APPENDIX

Sample Frequencies of Unlinked Trips by Purpose, Mode and Household Characteristics

As a preliminary step to selecting a sample of data to be used in the estimation of parameters of the demand model, the raw data for a random sample of 150 households were examined. The objectives of this examination were: to determine the frequencies of trips per household, as an aid in selecting the sample size for actual empirical estimation; to determine frequencies of trips by purpose and mode for the same reason; to see how complex trips really are in the raw, unlinked stage; to see how frequently multimode or multipurpose trips occur; and generally to provide an early perspective on the trip and household data which could be used in guiding our thinking in the theory development stages of the study.

This appendix describes the frequencies of different types of trips found in cross-classifying the raw data for the sample of 150 households.

Table A.1 presents a summary of the trip data for the sample of households and the proportions of single-purpose and single-mode trips relative to more complex trips. An interesting observation is the substantial number of non-trip-makers, about 40 percent of the sample. Another important result is that even in the raw, unlinked stage the large majority of trips are single-purpose and single-mode trips. Further detail on both the non-trip-makers and the frequencies of trips by purpose and mode will be given below.

Table A.2 gives a breakdown of the frequencies of trips by purpose and mode, and table A.3 shows the percentage breakdown of these trips. These tables show that, as expected, work trips are the most frequent trip purpose. Single-purpose work trips make up about 28 percent of total trips in the sample. Since the auto passenger trips involve decisions

Table A.1
Summary of trip data.

Household data	
Households	150
People	477
Trip-makers	284 (59.53%)
Non-trip-makers	193 (40.46%)
Trips/household	2.44
Trips/trip-maker	1.29
People/household	3.18
Trip data	
Total round trips from home	366
Single-purpose trips	300 (81.96%)
Multipurpose trips	66 (18.03%)
Single-mode trips	347 (94.80%)
Multimode trips	19 (5.19%)
Multimode, multipurpose trips	8 (2.18%)

among several persons, they are more complicated to analyze than either auto driver (driving alone) or bus trips. Work trips by these latter two modes comprise 80 of the 366 total trips, or about 22 percent. In fact, looking down the list of trip purposes, it can be seen that 25 of the single-purpose trips are serve-passenger trips, which involve decisions among several persons. The combination of auto passenger trips and auto drivers serving passengers is sizeable, comprising 102 of the 366 trips, or about 28 percent of the total. When these trips are subtracted, the number of single-mode and single-purpose trips drops from 289 to 187, or only about 51 percent of the total sample of 366 trips. Thus the number of complex trips is substantial. In Pittsburgh, where there is very little transference from one transit mode to another, the number of multimode trips is accordingly small. With a more complicated transit system, the number of multimode transit trips would be greater; and, accordingly, the number of relatively simple trips would probably be less than half the total.

Tables A.4 to A.6 give additional detail on multipurpose trips. Dual-purpose trips are more complex than might be expected. Except where work is one of the purposes, or where the two purposes are the same, it is difficult to decide which of the two purposes generated the trip. We have made some largely arbitrary categorizations of these trips at the top of table A.4, but the actual trip combinations are given below.

Table A.2
Frequency of trips by mode and purpose.

(Units: round trip from home)

Purpose	Auto driver	Auto passenger	Bus	Streetcar	Taxi	School Bus	Single-mode total	Multi-mode	Total
Work	72	19	8	—	—	—	99	3	102
Shop	26	15	2	—	—	—	43	—	43
Personal business	14	13	3	—	1	—	31	3	34
School	5	11	4	1	—	35	56	5	61
Recreation	6	10	—	—	—	—	16	—	16
Social	10	8	—	—	—	—	18	—	18
Serve-passenger	25	—	—	—	—	—	25	—	25
Ride	—	1	—	—	—	—	1	—	1
Single purpose total	158	77	17	1	1	35	289	11	300
Dual-purpose	29	6	—	—	—	—	35	4	39
Tri-purpose	12	2	1	—	—	—	15	3	18
Four or more purposes	6	2	—	—	—	—	8	1	9
Multipurpose total	47	10	1	—	—	—	58	8	66
Total	205	87	18	1	1	35	347	19	366

Table A.3
Types of trips by mode and purpose.

(Units: % of total 366 round trips from home)

Purpose	Auto driver	Auto passenger	Bus	Streetcar	Taxi	School Bus	Single-mode total	Multi-mode	Total
Work	19.67	5.19	2.18	—	—	—	27.04	0.81	27.86
Shop	7.10	4.09	0.54	—	—	—	11.74	—	11.74
Personal business	3.82	3.55	0.81	—	—	—	8.46	0.81	9.28
School	1.36	3.00	1.09	0.27	—	9.56	15.30	1.36	16.66
Recreation	1.63	2.73	—	—	—	—	4.37	—	4.37
Social	2.73	2.18	—	—	—	—	4.91	—	4.91
Serve-passenger	6.83	—	—	—	—	—	6.83	—	6.83
Ride	—	0.27	—	—	—	—	0.27	—	0.27
Single-purpose total	43.16	21.03	4.64	0.27	0.27	9.56	78.96	3.00	81.96
Dual-purpose	7.92	1.63	—	—	—	—	9.56	1.09	10.65
Tri-purpose	3.27	0.54	0.27	—	—	—	4.09	0.81	4.91
Four or more purposes	1.63	0.54	—	—	—	—	2.18	0.27	2.45
Multipurpose total	12.84	2.73	0.27	—	—	—	15.84	2.18	18.03
Total	56.01	23.77	4.91	0.27	0.27	9.56	94.80	5.19	99.99

Table A.4
Dual-purpose trips.

