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Publication Date
1998-08-01

UCI-ITS-WP-98-5

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August 1998

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ABSTRACT

This paper is a case study of carpooling behavior on the 91 Express Lanes. The 91 Express Lanes are the nation's first implementation of High Occupancy/Toll (HOT) lanes where carpools with three or more passengers could use the lanes for free (at the time the data for this study was collected) and others pay a toll that varies by time of day to use the premium Express Lane. One concern over such a policy is that people won't carpool if they can just pay for the travel time savings that they would normally obtain by carpooling and using a High Occupancy Vehicle (HOV) lane. Our survey data show that the rate of carpooling did not change much between the opening of the Express Lanes and now, there is a lot of changing between modes (increases and decreases in the number of passengers), there are a large number of people that carpool a few times a week, and that HOV-2s use both the regular lanes and the Express Lanes. We further investigate whether HOT lanes encourage carpooling by modeling carpool formation with discrete choice models. The results show that mode choice behavior in the corridor is similar to carpooling behavior in other locations and carpooling in the corridor is not discouraged.

Can HOT Lanes Encourage Carpooling?
A Case Study of Carpooling Behavior on the 91 Express Lanes

Many travel demand management schemes have been proposed and implemented in order to reduce congestion on our roadways. One such policy is to encourage carpools. Ideally, each passenger riding in a carpool represents a person not in their own vehicle congesting the roadway. Larger companies have been encouraged to form rideshare programs and to provide incentives to employees who carpool: better parking, cash subsidies, guaranteed ride home for emergencies, etc. Current federal funding policy has encouraged the design and implementation of High Occupancy Vehicle (HOV) lanes for the exclusive use of carpoolers. HOV lanes are usually separated from the general traffic and allow vehicles that meet the requirements to travel at a faster speed than their counterparts in the regular lanes. Over 700 miles of HOV lanes are in operation today and at least as many more are in various stages of planning and design. In several areas, HOV lanes are underutilized while the adjacent regular freeway lanes are congested for many hours of the peak. Some areas restrict HOV lanes to three or more people per vehicle; others allow HOV-2s to use the lane(s). Some HOV-2 systems have enough traffic so that speeds are below free-flow. This affects a great attraction of HOV lanes: that the lanes are free-flowing even at peak times which reduces the travel time of carpoolers compared to those traveling in the regular lanes. However, changing the HOV-2 lane to a HOV-3 lane may result in underutilization.

High Occupancy/Toll (HOT) lanes have been heralded as the answer for non-efficient use of High Occupancy Vehicle (HOV) lanes. The term HOT was first coined by Fielding and Klein (*1*) who envisioned that converting underutilized HOV lanes to HOT lanes would introduce congestion pricing gently. Since then, the idea has been grasped by policy makers and congestion pricing advocates who see HOT lanes as a way to provide a premium service to commuters who would like to save travel time and would rather pay a price than incur the cost of finding carpool partners and limiting their personal travel flexibility. Some solo drivers and politicians in some areas consider HOV lanes to be "wasted space". HOT lanes can better use that space. HOT lanes represent a way for carpoolers to still have their premium lane and for solo drivers to also benefit. Potential solo occupant users of HOT lanes do not have to use the lanes every day, but can use the HOT lane on days when they have time constraints or traffic is disrupted on another part of their commute. Three HOT lane projects have been implemented in the U.S., the 91 Express Lanes in Orange County, CA, the I-15 reversible lanes in San Diego, and the Katy Freeway in Houston. At least twelve more have been proposed (*2*).

Transportation policy makers are eagerly looking at HOT lanes now that they have been implemented. Many think that HOT lanes can be popular across the country and especially in their own areas to help alleviate their congestion difficulties and to better-utilize existing or planned HOV lanes. Additionally, because HOT lanes have the potential to pay for themselves with toll revenue, areas with available right-of-way can seriously consider HOT lane construction rather than building unpopular HOV lanes or additional general-purpose lanes.

Can HOT lanes encourage carpooling? Or do we expect the opposite? At first we may expect that if people can buy into an "express lane", then there is no need for forming a carpool to obtain travel time savings. However, it is also possible that people are interested in using HOT lanes in a carpool because they can then travel for "free" (without payment) and get something (better travel time) that others have to pay for. Additionally, users may want the benefit of using the HOT lanes and yet to share the cost by traveling with one other person. Like HOV lanes, HOT lanes may provide a more reliable commute and may encourage the formation of carpools because the workers can get to their destination within an acceptable time window. I also want to examine the people who use HOT lanes infrequently and try to determine whether they are price sensitive (like the premium service but don't always want to pay for it) or have other reasons for their infrequent use.

