Destination Choice Study by Activity for Rural Vermont Households

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Abstract

Many studies have found that household structure and land use type are strongly correlated with travel behavior in non-rural or urban settings. This study expands upon previous literature by testing the strength of this relationship in rural neighborhoods. Employing survey results from the Two Rivers-Ottauquechee Region (TROR) in Vermont, we adopted an ordered Probit model to investigate consistency in destination choice among several pre-selected activity types and a multinomial logit model to examine the destination preferences of households/individuals for specific activities. The results obtained are similar to those identified in previous research, showing that differences in travel patterns between households can likely be explained by differences in time budget flexibility and the activity types required by each household's structure. Commercial development level was found to be positively associated with local (within town of residence) travel. Our findings also point to the power of economic incentives, such as "no sales tax" on trip making behavior and destination choice. Taken together, our study indicates that the relationship between travel patterns and household structure in rural areas has similar characteristics to those found in suburban or urban areas. The unique land use patterns and development distribution often found in rural areas however, tends to be associated with the distinctive travel behavior of their residential population. In the long run, rural neighborhoods might have the opportunity to direct their future development to encourage less travel by expanding opportunities for residents to fulfill their activity needs locally.

Introduction

Although the activity-based demand modeling method has been consistently researched and practiced to improve accuracy and applicability, most of the previously conducted studies have focused on non-rural areas, especially large metropolitan areas such as Boston (MA), Portland (OR), Bay Area (CA), New York City (NY), etc. (*1, 2, 3*). One of the main goals of these studies was to more accurately represent the demand issues in transportation system network, improving the ability of agencies to plan for and respond to the social and environmental concerns associated with traffic congestion. Rural areas, especially those in low population density states, have less severe traffic congestion and therefore received very little attention from researchers in this regard.

The state of Vermont, along with many other areas in Northern New England, is largely considered rural, with land use patterns that are distinct from urban areas. Low population density results in fewer congregations of residential and retail/commercial land uses, as well as more disperse amenities and facilities. Consequently, rural residents must often travel longer distances to reach their destinations. In addition, scattered ridership demand reduces the availability of public transportation in rural areas. Non-motorized travel modes such as walking and biking for non-leisure purposes are less feasible in rural areas due to the remote nature of many residential locations and lack of the necessary transportation facilities. As a result, the majority of rural population relies on their personal

automobiles for more activity types and a larger portion of travel than typical urban residents. Previous studies have found households/individuals to have selective behaviors based on the type of residential neighborhood style they reside in (*4, 5*); therefore, the travel behavior in rural neighborhood needs to be explored to reveal its dependency and correlation with land use in an activity-based context.

In the current paradigm of new modeling approaches, the framework is often multi-modal, allowing individuals to conduct tour-based travel while trying to fulfill multiple activity purposes. Rural residents, on the other hand, are not offered many alternatives other than their personal vehicles, leading to a destination choice model that is determined by the availability of amenities to suite the activity purpose. Therefore, knowing how rural individual households choose their destinations for specific activities is crucial for understanding the travel patterns of rural residential population. For example, a household/individual choosing one single destination for multiple activities such as grocery shopping, eating-out, and other entertainments certainly commits a different travel pattern from a household/individual who goes to multiple destination towns for the same set of trip purposes. As a first step approaching an activity-based demand research for rural areas, this study utilized survey results from the Two Rivers-Ottauquechee Region (TROR) to identify, for non-work activities, patterns in destination choice making for a series of activity purposes.

In addition to the characteristics of a particular destination and an individual's residence or origin, household context also has significant impact on travel patterns. First, the travel pattern of a given household or individual is highly associated with the presence of young or elderly family members. Lee et al (*6*), in their study of travel time use by activity type, stated that the presence of small children (less than 5 years) tends to reduce the time spent on out-of-home discretionary activities due to the constraints associated with traveling with small children. Similarly, Ye et al (*7*) discovered in their study based on Swiss travel survey data that the young and the elderly, due to a smaller number of obligations, tend to conduct fewer non-work trips. As pointed out by Copperman and Bhat (*8*), the travel patterns of adults in families with small children are more likely to be restricted by children-related trips, such as those for chauffeuring and escorting. Such restrictions are often difficult to overcome either temporally or spatially, even when those adults have flexible work schedules.

In addition to family structure, restrictions inflicted by the amount of work-related travel conducted and the availability of vehicles may cause variations in travel patterns. Not surprisingly, in rural households, travel flexibility is closely related to number of vehicles owned. For a household with working adults and other dependents, trips must often be coordinated with work schedules, possibly restricting the destination choice for particular activities by time and distance. Lee et al (*9*) studied time use on trip chains for five types of households categorized by number of household heads and workers. Their findings showed that households that spent more time on work-related activities spent less time on activities other than work and maintenance. Similar results were presented in the study by Kuppam and Pendyala (*10*).

In the TROR survey data, we collected general household information including the number of household members at different age groups, number of workers, registered vehicles, and also licensed

drivers. This study was conducted with the goal of broadly examining the effect of household type and structure on complicated activity-based destination choice making in rural Vermont. The primary research questions were: 1. Do households with different family structures have different patterns of destinations choice (by activity)? and 2. Do different household types have different propensities for shopping locally or out of state (New Hampshire) In addition, researchers were interested in indirectly evaluating the impact of sales tax differences on destination choice making, which was a factor in this study because of the lack of sales tax in New Hampshire towns that border Vermont. This factor has not been explored previously, in investigating social economic factors affecting decision making of destination choices. Moreover, existing literatures consists mostly of studies preformed on urban or non-rural areas. This study of a rural area and rural residents' travel patterns is of interest due to increasing household travel costs and the potential of rising future energy costs which disproportionately affect rural residents.

