CALIBRATION AND APPLICATION
OF THE OHIO LONG DISTANCE TRAVEL MODEL

by:

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Abstract

The Ohio Statewide Travel Demand Model is a state-of-the-art economic, land use and transport model. The person transport component of this model is a tour-based, micro-simulation model of the entire population of the State of Ohio. A special feature of the person transport models is the inclusion of a long distance travel model designed to capture the unique behavior associated with individual's trips longer than 50 miles. This paper will focus on the calibration and application of the long distance travel model.

The Ohio long distance travel model includes six primary components: binary choice of travel, pattern choice, scheduling, internal-external choice, destination choice, and mode choice. In application, each of these choices is simulated for the same synthetic population used by the short distance travel model. Both short and long distance trips are assigned to the same networks, competing for transportation capacity.

Previous work (1) described the design and estimation of the long distance model in further detail. This paper will describe the calibration of each of the long distance model. It compares the model's performance to observed data, primarily from the 2002-2003 Ohio Long Distance Travel Survey. It includes discussion of changes to model parameters and model structure made as part of the calibration process.

This paper seeks to provide several benefits to future practitioners. First, by reporting the model calibration targets it illustrates the magnitude and characteristics of long distance travel. This information is not as readily available as information about short distance travel, and provides context to those considering which model components to prioritize when investing limited resources. Second, the paper compares the performance of an innovative new approach to modeling long distance travel, allowing future model developers to build upon the work with full knowledge of their starting point.

Introduction

The Ohio long distance travel model includes individuals' travel for distances greater than 50 miles; the complementary short distance travel model covers distances less than 50 miles. Both operate in a micro-simulation framework on the same synthetic population. The trips from both models are assigned together to the same networks. The short distance travel model is a tour based model, and the long distance model follows that general structure, linking inbound and outbound journeys, but not specifically modeling intermediate stops.

The behavior of long distance travel is modeled in six steps. First, each eligible traveler is given the choice of whether or not to engage in long distance travel during a two week period. For those who travel during the two week period, the pattern model predicts the type of travel that occurs on the actual simulation day. Third, the tours are scheduled to a time-of-day. Next, each tour is evaluated to determine whether the destination is internal or external to the model area boundary. Finally, a specific destination and then a mode are chosen.

Each of these models is segmented into three purposes, defined as follows:

- Household travel: Travel in which entire household participates,
- Work-related travel: Individual business travel, and
- Other travel: Individual travel for non-work purposes.

Previous work (1) described the design and estimation of the long distance model in further detail. In contrast, this paper focuses on the calibration of the above model components. Specifically, it seeks to explain the process used to calibrate these model components, and present the results of each. It evaluates the model's performance relative to observed data, from the 2002-2003 Ohio Long Distance Travel Survey. Separate papers describe the short distance travel model calibration (2) and the system level calibration (3), and this paper will briefly describe the integration with those efforts. A related paper (4) focuses on passenger transit calibration, both for long and short distance trips.

Calibration Results

The calibration of each long distance model component is described briefly below.

Binary Choice of Travel

The binary choice of travel model predicts if a person will engage in any long distance travel of each purpose during a two-week period. The models were calibrated to match targets derived from the expanded survey data, scaled to the total number of persons in the model area. The only coefficient changed during the calibration process was the alternative specific constant associated with traveling, which in all cases was reduced, resulting in less travel.

Table 1 shows the results of the binary choice of travel model compared to the calibration targets. Overall, the highest rate of travel is for other tours, at 18%, and the lowest is for work related tours, at 2%. The total number of persons traveling, and the percent of persons traveling are calibrated to match very well by purpose. The total number of people traveling is slightly high because the model does not account for the fact that persons engaging in travel for one purpose may also be more likely to engage in travel for the other purposes. This difference does not affect the final model outcomes because while too many different persons are traveling, the right amount of travel is occurring.