This paper investigates several of these issues. The pre-HOT lane carpooling literature is described in terms of how much carpooling has been done and is done and what researchers have found to be significant in describing how carpools are formed. The 91 Express Lane Corridor in Orange County, California, the nation's first HOT lane facility, is described. A comparison of the 91 Corridor is made against typical implementations of HOT, HOV, and regular lanes. Our survey data is described and compared with other carpool statistics. Multinomial logit models are used to substantiate the hypotheses formed. The results suggest that carpooling behavior is largely similar in this corridor compared to the behavior presented by other researchers. The results also suggest that HOT lanes do not discourage carpool formation.

BACKGROUND ON CARPOOLING

There are many advantages to carpooling compared to driving alone (for example, saving travel time, saving money on gas and car maintenance), but it is not a popular mode choice. Recent articles on carpooling lament the decline of carpooling in the U.S. from 19.7% of commuters in 1970 to about 13.4% of commuters in 1990 (1990 U.S. Census) despite travel demand management programs and the implementation of high occupancy vehicle lanes (*3,4*). These articles point out that relative incomes have risen during this span, jobs have become spatially more distributed, and car ownership levels have risen which all contribute to the fall in carpooling. The results of these papers seems to be that carpooling should still be considered an important way to reduce congestion on our roadways but that HOV lanes on a significant portion of their commute and ridesharing incentives are necessary to encourage people to form carpools.

Although several papers discuss the policy implications of HOV lanes (*4-8*), there are only a few recent carpool papers that give analytical or econometric support of the significance of several characteristics of typical carpoolers. Teal (*9*) and Ferguson (*10*) discuss the demographics of carpoolers. Teal found that commute length, commuting cost, and vehicle availability affect mode choice, but that 1/3 of the sample he used did not have the expected combination of these attributes suggesting that attitudes are important in determining which commuters carpool. Ferguson suggests that auto availability and education are more significant influences in carpooling than income, gender, and distance to work. At least one paper has tried to analytically show the relationship between carpool formation and speed limits, gas prices, and wage rates (*11*).

There are a few others that use discrete choice models to show the effects of various attributes on carpool formation (*3,12-15*). The results of Cevero and Griesenbeck (*12*) show that distance from work, whether or not the employee is a professional, and whether the work-site is one company or a number of smaller companies heavily influence mode choice in their case study of Pleasanton, CA. Ferguson (*3*) fits logit models with 1990 National Personal Transportation Survey (NPTS) data and find that distance, the number of vehicles per household, education, the number of children influence the formation of household-based and non-household (external) carpools. Brownstone and Golob (*13*) analyze the effectiveness of various California state-mandated carpool incentives such as guaranteed ride home and better parking spaces in Southern California (Orange County and Los Angeles County) and find that women, people with larger households with multiple workers, people with longer commutes, and people who work at larger worksites are more likely to carpool. They find that a guaranteed ride home is the most effective incentive which companies can offer their employees. Golob et. al. (*14*) analyze panel data of HOV users on I-15 in San Diego and use a structural equation model to find that travel time and traffic perception influence the decision to carpool and use the HOV lane. They also discovered that, although the numbers of carpoolers on the I-15 HOV lanes increased, only 75% of carpoolers a year ago carpool now. Sarmiento's (*15*) logit model of Southern California commuters reveals that carpool incentives, the number of cars in the household, and fixed work schedule are all strong indicators of mode choice. The models presented in this paper will consider most of the variables that other researchers found to be significant in describing the characteristics of carpoolers.

CASE STUDY: 91 EXPRESS LANES DESCRIPTION

The 91 Express Lanes is the nation's first implementation of a fully automated, time-of-day-priced, toll road in the median of an existing freeway. The 91 Express Lanes are a ten-mile stretch of roadway from the Riverside County line until the 55/91 interchange within Orange County. Vehicles can enter the system from either end. The roadway largely serves exurban commuters in Riverside County which travel to Orange or Los Angeles counties to work. Commuters have few options within this corridor which is a natural canyon with hills (and few alternate roadways) on either side.

Most of the data for this study comes from a survey conducted at the Institute of Transportation Studies at the University of California, Irvine. When the survey was conducted in summer 1997, the toll for single occupancy vehicles or two-person carpools during the 5 a.m. to 9 a.m. Westbound rush hours in the morning and 3 p.m. to 7 p.m. Eastbound rush hours in the evening was $2.75. In 1998, the toll increased and the peak hours have been refined. The peak hour during each rush period is charged $3.20. During "normal" conditions, travelers save up to 12 minutes each way by using the Express Lanes (*16*). Anecdotes from the newspaper and the private toll road operator's marketing literature suggest that perceived savings are much larger.

