Vanpooling is a travel mode that brings five to 15 commuters together in one vehicle, typically a van. As a mode of travel, public transit agencies report that vanpooling accounts for 0.4% of total unlinked passenger trips, but 2.7% vehicle revenue miles (4). In metropolitan areas with high-occupancy vehicle lanes, vanpools are touted for their ability to bypass traffic jams, giving commuters potentially significant time savings.

Publicly sponsored vanpooling programs have been established since the late 1970s in response to the energy crises and have since experienced periods of surge and abandonment (2). These programs are now a relevant component of transportation demand management (TDM) initiatives geared at reducing the negative impacts of congestion caused by more traditional modes of transportation, while promoting their use as an efficient and cost-effective commuting alternative.

Vanpool programs, in their promotional efforts, tend to overestimate the relevance of fare pricing as a means to increase ridership. At the same time, it is imperative for these programs to objectively assess the impact of fare pricing and subsidy policies to meet program goals and requirements.

In the literature, TDM research has been concerned mostly with evaluating the effectiveness of measures aimed at reducing solo driving. Its focus has been on strategies geared toward penalizing single-occupancy vehicle (SOV) use, providing incentives to use alternative modes, or changing the time and frequency of trips. Several studies have examined the effects of incentives and disincentives on commuters’ mode choice, concentrating their efforts mostly on assessing the impact of pricing policies as a means of discouraging solo driving, often with contrasting results. For example, some suggest that free parking is considered as a major barrier to many work site ridesharing programs (3). Baldassarre, et al. however, conclude that commuter responses to parking pricing are less marked than previously inferred, suggesting a resistance to changes in solo driving behavior in response to higher parking costs (4). Using a stated preference approach, Kuppam et al. demonstrate that travel behavior is affected by parking pricing, with trade-offs between transportation modes related to commuter sociodemographic attributes and travel patterns (5).

Most studies that attempt to establish measures of price responsiveness with respect to mode shifts focus on transit ridership [for a comprehensive review of elasticity studies with a focus on transit, see TCRP Project H-6 Synthesis (6)]. However, relatively few studies commissioned to assess specific vanpool programs have attempted to establish measures of price responsiveness as a means of promoting successful ridership programs (7). In a more generic framework, although Ferguson demonstrates that direct incentives to employees have the largest and most consistent impact among TDM pricing instruments, accounting for firm cohort and size, he does not model the impact of fares on rideshare (8).

The objective of this study is to empirically examine fare pricing responsiveness and the impact of subsidies on vanpool ridership. By means of a discrete choice modeling approach, the choice of vanpool services and the effects of subsidy programs and price on vanpool demand are investigated. By using employer and employee data from the 1999 survey of the commute trip reduction (CTR) program of the Puget Sound region (Washington), a conditional logit model is built to analyze vanpool choice with respect to competing means of transportation as a function of various socioeconomic characteristics.

Results indicate that vanpool demand is relatively inelastic with respect to fare changes. In particular, the direct elasticity of demand with respect to its fare is equal to −0.73, indicating a relatively low responsiveness to fare pricing changes. For example, a fare reduction of 10% is associated with an increase of 7.3% in demand. This is in contrast with a reported elasticity factor of −1.16 used in a previous study (7). Furthermore, the sensitivity to price fare changes declines as the distance increases beyond 60 mi, as individuals become less responsive to price changes.

Center for Urban Transportation Research, University of South Florida, 4202 East Fowler Avenue, CUT 100, Tampa, FL 33620-5375.


Fare Pricing Elasticity, Subsidies, and Demand for Vanpool Services

Sisinnio Concas, Philip L. Winters, and Francis W. Wambalaba
Subsidies have a relevant effect in increasing ridesharing, accounting for firm size and controlling for employee adherence to the CTR law and geographical heterogeneity. When a subsidy is offered, the odds of choosing vanpool over drive-alone more than double. Firm size influences the likelihood of choosing vanpool as an alternative ridesharing mode. Results show that as firm size increases above 1,100 employees, the odds of choosing vanpool more than double, everything else constant. The negative impact of free parking on mode shift is more accentuated for employees working for large firms (above 2,600 employees).