Table 1: Percent of Persons Making a Long Distance Tour in a Two-Week Period

Observed	No	Yes	Total
Household	90.6%	9.4%	100.0%
Work Related	97.9%	2.1%	100.0%
Other	81.5%	18.5%	100.0%
Total	73.3%	26.7%	100.0%
Modeled	No	Yes	Total
Household	90.6%	9.4%	100.0%
Work Related	97.9%	2.1%	100.0%
Other	81.5%	18.5%	100.0%
Total	72.6%	27.4%	100.0%
Difference	No	Yes	Total
Household	0.0%	0.0%	0.0%
Work Related	0.0%	0.0%	0.0%
Other	0.0%	0.0%	0.0%
Total	-0.7%	0.7%	0.0%

Tour Pattern

Given the long-term choice of travel, the tour pattern model predicts the type of travel that occurs on the simulation day, if any. The model applies a set of factors, by purpose, derived from the survey data. Given this model structure, no calibration is required. Table 2 shows the tour pattern frequencies. There are a total of about 300,000 long distance person tours occurring on a typical weekday (Monday through Thursday).

Table 2: Tour Pattern Choice Frequencies

Pattern Type	Household	Work Related	Other
Complete Tour	2.48%	6.95%	2.86%
Begin Tour	2.37%	4.72%	2.11%
End Tour	2.03%	3.36%	1.71%
Away	7.90%	11.26%	5.43%
No Tour	85.21%	73.71%	87.88%

Scheduling

Tours are scheduled to a time-of-day with a one-hour resolution. Beginning tours are given a departure time, ending tours are given an arrival time, and complete tours are given a departure time and duration to fully define their schedule. As with the tour pattern model, the scheduling model draws from observed frequency distributions for beginning tours and ending tours. No calibration was required for the departure time of beginning tours.

The schedule of complete tours is determined using a constants-only logit model. Some changes were made to the model during calibration to better fit the observed departure time, arrival time and duration distributions. The model was initially estimated with the constants constrained to be equal within each two-hour period. During calibration, some of these constraints were relaxed, and the models were re-estimated. Also, constants were added for arrival times of 9 PM or later to avoid over-predicting late arrivals. Figures 1 and 2 show the departure and arrival times for complete tours.