Part of the franchise agreement that the California Private Transportation Company (CPTC), the Express Lane operators, had with Caltrans was that, depending on a sufficient amount of revenues and for at least two years, they would operate the lanes as High Occupancy/Toll (HOT) lanes. Carpools and vanpools with three or more people (HOV-3+) would use the Express Lanes without paying a toll. Citing insufficient Express Lane revenues necessitating a toll for carpoolers, after January 1, 1998 CPTC charges HOV-3+ half of the toll charged to other vehicles. However, our survey data was collected six months earlier than this and so we can consider the data as representative HOT lane data.

Table 1 gives a comparison of HOT lanes, HOV lanes, and "regular" lanes using typical definitions and how they compare specifically in the case of the 91 Express Lanes. Obviously, there is some similarity in that the lanes all go from point A to point B. But the chart shows some differences between the three types of lanes. The specifics of the 91 Corridor help describe the case study that is discussed and analyzed in this paper.

DATA

This study will examine mail-survey data of 91 Corridor users collected in summer 1997. The survey includes corridor users: those that use the Express Lanes and those that have the opportunity to use the Lanes but don't. Effort was made to solicit respondents that use all three modes: solo drivers, two-person carpools, and three-person carpools. We intentionally over-sampled carpoolers and Express Lane users because we are more interested in their behavior. Our data set includes a seven-day "diary" of corridor travelers that, unlike other reported studies, tells us that many users use both routes and multiple modes. Some drivers use the regular lanes for most of their trips. Some mainly use the Express Lanes. Some two-person carpools regularly use the Express Lanes (mostly splitting the full toll), many two-person carpools regularly use the untolled lanes. At the time of the survey, most cars with three or more passengers used the Express Lanes since they didn't have to pay a toll. Peak periods are studied because more commuters are expected during these times.

Table 2 shows that the mode shares of the people in the Express Lane corridor are slightly different from reported mode shares in the Los Angeles region and nationally because there are few transit options in the corridor and people don't have the option to walk or ride bikes. The second column shows data that we collected by observing individual vehicles in the corridor during our survey data collection phase. The Los Angeles data is taken from the State of the Commute Survey administered every year by California Rideshare. The national data is from the National Personal Transportation Survey data administered by the Federal Highway Administration. A high proportion of people carpool in this corridor compared to the regional and national averages of carpoolers. Another important difference between 91 Corridor users and other commuters is that they have a longer commute than the averages for Los Angeles and nationally.

To learn more about what modes use which route and whether our respondents show this behavior daily (during a week) or sometimes, refer to Table 3. The unweighted data shows our individual respondents. The sample is choice-based, that is carpoolers and Express Lane users were oversampled in order to obtain richer information with fewer respondents. The manual counts made of corridor users (volume, one or more passengers, hour observed) in summer 1997 are used to determine weights to assign to the survey respondents in order to better reflect true behavior on the corridor. N_{hlm}, obtained from the manual counts, is used to represent the true population of corridor users in hour *h*, lane *l* (either Express or regular), and mode *m* (solo driver or one or more passengers). The survey respondents are used to determine n_{hlm}. The data for each observation is multiplied by N_{hlm}/n_{hlm} to obtain weighted data. The weighted data shows that 1/3 of regular (daily) users of the Express Lanes are carpoolers, but only about 20% of the infrequent Express Lane users are carpoolers. The table also shows that nearly 40% ((19+9)/(48+25)) of the HOV-2s never use the Express Lanes. This is less than the 50% of solo drivers who never use the Express Lanes and is expected since the HOV-2s can share the cost of the toll.

One of the first ways I can use the data to determine if the presence of HOT lanes encouraged or discouraged carpooling is to examine carpooling before the facility opened, carpooling changes, and current mode choices in the corridor. Table 4 shows the number of our respondents who use the full 91 corridor and carpooled in November 1995 (before the Express Lanes opened) and summer 1997. The first column shows the number of passengers in November 1995. The second and third columns show the number of the respondents in the first column that increased and decreased the number of passengers by summer 1997. We must remember that these are fairly small numbers and so sampling error may be significant. Also, it is possible that those who carpool or who have changed their carpooling behavior are more likely to return their surveys and provide responses. And, since these are unweighted figures, there may be biases because we oversampled HOVs. Finally, because our sampling process involved drivers of passenger vehicles, we may not have received responses from people that always ride in a carpool or vanpool. But our respondents' numbers are probably indicative of the types of changes that occurred and the proportion of carpoolers that made a change in the nineteen months between the opening of the Express Lanes and when our survey was conducted.

