Project No. NCDOT 3205

TRIP MAKING PATTERNS OF NC'S UNIVERSITY STUDENTS

FINAL REPORT

Technical Report B: Model Development

Prepared for

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I. Executive Summary

This report documents the university student travel models that were developed based on the university student travel surveys conducted on six university campuses in North Carolina during 2013 and 2014. Recommendations for applying these models to other universities are also provided.

Some trips collected in the surveys were removed from the modeling efforts so that emphasis could be placed on the modeling of university student trips that most affect the surrounding road system. The trips removed include trips with both trip ends on campus, non-motorized trips and trips with at least one end outside of the region where the studied university is located. The remainder of the trips were further divided into four groups for modeling purposes:

1) crossing the university boundary trips made by students living off campus (called off- crossing trips);
2) outside of the university trips made by students living off campus (called off-outside trips);
3) crossing the university boundary trips made by students living on campus (called on-crossing trips); and
4) outside of the university trips made by students living on campus (called on-outside trips).

For each group of university student trips, models were developed for trip generation, trip distribution and mode choice. The final output is the motorized Origin Destination (OD) trip matrix by mode (auto or transit). Please note that while models developed are daily models, time of day factors have been developed using the survey data to apply to matrices prior to adding them to the travel model for assignment by time period. These OD matrices can be added to the corresponding OD matrices from a local travel demand model for traffic assignment or transit assignment to evaluate the impact of university student trips.

In trip generation, it is suggested to use a cross-classification model, in which stratified production rates are multiplied by the number of students enrolled in a university by student stratification to calculate the control total of trip productions. The zonal trip production can be obtained by disaggregating the control total to each campus zone based on zonal characteristics for off-crossing and on-crossing trips; or to each non-campus zone based on its distance to campus and zonal characteristics for off-outside and on-outside trips.

In trip distribution, it is suggested to use a gravity model. For off-crossing trips, the six surveyed universities are divided into three groups based on the proportion of part-time students, and a Gamma function is developed for each group. For off-outside, on-crossing and on-outside trips, only one Gamma function is developed. The gravity model is singly constrained to productions for off-crossing and on-crossing trips, and is doubly constrained for off-outside and on-outside trips. The average trip distance and travel time are also summarized to be used as calibration targets.

To determine mode shares, it is suggested that a logit-based choice model be used for off-crossing trips. Several logit-based mode choice models were developed in this study from which one can be chosen. The chosen logit model should be calibrated based on an overall transit share before being applied for

forecasting. The overall share can be estimated using a regression model developed in this study or can be chosen from a set of values derived from the surveys with adjustments as necessary. For on-outside trips, transit shares derived from the surveys can be employed with reasonable adjustments. On-crossing and off-outside trips can use either the more sophisticated off-crossing approach or the more straight-forward on-outside approach.

II. Design of the University Student Travel Models

A. Grouping of the Trips for the Modeling Purpose

Traditional travel demand models group trips based on trip purposes, and each trip purpose would be modeled separately. Following the same method, four trip purposes can be defined for university students. They are Home Based University (HBU) trips, Home Based Other (HBO) trips, University Based Non-Home (UBNH) trips and Non-Home Non-University (NHNU) trips. These four trip purposes actually consist of five types of trips, which are shown in Figure 1.

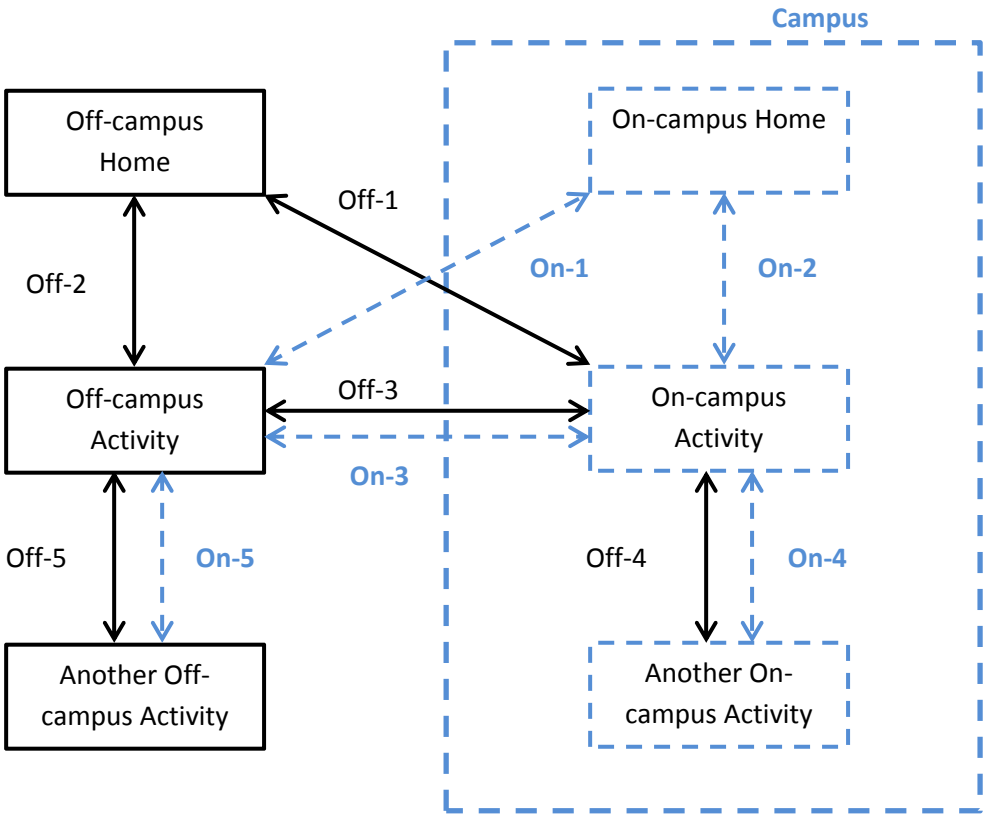


Figure 1 Illustration of Trip Types

In Figure 1, trip ends are represented as boxes: boxes with solid black borders for off-campus trip ends, and boxes with blue dashed line borders for on-campus trip ends. The lines linking these boxes represent

the trips between these trip ends. The trips made by off-campus students are represented in solid black lines and on-campus students in dashed blue lines. Trips are numbered as Off-1 to Off-5, and On-1 to On-5 in Figure 1. These numbers are used to differentiate trips, and they do not indicate trip sequences. Although not all possible trips are shown in Figure 1, Figure 1 covers all types of trips. These trips are summarized in Table 1.

Table 1 Summary of Trip Types

Student Type	ID	Description	Characteristics
Off-campus Student	Off-1	Between home and university	Crossing the university boundary
	Off-2	Between home and non-university	Outside of the university
	Off-3	Between university and non-university	Crossing the university boundary
	Off-4	Within university	Within the university
	Off-5	No trip end is home or university	Outside of the university
On-campus Student	On-1	Between home and non-university	Crossing the university boundary
	On-2	Between home and university	Within the university
	On-3	Between university and non-university	Crossing the university boundary
	On-4	Within university	Within the university
	On-5	No trip end is home or university	Outside of the university

Table 2 is the correspondence table of trip purposes and trip types. It shows that each trip purpose corresponds to a trip type, except for the UBNH trips. For both off-campus and on-campus students, UBNH trips could be trips between a university activity and a non-university activity (Off-3 and On-3), and they could be trips between two university activities (Off-4 and On-4).

Table 2 Summary of Trip Purposes

ID	Trip Purpose	Off-campus Student	On-campus Student
1	HBU (Home Based University)	Off-1	On-2
2	HBO (Home Based Other)	Off-2	On-1
3	UBNH (University Based Non-home)	Off-3, Off-4	On-3, On-4
4	NHNU (Non-home Non-university)	Off-5	On-5

There are two issues for using the trip purposes shown in Table 2 to model the university students:

1) The two trip types for UBNH have quite different characteristics in trip distribution and mode choice, as supported by the survey results shown in Technical Report A – Survey Documentation. Off-3 and On-3 trips are trips between a university activity and a non-university activity. They are usually much longer and many fewer take non-motorized modes than Off-4 and On-4, which are trips between two university activities. Therefore, it is better not to group and model these two types of trips together.
2) With four trip purposes and two student types (off-campus students and on-campus students), there would be eight models to develop for each model step. This not only requires more survey samples to support the model development, which might not be available for some trip

purposes, but also imposes a lot of burdens on the model application. Therefore, it is better to group the trips into fewer categories.

A way to group the trips based on the trip ends was proposed: trips crossing the university boundary; trips within the university; and trips outside of the university. Table 3 shows the correspondence table of trip classifications and trip types.

Table 3 Summary of Trip Classifications

ID	Trip Classifications	Off-campus Student	On-campus Student
1	Crossing the university boundary	Off-1, Off-3	On-1, On-3
2	Within the university	Off-4	On-2, On-4
3	Outside of the university	Off-2, Off-5	On-5

The survey results in Technical Report A: Survey Documentation show that the travel characteristics for trips in the same trip classification are similar. In addition, during the kickoff meeting held on October 11, 2012, NCDOT indicated that university student trips that most affect the surrounding road system were of most interest. Therefore, the university student travel models focus on modeling "crossing the university boundary" trips and "outside of the university" trips. With two trip classifications and two student types, there would be four models to develop, instead of eight if trip purposes are used.

In summary, the university student travel models group trips to "crossing the university boundary" trips and "outside of the university" trips. They were used in the following model development work.

For "crossing the university boundary" trips, trip production ends are defined to be the campus ends, and trip attraction ends are the non-campus ends. For "outside of the university" trips, trip production ends are defined to be the trip origin ends, and trip attraction ends are the trip destination ends, which is the same as the Non-Home Non-Work (NHNW) trip in traditional travel demand models.

B. Scope of the University Student Travel Models

The goal of this project is to model the university student trips that most affect the surrounding road system. Since non-motorized trips are usually not a concern for the road system, it is suggested to model the motorized trips only. Other advantages for doing this include:

1) Motorized trip rates are more robust than total trip rates. When students answered the survey questions, it is possible that they did not report some trips either because they thought these trips were not important to the study (such as on-campus trips or non-motorized trips), or because they forgot these trips (usually short trips or non-motorized trips). Non-motorized trips are much more likely to be missing than motorized trips, so motorized trip rates are more robust than total trip rates, which are the sum of motorized and non-motorized trip rates.
2) Motorized trips and non-motorized trips are quite different in the characteristics of trip distribution. So modeling motorized trips directly yields more accurate trip distributions than modeling a mixture of motorized trips and non-motorized trips.

3) When only motorized trips are modeled, mode share models only need to split trips among different motorized modes. This approach could yield more accurate results since it does not need to consider the shares of non-motorized trips, which could be quite different for different universities (one reason is that some students fail to report their non-motorized trips, as mentioned in Item 1).

The university student travel models will also focus only on trips with both trip ends in the model study area (internal to internal trips). Most of the trips made by university students do have both trip ends inside the model study area.

C. How to Fit University Student Travel Models in a Local Travel Demand Model

The university student travel models presented in this report include models of trip generation, trip distribution and mode choice for university students (stratified as off-campus students and on-campus students). The final output is the motorized Origin Destination (OD) trip matrix by mode (auto or transit). These OD matrices can be added to the corresponding OD matrices from a local travel demand model for traffic assignment or transit assignment to evaluate the impact of university student trips.

However, caution is needed to avoid double-counting the trips made by off-campus students. Off-campus students live off-campus, and they are counted as household population in the census. So in most travel demand models, they have already been counted in the zonal population in the socio-economic data, and their trips have already been modeled based on the assumption that the household characteristics and travel behaviors of off-campus students are the same as the non-student population. Therefore, if the off-campus student trips from the university student travel models are added to a local travel demand model, the trips made by off-campus students are doubly counted.

The ideal way to avoid double-counting the off-campus student trips is to separate the off-campus students from the non-student population before the step of trip generation, either by collecting data from the field, or by developing an off-campus student residence location model (such as in the Triangle Regional Model). However, this requires substantial effort and the improvement to the model might be marginal (especially for regions where university student trips are trivial).

An approximate way to address this issue is to keep all trips from a local travel demand model, but add some trips to better represent the trips made by off-campus students. As discussed in Section II.A, the university student travel models will model “crossing the university boundary” trips and “outside of the university” trips for off-campus students. “Outside of the university” trips are trips with both trip ends outside of the university, and off-campus students’ travel behaviors are close to the non-student population for this trip classification. On the other hand, “crossing the university boundary” trips have one trip end on campus, which are trips that the non-student population usually do not make. So “crossing the university boundary” trips are more likely to be the trips that are missed in a local travel demand model, and they should be added.

In summary, it is suggested to only add the "crossing the university boundary" trips to a local travel demand model for the off-campus students. However, this report presents the models for both "crossing the university boundary" trips and "outside of the university" trips, in case they are needed by some model developers.

On-campus students live on campus, and they are counted as group quarters population in the census. Therefore, they are easy to separate from the non-student population. It is suggested to use the university student travel models in this report to model the "crossing the university boundary" trips and "outside of the university" trips for on-campus students, and add them to a local travel demand model.

III. Trip Generation

Based on the literature review, it is suggested to use a cross-classification model for trip productions, in which stratified production rates are multiplied by the number of students in a university by student stratification to calculate trip productions. The university students are stratified as off-campus students and on-campus students. On-campus students live in the university owned or operated properties, including dormitories, apartments and fraternity and sorority houses. Off-campus students are the rest of the students, and they live off campus.

A. Crossing the University Boundary Trips made by Off-campus students

Table 4 shows the production rates for the "crossing the university boundary trips" made by off-campus students (called off-crossing trips) collected from all six universities. In this table and the remainder of this report, NCSU stands for North Carolina State University, UNCG stands for University of North Carolina at Greensboro, ASU stands for Appalachian State University, FSU stands for Fayetteville State University, UNCW stands for University of North Carolina at Wilmington, and UNCC stands for University of North Carolina at Charlotte. Please notice that the numbers shown in Table 4 are based on motorized internal to internal (I-I) trips only.

Table 4 Production Rate for Crossing the University Boundary Trips by Off-campus Students

	Number of Student Samples	Number of Trip Samples	Weighted Average Production Rate	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
NCSU	192	361	1.98	1.80	2.16
UNCG	295	426	1.41	1.25	1.56
ASU	183	341	1.93	1.70	2.17
FSU	188	326	1.61	1.40	1.81
UNCW	562	961	1.72	1.59	1.84
UNCC	1,122	1,882	1.70	1.62	1.77

Table 4 shows the number of student samples, the weighted average production rate, and the 95% confidence interval of the average production rate. The procedure for calculating the weights is described in section VII. D. Data Weighting in "Technical Report A: Survey Documentation." In Table 4, the average production rate varies for different universities. Hypothesis testing shows that some of the average production rates are significantly different, for example, UNCG is significantly lower than NCSU.

Intuitively, the production rate of motorized off-crossing trips is related to the level of transit service around campus and how difficult it is to get an on-campus parking permit. When a university provides good transit service to connect the surrounding area to campus (such as NCSU and ASU), it is easier for off-campus students to make motorized off-crossing trips, so the off-crossing production rate is higher. Similarly, higher ownership of on-campus parking permits induces more motorized off-crossing trips. The survey results show that 62% to 72% of FSU, UNCW and UNCC off-campus students own on-campus parking permits, whereas it is only 34% for UNCG. Based on the level of transit service and the on-campus parking permit ownership, the six surveyed universities can be divided into three groups. Within each group, hypothesis testing shows that the average production rates are not significantly different. The average production rate for each group is shown in Table 5.

Table 5 Grouped Production Rate for Crossing the University Boundary Trips by Off-campus Students

Group	Criteria for Group	Example	Number of Student Samples	Average Production Rate
1	Good transit service around campus	NCSU, ASU	375	1.97
2	Plenty parking for off-campus students	FSU, UNCW and UNCC	1,872	1.69
3	Limited parking for off-campus students	UNCG	295	1.41
All	If cannot fit into one of the three groups		2,542	1.75

In a travel demand model, the total number of off-crossing trips can be calculated as the number of off-campus students in the university multiplied by the corresponding average production rate. For the six surveyed universities, Table 4 can be used; and for universities that were not surveyed for the project, Table 5 can be used. When determining the group to which a university belongs, good transit service around campus is a more important factor than the on-campus parking permit ownership: the surveys show that 42% and 21% of NCSU and ASU off-campus students have an on-campus parking permit, which are lower than for FSU, UNCW or UNCC, but they have a higher off-crossing production rate due to good transit service around the campus. If it is difficult to classify a university into one of the three groups, it is suggested to use the trip production rate developed based on all six surveyed universities, as shown in the last row of Table 5.

To obtain the zonal trip production, the total off-crossing trips produced in a university can be disaggregated to each campus zone (TAZ) based on zonal characteristics, such as employment or building square footage.

B. Crossing the University Boundary Trips made by On-campus students

Table 6 shows the production rates for the “crossing the university boundary trips” made by on-campus students (called on-crossing trips) collected from all six universities. Again, the numbers shown in Table 6 are based on motorized internal to internal (I-I) trips only.

Table 6 Production Rate for Crossing the University Boundary Trips by On-campus Students

	Number of Student Samples	Number of Trip Samples	Weighted Average Production Rate	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
NCSU	144	100	0.64	0.46	0.82
UNCG	88	75	0.85	0.62	1.09
ASU	83	78	0.94	0.64	1.25
FSU	36	29	0.79	0.31	1.27
UNCW	276	307	1.11	0.95	1.27
UNCC	228	209	0.90	0.75	1.05

In Table 6, the average production rate varies for different universities. Hypothesis testing shows that some of the average production rates are significantly different: for example, UNCW is significantly higher than NCSU.

The motorized on-crossing trips are trips made by on-campus students to go between campus and outside for different activities. Intuitively, the production rate is related to the level of transit service around campus and car ownership. However, the survey results do not show that better transit service leads to a higher on-crossing production rate: NCSU and ASU have good transit service, but NCSU has the lowest on-crossing production rate. The survey results do show the impact of higher car ownership. UNCW and UNCC have about 70% of on-campus students who can access vehicles according to the surveys, which are much higher than the other four surveyed universities (varies from 36% to 47%). Table 6 shows that the on-crossing production rates for UNCW and UNCC are higher than NCSU, UNCG and FSU. Although the average production rate for ASU is higher than UNCC, ASU has a relatively larger confidence interval and its lower bound is lower than that for UNCC.

Based on the car ownership, the six surveyed universities can be divided into two groups. Within each group, hypothesis testing shows that the average production rates are not significantly different. The average production rate for each group is shown in Table 7.

Table 7 Grouped Production Rate for Crossing the University Boundary Trips by On-campus Students

Group	Description	Example	Number of Student Samples	Average Production Rate
1	Higher car ownership for on-campus students	UNCW and UNCC (70% to 71%)	504	0.99
2	Lower car ownership for on-campus students	NCSU, UNCG, ASU and FSU (36% to 47%)	351	0.78
All	If cannot fit into one of the two groups		855	0.85

In a travel demand model, the total number of on-crossing trips can be calculated as the number of on-campus students enrolled in the university multiplied by the corresponding average production rate. For the six surveyed universities, Table 6 can be used; and for universities that are not surveyed in the NCDOT project, Table 7 can be used. If it is difficult to classify a university into one of the two groups, it is suggested to use the trip production rate developed based on all six surveyed universities, as shown in the last row of Table 7.

