Chapter 7

Joined Trips

Joined trips, in which people make more than a single stop on a trip from home, are drawing increasing attention from those who study urban travel patterns (Ben Akiva and Bowman, 1998; Metropolitan Washington Council of Governments, 1997; Ken Ornski in Lincoln Institute for Land Policy, 1995; Rutherford, McCormack and Wilkinson, 1997)). In the data used in this analysis twenty eight percent of all employed persons made at least one stop on the way home from work. Fourteen percent stopped on the way to work.[1] With joined trips being so commonplace one may ask whether they have altered household travel times and thereby influenced urban form.

Joined trips may have a significant impact on urban form if people are able to use them to overcome even some of the disadvantages of a housing location with less access to economic centers. By using an automobile to join trips this effect may be enhanced as auto travel enables people to travel to destinations greater distances from home and more dispersed from each other. Businesses may also contribute to a rise in the number of joined trips by choosing sites and designs that facilitate joined trips. Drive-through windows can only be accessed as part of a joined trip. Clustering of grocery and retail stores along major commuting thoroughfares, commonplace in metropolitan areas, also facilitate joined trips. People taking advantage of these designs by joining trips are able to choose housing at greater distances from economic centers with less increase in their total travel time.

Testing for the existence of a relationship between a household's access to economic centers (including the central business district) and the number of joined trips made by members of that household should begin to reveal whether the use of joined trips has influenced urban form. If the number of joined trips are increasing in the distance from economic centers then people may in fact use joined trips to overcome (at least in part) the disadvantage of living further from economic activity posited by monocentric and limited polycentric models. Those models adhere to an implicit assumption that household travel expenditures are increasing in distance of the housing location from economic centers. Using joined trips, however, may allow people to reduce their transportation expenditures

[1] Frequency tables enumerating the number of stops made on trips to and from work appear in Appendix 8A.

while still accessing the goods and services that they desire. This may be accomplished by accessing many different destinations on a single trip to an economic center. Alternatively, a person may go to a variety of destinations that are dispersed away from economic centers.[2] In either case a person is making use of a joined trip to reduce travel expenditures.

The Theory

Another look at the theoretical model set out above provides some insight into the use of joined trips in the context of the monocentric and limited polycentric models. As pointed out earlier, the rent and density gradients generated by the model depend critically on the assumption that total household travel is an increasing function of access to centers. The rent gradient (p_k) found in equation (6) exists only under the assumption that total household travel time is an increasing function of travel time to economic centers (i.e., that t_k is positive).[3]

$$c(y)\frac{\partial t}{\partial k} = -p_k h \qquad (6)$$

Likewise, the density gradient (h_k) of equation (8) is negative if and only if both household travel time is increasing and rents are decreasing in travel time to economic centers (i.e., t_k.>0 and p_k<0). Since the price gradient is dependent on the assumption concerning travel time, the travel time condition alone is sufficient to derive the result.

$$\frac{\partial h}{\partial k} = \frac{pc(y)t_k - p_k(y - x - c(y)t)}{p^2} \qquad (8)$$

Joined trips may influence both rent and density gradients by affecting the relationship between t and k. The failure to observe an increase in household travel time (t) as travel time to centers (k) increases may be explained, at least in part, if the use of joined trips increases as travel time to centers (k) increases. If the use of joined trips is shown to be increasing in travel time to centers, we may see flatter rent and density gradients, even assuming the continued importance of centers to urban form.

An empirical model is useful to test whether the number of joined trips made by people increase if they live further from economic centers. Much of the attention given

[2] Avoiding congestion typically found in centers reduces travel time in this case. Travel time will increase, however, if destinations are widely dispersed in the outlying areas.

joined trips has focused on people making stops on trips to and from work. For most people commuting to and from work is required. Making use of the commute for other errands is thought to be the primary way in which people join trips (Ken Ornski in Lincoln Institue for Land Policy, 1995; Sipress, 1999; Reid, 1998; Bowles, 1998).[4] The tests conducted here will encompass only those joined trips on the way to and from work. These tests should provide some understanding of the degree to which the use of joined trips has influenced urban form.

