/37.7
Age in years	42.9
Annual household income in thousands of dollars	75.6
Level of education	16.0
Household size	2.9
Number of household members older than 15 years old	2.2
Number of household members working outside of home	1.9
Number of household vehicles	2.4
Work schedule of commuters (% fixed/flexible)	48.4/51.6
Percent of usual travel mode in area highways between 6-9 am and 3-6 PM (SOV/ carpool or vanpool/ bus/ other)	77.3/17.1/5.3/0.3
Percent having ever used HOV lanes in the Seattle area between 6-9 am and 3-6 PM	70.2
Percent of usual travel mode when using HOV lanes in the Seattle area between 6-9 am and 3-6 PM (SOV/ carpool or vanpool/ bus/ motorcycle)	2.7/85.2/10.3/1.8
Percent sometimes qualifying for HOV lane use but not using them	37.9
Percent of reason for not using the HOV lane when qualified (slower than regular lanes/ too much trouble to change lanes/ HOV lanes are not safe/ all traffic moves fast enough/ forget to use HOV lane/ other)	24.4/7.9/9.4/38.6/7.9/11.8
Percent of commuters who used HOV lanes on I-90 during past five commutes (not at all/ 1-4 times/ every day)	75.6/10.8/13.6
Percent of commuters who changed usual departure time to work after new HOV lanes added	35.2
Percent of commuters who changed usual departure time to work because of HOV lanes	2.1
Percent of commuters who changed usual route to work after new HOV lanes added	21.3
Percent of commuters who changed usual route to work because of HOV lanes	2.1
HOV lanes help save all commuters time (disagree strongly or disagree/ neutral/ agree strongly or agree)	47/11/42
Existing HOV lanes are being adequately used (disagree strongly or disagree/ neutral/ agree strongly or agree)	69/13/18
HOV lanes should be open to all traffic (disagree strongly or disagree/ neutral/ agree strongly or agree)	57/7/36
Converting some regular highway lanes to HOV lanes is a good idea (disagree strongly or disagree/ neutral/ agree strongly or agree)	45/16/39

negative, there does not seem to be a strong public resentment toward lane conversion. This is certainly a shift from the lane conversion resistance observed in the 1970s.

Finally, the comments gathered at the end of the survey provided some interesting information, because it allowed respondents to air their frustrations or opinions about WSDOT's HOV lane and lane conversion policies. A large proportion of the respondents (about 51 percent) provided no comments. For the 49 percent of the respondents who did provide comments, the authors carefully screened the comments and classified them as negative (anti-HOV lane), positive (pro-HOV lane), and neutral. Nearly 50 percent had negative comments, 37 percent had positive comments or positive comments with criticism, and 13 percent were neutral. The relatively high percentage of negative comments shows some persistent dissatisfaction with HOV improvements or projects, but the overall proportion (slightly less than 25 percent of the entire sample) is relatively small.

Although the statistics discussed earlier provide some information as to the public's acceptance of HOV lanes in general and lane conversions in particular, a true multivariate analysis will allow determination of the characteristics of individuals who have predisposed positive or negative opinions toward HOV lanes or HOV lane conversions, or both. This type of information is critical, because it will permit state agencies to effectively market HOV lane projects by targeting specific commuter market segments. It will also allow agencies to forecast probable acceptance of HOV facilities on spe-

cific corridors once the socioeconomic and commute characteristics of the corridor are known.

Two types of multivariate analyses will be conducted in this paper. First, a model is developed to determine the probability that a survey respondent offers a negative, neutral, or positive comment, given that the respondent provides a comment. Second, a model is developed for each of the questions relating to commuters' opinions toward HOV facilities. These models will enable us determination of commuters' likelihood of disagreeing, being neutral, or agreeing with specific HOV-related statements. A description of these models and the model estimation results are provided in the following sections.