To obtain the zonal trip production, the total on-crossing trips produced in a university can be disaggregated to each campus zone based on zonal characteristics, such as on-campus housing capacity or on-campus housing building square footage.

C. Outside of the University Trips made by Off-campus students

1. Control Total

Table 8 shows the production rates for the "outside of the university trips" made by off-campus students (called off-outside trips) collected from all six universities. Again, the numbers shown in Table 8 are based on motorized internal to internal (I-I) trips only.

Table 8 Production Rate for Outside of the University Trips by Off-campus Students

	Number of Student Samples	Number of Trip Samples	Weighted Average Production Rate	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
NCSU	192	261	1.40	1.15	1.65
UNCG	295	543	1.84	1.61	2.08
ASU	183	217	1.18	0.96	1.40
FSU	188	349	1.84	1.54	2.13
UNCW	562	902	1.62	1.47	1.77
UNCC	1,122	2,123	1.91	1.80	2.02

In Table 8, the average production rate varies for different universities. Hypothesis testing shows that some of the average production rates are significantly different, for example, ASU is significantly lower than UNCG and UNCC.

The motorized off-outside trips are trips made by off-campus students with neither trip end on campus. Intuitively, the production rate is related to the car ownership, which is supported by the survey results. According to the survey results, NCSU and ASU have relatively lower car ownership (86% to 89%), compared to the other four surveyed universities (92% to 95%). Table 8 shows that the off-outside production rates for NCSU and ASU are lower than UNCG, FSU, UNCW and UNCC.

Based on the car ownership, the six surveyed universities can be divided into two groups. Within each group, hypothesis testing shows that the average production rates are not significantly different at the 0.05 significance level (except for UNCW and UNCC, which are not significantly different at the 0.01 significance level). The average production rate for each group is shown in Table 9.

Table 9 Grouped Production Rate for Outside of the University Trips by Off-campus Students

Group	Description	Example	Number of Student Samples	Average Production Rate
1	Higher car ownership for off-campus students	UNCG, FSU, UNCW and UNCC (92% to 95%)	2,167	1.84
2	Lower car ownership for off-campus students	NCSU and ASU (86% to 89%)	375	1.32
All	If cannot fit into one of the two groups		2,542	1.63

In a travel demand model, the control total of off-outside trips can be calculated as the number of off-campus students in the university multiplied by the corresponding average production rate. For the six surveyed universities, Table 8 can be used; and for universities that are not surveyed in the NCDOT project, Table 9 can be used. If it is difficult to classify a university into one of the two groups, it is suggested to use the trip production rate developed based on all six surveyed universities, as shown in the last row of Table 9.

2. Zonal Productions and Attractions

Neither trip end of off-outside trips are on campus. Intuitively, the off-outside trip productions and attractions in each TAZ are determined by two factors: the amount of population and employment in a TAZ, and the distance between the TAZ and campus. TAZs with more population and employment are more likely to produce and attract more off-outside trips than TAZs with less population and employment; and TAZs closer to campus are more likely to produce and attract more off-outside trips. This is what a gravity model can describe. So gravity models were developed to distribute the control total of off-outside trips obtained in Section III.C.1 into each TAZ to obtain the zonal productions and attractions.

The gamma function is selected to model the friction factors in the gravity model. The typical equation for a Gamma function is as follows:

$$FF_{ij} = a * d_{ij}^{-b} * e^{-c*d_{ij}} \quad (1)$$

Where,

FF_{ij} is the friction factor from production TAZ i to attraction TAZ j;

d_{ij} is the highway distance from production TAZ i to attraction TAZ j; and

a, b and c are the coefficients $a > 0$, $c \geq 0$.

For the purpose of determining the zonal off-outside productions and attractions, TAZ i in Equation (1) is actually the campus TAZ. If a campus is located in more than one TAZ, the TAZ with the most campus activities should be selected as TAZ i.

Friction factors were calculated based on survey data for each university. A linear regression is then conducted to estimate coefficients a, b and c, because Equation (1) can be transformed as follows:

$$ln(FF_{ij}) = ln(a * d_{ij}^{-b} * e^{-c*d_{ij}}) = ln(a) - b * ln(d_{ij}) - c * d_{ij} \quad (2)$$

So,

$a = \exp(constant)$;

$b = negative\ of\ the\ coefficient\ for\ \ln(d_{ij})$; and

$c = negative\ of\ the\ coefficient\ for\ d_{ij}$.

Since neither trip end of off-outside trips are on campus, they are treated in the same way as the Non-Home Based (NHB) trips in traditional travel demand models, that is; it is assumed that zonal productions are equal to zonal attractions. The Gamma functions developed based on survey data also show that the Gamma functions for off-outside productions are close to off-outside attractions. So only the Gamma functions for off-outside attractions are presented in this report.

Based on the similarity of the friction factors, the six surveyed universities are divided into three groups, and a regression line is developed for each group. They are shown in Figures 2 to 4, in which the Y-axis is the friction factor using a base 10 logarithmic scale.

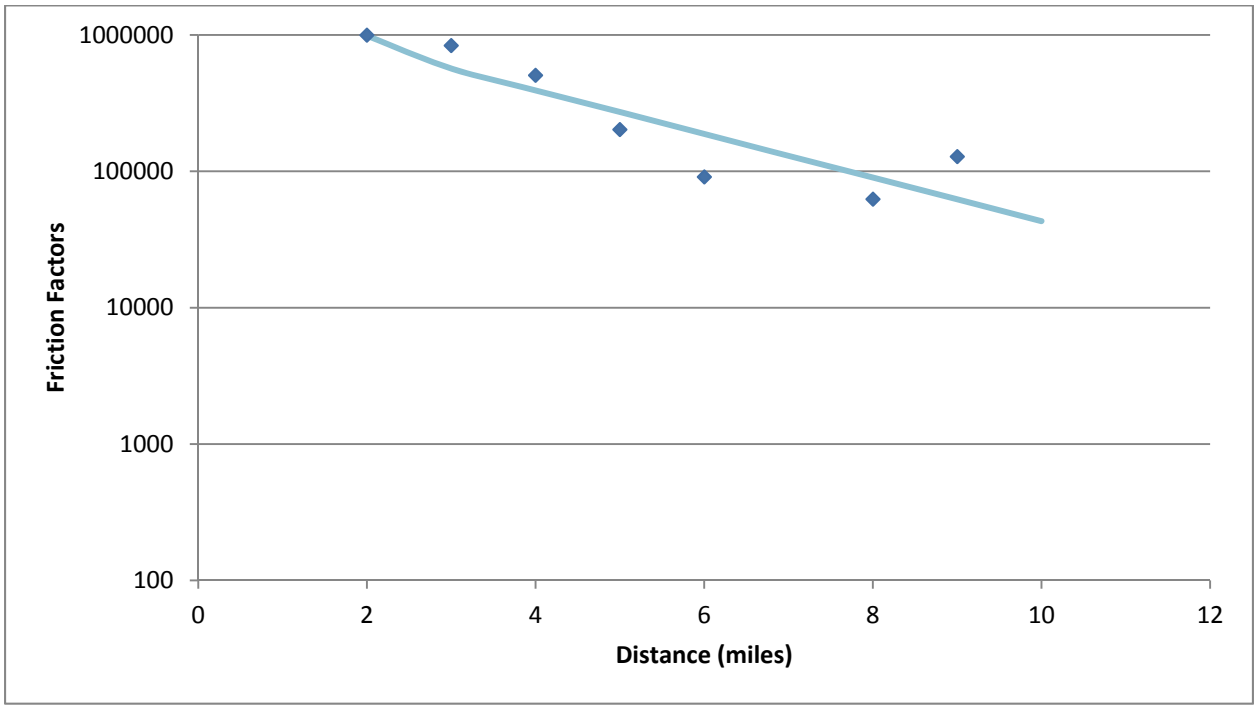


Figure 2 Friction Factors and the Regression Line for Off-outside Attractions Group 1 (ASU)

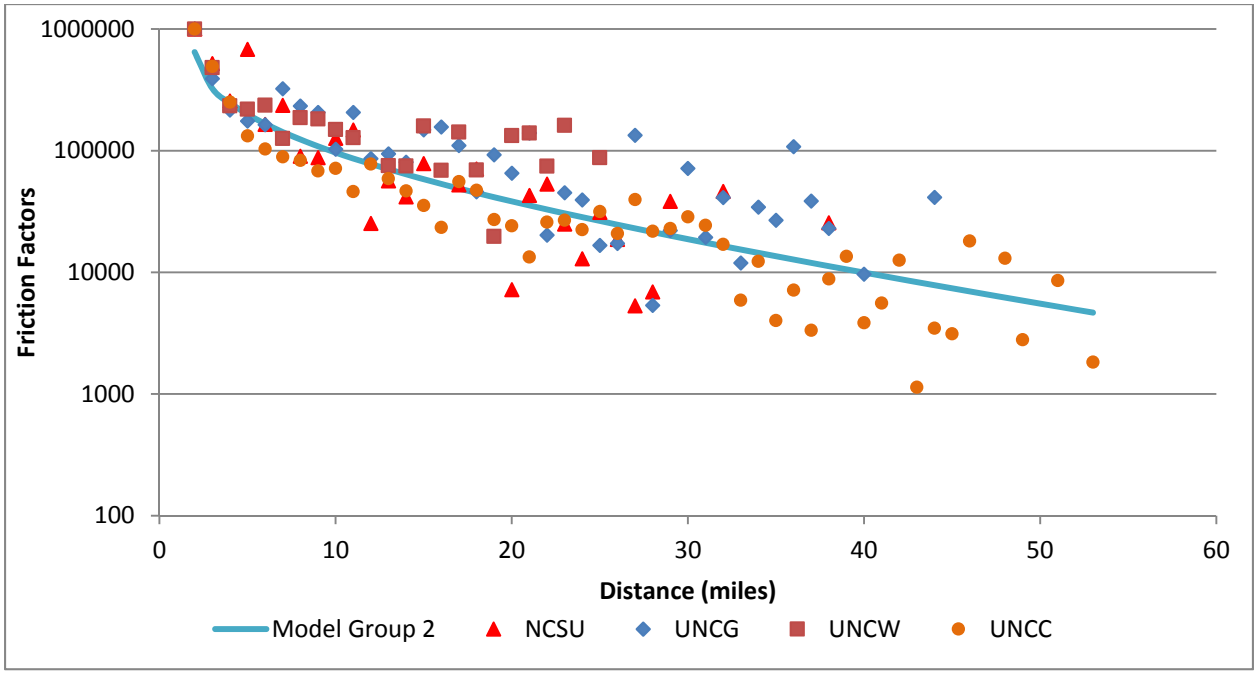


Figure 3 Friction Factors and the Regression Line for Off-outside Attractions Group 2 (NCSU, UNCG, UNCW and UNCC)

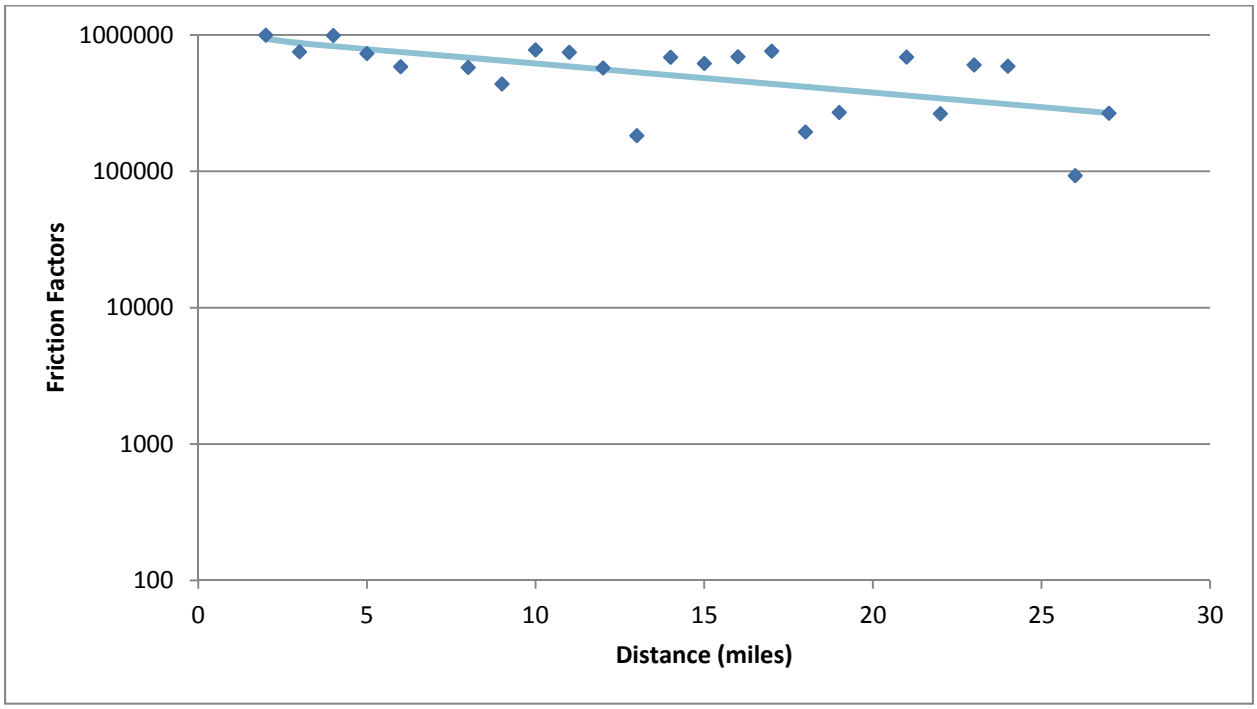


Figure 4 Friction Factors and the Regression Line for Off-outside Attractions Group 3 (FSU)

The regression lines in Figure 2 to Figure 4 are the estimated Gamma functions. Since Gamma functions can be scaled without impacting the distribution, the coefficient a is scaled so that the resulting friction factor is 1,000,000 at two miles of travel distance. The three scaled Gamma functions are plotted in Figure 5, and the coefficients are shown in Table 10.

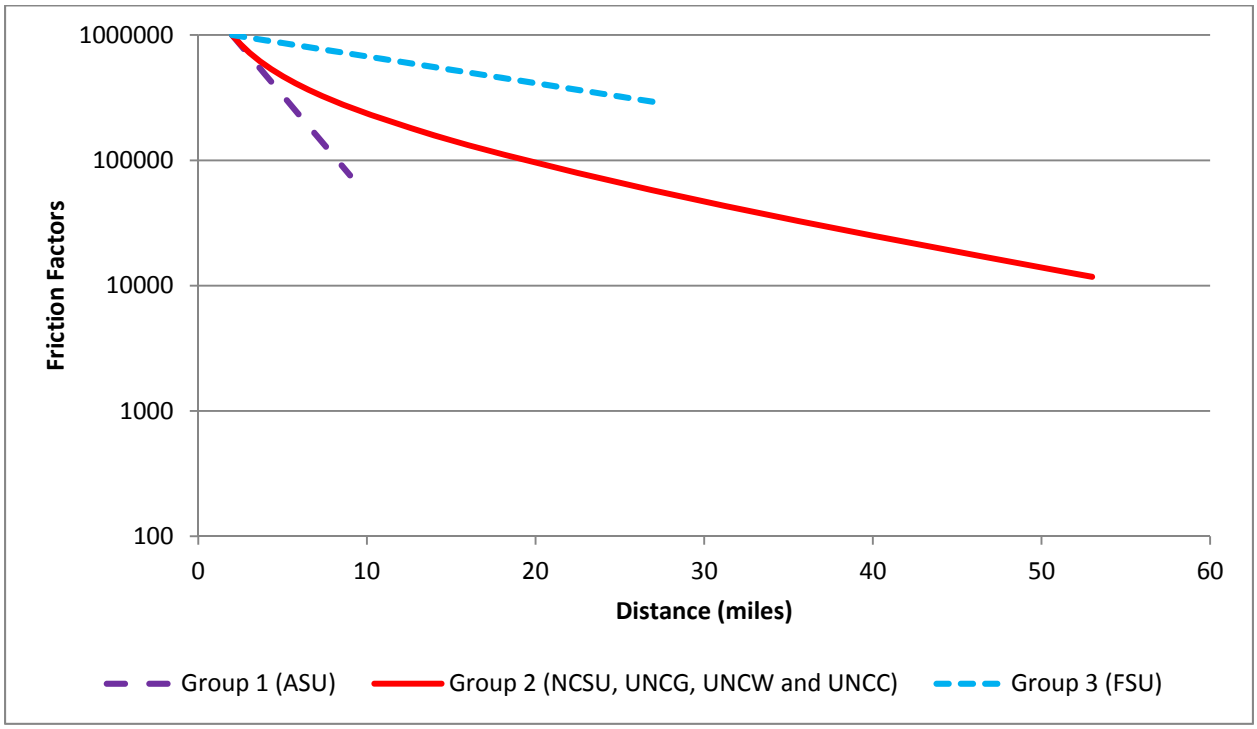


Figure 5 Comparison of the Scaled Gamma Functions for Off-Outside Attractions

Table 10 Gamma Functions for Off-outside Attractions

	Example	Ln(a)	b	c
Group 1	ASU	14.55213	0	0.36831
Group 2	NCSU, UNCG, UNCW and UNCC	14.37405	0.68064	0.04338
Group 3	FSU	13.91362	0	0.04906

The comparison of the Gamma functions shown in Figure 5 and studying each university's characteristics reveals that the proportion of part-time students is related to the distribution of off-outside attractions. Part-time students usually do not need to come to campus frequently, so their homes, as well as their off-outside trip ends, could be farther from campus. Therefore, a bigger portion of part-time students leads to a flatter Gamma function.

Table 11 summarizes the proportion of part-time students in the six surveyed universities. It shows that Group 3 has a higher proportion of part-time students than Group 2, which is higher than Group 1, and consistently Group 3 has a flatter Gamma function than Group 2, which is flatter than Group 1 in Figure 5.

Table 11 Proportion of Part-time Students

	Proportion of Part-time students (%)	Group	Trip Sample Size
ASU	4.2%	Group 1	217
UNCW	14.2%	Group 2	3,829
NCSU	14.8%		
UNCG	23.1%		
UNCC	23.1%		
FSU	30.0%	Group 3	349

Table 11 also shows the number of trips used to develop the Gamma functions. Group 2 has 3,829 trip samples, and this Gamma function is more robust than the other two due to the larger sample size.