The number of respondents who answered questions about their mode choice in November 1995 is smaller than the Summer 1997 sample because some people moved or changed jobs in the eighteen months in between. Ten percent of the solo drivers and 25 % of the drivers who always drove in a two-person carpool increased the number of passengers in their vehicle by Summer 1997. However, more carpools reduced the number of passengers in the eighteen months including, surprisingly, forty percent of the cars that had been previously traveling with three or more in the vehicle. We can imagine that many of these are people that dropped out of vanpools during this time. By summer 1997, the rate of carpooling has dropped according to this data which follows the regional and nationwide trend of fewer carpoolers. But, given the decreases among those that started, a significant number of carpools were formed during this period. There is also a greater proportion of "sometimes" carpoolers.

BEHAVIORAL MODELS

Here I present multinomial logit models of carpool formation. The logit model is chosen in order to do a behavioral study of the characteristics that influence each choice. Multinomial logit is implemented rather than ordered logit because, on this corridor, it is anticipated that traveling with three or more is qualitatively different from carpooling with one other person or driving alone. Here the models are shown estimated with the same variables. Tables 5-7 present the models, estimated values of the coefficients, and t-statistics for each coefficient (provided below the coefficient value in parentheses).

Carpooling in a HOT corridor is probably different from carpooling in other locations. Similar to other research efforts that examine carpooling behavior, the data can be used to analyze long-term carpooling models. That is, I can include the characteristics that other research efforts have shown to be significant in forming carpools and show whether the travelers on this corridor follow the same patterns. These would be long-term models of carpool formation that show formation of carpools given personal and household characteristics and information about the respondents' work place. But this study also allows us to examine a short-term model of carpool formation given the new facility and special characteristics of this corridor. For this, I identify (with our survey data) what mode respondents used just before the 91 Express Lanes opened. Including dummy variables of whether they carpooled with HOV-2 or HOV-3+ just before the Express Lanes opened, I can examine behavioral changes since the Lanes opened. I expect carpooling before the Lanes opened would be a big indicator of the inclination to carpool now, but from Table 4, we know that many changes have occurred in the nineteen months between the opening and the time the survey data was collected. The dummy "inertia" variables also absorb some of the random (unobserved) factors that influence the carpooling decision, leaving the other coefficients to define a purer short-term model. The coefficients of the inertia variables also help with considering the question of whether HOT lanes can encourage carpooling.

The variables shown in the presented models and others were chosen considering the literature and specific characteristics of this corridor. Other variables were tested, but they did not explain much in the models and have been removed in order to present consistent yet reasonably parsimonious models for comparison purposes. Trip length and vehicle availability are standard to include in a carpool model because many past researchers have found correlation between these variables and carpooling. The number of carpool incentives offered at the workplace is included to consider Southern California travel demand management policies and to follow-up on the work of Brownstone and Golob (*13*).

It is typical to include the demographic variables of age, gender, and number of children. It is not clear how children effect carpooling because it is possible that the presence of children reduces carpooling because the car is needed for drop-offs or pick-ups of children before and after work. However, children can also represent a settled, stable work and lifestyle that is amenable to carpooling. Household income is included because it is expected that observations with higher income are more likely to use the Express Lanes. However, carpooling saves money in gas and car maintenance and HOV-3+ do not pay a toll and HOV-2s can split the toll so the two effects may offset each other. "Other language" is equal to one for the people who indicate that they speak a language other than English at home. Language may be capturing cultural, technology understanding, and income distinctions that are not captured with the other variables. Several studies have been undertaken in Southern California to discuss the carpooling behavior of different ethnic groups (*5,6*).

Each coefficient of the short and long term models presented in Tables 5-7 shows the effect of that variable on the propensity to use that mode compared to the base case of driving solo. Positive coefficients suggest that having that characteristic or a lot of that characteristic denotes a propensity towards that mode and away from the base case. The opposite is true for negative coefficients. T-statistics are given in parentheses underneath each coefficient. These models use unweighted data due to technical difficulties in incorporating weights into the logit routine. My experience is that weighting so that true proportions with respect to mode, route, and hour in the corridor are properly represented by each observation only slightly modifies the results.