MODELING NATURE OF COMMUTERS' COMMENTS

For the 159 individuals who provided comments on their completed survey forms (roughly half of the 322 respondents), comments with regard to HOV lanes and HOV lane conversions were classified as being negative, neutral, or positive. Given the discrete nature of the three possible choice alternatives, a multinomial probabilistic choice model is a natural selection. In developing such a model it is assumed that a respondent will make the comment that provides the most satisfaction. Therefore, the probability of individual n making comment type i from the set of comment alternatives I is

$$P_n(i) = P(U_{in} \geq U_{In}) \; \forall \; I \tag{1}$$

where P denotes probability and U_{in} is the satisfaction provided by comment type i to individual n. To estimate this probability, the satisfaction function (or in economic terms, the utility function) must be specified. This is usually done in a linear form such that

$$U_{in} = \beta \mathbf{X}_{in} + \epsilon_{in} \tag{2}$$

where

$\mathbf{X}_{in}$ = a vector of measurable characteristics that define utility (e.g., age, gender, current mode of travel, departure time changes, and so on),
β = a vector of estimable parameters, and
ϵ_{in} = an error term that accounts for unobserved factors influencing an individual's utility of making comment type i.

The term $\beta \mathbf{X}_{in}$ in this equation is said to be the observable portion of utility because the vector $\mathbf{X}_{in}$ contains measurable characteristic variables (e.g., age of individual n), and ϵ_{in} is the unobserved portion.

Given Equations 1 and 2, the following can be written:

$$P_n(i) = P(\beta \mathbf{X}_{in} + \epsilon_{in} \geq \beta \mathbf{X}_{In} + \epsilon_{In}) \; \forall \; I \tag{3}$$

With Equation 3 an estimable discrete choice model can be derived by assuming a distributional form for the error term. A natural choice would be to assume that this error term is normally distributed. If this is done a probit model results. However, probit models are computationally difficult to estimate. A more common approach is to assume that the ϵ_{in} terms are generalized extreme value (GEV) distributed. The GEV assumption produces a closed-form model that can be readily estimated by standard maximum likelihood methods. It can be shown (*8*) that the GEV assumption results in the multinomial logit model

$$P_n(i) = \exp[\beta \mathbf{X}_{in}] / \Sigma_I \exp[\beta \mathbf{X}_{In}] \tag{4}$$

where all variables are as defined previously and the vector β is estimable by standard maximum likelihood methods.

Multinomial logit model coefficient estimates for the three types of comments are presented in Table 2 (note that only 155 of the 159 did not have missing data in either the dependent or independent variables; this explains the 155 observations given at the bottom of Table 2). Turning to specific estimation results, the model shows that individuals under the age of 21 are more likely to give a negative comment (i.e., negative coefficients for neutral and positive comment utilities). Also, since the coefficient for the positive comment alternative is more negative (i.e., larger absolute value) than the negative coefficient for the neutral comment (-1.367 versus -0.732), this age group is more likely to be neutral than positive. Although these coefficients are not highly significant (t-statistics just greater than 1), they do suggest the presence of anti-HOV sentiments among the young.

Next, the coefficients for the higher education dummies indicate that individuals with postgraduate work are more likely to give positive comments (i.e., a positive coefficient in the positive utility function) and less likely to be neutral (a negative coefficient in the neutral utility function). This shows that postgraduate education polarizes opinions with a greater likelihood of being positive.

Surprisingly, the same result was found with regard to the number of household vehicles per person. That is, a high number of vehicles per person made the individual more likely to make a positive comment and less likely to make a neutral comment. This finding appears to be an artifact of the sample that consists of affluent suburbanites with high vehicle ownership levels (Table 1).

Next we find that individuals with fixed work hours are less likely to make a neutral comment. The absence of work departure time flexibility seems to have polarized this population segment into making either a positive or a negative comment.

Individuals that indicated that SOV was their usual mode of travel were less likely to give a neutral comment and, as expected, less likely to give a positive comment. The tendency toward negative comments from SOV users is not surprising given their frustration in seeing what many of them consider to be underused HOV lanes during congested periods.

Individuals who were observed to change their departure times after the HOV lane conversion were much more likely to give a negative response and much less likely to give a positive response (as indicated by the highly significant negative coefficient in the positive alternative). As Table 1 shows, nearly 38 percent of commuters changed their usual departure times between September 1993 and June 1994, but only 2.1 percent listed the HOV lane conversion as the reason for this change. The most common reason for the change was an increase in traffic congestion (42 percent), which may have been due in some part to the reduction in SOV capacity due to the loss of a lane [change in work hours was the next most common reason (16 percent)]. It appears that these departure time change dummy variables are capturing the frustration of commuters in having to change their usual departure times, which has been shown to cause a significant loss in commuter welfare (*6*).

