A Comparison of the Four-Step Versus Tour-Based Models in the Context of Predicting Travel Behavior Before and After Transportation System Changes

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ABSTRACT
The main objective of this study is to examine the performance of the MORPC trip-based and tour-based frameworks in the context of three specific projects started and completed within the past 20 years in the Columbus metropolitan area. Regional- and project-level comparisons of the performance of the trip-based and tour-based models are made for three scenario years: 1990, 2000 and 2005. The regional-level analysis is undertaken in the context of four travel dimensions based on data availability and observed data to model output compatibility. These four dimensions are vehicle ownership, work flow distributions, work flow distribution by time-of-day, and average work trip travel times. The tour-based model performs better overall than the trip-based model for all these four dimensions. The project-level comparative assessment of the predicted link volumes from the trip-based and the tour-based models is undertaken with respect to the observed link counts and by roadway functional class. The results did not show any clear trends in terms of performance of the models by functional class or year.

1. INTRODUCTION

The need to examine individual-level behavioral responses, and accurately forecast long-term travel demand in a rapidly changing demographic context, has led to a behaviorally-oriented tour-based approach to travel demand modeling. Indeed, the potential benefits of the tour-based approach, combined with the increasing levels of demands placed by legislations on the abilities of travel demand models, has led several planning agencies in the United States to shift (or consider the shift) to the tour-based approach.[1] The Mid-Ohio Regional Planning Commission (MORPC) is one of the agencies that adopted a fully operational tour-based model, for the Columbus region. Subsequently, the Ohio Department of Transportation (ODOT) developed a parallel traditional trip-based model from the same data as used for the tour-based model for use in a research study. This presence of both a trip-based and a fully operational tour-based model provides a unique opportunity to test and compare the models for their policy sensitivity and forecasting ability. Accordingly, the main objective of this paper is to examine and compare the performance of the MORPC trip-based and tour-based frameworks in the context of specific highway projects. Toward this end, the current paper presents an analysis and assessment of the accuracy of predicted travel patterns by the trip-based and the tour-based models of MORPC before and after several highway projects.

The rest of the paper is organized as follows. Section 2 discusses study projects and a control area identified for the analysis. Data preparation tasks undertaken for the study projects are briefly discussed in Section 3. Empirical comparison exercises between model outputs and observed data are presented in Section 4. The final section concludes the paper by summarizing important findings and recommendations.

2. STUDY PROJECTS AND CONTROL AREA

The emphasis of the current research study is to compare predictions of travel behavior before and after major developments and roadway projects that have started and been completed in the past 15 years or so in the Columbus metropolitan area.[2] Accordingly, the following projects and control area were identified for undertaking before-and-after effects analysis (see Figure 1 for the geographic locations of the selected projects and the control area):

Polaris: The Polaris region has seen large retail and employment growth in the last 20 years. The roadway improvements that coincide with this land-use growth include: (1) I-71 interchange with Polaris Parkway and new Polaris Parkway completed in 1993, (2) Polaris parkway widening completed in early 2000, and (3) I-71 split interchanges with Polaris Parkway and Gemini Parkway completed in 2007.

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[1] Planning agencies within the United States that have developed a tour-based or an activity-based travel model include Portland METRO, New York NYMTC, Columbus MORPC, Sacramento SACOG, the Los Angeles SCAG, Denver DRCOG, and the San Francisco SFCTA. Planning agencies that are in the process of either moving toward or considering the move toward the activity-based modeling approach include ARC of Atlanta GA, NCTCOG of Dallas-Fort Worth TX, HGAC of Houston, TX, CMAP of Chicago, ILPSRC of Seattle WA, MAG of Phoenix AZ, El Paso MPO, and SBCAG of Santa Barbara CA. Also, the reader is referred to Bowman and Bradley (*1*) and Pinjari and Bhat (*2*) for a summary of the design features of several of the activity based models developed (or under development) for practice. In addition, there have been activity based models developed in the research community, which include TRANSIMS, ILUTE (*3*), CEMDAP (*4-6*), FAMOS (*7,8*), SimAGENT (*9*), and ALBATROSS (*10*).

[2] In the current study, travel behavior is compared before projects, and again after projects, although changes in behavior from before to after are not compared due to data limitations. This issue is discussed in more detail in the final report submitted to ODOT (see Ferdous *et al.* (*11*)).

Hilliard-Rome project: No major roadway improvements were undertaken in this study area between 1990 and 2005. However, the Hilliard-Rome Road and the region on the west side of Columbus around I-70/I-270 have experienced large land-use related developmental changes in the late 1990s and early 2000s.

Spring-Sandusky interchange project: The Spring-Sandusky interchange project involved (1) reconstruction of SR 315 between I-670 and I-70/71, (2) new construction of the portion of I-670 between I-70 and SR 315 and (3) reconstruction and widening of I-670 between SR 315 and I-71. The project did not directly attract any substantial land use related changes. The project started in 1993 and was completed in 2003.

Control area: A control area with no substantial land use and network changes to significantly alter travel patterns in the time period under consideration is identified (the time period under consideration is 1990 to 2005; the years 1990, 2000, and 2005 are the three analysis years used in the current analysis, as discussed further in Section 4). The selected control area is I-71 bounded by Harrisburg Pike (SR 3) and I-270 in southern Franklin County.

3. DATA PREPARATION EFFORTS FOR STUDY AREAS

A study area was established for each project to reflect the geographic location within which roadway link volumes would most substantially be impacted directly from the planned developments. A detailed review of the roadways was undertaken for each study area, including verifying the accuracy of roadway connectivity, lane configuration, and traffic counts. Both the trip-based and tour-based models used identical highway networks for each analysis year.

Demographic data were generated for both models for each of the three years (1990, 2000, and 2005) based on Census data (see Ferdous *et al.* (*11*) for more details). Some variables were added to the trip-based model dataset to reflect the travel generation needs for that model. Income is represented in year 2000 dollars in all analysis years.

Six model runs were developed: one for each analysis year (1990, 2000, and 2005) and each model (trip-based and tour-based). The trip-based model runs one iteration of feedback to mode choice with no convergence criteria. The tour-based model runs two iterations of feedback to travel generation with no convergence criteria.[3] Both models use the identical equilibrium highway assignment closure criteria during the initial highway assignment(s) (a relative gap of 10^{-3} or 200 iterations, whichever is reached first). For the final highway assignment procedures, 500 iterations of equilibrium were specified.

After each model run, post-processing scripts were applied to the output files to generate the datasets used in the current study. The post-processing scripts varied slightly for each model to account for the different units of travel and trip purposes.