Figure 1: Departure Time for Complete Tours

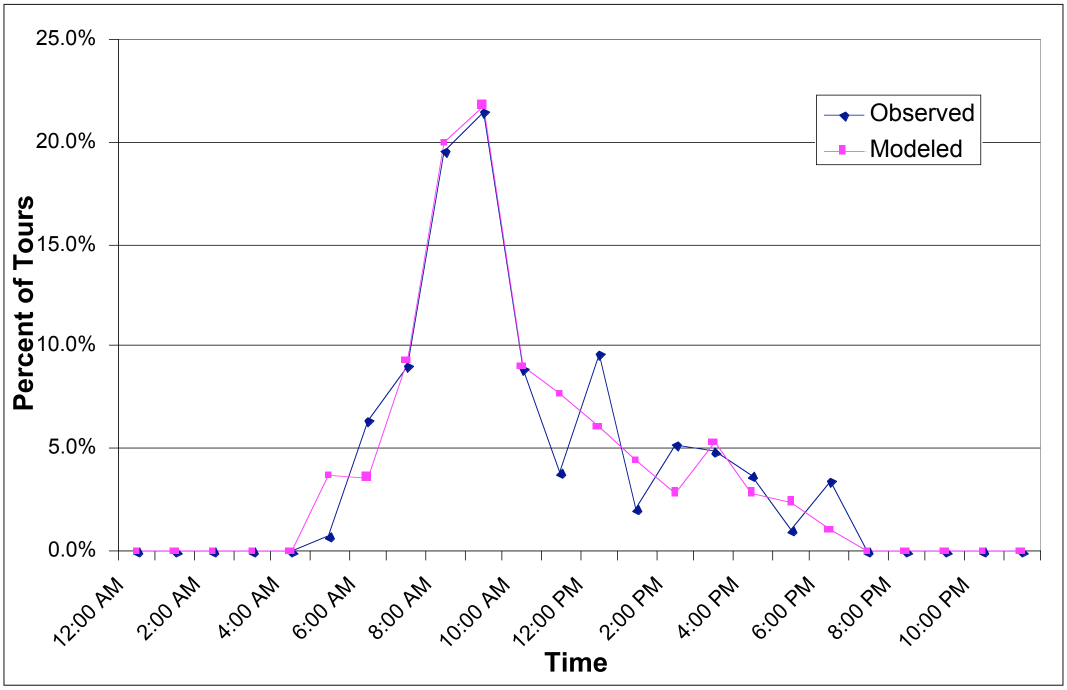
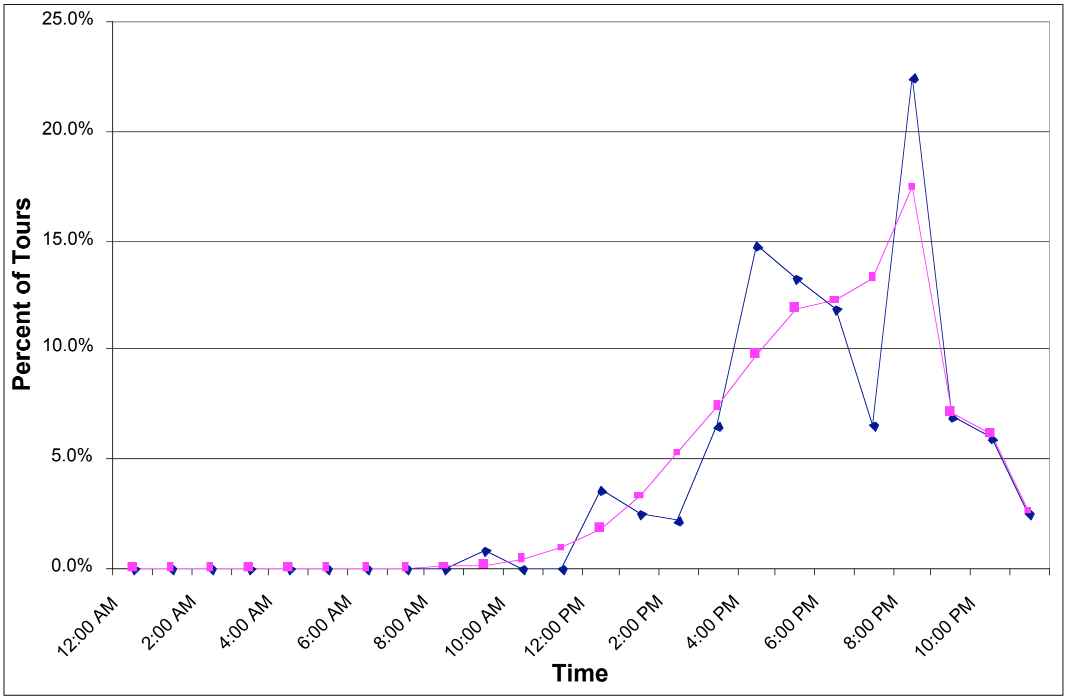


Figure 2: Arrival Time for Complete Tours



Internal-External Choice

The internal-external choice model is a binary choice model predicting whether a tour will have a destination within the model area or beyond the bounds of the model area. The models were calibrated to match the internal-external shares found in the survey data. The only changes made during calibration were to the alternative specific constants. Table 3 shows the modeled and observed internal-external shares. The calibrated models match the observed data well.