Finally, the route change dummy coefficient indicates that commuters who changed their usual routes after the HOV lane conver-

TABLE 2 Multinomial Logit Estimation Results for Comments About HOV

Variable*	Estimated coefficients (t-statistics)
Constant [0]	2.280 (2.906)
Constant [P]	-1.291 (-1.727)
Younger age dummy (1 if age is less than 21, 0 otherwise) [0]	-0.732 (-1.061)
Younger age dummy (1 if age is less than 21, 0 otherwise) [P]	-1.367 (-1.093)
Higher education dummy (1 if post graduate, 0 otherwise) [0]	-0.693 (-1.581)
Higher education dummy (1 if post graduate, 0 otherwise) [P]	0.790 (1.472)
Number of adults in a household (greater than 15 years old)[0]	-0.328 (-1.471)
Number of household vehicles per person [0]	-0.527 (-1.037)
Number of household vehicles per person [P]	0.811 (1.949)
Fixed-work dummy (1 if work-schedule is fixed, 0 otherwise) [0]	-0.458 (-1.235)
SOV dummy (1 if SOV is a usual mode in area highways between 6-9 AM and 3-6 PM, 0 otherwise) [0]	-1.416 (-3.099)
SOV dummy (1 if SOV is a usual mode in area highways between 6-9 AM and 3-6 PM, 0 otherwise) [P]	-0.787 (-1.290)
Departure time change dummy (1 if changed usual departure time to work after new HOV lanes, 0 otherwise) [0]	-0.665 (-1.580)
Departure time change dummy (1 if changed usual departure time to work after new HOV lanes, 0 otherwise) [P]	-1.689 (-2.265)
Route change dummy (1 if changed usual route to work after new HOV lanes, 0 otherwise) [0]	-0.774 (-1.434)
Log-likelihood at zero	-170.28
Log-likelihood at convergence	-136.18
Number of observations	155

* Numbers in brackets indicate variables defined for: [N] Negative opinion, [0] Neutral opinion, [P] Positive opinion alternatives.

sion were less likely to give a neutral comment. As was the case with departure time, the most common reason for the 21 percent of respondents who changed their routes was increasing traffic congestion (about 46 percent), with only 2.1 percent citing HOV lanes as the cause of the change. The polarization of the route change response (i.e., respondents are more likely to make positive or negative responses) seems to indicate that some commuters are happy with their new routes (the result of congestion being to force them to find a possibly better route in terms of travel time) and others are less pleased. The more consistent negative response of departure time changers suggests that departure time has a greater impact on commuter utility than the route choice. This is consistent with the earlier findings of Mannering and Hamed (*6*).

MODELING COMMUTER OPINIONS

The questions relating to commuter opinions have responses that range from disagree strongly to agree strongly. This type of data is referred to as ordered (because there is a consistent transition from disagreeing to agreeing) and can be translated into an integer form for the purposes of model estimation. In their case the statistical analysis showed that the data can best be grouped into three categories: (a) disagree (which includes strongly disagree and disagree), (b) neutral, and (c) agree (which includes agree and strongly agree). This grouping suggests that respondents did not adequately distinguish between strongly and simply agreeing and disagreeing. This reordering will have no effect on the substantive findings of the forthcoming statistical analysis.

Translating these three choices into integer form provides the following: 1 as disagree, 2 as neutral, and 3 as agree With this ordering, an ordered probability model can be derived (*9*). Such models begin by defining an unobserved variable, z, that is used as a basis for modeling the ordinal ranking of the data. This unobserved variable is specified as

$$z = \beta \mathbf{X} + \epsilon \tag{5}$$

where

$\mathbf{X}$ = a vector of characteristics determining individuals' choice of ranking category,
β = a vector of estimable parameters, and
ϵ = a random disturbance.

By using this equation observed ordinal rankings, y (ranging from 1 to 3 here), are defined as

$$y = 1 \text{ if } z \leq \mu_1 \quad (6)$$

$$y = 2 \text{ if } \mu_1 < z \leq \mu_2$$

$$y = 3 \text{ if } z > \mu_2$$

where the μ's are estimable parameters that define y, which corresponds to integer rankings. Note that without the loss of generality, μ_1 can be constrained to be zero so that only the threshold μ_2 needs to be estimated.