Data

The Two Rivers-Ottauquechee Region, consisting of 31 towns with an area of 1,300 square miles and a population of 56, 200, is one of 11 Vermont planning regions (Figure 1). The region's population density of 43 people per square mile is below the US average of 81 people per square mile and well below urban population densities which are typically above 200 (*11*). Due to a relatively slow growth rate in both population and economy during the past decade, the TROR has maintained a relatively stable distribution of demographics, employment and housing. Located in the eastern part of Vermont, TROR is separated from the state of New Hampshire by the Connecticut River and also adjacent to one of New Hampshire's largest metropolitan areas – the towns of Hanover and Lebanon. The area has nine bridges or crossings connecting traffic traveling between Vermont and New Hampshire.

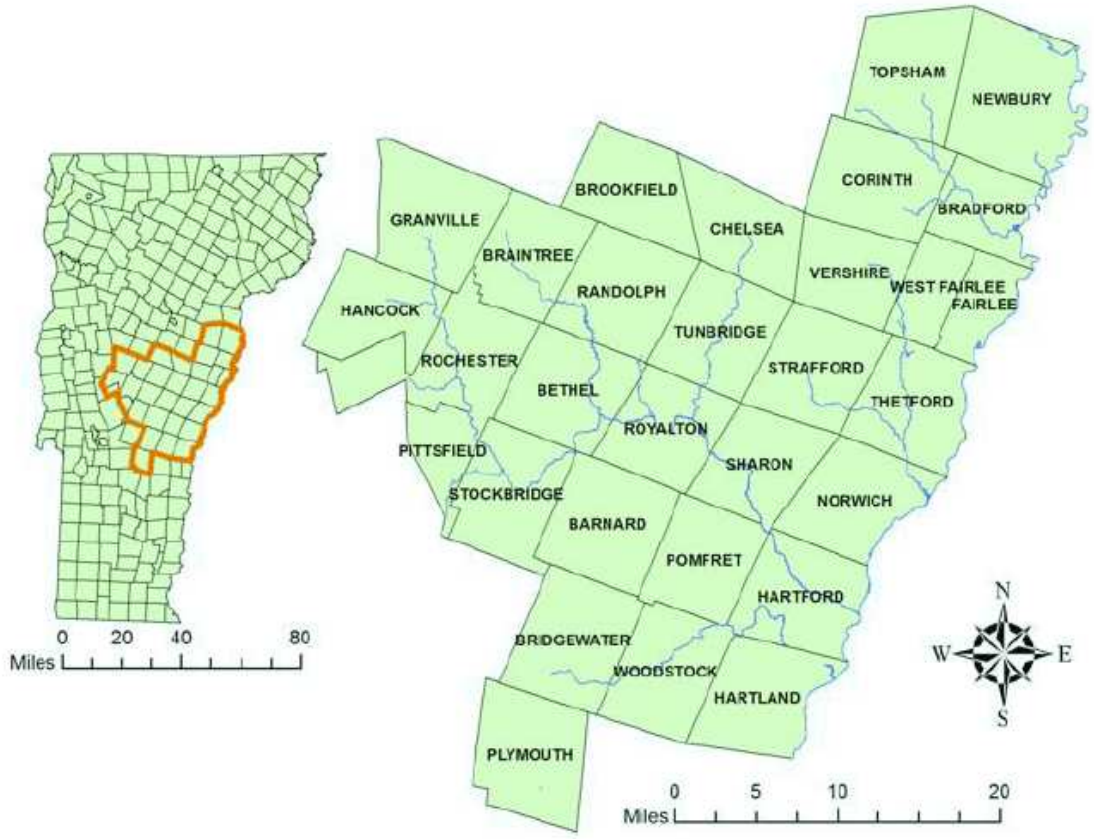


Figure 1 Map of Vermont Two Rivers-Ottauquechee Region

A travel survey aimed at collecting household demographic information as well as their non-work travel destinations by activities from the TROR was conducted in partnership with Steve Falbel at TranSystems. The sample, weighted by town population size, included 964 randomly selected households. Manually delivered survey questionnaires to selected homes in combination with a press release to area news agencies yielded a response rate of 25 percent, which is higher than the normal average mail-back survey response rate of 10 percent. Each of the 243 respondents answered questions about their household structure, including the number of members by age categories: infants and toddlers (no older than 5 years), school age children (6 to 17 years), adults (18 to 64 years), and senior adults (no younger than 65 years). The 243 households were separated into three groups based on the distribution of age groups as Table 1 shows. The three groups are households of adults with children (infants/toddlers/teenagers), households of no less than two adults/senior adults without children, and households of single adult/senior adult.

Table 1 Household member age distribution by group

	# of households			
	Total	< 18 years	18 to 64 years	>= 65 years
All	243	# of members (in the age category)		

		0	1	>=2	0	1	>=2	0	1	>=2
Group 1	60	0	20	40	1	10	49	59	0	1
Group 2	142	142	0	0	44	16	82	77	20	45
Group 3	41	41	0	0	21	20	0	20	21	0

The survey collected additional information from households including number of vehicles owned, number of licensed drivers, and number of full time workers. As discussed in the introduction section, the travel patterns of households and individuals are highly correlated with these characteristics. Table 2 shows the distribution percentages by group for the three variables. Comparing across groups, the percentages of group 1 and group 2 follow similar patterns for all full time workers, vehicles owned and licensed drivers. Single adult households included in group 3 seem to have less diversity in all three categories, which might possibly correspond with their less dynamic travel patterns. Comparing across the three categories, vehicles owned and licensed drivers follow similar patterns for all three groups.