Simple Three Choice Carpooling Model

The first models to analyze are the short and long-term choices between the three alternatives: driving solo, carpooling with one other person in the car (HOV-2) and carpooling with two or more others (HOV-3+) (shown in Table 5). For all of these models, "solo drivers" are defined as those peak hour corridor users who always drive alone, HOV-3+ are people who carpooled with two or more passengers at least once in the week before they fill in the survey, and HOV-2s are those who don't fit into either of the other categories (they must have travelled at least once a week in a peak-hour two-person carpool on the 91 corridor).

Analyzing the coefficient estimates for these simple models helps us to understand the fundamental influences of carpool formation before considering frequency of use and route choice between the Express Lanes and the regular lanes. The number of vehicles per adult in the household is significant in both models for HOV-3+ carpoolers. This holds true in all of the models presented here. Many of the 3+ carpoolers in this corridor are vanpoolers that don't need their own vehicle for the commute. Trip length and language are significant only for the HOV-2 trip. This may suggest that for longer distances and with cultural differences, it may be generally possible to find just one other carpool partner rather than a larger group. Interestingly, the number of carpool incentives and gender "shows up" fairly strongly in the long-term model. Incentives such as preferred parking, help organizing vanpools and guaranteed rides home help people in making the long-term mode decision. Also, in the absence of the Express Lanes, women are more likely to carpool.

The coefficients and t-statistics in the short-term model support that carpooling in November 1995 significantly affects carpooling at the time of the survey. As expected, there is a strong propensity to not change the number of passengers and to remain a carpool. Relatively few HOV-2 carpoolers increased to HOV-3 carpools with the opening of the Express Lanes.

Mode Choice and Frequency

I expand the three choices to reflect how often carpoolers carpool in the corridor. With the opening of the HOT lanes, our data show (Table 6) that there is an increase in the number of carpoolers that don't carpool every day but a few times a week. The data also show that the Express Lanes are used infrequently by a large percentage of users (more than once a week but not eight or more times a week). Previous work has analyzed infrequent use of the Express Lanes (*17,18*). Here I concentrate on mode choice and frequency which can be distinguished in this corridor with the following five choices: HOV-3+ always, HOV-3+ sometimes, HOV-2 always, HOV-2 sometimes and SOLO drive always. The short and long-term multinomial results for the five choices are presented in Table 7. The results are presented against the base case of always driving solo. Here, consistent with the HOV-2 results above, trip length is significant only for the choice of always travel HOV-2. Language and gender are significant for the sometimes and HOV-2 always choices. Age and language are significant for both of the "sometimes" cases in the short-term model. This implies that women and minorities are more likely to form carpools for part of the week rather than the whole week. However, the long-term gender coefficients imply that women are more likely to form daily carpools in the long term. Language and gender are also strong for the HOV-2 always case. The negative sign for age associated with the "sometime" cases implies that older people are more settled and have regular mode and route habits. For the long-term model, three additional variables are significant for the HOV-3+ always case (these are all consistent with the simpler mode model): the number of carpool incentives at work, the number of children in the household, and vehicles per adult.

The coefficients of the inertia variables show a propensity to stay with the same size carpool, but people who carpooled in an HOV-2, before the Express Lanes opened, sometimes travel in an HOV-3+ now and a fewer number of HOV-3s now travel in HOV-2 always carpools. These coefficients support the hypothesis that the Express Lanes are encouraging carpooling—people are not dropping out of carpools and paying for the premium service.

Mode and Route Choice

It is difficult to assess with these results whether people who drove alone before the Express Lanes opened have been motivated to form carpools because of the Express Lanes. However, this data allows us the first opportunity to form simultaneous carpool and route choice models of people with access to a HOT lane. The five choices here are HOV-3+ (expected to use the Express Lanes because they can travel for free), HOV-2 Express, HOV-2 regular, SOLO Express, and SOLO regular. The short and long-term models are presented in Table 7. The coefficients should be compared to the base case of driving alone on the regular lanes. As expected, income is significant for the Express Lane choices. Here, trip length is again significant for HOV-2s and for SOLO drivers on the Express Lanes. The coefficients tell us that there is a greater chance for solo drivers on the Express Lanes to be younger. Women have a greater propensity to carpool and use the Express Lanes. The coefficients for women using the Express Lanes are consistent with our results in previous research. Like the mode and frequency models, carpool incentives, household children, and vehicles per adult influence the long-term HOV-3+ decision which can be interpreted as the correct combination of these factors likely influence carpooling with or without the Express Lanes.

I examine the coefficients of the dummy variable HOV-3+ in November 1995 to determine whether respondents are breaking up their carpools to travel (and pay) on the Express Lanes. The variable is small and insignificant. This indicates that people are not dropping out of their carpools to use the Express Lanes. Similarly, those who carpooled in November 1995 with two people in the vehicle are not regularly using the Express lanes by themselves. I can conclude from this that HOT lanes do not discourage carpooling.