4. EMPIRICAL COMPARISON EXERCISE

This section discusses the performance of the MORPC trip-based and tour-based models. The performance evaluation of the models is pursued at two levels. The first level corresponds to a region-level analysis (independent of the specific project identified in Section 2) that compares selected model outputs from each of the trip-based and tour-based model systems with

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[3] Future efforts should examine convergence criteria-related considerations carefully, since it is likely that several iterations will be needed to bring supply and demand to anything close to an equilibrium solution.

corresponding region-level observed data. The second level corresponds to a local-level analysis (specific to each of the three projects and the control area identified in Section 2) that compares the model predicted link volume outputs on selected roadways in and around the project region with corresponding observed link counts. For both the region-level and local-level analysis, we consider three years for analysis, as identified below:

- Model year 1990: This is the base year/ no-build case; construction of the selected study projects did not begin prior to this year.
- Model year 2000: The Hilliard-Rome project was complete, the Polaris Interchange (Phases 1 and 2 of 3) was complete, while the Spring-Sandusky Interchange was under construction.[4]
- Model year 2005: The Hilliard-Rome project, Spring-Sandusky Interchange, and the first two phases of the Polaris project were complete, while Phase 3 of the Polaris project was not yet constructed.

The fit measures employed for comparison of model attributes with the observed data (for both the region-level and local-level analyses) are the Absolute Percentage Error (APE) measure and the Root Squared Error (RSE) measure, defined as follows:

$$APE = \frac{|\,(\text{Observed Data} - \text{Predicted Data})\,|}{\text{Observed Data}} \times 100$$

$$RSE = \sqrt{(\text{Observed Data} - \text{Predicted Data})^2}$$

The measures above were computed for each "cell", where a cell represents an appropriate spatial context in each of the region-level and local-level analyses (for example, a "cell" may be a specific county-to-county work flow). We also developed a weighted mean of the absolute percentage error statistic that was computed as the sum of the absolute percentage error for each cell weighted by the fraction of observations in that cell. Similarly, we computed a root weighted mean square error as the root of the sum of the squared error for each cell weighted by the fraction of observations in that cell. The results of the comparison exercise allow us to understand the relative predictive capabilities of the trip-based and tour-based model frameworks. In the subsequent sections, we present comparative performance assessment of the trip-based and the tour-based models with the observed data.

4.1 Region-Level Comparison

A number of data sources were used to undertake the comparison between the model outputs and the observed data. These included, for the most part, the Census Summary Files 3 (SF3) (for the years 1990 and 2000), the 1999 Household Interview Survey (HIS) (for the year 2000), and the American Community Survey (ACS) (for the year 2005). In the rest of this paper, we will refer to the Census SF3 data simply as the Census data.

The geographic coverage of the HIS matches up with the MORPC study region that includes Delaware, Franklin, and Licking counties completely and Fairfield, Madison, Pickaway,

[4] The year 2000 was included in the "before-after" project analysis because of the availability of the 2000 Census data, as well as the 1999 Household Interview Survey (HIS), that contributed toward our region-level analysis comparison of the trip-based and tour-based model system outputs. Further, for the local-level analysis, the year 2000 represented the completion of the Polaris Parkway widening (even though the I-71 split interchanges were not completed by then) and the immediate "after" situation for the Hilliard-Rome project.

and Union counties partially. However, the Census and the ACS data correspond to entire counties in the region.[5] As a result, the comparisons between the HIS data and the trip/tour-based model are one-to-one from a spatial coverage standpoint, while the comparisons between the Census/ACS data and the trip/tour-based model for Fairfield, Madison, Pickaway, and Union counties (these are the counties represented only partially in the study region) need to be interpreted with caution. For these counties that are only partially contained in the study region, the travel quantities (such as car ownership levels and total work flows in and out of counties) as obtained from the Census and ACS data are factored down based on the percentage area of the county in the study region relative to the total area of the county. (Alternative factoring methods, such as those based on number of county households in the study region relative to total county households in the county, county population in the study region relative to total county population, and number of county workers in the study region relative to total workers in the county, were also considered, but these alternative methods provided similar results.)

The model attributes evaluated in this section include household vehicle ownership level, county level O-D work flow distribution, split in work trip start time distribution by time of day (peak and off-peak period) and county of residence, and average travel time for work trips by county of residence.[6] The results corresponding to these model attributes are presented and discussed in the subsequent sections.

4.1.1 Vehicle Ownership

Table 1a presents the results for vehicle ownership level by county for the year 1990. Similarly, Tables 1b and 1c show the results of the performance metrics of the trip-based and tour-based models in comparison to the 2000 Census and the 1999 Household Interview Survey (HIS), respectively, and Table 1d presents the results for the year 2005 compared to the 2005 American Community Survey (ACS). Several interesting observations may be made from Tables 1a through 1d. Across all years, the tour-based model outperforms the trip-based model in terms of vehicle ownership model predictions for Franklin County. This is important, because Franklin County represents about 80% of the population of households and overall activity-level in the study region. Given that vehicle ownership impacts several other activity-travel decisions downstream in the modeling framework, and the vehicle ownership prediction for a substantial fraction of the study region is better from the tour-based model, it may be expected that the tour-based model would provide better disaggregate-level predictions for specific activity-travel

[5] The Census data are available for all seven counties under consideration here. However, the ACS data are available only for Delaware, Fairfield, Franklin, and Licking counties.

[6] In the interest of brevity, results of the evaluation of district-level O-D work flow distributions within Franklin County (which is the dominant county in the study region) and average trip distance distribution (by trip type and by county of residence) are not presented in the current paper. The analysis of the district-level O-D work flow distributions within Franklin County indicated that the tour-based model significantly outperformed the trip-based model (when compared against estimates from the 2000 Census Transportation Planning Products or CTPP 2000). For the trip distance distribution, we are unable to compare the outputs from the model systems to the Census, the ACS, or the HIS because these data sets do not provide information on observed trip distances.

dimensions and may better be able to examine policy response effects.[7] Interestingly, the trip-based model predictions of vehicle ownership are superior to the tour-based model predictions for essentially all non-Franklin counties and for all years and all data sets. This consistent underperformance of the tour-based model for non-Franklin counties is an issue that needs to be tagged for further examination in future model development efforts. Overall, across the entire study region, the tour-based model performs somewhat better than the trip-based model in 1990 and 2000 when compared with the Census data, while the trip-based model performs somewhat better than the tour-based model in 2000 (compared to the HIS data) and in 2005 (compared to the ACS data). It is also interesting to note that the error measures are about the same magnitude across the many years, suggesting that the vehicle ownership components of the trip-based and tour-based models perform reasonably well when temporally transferred to other years.

4.1.2 Work Flow Distributions

Tables 2a through 2d present performance measures for person work flow distributions in a county-level origin-destination format.[8] For Tables 2a, 2b, and 2d, the trip-based and the tour-based model outputs are compared with the observed person work flows from each county to within that county and to outside that county. This was because flow information was available only at this level from the Census SF3 data and the ACS data. However, for Table 2c, the models are compared with the observed county-to-county person work flows, since county-to-county work flows are available from the 1999 HIS.