The procedures to obtain the zonal off-outside trip productions and attractions are as follows:

1) Obtain the control total (CT) of off-outside trips for a university based on the procedure described in Section III.C.1

2) Distribute the control total to each non-campus TAZ using the following equation:

$$A_j = CT \cdot \frac{f(Emp_j, Pop_j) \cdot FF_{cj}}{\sum_k f(Emp_k, Pop_k) \cdot FF_{ck}} \quad (3)$$

Where,
A_j is the number of off-outside trips attracted to TAZ j (TAZ j is a non-campus TAZ);
CT is the control total of the off-outside trips for a university;
$f(Emp_j, Pop_j)$ is a function of the total employment and total population in TAZ j;
FF_{cj} is the friction factor between the campus TAZ and TAZ j; and
k are all non-campus TAZs.

In Equation 3, $f(Emp_j, Pop_j)$ is a function of the total employment and total population in TAZ j. Obviously, a TAZ with more employment and population is more likely to attract off-outside trips than a TAZ with less employment and population, given that they are at the same distance to campus. It is suggested to use the following function for $f(Emp_j, Pop_j)$

$$f(Emp_j, Pop_j) = Pop_j + \frac{Regional\ Total\ Pop}{Regional\ Total\ Emp} \cdot Emp_j \quad (4)$$

For FF_{cj}, please use the Gamma functions in Table 10. For universities that are not surveyed, if its proportion of part-time students is less than 5%, it is recommended to use the Gamma function for Group 1; if it is between 5% and 30% (exclusive), it is recommended to use the Gamma function for Group 2; and if it is above 30% (inclusive), it is recommended to use Group 3.

3) Make off-outside trip productions in TAZ j equal to A_j.

D. Outside of the University Trips made by On-campus students

1. Control Total

Table 12 shows the production rates for the "outside of the university trips" made by on-campus students (called on-outside trips) collected from all six universities. The numbers shown in Table 12 are based on motorized internal to internal (I-I) trips only.

Table 12 Production Rate for Outside of the University Trips by On-campus Students

	Number of Student Samples	Number of Trip Samples	Weighted Average Production Rate	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
NCSU	144	29	0.21	0.08	0.33
UNCG	88	29	0.33	0.16	0.50
ASU	83	15	0.18	0.07	0.30
FSU	36	9	0.25	0.04	0.45
UNCW	276	61	0.22	0.15	0.29
UNCC	228	49	0.21	0.13	0.28

In Table 12, the average production rates are very close. Hypothesis testing shows that all of the average production rates are not significantly different from each other. So the data from the six surveyed universities can be pooled together to calculate one average production rate, which is shown in Table 13.

Table 13 Grouped Production Rate for Outside of the University Trips by On-campus Students

Group	Description	Example	Number of Student Samples	Average Production Rate
1	All universities in North Carolina	NCSU, UNCG, ASU, FSU, UNCW and UNCC	855	0.22

In a travel demand model, the control total of on-outside trips can be calculated as the number of on-campus students in the university multiplied by the average production rate (0.22).

2. Zonal Productions and Attractions

The same as for the off-outside trips, gravity models were developed to distribute the control total of on-outside trips obtained in Control Total into each TAZ to obtain the zonal productions and attractions. However, on-campus students live on campus, so the proportion of part-time students is no longer a factor that affects where the on-outside trip ends are. In addition, due to the low on-outside trip rate (only 0.22), only 192 on-outside trip records were collected from all six universities (as shown in Table 12). The small sample size does not support further grouping of universities. Therefore, only one Gamma function was developed based on the friction factors for all six universities. It is shown in Figure 6, in which the Y-axis is the friction factor using a base 10 logarithmic scale. Please note that for ASU trips are very short, so they appear in Figure 6 in the upper left corner and are over laid by symbols for other campuses.

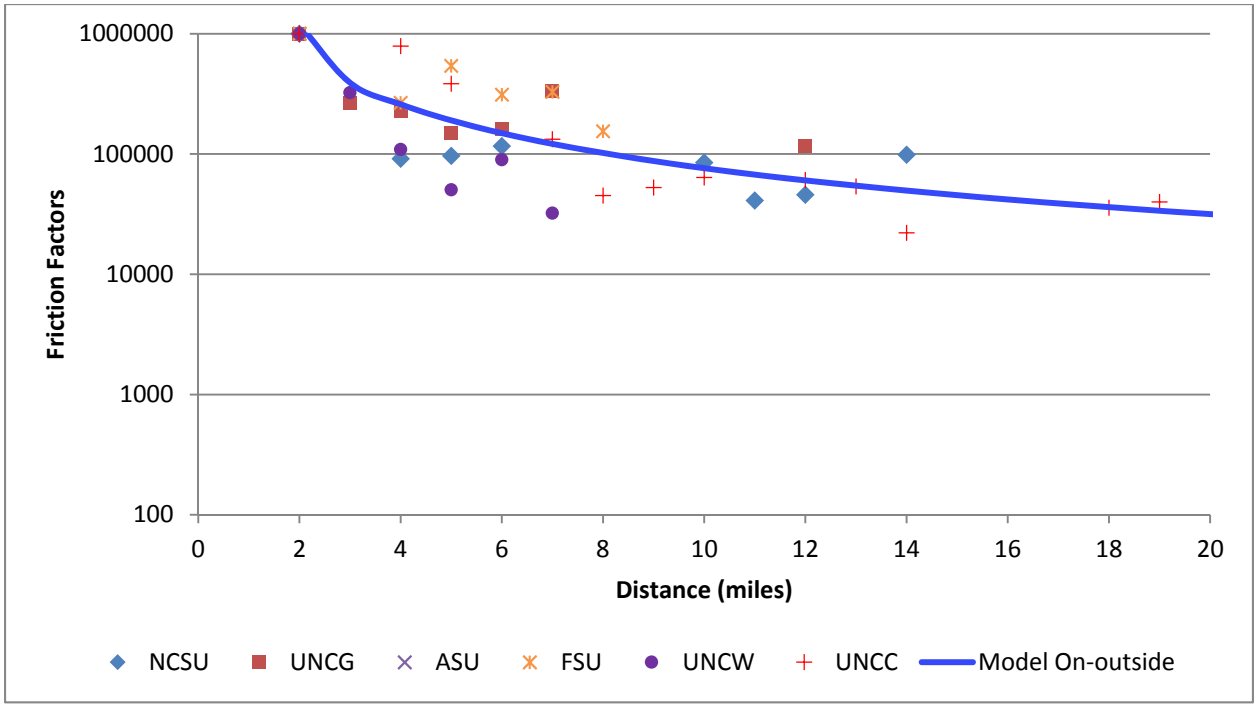


Figure 6 Friction Factors and the Regression Line for On-outside Attractions

The regression line in Figure 6 is the estimated Gamma function. Since Gamma functions can be scaled without impacting the distribution, the coefficient a is scaled so that the resulting friction factor is 1,000,000 at two miles of travel distance. The coefficients after scaling are shown in Table 14 Gamma Functions for On-outside Attractions.

Table 14 Gamma Functions for On-outside Attractions

	Example	Ln(a)	b	c
All universities in North Carolina	NCSU, UNCG, ASU, FSU, UNCW and UNCC	14.664055	1.22419	0

The procedure to obtain the zonal on-outside trip productions and attractions are the same as the off-outside trips, which is presented in Section III.C.2

IV. Trip Distribution

The Gravity model is widely used by travel demand models across North Carolina. It is suggested to use the gravity model in the distribution of university student trips.

A. Crossing the University Boundary Trips made by Off-campus students

Crossing the university boundary trips made by off-campus students are called off-crossing trips in this report. Their production ends are on campus, and attraction ends are off campus. The zonal off-crossing trip productions can be obtained from the procedure described in Section III.A. They are then distributed to off-campus TAZs based on a gravity model that is singly constrained to productions.

Most (58% to 73%) of the off-crossing trips are HBU trips made by off-campus students, that is, they are between off-campus homes and campus. So the locations of off-campus homes determine the distribution of off-crossing trips. Similar to the analysis in Section III.C.2, if a university has a bigger portion of part-time students (who tend to live further from campus), its Gamma function is flatter so more students would have longer trips. Following the same practice shown in Section III.C.2, the six surveyed universities are divided into three groups based on the proportion of part-time students. A regression line is developed for each group. They are shown in Figure 7 to Figure 9, in which the Y-axis is friction factor using a base 10 logarithmic scale.

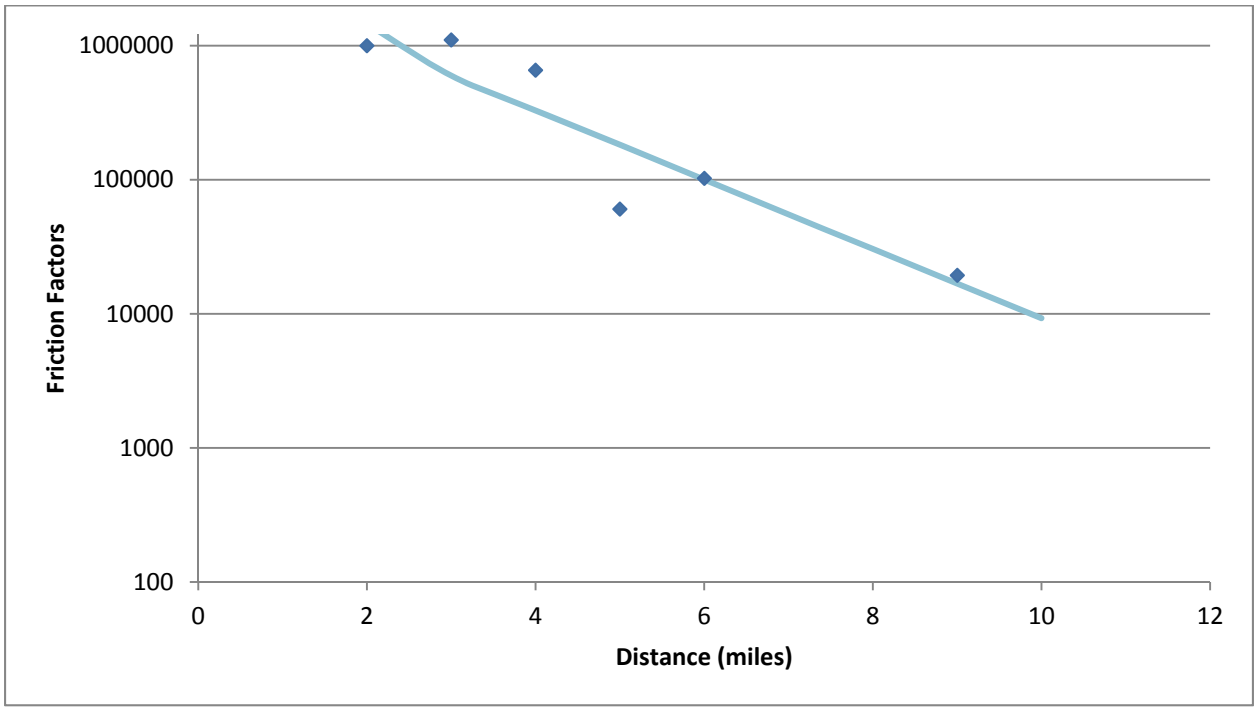


Figure 7 Friction Factors and the Regression Line for Off-crossing Trip Distribution Group 1 (ASU)

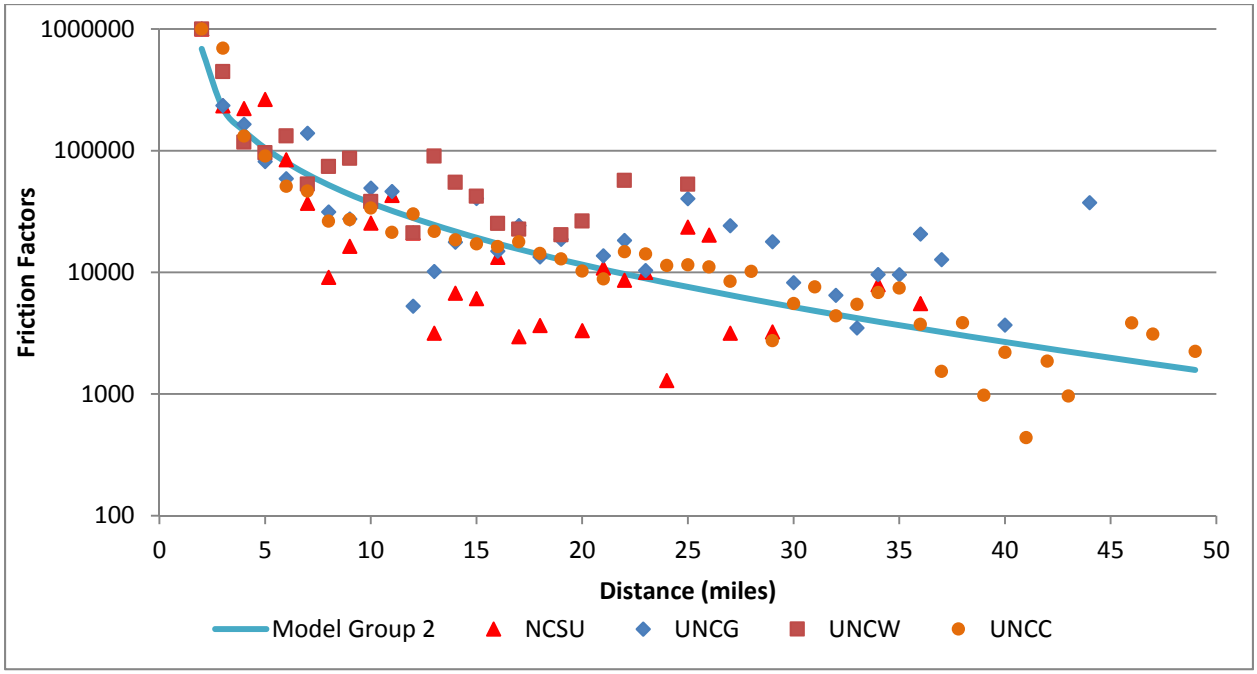


Figure 8 Friction Factors and the Regression Line for Off-crossing Trip Distribution Group 2 (NCSU, UNCG, UNCW and UNCC)

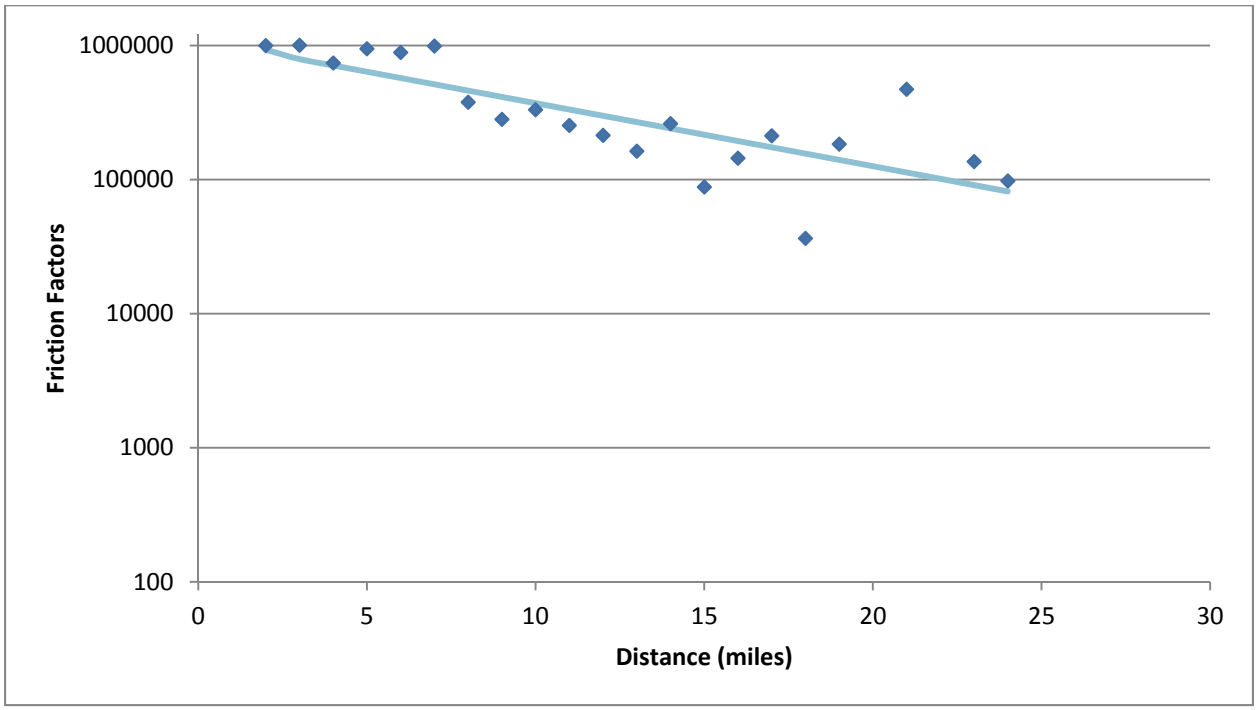


Figure 9 Friction Factors and the Regression Line for Off-crossing Trip Distribution Group 3 (FSU)

The regression lines in Figures 7 to 9 show the estimated Gamma functions. Since Gamma functions can be scaled without impacting the distribution, the coefficient a is scaled so that the resulting friction factor is 1,000,000 at two miles of travel distance. The three scaled Gamma functions are plotted in Figure 10, and the coefficients are shown in Table 15.

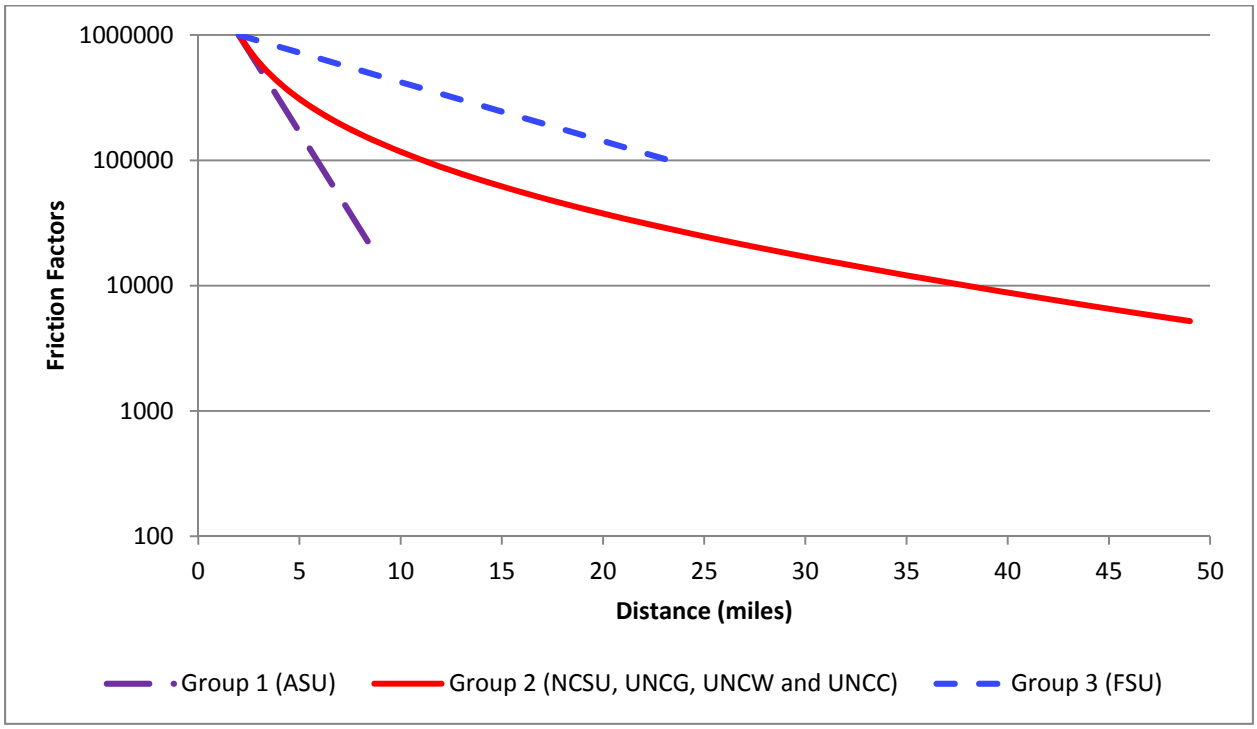


Figure 10 Comparison of the Scaled Gamma Functions for Off-crossing Trip Distribution

Table 15 Gamma Functions for Off-crossing Trip Distribution

	Example	Ln(a)	b	c
Group 1 <5% part time	ASU	15.00574	0	0.59512
Group 2 5% - 30% part time	NCSU, UNCG, UNCW and UNCC	14.69400	1.17543	0.03188
Group 3 >=30% part time	FSU	14.03188	0	0.10818

Group 2 has 3,630 trip samples, and it is much larger than the other two (341 and 326 respectively), so the Gamma function for Group 2 is more robust.