If the disturbance term in Equation 6 is assumed to be standard normal (with the equal to mean zero and variance equal to 1) an ordered probit model results, and if the disturbance is assumed to be standard logistic, an ordered logit model results. Unlike the case of the discrete choice model presented in the previous section, the ordered logit model does not have a significant computational advantage over the ordered probit. The choice of one model over the other is often made purely on theoretical grounds, and because of the widespread use of the normal distribution in statistics, a standard normal distribution of the error term is assumed and a series of ordered probit models is estimated. Ordered probit models of attitude statements made in the survey are discussed below.

HOV Lanes Help Save All Commuters Time

As shown in Table 1, more people believe that HOV lanes do not save all commuters time relative to those that do. It is important to understand this skepticism with regard to the value of HOV lanes. Model estimation results for this statement are presented in Table 3. The estimation results show that respondents less than 21 years old are less likely to agree with this statement. This is consistent with the tendency of this group to provide negative comments, as shown in the preceding section.

Higher-income households were also less likely to agree with this statement (i.e., a negative coefficient). This may be because higher-income households are more dependent on automobiles than their lower-income counterparts. The greater the number of adults in the household, the less likely the respondent is to agree with this statement. This suggests some lingering skepticism among larger, older households as to the effectiveness of HOV lanes.

Respondents with fixed work hours were less likely to agree that HOV lanes save all travelers time. This group of travelers has limited ability to adjust departure times to avoid congestion, and in the absence of what they believe are reasonable modal alternatives, they may harbor bitter feelings toward losing a lane of capacity to HOVs.

People who are regular SOV users do not tend to believe that HOV lanes save all travelers time, and people who are regular HOV users tend to believe that HOV lanes save all travelers time (as indicated by the negative and positive coefficients, respectively). This sort of modal bias is an expected result.

Finally, the 2.1 percent of respondents who indicated that they changed their usual departure times because of the presence of HOV lanes were less likely to agree with the statement that HOV lanes save all commuters time. Correct or not, these respondents seem to be blaming their forced departure time changes on the presence of HOV lanes.

Existing HOV Lanes Are Being Adequately Used

Table 1 shows that nearly 70 percent of respondents do not believe that HOV lanes are being adequately used. From a policy perspec-

TABLE 3 Ordered Probit Estimation Results for Opinion of HOV Lanes Saving all commuters time

Variable*	Estimated coefficients (t-statistics)
Constant	0.900 (3.913)
Younger age dummy (1 if age is less than 21, 0 otherwise)	-0.276 (-1.156)
Higher income dummy (1 if annual household income is greater than $75K, 0 otherwise)	-0.238 (-1.646)
Number of adults in a household (greater than 15 years old)	-0.147 (-2.075)
Fixed-work dummy (1 if work-schedule is fixed, 0 otherwise)	-0.319 (-2.160)
SOV dummy (1 if SOV is a usual mode in area highways between 6-9 AM and 3-6 PM, 0 otherwise)	-0.684 (-3.254)
HOV use dummy (1 if used HOV lanes on I-90 during past five commutes, 0 otherwise)	0.347 (1.627)
Departure time change due to HOV lanes dummy (1 if changed usual departure time to work due to presence of HOV lanes, 0 otherwise)	-0.943 (-1.353)
Threshold μ_2	0.312 (6.260)
Log-likelihood at zero	-302.30
Log-likelihood at convergence	-280.17
Number of observations	313

* Dependent variables: 1 is base (disagree), 2 is neutral, 3 is agree

tive, such a belief is clearly a matter of concern with regard to future expansions of HOV systems. Ordered probit estimation results of opinions on this statement are presented in Table 4. The results show that men are more likely to agree with this statement, although the level of statistical significance ($t = 1.261$) is not very high. This finding may be an outgrowth of the demographic characteristics of the sample. A sample drawn from lane conversions in other corridors would provide evidence to either support or refute this finding.