The results in Tables 2a through 2d indicate that, in general, the tour-based model performs better than the trip-based model. This is particularly so for inter-county flows, as can be observed from the final row entitled “Total flows/overall weighted mean error” for the column entitled “outside origin county” in Tables 2a, 2b, and 2d (for comparison with the 1990 Census, the 2000 Census, and the 2005 ACS, respectively). Specifically, the overall weighted mean error measures for the tour-based model are consistently lower for the “outside origin county” flows than the corresponding flows from the trip-based model. In particular, the flows originating in Delaware, Franklin, and Licking counties (the three largest counties in the study area in terms of work trip generation) and destined outside these counties are better predicted by the tour-based model for all years (*i.e.*, 1990, 2000, and 2005). For work flows originating from the remaining counties (Fairfield, Madison, Pickaway, and Union) and terminating outside these counties, the tour-based model provides somewhat better results in 1990 and the trip-based model provides clearly better results for 2000 and 2005. For intra-county flows, both the trip-based and tour-based models provide about the same results for Franklin and Licking counties (the largest two counties in terms of work trip generation), while the trip-based model clearly performs better for Delaware and Fairfield counties. The trip-based model also performs better in 2000 for Madison and Pickaway counties, while the tour-based model is superior for Union county in that year. The

[7] This immediately brings attention to the aggregate-level modeling approach of the MORPC trip-based model relative to the disaggregate-level modeling approach of the MORPC tour-based model. Note that the vehicle ownership model in the trip-based modeling framework is implemented for each TAZ using the Iterative Proportional Fitting (IPF) technique to predict household vehicle ownership level within each TAZ by household size and income group, while vehicle ownership is estimated at the household level (using a discrete choice model) and also applied at the household level in the activity-based modeling framework. It is important to emphasize that the comparison being undertaken in this project is between the aggregate-level trip-based and disaggregate-level tour-based modeling frameworks as represented in the MORPC efforts.

[8] See Ferdous *et al.* (*11*) for a description of the steps undertaken to process the work flow outputs from the trip-based and the tour-based models.

comparison with the HIS data in Table 2c again indicates the better overall performance of the tour-based model for work flows originating from Franklin County (the largest county in terms of work flow), though the trip-based model performs better for work flows from Licking County (especially, the work flow from Licking to Franklin County). But, overall, even from the HIS data comparison, the tour-based model performs better than the trip-based model for county-to-county work flows, as can be observed from the final row of Table 2c.

4.1.3 Work Flow Distribution by Time-of-Day of Trip Start

Table 3 presents the error statistics for the work flow distribution by county of origin and two times of the day of the work trip start from the home end: the peak period (6:30 am to 9:29 am and 3:30 pm to 6:29 pm) and the off-peak period (all times that do not fall within the peak period).[9] The results consistently and across years show the tour-based model to be a better match overall of the observed peak period and off-peak period work flow distributions compared to the trip-based model (see the final row labeled "Overall weighted mean error"). This is not surprising, given that the tour-based model consistently outperforms the trip-based model predictions of work flow distribution by time of day of trip start for work trips originating in Franklin County (which is the largest generator of work trips). The tour-based model also does better for work trip flow distribution by trip start time for trips from Fairfield County (except for the off-peak period in 1990). Interestingly, though, for Licking County (the second largest generator of work trips), the trip-based model performs better than the tour model in 1990 and 2000, but not in 2005.

In summary, the work flow distribution by time of day forecasting ability of the tour-based model is better in the overall than the trip-based model for all years based on the Census/ACS data.

4.1.4 Average (Person) Work Trip Travel Time

The average (person) work trip travel times from the trip-based and tour-based models are compared next with the corresponding values from the Census and ACS data sets (see Table 4). The results indicate that, except for Fairfield County for the year 1990, the average work trip travel time predictions for other counties and all years from the tour-based model are better than or about the same or only marginally worse than from the trip-based model. This generally better performance of the tour-based model is also clear from the overall weighted (by flow from origin county) mean error rows of the table, indicating an edge for the tour-based model over the trip-based model (across all years) in terms of average work trip travel time prediction.

4.2 Project-Level Comparison

This section presents a comparative assessment of the predicted link volumes from the trip-based and the tour-based models with the observed link counts. The observed link counts were available only at an annual average daily traffic (AADT) level. The fit measures employed for comparison of model predicted link volumes with the observed counts are the Absolute

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[9] For compactness, we have suppressed the results comparison with the HIS data in this section as well as in the next section (*i.e.*, Section 4.1.4) of the current paper. These results are available in the ODOT final report (see Ferdous *et al.* (*11*)). Also, a time-of-day model component was developed for the trip-based model, with the same time periods and structure as the tour based model. The time periods were am peak (6:30 am-9:29 am), mid-day (9:30 am-3:29 pm), pm peak (3:30 pm-6:29 pm), and evening (6:30 pm-6:29 am).

Percentage Error (the APE error measure was also used in the region-level comparison) and the Percentage Root Mean Squared Error (%RMSE), defined as follows:

$$\%RMSE = \frac{\sqrt{\dfrac{\sum_{i=1}^{N}(\text{Observed Count}_i - \text{Predicted Count}_i)^2}{N-1}}}{\dfrac{\sum_{i=1}^{N}\text{Observed Count}_i}{N}} \times 100$$

where i is an index for road link (i = 1, 2, …, N). We also calculated a weighted mean of the %RMSE statistic that was computed as the sum of the percentage root mean squared error for each cell weighted by the fraction of observations in that cell.

Table 5 presents the observed link volumes and the model results for each study project and model year, aggregated by roadway functional class.[10] For the Polaris project, the tour-based model provides clearly better results than the trip-based model for 1990, while the two models perform about equally well for 2000 and 2005 (based on the overall weighted mean across all links in the Polaris study area). Across all years, the tour-based model provides better predictions for the freeway functional class. However, the trip-based model is better than the tour-based model in terms of predicting flows on major arterial links.

For the Hilliard-Rome project, the tour-based model provides better results (relative to the trip-based model) for the freeway functional class in 1990 and 2005, but worse results (relative to the trip-based model) for the freeway functional class in 2000. The tour-based model also provides better results for the major arterial class in 2000 and 2005.

For the Spring-Sandusky project, the tour-based model provides worse results for the freeway and expressway functional class, but performs marginally better for the major arterial class. Overall, the predictive power of the tour-based model is marginally lower than from the trip-based model.

Finally, for the control area, the tour-based model predicts link flows on freeways with a better accuracy than the trip-based model for 1990, though the roles are reversed for 2005. There is no difference in predictive ability for the freeway functional class in 2000. The trip-based model’s performance is also superior to that of the tour-based model for the major arterial class.

Overall, the results from the trip-based and tour-based models indicate about equal predictive abilities for both the before-project and after-project situations at the level of link predictions (see final three rows of Table 5). It is difficult to make a strong case for one of the MORPC models being superior to the other from this standpoint. It should be noted that the use of a traditional static traffic assignment process does, to an extent, “undo” the benefits of the fine resolution of time represented in the tour model. This happens because the tours are grouped back to four aggregate time periods in the assignment stage and the static assignment process does not consider the dynamics of vehicle delays (see also Pinjari *et al.* (*6*)). In general, the results in this section do provide validation that the tour-based model, being a more recent entrant to the travel demand practitioner’s toolbox, is producing reasonable results at the link level.