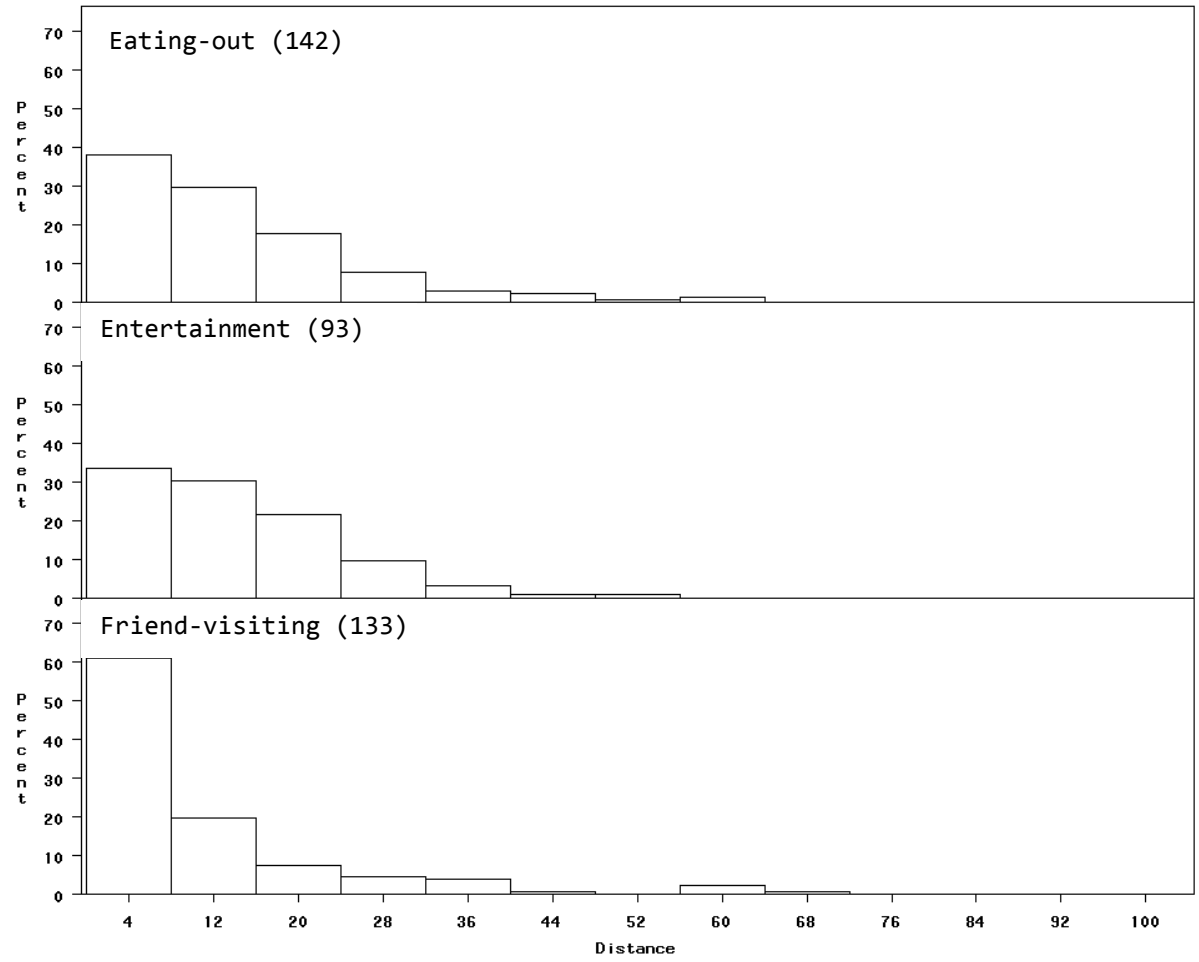
Table 2 Distribution percentages by group for full time workers, vehicles owned, and licensed drivers

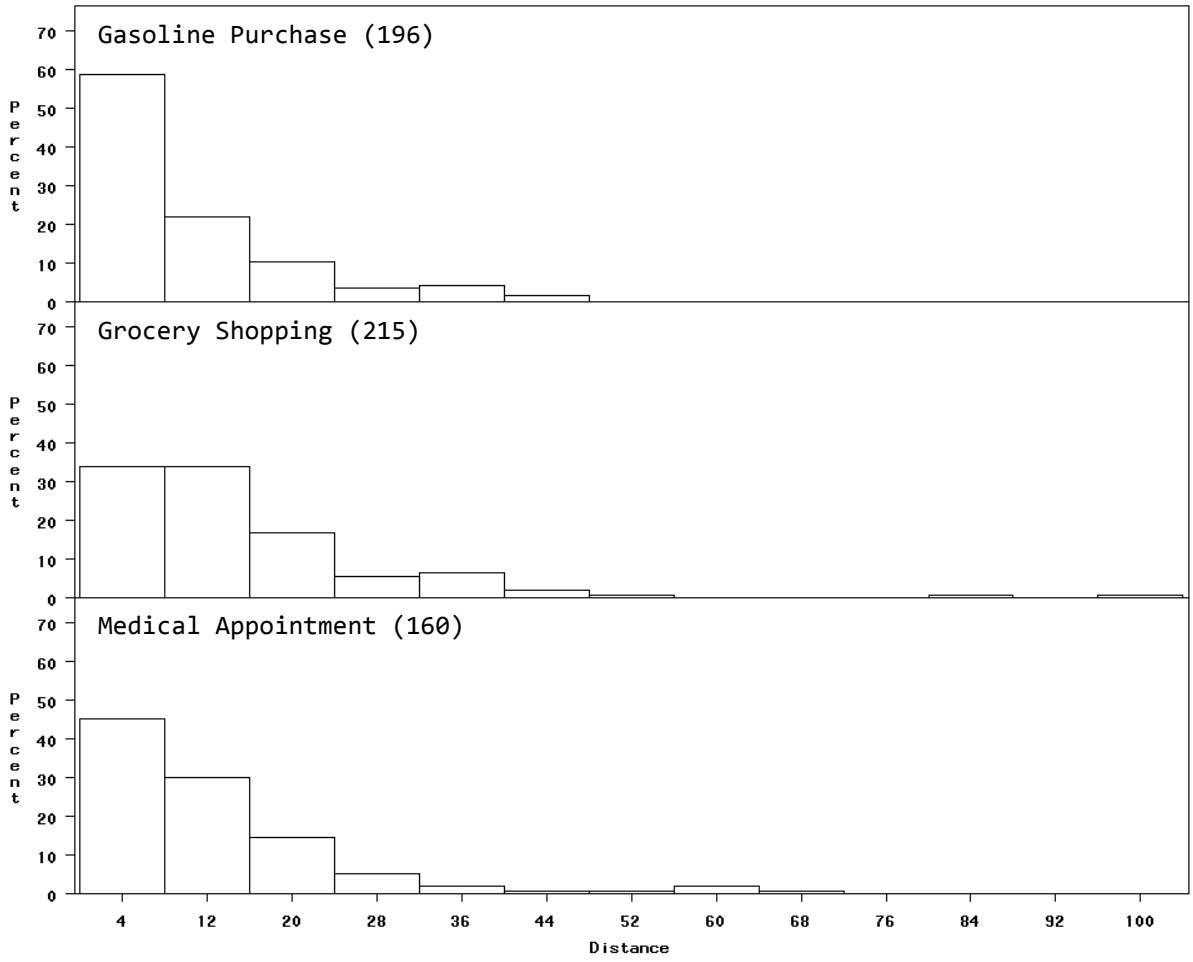
		Group 1	Group2	Group3
Number of full time workers	0	8%	38%	63%
	1	45%	25%	37%
	2	45%	33%	0%
	>=3	2%	4%	0%
Number of vehicles owned	0	0%	1%	0%
	1	17%	12%	76%
	2	50%	64%	17%
	>=3	33%	24%	7%
Number of licensed drivers	0	0%	2%	3%
	1	13%	6%	97%
	2	72%	85%	0%
	>=3	15%	8%	0%