The Data

The data used for this analysis are, for the most part, the same as those identified in Table 3A above. The analysis in this section, however, is on an individual basis rather than a household basis. Since household characteristics may affect the number of stops that a person makes when commuting the influence of those factors is tested. For clarity a complete listing of the variables used and their sources appears in Table 7.1.

Table 7.1 Data Sources and a Description of Data for the Joined Trips Models

Data from the Metropolitan Washington Council of Governments Transportation Planning Board *(by person and household)*

Variable Name	*Description*
Und30*	person under 30 years of age
Ovr65*	person over 65 years of age
Trns*	used transit (at least once) on trip
Hinc12*	household income of less than $10,000
Hinc3*	household income of $10,000-20,000
Hinc4*	household income of $20,000-30,000
Hinc5*	household income of $30,000-50,000
Hinc7*	household income of $75,000-100,000
Hinc8*	household income of $100,000-125,000
Hinc91*	household income of more than $125,000
Kids	number of children under 17
Numveh	number of household vehicles

[3] Note that t_k is used to represent the partial derivative of t with respect to k.

[4] Joining trips on commutes is also consistent with urban economic theory. If, as economic theory posits, both employment and economic activity are concentrated in and around economic centers, it is likely that people will use their commutes to obtain good and services they desire (See Hanson's (1980) study of stops on the way to work in Uppsalla, Sweden).

Numlic	number of licensed drivers
Twnhs*	townhouse
Apt*	apartment
Own*	household tenure
Mv8090*	moved to home between 1980 and 1990 (inclusive)
Mvpst90*	moved to home after 1990
Wkad	number of working adults in the household
Nwkad	number of working adults in the household

* Variable is a 0/1 dummy

Data from the Census Transportation Planning Package

Variable Name	*Description*
Hcbd	travel time to the CBD in hours
Nrst	travel time to the nearest subcenter in hours

The Empirical Model

Independent tests of the number of stops made on the commutes to and from work were conducted using negative binomial regressions. The negative binomial estimation used maximum likelihood to maximize the following distribution:

$$\text{Prob}[Y = y_i] = \frac{\Gamma(\theta + y_i)}{\Gamma(\theta)\, y_i!} u_i^{\theta} (1 - u_i)^{y_i}$$

$$\text{where} \qquad u_i = \frac{\theta}{\theta + \lambda_i}$$

$$\text{and} \qquad \theta = \frac{1}{\alpha}$$

and α is determined such that

$$Var[y_i] = E[y_i]\{1 + \alpha E[y_i]\}$$

for the discrete random variable Y, with observed frequencies, $y_i, i = 1,2,3,...$ where $y_i > 0$ with regressors x_i such that

$$\ln \lambda_i = \beta' x_i$$

Negative binomial and Poisson regressions are both suitable for count data analysis. Tests of overdispersion revealed that the data violate the assumption of equality of the mean and variance of the Poisson distribution. In cases of overdispersion a Poisson regression

provides inconsistent estimates of the variance preventing hypothesis testing. The negative binomial model, which relies on a distribution that allows the mean to differ from the variance, is then more efficient (Cameron and Trivedi, 1990). [5] Two models were tested one for stops on the way to work and one for stops on the way home from work.

The Results

The results of regressions for stops on the way home from work and for stops on the way from home to work appear in Tables 8.2. For ease of interpretation marginal effects are reported. Each parameter estimate may therefore interpreted as the change in the dependent variable (the number of stops) arising from a change from the mean of the corresponding independent variable, holding all other independent variables constant at their means.

Table 7.2. Models of stops on the way to and from work

Model	***Stops on trip from home to work***		***Stops on trip from work to home***	
Variable	*Marginal Effect*	*Standard Error*	*Marginal Effect*	*Standard Error*
Intercept	-0.511*	.014	-0.872*	.164
Under 30 years old	0.006	.024	0.008	.036
Over 65 years old	0.052	.081	-0.060	.113
Travel time to the central business district	0.147*	.067	0.392*	.103
Travel time to the nearest subcenter	0.128**	.071	0.272*	.095
Household income less than $10,000	-0.180	.112	-0.199*	.101
Household income of $10,000-20,000	0.038	.050	0.006	.073
Household income of $20,000-30,000	-0.012	.040	0.020	.056
Household income of $30,000-50,000	-0.033	.028	-0.030	.041
Household income of $75,000-100,000	0.005	.025	0.016	.037
Household income of $100,000-125,000	-0.045	.037	-0.026	.052
Household income of	-0.056	.045	-0.016	.059

