
# Analysis of Automobile Travel Demand Elasticities with Respect to Travel Cost

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This study establishes quantitative relationships between automobile travel demand and cost to analyze the elasticities of the demand for personal vehicle travel with respect to travel costs, alternative mode's level-of-service and travelers' socioeconomic characteristics.

## VMT Elasticities: Derived from Disaggregate Cross-Sectional Regression Models

A relationship between household-level vehicle miles traveled (VMT) and a set of explanatory variables is established using a log-log regression model.

$$\log M = \beta_0 + \beta_P \cdot \log P + \beta_I \cdot \log I + \beta_D \cdot \log D + \beta_S \cdot S + \beta_V \cdot V + \beta_W \cdot W \quad (1)$$

where

- *M* = annual household vehicle miles,
- *P* = fuel price,
- *I* = household income,
- *D* = directional route miles (DRM) per square miles, a measure of transit service coverage,
- *S* = household size,
- *V* = the number of household vehicles,
- *W* = the number of employed household members, and
- *β's* = the parameters.

The weighted ordinary least squares (WOLS) method is used to estimate the coefficients in the regression model using the 2009 National Household Travel Survey (NHTS) dataset, supplemented with the National Transit Database (NTD). The elasticity of vehicle miles with respect to the explanatory variables that are in the natural log form comes directly out of the regression.

Table 1 shows that increasing transit service route miles in an area will help to reduce the miles traveled by personal vehicles. The elasticities with regard to income are similar for urban and rural households. However, fuel price elasticity is smaller for urban households, compared to the entire population.

**Table 1. Household Vehicle Miles Elasticities**

| Variable | All Households | Urban Households |
|---|---|---|
| Fuel price | -0.76 | -0.31 |
| Income | 0.18 | 0.18 |
| Directional route miles per square miles | - | -0.06 |

## Long Distance Auto Travel Demand Elasticities: Derived from Discrete Choice Model

As part of the traditional transportation planning model suite, discrete choice models are widely used to estimate the demand for particular travel frequencies, modes, destinations, routes, and departure times. A binary logit model capturing long distance travel mode choice between the personal vehicle and air modes is developed, considering policy significant factors related to travel times and costs. The observed utility of the binary logit model is represented by the value function:

$$V_{ij} = \alpha_j + \beta_1 \cdot d_{ij} + \beta_2 \cdot t_{ij} + \beta_3 \cdot c_{ij} + \gamma_{j1} \cdot inc_i + \gamma_{j2} \cdot s_i \quad (2)$$

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where

- *aj* = alternative specific constant;
- *dij* = mode specific access distance with a generic coefficient $\beta_1$;
- *tij* = mode specific trip time with a generic coefficient $\beta_2$;
- *cij* = mode specific cost with a generic coefficient $\beta_3$; and
- *inci* = income with an alternative specific coefficient $\gamma_{j1.}$
- *si* = travel party size with an alternative specific coefficient $\gamma_{j2.}$

The binary logit model is calibrated using the 2001 NHTS long distance travel records, supplemented with the Office of Airline Information (OAI) data. Aggregate direct- and cross-elasticities of long distance auto trips with respect to access distance, travel time, monetary cost, income, and travel party size are derived.

**Table 1. Long Distance Auto Travel Demand Elasticities**

| Variable | All | <20K | 20-45K | 45-75K | 75-100K | >100K |
|---|---|---|---|---|---|---|
| Airport access distance | 0.05 | 0.02 | 0.03 | 0.04 | 0.06 | 0.07 |
| Time by Air | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| Cost by Air | 0.06 | 0.03 | 0.04 | 0.05 | 0.08 | 0.10 |
| Time by Auto | -0.13 | -0.09 | -0.10 | -0.12 | -0.14 | -0.18 |
| Cost by Auto | -0.11 | -0.06 | -0.07 | -0.09 | -0.13 | -0.16 |
| Income | -0.23 | -0.02 | -0.06 | -0.14 | -0.30 | -0.54 |
| Travel party size | 0.03 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 |

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