IMPORTANCE OF RESULTS/POLICY IMPLICATIONS

There are many who think that we can solve our congestion problems by just building more traffic lanes. However, in many locations, the cost is prohibitive. Further, in most cases of general purpose lanes, latent demand arrives and jams the roadway just as much as before. Federal policy has encouraged the building of high occupancy vehicle lanes by providing greater incentives to states to build HOV lanes rather than expand capacity on roadways. Another alternative is to build HOT lanes. HOT lanes can very likely pay for themselves through tolls. Thus the municipality gets a road, people can either form a carpool and get a service (free-flowing lane) for free, or people can pay a user-fee and use the premium lane.

Alternatively, where converting underutilized HOV lanes to regular lanes is being considered, it may become politically feasible to convert them to HOT lanes instead where everyone benefits. Is it possible for more people to consider paying for premium roads? People already pay for toll roads and bridges. They pay for private colleges, to eat at better restaurants, and to sit in better seats at ball games. Paying to use a road that will get you there faster may become just as acceptable.

However, it is reasonable to be concerned over whether HOT lanes will discourage carpool formation if people can pay for the same time savings that carpoolers receive. But arguments can be made that HOT lanes may encourage carpools. The toll provides an incentive to form a three-person carpool and not pay. Additionally, it is plausible that many new two-person carpools were formed that use the lanes and then split the cost of the toll. The data and results provided here are inconclusive about whether HOT lanes encourage new carpools. However, I can conclude with the results that carpooling in the corridor is consistent with previous results in the literature. The significant variables are analogous to results provided by other carpool researchers which suggests that carpooling behavior in this corridor is similar to carpool behavior anywhere. The results also show that carpooling has not been discouraged in the nineteen months between the opening of the HOT lane and when our survey data was collected.

The corridor presents an opportunity to study non-daily carpoolers given that use of the Express Lanes is also not regular. However, the results of the frequency models are consistent with the simpler mode choice model and with a model expanded to include the different lane types. There are not many differences between regular and infrequent carpoolers which makes it hard to distinguish infrequent carpoolers from frequent carpoolers. Thus, carpooling incentives and policies may have similar effects on both groups. The non-frequent use contributes to a reasonably high overall rate of carpooling for the corridor. We expect the Express Lanes to be an incentive for forming both regular and irregular carpools. The results here may be interpreted to support that hypothesis.

ACKNOWLEDGEMENTS

The author wishes to thank her advisor Kenneth A. Small for the help provided in writing this paper and during the course of the project. Funding for the project has been provided by ITF Intertraffic, a Daimler-Benz company.

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TABLE 1 Characteristics of Typical HOT, HOV, and Regular Lanes Compared to Conditions in the 91 Corridor

	Typical	In the 91 Corridor
HOT (High Occupancy/ Toll) Lanes	Everyone can use	Electronic transponder required
	Solo drivers pay a toll	HOV-3+ went free until Jan '98
	Free-flowing	Tolls increase (4 times since inception) if delays become regular
	Limited access	Ten-mile length
		Full separation from other traffic lanes
	Fines for enhancement	Private company hires off-duty state police officers and equipment for enforcement
	Toll facility	Electronic tolling (no slowing down to pay)
	TEA-21 Value Pricing Program encourages design and implementation	First private toll road resulting from AB 680 (CA) legislation
HOV (High Occupancy Vehicle) Lanes	Flow better than regular lanes	HOV-2 lanes before and after the 91 Express Corridor
	HOV-2 usually	
	Free	
	May have limited access	
	May be separated from regular lanes	
	Fines for enforcement	Steep fines in CA ($271)
	ISTEA encouraged design and implementation	Private operators of the Express Lane have the option to extend their HOT facility west and east before government-funded HOV lanes are implemented there
"Regular" lanes	Everyone	Volumes decreased due to extra capacity provided by Express Lanes
	Easily congested	Four hour peak
	Free	

TABLE 2: Mode Share and Travel Length Comparisons Between Commuters on the 91 Corridor, in the Los Angeles Region, and Nationally

	Survey Respondents	Counts from Summer 1997	Los Angeles Region State of the Commute 1996	1995 National Personal Transportation Survey
Travel Mode				
Drive Alone	71.3	78.6	78.5	74.5
Carpool/ Vanpool	28.3	21.4	14.5	16.0
Other	0.4	---	7.0	9.3
Travel Miles	43.8	---	11.5	11.6
Travel Time	62.0	---	20.0	20.7