ArcGIS was adopted as a visualization and spatial analysis tool to analyze the geographic and land use information associated with the study components. All the households surveyed in the study were coded to the town where they reside. For all the activity purposes, namely grocery shopping, non-grocery shopping, gasoline purchase, banking, medical appointments, religion, eating out, friend visiting, recreation, and entertainment, the destination town was coded for that particular activity for each household[1]. Figure 2 illustrates histograms for the distance traveled to destinations for the above mentioned activity types. As seen from the histograms, most of the traveling was conducted in towns

[1] *Not every household conducts in the past month all activities being asked in the survey. Such origin-destination information by activity is normally available for only a subset of the 243 households.

less than 35 miles away from the origin town. Especially for friend-visiting and religion purpose trips, a higher percent of traveling was less than 20 miles. The number included in every each histogram indicates the number of households that conducted that particular activity in the past month. Grocery shopping and gasoline purchases were the most frequently visited activity types, while travling for the purposes of entertainment, recreational and religion occurred less frequently.




Gasoline Purchase (196)
Grocery Shopping (215)
Medical Appointment (160)
Percent
0
10
20
30
40
50
60
70
4
12
20
28
36
44
52
60
68
76
84
92
100
Distance

1

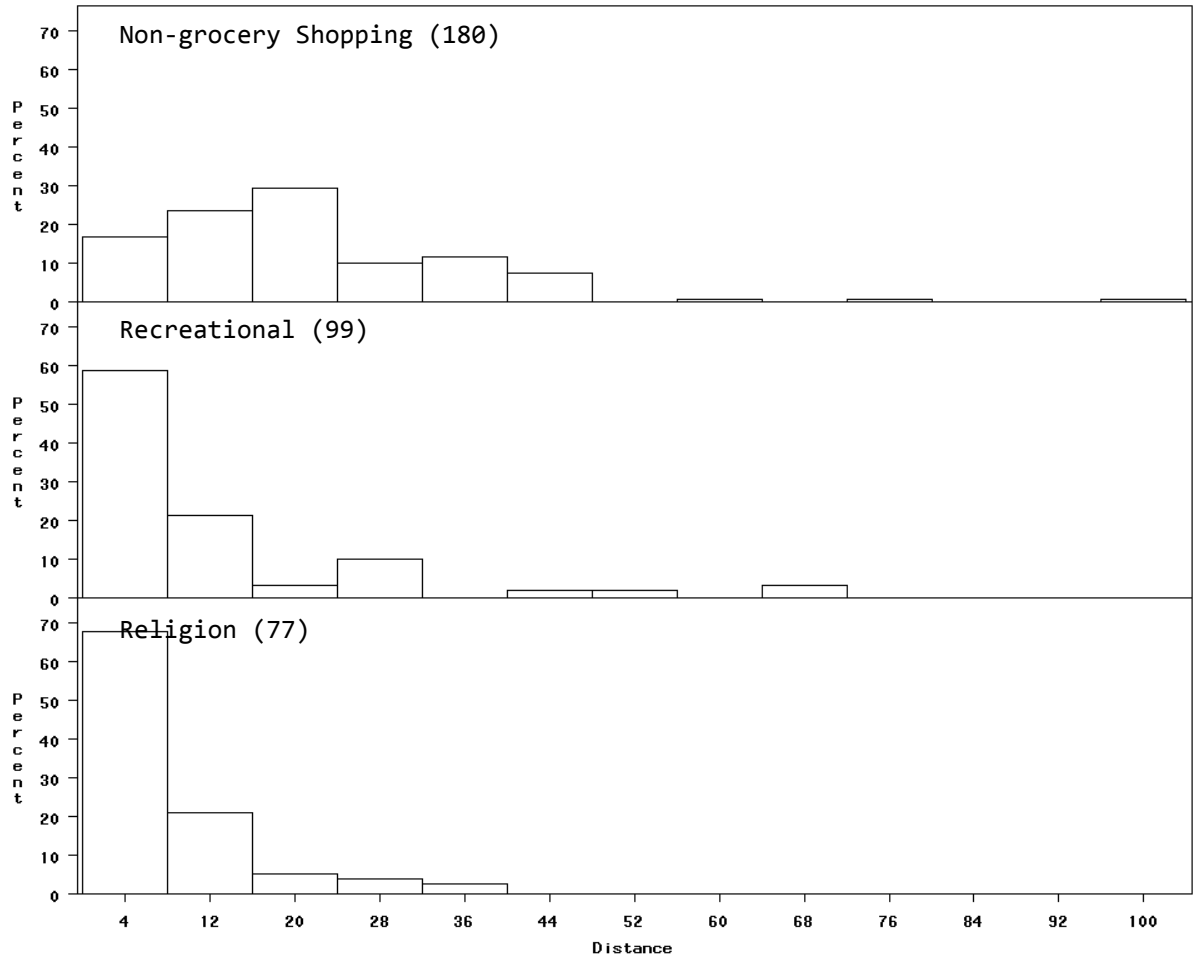


Figure 2 Histograms of distance traveled to destination by activity type (figures in titles indicate the number of households fulfilling those activity types)

For every each pair of origin-destination towns by activity, a geographic distance was computed between the town centers to represent or substitute the travel time required to reach to that activity. The Vermont Emergency-911 land use data were also utilized to estimate the retail development level in each origin town. The Vermont E-911 data contain information of all the buildings inside the state that is also tagged with usage type, such as commercial, residential, industrial, etc. We counted the number of commercial buildings inside every each origin town and computed the building density as "building/square mile" to be used as a surrogate for commercial activity level in that town. Figure 2 illustrates the commercial activity level of the 31 origin towns.