The rest of the paper is structured as follows. In the next section the sample survey data set is analyzed and the proposed set of predictors is described. In the section on the econometric model the approach to model building is outlined and the model is estimated and checked against violations of assumptions. After the model is validated, results are discussed. In the final section conclusions and caveats are considered.

DATA DESCRIPTION AND ANALYSIS

The Puget Sound region has the largest vanpool fleet in the United States, with six local vanpool operators providing more than 40% of the public vanpools in the country (9).

Washington State adopted the CTR law in 1991 with the objective of improving air quality, reducing congestion, and decreasing dependence on petroleum fuels by instituting employer-based programs (10). The law applies to employers with 100 or more full-time employees at a single work site, employees who are scheduled to begin their workdays between 6:00 a.m. and 9:00 a.m. weekdays, and a work site that is located in counties with populations of more than 150,000 (Clark, King, Kitsap, Pierce, Snohomish, Spokane, Thurston, Whatcom, and Yakima counties). The purpose of this program is to encourage the use of alternatives to SOV for commuter trips as part of a comprehensive TDM strategy. Beginning in 1992 all employers participating in CTR programs began implementing surveys of their employees biannually to measure changes in commuting patterns. The purpose of the survey instrument is to track both employer programs and employee commute patterns to establish subsequent goals and measures geared toward reaching program goals.

The data set used to estimate the model was derived from the 1999 CTR program employee and employer surveys. The employee survey is a survey of revealed preferences (commuters are asked what their choice of transportation was in the week before the day being surveyed), making the data set sufficiently fit to discrete choice analysis. The employer survey data set provided information on mode-specific subsidy programs, as well as firm-specific descriptors. This data set provided quantitative and qualitative information on parking services and on subsidies to vanpool, carpool, and transit modes. Table 1 lists the variables tested in the model, and a more detailed description of the most relevant ones follows below.

From the employee survey, the following information was extracted for consideration in the model-building process.

Mode Choice

The following means of transportation constitute the mode choice set available to commuters:

- Drive-alone,
- Carpool,
- Vanpool,
- Bus and transit,
- Bicycle,
- Motorcycle,
- Walk,
- Telecommute, and
- Other.

To focus on vanpool choice, the data set was subsequently resized to consider a mode choice subset fit to estimate a binomial model of choice of vanpool versus all other modes of transportation. Because the cost of using each mode of transportation was not reported in the employee survey, each of the cost variables was constructed based on a set of assumptions. The cost components of each mode are described below.

Drive-Alone (DA_COST)

The costs components and estimates used to construct the drive-alone variable were derived directly from the American Automobile Association (AAA) (11). According to AAA the average operating cost of an automobile was about 13.4 cents per mile. Operating costs include gas, oil, maintenance, and tires. The variable was created using that estimate and the employee reported distance, as follows:

\[ DA_{\text{cost}} = \text{DIST} \times \text{COST} + \text{PARKING} \]

where

- \( \text{DIST} \) = distance (reported daily round-trip distance as per employee survey),
- \( \text{COST} \) = daily average operating cost (AAA estimates),
- \( \text{PARKING} \) = average reported daily parking cost as per employee survey (obtained from employer survey).

Assuming an average of 22 working days per month, this cost variable was translated into a daily cost.