[10] In discussions with MORPC and ODOT staff, it was decided that, as the Spring-Sandusky project was incomplete in the year 2000, no comparison will be undertaken for this project for this year. However, as the Polaris project was undertaken in phases and the year 2000 marked the completion of the parkway widening phase of the project, we undertook a comparative analysis for the Polaris project for the year 2000 even though the entire project was not complete until 2007 (see also footnote 7).

5. CONCLUSIONS

This study compared the performance of the MORPC trip-based and the tour-based models with regional-level information from the Census, ACS, and HIS as well as project-level information before and after projects. Such a comparative exercise provides a good opportunity for both models to be tested for their travel behavior and forecasting ability.

Regional- and project-level comparisons were made for three scenario years: 1990, 2000 and 2005. The tour-based model performed slightly better overall than the trip-based model in the regional-level comparisons. It performed better than the trip-based model, with some exceptions, in terms of vehicle ownership levels, work flow distribution, work start time distribution, and the average travel time for work trips. Neither model distinguished itself in the project-level comparison of link flows, as both models generally produced the same level of accuracy.

Through this analysis, the project team has learned firsthand the difficulties of making disaggregate model comparisons when the models have different units of travel. A major challenge is that translating the results to a common unit of travel generally causes inconsistencies except when performed at an aggregate level, because one must apply off-model rules to convert one model's data set to the other model's unit of travel. Given this challenge, definitive statements about the superiority of one model over the other are not easily made. Generally, the performance of the tour-based model in these specific tests provides evidence of the ability of these types of models to provide decision makers with better information on travel behavior. The MORPC tour-based model's vehicle ownership procedures appear to need further investigation, as they underperformed in all counties except for Franklin County.

The performance of the tour-based model in the project situations was somewhat disappointing, even if it performed about as well as the trip-based model. The results suggest that this tour-based model will not forecast better than traditional methods without additional behavioral resolution, network resolution, validation procedures or some combination thereof. It should, however, also be pointed out that the study projects selected in this analysis corresponded to land-use developments and roadway supply enhancements, not to demand-management actions. There is a need in the future to examine the performance of the trip- and tour-based models in the context of demand-management strategies.

This research effort is an important step toward a better understanding of the tangible benefits of disaggregate tour-based modeling methods. But it should be viewed as only one step. It would be imprudent to judge all model systems strictly on the results of this one project, since the transportation planning community has accumulated four decades of learning and experience on trip-based models while this particular tour-based model represents only one attempt, and one of the earliest, at implementing the tour-based or activity-based approach for practical use. Regardless, the results in this paper should serve as an important reference in the assessment of the potential practical benefits of disaggregate tour-based modeling approaches vis-à-vis aggregate trip-based methods.

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LIST OF FIGURE AND TABLES

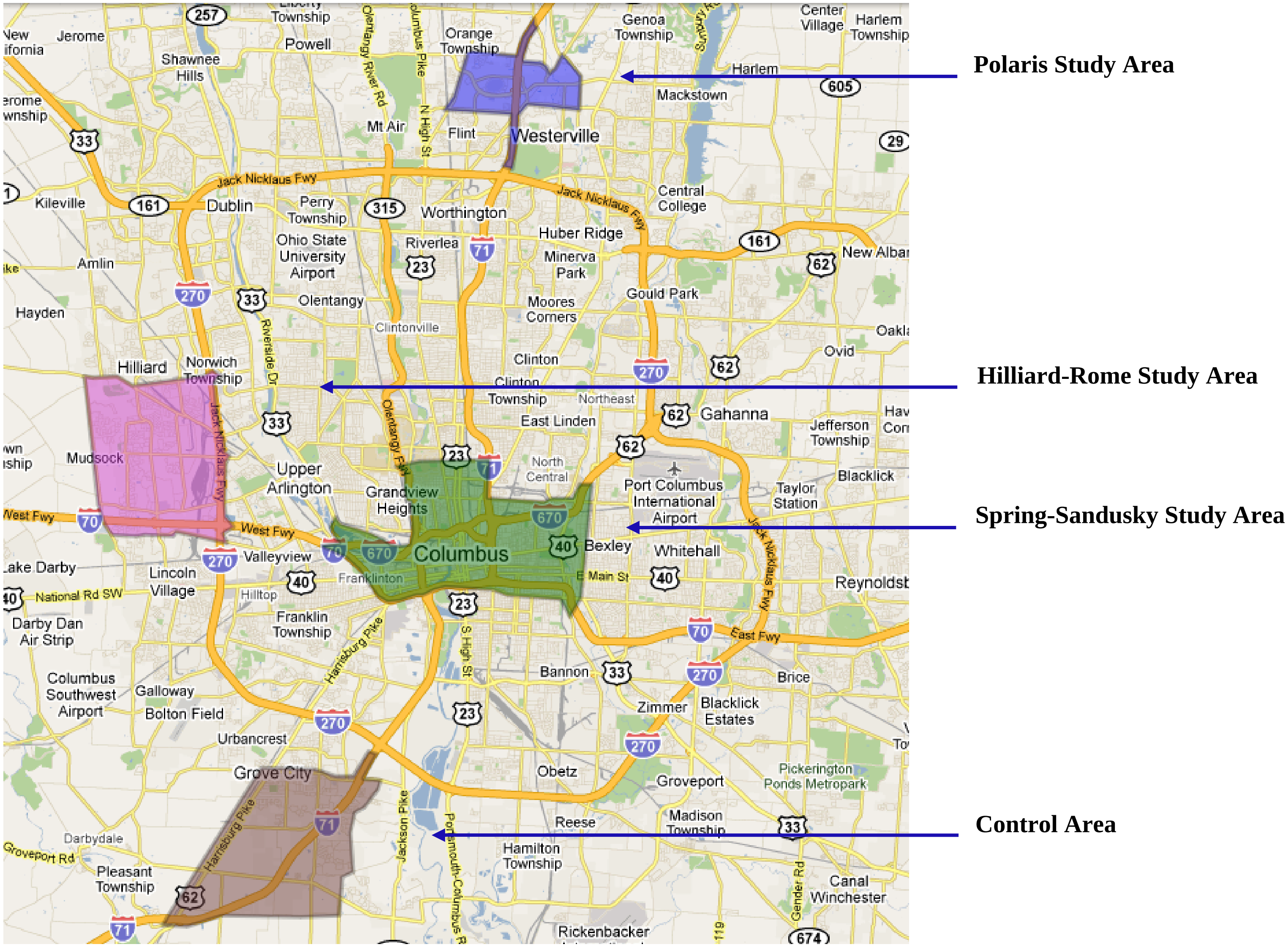

FIGURE 1 Selected study projects and control area.

