CHAPTER 4

SOME SPECIFICATION TESTS ON THE POST-BART MODEL

Introduction

In the previous chapter the possibility was raised that the "non-genericity" of BART was partly responsible for the mispredictions of BART usage using pre-BART models. In this chapter statistical tests are conducted to investigate the plausibility of such a hypotheses. Another often-varied opinion is that the value of an incremental unit of time is not constant for all levels of total time. Tests of this hypothesis are conducted for walk, headway, and on-vehicle times. Yet a third opinion is often expressed: there exist taste variations in the population; suburban dwellers have different values-of-time than urban dwellers. Such a supposition is also tested in this chapter.

Tests of Non-Genericity

The post-BART model in Table 11 in the previous chapter is restrictive because the attributes of BART and bus are constrained to have the same value. Possibly, bus on-vehicle time is valued differently from BART on-vehicle time because the BART trains are more comfortable than buses. Similarly, initial headway and transfer wait times are perhaps considered less onerous for BART than for bus because one generally waits for BART trains indoors, or more onerous because BART runs on headways and not on schedule. Tests of such non-genericities between bus and BART attributes were conducted against the model of Table 17. The results of the tests are summarized below.

The joint hypothesis was tested that the coefficients of bus and BART on-vehicle times are the same and that the coefficients of bus and BART walk times are the same. A model similar to that of Table 17 was estimated with the four variables "bus on-vehicle time," "BART on-vehicle time," "bus-walk time," and "BART-walk time," which replace the variables "transit on-vehicle time" and "walk time" of Table 17. Estimation was performed with the BART-with-bus-access alternative considered unavailable to all workers because the walk from a bus to BART, or vice versa, could not be identified as either bus-walk or BART-walk. The log likelihood function attained the value of -504.0 for this model. The model of Table 17 was re-estimated without the BART-with-bus-access alternative considered available; the value of the log likelihood for this model was -505.0 .

McFadden (1973) has shown that, under a null hypothesis implying r restrictions, the following test-statistic is distributed chi-square with r degrees of freedom:

$$(1) \qquad -2(LLR - LLU) \quad ,$$

where LLU is the value of the log likelihood function for the unrestricted model and LLR is the value of the log likelihood function for the restricted model. Therefore, the test-statistic for the hypothesis that the coefficients for bus and BART on-vehicle times are equal, and that the coefficients of bus-walk and BART-walk times are also equal, is $[-2(-505.0 + 504.0)] = 2.0$. The critical value (at the .05 confidence level) of chi-squared with two degrees of freedom is 6.0 . Because the test-statistic falls below the critical value, the hypothesis is accepted that the coefficients of bus and BART on-vehicle times are equal and that the coefficients of bus- and BART-walk times are equal.

The joint hypothesis that the coefficients of bus and BART initial headways are equal and that the coefficients of bus and BART transfer wait times are equal was tested in a similar manner. A model similar to that of Table 17 was estimated with the four variables "bus initial headway," "BART initial headway," "bus transfer wait time," and "BART transfer wait time" replacing the variables "initial headway" and "transfer wait time" of Table 17. Estimation was performed with the BART-with-bus-access alternative considered unavailable to all workers. The log likelihood function attained the value of -504.8 for this model. Hence, the test-statistic is 0.4 . The critical value (at the .05 significance level) of chi-squared with two degrees of freedom is 6.0 . Therefore, the hypothesis is accepted that the coefficients of bus and BART transfer-wait times are equal.

These tests indicate that the restriction on the model of Table 17 that similar attributes of bus and BART have equal coefficients is not unjustified.

The model of Table 17 allows the coefficient of auto on-vehicle time to be different from that of transit on-vehicle time. A test of the equality of these coefficients was performed and the hypothesis of equal coefficients for auto and transit on-vehicle times was rejected. A model similar to that of Table 17 was estimated with the variable "on-vehicle time" replacing the variables "auto on-vehicle time" and "transit on-vehicle time." This model obtained a log likelihood value of -529.7 . The log likelihood value for the model of Table 17 was -520.9 . Therefore, the test-statistic is 17.6 . The critical value (at the .05 significance level) of chi-squared with one degree of freedom is 3.8 . The hypothesis of equal coefficients of auto and transit on-vehicle time is rejected.

The value of auto on-vehicle time is estimated to be higher than that of transit on-vehicle time. This relation was also obtained in the pre-BART model of similar specification (Model 11). While this result seems to be contrary to popular belief about the disutility of transit travel, the belief is perhaps based upon a consideration of all transit time, including walk and wait time, rather than simply on-vehicle time. Furthermore, the result relates only to the value of a marginal unit of on-vehicle time. Many of the attributes of transit use that are considered onerous, such as lack of comfort and the possibility of crime, do not vary substantially with length of time spent on-vehicle and are captured by the alternative-specific dummy variables rather than the on-vehicle time coefficient.