Carpool Cost (CP_COST)

To account for the cost of carpooling, the general guidelines of commuter reduction programs were considered. For example, according to the Spokane County Commute Trip Reduction Office (12), the guidelines for charging passengers suggest the use of the auto cost estimates as derived above, divided by the number of passengers carpooling. The cost of carpooling is equal to the cost of driving alone adjusted by the reported vehicle occupancy. In the employee survey, all respondents who chose a mode alternative to auto were asked to report vehicle occupancy.

\[ CP_{\text{cost}} = (\text{DIST} \times \text{COST} + \text{PARKING})/\text{OCCUPANCY} \]

Pearson correlation coefficients showed modest correlation between DA_COST and CP_COST, but not at a point that would cause multicollinearity issues as discussed in the section on results.
Vanpool Cost (VP_COST)

The vanpool cost variable was constructed using information from both the employer and the employee surveys. By using the reported response identification code number, each survey respondent in the employee survey was matched to each respective firm in the employer survey. By applying this matching procedure, the fare schedules of each vanpool company serving the employers’ county were used. The fare schedules are based on distance and vehicle occupancy and are published as a monthly cost. The vanpool cost variable was constructed using the employee reported distance and vehicle occupancy. By assuming an average of 22 working days per month, this cost variable was translated into a daily cost.

Transit Cost (TR_COST)

By using the employer and employee survey matching procedure, transit costs were derived using published fare schedules of the county in which the employer was located.

TABLE 1  Predictors of Vanpool Mode Choice

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>0.01</td>
<td>—</td>
<td>1 if vanpool, 0 if otherwise</td>
</tr>
<tr>
<td>DIST</td>
<td>14.54</td>
<td>11.55</td>
<td>Distance (one way) from home to work</td>
</tr>
<tr>
<td>DA_COST</td>
<td>2.64</td>
<td>2.74</td>
<td>Driving cost: $ per day</td>
</tr>
<tr>
<td>VP_COST</td>
<td>2.26</td>
<td>1.75</td>
<td>Vanpool cost: $ per day</td>
</tr>
<tr>
<td>CP_COST</td>
<td>1.96</td>
<td>2.04</td>
<td>Carpool cost: $ per day</td>
</tr>
<tr>
<td>TR_COST</td>
<td>2.12</td>
<td>0.48</td>
<td>Transit cost: $ per day</td>
</tr>
<tr>
<td>VP_SUB</td>
<td>0.40</td>
<td>—</td>
<td>Vanpool subsidy: 1 if yes, 0 if otherwise</td>
</tr>
<tr>
<td>CP_SUB</td>
<td>0.20</td>
<td>—</td>
<td>Carpool subsidy: 1 if yes, 0 if otherwise</td>
</tr>
<tr>
<td>TR_SUB</td>
<td>0.47</td>
<td>—</td>
<td>Transit subsidy: 1 if yes, 0 if otherwise</td>
</tr>
<tr>
<td>WDUM1</td>
<td>0.14</td>
<td>—</td>
<td>Work status: 1 if administrative, 0 if otherwise</td>
</tr>
<tr>
<td>WDUM2</td>
<td>0.14</td>
<td>—</td>
<td>Work status: 1 if craft/production/labor, 0 if otherwise</td>
</tr>
<tr>
<td>WDUM3</td>
<td>0.12</td>
<td>—</td>
<td>Work status: 1 if management, 0 if otherwise</td>
</tr>
<tr>
<td>WDUM4</td>
<td>0.04</td>
<td>—</td>
<td>Work status: 1 if sales/marketing, 0 if otherwise</td>
</tr>
<tr>
<td>WDUM5</td>
<td>0.08</td>
<td>—</td>
<td>Work status: 1 if customer services, 0 if otherwise</td>
</tr>
<tr>
<td>WDUM6</td>
<td>0.34</td>
<td>—</td>
<td>Work status: 1 if professional/technical, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM1</td>
<td>0.01</td>
<td>—</td>
<td>County: 1 if Yakima, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM2</td>
<td>0.02</td>
<td>—</td>
<td>County: 1 if Thurston, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM3</td>
<td>0.12</td>
<td>—</td>
<td>County: 1 if Spokane, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM4</td>
<td>0.08</td>
<td>—</td>
<td>County: 1 if Snohomish, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM5</td>
<td>0.08</td>
<td>—</td>
<td>County: 1 if Pierce, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM6</td>
<td>0.02</td>
<td>—</td>
<td>County: 1 if Kitsap, 0 if otherwise</td>
</tr>
<tr>
<td>CDUM7</td>
<td>0.58</td>
<td>—</td>
<td>County: 1 if King, 0 if otherwise</td>
</tr>
<tr>
<td>FDUM1</td>
<td>0.01</td>
<td>—</td>
<td>Firm size (employees): 1 if firm size greater than 1 and less than or equal to 100, 0 if greater than 2600</td>
</tr>
<tr>
<td>FDUM2</td>
<td>0.24</td>
<td>—</td>
<td>Firm size (employees): 1 if firm size greater than 100 and less than or equal to 280, 0 if greater than 2600</td>
</tr>
<tr>
<td>FDUM3</td>
<td>0.24</td>
<td>—</td>
<td>Firm size (employees): 1 if firm size greater than 280 and less than or equal to 550, 0 if greater than 2600</td>
</tr>
<tr>
<td>FDUM4</td>
<td>0.25</td>
<td>—</td>
<td>Firm size (employees): 1 if firm size greater than 550 and less than or equal to 1100, 0 if greater than 2600</td>
</tr>
<tr>
<td>FDUM5</td>
<td>0.19</td>
<td>—</td>
<td>Firm size (employees): 1 if firm size greater than 1100 and less than or equal to 2600, 0 if greater than 2600</td>
</tr>
<tr>
<td>AFFECTED</td>
<td>0.92</td>
<td>—</td>
<td>Dummy variable indicating whether employee is affected by CTR law (1 if yes, 0 if otherwise)</td>
</tr>
<tr>
<td>FPARKING1</td>
<td>—</td>
<td>—</td>
<td>Dummy interaction variables between firm size and free parking offered by employers (1 if yes, 0 if otherwise)</td>
</tr>
<tr>
<td>FPARKING2</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>FPARKING3</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>FPARKING4</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>FPARKING5</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
Mode Subsidies