(Units: round trip from home)

Work	16
Shop and personal business	17
Serve-passenger	3
Recreation and social	3
Total	39

Actual trip patterns observed

Number of observations	Pattern	Number of observations	Pattern
Work		*Shop and personal business*	
7	H-W-S-H	9	H-P-S-H
4	H-W-Soc-H	2	H-S-S-H
2	H-W-SP-H	2	H-S-Soc-H
2	H-W-R-H	1	H-S-SP-H
1	H-W-W-H	1	H-Soc-P-H
		1	H-Sch-P-H
		1	H-Sch-S-H
Serve-passenger		*Recreation and social*	
1	H-Sch-SP-H	1	H-R-Soc-H
1	H-SP-SP-H	2	H-Sch-Soc-H
1	H-R-SP-H		

The same procedure is followed for tri-purpose and four-purpose trips in tables A.5 and A.6. The notation used is as follows:

H = home,
W = work,
S = shop,
Sch = school,
C = change travel mode,
P = personal business,
Soc = social,
R = recreation,
SP = serve-passenger.

Tri-purpose trips are at once more complex and less complex than dual-purpose trips. They involve an additional stop; yet there is a

Table A.5
Tri-purpose trips.

(Units: round trip from home)

Work	9
Shop and personal business	9
Total	18

Actual trip patterns observed

Number of observations	Pattern	Number of observations	Pattern
Work		*Shop and personal business*	
2	H-SP-W-SP-H	2	H-P-S-S-H
2	H-C-W-C-H	1	H-SP-S-SP-H
1	H-W-Sch-R-H	1	H-S-S-S-H
1	H-W-W-W-H	1	H-Soc-Soc-S-H
1	H-W-P-W-H	1	H-Soc-P-Soc-H
1	H-P-W-SP-H	1	H-S-SP-P-H
1	H-S-W-S-H	1	H-P-Soc-S-H
		1	H-P-SP-Soc-H

Table A.6
Four-purpose trips.

(Units: round trip from home)

Work	3
Shop and personal business	5
Serve-passenger	1
Total	9

Actual trip patterns observed

Number of observations	Pattern	Number of observations	Pattern
Work		*Shop and personal business*	
1	H-W-W-W-W-H	2	H-S-S-S-P-H
1	H-SP-C-Sch-W-H	1	H-P-R-R-P-SP-H
1	H-W-W-W-W-W-W-W	2	H-S-S-S-S-S-H
Serve-passenger			
1	H-SP-SP-SP-P-SP-SP-S-H		

greater chance for one purpose to be repeated once or twice. The latter point may indicate what generated the trip. Although such an assumption may also prove fallacious—an example being a pattern H-SP-W-SP-H. For despite the fact that SP is repeated twice, the prime purpose involved is a work trip which happens to be combined with perhaps a car pool. Again, a point is reached where categorizing trip purposes is arbitrary unless it is a work trip in part, or the purpose is repeated three times.

As noted earlier, of the 150 households and 477 people in the sample, 193 people, or 40.46 percent of the sample, took no trips at all during the travel day. When this group was broken down, it revealed that of this group approximately half had actually stayed home. The reason for this difference is that walking trips were not counted, and that trips do not always show if the work place was not the usual, if the trip was made by truck, or if the trip was made by "non-motorized vehicle". Trips by drivers of commercial vehicles also do not show up. The groups who made no trips are shown in table A.7.

Table A.7
Non-trip-makers.

Students	82
Housewives	42
Elderly	36
Walked or worked at home	8
Employed but not at work	9
Unemployed	5
Drove truck	5
Went in vehicle	2
Pre-school	2
Worked away from usual place	2
Total	193

It can be assumed that most of the students walked to school. Of the housewives making no trips, 30 of the 42 were left at home without a car; and of this group of 30, only 3 of the households did not own a car. Eleven of the elderly who did not make trips were in households which did own cars. Seven people made trips which did not show up in the survey: 5 drove a truck and 3 worked away from their normal place of employment.

An effort was made to determine whether or not car pooling could be

picked up in the data. This was done by picking out the passenger work trips and serve-passenger trips which are combined with work trips. The problem is that the way the data are organized, the only information that can be gained about passenger trips is whether the passenger is being driven by a household member and, likewise, for serve-passenger trips, whether the rider is a household member. Consequently, the knowledge gained about the nature of these trips is quite incomplete. All that can be picked out from the data is which trips look like car pool trips.