TABLE 1a Vehicle Ownership Level by County – Comparison with the Census Data (Year 1990)

County	Vehicle ownership level (VOL)	Number of households in vehicle ownership level from Census	Absolute Percentage Error (APE)				Root Squared Error (RSE)			
			Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean
Delaware	**No vehicle**	918	54.36	19.07	98.79	50.65	499	1,606	907	3,796
	1 vehicle	5,363	4.34		70.70		233		3,792	
	2 vehicles	10,525	18.65		43.12		1,963		4,538	
	3+ vehicles	6,310	27.16		39.15		1,714		2,470	
Fairfield	**No vehicle**	805	32.56	31.80	10.05	34.07	262	1,425	81	2,308
	1 vehicle	3,835	32.26		0.74		1,237		29	
	2 vehicles	6,319	20.14		52.15		1,273		3,295	
	3+ vehicles	3,766	50.72		42.83		1,910		1,613	
Franklin	**No vehicle**	38,414	32.62	15.41	16.59	7.82	12,532	14,719	6,372	7,417
	1 vehicle	136,598	10.65		6.54		14,549		8,939	
	2 vehicles	147,952	9.88		2.28		14,624		3,380	
	3+ vehicles	55,759	29.86		19.61		16,650		10,936	
Licking	**No vehicle**	3,090	42.23	15.09	133.67	37.49	1,305	2,036	4,131	6,025
	1 vehicle	13,901	7.96		3.79		1,107		527	
	2 vehicles	19,644	12.56		43.67		2,468		8,578	
	3+ vehicles	10,619	21.21		42.20		2,252		4,481	
Madison	**No vehicle**	210	31.03	25.99	138.89	49.38	65	350	291	590
	1 vehicle	1,019	3.08		7.06		31		72	
	2 vehicles	1,539	17.45		36.39		268		560	
	3+ vehicles	950	63.29		96.04		601		912	
Pickaway	**No vehicle**	249	63.89	12.85	565.86	121.34	159	161	1,409	1,261
	1 vehicle	1,173	3.51		132.42		41		1,553	
	2 vehicles	1,785	1.42		22.21		25		396	
	3+ vehicles	1,006	31.41		174.28		316		1,753	
Union	**No vehicle**	186	140.59	82.69	554.21	115.67	261	914	1,030	1,119
	1 vehicle	954	83.92		128.32		800		1,224	
	2 vehicles	1,557	64.71		14.22		1,008		222	
	3+ vehicles	945	99.69		183.83		943		1,738	
Overall weighted mean error			**16.64**		**15.82**		**13,160**		**6,951**	

TABLE 1b Vehicle Ownership Level by County – Comparison with the Census Data (Year 2000)

County	Vehicle ownership level (VOL)	Number of households in vehicle ownership level from Census	Absolute Percentage Error (APE)				Root Squared Error (RSE)			
			Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean
Delaware	**No vehicle**	1,153	130.44	27.08	197.49	49.88	1,504	4,047	2,277	7,574
	1 vehicle	8,576	10.40		66.48		892		5,702	
	2 vehicles	20,294	25.50		48.33		5,174		9,808	
	3+ vehicles	9,651	32.88		20.75		3,173		2,003	
Fairfield	**No vehicle**	846	1.49	18.26	140.57	47.34	13	1,481	1,189	2,800
	1 vehicle	4,660	9.24		27.99		431		1,304	
	2 vehicles	7,855	0.35		46.33		27		3,639	
	3+ vehicles	4,810	59.20		51.35		2,847		2,470	
Franklin	**No vehicle**	37,656	55.13	15.41	13.06	7.08	20,761	16,448	4,918	7,828
	1 vehicle	168,620	10.15		4.96		17,121		8,365	
	2 vehicles	171,804	8.93		2.58		15,346		4,440	
	3+ vehicles	60,698	23.73		21.97		14,401		13,333	
Licking	**No vehicle**	3,408	25.06	9.76	161.98	31.96	854	1,763	5,520	6,158
	1 vehicle	15,580	2.82		1.59		439		248	
	2 vehicles	23,152	9.92		38.97		2,296		9,022	
	3+ vehicles	13,469	13.63		22.13		1,836		2,980	
Madison	**No vehicle**	265	7.28	24.48	182.43	49.35	19	367	483	587
	1 vehicle	1,159	8.99		16.79		104		195	
	2 vehicles	1,732	18.79		36.84		325		638	
	3+ vehicles	1,083	54.37		71.66		589		776	
Pickaway	**No vehicle**	232	17.85	17.30	1085.47	123.72	41	310	2,515	1,230
	1 vehicle	1,245	5.38		91.81		67		1,143	
	2 vehicles	2,040	6.60		55.98		135		1,142	
	3+ vehicles	1,235	46.92		87.38		579		1,079	
Union	**No vehicle**	193	186.97	95.16	853.41	126.87	361	1,374	1,648	1,468
	1 vehicle	1,115	111.85		165.02		1,248		1,841	
	2 vehicles	2,094	69.04		24.49		1,446		513	
	3+ vehicles	1,332	108.93		150.60		1,450		2,005	
Overall weighted mean error			**16.52**		**16.11**		**14,536**		**7,453**	

TABLE 1c Vehicle Ownership Level by County – Comparison with the HIS Data (Year 2000)

County	Vehicle ownership level (VOL)	Number of households in vehicle ownership level from HIS	Absolute Percentage Error (APE)				Root Squared Error (RSE)			
			Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean
Delaware	**No vehicle**	0	-	29.47	-	42.14	2,657	2,623	3,430	4,166
	1 vehicle	4,719	100.64		202.56		4,749		9,559	
	2 vehicles	12,813	18.01		18.16		2,307		2,327	
	3+ vehicles	11,364	12.85		2.55		1,460		290	
Fairfield	**No vehicle**	0	-	93.48	-	76.67	833	3,376	2,034	2,742
	1 vehicle	1,832	130.84		225.53		2,397		4,132	
	2 vehicles	4,487	74.46		6.03		3,341		271	
	3+ vehicles	3,870	97.86		88.10		3,787		3,409	
Franklin	**No vehicle**	40,236	45.19	14.01	18.64	9.99	18,181	12,195	7,498	14,274
	1 vehicle	158,956	4.69		11.34		7,457		18,029	
	2 vehicles	162,742	3.86		8.30		6,284		13,502	
	3+ vehicles	49,410	51.99		4.14		25,689		2,045	
Licking	**No vehicle**	2,868	48.61	9.42	211.30	34.53	1,394	1,310	6,060	5,477
	1 vehicle	14,715	2.90		7.56		426		1,113	
	2 vehicles	21,886	4.71		35.44		1,030		7,756	
	3+ vehicles	13,193	16.01		24.68		2,112		3,256	
Madison	**No vehicle**	114	149.12	192.46	555.88	180.17	170	1,097	634	865
	1 vehicle	217	482.03		523.68		1,046		1,136	
	2 vehicles	747	175.37		46.43		1,310		347	
	3+ vehicles	726	130.30		156.11		946		1,133	
Pickaway	**No vehicle**	0	-	91.10	-	184.22	273	899	2,746	1,730
	1 vehicle	760	72.63		214.20		552		1,628	
	2 vehicles	900	141.67		253.63		1,275		2,283	
	3+ vehicles	1,114	62.84		107.69		700		1,200	
Union	**No vehicle**	0	-	2.23	-	25.60	554	69	1,841	785
	1 vehicle	2,244	5.30		31.73		119		712	
	2 vehicles	3,583	1.20		27.24		43		976	
	3+ vehicles	2,813	1.10		18.62		31		524	
Overall weighted mean error			**16.81**		**17.40**		**10,921**		**12,905**	