Older respondents (older than 50 years) and respondents from higher-income households (greater than $75,000) were less likely to believe that HOV lanes are being adequately used. Again, this could be the result of their greater dependence on SOV travel and their concern over the loss of roadway capacity caused by HOV lanes.

Respondents who were more highly educated were more likely to agree with this statement. This is consistent with the earlier finding that such respondents were more likely to make a positive comment on the survey.

Both the higher the number of adults in the household and having a fixed work schedule reduced the likelihood of believing that HOV lanes are being adequately used. This finding shows skepticism among people with these characteristics, as was the case with their believing that HOV lanes saved all commuters time.

Finally, as expected, respondents who currently list HOV modes as their usual modes of travel are more likely to believe that HOV lanes are being adequately used. This result is consistent with earlier findings.

HOV Lanes Should Be Opened to All Traffic

The statement that HOV lanes should be opened to all traffic is interesting because it asks consumers to pass judgment on a national transportation policy. As shown in Table 1, 36 percent of respondents agreed with this statement. Although this is not a majority, it is nonetheless a disturbingly high figure. The ordered probit estimation results presented in Table 5 provide some insight into the characteristics of respondents who are likely to agree or disagree with this statement.

Many of the results are consistent with earlier findings that isolated characteristics of respondents made them likely to have opinions that favor or oppose HOV lanes. For example, older respondents, respondents from higher-income households, respondents with fixed work start times, regular SOV users, and individuals who attribute departure time changes to the presence of HOV lanes are all more likely to favor opening HOV lanes to all traffic. These consistent findings clearly isolate the characteristics of individuals who are likely to oppose HOV policies.

Table 5 shows that regular HOV users and households with a large number of children were factors that increased the likelihood of disagreeing with this statement. The presence of a large number of children increases the likelihood of qualifying for HOV lane usage (i.e., transporting children) and thus results in a more favorable attitude toward future HOV lane use. Finally, it is important to note that the negative coefficient of the constant term indicates a general disposition of the public to oppose opening HOV lanes to all traffic.

Converting Some Regular Highway Lanes to HOV Lanes Is a Good Idea

The statement that converting some regular highway lanes to HOV lanes is a good idea had a response showing 45 percent disagreeing, 16 percent neutral, and 39 percent agreeing (Table 1). It is clear that opposition toward lane conversion exists, but it is by no means overwhelming. Ordered probit estimation results for this statement are presented in Table 6.

The model results presented in Table 6 closely parallel the findings of earlier models. Regular SOV users and respondents who attribute departure time changes to the presence of HOV lanes are

TABLE 4 Ordered Probit Estimation Results for Opinion of Existing HOV Lanes Being Adequately Used

Variable*	Estimated coefficients (t-statistics)
Constant	-0.583 (-3.146)
Gender dummy (1 if male, 0 if female)	0.204 (1.261)
Older age dummy (1 if age is greater than 50, 0 otherwise)	-0.449 (-2.202)
Higher income dummy (1 if annual household income is greater than $75K, 0 otherwise)	-0.181 (-1.165)
High education dummy (1 if post graduate, 0 otherwise)	0.358 (2.169)
Number of adults in a household (greater than 15 years)	-0.216 (-2.683)
Fixed-work dummy (1 if work-schedule is fixed, 0 otherwise)	-0.150 (-0.954)
HOV use dummy (1 if used HOV lanes on I-90 during past five commutes, 0 otherwise)	0.996 (5.628)
Threshold μ_2	0.487 (6.993)
Log-likelihood at zero	-294.77
Log-likelihood at convergence	-239.57
Number of observations	314

* Dependent variables: 1 is base (disagree), 2 is neutral, 3 is agree

TABLE 5 Ordered Probit Estimation Results for Opinion That HOV Lanes Should Be Opened to All Traffic

Variable*	Estimated coefficients (t-statistics)
Constant	-0.740 (-2.369)
Older age dummy (1 if age is greater than 50, 0 otherwise)	0.290 (1.600)
Higher income dummy (1 if annual household income is greater than $75K, 0 otherwise)	0.216 (1.479)
Number of children 0-15 years	-0.156 (-1.953)
Fixed-work dummy (1 if work-schedule is fixed, 0 otherwise)	0.310 (2.025)
SOV dummy (1 if SOV is a usual mode in area highways between 6-9 AM and 3-6 PM, 0 otherwise)	0.900 (3.819)
HOV use dummy (1 if used HOV lanes on I-90 during past five commutes, 0 otherwise)	-0.375 (-1.593)
Departure time change due to HOV lanes dummy (1 if changed usual departure time to work due to presence of HOV lanes, 0 otherwise)	1.568 (2.158)
Threshold μ_2	0.246 (5.334)
Log-likelihood at zero	-285.44
Log-likelihood at convergence	-254.08
Number of observations	311