TABLE 3 Mode Choice Frequency vs. Route Choice Frequency

	Express Lane Always	Express Lane Sometimes	Never Use Express	Total
UNWEIGHTED				
HOV-3+ Always	34	14	2	50
HOV-3+ Sometimes	4	11	0	15
HOV-2 Always	13	27	7	47
HOV-2 Sometimes	5	17	3	25
SOLO Always	45	149	97	291
Total	101	218	109	428
WEIGHTED				
HOV-3+ Always	13	6	4	23
HOV-3+ Sometimes	2	4	0	6
HOV-2 Always	4	25	19	48
HOV-2 Sometimes	2	14	9	25
SOLO Always	24	138	164	326
Total	45	188	195	428

TABLE 4 Mode Changes by Respondents Between November 1995 and Summer 1997

	November '95	Respondents who increased the number of passengers	Respondents who decreased the number of passengers	Summer '97 (Respondents who indicated mode choice in Nov '95)	Summer '97 (All respondents)
HOV 3+ Always	48	2	22	43	51
HOV 3 + Sometimes	11	0	7	13	15
HOV 2+ Always	38	9	13	38	49
HOV 2+ Sometimes	23	1	13	16	30
Always solo	220	20	---	213	305
Number of observations	329			323	450

TABLE 5 Multinomial Logit Models of Mode Choice

	Short-term Model		Long-term Model	
	HOV-3+	HOV-2	HOV-3+	HOV-2
Household income ($1000)	.0010 (0.155)	.0009 (0.178)	-.0001 (-0.018)	.0020 (0.409)
Trip length	.0016 (0.177)	**.0146** **(2.243)**	.0030 (0.397)	.0098 (1.622)
Number of carpool incentives	.2014 (1.655)	.1039 (0.963)	**.4085** **(4.155)**	**.1836** **(1.852)**
Age	-.0134 (-0.695)	-.0069 (-0.461)	.0023 (0.134)	.0095 (0.695)
Other language	.7772 (1.619)	**1.141** **(3.196)**	.5977 (1.403)	**1.107** **(3.357)**
Gender	-.5602 (-1.543)	-.2980 (-1.014)	**-.6573** **(-2.091)**	-.4171 (-1.529)
Household children	.2330 (1.629)	.0262 (0.212)	**.3949** **(3.184)**	.0934 (0.827)
Vehicles per adult	**-.8596** **(-1.769)**	-.2637 (-0.756)	**-.9674** **(-2.314)**	-.2322 (-0.734)
HOV-2 in November '95	.9283 (1.687)	**2.1953** **(6.523)**		
HOV-3+ in November '95	**3.431** **(8.120)**	**1.806** **(3.840)**		
Alternative-specific constant	-1.519 (-1.472)	-2.331 (-2.974)	-1.510 (-1.715)	-2.358 (-3.186)
Number of observations	490		490	
Log likelihood	-304.771		-363.197	
Pseudo R^2	0.2130		0.0622	