The procedures to conduct the off-crossing trip distributions are as follows:

1) Obtain the zonal off-crossing trip productions (P_i for TAZ i) based on the procedure described in Section III.A.

2) Distribute the zonal productions to each non-campus TAZ using the following equation:

$$T_{ij} = P_i \cdot \frac{Pop_j \cdot FF_{ij}}{\sum_k Pop_k \cdot FF_{ik}} \quad (5)$$

Where,
T_{ij} is the flow produced by TAZ i and attracted to TAZ j (a non-campus TAZ);
P_i is the number of off-crossing trips produced by TAZ i;
Pop_j is the total population in TAZ j;
FF_{ij} is the friction factor between TAZ i and TAZ j; and
k are all non-campus TAZs.

In Equation 5, Pop_j is used as a surrogate of zonal attraction. It is believed that a TAZ with more population is more likely to attract off-crossing trips than a TAZ with less population, given that they are at the same distance to campus.

For FF_{ij} and FF_{ik} in Equation 5, please use the Gamma functions in Table 15. For universities that are not surveyed, if its proportion of part-time students is less than 5%, it is recommended to use the Gamma function for Group 1; if it is between 5% and 30% (exclusive), it is recommended to use the Gamma function for Group 2; and if it is above 30% (inclusive), it is recommended to use Group 3.

B. Crossing the University Boundary Trips made by On-campus students

The same as for the off-crossing trips, gravity models (singly constrained to productions) were developed to distribute the zonal on-crossing trips obtained in Section III.B into each off-campus TAZ. However, on-campus students live on campus, so the proportion of part-time students is no longer a factor that affects where the on-crossing attraction ends are. In addition, only few on-crossing trips were collected from some universities (such as FSU, ASU and UNCG as shown in Table 6), and it is difficult to obtain robust estimation of Gamma functions for these universities. Therefore, only one Gamma function was developed based on the friction factors for all six universities. It is shown in Figure 11, in which the Y-axis is the friction factor using a base 10 logarithmic scale.

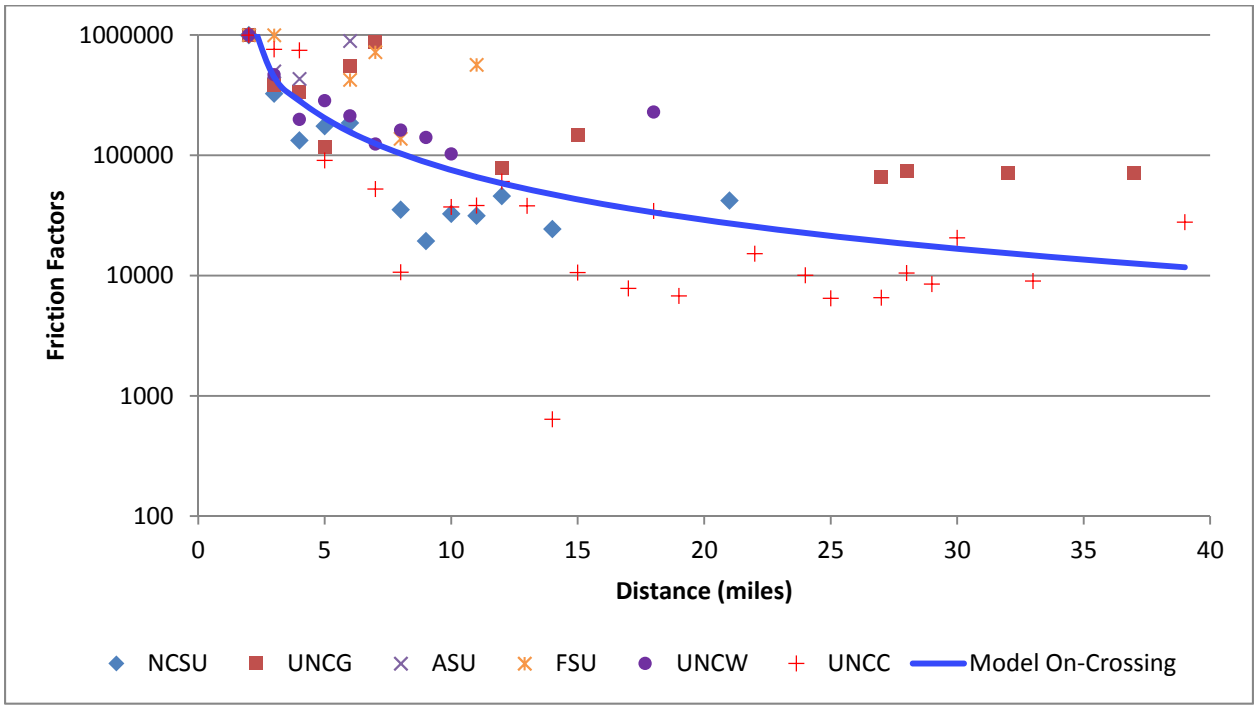


Figure 11 Friction Factors and the Regression Line for On-Crossing Trip Distribution

The regression line in Figure 11 is the estimated Gamma function. The coefficient a is scaled so that the resulting friction factor is 1,000,000 at two miles of travel distance. The coefficients after scaling are shown in Table 16.

Table 16 Gamma Functions for On-crossing Trip Distribution

	Example	Ln(a)	b	c
All universities in North Carolina	NCSU, UNCG, ASU, FSU, UNCW and UNCC	14.73776	1.33053	0

The procedures to conduct the on-crossing trip distributions are as follows:

1) Obtain the zonal on-crossing trip productions (P_i for TAZ i) based on the procedure described in Section III.B.

2) Distribute the zonal productions to each non-campus TAZ using the following equation:

$$T_{ij} = P_i \cdot \frac{SerRet_j \cdot FF_{ij}}{\sum_k SerRet_k \cdot FF_{ik}} \quad (6)$$

Where,
T_{ij} is the flow produced by TAZ i and attracted to TAZ j (a non-campus TAZ);
P_i is the number of off-crossing trips produced by TAZ i;

$SerRet_j$ is the total number of service and retail workers employed in TAZ j;
FF_{ij} is the friction factor between TAZ i and j (use the Gamma function in Table 16); and
k are all non-campus TAZs.

In Equation 6, $SerRet_j$ is used as a surrogate of zonal attraction. It is believed that a TAZ with more service and retail employment is more likely to attract on-crossing trips than a TAZ with less service and retail employment, given that they are at the same distance to campus.

C. Outside of the University Trips made by Off-campus students

Outside of the university trips made by off-campus students are called off-outside trips in this report. Both their production end and attraction end are off campus. The zonal off-outside trip productions and attractions can be obtained from the procedure described in Section III.C.

Different from the off-crossing trips and on-crossing trips whose production ends can only be the campus TAZ(s), off-outside trips have many TAZs for their production ends. To obtain the Gamma functions for off-outside trips, the Gravity Calibration tool in TransCAD was used, because the friction factors could not be directly calculated. The results show that the Gamma function for ASU does not look reasonable, and the Gamma functions from the other five universities are close. So, the other five universities are pooled together with ASU to develop a single Gamma function, which is shown in Table 17 Gamma Function for Off-outside Trip Distribution.

Table 17 Gamma Function for Off-outside Trip Distribution

	Example	Ln(a)	b	c
All universities in North Carolina	NCSU, UNCG, ASU, FSU, UNCW and UNCC	14.54861	0.91133	0.05071

The procedures to conduct the off-outside trip distributions are as follows:

1) Obtain the zonal off-outside trip productions and attractions based on the procedure described in Section III.C.

2) Apply the doubly constrained gravity model based on the Gamma function in Table 17 Gamma Function for Off-outside Trip Distribution.

D. Outside of the University Trips made by On-campus students

Outside of the university trips made by on-campus students are called on-outside trips in this report. The same as for the off-outside trips, the production end and attraction end of on-outside trips are off campus. The zonal on-outside trip productions and attractions can be obtained from the procedure described in Section III.D.

The same as for the off-outside trips, the Gravity Calibration tool in TransCAD is used to estimate the coefficients for the Gamma functions. However, due to the low on-outside trip rate (only 0.22), only 192

on-outside trip records were collected from all six universities (as shown in Table 12). The small sample size leads to unreasonable coefficients.

Table 18 and Table 19 in Section IV.E show that on-outside trips have similar average trip distances and travel times as the on-crossing trips. Therefore, it is suggested to use the Gamma function for on-crossing trips presented in Section IV.B for on-outside trips.

The procedures to conduct the off-outside trip distributions are as follows:

1) Obtain the zonal on-outside trip productions and attractions based on the procedure described in Section III.D.
2) Apply the doubly constrained gravity model based on the Gamma function in Table 16.

E. Calibration Targets for Trip Distribution

Sections IV.A to IV.D described procedures to distribute the university students' trips based on gravity models. When these procedures are applied in a travel demand model, it is important to calibrate the models so that the modeled average trip distance and travel time are close to the observed values. Table 18 and Table 19 show the observed average trip distance and travel time from the six surveyed universities. In Table 19, the average travel time is calculated based on the off-peak travel time.

Table 18 Average Trip Distance of the Six Surveyed Universities

	Model Area ($mile^2$)	Proportion of Part-time Students	Transit Share	Weighted Average Trip Distance (miles)			
				Off-crossing	Off-outside	On-crossing	On-outside
ASU	93	4.2%	27.8%	2.18	2.40	1.62	1.66
UNCW	814	14.2%	5.8%	3.93	4.41	3.32	3.86
FSU	1,406	30.0%	2.8%	7.78	6.18	4.81	4.59
UNCG	1,940	23.1%	5.7%	6.89	5.86	5.49	4.65
NCSU	3,379	14.8%	19.9%	5.88	5.86	3.93	4.46
UNCC	4,600	23.1%	2.6%	9.72	7.62	6.70	6.09

Table 19 Average Travel Time of the Six Surveyed Universities

	Model Area ($mile^2$)	Proportion of Part-time Students	Transit Share	Weighted Average Travel Time (minutes)			
				Off-crossing	Off-outside	On-crossing	On-outside
ASU	93	4.2%	27.8%	3.71	3.84	2.63	2.73
UNCW	814	14.2%	5.8%	8.98	9.01	6.99	7.51
FSU	1,406	30.0%	2.8%	15.30	11.10	9.24	8.53
UNCG	1,940	23.1%	5.7%	11.81	10.75	10.24	8.96
NCSU	3,379	14.8%	19.9%	9.56	9.22	7.14	7.25
UNCC	4,600	23.1%	2.6%	13.48	10.96	9.44	9.20

The size of the study area of the travel demand model for each of the six surveyed universities is also listed in Table 18 and Table 19. It is believed that it is an important factor for average trip distance and travel time since only internal to internal (I-I) trips are modeled and any trips with one or two trip ends outside of the study area are not considered in the model development work. The universities in Table 18 and Table 19 are sorted based on the model area, and the data show that in general universities in larger model areas have longer average trip distance and longer average travel time.

Two more factors could impact the average trip distance and travel time, and they are listed in Table 18 and Table 19 as well. Part-time students tend to live farther from campus, so a higher proportion of part-time students leads to a higher average trip distance and travel time (such as FSU). Transit trips tend to be shorter than auto trips (especially around campus), so higher transit share leads to lower average trip distance and travel time (such as NCSU). The transit shares shown in Table 18 and Table 19 are calculated as the total weighted transit trips divided by the total weighted motorized trips (considering off-crossing, off-outside, on-crossing, on-outside II trips only). The procedure for calculating the weights is described in section VII. D. Data Weighting in "Technical Report A: Survey Documentation."

It would be best if observed average trip distance and travel time are used for gravity model calibration. If they are not available, professional judgment can be applied to determine reasonable values based on Table 18 and Table 19, and the size of model area, proportions of part-time students and transit shares.

V. Mode Choice

Mode choice models model the choices that travelers make in selecting transportation modes, such as auto, bus, and bicycle. Discrete choice models have been a proven technique for modeling mode choice,

and among a variety of functional forms the multinomial logit (MNL) form has been a widely used one, due to its closed form and being easier to estimate and interpret. This study utilizes the discrete choice model technique with the multinomial logit form. The linear regression technique is also employed where needed as an assisting tool.

Considering the limited sample size of surveyed college student trips, it is determined that:

1) Auto trips are not further stratified by drive-alone and shared ride;

2) Transit trips are not further stratified by access modes (drive- or walk-access), because there are only a few drive-access transit trips in the surveys; and

3) Transit trips are not further stratified by transit mode, such as local bus, express bus, and rail (for UNC-Charlotte students only): all the transit modes are grouped together.

Since only two modes are modeled (auto and transit), the multinomial logit form simplifies to binary logit in this study.

It should also be noted that, of the six metropolitan areas where the surveyed universities are located, only four provided transit route system files along with their regional travel demand models. They are the Triangle Region (for NCSU), the Triad Region (for UNCG), the Metrolina Region (for UNCC), and the Cape Fear Region (for UNCW). Without a transit route system file, the transit mode cannot be modeled and therefore mode choice models are only developed for the four aforementioned universities in this study.

A. Survey Sample Sizes and Summary Statistics about Mode Choice Behavior

To model choices using logit models, there have to be at least two alternatives from which the traveler can choose. If there is only one alternative, the traveler will have no choice and the probability he or she uses the only available alternative will be 100%. In this situation, no choice model is actually needed and the cases with only one alternative can be identified directly using some criteria.

This section therefore summarizes sample sizes and some statistics about mode choice characteristics of the student trips in the surveys that have both auto and transit as travel mode alternatives. The statistics are stratified by student type (on-campus or off-campus) and trip type (crossing or outside) for each university as follows. Exclusion of the trip records with only the auto alternative is described in detail in Section V.E.1.

1. Sample Size for Each University

Table 20 shows the sample sizes of off-crossing trips for the four universities (NCSU, UNCC, UNCG, and UNCW), while Table 21 shows the sample sizes of off-outside trips. Sample sizes of on-campus student trips are displayed in Table 22 and Table 23, with crossing trips in the former and outside trips in the latter. As can be seen from the tables, off-campus students make much more crossing or outside trips

than on-campus students. Very small sample sizes as shown in Table 23 can make model development work very challenging.

Table 20 Sample Size of Off-crossing Trips by University

Number of Observed Trips	University			
	NCSU	UNCC	UNCG	UNCW
Total	245	751	300	810
Transit	78	85	45	109
Auto	167	666	255	701

Table 21 Sample Size of Off-outside Trips by University

Number of Observed Trips	University			
	NCSU	UNCC	UNCG	UNCW
Total	138	499	257	582
Transit	8	8	1	14
Auto	130	491	256	568

Table 22 Sample Size of On-crossing Trips by University

Number of Observed Trips	University			
	NCSU	UNCC	UNCG	UNCW
Total	70	127	57	267
Transit	13	6	6	4
Auto	57	121	51	263

Table 23 Sample Size of On-outside Trips by University

Number of Observed Trips	University			
	NCSU	UNCC	UNCG	UNCW
Total	10	18	20	40
Transit	1	0	3	0
Auto	9	18	17	40

2. Percent of Transit Trips in Total Transit Trips by University

Table 24 lists for each university the percent of transit trips by type with unweighted survey data. Of the four types of trips, crossing trips made by off-campus students (i.e. off-crossing) are the most, accounting for 78% to 86% with an average of 83% across the four universities. On-outside trips are the least, averaging at 1% with no observations at UNCC and UNCW.

Table 24 Percent of Transit Trips by University and Trip Type (Unweighted)

Percent of Observed Transit Trips	University				All Universities
	NCSU	UNCC	UNCG	UNCW	
Off-crossing	78%	86%	82%	86%	83%
Off-outside	8%	8%	2%	11%	8%
On-crossing	13%	6%	11%	3%	8%
On-outside	1%	0%	5%	0%	1%
Total	100%	100%	100%	100%	100%

Table 25 basically conveys the same information as Table 24, except that the percentages in it are derived based on the weighted survey data.

Table 25 Percent of Transit Trips by University and Trip Type (Weighted)

Percent of Weighted Transit Trips	University				All Universities
	NCSU	UNCC	UNCG	UNCW	
Off-crossing	89%	84%	80%	92%	88%
Off-outside	4%	8%	2%	4%	4%
On-crossing	6%	8%	12%	3%	7%
On-outside	1%	0%	6%	0%	1%
Total	100%	100%	100%	100%	100%

3. Transit Mode Shares

Based on the weighted survey data, transit mode shares, defined as the number of transit trips divided by total motorized trips for different trip types (e.g. off-crossing), are derived for each university and displayed in Table 26. Overall, NCSU has much higher transit shares than the other three universities. Broken down by trip types, it is also much higher in every type except for on-outside. Therefore, two sets of aggregated shares are produced, one with all four universities included and the other with NCSU excluded, as shown in Table 26.

Table 26 Transit Mode Shares* by University and Trip Type (based on weighted data)

Transit Mode Share	University				All Universities	All Universities excluding NCSU
	NCSU	UNCC	UNCG	UNCW		
Off-crossing	36.4%	9.2%	14.2%	14.0%	23.5%	12.3%
Off-outside	3.2%	1.3%	0.4%	0.9%	1.7%	0.8%
On-crossing	18.9%	4.2%	9.6%	1.5%	9.3%	4.7%
On-outside	9.5%	0.0%	14.1%	0.0%	7.5%	6.8%
Total	24.5%	5.8%	8.2%	7.0%	14.2%	7.0%

* Transit mode share is defined as the percent of transit trips in total motorized trips.