Section 132(f) of the Internal Revenue Code allows most employers to provide a tax-free benefit to employees of up to $100 per month for transit, carpool, and vanpool fares and up to $185 per month for parking fees. An attempt was made to model subsidies as continuous regressors without success, because of few reported values of monthly subsidies offered by employers (only about 13,000 observations, of which 176 were identified as vanpool users). However, by using the employer-employee survey matching procedure, it was possible to determine which firms offered a vanpool, carpool, and transit subsidy. The presence or lack of these subsidies was entered into the model as a set of dummy variables.

Data Analysis

Table 2 displays information on the mode choice frequencies. After the data set was resized to account for auto, carpool, vanpool, and transit and after reporting errors were eliminated, 141,103 observations were retained. Because the modal split remained unchanged throughout the days of the week, only 1 day of the week was taken into consideration, specifically Tuesday. The employees who chose vanpool as a means of transportation represent 1.76% of the sample, with 1,565, or 63%, receiving some form of subsidy from their employers. That provides the first indication of the relevance of subsidies in influencing rideshare. Sample descriptive statistics showed that the daily cost of vanpooling ranges between $1.08 and $8.22, with a daily average of $2.26. The sample median distance traveled was 25 mi, suggesting that vanpool users are more likely to have a longer journey to work.

ECONOMETRIC MODEL

The objective of this study was to build a model that could ultimately account for a set of relevant factors affecting the choice of vanpool as a mode of transportation with respect to the other modes being considered. Given that the choice set consists of two outcomes, an econometric modeling approach in the form of a discrete choice model was considered. Given that the choice set consists of two outcomes, an econometric modeling approach in the form of a discrete choice model was suggested.

Conditional choice models are index-based in nature. That is, they postulate models in which choices are governed by the value of an index function that aggregates information contained in variables believed to influence choice. These models are best suited to analyze the relationship between a discrete dependent variable representing the choice set and individual characteristics. For overviews of discrete (binomial and multinomial) choice analysis, see Amemiya (13), McFadden (14), Blundell (15), and Domencich and McFadden (16).