Table 3: Tours with Internal versus External Destinations

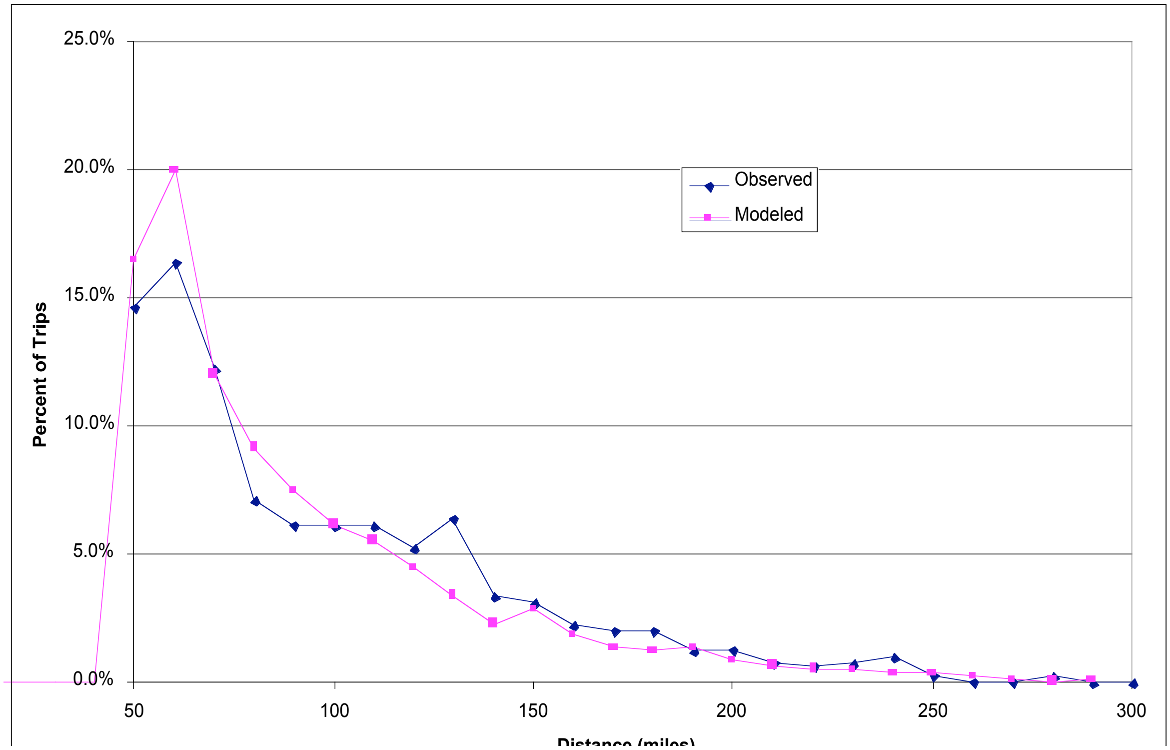
Observed		Destination	
Pattern Type	Internal	External	Total
Begin & End	41.3%	58.7%	100.0%
Complete Tour	84.8%	15.2%	100.0%
Total	59.2%	40.8%	100.0%
Modeled		Destination	
Pattern Type	Internal	External	Total
Begin & End	40.7%	59.3%	100.0%
Complete Tour	84.6%	15.4%	100.0%
Total	58.8%	41.2%	100.0%
Difference		Destination	
Pattern Type	Internal	External	Total
Begin & End	-0.6%	0.6%	0.0%
Complete Tour	-0.2%	0.2%	0.0%
Total	-0.5%	0.5%	0.0%

Destination Choice

The destination choice models are applied separately for internal versus external destinations, allowing the internal destination choice models to take advantage of the more robust data available within the model area. Prior to calibrating the models, they were re-estimated using a mode choice logsum as the measure of impedance, rather than the generalized cost, as initially used. The models were calibrated iteratively with the mode choice models, because the mode choice model constants affect the logsum value. The difference between the estimated and calibrated models is that constants were added to properly match the number of trips in three distance bands: less than 60 miles, 60 to 70 miles, and 70 to 150 miles. The inclusion of these distance band constants allows the model to match the observed trip length distributions without modifying the mode choice logsum coefficients. The model appeared to have more difficulty matching these relatively short trips, possibly due to behavioral overlap between short and long distance travel behavior.

The average trip length is 100 miles. The modeled and observed average trip lengths match within 2% overall, with some minor variations by purpose and pattern type. Figure 3 shows the modeled and observed trip length distributions. Due to relatively small sample sizes, the observed distributions are somewhat lumpy, but the models generally match those curves well.