B. Auto and Transit Networks and Monetary Costs

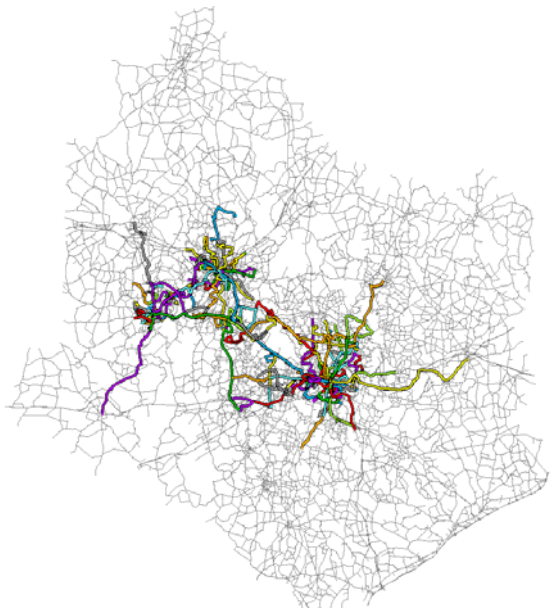
As has long been proven, travel time and monetary cost are among the most important factors that impact the traveler's choice of transportation modes. To get more accurate travel times, it is common practice to

use model network generated estimates rather than to directly use travelers' reported ones, since the latter most of the time are a guess by the traveler, rounded to 5 or 10 minutes, and therefore are not reliable.

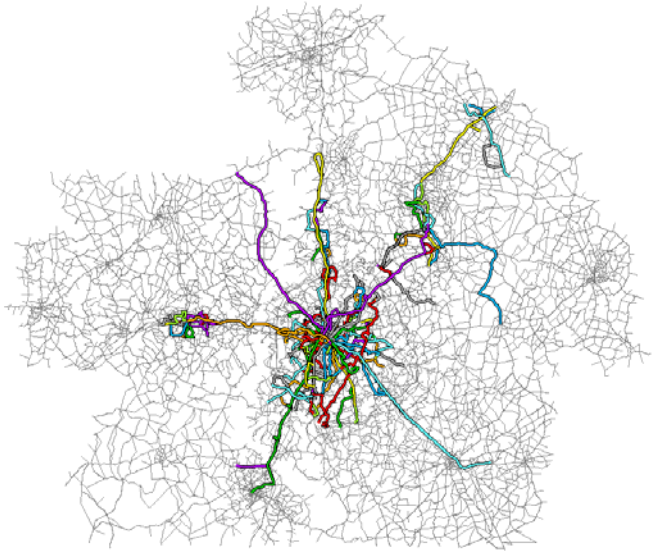
To generate transit travel times and a skim of other variables, a transit network file is needed. As stated earlier, only the Triangle, Triad, Metrolina, and Cape Fear Regions provided a transit network file. Figure 12 shows both the transit and highway networks in each of the regions.

Before a transit network from the regional model can be used, some attributes in the network need to be changed. This is because those attributes in the regional model are mostly set for the general population. For students, those attributes can take different values. A critical one is transit fare. The original fare values in the regional model are for the general population. The fare policy can be very different for college students, and therefore student fare policies of all the transit providers in the four regions were investigated. It was found that many providers offer college students rides for free, while the others provide discounted fares. Based on the investigation, transit fares (including transfer fares) in the transit networks are adjusted accordingly.

On the auto side, besides travel time, another factor that may need to be considered is auto operating cost, which mostly includes gas expenses and is proportional to miles traveled.



Triangle / NCSU



Metrolina / UNCC

Triad / UNCG Cape Fear / UNCW

Figure 12 Transit and Highway Networks in the Four Regions Surveyed

C. Auto Availability and Parking Permit Policy

Availability of autos for use has been proven by many studies to be a critical factor in choosing which transportation mode(s) to use. It is therefore included in the potential explanatory variable set in this study too. Whether a student has a campus parking permit is also considered an important factor for mode choice especially when a student makes trips with one end on campus. This factor is included in the potential explanatory variable set and defined as the terminal burden dummy variable. Specifically, this terminal burden variable is defined as whether the student who drives alone to or from the campus within the permit enforcement time period has a parking permit. If yes, that variable is given a value of 0, meaning no burden; if no, a value of 1 is assigned to take into account the fact that the student may either have to pay a one-time fee for parking on campus or have to park off-campus and then travel extra distance to the destination. Purchasing a yearly, semester, or monthly on-campus parking permit is not considered a burden for a specific trip as the purchase is a historical decision at the strategic level.

D. Generating Auto and Transit Skims

The auto travel time and distance skims used for mode choice model development are the same as those generated and used in the trip distribution step (for details, please see Section IV). Each trip record in the surveys gets an auto travel time and an auto travel distance based on its production and attraction ends.

Transit skims are generated using the transit networks as described in Section V.B. Transit skims include walk access time, initial wait time, in-vehicle travel time (IVTT), transfer walk time (if any), transfer wait time (if any), egress walk time, and fare. The number of transfers can be obtained as well. Transit skims

are generated by time of day, i.e. for the peak period and off-peak period. To make the skims as consistent as possible among the four models, the same set of weighting factors were used for all four of them, as shown in Table 27 below. These factor values are within the range commonly used in many regional models.

Table 27 Weighting Factors for Creating Transit Skims

Skim Variable	Weighting Factor
Access walk time	3
Initial wait time	2
In-vehicle travel time	1
Transfer walk time	3
Transfer wait time	2
Egress walk time	2

Transfer penalties are used as is in the skimming. The Triangle and Wilmington regional models use 10 minutes per transfer, while the Metrolina and Triad models use 6 minutes.

Each trip record in the surveys gets a set of transit skim values based on its production and attraction ends. If a trip has no access to transit, the transit skim values for it are all nulls.

E. Model Estimation Data Preparation

1. Trips Records

Only the trip records that have both non-null auto and transit skim values are included in the mode choice model estimation data file. The trips with null-valued transit skims are those having no transit services and can only use the auto mode; these trips do not need a choice model and can be assigned the auto mode with a 100% probability. Therefore, they are excluded from the model estimation data file.

2. Trip Record Attributes

The model estimation data file contains the following attributes for each trip record, as shown in Table 28.

Table 28 Trip Attributes in Mode Choice Model Estimation Data File

Column Heading	Note
Person_ID	ID of the student who made the trip
Start_PlaceID	ID of the start place of the trip
Person_OnCampus	Whether the student lives on-campus or off-campus. 1 = on-campus and 0 = off-campus
Trip_classification	Classification of the trip: 1 = crossing and 2 = outside
AutoTime	Auto travel time (in minutes) if the trip is made by the auto mode
AutoDistance	Auto travel distance (in miles) if the trip is made by the auto mode
AccessWalkTime	Walk access time (in minutes) to the transit stop
InitWaitTime	Initial wait time (in minutes) at the transit stop
IVTT	In vehicle (transit) travel time (in minutes)
XferWalkTime	Transfer walk time (in minutes)
XferWaitTime	Transfer wait time (in minutes)
NumXfers	Number of transfers
EgressWalkTime	Egress walk time (in minutes)
Fare	Transit fare (in dollars)
HasCar	Whether the student has a car to use: 1 = yes and 0 = no
TerminalBurden	Whether there is extra burden at the on-campus terminal: 1 = yes and 0 = no
Mode	What mode the student actually used for the trip: 0 = auto and 1 = transit

For model development, the Mode column in the data file is used as the dependent variable, while the columns from AutoTime to TerminalBurden are tested for inclusion as independent variables. The Person_OnCampus and Trip_classification columns are used jointly to stratify the trips into the four categories: on-crossing, on-outside, off-crossing, and off-outside.

As for travel times, if a trip is made within the peak period, then the peak-period travel time is used for the trip record; if it is made within the off-peak period, then the off-peak travel time is used. A trip is

classified either into the peak or the off-peak period. If a trip is started in the peak period and ended in the off-peak period (or the other way), it is classified into the peak period if over 50% of the trip occurs in the peak period; otherwise, it is classified as an off-peak trip.

F. Model Specification, Estimation and Results

As described at the very beginning of this section, the model to be developed is a binary logit model with two choices – auto and transit. Furthermore, the model is stratified by student type (on-campus or off-campus) and trip type (crossing or outside).

The initial model specification for the auto mode is a combination of auto travel time and auto operating cost, and the latter is expressed as auto travel distance multiplied by operating cost per mile ($0.20/mile). However, it is found that auto travel time and distance are highly correlated (each with a correlation coefficient above 0.9 for all the four universities) and the model estimation results also indicate that only one of the two can be included in the model. Therefore, auto distance is dropped, while auto time is retained in order to make the model somewhat sensitive to congestion. HasCar is another factor considered important in determining mode choice: If a student has no car to use, he/she is expected to more likely take transit. From the models estimated, this variable is proven to be a significant variable with a significant impact. The terminal burden dummy variable is also tested but found to be insignificant most of the time and to have an incorrect sign sometimes.

The initial model specification for the transit mode has the detailed components of transit skims expressed separately, including access time, initial wait time, in-vehicle travel time (IVTT), transfer walk time (if any), transfer wait time (if any), egress walk time, and fare. However, it was found that for every model estimated, at least one variable (most of the time, multiple variables) either had a coefficient with an incorrect sign or was insignificant. Merging multiple variables into one, such as access time, transfer walk time, and egress walk time into one walk time variable, and initial wait time and transfer wait time into one wait variable, was also tested, along with IVTT and fare kept separately. No satisfactory results were achieved. Finally, all the times were merged to form one TransitTime variable. For the definition of the TransitTime variable, two specifications were tried – one being plain addition of all the time terms described above and the other being addition of weighted times using weighting factors (as described in Table 27). Better results were obtained with the latter specification, and the results presented below are based on this specification.

Last but not least, transit fare was tested thoroughly and it was found to be insignificant in all the model specifications. Investigation reveals that most of the trips made by students are either free of charge or charged with a small flat fee; in either case, the variable lacks variability.

To summarize, the final variables to be included in the models are auto time, transit time, and the has-car dummy, and the final mathematical form of the choice model is as follows:

$$P_{transit} = \frac{e^{U_{transit}}}{e^{U_{transit}} + e^{U_{auto}}} \quad (7)$$

$$U_{transit} = C_{transit} + \beta_1 * \text{TransitTime} \quad (8)$$

$$U_{auto} = \beta_2 * \text{HasCar} + \beta_3 * \text{AutoTime} \quad (9)$$

Where,

$P_{transit}$ is the probability of taking the transit mode;

$U_{transit}$ is the utility function for transit;

U_{auto} is the utility function for autos;

$C_{transit}$ is the bias constant for transit;

HasCar is a dummy variable indicating whether the student has a car to use or not: 1 = yes and 0 = no;

AutoTime is the auto travel time from origin to destination;

TransitTime is the transit travel time from origin to destination, which is defined as (3 * access walk time + 2 * initial wait time + in-vehicle travel time + 3 * transfer walk time + 2 * transfer wait time + 2 * egress walk time + number of transfers * transfer penalty); and

$\beta_1, \beta_2, \beta_3$ are the coefficients for corresponding variables

It would be considered best if the model includes all three independent variables since the model can respond to changes in all three aspects the variables represent. It would be second best if the model only includes transit time and the has-car dummy; the model now cannot respond to the change in auto travel time, but it still captures the very important factor on the auto part – whether a student has a car to use. From the models estimated, it can be seen that this factor is a lot more economically significant than the travel time variables (its magnitude equivalent to 10 to 60+ minutes of auto travel time and even more of transit travel time).

1. Model for Off-crossing Trips

Among the four groups of models classified by student type and trip type, the best models achieved are the off-crossing models, as shown in Table 29 showing first coefficient values estimated and corresponding t-statistics. One of the reasons might be that this group has sufficient samples for both modes, especially for transit (as shown in Table 20), to estimate a reliable model. All the variable coefficients have correct signs and all the variables are significant at the 95% confidence level, except for the auto time in the UNCC model, according to the t-statistics shown in the lower part of Table 29. All the models have pretty high rho-squared values, indicating a good fit of the model to the data.

Table 29 Mode Choice Model for Off-crossing Trips

Coefficient Value		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	3.18	4.07	1.02	1.36
	HasCar	2.9	4.13	0.964	1.69
	AutoTime	-0.113	-0.0643		
	TransitTime	-0.0384	-0.0301	-0.0219	-0.0161
Rho-Squared		0.353	0.691	0.422	0.497

Coefficient t-stat		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	4.7	5.88	1.38	2.49
	HasCar	5.44	11.18	2.34	3.52
	AutoTime	-2.67	-1.84		
	TransitTime	-3.41	-4.95	-2.96	-5.84

For model interpretation, take the NCSU model for an example. As the model coefficients imply, one minute of change in auto time is equivalent to 2.94 (=0.113/0.0384) minutes of change in transit time. Please note that weighting factors of 3 and 2 are used for walk time and wait time, respectively, in calculation of total transit time; one minute of change in walk or wait time therefore has 3 or 2 times an impact as the same change in IVTT does. The coefficient of 2.9 for the HasCar dummy indicates this dummy variable alone has the same impact as 25.7 (=2.9/0.113) minutes of auto time does to the mode choice decision. The larger the number, the higher the propensity for a traveler to drive than take a bus when a car is available.

Following the same logic above, interpretation of all the models in Table 30 is tabulated as follows, in terms of variable impact to mode choice decision making. Since the UNCG and UNCW models do not include auto time, transit time (more accurately, the IVTT part) is used instead as the reference across all the models. The numbers can be interpreted as equivalent transit minutes when there is one unit of change in the variable of interest.

Table 30 Impact of Variables in the Off-crossing Mode Choice Model

Impact of Variable		University			
		NCSU	UNCC	UNCG	UNCW
Variables	HasCar	75.5	137.2	44.0	55.0
	AutoTime	2.94	2.14	-	-
	TransitTime (IVTT)	1	1	1	1

2. Model for Off-outside Trips

The models achieved for off-outside trips are shown in Table 31. Only two models could be developed, and no satisfactory models were found for UNCG and UNCW. This is not surprising for UNCG: As Table 21 indicates, out of the 257 off-outside trips made by UNCG students only one is a transit trip. The NCSU and UNCC models look reasonable, but keep in mind that they are both estimated with few transit trip records (8 each), and these models should be used carefully.

Table 31 Mode Choice Model for Off-outside Trips

Coefficient Value		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	1.28	2.06	No satisfactory model achieved	No satisfactory model achieved
	HasCar	3.28	6.31		
	AutoTime	-0.37	-		
	TransitTime	-0.0663	-0.015		
Rho-Squared		0.781	0.943		

Coefficient t-stat		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	1.13	1.4	n/a	n/a
	HasCar	3.1	4.56		
	AutoTime	-2.63	-		
	TransitTime	-2.69	-1.8		

Following the same procedure in Section V.F.1, interpretation of the models in Table 31 is tabulated as follows, in terms of variable impact to mode choice decision making. Again, the numbers in Table 32 can be interpreted as equivalent transit minutes when there is one unit of change in the variable of interest.

Table 32 Impact of Variables in the Off-outside Mode Choice Model

Impact of Variable		University			
		NCSU	UNCC	UNCG	UNCW
Variables	HasCar	49.8	420	n/a	n/a
	AutoTime	5.58	-		
	TransitTime (IVTT)	1	1		

3. Model for On-crossing Trips

As shown in Table 33, no satisfactory models were found for NCSU or UNCC for their on-crossing trips. The models estimated for UNCG and UNCW seem to be reasonable with respect to variable coefficient signs and magnitude (compared with the other models developed in this study) and the overall goodness of fit of the model. However, the small sample size of transit trips (6 and 4, respectively), on which the model estimation is based, also reminds us to be careful when applying these models.

The HasCar dummy variable did not make the list for the UNCG model, which seems to be a weak point of the model, considering the significant impact of this variable in the other models. However, we have to keep in mind that the data used for the model estimation is so limited (57 records in total with 6 transit ones, as shown in Table 22).

Table 33 Mode Choice Model for On-crossing Trips

Coefficient Value		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	No satisfactory model achieved	No satisfactory model achieved	-0.116	-0.722
	HasCar			-	1.5
	AutoTime			-0.238	-
	TransitTime			-0.049	-0.0246
Rho-Squared				0.463	0.883

Coefficient t-stat		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	n/a	n/a	-0.1	-0.37
	HasCar			-	1.48
	AutoTime			-2.62	-
	TransitTime			-2.29	-1.34

Interpretation of the models in Table 33 is tabulated as follows, in terms of variable impact to mode choice decision making. The numbers in Table 34 indicate the equivalent transit minutes for one unit of change in the variable of interest.

Table 34 Impact of Variables in the On-crossing Mode Choice Model

Impact of Variable		University			
		NCSU	UNCC	UNCG	UNCW
Variables	HasCar	n/a	n/a	-	61
	AutoTime			4.86	-
	TransitTime (IVTT)			1	1

4. Model for On-outside Trips

No satisfactory models were found for NCSU and UNCG for on-outside trips. Since there are no transit trip observations in the survey data for UNCC and UNCW, no choice models can be developed for these two campuses.

Table 35 Mode Choice Model for On-outside Trips

Coefficient Value		University			
		NCSU	UNCC	UNCG	UNCW
Variables	Constant for transit	No satisfactory model achieved	No observations of transit trips	No satisfactory model achieved	No observations of transit trips
	HasCar				
	AutoTime				
	TransitTime				
Rho-Squared					

G. Summary and Recommendations for Mode Choice

The surveyed student trips are classified into four groups: 1) crossing campus boundary trips made by students living off-campus (off-crossing); 2) outside campus trips made by students living off-campus (off-outside); 3) crossing campus boundary trips made by students living on-campus (on-crossing); and 4) outside campus trips made by students living on-campus (on-outside). Of these four groups, mode choice models for the off-crossing group are developed for all the four universities based on an acceptable number of trip records. The off-outside and on-crossing groups each have seemingly reasonable models developed for two of the universities, but unsatisfactory models for the other two, although the models developed are based on small sample sizes for transit trips. The on-outside group has no satisfactory models at all.

While at first glance this situation does not seem to be optimal, however, as Table 25 indicates, about 80 to 92% (with an average of 88%) of total transit trips made by university students are off-crossing, for which there are fairly reasonable models.

Recommendations about how to utilize the findings from this study for modeling student trip mode choice at other universities or college are made in the following sections. First of all, however, it has to be kept in mind that the models developed in this study are for trips having both auto and transit as travel mode alternatives. If a trip only has one alternative available (i.e. either the auto skim or the transit skim being null), do not use the models or follow the recommendations below and instead assign the mode with non-null skim to the trip directly.

1. Recommendations on Mode Choice Models for Off-Crossing Trips

Different recommendations are made for the following three situations:

1) Local survey data is available and sufficient for developing mode choice models:

   Go ahead with the local data and develop university-specific models. The models developed in this study can be used for comparison and for a reasonableness check.