TABLE 1d Vehicle Ownership Level by County – Comparison with the ACS Data (Year 2005)

County	Vehicle ownership level (VOL)	Number of households in vehicle ownership level from ACS	Absolute Percentage Error (APE)				Root Squared Error (RSE)			
			Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean	By VOL	Wtd. Mean
Delaware	No vehicle	1,040	187.12	23.69	153.13	56.64	1,946	5,124	1,593	11,991
	1 vehicle	12,325	0.20		72.51		25		8,937	
	2 vehicles	26,856	24.71		57.74		6,637		15,508	
	3+ vehicles	13,196	30.65		31.97		4,044		4,219	
Fairfield	No vehicle	910	9.01	17.86	184.12	56.18	82	1,675	1,676	3,345
	1 vehicle	4,624	4.16		58.65		193		2,712	
	2 vehicles	8,813	0.58		46.45		51		4,093	
	3+ vehicles	5,390	59.35		48.38		3,199		2,608	
Franklin	No vehicle	31,839	96.97	14.03	7.35	11.19	30,874	12,929	2,339	17,722
	1 vehicle	166,746	2.07		8.76		3,448		14,603	
	2 vehicles	181,284	6.14		12.84		11,139		23,272	
	3+ vehicles	67,010	25.70		14.62		17,224		9,799	
Licking	No vehicle	2,958	60.55	11.46	243.85	35.73	1,791	2,089	7,213	7,707
	1 vehicle	14,696	6.50		14.39		955		2,115	
	2 vehicles	24,432	12.18		47.56		2,975		11,621	
	3+ vehicles	17,174	6.22		1.31		1,068		225	
Overall weighted mean error			**14.79**		**19.43**		**11,486**		**16,186**	

TABLE 2a Work Flow Distribution by County – Comparison with the Census Data (Year 1990)

Origin county	Destination										Overall Weighted Mean Absolute Percentage Error (OWMAPE) by origin county		Overall Weighted Mean Root Squared Error (OWMRSE) by origin county	
	Within origin county					Outside origin county								
	Census flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)		Census flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)					
		Trip-based model	Tour-based model	Trip-based model	Tour-based model		Trip-based model	Tour-based model	Trip-based model	Tour-based model	Trip-based model	Tour-based model	Trip-based model	Tour-based model
Delaware	14.00	80.97	87.33	11,336	12,226	18.90	55.97	51.23	10,579	9,682	66.61	66.59	10,907	10,838
Fairfield	9.24	85.44	91.32	7,895	8,438	9.84	97.97	94.82	9,640	9,330	91.90	93.12	8,838	8,909
Franklin	464.10	1.69	0.83	7,833	3,861	20.20	74.45	61.27	15,038	12,377	4.72	3.35	8,260	4,547
Licking	39.40	12.64	10.04	4,978	3,957	19.00	28.06	6.26	5,332	1,190	17.65	8.81	5,096	3,320
Madison	2.17	100.00	100.00	2,170	2,170	2.85	140.69	126.39	4,013	3,605	123.11	114.99	3,343	3,068
Pickaway	2.65	100.00	100.00	2,646	2,646	2.62	137.77	126.00	3,608	3,300	118.79	112.93	3,161	2,989
Union	3.14	100.00	100.00	3,135	3,135	1.75	394.63	346.86	6,902	6,067	205.51	188.40	4,834	4,415
Total flow/overall weighted mean error	**534.70**	**7.48**	**6.81**	**7,722**	**4,399**	**75.16**	**73.33**	**60.60**	**10,510**	**8,844**	**15.59**	**13.44**	**8,117**	**5,158**

TABLE 2b Work Flow Distribution by County – Comparison with the Census Data (Year 2000)

Origin county	Destination										Overall Weighted Mean Absolute Percentage Error (OWMAPE) by origin county		Overall Weighted Mean Root Squared Error (OWMRSE) by origin county	
	Within origin county					Outside origin county								
	Census flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)		Census flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)					
		Trip-based model	Tour-based model	Trip-based model	Tour-based model		Trip-based model	Tour-based model	Trip-based model	Tour-based model	Trip-based model	Tour-based model	Trip-based model	Tour-based model
Delaware	21.10	1.87	16.93	395	3,572	36.30	6.23	1.05	2,260	382	4.63	6.89	1,813	2,187
Fairfield	10.68	56.51	71.16	6,035	7,600	13.36	86.41	91.65	11,544	12,244	73.13	82.55	9,500	10,439
Franklin	508.40	0.32	1.70	1,624	8,658	37.30	31.38	11.64	11,704	4,340	2.44	2.38	3,438	8,433
Licking	42.40	15.47	17.75	6,560	7,525	28.40	28.92	12.13	8,212	3,445	20.86	15.49	7,268	6,218
Madison	2.36	38.60	65.50	909	1,543	3.16	79.64	93.18	2,518	2,946	62.12	81.36	1,997	2,448
Pickaway	2.65	25.96	57.28	687	1,516	3.24	60.23	80.77	1,951	2,617	44.82	70.21	1,519	2,192
Union	3.86	60.56	37.66	2,338	1,454	2.87	100.19	122.07	2,876	3,505	77.46	73.66	2,581	2,540
Total flow/overall weighted mean error	**591.45**	**3.14**	**5.39**	**2,461**	**8,368**	**124.63**	**32.95**	**23.65**	**8,520**	**5,014**	**8.33**	**8.57**	**4,200**	**7,887**

TABLE 2c Work Trip Flow Distribution by County – Comparison with the HIS Data (Year 2000)

Origin county	Destination county	HIS flow (in 1000s of trips)	Absolute Percentage Error (APE)				Root Squared Error (RSE)			
			Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			Destination county	Wtd. Mean	Destination county	Wtd. Mean	Destination county	Wtd. Mean	Destination county	Wtd. Mean
Delaware	Delaware	13.08	47.59	24.08	25.34	11.80	6,223	4,979	3,313	2,136
	Fairfield	0.00	-		-		54		58	
	Franklin	33.23	13.57		4.48		4,508		1,489	
	Licking	0.25	183.37		163.00		467		415	
	Madison	0.00	-		-		208		272	
	Pickaway	0.00	-		-		27		42	
	Union	1.12	25.10		36.52		280		408	
Fairfield	Delaware	0.39	38.12	79.17	38.93	96.77	149	6,880	152	8,001
	Fairfield	4.85	14.09		40.67		684		1,974	
	Franklin	10.03	86.53		99.86		8,681		10,018	
	Licking	0.19	1409.89		1512.40		2,633		2,824	
	Madison	0.59	95.67		96.08		562		564	
	Pickaway	0.00	-		-		543		612	
	Union	0.00	-		-		19		8	
Franklin	Delaware	20.54	38.97	7.07	16.33	4.70	8,003	24,379	3,353	15,249
	Fairfield	1.58	35.10		95.45		554		1,508	
	Franklin	483.00	5.19		3.25		25,053		15,689	
	Licking	2.94	31.95		30.65		939		901	
	Madison	1.21	26.33		90.13		319		1,093	
	Pickaway	0.75	80.56		194.44		605		1,461	
	Union	2.29	32.26		4.13		738		94	