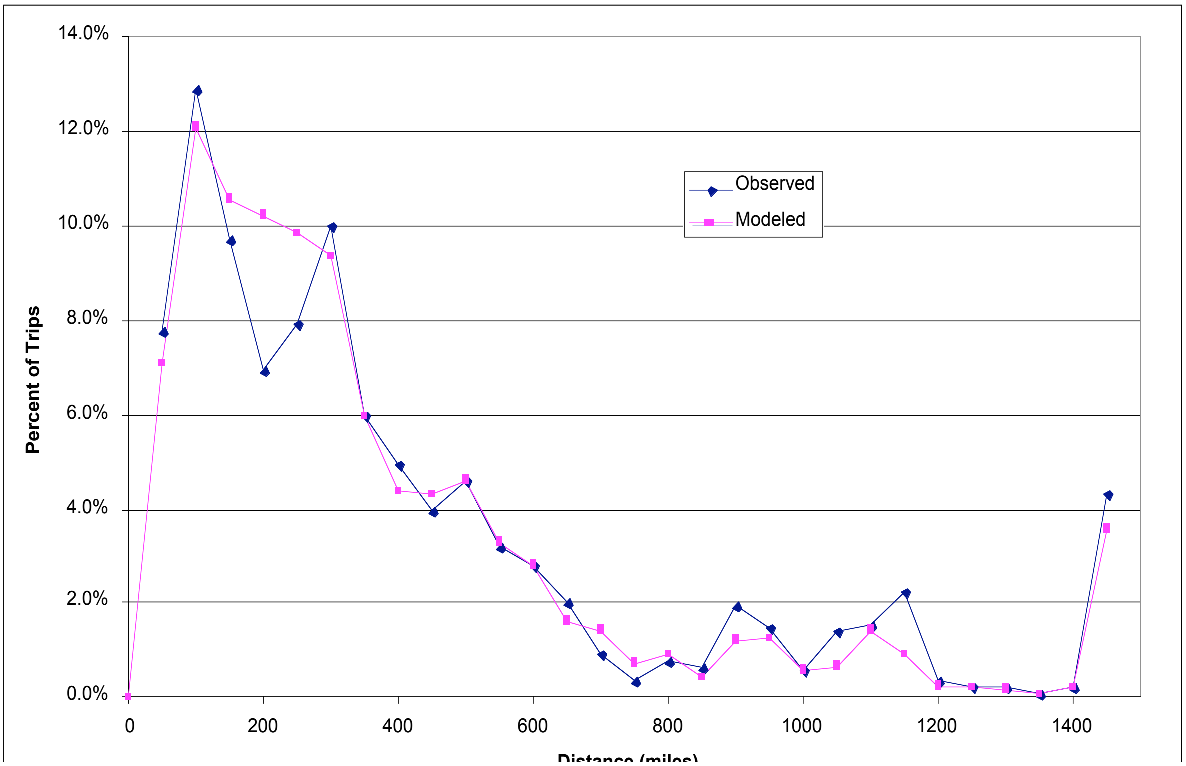
Figure 3: Trip Length Distribution of Tours with Internal Destinations



Destinations outside the model area are drawn from the observed distribution of external destinations. These observed distributions are segmented by the home location into one of the five super-districts. They are not segmented by purpose or pattern type. During calibration, two changes were made to the original model design. First, for complete tours, the available destinations were restricted to those that could be reached within the time available. Second, the destination frequencies were smoothed. For the central super-district, the smoothed frequencies were derived as the central frequency plus _ of each of the four corner super-districts. For the four corner super-districts, the smoothed frequency was derived as the value for that super-district plus _ the value for the central super-district. This smoothing process overcame some of the challenges associated with the relatively small samples, and provided better results.

The average length of trips with external destinations is 460 miles, although much of that distance is beyond the boundary of the model area. There are some differences by purpose and pattern type because there are too few observations to segment the model by purpose or pattern type. The overall average trip length, however, matches closely. Figure 4 shows the modeled and observed trip length distributions for all tours with external destinations. Overall, the distribution is reasonable.

Figure 4: Trip Length Distribution of Tours with External Destinations



Mode Choice

Prior to calibrating the mode choice model, it was enhanced by adding two new alternatives: walk to high speed rail, and drive to high speed rail. These alternatives, which do not exist in the base year, are distinct from the walk to transit and drive to transit alternatives, which include the existing Greyhound and Amtrak service. The new alternatives allow for competition when the modes are introduced in the future. In the nesting structure, the top level choice is between auto air and transit. Transit is further segmented, first into traditional transit versus high speed rail, then by walk versus drive access. The upper level nesting coefficient was set to 0.65, and the lower level nesting coefficients were set to 0.5.

The models were calibrated to match the mode shares found in the survey data. The high speed rail alternatives were initially set to use the same coefficients as the transit alternatives, and were calibrated with the same constants. Subsequent scenario testing is being performed in which these high speed rail constants are being re-evaluated. It is not possible to reliably differentiate the access mode in the survey data, so the walk and drive access modes are calibrated with the same constants. Therefore, with auto as the reference mode, there is a single constant for air, and a single constant for all four transit and high speed rail modes.