2) Local survey data is available and sufficient for developing mode shares but not mode choice models:

   Choose an appropriate mode choice model from this study and use the mode share derived from the local survey to calibrate the bias constant of the chosen model. Then use the calibrated mode choice model for forecasting. How to choose an appropriate model from this study is discussed in this section later.

3) Local survey data is not available:

   First, use the following model to estimate an overall transit share for the subject university. Then, choose an appropriate mode choice model from this study and use the estimated share to calibrate the bias constant of the chosen model. The calibrated mode choice model can then be used for forecasting.

$$S_t = 0.1238 + 0.00912 * N - 0.00237 * H \quad (10)$$

   Where,

   S_t is the overall transit share (in the range of 0 to 1);

   N is the number of transit routes that serve the subject university. Please note that routes are by direction as conventionally coded in TransCAD (e.g. the inbound direction and the outbound direction of a route are coded as two routes and counted as two routes for use in the formula above); and

   H = average headway of the transit routes that serve the subject university.

For more details about this model, please read Appendix A. For how to select the routes that serve the subject university, please see Appendix B.

Selection of an appropriate mode choice model to use for a new university can be a bit challenging, considering the very limited number of models developed in this study. The suggestions provided by the research team here should be considered preliminary and be taken with caution. So first, we should remember that the numbers in Table 30 are actually ratios of the coefficients of the other variables to those of transit time (as shown in Table 29), with transit time's normalized to one and all signs removed. These ratios reflect the relative magnitude of impact of the variables on choice making. Table 36 shows characteristics for the region in which each university is located and transit services provided to the university across the four universities; allowing for comparisons to be made.

Table 36 Region and Transit Service Characteristics

	University			
	NCSU	UNCC	UNCG	UNCW
Size of the region (miles^2)	3379 (large)	4668 (large)	1940 (medium)	824 (small)
Number of routes serving the university	34	9	20	12
Average headway of the serving routes (minutes)	29	44.4	69	43.3

Putting Table 36 and Table 30 together, some recommendations are made as follows:

1) For a large region, if the number of bus routes serving the university is pretty limited with relatively long headways (like UNCC), students with cars are more likely to drive or ride a car to the campus. This indicates higher impact of the HasCar dummy variable; therefore, using a larger coefficient for HasCar appears to be reasonable.

2) For a large region, if the number of bus routes serving the university is high with short headways (like NCSU), the chance that students with cars will drive or ride in a car to the campus decreases. This means using a relatively smaller coefficient for the HasCar dummy may be fine.

3) Based on the two situations as described in 1) and 2) above, if the bus service level for a university in a large region is somewhere in between, the coefficient for HasCar can be interpolated. If the service is better than NCSU, an even smaller coefficient can be used; or if the service is less than UNCC, using an even larger coefficient should be reasonable.

4) For a large region, use a coefficient for auto time 2 to 3 times that for transit time. When transit routes are fewer and/or headways are longer, transit itself becomes less attractive and hence auto time matters less to the traveler; therefore a smaller coefficient should be used for auto

time (don't consider the sign at this moment). Otherwise, use a larger coefficient for auto time (again, no sign at this stage). Finally, add a negative sign to the chosen coefficient.

5) For a small or medium region, the larger the number of transit routes serving the university, the lower the chance students with cars will drive or ride a car to the campus (Like UNCG). Therefore, a smaller coefficient can be used for the HasCar dummy; otherwise, use a larger one (like UNCW).

6) For a small or medium region, since auto travel time is usually pretty short, it is not considered as big a burden as in large regions. This may help explain why auto time is not shown as a significant variable in the UNCG and UNCW models. So the suggestion here is – ignore auto time for a mode choice model for a university in a small or medium region.

Regarding values of the independent variables to use in the mode choice model for forecasting, it is pretty straightforward for auto time and transit time as both can be obtained from the regional model network of the target year. However, for the HasCar dummy variable – whether a student has a car or not – it is a bit more challenging. The best data source is always a local survey for the base year and a reasonable change (or even no change) for the future based on sensible assumptions. If a local survey is not available, the following have-a-car-to-use percentages derived from the four universities may be used as references. Table 37 includes the percentages for off-crossing, on-crossing, off-outside, and on-outside trips.

Table 37 Percent of Trips Made by Students Having Cars to Use (based on weighted data)

	University				All Universities
	NCSU	UNCC	UNCG	UNCW	
Off-crossing	86%	91%	89%	97%	89%
On-crossing	65%	86%	65%	82%	74%
Off-outside	95%	97%	95%	97%	96%
On-outside	66%	87%	57%	84%	70%
Total	86%	93%	88%	94%	89%

Once a percentage is determined, the mode choice model should be applied as follows to avoid biases:

1) Set the value of HasCar to 1 and run the mode choice model to get a probability (denoted as P1);

2) Set the value of HasCar to 0 and run the mode choice model to get a probability (denoted as P0);

3) Assuming the have-a-car-to-use percentage is k (between 0 and 1), the final probability is calculated as Pfinal = P1 * k + P0 * (1 – k)

2. Recommendations on Determining Mode Shares for On-crossing Trips

On-crossing trips account for about 7% of the total transit trips made by students from the four universities. They are second to the off-crossing trips (88%). However, unlike off- crossing trips, no robust models were able to be developed for predicting an overall transit share for on-campus crossing trips based on the survey data from the four universities.

Without local survey data, the transit shares derived from the surveys in this study (as shown in Based on the weighted survey data, transit mode shares, defined as the number of transit trips divided by total motorized trips for different trip types (e.g. off-crossing), are derived for each university and displayed in Table 26. Overall, NCSU has much higher transit shares than the other three universities. Broken down by trip types, it is also much higher in every type except for on-outside. Therefore, two sets of aggregated shares are produced, one with all four universities included and the other with NCSU excluded, as shown in Table 26.

Table 26) are good options or good starting points. Table 26 provides six transit share values for on-crossing trips, four from the four universities separately, one from all the universities combined, and the last from all the universities except NCSU, because NCSU has the most transit routes and shortest headway, so is a bit different from the other three. Reasonable interpolation or extrapolation should be acceptable if local evidence supports it. The chosen/determined share can then be applied uniformly to all the cells in the on-crossing trip matrix.

If not satisfied with applying one single share value across the matrix, the mode choice models developed in this study for UNCG and UNCW (as shown in Table 33) may be used with discretion. In this case, the overall share calculated or chosen can be used to calibrate the bias constants of the models. Since only two models were able to be developed and the data used to develop the models are very limited, it is really hard to generalize something for use at other universities. It might be best to test both models and see how they work. After calibration, the model can be used for forecasting.

3. Recommendations on Determining Mode Shares for Outside Trips

Off-outside trips and on-outside trips account for about 4% and 1% of the total student transit trips, respectively. Since these trips have both ends outside of the university, they are not university-related and somewhat more like those made by the general population.

For off-outside trips, the approach described in Section V.G.2 for on-crossing trips can be similarly applied here. In addition, since the regular household travel survey usually captures off-campus students and their trips made outside the university, these trips can be taken care of along with the general population trips by the regional model.

For on-outside trips, since no mode choice models were able to be developed based on the survey data, it is suggested to pick one of the transit shares derived from the surveys (as shown in Table 26) for use for other universities with adjustments as necessary. Table 26 also provides six transit share values for on-outside trips, four from the four universities separately, one from all the universities combined, and the last from all the universities except NCSU. Considering the very small sample size in this category across all the universities, the average of the four (i.e. 7.5%) might be the best one to use. Again, reasonable adjustments should be acceptable if local evidence supports them. The chosen/adjusted share can then be applied uniformly to all the cells in the on-outside trip matrix to compute a transit trip matrix.

4. Auto Occupancy Rates for Transforming Auto Person Trips to Auto Vehicle Trips

In order to prepare tables of auto vehicle trips for trip assignment, person trips need to be converted to vehicle trips based on shares of one, two, and three plus persons per vehicle. The following tables show for each campus surveyed the number of weighted and expanded trips for each auto occupancy and the share of auto vehicle trips for each.

Table 38 Auto Occupancies for Appalachian State University

Number of Travelers	Weighted & Expanded Trips	Percent of Total Trips	Auto Occupancy Rate
1	23831.1	64.9%	1
2	7456.1	20.3%	2
3	2439.3	6.6%	3.72
4	2172.0	5.9%	
5	762.1	2.1%	
6	70.0	0.2%	
Total	36730.5	100.0%	1.61

Table 39 Auto Occupancies for North Carolina State University

Number of Travelers	Weighted & Expanded Trips	Percent of Total Trips	Auto Occupancy Rate
1	50997.3	75.2%	1
2	12287.9	18.1%	2
3	2432.7	3.6%	3.67
4	1508.1	2.2%	
5	383.4	0.6%	
6	174.4	0.3%	
8	52.3	0.1%	
Total	67836.1	100.0%	1.36

Table 40 Auto Occupancies for UNC Charlotte

Number of Travelers	Weighted & Expanded Trips	Percent of Total Trips	Auto Occupancy Rate
1	66982.3	78.8%	1
2	13278.2	15.6%	2
3	3065.6	3.6%	3.46
4	1187.9	1.4%	
5	469.8	0.6%	
7	9.5	0.0%	
Total	84993.3	100.0%	1.29

Table 41 Auto Occupancies for UNC Greensboro

Number of Travelers	Weighted & Expanded Trips	Percent of Total Trips	Auto Occupancy Rate
1	33978.9	66.2%	1
2	11986.1	23.3%	2
3	3441.4	6.7%	3.59
4	1401.1	2.7%	
5	225.4	0.4%	
6	147.0	0.3%	
8	181.2	0.4%	
Total	51361.1	100.0%	1.51

Table 42 Auto Occupancies for Fayetteville State University

Number of Travelers	Weighted & Expanded Trips	Percent of Total Trips	Auto Occupancy Rate
1	17882.2	81.6%	1
2	2829.0	12.9%	2
3	576.2	2.6%	3.82
4	380.9	1.7%	
5	172.0	0.8%	
6	55.5	0.3%	
8	18.5	0.1%	
Total	21914.3	100.0%	1.28

Table 43 Auto Occupancies for UNC Wilmington

Number of Travelers	Weighted & Expanded Trips	Percent of Total Trips	Auto Occupancy Rate
1	27288.7	72.7%	1
2	7592.3	20.2%	2
3	1479.3	3.9%	3.70
4	765.6	2.0%	
5	288.8	0.8%	
6	30.9	0.1%	
7	46.0	0.1%	
8	45.4	0.1%	
Total	37537.0	100.0%	1.39

VI. Time of Day

Time of day factors were prepared from the survey data to allow model output trip tables for each trip purpose and student residence location to be prepared by time of day and direction for trip assignment. The time of day distribution was prepared using weighted and expanded trips for each university surveyed and for all universities combined. The distribution has been prepared for each hour to allow flexibility in defining peak and off peak periods to match the travel demand model. The combined universities table is presented below, and the six surveyed universities are provided separately in Appendix C.

Table 44 Off Campus Student Time of Day Factors All Universities Combined

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.06%	0.35%	0.00%	0.00%	0.00%	0.28%	0.24%
1:00	2:00	0.18%	0.24%	0.03%	0.00%	0.00%	0.53%	0.34%
2:00	3:00	0.00%	0.24%	0.00%	0.33%	0.00%	0.27%	0.23%
3:00	4:00	0.04%	0.04%	0.33%	0.04%	0.00%	0.05%	0.09%
4:00	5:00	0.11%	0.06%	0.00%	0.00%	0.29%	0.15%	0.16%
5:00	6:00	0.23%	0.09%	0.04%	0.17%	0.00%	0.47%	0.31%
6:00	7:00	1.17%	0.17%	0.31%	0.54%	0.06%	2.25%	1.43%
7:00	8:00	6.68%	0.88%	1.96%	0.08%	1.23%	5.49%	5.00%
8:00	9:00	9.34%	0.57%	3.46%	0.64%	3.07%	4.88%	6.06%
9:00	10:00	8.30%	1.59%	3.14%	1.63%	9.58%	3.29%	6.54%
10:00	11:00	6.08%	2.31%	2.81%	1.71%	11.02%	2.76%	6.05%
11:00	12:00	3.03%	2.61%	3.14%	4.33%	13.03%	3.52%	6.20%
12:00	13:00	2.44%	4.24%	2.96%	7.97%	13.38%	4.69%	7.52%
13:00	14:00	2.84%	3.67%	4.18%	6.79%	13.14%	5.00%	7.56%
14:00	15:00	1.68%	3.28%	2.04%	5.61%	7.58%	5.28%	5.86%
15:00	16:00	1.95%	4.51%	3.12%	6.90%	9.99%	6.67%	7.58%
16:00	17:00	1.12%	4.59%	1.90%	5.76%	5.41%	8.07%	6.86%
17:00	18:00	1.86%	4.70%	3.68%	7.47%	4.68%	9.95%	8.23%
18:00	19:00	1.04%	3.67%	2.28%	5.70%	2.44%	9.25%	6.60%
19:00	20:00	0.79%	2.97%	0.68%	3.15%	2.44%	7.61%	5.08%
20:00	21:00	0.79%	3.12%	0.42%	2.14%	1.92%	7.37%	4.78%
21:00	22:00	0.30%	3.37%	0.48%	1.01%	0.42%	5.32%	3.52%
22:00	23:00	0.09%	1.41%	0.17%	0.52%	0.19%	4.34%	2.31%
23:00	24:00	0.18%	1.06%	0.10%	0.21%	0.14%	2.50%	1.45%
Grand Total		50.26%	49.74%	37.23%	62.77%	100.00%	100.00%	100.00%

Table 45 On Campus Student Time of Day Factors All Universities Combined

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.32%	0.00%	0.12%	0.46%	0.00%	0.40%
1:00	2:00	0.06%	1.11%	1.01%	0.00%	0.58%	0.81%	0.70%
2:00	3:00	0.80%	0.37%	0.12%	0.12%	0.08%	0.62%	0.27%
3:00	4:00	0.27%	0.00%	0.00%	0.00%	0.07%	0.81%	0.13%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.07%
5:00	6:00	0.38%	0.00%	0.00%	0.00%	0.21%	0.00%	0.21%
6:00	7:00	0.61%	0.06%	0.12%	0.51%	0.12%	0.66%	0.25%
7:00	8:00	0.79%	0.00%	0.69%	1.46%	3.63%	1.50%	3.03%
8:00	9:00	1.87%	0.42%	0.00%	0.58%	5.38%	0.00%	4.38%
9:00	10:00	0.83%	0.09%	0.77%	1.14%	9.64%	0.60%	7.49%
10:00	11:00	2.40%	0.65%	3.02%	0.61%	10.09%	0.96%	8.26%
11:00	12:00	2.92%	0.24%	3.82%	1.46%	7.99%	3.26%	6.92%
12:00	13:00	4.45%	1.45%	5.68%	3.75%	10.77%	2.90%	9.65%
13:00	14:00	4.40%	0.38%	6.23%	2.95%	9.78%	2.83%	8.73%
14:00	15:00	2.82%	1.46%	5.35%	2.28%	5.62%	6.56%	5.61%
15:00	16:00	5.77%	2.50%	9.33%	1.32%	6.24%	6.46%	6.84%
16:00	17:00	4.48%	4.12%	6.17%	2.72%	4.88%	8.69%	5.85%
17:00	18:00	5.65%	2.78%	7.25%	2.43%	5.93%	15.57%	6.96%
18:00	19:00	6.58%	2.29%	3.61%	3.13%	5.61%	12.89%	6.46%
19:00	20:00	4.25%	4.25%	6.76%	3.26%	4.38%	8.91%	5.54%
20:00	21:00	5.16%	4.46%	2.75%	1.91%	3.05%	10.32%	4.40%
21:00	22:00	3.27%	3.70%	2.26%	2.11%	2.35%	6.22%	3.31%
22:00	23:00	2.55%	3.67%	1.56%	0.58%	1.86%	5.99%	2.68%
23:00	24:00	2.43%	2.24%	0.74%	0.19%	1.01%	3.06%	1.64%
Grand Total		62.97%	37.03%	67.36%	32.64%	100.00%	100.00%	100.00%

Table 46 Time of Day Factors All Students, All Trips, All Universities Combined

Start Time	End Time	All Students, All Trips
0:00	1:00	0.29%
1:00	2:00	0.46%
2:00	3:00	0.24%
3:00	4:00	0.10%
4:00	5:00	0.13%
5:00	6:00	0.28%
6:00	7:00	1.05%
7:00	8:00	4.37%
8:00	9:00	5.52%
9:00	10:00	6.84%
10:00	11:00	6.76%
11:00	12:00	6.43%
12:00	13:00	8.20%
13:00	14:00	7.94%
14:00	15:00	5.78%
15:00	16:00	7.34%
16:00	17:00	6.54%
17:00	18:00	7.82%
18:00	19:00	6.55%
19:00	20:00	5.23%
20:00	21:00	4.66%
21:00	22:00	3.45%
22:00	23:00	2.43%
23:00	24:00	1.58%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university

Appendix A Development of an Overall Transit Share Model for *Off-crossing* Trips

This is a regression model that is intended to be used to determine the overall transit share of off-crossing trips for a university based on a couple of explanatory variables. After a lot of testing, the data finally used to develop the model is shown in Table A-1 below. Among the data, the Observed Transit Share is used as the dependent variable, and the Number of Transit Routes and the Average Headway are used as independent variables. Please note that the number of transit routes used here only includes those that serve the university directly. Regarding how those routes are selected, please see Appendix B.

As shown in Table A-1, in total there are only four records for model estimation, one from each university. This places a limit on how many independent variables can be used.

Table A-1 Data for Off-crossing Trip Transit Mode Share Model Development

University	Observed Transit Share	Number of Transit Routes*	Average Headway**	Model Reproduced Transit Share
NCSU	0.364	34	29	0.365
UNCC	0.092	9	44.44	0.100
UNCG	0.142	20	69	0.142
UNCW	0.140	12	43.3	0.130

* only include those routes that serve the university directly

** only headways of the routes that serve the university directly are included

Using the Regression module in the Data Analysis add-in of Excel 2010, a regression model is estimated as follows and detailed model-fitting statistics can be found in Table A-2.

$$S_t = 0.1238 + 0.00912 * N – 0.00237 * H$$

Where,

S_t = overall transit share (in the range of 0 to 1)

N = the number of transit routes that serve the subject university. Please note that routes are by direction as conventionally coded in TransCAD (e.g. the inbound direction and the outbound direction of a route are coded as two routes and counted as two routes for use in the formula above). Regarding how to select those routes, please see Appendix B.

H = average headway of the transit routes that serve the subject university.

As shown in Table A-2, an adjusted R square of 0.989 is achieved and the two variables are significant at reasonable confidence levels with correct signs. To check the performance of the model, the estimated coefficients are then used along with the original input data to calculate the transit shares, which are

listed in the right-most column in Table A-1. As can be seen, the reproduced shares are pretty close to the observed ones.

Please note, however, that the model is developed based on very limited data and therefore may not be robust enough. When applying the model, it is desirable that the values of the independent variables be in the range of or close to those in Table A-1. Differences that are too large may lead to unreasonable predictions.