TABLE 6 Multinomial Logit Models of Mode Choice and Frequency

	Short-term Model				Long-term Model			
	HOV-3+ Always	HOV-3+ Sometimes	HOV-2 Always	SOLO Sometimes	HOV-3+ Always	HOV-3+ Sometimes	HOV-2 Always	SOLO Sometimes
Household income ($1000)	-.0052 (-0.690)	**.0277** **(2.075)**	.0023 (0.332)	-.0043 (-0.536)	-.0066 (-1.027)	**.0244** **(2.023)**	.0030 (0.476)	-.0038 (-0.487)
Trip length	.0024 (0.225)	-.0096 (-0.443)	**.0222** **(2.767)**	.0059 (0.560)	.0041 (0.495)	-.0021 (-0.127)	**.0162** **(2.226)**	.0036 (0.346)
Number of carpool incentives	.2436 (1.741)	.1236 (0.548)	.0319 (0.214)	**.3027** **(2.032)**	**.4496** **(4.208)**	.3565 (1.767)	.1426 (1.060)	**.3944** **(2.780)**
Age	-.0218 (-0.954)	-.0692 (-1.736)	.0114 (0.544)	**-.0599** **(-2.393)**	.0045 (0.228)	-.0378 (-1.017)	.0312 (1.713)	**-.0444** **(-1.864)**
Other language	.7879 (1.342)	**2.224** **(2.635)**	**1.323** **(2.671)**	**1.315** **(2.481)**	.4828 (0.930)	**1.634** **(2.170)**	**1.334** **(3.033)**	**1.291** **(2.495)**
Gender	-.6550 (-1.550)	**-1.189** **(-1.776)**	**-.7616** **(-1.946)**	**-.1279** **(-0.281)**	**-.6983** **(-1.925)**	-1.171 (-1.860)	**-.8721** **(-2.462)**	-.1936 (-0.434)
Household children	.2175 (1.323)	-.1337 (-0.447)	.0621 (0.382)	-.0735 (-0.388)	**.4112** **(2.963)**	.0459 (0.169)	.1290 (0.908)	-.0188 (-0.103)
Vehicles per adult	-1.016 (-1.822)	-1.242 (-1.354)	-.5196 (-1.112)	-.4453 (-0.772)	**-1.118** **(-2.384)**	-1.016 (-1.132)	-.3024 (-0.750)	-.3690 (-0.674)
HOV-2 in November '95	1.084 (1.536)	**2.139** **(2.250)**	**2.876** **(6.396)**	**1.851** **(3.165)**				
HOV-3+ in November '95	**3.851** **(7.424)**	**4.310** **(5.100)**	**2.186** **(3.380)**	**2.077** **(2.960)**				
Alternative-specific constant	-.6538 (-0.539)	-1.454 (-0.756)	-3.509 (-3.045)	-.0772 (-0.065)	-1.110 (-1.076)	-2.144 (-1.155)	-3.686 (-3.597)	-.4047 (-0.350)
Number of observations	411				411			
Log likelihood	-331.988				-394.993			
Pseudo R^2	0.2325				0.0868			

TABLE 7 Multinomial Logit Models of Mode and Route Choice

	Short-term Model				Long-term Model			
	HOV-3+	HOV-2 Express	HOV-2 Regular	SOLO Express	HOV-3+	HOV-2 Express	HOV-2 Regular	SOLO Express
Household income ($1000)	.0105 (1.583)	**.0127** **(1.946)**	-.0085 (-1.066)	**.0158** **(3.385)**	.0093 (1.590)	**.0133** **(2.136)**	-.0081 (-1.035)	**.0157** **(3.415)**
Trip length	.0094 (0.968)	**.0236** **(2.821)**	**.0203** **(2.088)**	**.0141** **(2.253)**	.0106 (1.311)	**.0198** **(2.458)**	.0172 (1.835)	**.0134** **(2.136)**
Number of carpool incentives	.1927 (1.472)	.0194 (0.135)	.2015 (1.345)	-.0828 (-0.751)	**.3712** **(3.391)**	.0586 (0.431)	.2680 (1.865)	-.0965 (-0.886)
Age	-.0278 (–1.392)	-.0304 (-1.621)	-.0403 (-1.874)	**-.0343** **(-2.571)**	-.0100 (-0.572)	-.0126 (0.718)	-.0238 (-1.172)	**-.0308** **(-2.350)**
Other language	.3479 (0.703)	.2506 (0.508)	.6113 (1.163)	-.4192 (-1.099)	.2486 (0.561)	.3108 (0.660)	.6480 (1.270)	-.3770 (-0.998)
Gender	**-.9843** **(-2.577)**	**-1.181** **(-3.222)**	-.6383 (-1.475)	**-.6220** **(-2.322)**	**-1.029** **(-3.092)**	**-1.229** **(-3.526)**	-.6977 (-1.654)	**-.6263** **(-2.357)**
Household children	.1934 (1.310)	-.0616 (-0.386)	-.2112 (-1.120)	-.0580 (-0.525)	**.3259** **(2.548)**	-.0159 (0.105)	-1654 (-0.898)	-.0506 (-0.468)
Vehicles per adult	**-.8898** **(-1.895)**	-.7114 (-1.570)	-.2319 (-0.474)	-.3740 (-1.295)	**-.9776** **(-2.446)**	-.6505 (-1.526)	-.2604 (0.554)	-.4229 (-1.475)
HOV-2 in November '95	**1.772** **(3.055)**	**2.574** **(5.087)**	**2.305** **(3.938)**	.7142 (1.448)				
HOV-3+ in November '95	**3.410** **(6.558)**	.8256 (1.084)	**1.533** **(2.148)**	-.3379 (-0.500)				
Alternative-specific constant	-.4025 (-0.378)	-.5373 (-0.541)	.0051 (0.005)	.7856 (1.109)	-.4115 (0.450)	-.7940 (-0.823)	-.1627 (-0.152)	.7623 (1.082)
Number of observations	469				469			
Log likelihood	-578.706				-640.907			
Pseudo R^2	0.1559				0.0652			