Methodology and Analysis

The essential concept of the need-based theory is that every activity conducted by the traveler is to fulfill a particular need within a frame of time budget. A shopping activity is to restock the household's maintenance requirements and an eating-out activity might be to fulfill needs of social networking or

family functions, at a normally pre-scheduled time slot. While choosing the activity destination relies on the availability of the necessary amenities and services, the choices may also vary to the extent in which they are related to a particular decision made by the household or some sequential impact of decisions made for other activities. Of households belonging to different groups and possessing different characteristics, we were interested in the impact of local commercial development levels on the destination choice making of the local residents. The first question we wanted to answer was: of several activities a household/individual conducts, how consistent would the destination choice making be? In other words, of activities potentially intertwining with each other, would the household/individual tend to choose one single destination town for all the activities, or different destination towns for separate activities? Sequentially, we also investigated how household/individual decision making on destination choice for a particular activity type is linked to land use, economic benefits, and household characteristics. For example, if given relatively more sufficient local (in the same residential town) commercial development, would a household be more likely to choose shopping destination locally? Furthermore, if a household chooses a non-local destination for an activity such as shopping, would they choose a different town in Vermont or in New Hampshire? Choosing Vermont might allow them to travel shorter distance with more convenience but by choosing New Hampshire they would be able to take advantage of "no sales tax" and have access to larger commercial centers. The following two sections will address these questions raised regarding destination choice making.

1. Consistency in choosing destination locations?

This section presents the methodology and results for evaluating the consistency level in destination choice making. For different activities, a household/individual might be going to one destination town or several different towns to fulfill their needs. We were interested to find out whether this behavior of "chaining destinations" is related to commercial development level in the towns, household characteristics, or perhaps economic benefits. We chose to focus on grocery shopping, gasoline purchase, and eating-out trips to evaluate the consistency of destination choice making. These three activity types were chosen is because to a certain extent they can be viewed as maintenance activities of similar type. However, due to the incomplete amenities and services or other discretionary reasons, households/individuals might be forced to fulfill them at separate towns even if they would prefer visiting just one same town. In this example, a new variable "consistency" was generated to represent the number of distinctive destination towns where a household chose to fulfill their activity purposes. As a result, three consistency levels were coded to correspond to three choices: all three activities in three different towns, three activities in two different towns and three activities in the same town. We viewed choosing one town for all three activities as the most "consistent" destination choice, and choosing three different destination towns as the most "inconsistent" choice.

Methodology

An ordered Probit model was chosen for the analysis because of its ability to respond to the indexed nature of variables. In Kockelman and Kweon's study of injury levels in traffic crashes (*12*), they adopted Probit models and discovered linkage between driver characteristics and crash severity levels. In this

example, a similar Probit modeling approach was taken to verify the connection between household characteristics and consistency level of destination choice. To note the coded consistency level as Y_n and write the predictor variables as well as their parameter estimates as $\beta' X$, Probit model interprets the relationship through a latent variables Y_n'. Y_n and Y_n' can be expressed as:

$$\begin{aligned} Y_n = \{ & 0, \quad if \quad Y_n' <= 0, \quad low \quad consistency \quad level \\ & 1, \quad if \quad 0 < Y_n' <= \alpha_1, \quad medium \quad consistency \quad level \\ & 2, \quad if \quad Y_n' > \alpha_1, \quad high \quad consistency \quad level \} \end{aligned} \qquad \text{Equation (1)}$$

Since $Y_n' = \beta' X_n + \varepsilon_n$, if we assume ε_n has a cumulative distribution G, the probability of choosing each consistency level can be shown as:

$$\begin{aligned} P_n(Y_n = 0) &= \Pr(Y_n' <= 0) = G(-\beta' X_n) \\ P_n(Y_n = 1) &= \Pr(0 < Y_n' <= \alpha_1) = \Pr(\beta' X_n + \varepsilon_n <= \alpha_1) - G(-\beta' X_n) \\ &= \Pr(\varepsilon_n <= \alpha_1 - \beta' X_n) - G(-\beta' X_n) \\ &= G(\alpha_1 - \beta' X_n) - G(-\beta' X_n) \qquad \text{Equation (2)} \\ P_n(Y_n = 2) &= \Pr(Y_n' > \alpha_1) = 1 - \Pr(\beta' X_n + \varepsilon_n <= \alpha_1) \\ &= 1 - \Pr(\varepsilon_n <= \alpha_1 - \beta' X_n) \\ &= 1 - G(\alpha_1 - \beta' X_n) \end{aligned}$$

For a Probit model, the cumulative distribution of ε_n is chosen to best describe the distribution of the observed data. Normal and logistic distributions are more appropriate to use when ε_n is distributed symmetrically around zero. Gompertz (or the extreme value) distribution is not asymmetric, therefore, it is proper for the situation when the probability distribution approaches 0 on the left slower than 1 on the right (*13*). Of all the households evaluated in this consistency study, 35 percent households choose their activity-based destinations with a high consistency, 42 percent with a medium consistency, and 23 percent with a low consistency. Hence, we choose the cumulative Gompertz distribution for *G*. The maximum log-likelihood method is used to estimate the parameters in Equation (2) including $\alpha_1, \quad \beta'$. A positive sign for β' indicates the probability of high consistency level increases as the value of the predictor variable increases; similarly, a negative sign indicates the probability of high consistency level decreases as the value of the predictor variable increases (*14*).