Among the serve-passenger trips, there were two of the pattern H-SP-W-SP-H which could be car pools, as the passenger is not a household member; but there is no way of knowing with certainty what the passenger is doing or whether it is the same passenger both times. Among passenger work trips (round trips), 3 were driven by household members, and 17 were driven by non-household members. These 17 are possible car pool trips, but there is no way of knowing for sure whether or not these are regular car pools.

Therefore, the data indicates only that there are 17 work trips (comprising about 17 percent of total work trips) which are potentially car pools. The assumption cannot be verified.

Having gained an impression of the frequency of types and modes of trips, certain socioeconomic characteristics of the 150 households were examined to see their relationships to trip frequencies. For this purpose the number of trips per household was not computed on a round trip or linked-trip from home-to-home basis. Instead, the SPRPC definition of a trip as "one-way travel from one place to another" was used.

Table A.1 showed that with 150 households and 366 trips, the average number of round trips per household was 2.44. Yet some households made more trips and others made none. Table A.8 shows the relationship between auto ownership and trips per household.

Households with no cars made the least trips, and of the 33 households in this category, 19 made no trips on the travel day. Households with one car made about half the number of trips that two-car families made; likewise the number of licensed drivers per household goes up from one to two between the two categories. The relative increase in numbers of trips generated begins to level off with three-car families.

Table A.8 shows that the modes used by each type of household reflect the increased availability of cars.

Table A.8
Trips generated per household by car ownership.

Number of cars owned	Mean	Median
0	1.39	0
1	5.71	7
2	10.55	9
3	10.60	11

Table A.9
Percentage distribution of trips by mode.

Number of cars	Auto driver	Auto passenger	Bus	Taxi	School bus	Street-car	Total
0	4.34	36.95	45.65	4.34	8.69	—	100
1	53.40	30.45	5.22	0.45	10.00	0.45	100
2	70.40	18.67	3.44	—	7.47	—	100
3	77.35	15.09	—	3.77	3.77	—	100

Car ownership substantially affects the frequency of transit ridership. Household data shows that gross household income and car ownership are positively related.

The final aspect of the review of the initial sample of 150 households was to break down the households according to "life cycle" and ownership, and to look at the number of trips by mode for each category generated.

"Life cycle" was defined by essentially two household characteristics, marriage status and age of children. The age ranges of children are pre-school, school, and grown, with the distinction between school-age and grown resting on whether or not the child is a licensed driver. Dependents other than children were categorized as school-age or grown according to their license status. The nine life-cycle categories were:

(1) Married, no children;
(2) Married, pre-school children;
(3) Married, school children;
(4) Married, grown children;
(5) Married, pre-school and school;
(6) Married, school and grown;
(7) Married, pre-school and grown;

(8) Married, pre-school, school, and grown;
(9) Single, young and elderly.

Table A.10 shows the number of cars owned by the various types of households. Table A.11 shows the cross effects of car ownership and life cycle on the number of trips by mode.

Table A.10
Households by life cycle—car ownership.

(Units: number of households)

Type of household	Number of cars				
	0	1	2	3 or more	Total
(1) Married, no children	13	17	6	—	36
(2) Married, pre-school	—	4	2	1	7
(3) Married, school	5	19	5	—	29
(4) Married, grown	1	9	9	4	23
(5) Married, pre-school and school	1	19	3	—	23
(6) Married, school and grown	—	5	7	2	14
(7) Married, pre-school and grown	—	—	1	—	1
(8) Married, all	—	1	—	1	2
(9) Single, young and elderly	6	2	—	—	8
	7	1	—	—	8
Total	33	77	33	8	151

Table A.11
Trip generation of households by life cycle.

(Unit: unlinked trips)

	Married, no children	Married, pre-school	Married, school	Married, grown	Married, pre-school and school	Married, school and grown	Married, pre-school and grown	Married, all	Single, young/ elderly
Number of households	36	6	29	23	23	14	1	1	16
No car, total trips	14	0	19	2	3	0	0	0	6/2
Driver	2	—	—	—	—	—	—	—	2/2
Passenger	6	—	5	2	—	—	—	—	—
School bus	—	—	4	—	—	—	—	—	—
Bus	6	—	10	2	—	—	—	—	3/0
Taxi	—	—	—	—	1	—	—	—	0/1
1 car, total trips	58	14	171	33	96	48	0	4	8/2
Driver	37	10	81	19	56	16	—	—	8/2
Passenger	11	2	56	7	31	25	—	2	—
School bus	—	—	30	2	8	2	—	2	—
Bus	10	2	3	3	—	5	—	—	—
Taxi	—	—	1	2	1	—	—	—	—
2 cars, total trips	31	21	71	82	45	63	12	—	—
Driver	—	21	43	51	31	43	10	—	—
Passenger	—	—	22	20	11	8	—	—	—
School bus	—	—	6	5	3	12	—	—	—
Bus	—	—	—	6	—	—	2	—	—
3 or more cars, total	0	—	0	26	0	0	0	12	—
Driver	—	—	—	20	—	17	—	10	—
Passenger	—	—	—	6	—	2	—	2	—
School bus	—	—	—	—	—	2	—	—	—
Taxi	—	—	—	—	—	2	—	—	—
Total trips, all categories	103	35	261	143	144	134	12	16	18