The mode choice model applied to tours with external destinations is a simplified model based on the distance, such that it can be applied without detailed skim values. The model was calibrated with changes to the alternative specific constants.

The observed and modeled mode choice results are shown in Table 4 for both internal and external destinations. The models are calibrated to match well for auto, air and transit. The drive to transit values are generally higher than the walk to transit values because of the time savings associated with the access mode.

Table 4: Percent Mode Choice Results for Tours

Observed	Internal	External	Total
Auto	99.1%	84.0%	88.6%
Air	0.1%	15.0%	10.4%
Transit	0.8%	1.0%	0.9%
Total	100.0%	100.0%	100.0%
Bus	*0.8%*	*0.7%*	*0.8%*
Rail	*0.0%*	*0.2%*	*0.2%*
Modeled	Internal	External	Total
Auto	99.1%	83.6%	88.3%
Air	0.1%	15.2%	10.6%
Transit	0.8%	1.2%	1.1%
Total	100.0%	100.0%	100.0%
Walk to Transit	*0.2%*	*0.6%*	*0.5%*
Drive to Transit	*0.5%*	*0.6%*	*0.6%*
Difference	Internal	External	Total
Auto	0.0%	-0.5%	-0.3%
Air	0.0%	0.2%	0.2%
Transit	0.0%	0.2%	0.1%
Total	0.0%	0.0%	0.0%

Auto Details

During the calibration process, it was recognized as important to account for auto occupancy in order to get the number of auto vehicle trips correct. For work related and other tours, a simple model is applied to determine if an auto person trip becomes a vehicle trip by calculating the probability of being a vehicle trip as one divided by the average auto occupancy. For household tours, all household members travel together, so the auto occupancy is, by definition, the household size. Table 5 shows the modeled and observed auto occupancies. The modeled household tour auto occupancy is somewhat lower than the observed value, indicating that the average size of households traveling is lower in the model than in the survey data. This is not considered a major issue because the number of vehicle trips is still correct.

Table 5: Average Auto Occupancy

Observed	Internal	External	Total
Household	2.79	2.84	2.81
Work Related	1.21	1.27	1.22
Other	1.86	2.04	1.91
Modeled	Internal	External	Total
Household	2.12	2.21	2.19
Work Related	1.23	1.20	1.21
Other	1.94	1.92	1.93
Difference	Internal	External	Total
Household	-0.67	-0.63	-0.62
Work Related	0.02	-0.07	-0.01
Other	0.08	-0.12	0.02

One additional auto detail filled in by this component is to generate auto trips from the home zone to the airport for air trips.

Application to Oregon

Following the development of the Ohio long distance travel model, it was implemented as part of the second generation Oregon statewide model (Oregon2TM). This allowed Oregon2TM to account for this important component of travel in a cost-effective manner. The model was applied in Oregon using the same software and the same software and model coefficients, but re-calibrated to match targets specific to Oregon where possible. One important difference between the Ohio and Oregon models is that Ohio had a survey of long distance travel available for model estimation and calibration. Oregon does not have such a specialty survey available, so the Oregon models are calibrated more generally to data available from the American Travel Survey. Because the American Travel Survey only covers trips longer than 100 miles the calibration effort focused on that subset of trips.

Conclusions

This paper has described the calibration of the Ohio long distance travel model. The model was developed as part of the Ohio Statewide Travel Demand Model to account for an important aspect of travel with a behavioral foundation different from what is observed in traditional urban travel demand models. The model has been successfully calibrated to match targets derived from the 2002-2003 Ohio Long Distance Travel Survey. It has also been successfully applied as part of the Oregon statewide model and calibrated there to match American Travel Survey data.

This paper will provide several benefits to future practitioners. First, by reporting the model calibration targets it illustrates the magnitude and characteristics of long distance travel. This information is not as readily available as information about short distance travel, and provides context to those considering which model components to prioritize when investing limited resources. Further, by discussing the changes made to the models in order to match the calibration targets, it provides practitioners with insight to what might be necessary in future applications. Finally, the paper evaluates the performance of an innovative new approach to modeling long distance travel, allowing future model developers to build upon the work with full knowledge of their starting point.

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