* Dependent variables: 1 is base (disagree), 2 is neutral, 3 is agree

likely to oppose lane conversion, whereas regular HOV users and households with a large number of children are likely to favor lane conversions.

IMPLICATIONS OF FINDINGS AND CONCLUSIONS

The findings of the survey of commuters using the I-90 HOV lane conversion corridor show that the lane conversion was not overwhelmingly accepted by the public. In fact, more respondents oppose lane conversions than favor them. Still, the percentage of people who oppose lane conversions is just slightly greater than the percentage who favor them, suggesting that the long-held resistance of the public to lane conversions may be waning. However, ordered probit model results show that lane conversion resistance is higher among the young (commuters less than 21 years old), higher-income households, SOV users, and individuals who changed their departure times as a result of the presence of HOV lanes. Given the size of some of these population groups (e.g., more than 77 percent are usual SOV users), it is clear that considerable marketing is needed before a significant majority of

TABLE 6 Ordered Probit Estimation Results for Opinion About Converting Some Regular Highway Lanes to HOV Lanes

Variable*	Estimated coefficients (t-statistics)
Constant	0.259 (0.987)
Number of children 0-15 years	0.152 (2.026)
SOV dummy (1 if SOV is a usual mode in area highways between 6-9 AM and 3-6 PM, 0 otherwise)	-0.702 (-3.510)
HOV use dummy (1 if used HOV lanes on I-90 during past five commutes, 0 otherwise)	0.458 (2.276)
Departure time change due to HOV lanes dummy (1 if changed usual departure time to work due to presence of HOV lanes, 0 otherwise)	-1.031 (-1.370)
Threshold μ_2	0.445 (7.640)
Log-likelihood at zero	-322.94
Log-likelihood at convergence	-297.30
Number of observations	313

* Dependent variables: 1 is base (disagree), 2 is neutral, 3 is agree

the public comes to accept HOV lane conversions as a tolerable transportation policy.

With regard to HOV lanes in general, the public is not completely dissatisfied. Only 36 percent of the commuting public believe that HOV lanes should be opened to all traffic. On the down side 47 percent do not believe that HOV lanes save all commuters time, and more than 69 percent believe that HOV lanes are not being adequately used. Ordered probit models show that individuals most likely to have a negative bias toward HOV lanes are young (less than 21 years old), are from higher-income households, have a large number of adults in their households, indicate SOVs as the usual mode of travel, and have fixed work hours. Apparently, individuals who fit this mold have yet to be convinced of the purported virtues of HOV lanes.

In terms of the types of comments individuals made on their survey forms, slightly more than 50 percent made no comment at all. Of those who did comment, the majority responded negatively to the lane conversion or HOV facilities in general, or both. Multinomial logit estimation results show, as was the case with the opinion models discussed earlier, that commuters who were likely to make negative comments were younger (less than 21 years old), were regular SOV users, and had fixed work schedules. One different finding is that individuals were more likely to make negative comments if they changed their usual departure times after the lane conversion, regardless of the reason (previous results on HOV opinions show this to be important only if respondents attribute the departure time change to HOV lanes). It appears that many respondents are venting their frustrations about having to change their usual departure times.

In summary, from a public opinion point of view, the I-90 lane conversion in the Seattle area can be classified as a qualified success. Although a slight majority of commuters oppose the conversion, public opinion for and against is surprisingly close. It appears that with effective marketing and careful implementation, lane conversions can be successfully made. However, it is important to recognize that significant opposition may arise from the young, higher-income households with a high number of adults, commuters with fixed work times, regular SOV users, and commuters who will be forced to make departure time changes. Commuters who fit this mold should be dealt with through informational campaigns and other strategies in an effort to reduce their opposition.

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