Tests of Non-Linearity

The model of Table 17 is restrictive in that the relation between representative utility and each time variable is constrained to be linear. That is, the effect of an extra unit of time (say, walk time) on representative utility is assumed to be the same for all levels of total time. It is possible, however, that an extra minute of walking after having walked ten minutes is considered more onerous than an extra minute of walking after having walked three minutes Similarly, an extra minute of headway is perhaps considered more onerous for total headways of fifteen minutes than for those of five minutes. Tests of possible non-linearity in the relation between representative utility and time were performed.

The hypothesis was tested that walk time in excess of 7.5 minutes to the first transit carrier (or from the last carrier for the work-to-home trip) has the same coefficient as other walk times. This test of non-linearity in the walk-time-to-transit is particularly interesting because transportation models often assume that persons living more than some stated distance, say half-a-mile, from the closest transit stop will use auto access to transit and persons living less than the stated distance will walk to the transit stop. This decision rule is based on the assumption that the value of walk time is much higher for long walks to the first transit carrier than for short walks.

A model similar to that of Table 17 was estimated with an extra variable representing the walk time 7.5 minutes in excess of the first carrier for the home-to-work trip or from the last carrier for the work-to-home trip. The test-statistic (using formula (1)) is 0.4 . The critical value (at the .05 significance level) of chi-squared with one degree of freedom is 3.8 . Therefore, the hypothesis is accepted that the coefficient of walk time in excess of 7.5 minutes to the first transit carrier (or from the last transit carrier for the work-to-home trip) is the same as that of other walk times.

The hypothesis was tested that initial headways in excess of eight minutes have the same coefficient as initial headways of less than eight minutes. A model similar to that of Table 16 was estimated with an extra variable representing initial headways in excess of eight minutes. This extra variable took the value of zero for initial headways of eight minutes or less and the value of initial headway minus eight for initial headways exceeding eight minutes. The value of the log likelihood function for this model is -519.9 Therefore, the test-statistic is 0.0 . The hypothesis is accepted that initial headways exceeding eight minutes have the same coefficient as those less than eight minutes.

The hypothesis was tested that transit and auto on-vehicle times in excess of thirty minutes in either direction have the same coefficients as transit and auto on-vehicle times less than thirty minutes. A model similar to that of Table 17 was estimated with two extra variables representing transit on-vehicle time in excess of thirty minutes either home-to-work or work-to-home and a similarly defined auto variable. The excess transit on-vehicle time variable took the value of transit on-vehicle time for the trip to work minus thirty for trips to work requiring more than thirty minutes of transit on-vehicle time to work and zero for trips requiring less than thirty minutes, plus a similarly defined quantity for the trip from work to home. The excess auto on-vehicle time variable was defined similarly. The test-statistic for the hypothesis of equality of the two on-vehicle time components is 5.6 . The critical value (at the .05 significance level) of chi-squared with two degrees of freedom is 6.0 . The hypothesis is thus accepted.

These three tests indicate that the assumptions of linear relations between representative utility and time are not unjustified and that the model of Table 17 is not unduly restrictive.

Tests of Taste Variations

The model of Table 17 includes an implicit assumption that the coefficients of times and cost do not vary in the population. That is, it is assumed that all people have the same values of time. A more general model is one in which tastes are allowed to vary systematically with some observed socioeconomic characteristics.

Table 20 presents a model in which the coefficients of the variables "cost divided by wage," "auto on-vehicle time," "transit on-vehicle time," and "walk time" are allowed to be different for suburban dwellers and urban dwellers. The model is significantly better than the corresponding model for all the travelers in that the hypothesis of equal coefficients for suburban and urban dwellers is rejected. The test-statistic (using formula (1)) is 11.0 . The critical value (at the .05 siqnificance level) of chi-squared with four degrees of freedom is 9.5 . Therefore, the hypothesis that the coefficients of the four variables are the same for suburban and urban dwellers is rejected.

The estimated values of time and headways are higher for urban dwellers than suburban dwellers, except for the value of transit on-vehicle time. This result is expected. There is, generally, a tradeoff between cost of housing (normalized for quality) and the time necessary for travel to work, shopping, and recreation. Housing units in urban areas are generally more expensive than housing units of comparable quality in suburban areas, yet travel times to, say, shopping are generally shorter in urban areas than suburban areas. Given this tradeoff, people with high values of time are expected to locate their homes more in urban areas than persons with low values of time. This expectation is confirmed by the estimates of Table 20.[1]

The higher estimated value of transit on-vehicle time for suburban dwellers than urban dwellers does not fit into the pattern expected from the above argument. It might be the case, however, that suburban dwellers dislike the discomfort of transit and fear crime sufficiently (relative to urban dwellers) to offset the effect of locational patterns.