Results

Ordered Probit models were estimated for the consistency levels by first only including household type variables, then having commercial development indicator variable added, and lastly including the number of full time workers or registered vehicles as well as the variables used in the previous two steps. Table 3 shows the four sets of model results in the above mentioned order. Note no variables were

removed from the table because of their non-significant association with the consistency level. Household type indicators were used in the models in a categorical fashion, and the parameter coefficients were estimated to assess how household types differentiate from each other in relating to the consistency level in destination choice making. In model 1, Households without children are estimated to have significantly more "inconsistent" destination choice making, meaning they are most likely to choose separate destinations for the defined subset of activities than those of the other household types. Households with children are more likely to choose multiple destinations for the dedicated activities than the single adult households. These results are consistent with earlier research findings that concluded households with children were imposed with more restrictions for making travel plans. For younger children, especially if traveling by car, the child safety devices need to be installed and uninstalled every time getting in and out of the vehicle. In our study, a large portion of the single adult households consist of only senior adults. Consequently, even more restrictions could be applied to this group due to their reduced mobility level and also likely reduced requirements for such activities.

In model 2, while keeping the household type variables in the model, a commercial development indicator ratio is added to the model to account for the impact of local commercial/retail development on households' choice making for destinations. Although the sign of the parameter estimate does indicate a positive relationship between local commercial development and the consistency level of destination choices, the variable is not found to be significantly associated with the consistency level in destination choices. The positive sign of the parameter estimate might have only captured the fact that more commercially developed towns tend to offer more adequate services and amenities for various activities and therefore attract households to fulfill more activities locally. The overview of commercial development ratio for all the origin towns in the previous section indicates the generally low development density in this rural Vermont region. Only several towns providing such multi-activity destinations cannot generate a significant tendency for "going local". In model 3, the number of full time workers was further added to the model in order to capture the part of destination choice making complicated by having different number of full time workers in the households. Similarly, the sign of the parameter estimate reinforces the general conception that households with more workers have more dynamic travel patterns and therefore tend to visit more destinations for different activity purposes. The reason that it is not found to be significant at 95 percent confidence level might be due to the variable itself overlooking the impact of other non-full time workers on household traveling. Comparing parameter estimates for the household types in model 1 to those in model 2 and model 3, we can only detect minor changes in the magnitude of the coefficients along with the same correlation prototype identified between household types and the consistency level. This could imply that both the commercial development ratio and the number of full time workers shared predicting ability with household types to an extent, but the correlation they had with consistency level was not sufficient enough to alter the already perceived household type correlation with consistency level. Finally, model 4 estimated for all the variables when the number of vehicle ownerships was introduced. Having a negative sign, the number of vehicles owned was found to be only marginally significant in the model. Yet again, the negative relationship spotted between the number of vehicles owned and the consistency level is compatible with the experience that higher availability of vehicles in the household presents less

restriction on traveling, hence, a greater variety in destination choice. While the signs of the other variables already included in the model did not change, the parameter estimates for household types anticipated modification and this might be possibly caused by the embedded intersecting effects with number of vehicles owned. Although not statistically significant, households with children replaced single adult households to show the least consistent destination choice making behavior. This change in order could be largely due to that the part of difference in consistency level was better explained by number of vehicles owned and therefore was removed from household types. The true situation could be single adult households traveled with more restrictions because their travel plans were mainly conditional on the vehicle availability. In contrast, the travel experience of households with children was actually confined to a higher extent because of the restrictions from traveling with children.

In the fifth model, we added one additional variable, average distance calculated based on the distance traveled for grocery shopping, gas, and eating-out, given household type variables being already in the model. The model results found, that the longer the average distance is, the lower the consistency level is, while preserving the same order by household types. This could be counter intuitive as one might consider a person would combine more purposes and plan more for a longer trip. What might be captured in this model is that households need to travel further for one or more activity purposes than for others. Nevertheless, the average distance could obscure the difference between situations when households commits all three activities at one same destination town and when they fulfill one activity purpose locally and travel far to another destination town for other purposes. To verify the true effect of distance we proposed a second study step in which we chose one activity type, grocery shopping, as an example to explore in detail this particular activity-based destination choice making among local towns, other Vermont towns, and New Hampshire towns.

Table 3 Model results for consistency in destination choice making*

Variables		Model 1		Model 2		Model 3		Model 4		Model 5 (with Average distance)	
		coefficient	p-value	coefficient	p-value	coefficient	p-value	Coefficient	P-value	Coefficient	p-value
α_1		1.4355	<0.0001	1.4388	<0.0001	1.4492	<0.0001	1.4743	<0.0001	1.4975	<0.0001
Household type	With children	-1.2374	<0.0001	-1.313	<0.0001	-1.0827	0.0009	-0.3908	0.4008	-0.6397	0.0330
	w/o Children	-1.5889	<0.0001	-1.6482	<0.0001	-1.4879	<0.0001	-0.8471	0.0398	-0.9137	0.0020
	Single adult	-1.0343	<0.0001	-1.1394	0.001	-1.0872	0.0018	-0.6713	0.0972	-0.4616	0.1863
Commercial development (indicator) ratio				0.0266	0.5317	0.028	0.5106	0.0209	0.6285	Average distance	
# of full time workers						-0.1788	0.2243	-0.0818	0.6040	-0.0548	0.0025
# of vehicles owned								-0.3720	0.0502		
N (total # of observations)		130		130		130		130		130	

2. Choosing Local, Vermont or New Hampshire?

Methodology

To further understand relationship between commercial development/distance traveled and activity-based destination choice and test for whether it holds true for all or subgroups of the households, we adopted multinomial logit models to measure the impact of land use and household characteristics on destination choice selection. The choice set modeled includes town of origin, Vermont town of non-origin, and New Hampshire town. Of the three, Vermont town of non-origin was chosen to be the reference category, which was compared to the other categories simultaneously. The three choices in the multinomial logit models were treated as nominal categories since they do not appear to follow a specific order.