Table A-2 Regression Model Fitting Statistics

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.12379	0.02947	4.20	0.149
Average Headway	-0.00237	0.00046	-5.11	0.123
# of Transit Routes	0.00912	0.00069	13.22	0.048

Regression Statistics	
R Square	0.996
Adjusted R Square	0.989
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.044	0.022	142.148	0.059
Residual	1	0.000	0.000		
Total	3	0.044			

Appendix B Determination of Transit Routes Serving the Crossing Trips

For crossing-university-boundary trips, it is reasonable to think that transit routes that connect the university and the outside world should have an impact on the choice of travel modes by students. Therefore, in order to develop a model to estimate an overall transit share for a university, those routes need to be identified. They include not only the routes passing through the campus of the university, but also those outside of the campus, that are walk-accessible from the campus within a reasonable amount of time, e.g. 10 minutes. Therefore, a buffer of 0.5 miles surrounding the campus is used to take care of the latter. In addition, if a route runs fully on-campus without any segment off-campus, it is removed from the set, as they don't serve the crossing trips.

The detailed procedure used in this study is as follows:

1) If a geographic file for the area of the university alone is available, open it in TransCAD; if not, open the TAZ system of the regional model in TransCAD, and select the TAZs that overlap with the university. In the latter case, you may not have a perfect match, but a close approximation would be fine.

2) Create a 0.5-mile buffer surrounding the university. TransCAD will create a separate geographic file that includes both the university and the buffer area as a single area entity.

3) Add the newly created buffered area file to the map as a new layer.

4) Select transit routes that touch the buffered area.

5) Identify the routes that run completely on-campus.

6) Remove the routes identified in step 5) from those selected in step 4). The remaining routes are those serving the crossing trips of the university.

Now you can count the number of routes, compute the average headway, and use both numbers in the regression model for off-crossing trips (Appendix A).

Instead of simply using the number of routes, this study actually went one step further to compute a more reasonable measure for quantifying the impact of the transit routes. However, a regression model based on this variable did not give as good a fit as using the number of routes, so it was abandoned. However, the idea seems to be good and can be tested when more data is available in the future. The procedure is documented here following step 6) above.

7) Based on the final routes selected, create a 0.5-mile buffer surrounding all the stops of these routes.
8) Compute household population falling with this buffer.
9) Divide the population computed in step 8) by the total household population in the region to come up with a ratio.
10) Use this ratio rather than the number of routes to fit a regression model, along with other variables.

Appendix C Time of Day Factors by University by Student Residence Location

Below are provided tables of time of day factors for on and off campus students by trip type for each university surveyed. These can be used to develop trip tables by time of day for trip assignment based on the definition of peak and off periods.

A. Appalachian State University

Time of day factors for off campus and on campus students and all students combined are provided below for Appalachian State University.

Table 47 Off Campus Student Time of Day Factors Appalachian State University

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.35%	0.69%	0.00%	0.00%	0.00%	0.35%	0.49%
1:00	2:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.35%	0.12%
2:00	3:00	0.00%	1.04%	0.00%	0.00%	0.00%	0.71%	0.62%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.21%	0.07%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.46%	0.16%
5:00	6:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6:00	7:00	2.08%	0.00%	0.88%	0.00%	0.00%	1.87%	1.51%
7:00	8:00	4.82%	0.69%	1.13%	0.00%	0.00%	2.72%	3.06%
8:00	9:00	9.66%	1.04%	0.26%	0.00%	1.79%	3.05%	5.18%
9:00	10:00	7.62%	1.94%	7.59%	2.03%	6.92%	3.76%	7.14%
10:00	11:00	5.17%	3.64%	4.68%	1.76%	10.25%	2.50%	6.52%
11:00	12:00	3.12%	2.08%	0.88%	4.06%	9.58%	3.61%	5.31%
12:00	13:00	1.49%	5.07%	2.54%	4.06%	14.63%	4.57%	7.15%
13:00	14:00	3.19%	2.19%	3.97%	6.69%	14.62%	3.97%	7.09%
14:00	15:00	1.89%	3.63%	1.38%	11.38%	9.35%	4.06%	6.63%
15:00	16:00	2.19%	4.96%	5.29%	6.97%	12.85%	5.26%	8.11%
16:00	17:00	0.80%	6.12%	0.26%	4.59%	3.82%	7.98%	6.51%
17:00	18:00	1.24%	3.55%	4.06%	4.04%	4.81%	9.99%	7.06%
18:00	19:00	0.69%	3.08%	1.76%	10.13%	4.68%	12.40%	8.05%
19:00	20:00	1.89%	3.58%	0.88%	3.16%	4.13%	12.97%	7.66%
20:00	21:00	1.39%	2.78%	1.13%	3.04%	1.79%	8.91%	5.44%
21:00	22:00	0.35%	2.63%	0.88%	0.51%	0.00%	3.00%	2.29%
22:00	23:00	0.00%	0.69%	0.00%	0.00%	0.00%	5.50%	2.16%
23:00	24:00	0.69%	1.94%	0.00%	0.00%	0.78%	1.78%	1.68%
Grand Total		48.64%	51.36%	37.58%	62.42%	100.00%	100.00%	100.00%

Table 48 On Campus Student Time of Day Factors Appalachian State University

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.61%	0.00%	0.00%	0.30%	0.00%	0.37%
1:00	2:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2:00	3:00	1.82%	0.00%	0.00%	0.00%	0.00%	0.00%	0.55%
3:00	4:00	0.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.18%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5:00	6:00	0.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.18%
6:00	7:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
7:00	8:00	0.61%	0.00%	0.00%	0.00%	5.48%	5.88%	3.69%
8:00	9:00	1.21%	0.00%	0.00%	0.00%	4.87%	0.00%	3.32%
9:00	10:00	0.61%	0.00%	0.00%	0.00%	15.74%	0.00%	9.72%
10:00	11:00	4.25%	0.61%	3.13%	0.00%	11.79%	0.00%	8.80%
11:00	12:00	5.46%	0.00%	3.13%	0.00%	7.83%	0.00%	6.59%
12:00	13:00	7.89%	0.61%	3.13%	0.00%	10.34%	0.00%	9.03%
13:00	14:00	6.68%	0.00%	0.00%	0.00%	11.79%	0.00%	9.17%
14:00	15:00	3.64%	0.00%	6.25%	0.00%	6.08%	5.88%	5.35%
15:00	16:00	8.50%	1.21%	15.63%	0.00%	6.08%	0.00%	7.56%
16:00	17:00	5.46%	2.43%	9.38%	3.13%	3.95%	17.65%	6.08%
17:00	18:00	7.28%	1.82%	9.38%	6.25%	3.95%	17.65%	6.64%
18:00	19:00	6.07%	1.82%	0.00%	3.13%	3.95%	5.88%	5.16%
19:00	20:00	4.86%	1.21%	9.38%	6.25%	3.88%	0.00%	5.11%
20:00	21:00	7.28%	1.82%	3.13%	6.25%	2.74%	23.53%	5.71%
21:00	22:00	6.52%	0.61%	0.00%	6.25%	0.61%	11.76%	3.27%
22:00	23:00	1.82%	1.82%	3.13%	0.00%	0.30%	11.76%	1.84%
23:00	24:00	3.03%	1.21%	3.13%	0.00%	0.30%	0.00%	1.66%
Grand Total		84.22%	15.78%	68.75%	31.25%	100.00%	100.00%	100.00%

Table 49 All Students Time of Day Factors Appalachian State University

Start Time	End Time	All Students, All Trips
0:00	1:00	0.44%
1:00	2:00	0.07%
2:00	3:00	0.59%
3:00	4:00	0.12%
4:00	5:00	0.10%
5:00	6:00	0.07%
6:00	7:00	0.91%
7:00	8:00	3.31%
8:00	9:00	4.44%
9:00	10:00	8.17%
10:00	11:00	7.43%
11:00	12:00	5.82%
12:00	13:00	7.90%
13:00	14:00	7.92%
14:00	15:00	6.12%
15:00	16:00	7.89%
16:00	17:00	6.34%
17:00	18:00	6.89%
18:00	19:00	6.90%
19:00	20:00	6.65%
20:00	21:00	5.55%
21:00	22:00	2.68%
22:00	23:00	2.03%
23:00	24:00	1.67%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university

B. Fayetteville State University

Time of day factors for off campus and on campus students and all students combined are provided below for Fayetteville State University.

Table 50 Off Campus Student Time of Day Factors Fayetteville State University

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.57%	0.31%
1:00	2:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.34%	0.18%
2:00	3:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.16%	0.09%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.34%	0.18%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%	0.27%
5:00	6:00	0.79%	0.00%	0.00%	0.00%	0.00%	1.66%	1.08%
6:00	7:00	1.35%	0.00%	0.00%	0.00%	0.00%	2.44%	1.62%
7:00	8:00	12.95%	0.79%	2.76%	0.00%	2.57%	7.78%	7.91%
8:00	9:00	11.13%	0.40%	8.05%	0.54%	5.01%	6.07%	7.61%
9:00	10:00	8.47%	0.79%	2.22%	2.76%	9.90%	2.74%	5.07%
10:00	11:00	4.51%	1.98%	2.76%	2.16%	19.20%	2.87%	5.18%
11:00	12:00	3.21%	0.40%	2.70%	3.84%	16.26%	2.92%	4.62%
12:00	13:00	1.69%	4.18%	1.62%	13.08%	15.04%	5.99%	8.03%
13:00	14:00	3.32%	3.21%	3.99%	6.49%	11.12%	6.07%	7.25%
14:00	15:00	0.79%	5.67%	1.08%	5.16%	7.46%	6.80%	6.68%
15:00	16:00	1.58%	2.77%	2.16%	7.84%	4.89%	12.17%	9.56%
16:00	17:00	0.79%	4.15%	1.23%	4.98%	0.00%	7.77%	6.33%
17:00	18:00	5.26%	5.23%	8.88%	3.57%	6.11%	12.57%	11.63%
18:00	19:00	0.90%	0.79%	2.82%	2.16%	1.22%	6.16%	4.62%
19:00	20:00	0.00%	1.58%	0.00%	3.06%	1.22%	2.46%	2.27%
20:00	21:00	0.00%	3.88%	0.00%	2.31%	0.00%	4.26%	3.55%
21:00	22:00	0.00%	6.50%	0.00%	1.23%	0.00%	3.25%	3.41%
22:00	23:00	0.00%	0.90%	0.54%	0.00%	0.00%	2.82%	1.82%
23:00	24:00	0.00%	0.00%	0.00%	0.00%	0.00%	1.31%	0.71%
Grand Total		56.76%	43.24%	40.81%	59.19%	100.00%	100.00%	100.00%

Table 51 On Campus Student Time of Day Factors Fayetteville State University

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.00%	0.00%	0.00%	2.54%	0.00%	1.82%
1:00	2:00	0.00%	17.65%	0.00%	0.00%	4.24%	0.00%	4.85%
2:00	3:00	0.00%	0.00%	0.00%	0.00%	0.85%	11.11%	1.21%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.85%	0.00%	0.61%
5:00	6:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6:00	7:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
7:00	8:00	0.00%	0.00%	0.00%	0.00%	0.85%	0.00%	0.61%
8:00	9:00	0.00%	0.00%	0.00%	0.00%	6.78%	0.00%	4.85%
9:00	10:00	0.00%	0.00%	0.00%	0.00%	6.78%	0.00%	4.85%
10:00	11:00	5.88%	0.00%	0.00%	0.00%	7.63%	0.00%	6.06%
11:00	12:00	0.00%	0.00%	0.00%	0.00%	8.47%	11.11%	6.67%
12:00	13:00	0.00%	0.00%	9.52%	9.52%	11.02%	0.00%	10.30%
13:00	14:00	5.88%	0.00%	9.52%	0.00%	14.41%	0.00%	12.12%
14:00	15:00	0.00%	0.00%	14.29%	4.76%	3.39%	22.22%	6.06%
15:00	16:00	5.88%	5.88%	14.29%	4.76%	2.54%	0.00%	5.45%
16:00	17:00	5.88%	5.88%	0.00%	0.00%	0.85%	0.00%	1.82%
17:00	18:00	0.00%	5.88%	9.52%	0.00%	10.17%	0.00%	9.09%
18:00	19:00	0.00%	0.00%	4.76%	4.76%	3.39%	11.11%	4.24%
19:00	20:00	0.00%	11.76%	0.00%	0.00%	4.24%	33.33%	6.06%
20:00	21:00	0.00%	5.88%	0.00%	0.00%	0.00%	0.00%	0.61%
21:00	22:00	0.00%	5.88%	4.76%	4.76%	3.39%	0.00%	4.24%
22:00	23:00	5.88%	5.88%	0.00%	4.76%	3.39%	0.00%	4.24%
23:00	24:00	5.88%	0.00%	0.00%	0.00%	4.24%	11.11%	4.24%
Grand Total		35.29%	64.71%	66.67%	33.33%	100.00%	100.00%	100.00%

Table 52 All Students Time of Day Factors Fayetteville State University

Start Time	End Time	All Students, All Trips
0:00	1:00	0.73%
1:00	2:00	1.48%
2:00	3:00	0.40%
3:00	4:00	0.13%
4:00	5:00	0.37%
5:00	6:00	0.78%
6:00	7:00	1.17%
7:00	8:00	5.89%
8:00	9:00	6.84%
9:00	10:00	5.01%
10:00	11:00	5.42%
11:00	12:00	5.19%
12:00	13:00	8.66%
13:00	14:00	8.60%
14:00	15:00	6.51%
15:00	16:00	8.42%
16:00	17:00	5.08%
17:00	18:00	10.92%
18:00	19:00	4.52%
19:00	20:00	3.32%
20:00	21:00	2.73%
21:00	22:00	3.64%
22:00	23:00	2.50%
23:00	24:00	1.69%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university

C. North Carolina State University

Time of day factors for off campus and on campus students and all students combined are provided below for North Carolina State University.

Table 53 Off Campus Student Time of Day Factors North Carolina State University

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.00%	0.46%	0.00%	0.00%	0.00%	0.32%	0.26%
1:00	2:00	0.46%	0.46%	0.00%	0.00%	0.00%	0.00%	0.32%
2:00	3:00	0.00%	0.14%	0.00%	1.15%	0.00%	0.00%	0.21%
3:00	4:00	0.00%	0.00%	1.15%	0.00%	0.00%	0.00%	0.16%
4:00	5:00	0.31%	0.14%	0.00%	0.00%	0.75%	0.00%	0.32%
5:00	6:00	0.14%	0.14%	0.00%	0.00%	0.00%	0.16%	0.14%
6:00	7:00	0.14%	0.46%	0.00%	1.59%	0.00%	1.48%	0.87%
7:00	8:00	4.68%	0.93%	1.50%	0.00%	1.32%	5.85%	4.19%
8:00	9:00	10.09%	0.59%	5.24%	1.15%	4.16%	6.20%	7.35%
9:00	10:00	9.17%	1.84%	1.15%	1.15%	12.43%	3.44%	7.84%
10:00	11:00	5.48%	2.44%	2.28%	1.15%	7.09%	1.80%	5.29%
11:00	12:00	2.90%	4.17%	5.47%	3.00%	19.35%	4.04%	9.00%
12:00	13:00	2.43%	3.84%	3.34%	8.58%	10.82%	2.91%	7.04%
13:00	14:00	1.38%	5.36%	3.67%	10.77%	11.18%	5.67%	8.45%
14:00	15:00	2.58%	3.98%	2.65%	3.34%	8.88%	6.30%	6.90%
15:00	16:00	1.80%	2.80%	1.59%	3.88%	6.98%	7.88%	6.21%
16:00	17:00	0.60%	3.50%	0.00%	8.83%	4.67%	7.58%	5.92%
17:00	18:00	2.27%	5.59%	5.56%	8.03%	5.12%	9.75%	8.63%
18:00	19:00	0.45%	4.11%	3.80%	6.53%	1.18%	8.52%	5.82%
19:00	20:00	0.46%	3.25%	0.00%	2.28%	2.92%	7.21%	4.38%
20:00	21:00	0.93%	3.45%	0.00%	0.44%	2.92%	7.16%	4.35%
21:00	22:00	0.14%	3.77%	0.00%	0.00%	0.22%	5.07%	2.92%
22:00	23:00	0.00%	1.73%	0.00%	0.69%	0.00%	6.21%	2.55%
23:00	24:00	0.00%	0.45%	0.00%	0.00%	0.00%	2.43%	0.88%
Grand Total		46.40%	53.60%	37.42%	62.58%	100.00%	100.00%	100.00%

Table 54 On Campus Student Time of Day Factors North Carolina State University

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.00%	0.00%	0.00%	0.37%	0.00%	0.32%
1:00	2:00	0.00%	1.70%	1.86%	0.00%	0.74%	3.11%	0.95%
2:00	3:00	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.11%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.12%	3.11%	0.21%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5:00	6:00	0.00%	0.00%	0.00%	0.00%	0.50%	0.00%	0.42%
6:00	7:00	0.00%	0.00%	0.00%	1.86%	0.00%	0.00%	0.11%
7:00	8:00	0.00%	0.00%	1.86%	1.86%	3.47%	0.00%	3.15%
8:00	9:00	3.92%	1.70%	0.00%	2.14%	6.82%	0.00%	6.25%
9:00	10:00	0.00%	0.00%	0.00%	0.00%	8.31%	0.00%	7.05%
10:00	11:00	0.00%	1.70%	3.72%	0.00%	8.55%	0.00%	7.57%
11:00	12:00	0.00%	0.00%	3.72%	2.14%	10.25%	0.00%	9.02%
12:00	13:00	0.00%	1.70%	8.39%	4.67%	10.60%	0.00%	9.83%
13:00	14:00	1.70%	0.00%	11.16%	5.58%	8.57%	0.00%	8.32%
14:00	15:00	3.40%	3.40%	4.00%	2.14%	7.48%	6.22%	7.32%
15:00	16:00	1.70%	1.70%	10.82%	0.00%	4.86%	6.22%	5.15%
16:00	17:00	3.40%	6.81%	7.73%	0.00%	4.50%	9.33%	5.20%
17:00	18:00	6.81%	2.57%	5.58%	2.14%	6.40%	19.13%	7.09%
18:00	19:00	13.62%	1.96%	1.86%	0.00%	5.78%	12.44%	6.39%
19:00	20:00	3.66%	4.53%	7.44%	0.00%	4.04%	12.44%	4.78%
20:00	21:00	1.96%	3.40%	1.86%	0.00%	2.79%	6.22%	3.01%
21:00	22:00	0.00%	5.62%	3.72%	1.86%	2.48%	3.11%	2.87%
22:00	23:00	5.11%	5.98%	1.86%	0.00%	1.74%	9.33%	2.58%
23:00	24:00	5.11%	6.81%	0.00%	0.00%	1.51%	9.33%	2.33%
Grand Total		50.40%	49.60%	75.59%	24.41%	100.00%	100.00%	100.00%

Table 55 All Students Time of Day Factors North Carolina State University

Start Time	End Time	All Students, All Trips
0:00	1:00	0.28%
1:00	2:00	0.55%
2:00	3:00	0.17%
3:00	4:00	0.18%
4:00	5:00	0.20%
5:00	6:00	0.24%
6:00	7:00	0.60%
7:00	8:00	3.82%
8:00	9:00	6.95%
9:00	10:00	7.56%
10:00	11:00	6.11%
11:00	12:00	9.00%
12:00	13:00	8.04%
13:00	14:00	8.40%
14:00	15:00	7.05%
15:00	16:00	5.83%
16:00	17:00	5.66%
17:00	18:00	8.08%
18:00	19:00	6.03%
19:00	20:00	4.52%
20:00	21:00	3.87%
21:00	22:00	2.90%
22:00	23:00	2.56%
23:00	24:00	1.40%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university

D. UNC Charlotte

Time of day factors for off campus and on campus students and all students combined are provided below for University of North Carolina at Charlotte.