In the case of a binomial choice \( Y \in \{0, 1\} \), the model of interest is a model of the form \( m(x, \beta) = f(Y | x, \beta) \) in which the objective is to predict the outcome:

\[
Y = 1 \quad \text{if} \quad f(Y | x, \beta) > 0 \quad \left[ f(Y | x, \beta) > 1 - f(Y | x, \beta) \right]
\]

\[
Y = 0 \quad \text{if otherwise} \quad i, j = 1, \ldots, n
\]

where \( x \) represents a set of mode- and individual-specific predictors.

The proposed equation is equivalent to the traditional conditional logit model (with error term assumed independent and from a Weibull distribution):

\[
\Pr(y_{ij}) = \frac{e^{\beta x_{ij}}}{1 + e^{\beta x_{ij}}}
\]

where \( \Pr(y_{ij}) \) is the probability that individual \( i \) chooses outcome \( j \) (vanpool) and \( \beta \) is the estimated parameter.

Assuming that the error terms are independent across the different options and that individuals choose the option (i.e., the mode) that yields the highest value of this latent index function, then the probability that person \( i \) chooses option \( j \) is given by the previous equation. Concern is always expressed about the assumption of independence of the error term. This assumption implies a condition that is known as independence of irrelevant alternatives, frequently denoted as IIA, meaning that the odds of choosing option \( j \) rather than option \( k \) are not affected by other available options. Efforts to relax that assumption have centered on introducing correlations among the error terms. One way to solve this problem is to propose a nested logit model, as discussed in the concluding section of this paper.

The vector of explanatory variables for the initial model contained the following predictors:

- **Choice-specific**
  - Mode costs
  - Mode subsidies
  - Free parking
- **Individual-specific**
  - Work status
  - County of destination
  - Firm size
  - CTR law affected

RESULTS

Parameter estimates are shown in Table 3. The table displays the results of the first model with all regressors included, the relative standard errors, and Wald chi-square statistics. [Before estimating

<table>
<thead>
<tr>
<th>Mode</th>
<th>Vanpool Subsidy</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Auto</td>
<td>Number</td>
<td>38,351</td>
<td>54,538</td>
<td>92,889</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>41.29</td>
<td>58.71</td>
<td>65.83</td>
</tr>
<tr>
<td>Carpool</td>
<td>Number</td>
<td>8,571</td>
<td>12,769</td>
<td>21,340</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>40.16</td>
<td>59.84</td>
<td>15.12</td>
</tr>
<tr>
<td>Vanpool</td>
<td>Number</td>
<td>1,565</td>
<td>920</td>
<td>2,485</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>62.98</td>
<td>37.02</td>
<td>1.76</td>
</tr>
<tr>
<td>Transit</td>
<td>Number</td>
<td>6,210</td>
<td>11,328</td>
<td>17,538</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>35.41</td>
<td>64.59</td>
<td>12.43</td>
</tr>
<tr>
<td>Other</td>
<td>Number</td>
<td>2,422</td>
<td>4,429</td>
<td>6,851</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>35.35</td>
<td>64.65</td>
<td>4.86</td>
</tr>
<tr>
<td>Total</td>
<td>Observations</td>
<td>141,103</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the model and making any inferences, a regular regression model was run to investigate the presence of multicollinearity. Variance inflation factors (VIF) were used as indicators of the presence of multicollinearity. Given that the VIF ranged between 1.5 and 5.7 (well below the usual threshold of 7), it was concluded that the model does not suffer any relevant multicollinearity. This approach is preferred to the more simplistic analysis of Pearson correlation coefficients and graphical analysis of outliers. Indeed, multicollinearity is a property of the explanatory variables, not the dependent variable, thus running regular regression to spot this problem suffices (15). All explanatory variables were retained for model building.