TABLE 2c (continued) Work Trip Flow Distribution by County – Comparison with the HIS Data (Year 2000)

Origin county	Destination county	HIS flow (in 1000s of trips)	Absolute Percentage Error (APE)				Root Squared Error (RSE)			
			Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			Destination county	Wtd. Mean	Destination county	Wtd. Mean	Destination county	Wtd. Mean	Destination county	Wtd. Mean
Licking	Delaware	0.91	2.17	10.43	68.57	14.18	20	3,880	624	3,162
	Fairfield	0.55	28.02		149.76		155		827	
	Franklin	14.21	15.39		42.47		2,187		6,036	
	Licking	48.27	8.92		3.28		4,305		1,581	
	Madison	0.00	-		-		26		20	
	Pickaway	0.00	-		-		61		108	
	Union	0.00	-		-		43		45	
Madison	Delaware	0.25	40.16	118.70	5.62	143.62	101	2,217	14	2,523
	Fairfield	0.00	-		-		8		5	
	Franklin	1.45	218.27		247.02		3,175		3,593	
	Licking	0.00	-		-		13		14	
	Madison	1.20	8.36		36.59		100		439	
	Pickaway	0.00	-		-		49		84	
	Union	0.08	206.14		296.87		169		243	
Pickaway	Delaware	0.00	-	98.65	-	98.63	43	1,710	38	2,322
	Fairfield	0.10	40.63		7.53		42		8	
	Franklin	2.62	70.83		99.83		1,856		2,616	
	Licking	0.00	-		-		41		30	
	Madison	0.16	83.71		68.22		132		107	
	Pickaway	0.48	269.41		121.97		1,283		581	
	Union	0.00	-		-		13		10	
Union	Delaware	0.55	13.85	29.55	141.14	31.76	76	1,076	773	843
	Fairfield	0.00	-		-		3		1	
	Franklin	4.01	4.20		7.09		168		284	
	Licking	0.00	-		-		13		17	
	Madison	1.85	81.61		82.55		1,511		1,528	
	Pickaway	0.00	-		-		7		10	
	Union	4.19	32.85		18.62		1,376		780	
Total flow/overall weighted mean error		**656.92**	**11.73**		**9.94**		**21,633**		**13,575**	

TABLE 2d Work Flow Distribution by County – Comparison with the ACS Data (Year 2005)

Origin county	Destination										Overall Weighted Mean Absolute Percentage Error (OWMAPE) by origin county		Overall Weighted Mean Root Squared Error (OWMRSE) by origin county	
	Within origin county					Outside origin county								
	ACS flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)		ACS flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)					
		Trip-based model	Tour-based model	Trip-based model	Tour-based model		Trip-based model	Tour-based model	Trip-based model	Tour-based model	Trip-based model	Tour-based model	Trip-based model	Tour-based model
Delaware	28.29	4.67	21.52	1,321	6,088	45.73	9.78	3.76	4,472	1,719	7.83	10.55	3,609	3,999
Fairfield	12.36	55.08	69.58	6,808	8,602	14.51	69.94	78.91	10,151	11,453	63.10	74.62	8,773	10,241
Franklin	471.31	6.49	4.45	30,579	20,959	44.68	42.64	28.28	19,051	12,635	9.62	6.51	29,758	20,373
Licking	40.82	4.93	4.84	2,013	1,974	32.90	21.47	4.24	7,065	1,395	12.31	4.57	4,951	1,740
Total flow/overall weighted mean error	**552.78**	**7.37**	**6.81**	**28,261**	**19,452**	**137.82**	**29.56**	**19.74**	**12,127**	**8,186**	**11.80**	**9.39**	**25,858**	**17,783**

TABLE 3 Work Flow Distribution by Trip Start Time – Comparison with the Census/ACS Data

Origin county	Peak period					Off-peak period				
	Census/ ACS flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)		Census/ ACs flow (in 1000s)	Absolute Percentage Error (APE)		Root Squared Error (RSE)	
		Trip-based model	Tour-based model	Trip-based model	Tour-based model		Trip-based model	Tour-based model	Trip-based model	Tour-based model
Comparison with the Census Data - Year 1990										
Delaware	22.37	10.93	18.71	2,446	4,185	10.53	16.04	15.59	1,689	1,641
Fairfield	12.00	7.59	0.76	911	91	7.08	11.79	13.90	835	984
Franklin	336.38	12.07	9.71	40,587	32,646	147.92	22.57	16.31	33,381	24,131
Licking	36.00	0.03	9.89	12	3,562	22.40	1.52	7.08	341	1,586
Madison	3.15	35.07	19.29	1,105	608	1.87	39.41	44.20	737	827
Pickaway	3.24	19.13	6.37	620	206	2.02	16.90	22.10	342	447
Union	2.89	85.66	59.39	2,475	1,716	2.00	64.77	60.94	1,292	1,216
Overall weighted mean error		**11.57**	**10.34**	**36,500**	**29,390**	-	**19.93**	**15.91**	**29,166**	**21,093**
Comparison with the Census Data - Year 2000										
Delaware	41.13	16.30	18.16	6,703	7,468	16.27	29.75	26.31	4,838	4,279
Fairfield	14.88	23.15	18.78	3,444	2,794	9.16	22.53	20.20	2,065	1,851
Franklin	366.76	9.45	7.31	34,671	26,808	178.94	13.74	7.72	24,591	13,811
Licking	42.70	0.39	8.93	168	3,813	28.10	6.48	0.95	1,821	267
Madison	3.32	33.09	26.39	1,099	876	2.20	23.21	23.97	510	527
Pickaway	3.51	26.37	15.93	925	559	2.38	14.27	22.82	339	543
Union	3.98	85.99	81.15	3,424	3,232	2.75	65.10	62.80	1,790	1,727
Overall weighted mean error		**10.59**	**9.56**	**30,496**	**23,662**	-	**14.99**	**9.59**	**21,294**	**11,990**
Comparison with the ACS Data - Year 2005										
Delaware	52.40	19.28	21.03	10,104	11,022	21.61	19.95	14.88	4,311	3,216
Fairfield	16.03	16.87	15.90	2,705	2,549	10.84	5.88	2.79	637	302
Franklin	347.34	5.84	3.75	20,275	13,036	168.66	18.86	12.67	31,803	21,360
Licking	43.79	8.47	1.18	3,707	515	29.94	17.94	9.53	5,370	2,854
Overall weighted mean error		**8.01**	**5.90**	**17,997**	**11,939**	-	**18.23**	**12.00**	**27,272**	**18,305**

TABLE 4 Travel Time for Work Trips – Comparison with the Census Data (Year 1990)