Table 56 Off Campus Student Time of Day Factors University of North Carolina at Charlotte

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.00%	0.22%	0.00%	0.00%	0.00%	0.34%	0.22%
1:00	2:00	0.00%	0.07%	0.00%	0.00%	0.00%	0.47%	0.23%
2:00	3:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.44%	0.20%
3:00	4:00	0.00%	0.00%	0.00%	0.17%	0.00%	0.00%	0.02%
4:00	5:00	0.03%	0.07%	0.00%	0.00%	0.00%	0.15%	0.10%
5:00	6:00	0.30%	0.00%	0.17%	0.00%	0.00%	0.65%	0.40%
6:00	7:00	1.99%	0.00%	0.48%	0.00%	0.17%	2.92%	1.97%
7:00	8:00	8.17%	0.76%	2.29%	0.34%	1.19%	5.84%	5.75%
8:00	9:00	8.27%	0.22%	1.56%	0.59%	1.60%	4.45%	5.00%
9:00	10:00	7.30%	1.39%	3.45%	1.78%	7.20%	3.29%	5.67%
10:00	11:00	7.83%	1.92%	2.41%	2.10%	13.67%	2.86%	6.54%
11:00	12:00	3.26%	1.50%	2.08%	3.58%	5.87%	3.42%	4.43%
12:00	13:00	3.33%	4.32%	2.45%	8.00%	15.70%	4.44%	7.64%
13:00	14:00	3.39%	2.77%	5.35%	5.14%	14.60%	4.94%	7.28%
14:00	15:00	1.11%	1.84%	2.26%	6.58%	5.22%	5.58%	5.17%
15:00	16:00	1.83%	5.99%	2.93%	7.41%	13.16%	5.31%	7.74%
16:00	17:00	2.07%	4.21%	4.48%	4.77%	7.99%	8.36%	7.80%
17:00	18:00	0.96%	5.51%	2.23%	8.64%	6.19%	8.70%	7.99%
18:00	19:00	0.84%	3.57%	1.92%	4.56%	3.84%	8.89%	6.58%
19:00	20:00	0.73%	2.57%	0.42%	3.86%	0.97%	7.79%	5.10%
20:00	21:00	0.43%	4.09%	0.90%	3.90%	1.51%	8.00%	5.69%
21:00	22:00	0.44%	3.51%	0.51%	1.78%	0.69%	6.50%	4.43%
22:00	23:00	0.07%	1.26%	0.07%	0.49%	0.42%	4.12%	2.34%
23:00	24:00	0.07%	1.78%	0.17%	0.17%	0.00%	2.53%	1.71%
Grand Total		52.42%	47.58%	36.15%	63.85%	100.00%	100.00%	100.00%

Table 57 On Campus Student Time of Day Factors University of North Carolina at Charlotte

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.00%	0.00%	0.00%	0.60%	0.00%	0.45%
1:00	2:00	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.09%
2:00	3:00	0.00%	1.23%	0.00%	0.00%	0.00%	0.00%	0.18%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.09%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5:00	6:00	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.09%
6:00	7:00	1.32%	0.00%	0.00%	0.00%	0.36%	0.29%	0.48%
7:00	8:00	0.75%	0.00%	1.53%	1.53%	2.75%	0.00%	2.34%
8:00	9:00	2.45%	1.23%	0.00%	0.00%	2.16%	0.00%	2.15%
9:00	10:00	1.79%	0.61%	0.00%	3.06%	8.22%	3.64%	6.84%
10:00	11:00	1.23%	0.56%	1.53%	3.06%	11.50%	3.49%	9.28%
11:00	12:00	2.45%	1.23%	6.12%	3.06%	4.80%	3.64%	4.84%
12:00	13:00	0.61%	0.61%	1.77%	1.53%	12.72%	5.47%	10.13%
13:00	14:00	1.84%	0.61%	1.53%	1.53%	9.94%	3.64%	8.13%
14:00	15:00	0.61%	1.23%	6.12%	4.59%	3.99%	3.64%	4.05%
15:00	16:00	7.49%	1.84%	6.12%	1.53%	8.52%	10.93%	8.70%
16:00	17:00	4.29%	4.29%	6.45%	4.59%	6.47%	7.69%	7.10%
17:00	18:00	4.90%	3.68%	16.83%	0.00%	5.88%	15.26%	7.38%
18:00	19:00	6.13%	5.00%	6.12%	4.59%	7.20%	12.75%	8.25%
19:00	20:00	3.06%	6.13%	1.53%	1.53%	4.92%	3.64%	5.37%
20:00	21:00	3.68%	7.62%	4.59%	1.53%	3.83%	14.57%	5.59%
21:00	22:00	2.45%	7.96%	3.06%	0.00%	2.88%	7.69%	4.23%
22:00	23:00	2.40%	5.08%	0.00%	1.53%	1.32%	3.64%	2.35%
23:00	24:00	1.23%	2.45%	1.53%	1.53%	1.56%	0.00%	1.88%
Grand Total		48.66%	51.34%	64.82%	35.18%	100.00%	100.00%	100.00%

Table 58 All Students Time of Day Factors University of North Carolina at Charlotte

Start Time	End Time	All Students, All Trips
0:00	1:00	0.26%
1:00	2:00	0.20%
2:00	3:00	0.19%
3:00	4:00	0.04%
4:00	5:00	0.08%
5:00	6:00	0.33%
6:00	7:00	1.65%
7:00	8:00	5.03%
8:00	9:00	4.40%
9:00	10:00	5.92%
10:00	11:00	7.12%
11:00	12:00	4.52%
12:00	13:00	8.17%
13:00	14:00	7.46%
14:00	15:00	4.93%
15:00	16:00	7.94%
16:00	17:00	7.65%
17:00	18:00	7.86%
18:00	19:00	6.93%
19:00	20:00	5.16%
20:00	21:00	5.67%
21:00	22:00	4.39%
22:00	23:00	2.34%
23:00	24:00	1.75%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university

E. UNC Greensboro

Time of day factors for off campus and on campus students and all students combined are provided below for University of North Carolina at Greensboro.

Table 59 Off Campus Student Time of Day Factors University of North Carolina at Greensboro

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1:00	2:00	0.27%	0.27%	0.00%	0.00%	0.00%	1.48%	0.85%
2:00	3:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	0.07%
3:00	4:00	0.27%	0.27%	0.00%	0.00%	0.00%	0.00%	0.14%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5:00	6:00	0.41%	0.27%	0.00%	1.01%	0.00%	0.52%	0.57%
6:00	7:00	0.97%	0.00%	0.00%	0.51%	0.00%	2.76%	1.63%
7:00	8:00	8.62%	1.09%	2.40%	0.00%	2.55%	5.82%	5.93%
8:00	9:00	10.22%	0.00%	4.42%	0.52%	1.92%	4.64%	5.77%
9:00	10:00	9.23%	1.23%	2.28%	1.01%	7.70%	2.99%	5.56%
10:00	11:00	6.83%	1.65%	2.04%	2.03%	14.26%	3.34%	6.16%
11:00	12:00	3.05%	2.36%	3.12%	8.14%	10.79%	3.61%	6.05%
12:00	13:00	2.59%	4.00%	3.39%	8.34%	15.22%	6.16%	8.20%
13:00	14:00	4.24%	3.19%	4.18%	2.55%	15.45%	4.65%	7.04%
14:00	15:00	1.10%	2.05%	0.51%	3.55%	8.35%	3.91%	4.31%
15:00	16:00	2.19%	5.10%	4.90%	11.08%	11.36%	6.03%	8.42%
16:00	17:00	1.10%	5.96%	2.88%	2.79%	6.61%	7.84%	7.18%
17:00	18:00	2.33%	2.61%	0.78%	10.03%	2.21%	10.39%	8.00%
18:00	19:00	1.92%	3.98%	1.10%	4.34%	0.00%	9.83%	6.95%
19:00	20:00	0.55%	3.06%	2.04%	3.41%	1.37%	7.10%	5.24%
20:00	21:00	0.55%	1.24%	0.00%	1.27%	0.55%	6.81%	3.95%
21:00	22:00	0.28%	2.34%	1.01%	1.78%	1.10%	5.58%	3.86%
22:00	23:00	0.41%	1.92%	0.51%	1.03%	0.55%	2.98%	2.30%
23:00	24:00	0.27%	0.00%	0.00%	1.02%	0.00%	3.40%	1.83%
Grand Total		57.42%	42.58%	35.58%	64.42%	100.00%	100.00%	100.00%

Table 60 On Campus Student Time of Day Factors University of North Carolina at Greensboro

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.18%
1:00	2:00	0.00%	1.61%	1.79%	0.00%	0.52%	0.00%	0.74%
2:00	3:00	0.00%	1.61%	0.00%	0.00%	0.00%	0.00%	0.18%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.18%
5:00	6:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6:00	7:00	1.61%	0.00%	0.00%	0.00%	0.00%	2.57%	0.37%
7:00	8:00	1.61%	0.00%	0.00%	3.57%	3.88%	2.57%	3.50%
8:00	9:00	1.61%	0.00%	0.00%	0.00%	5.93%	0.00%	4.40%
9:00	10:00	1.61%	0.00%	3.57%	3.57%	9.05%	0.00%	7.36%
10:00	11:00	0.00%	0.00%	5.36%	0.00%	10.09%	0.00%	7.73%
11:00	12:00	0.00%	0.00%	5.36%	1.79%	6.45%	7.70%	5.87%
12:00	13:00	4.84%	4.84%	3.57%	5.36%	11.63%	5.13%	10.66%
13:00	14:00	4.78%	0.00%	5.36%	3.57%	8.02%	7.70%	7.72%
14:00	15:00	1.61%	4.84%	3.57%	1.79%	3.09%	7.60%	4.03%
15:00	16:00	0.00%	6.46%	3.57%	1.79%	9.04%	10.27%	8.46%
16:00	17:00	3.23%	6.46%	5.36%	3.57%	4.40%	2.57%	5.34%
17:00	18:00	1.61%	1.61%	3.57%	1.79%	7.50%	15.40%	7.36%
18:00	19:00	3.23%	1.61%	3.57%	5.36%	5.16%	17.97%	6.43%
19:00	20:00	6.46%	6.46%	10.72%	5.29%	4.66%	7.70%	6.98%
20:00	21:00	6.46%	9.68%	3.57%	1.79%	3.61%	5.13%	5.33%
21:00	22:00	0.00%	6.46%	0.00%	0.00%	2.58%	5.13%	2.94%
22:00	23:00	1.61%	4.84%	1.79%	0.00%	3.62%	2.57%	3.68%
23:00	24:00	0.00%	3.23%	0.00%	0.00%	0.00%	0.00%	0.55%
Grand Total		40.29%	59.71%	60.76%	39.24%	100.00%	100.00%	100.00%

Table 61 All Students Time of Day Factors University of North Carolina at Greensboro

Start Time	End Time	All Students, All Trips
0:00	1:00	0.05%
1:00	2:00	0.81%
2:00	3:00	0.10%
3:00	4:00	0.10%
4:00	5:00	0.05%
5:00	6:00	0.40%
6:00	7:00	1.26%
7:00	8:00	5.21%
8:00	9:00	5.37%
9:00	10:00	6.09%
10:00	11:00	6.62%
11:00	12:00	6.00%
12:00	13:00	8.93%
13:00	14:00	7.24%
14:00	15:00	4.23%
15:00	16:00	8.43%
16:00	17:00	6.64%
17:00	18:00	7.81%
18:00	19:00	6.80%
19:00	20:00	5.75%
20:00	21:00	4.35%
21:00	22:00	3.59%
22:00	23:00	2.71%
23:00	24:00	1.45%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university

F. UNC Wilmington

Time of day factors for off campus and on campus students and all students combined are provided below for University of North Carolina at Wilmington.

Table 62 Off Campus Student Time of Day Factors University of North Carolina at Wilmington

Start Time	End Time	Hm to U	U to Hm	NH outside to U	U to NH outside	Inside	Outside	Total
0:00	1:00	0.00%	0.32%	0.00%	0.00%	0.00%	0.31%	0.23%
1:00	2:00	0.00%	0.36%	0.32%	0.00%	0.00%	0.36%	0.30%
2:00	3:00	0.00%	0.24%	0.00%	0.00%	0.00%	0.09%	0.11%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.09%	0.04%
5:00	6:00	0.24%	0.12%	0.00%	0.00%	0.00%	0.28%	0.23%
6:00	7:00	1.03%	0.24%	0.64%	0.00%	0.24%	1.41%	1.09%
7:00	8:00	7.32%	1.03%	2.50%	0.00%	0.72%	5.07%	5.12%
8:00	9:00	7.44%	1.31%	3.25%	0.53%	4.78%	5.22%	6.09%
9:00	10:00	7.92%	1.55%	3.42%	2.40%	9.97%	3.34%	6.57%
10:00	11:00	4.87%	1.70%	3.89%	1.49%	14.98%	3.52%	6.47%
11:00	12:00	2.63%	2.51%	2.76%	4.43%	11.16%	2.91%	5.39%
12:00	13:00	1.96%	4.22%	3.94%	8.11%	13.63%	5.31%	7.66%
13:00	14:00	3.32%	3.94%	3.14%	6.78%	12.91%	4.99%	7.50%
14:00	15:00	1.06%	4.65%	4.00%	4.74%	4.19%	5.37%	5.68%
15:00	16:00	2.12%	5.28%	2.34%	6.62%	10.07%	6.87%	7.78%
16:00	17:00	1.09%	4.69%	2.34%	6.62%	4.98%	8.98%	7.35%
17:00	18:00	1.86%	4.50%	2.61%	6.40%	2.70%	10.92%	7.99%
18:00	19:00	2.67%	4.21%	1.12%	3.88%	4.41%	8.96%	7.14%
19:00	20:00	0.73%	2.49%	1.17%	3.53%	2.87%	6.08%	4.53%
20:00	21:00	0.85%	2.60%	0.32%	2.77%	1.51%	7.42%	4.76%
21:00	22:00	0.48%	3.20%	0.64%	1.33%	0.40%	6.39%	4.10%
22:00	23:00	0.12%	1.50%	0.32%	0.32%	0.24%	3.47%	2.06%
23:00	24:00	0.12%	1.55%	0.64%	0.00%	0.24%	2.64%	1.80%
Grand Total		47.80%	52.20%	39.39%	60.61%	100.00%	100.00%	100.00%

Table 63 On Campus Student Time of Day Factors University of North Carolina at Wilmington

Start Time	End Time	UH to Outside	Outside to UH	U to Outside	Outside to U	Inside	Outside	Total
0:00	1:00	0.00%	0.47%	0.00%	0.90%	0.31%	0.00%	0.36%
1:00	2:00	0.47%	0.93%	0.90%	0.00%	0.24%	0.00%	0.42%
2:00	3:00	0.00%	0.00%	0.90%	0.90%	0.00%	0.00%	0.12%
3:00	4:00	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%	0.06%
4:00	5:00	0.00%	0.00%	0.00%	0.00%	0.16%	0.00%	0.12%
5:00	6:00	0.93%	0.00%	0.00%	0.00%	0.08%	0.00%	0.18%
6:00	7:00	1.86%	0.47%	0.90%	0.00%	0.47%	0.00%	0.72%
7:00	8:00	1.86%	0.00%	0.00%	0.00%	3.32%	0.00%	2.78%
8:00	9:00	1.86%	0.00%	0.00%	0.00%	4.48%	0.00%	3.66%
9:00	10:00	0.93%	0.00%	0.00%	0.00%	8.88%	0.00%	6.90%
10:00	11:00	1.40%	0.47%	0.90%	1.80%	11.46%	2.99%	9.30%
11:00	12:00	1.40%	0.47%	2.70%	0.90%	6.78%	1.49%	5.72%
12:00	13:00	2.79%	2.33%	8.11%	2.70%	8.82%	5.97%	8.36%
13:00	14:00	1.86%	2.33%	8.11%	3.60%	10.77%	2.99%	9.67%
14:00	15:00	3.72%	1.86%	3.60%	2.70%	4.89%	2.99%	5.00%
15:00	16:00	4.19%	4.19%	7.21%	2.70%	6.15%	4.48%	6.62%
16:00	17:00	3.26%	4.19%	3.60%	6.31%	7.07%	13.43%	7.56%
17:00	18:00	4.65%	5.58%	3.60%	2.70%	4.30%	13.43%	5.56%
18:00	19:00	5.58%	2.33%	9.01%	3.60%	6.62%	13.43%	7.46%
19:00	20:00	3.26%	8.37%	4.50%	6.31%	5.08%	10.45%	6.52%
20:00	21:00	3.26%	6.05%	2.70%	1.80%	3.72%	11.94%	4.82%
21:00	22:00	0.47%	4.19%	3.60%	0.90%	3.01%	8.96%	3.56%
22:00	23:00	2.33%	4.19%	0.90%	0.00%	2.43%	4.48%	2.94%
23:00	24:00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Grand Total		47.91%	52.09%	62.16%	37.84%	100.00%	100.00%	100.00%

Table 64 All Students Time of Day Factors University of North Carolina at Wilmington

Start Time	End Time	All Students, All Trips
0:00	1:00	0.28%
1:00	2:00	0.34%
2:00	3:00	0.11%
3:00	4:00	0.02%
4:00	5:00	0.07%
5:00	6:00	0.21%
6:00	7:00	0.95%
7:00	8:00	4.25%
8:00	9:00	5.18%
9:00	10:00	6.70%
10:00	11:00	7.53%
11:00	12:00	5.51%
12:00	13:00	7.92%
13:00	14:00	8.31%
14:00	15:00	5.43%
15:00	16:00	7.34%
16:00	17:00	7.43%
17:00	18:00	7.09%
18:00	19:00	7.26%
19:00	20:00	5.27%
20:00	21:00	4.78%
21:00	22:00	3.90%
22:00	23:00	2.39%
23:00	24:00	1.72%
Grand Total		100.0%

Notes:

1) H: Home
2) U: University
3) NH Outside: A non-home place outside of university
4) Inside: Inside university
5) Outside: Outside university
6) UH: Home inside university