Table 3 also reports the global tests for the effects of each variable on the outcome variable (mode choice), controlling for the other variables in the model. (In the final model, the dummy variables depicting job occupation were removed because they were all statistically insignificant at any alpha level. One explanation could be that the original survey question was designed in a somewhat broad format, which allowed assessing only the industry of occupation but not the employee-specific occupation.) The reported chi-square statistics test the null hypothesis that the explanatory variables have no effect on the outcome variable. The adjusted $R^2$ shows that the model explains about 64% of the sample variation in the dependent value (mode choice) after adjusting for the sample size and number of independent variables in the model.

### Vanpool Cost (VP_COST)

The estimated parameter associated with the cost variable has a value of $-0.7168$; its sign agrees with the theory of demand. Figure 1 shows the plots of the estimated cumulative distribution function (CDF) and the individual marginal effects interpreted at the means of the regressors. The graph depicts the probability function (probability vanpool = 1) as a function of vanpool cost. The plot was constructed at the sample mean distance using King County and a firm size of 2,600 employees and greater (in the sample this corresponds to the most recurring profile of individuals that choose vanpool) as a reference.
and can be interpreted as the demand for vanpool services with respect to price. The marginal effect, or gradient, shows that the demand (e.g., the probability) is more sensitive to price changes for fares below $3 (daily).

The marginal effect is of direct interest to applied researchers, because it tells how choice probabilities change due to changes in the variables affecting choice. The marginal effects model the response of \( f(Y | x_i) \) due to changes in \( x_{ij} \), which is defined as follows:

\[
\nabla f(Y | x_i) = \frac{\partial f(Y | x_i)}{\partial x_j}
\]

This paper makes use of marginal effects as well as the interpretation of estimated parameters of interest.

**Elasticity of Vanpool Cost**

To understand how responsive the demand is to changes in fares, it is useful to employ the concept of demand elasticity.

The direct elasticity (\( E \)) formulas for the logit model are as follows:

\[
E_i = (1 - P_i) \beta_k z_{ij} \quad \text{(individual elasticity)}
\]

\[
E = \frac{\sum (1 - P_i) \beta_k z_{ij}}{\sum P_i} \quad \text{(aggregate elasticity, over individuals)}
\]

where the elasticity measures the percentage change in the frequency of making a given choice, in response to a 1% change in a given predictor \( z^k \), for attribute \( k \) and alternative \( j \).

That can be defined as the percentage change in the number of trips demanded, associated with a 1% change in the cost variable. An estimate of the direct elasticity of mode choice with respect to price was obtained using the cost parameter estimate, by evaluating the price elasticity at each sample observation and then taking a weighted average with respect to the predicted individual probabilities.

[This addresses the limitation due to the fact that elasticities are linear functions of the observed data, and there is no guarantee that the logit function will pass through that point defined by the sample averages (the sample mean of vanpool cost). Furthermore, the elasticity evaluated at the sample means of the predictors tends to overestimate the probability response to a change in an explanatory variable (16)].

The predicted value of the aggregate elasticity is equal to \(-0.73\), meaning that a 10% increase in vanpool price is associated with a 7.3% decrease in its demand. This result indicates that vanpool choice is relatively inelastic to fare changes.

Figure 2 shows the predicted individual elasticities plotted versus the distance traveled by respondents. Results corroborate what was suggested by the rideshare literature (3, 5, 17); the belief that individuals are more likely to use vanpool services the longer the distance from home to work. Clearly, it is evident that for trips below 30 mi, the individual elasticities are equivalent to the aggregate estimate. As the distance increases beyond 60 mi, individuals are less responsive to price changes, providing some insight in designing effective fare schedules.
Vanpool Subsidy (VP_SUB) Marginal Effect

The impact of vanpool subsidies is represented by a dummy variable indicating the presence of a vanpool subsidy when VP_SUB = 1, and its absence when VP_SUB = 0. The estimated parameter is 0.8707. Figure 3 shows the two probability functions plotted over VP_COST. The marginal effect is the difference between the two functions. Marginal effects can also be generated when dealing with a qualitative predictor by analyzing the effect of the dummy variable on the whole distribution by computing prob(vanpool = 1) over the range of $\beta_k z_k$ (using the sample estimates) employing the two values of the binary variable.] Figure 3 shows that the probability that an individual chooses vanpool decreases as its price increases, and that such effect is far greater for those employees who are not offered a subsidy. The difference is substantial at the sample mean value of VP_COST, where the predicted probability of choosing vanpool more than doubles when the employee is offered a subsidy, suggesting a relatively strong effect on ridership.