[5] Complete results of the tests of overdispersion appear in Appendix 8B.

more than $125,000				
Townhouse	-0.081*	.035	-0.102*	.042
Apartment	-0.065	.043	-0.008	.052
Own	0.006	.030	-0.009	.042
Moved to present residence between 1980 and 1990	0.030	.027	0.031	.038
Moved to present residence after 1990	0.069*	.034	0.045	.043
Used public transportation	-0.096*	.038	-0.144*	.047
Number of nonworking adults in the household	-0.021	.023	-0.084**	.046
Number of working adults in the household	0.000	.025	-0.084*	.050
Male	-0.001	.018	-0.021	.027
Number of children in the household	0.012	.012	-0.015	.018
Number of licensed drivers in the household	0.003	.026	0.096**	.050
Number of vehicles in the household	0.000	.015	0.007	.018
Observations	4019		4019	
Log likelihood function	-1895.211		-3201.039	
Restricted log likelihood	-1933.837		-3262.701	
X^2	77.25		123.32	
Significance Level	.000		.000	

*significant at α =.05
** significant at α =.10

In both models the parameter estimates on both travel time to the nearest subcenter and travel time to the central business district are significant and positive. Coefficient estimates for travel time to the nearest subcenters are slightly smaller than those for travel time to the central business district in both models. The results suggest that residents more distant from the economic concentrations make greater use of joined trips to reduce travel expenditures. The combined effect of the parameter estimates for travel time to the central

business district and travel time to the nearest subcenter in areas distant from both centers suggests that joined trips are more prevalent in the suburbs, where car use is greater and businesses are more disperse. This supports the hypothesis that joined trips are more useful in outlying regions where people are able to avoid the congestion caused by the dense concentration of jobs, people and activity in and around the central business district.

In the models of stops on the way to work parameter estimates are smaller than those of the model of stops on the way home suggesting that the relationship between travel time to economic centers and the use of joined trips on the way to work is less strong. This may be expected, as many commercial establishments are not open in the early morning when most people commute to work. People also are less able to use the commute to work for errands such as grocery shopping that would require storing perishables for the workday.

In both models a dummy variable identifying the use of public transportation for one or more legs of the journey was significant and negative. This is likely be because people that use public transportation have less flexibility in choice of destinations and more difficulty carrying goods with them. Both of these factors are likely to reduce the number of stops that a person makes during a commute. This result is also consistent with a conclusion that joining trips is more effective in less concentrated areas where it is easier to use a car.

Interestingly, none of the household or neighborhood variables - number of children, number of working adults and number of nonworking adults – had significance in any of the regressions. Many commentators argue that making stops on the way to and from work is almost a necessity for two worker households, particularly those with children. The growth in the share of these households is argued to contribute to the number of joined trips (Sipress, 1999; Reid, 1998; Bowles, 1998). The results here do not necessarily imply that members of those households do not join trips. Instead, they suggest that all households, not only two income households, use joined trips. This result should not be surprising at-home social activities are likely be increasing in the number of household members of any age. For example, singles that live alone would seem very likely to travel outside the home for social activities, including stops on the way home from work at the end of the day. Income levels, home and lot sizes and neighborhood characteristics also were insignificant in the regressions. This also supports a conclusion that the use of joined trips is evenly dispersed among all socioeconomic groups.

The findings of these regressions support the hypothesis that the use of joined trips may be contributing to changes in our urban form. The number of stops on the way to and from work is an increasing function of household travel time to both the central business district and other economic centers. Joined trips may therefore allow people to live greater distances from the economic concentrations while limiting the additional travel time. This reduction in travel time will reduce the amount of time one trades for a reduction in housing price. The outcome should be a reduction in both rent and density gradients. The use of joined trips seems to be strongest in outlying areas where the travel by car is easiest. The prevalence of car use for joined trips also suggests that businesses have responded to the demand for joining trips with the auto by choosing locations and designs that are more conducive to those trips. The results suggest that joined trips do in fact influence our city form.