Origin county	Census/ACS average travel time from origin county (in mins)	Absolute Percentage Error (APE)		Root Squared Error (RSE)	
		Trip-based model	Tour-based model	Trip-based model	Tour-based model
Comparison with the Census Data - Year 1990					
Delaware	22.74	28.88	30.70	6.57	6.98
Fairfield	24.75	10.94	16.19	2.71	4.01
Franklin	20.04	37.61	16.36	7.54	3.28
Licking	22.1	28.87	10.48	6.38	2.32
Madison	22.75	8.04	10.96	1.83	2.49
Pickaway	23.72	15.83	17.41	3.76	4.13
Union	20.97	50.82	46.83	10.66	9.82
Overall weighted mean error		**35.14**	**16.77**	**7.25**	**3.63**
Comparison with the Census Data - Year 2000					
Delaware	25.45	20.46	19.38	5.21	4.93
Fairfield	26.95	1.73	2.19	0.47	0.59
Franklin	21.41	26.74	21.53	5.73	4.61
Licking	24.12	20.32	22.70	4.90	5.48
Madison	25.01	7.11	7.15	1.78	1.79
Pickaway	26.19	9.13	4.72	2.39	1.24
Union	22.29	15.80	17.66	3.52	3.94
Overall weighted mean error		**24.36**	**20.54**	**5.45**	**4.62**
Comparison with the ACS Data - Year 2005					
Delaware	22.87	11.16	10.88	2.55	2.49
Fairfield	25.04	3.08	5.68	0.77	1.42
Franklin	18.76	15.93	11.69	2.99	2.19
Licking	24.28	9.02	11.67	2.19	2.83
Overall weighted mean error		**14.18**	**11.37**	**2.81**	**2.28**

TABLE 5 Project Level Link Volume Comparison by Roadway Functional Class

Study project	Year	Roadway functional class	Survey data		Absolute Percentage Error (APE)				Percentage Root Mean Squared Error (%RMSE)			
					Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			Number of links	Total link flow (vehs/day)	By roadway functional class	Wtd. Mean	By roadway functional class	Wtd. Mean	By roadway functional class	Wtd. Mean	By roadway functional class	Wtd. Mean
Polaris	1990	Freeway (interstate)	2	40,400	20.73	41.82	6.01	32.09	30.73	57.09	8.87	45.15
		Major roads (arterials)	6	9,410	81.36		93.69		93.87		112.97	
		Minor roads (collectors)	10	23,724	62.07		52.06		87.37		80.03	
	2000	Freeway (interstate)	4	168,300	10.45	22.13	8.45	23.31	12.92	29.22	11.88	28.59
		Major roads (arterials)	16	233,980	29.19		34.63		38.87		41.46	
		Minor roads (collectors)	8	42,438	29.47		19.78		40.64		23.97	
	2005	Freeway (interstate)	8	369,782	14.58	23.33	12.63	22.16	22.69	31.50	14.79	28.92
		Major roads (arterials)	26	343,350	28.27		28.28		35.92		39.26	
		Minor roads (collectors)	10	62,205	48.06		45.04		59.43		55.85	
Hilliard-Rome	1990	Freeway (interstate)	8	223,220	13.79	22.14	7.22	21.08	15.76	27.15	8.54	26.66
		Major roads (arterials)	42	388,064	22.27		24.90		26.41		30.70	
		Minor roads (collectors)	48	102,948	37.82		34.77		52.51		48.46	
		Local roads	4	2,808	92.04		94.44		106.36		109.09	
	2000	Freeway (interstate)	10	526,542	6.60	20.29	12.70	19.64	7.67	25.05	16.10	25.04
		Major roads (arterials)	52	570,258	26.47		19.89		33.45		26.21	
		Minor roads (collectors)	58	236,552	31.27		30.13		38.17		37.12	
		Local roads	10	15,406	90.67		86.32		106.88		102.05	
	2005	Freeway (interstate)	10	556,698	10.98	21.98	8.45	19.14	13.37	28.39	13.22	25.22
		Major roads (arterials)	65	803,945	24.07		19.57		32.20		25.26	
		Minor roads (collectors)	76	398,680	29.11		29.34		37.44		37.63	
		Local roads	14	23,206	90.90		85.58		101.51		98.23	

TABLE 5 (continued) Project Level Link Volume Comparison by Roadway Functional Class

Study project	Year	Roadway functional class	Survey data		Absolute Percentage Error (APE)				Percentage Root Mean Squared Error (%RMSE)			
					Trip-based model		Tour-based model		Trip-based model		Tour-based model	
			Number of links	Total link flow (vehs/day)	By roadway functional class	Wtd. Mean	By roadway functional class	Wtd. Mean	By roadway functional class	Wtd. Mean	By roadway functional class	Wtd. Mean
Spring-Sandusky	1990	Freeway (interstate)	39	1,704,739	11.95	32.62	24.87	35.73	15.20	41.71	29.71	45.40
		Expressway	10	481,194	5.10		17.90		7.17		20.83	
		On ramp	1	26,759	0.58		0.80		0.00		0.00	
		Major roads (arterials)	412	3,992,054	39.13		37.69		49.70		48.48	
		Minor roads (collectors)	103	435,751	60.47		56.67		76.33		73.59	
		Local roads	68	197,460	89.57		91.80		122.53		122.45	
	2005	Freeway (interstate)	42	2,364,702	11.00	27.36	17.34	29.13	14.69	36.21	21.85	37.93
		Expressway	10	448,944	25.45		31.50		34.19		41.45	
		On ramp	2	50,392	19.35		12.93		27.59		18.31	
		Off ramp	2	12,129	50.61		47.55		86.99		89.97	
		Major roads (arterials)	491	4,657,741	32.28		31.65		42.78		41.59	
		Minor roads (collectors)	135	530,099	47.45		47.06		60.34		58.36	
		Local roads	85	174,870	62.24		64.23		83.38		88.63	
Control Area	1990	Freeway (interstate)	6	128,604	7.86	20.33	4.65	26.91	8.90	25.04	6.21	30.43
		Major roads (arterials)	43	179,585	24.14		37.31		30.91		41.47	
		Minor roads (collectors)	14	16,496	66.18		78.09		71.45		83.59	
		Local roads	6	4,330	58.24		61.84		84.05		89.38	
	2000	Freeway (interstate)	6	175,990	7.23	16.27	7.18	17.97	8.48	19.97	8.33	22.37
		Major roads (arterials)	30	161,454	20.55		24.67		26.27		31.46	
		Minor roads (collectors)	12	16,742	60.89		57.13		68.90		68.33	
		Local roads	13	2,854	69.58		74.90		84.50		105.30	
	2005	Freeway (interstate)	8	253,258	8.30	25.22	10.05	25.90	11.22	37.07	12.04	37.82
		Major roads (arterials)	58	359,703	28.92		28.89		37.42		38.47	
		Minor roads (collectors)	24	67,545	60.19		58.24		116.94		114.99	
		Local roads	24	21,820	52.30		60.62		83.99		87.67	
Overall weighted mean error	1990	-	-	-	**31.26**		**34.01**		**39.85**		**43.09**	
	2000	-	-	-	**20.00**		**20.12**		**25.07**		**25.33**	
	2005	-	-	-	**26.13**		**26.91**		**34.73**		**35.34**	