Firm Size and Parking Policy

On the basis of results showing a significant positive relationship between employer-sponsored ridesharing programs choice and firm size, Ferguson concludes that public policy on ridesharing should focus on larger firms (17). Results of this model tend to confirm that firm size plays a major role in influencing the choice of vanpool services over SOV. The impact of firm size is statistically significant when the firm size is above the 280 threshold and becomes more substantial for firms with 2,600 employees and above as shown in Figure 4, which plots the probability functions of the statistically significant firm-size dummies over the distance traveled. Although the interaction between firm size and parking policies (by introducing an interaction term between firm size and free parking) resulted in estimated parameters that were not statistically significant, the signs agreed with what is generally concluded by the current literature. These results provide some indication of a negative relationship between free parking and vanpool use and firm size, in particular for those firms with 1,100 employees and above.

CONCLUSIONS

It has been demonstrated that employer-sponsored programs, such as vanpool services, could have a dramatic impact on ridesharing alternatives to driving alone (17). Given that the maximum amount an employee can apply toward the current tax benefit program is $100 per month for transit and vanpooling, it can be argued that employees who collect such a benefit from their employers could be receiving services at a very low cost or even free of charge and, therefore, ridership should be significantly higher. Additional research on price elasticity of vanpool fares and subsidies becomes essential to determine the potential impact of such programs.

This paper considered the use of logistic regression modeling techniques to investigate the effects of fare pricing and subsidies on vanpool demand. By using employer and employee data from the 1999 CTR program surveys of the state of Washington, a conditional discrete choice model was built to analyze the choice of vanpool services with respect to competing means of transportation as a function of various socioeconomic characteristics.

Results indicate that employer subsidies to vanpool users influence the choice of this mode of transportation with respect to using auto as a means of transportation, providing evidence of a strong positive impact in stimulating ridership.
FIGURE 3  Subsidies and demand for vanpool services.

FIGURE 4  Impact of firm size on vanpool demand.
A weighted average price elasticity value was estimated; the value is equal to −0.73, indicating that vanpool demand is relatively inelastic to fare pricing changes. Furthermore, the sensitivity to price fare changes declines as the distance increases beyond 60 mi, as individuals become less responsive to price changes. When considered in the context of subsidies, these results support the evidence that policies other than those intended to affect fare pricing could play a more important role. The analysis also showed that firm size plays a major role in influencing the choice of vanpool services over SOV. To focus on the magnitude of the direct price elasticity, the model controlled for its influence across sampled individuals.

The analysis presented in this study is increasingly relevant because vanpool employer-based ridesharing program initiatives are based largely on policies that either penalize SOV use or create incentives in the form of fare pricing strategies and subsidies. In conclusion, an enhancement on the model could be represented by a nested logit model, which allows the existence of different competitive relationships between groups of alternatives in a common nest (thus relaxing the IIA assumption). A next step in the analysis would be to include examining the impacts of programs offering vanpool users guaranteed emergency rides home, providing the assurance and flexibility most typical of SOV.

ACKNOWLEDGMENTS

The authors thank Janet L. Davis, Stephen L. Reich, and Gary L. Brosch for their help and editorial suggestions; Marlo Chavarria for his help and support in the preliminary steps of data analysis and variable design; and Edward Hillsman and Brian Lagerberg with Washington State Department of Transportation for providing the data.

REFERENCES


The Transportation Demand Management Committee sponsored publication of this paper.