Let Y_n stand for the destination choice set with three categories mentioned above. Let $\pi_j(\underset{\sim}{X}) = P(Y_n = j \mid \underset{\sim}{X})$ at a fixed setting $\underset{\sim}{X}$ for explanatory variables, with $\sum_j \pi_j(\underset{\sim}{X}) = 1$ and $\pi_j(\underset{\sim}{X}) = \dfrac{\exp(\alpha_j + \beta_j^{'}\underset{\sim}{X})}{1 + \sum_{k=1}^{J-1}(\alpha_k + \beta_k^{'}\underset{\sim}{X})}$ (*15*). Maximum Likelihood fitting for this multinomial logit model then maximizes the likelihood subject to the *J-1* $\pi_j(\underset{\sim}{X})$ equations simultaneously that specify the model (estimates). In a multinomial logit model, each response category is paired with a reference category in a form as

$$\log\frac{\pi_j(\underset{\sim}{X})}{\pi_J(\underset{\sim}{X})} = \alpha_j + \beta_j^{'}\underset{\sim}{X}, j = 1,2,...,J-1, \quad J \ \ is \ \ the \ \ reference \ \ category \qquad \text{Equation (3)}$$

Similarly, a pair of response categories can be generated to estimate logit parameters as

$$\log\frac{\pi_j(\underset{\sim}{X})}{\pi_{j^{'}}(\underset{\sim}{X})} = \log\frac{\pi_j(\underset{\sim}{X})}{\pi_J(\underset{\sim}{X})} - \log\frac{\pi_{j^{'}}(\underset{\sim}{X})}{\pi_J(\underset{\sim}{X})}, j = 1,2,...,J-1, \quad j^{'} = 1,2,...,J-1 \qquad \text{Equation (4)}$$

$$j \neq j^{'}, \ \ J \ \ is \ \ the \ \ reference \ \ category$$

$\beta^{'}$ in the models are used to measure the effects of predictor variables on the likelihood of choices relevant to the reference choice or the likelihood of choices versus one another. Although multinomial models can no longer estimate the exact odds ratios, the psudo-odds ratios that are proportional to the incremental distance in $\underset{\sim}{X}$ can still be assessed in the form

$$est.\left(\frac{\frac{\pi_j(X_1)}{\pi_J(X_1)}}{\frac{\pi_j(X_2)}{\pi_J(X_2)}}\right) = \exp\{\hat{\beta}_j(X_1 - X_2)\}, j = 1, 2, ..., J-1, \quad \text{Equation (5)}$$

$$J \quad is \quad the \quad reference \quad category$$

We estimated multinomial models for grocery shopping and eating-out activities, respectively. For each activity, the models included different sets of predictive variables that are of household characteristics, such as type of household defined as households with children, households without children and single adult households, number of full time workers, and number of vehicles owned, and commercial development ratio also defined in the same way as in the previous section. Besides these variables which are also considered in the consistency study, distance traveled to reach destination town was added to mainly investigate whether people choose their destinations in New Hampshire even if they have to travel further. The underlying assumption is the attractiveness of New Hampshire destinations, including their "no sales tax" benefit and larger commercial centers, increase positively with the level of willingness that residents show in the form of sacrificing the convenience of travel, e.g. shorter distance to travel.

Results

As Table 4 shows, we included only one predictor variable in each of the models 1 through 4 and showed the estimates of the models even if they were not found to have strong predicting capacity. Model 1 included only household type as indicator variable and used households with children as the reference group. Although the estimate of intercept indicated the likelihood of choosing New Hampshire destinations might be significantly higher than choosing Vermont destinations, household type indicator was not proved to be able to discriminate the likelihood of choosing different destinations. Results of models 2 and 3 also showed no significant impact of number of full time workers and number of vehicle ownership on likelihood of destination choices. Model 4 took account of commercial development level in the origin towns in Vermont and identified significant association between the commercial development level and destination choice making. Based on Equation (5), psudo-odds ratios in model 4 were calculated to be 1.58 and 1.86, which corresponded to 58 percent higher likelihood of choosing New Hampshire towns and 86 percent higher likelihood of choosing Vermont origin towns, given one unit of increase in commercial development density. These findings suggested that residents of more commercially developed towns are more likely to shop locally for groceries, and for those who choose to shop at a non-local destination town, more people who selected New Hampshire instead of other Vermont towns were actually from more commercialized towns.

To verify the influential effects brought by New Hampshire's beneficial features on destination choice making, Model 5 further included a variable of distance traveled from origin to destination town in addition to commercial development density - both variables turned out to be significant. Note the

parameter estimates were only available for comparing New Hampshire destinations vs. Vermont non-local destinations since the distance traveled to local destinations was coded as zero. A psudo-odds ratio of 1.08 was estimated for every mile of increase in the distance traveled, meaning 8 percent more likely a household would choose their destination in New Hampshire even if a longer distance is required to travel for. Comparing models 1 through 3 to models 4 and 5, we found household characteristics have a much weaker determination in destination choice making for grocery shopping.

Table 4 Model results for grocery shopping activity

Variables		Model 1		Model 2		Model 3		Model 4		Model 5	
		coefficient	p-value	coefficient	p-value	Coefficient	p-value	Coefficient	P-value	Coefficient	p-value
Comparing NH destinations to VT non-origin destinations											
α_{NH}		**0.5338**	**0.0026**	0.4744	0.2327	0.6414	0.1775	-0.2830	0.1885	**-1.4092**	**0.0001**
Household type	With children										
	w/o Children	-0.1548	0.3719								
	Single adult	0.2547	0.3127								
# of full time workers				0.0044	0.9796						
# of vehicles owned						-0.0809	0.7178				
Commercial development (indicator) ratio								**0.4579**	**<0.0001**	**0.3984**	**0.0002**
Distance										**0.0773**	**0.0001**
Comparing VT origin destinations to VT non-origin destinations											
$\alpha_{VT\ \ non-origin}$		-0.7615	0.2461	**-0.6735**	**0.0344**	-0.0245	0.9696	**-2.1142**	**<0.0001**		
Household type	With children										
	w/o Children	-0.1548	0.2941								
	Single adult	-0.2133	0.3097								
# of full time workers				-0.1471	0.5557						
# of vehicles owned						-0.4085	0.1999				
Commercial development (indicator) ratio								**0.6210**	**<0.0001**		
N (total # of observations)		215		215		215		215		184	