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[1]The values of time in Table 20 are normalized by the person's wage rate. If each person were able to optimize the number of hours that he worked, then the result obtained above (that people with higher values of time locate in urban areas) would not hold for values of time expressed as a percentage of wage. Given, however, that the number of hours a person works is not completely flexible, the above argument is plausible.

TABLE 20 Work-Trip Mode-Choice Model with Different Values of Time for Urban and Suburban Dwellers

Mode 1: Auto Alone
Mode 2: Bus, Walk Access
Mode 3: Bus, Auto Access
Mode 4: BART, Walk Access
Mode 5: BART, Bus Access
Mode 6: BART, Auto Access
Mode 7: Carpool

Model: Multinomial Logit, Fitted by the Maximum Likelihood Method

Independent Variable[1]	Estimated Coefficients	t-Statistics
Cost divided by post-tax wage, in cents divided by cents per minute, for urban dwellers; zero for suburban dwellers (1-7)	-.0175	2.27
Cost divided by post-tax wage, in cents divided by cents per minute, for suburban dwellers; zero for urban dwellers (1-7)	-.0412	4.21
Auto on-vehicle time, in minutes, for urban dwellers; zero for suburban dwellers (1,3,6,7)	-.0452	2.77
Auto on-vehicle time, in minutes, for suburban dwellers, zero for urban dwellers (1,3,6,7)	-.0617	3.72
Transit on-vehicle time, in minutes, for urban dwellers; zero for suburban dwellers (2-6)	-.00860	0.799
Transit on-vehicle time, in minutes, for suburban dwellers; zero for urban dwellers (2-6)	-.0318	2.35
Walk time, in minutes, for urban dwellers; zero for suburban dwellers (2-6)	-.0731	2.21

[1]The variable takes the described value in the alternatives listed in parentheses and zero in the non-listed alternatives.

Table 20, continued

Independent Variable	Estimated Coefficients	t-Statistics
Walk time, in minutes, for suburban dwellers; zero for urban dwellers (2-6)	-.111	3.33
Transfer wait time, in minutes (2-6)	-.0565	2.26
Number of transfers (2-6)	.184	1.28
Headway of first transit carrier, in minutes (2-6)	-.0281	2.47
Family income with ceiling of $7500, in $ per year (1)	-.000233	1.51
Family income minus $7500, with floor of $0 and ceiling of $3000, in $ per year (1)	.0000608	0.428
Family income minus $10,500 with floor of $0 and ceiling of $5000, in $ per year (1)	-.0000424	0.732
Number of persons in household who can drive (1)	1.37	4.82
Number of persons in household who can drive (3,6)	1.56	4.81
Number of persons in household who can drive (5)	-.916	1.42
Number of persons in household who can drive (7)	1.16	4.33
Dummy if person is head of household (1)	.672	3.15
Employment density at work location (1)	-.00159	3.33
Home location in or near CBD (2=in CBD; l=near CBD; 0=otherwise)	.1018	0.452
Autos per driver with a ceiling of one (1)	4.66	6.19
Autos per driver with a ceiling of one (3,6)	3.59	3.60
Autos per driver with a ceiling of one (7)	3.05	4.48
Auto-alone alternative dummy (1)	-3.86	2.66

Table 20, continued

Independent Variable	Estimated Coefficients	t-Statistics
Bus-with-auto-access dummy (3)	-7.98	6.33
BART-with-bus-access dummy (5)	.537	.546
BART-with-walk-access dummy (4)	2.17	3.14
BART-with-auto-access dummy (6)	-7.05	5.66
Carpool alternative dummy (7)	-4.47	4.57

Likelihood ratio index:	.4666
Log likelihood at zero:	-514.4
Log likelihood at convergence:	-964.4
Percent correctly predicted:	65.98

Values of time saved as a percent of wage (t-statistics in parentheses):

	Urban Dwellers		Suburban Dwellers	
Auto on-vehicle time	258	(1.72)	150	(2.93)
Transit on-vehicle time	49	(0.77)	77	(2.24)
Walk time	418	(1.57)	269	(2.66)
Transfer wait time	323	(1.59)	137	(1.97)

Value of initial headways as a percent of wage:

	161	(1.65)	68	(2.13)

Table 20, continued

All cost and time variables are calculated round-trip. Dependent variable is alternative choice (one for chosen alternative, zero otherwise).

Number of people in sample who chose:

Auto-alone	378
Bus-with-walk-access	68
Bus-with-auto-access	9
BART-with-walk-access	4
BART-with-bus-access	6
BART-with-auto-access	33
Carpool	137
Total Number Sampled	635