Table 5 shows the results of models for destination choice making in eating-out activities. Similar to the models estimated for grocery shopping activities, models 1 through 4 in Table 5 each had one predictor variable included. Model 5 tested the impact of distance traveled on choice making in addition to the commercial development density. In model 1, the significant negative parameter estimates indicated a lower likelihood of choosing New Hampshire destinations and local destinations vs. Vermont non-local destinations when comparing households without children and single adult households (reference household type). This result suggested, for households without children, non-local destinations in Vermont seemed to be the predominant choice, while more single adult households tended to choose local dining destinations perhaps due to the restrictions on their mobility level and reduced needs as discussed in the previous section. In model 2, increased number of full time workers was significantly associated with higher likelihood of choosing New Hampshire destinations; while in model 3, the decreased number of vehicle ownership was marginally significantly associated with the higher likelihood of choosing local destinations for dining out. The results of models 2 and 3 are not contradictory of each other. Moreover, they might be suggesting that destination choice making might be triggered by different factors when Vermont residents were facing choosing between New Hampshire destinations & non-local Vermont destinations and between local & non-local Vermont destinations. Model 4 results were very similar to what was shown in Table 4. Psudo-odds ratios 1.44 and 1.64 were estimated for every increment of 1 unit per square mile for likelihood of choosing New Hampshire destinations and local destinations. Namely, higher commercial development level would draw more local residents to dine locally and of people attracted to dine non-locally more tended to choose New Hampshire destinations.

A similar model was also estimated for eating-out activities considering both commercial development density and distance traveled from origin to destination town as predictor variables. The model results were comparable to those of Table 4. However, distance was not found to be significant, in other words, it was not evidential to show that households would rather travel further to dine at New Hampshire destinations. Since meal tax at New Hampshire is 8 percent which is 2 percent higher than in Vermont, the removal of this tax beneficial feature in New Hampshire might have caused more people to withdraw from visiting New Hampshire to dine.

Table 5 Model results for eating-out activity

Variables		Model 1		Model 2		Model 3		Model 4		Model 5	
		coefficient	p-value	coefficient	p-value	Coefficient	p-value	Coefficient	P-value	Coefficient	p-value
Comparing NH destinations to VT non-origin destinations											
α_{NH}		0.2151	0.3469	**-0.6301**	**0.0358**	-0.3675	0.5079	**-0.8506**	**0.0013**	**-1.2378**	**0.0015**
Household type	With children	0.4039	0.1756								
	w/o Children	**-0.9773**	**0.0004**								
	Single adult										
# of full time workers				**0.5181**	**0.0192**						
# of vehicles owned						0.1355	0.6077				
Commercial development (indicator) ratio								**0.3658**	**0.0002**	**0.3308**	**0.0004**
Distance										**0.0281**	**0.113**
Comparing VT origin destinations to VT non-origin destinations											
$\alpha_{VT\ \ non-origin}$		**-0.8189**	**0.0052**	**-0.8860**	**0.0103**	0.1805	0.7980	**-2.3752**	**<0.0001**		
Household type	With children	-0.0284	0.9443								
	w/o Children	**-0.7905**	**0.0284**								
	Single adult										
# of full time workers				-0.3445	0.2932						
# of vehicles owned						-0.7571	0.0515				
Commercial development (indicator) ratio								**0.4927**	**<0.0001**		
N (total # of observations)		142		142		142		142		122	

Conclusions

A variety of factors can come into play when households/individuals make their decision for the destination choice of many different activities. In terms of consistency level in destination choice making for grocery shopping, gasoline purchase, and dining-out, we found household type to have a significant impact on consistency level. In the TROR survey, households without children had the least consistent destination choice making behavior, while single adult households had the highest. This may be due to the constrictions on their mobility level and their reduced requirements for those activity needs. Number of vehicles owned had a marginally significant positive impact on consistency level. The presence of intersecting effects of vehicle ownership and household types might suggest that a vehicle availability-related restriction may account for part of the single adult households' mobility loss and households with children have in fact most restricted travel patterns. The model results also seemed to be contradictory to the common belief that people tend to plan more for longer trips. On one hand, this could be due to the limited availability of amenities for certain activity purposes forced households/individuals travel for further distance; on the other hand, the calculated average distance might have overlooked difference in distinctive travel patterns.

Our study investigating how Vermont rural residents chose among local town destinations, other Vermont town destinations and New Hampshire destinations revealed that household characteristics were not highly associated with the destination choice making for grocery shopping. For eating-out activities, single adult households tended to choose local destinations and households without children predominantly chose to dine in Vermont non-origin towns. While the number of full time workers and vehicle ownership did not seem to affect households' choice making for grocery shopping activities, they did play an important role in determining dining-out destinations. Commercial development density was found to be highly positively associated with choosing local destinations and New Hampshire destinations (compared to choosing other Vermont destinations) for both grocery shopping and eating-out activities. Interestingly, our study showed that households tended to travel further distance to reach New Hampshire destinations for grocery shopping; however, this tendency was not discovered for eating-out activities, possibly due to the "no sales tax" benefit of New Hampshire was not provided for dining.

The uniqueness of rural areas in land use pattern and development distribution tends to generate more travel at a further distance and therefore more dynamic travel pattern. Although the issues, such as congestions and the related concerns, the rural transportation system is facing are less challenging than those in urban areas, appropriate planning for future development might possibly open up opportunities for rural population to travel less for more. Our study took the very first step in revealing rural residents' destination choice making behavior related to other influential factors. For future studies, we are seeking to involve a broader range of residential neighborhoods and further identify seasonal effects on behavior changes given the severe winter condition in northern states.

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