

Midterm Exam

Thursday, October 9, 2008

- You have 1.5 hours to complete this exam.
 - Show all your work to get full credit, and please clearly box your answers.
 - This is an open book and open note exam
 - A scientific calculator will be required to answer some of the problems on this exam
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Question 1 (34 points)

A Freight Shipper's Mode Choice Model

An independent trucking company is considering entering the lumber transport market in the Pacific Northwest, in which lumber companies currently have only two choices for how to ship their product:

1. Private Carriage (that is, ship it themselves with their own trucks)
2. Rail Freight

The company has hired some consultants to help understand the current shape of the market for lumber shipping services. The first step in predicting the demand for this new trucking service is to estimate lumber companies' sensitivity to different shipping-related variables. A multinomial logit model was specified and then estimated on a dataset that included information on a number of shipping decisions made by shippers in the Pacific Northwest. Table 2.1 includes the specification of the model and the estimation results.

TABLE 2.1: Model specification and estimation results

	B ASC_PC	B SIZE	B VALUE	β COST	B TIME	B RELIABILITY	B DIST_SIDING
Private Carriage	1	0	0	COST_PC	TIME_PC	REL_PC	0
Rail Freight	0	SIZE	VALUE	COST_RAIL	TIME_RAIL	REL_RAIL	DIST_SIDING
Estimated Coefficient	0.04	2.5	7.51	-14.14	-6.43	-3.48	-11.21

Definitions of variables:

ASC_PC is the alternative-specific constant for Private Carriage.

SIZE is the size of the shipment in units of 10,000 pounds.

VALUE is the commodity value of the shipment in dollars per pound.

COST_PC is the cost of making the given shipment by Private Carriage, in units of \$10,000.

COST_RAIL is the cost of making the given shipment by Rail Freight, in units of \$10,000.

TIME_PC is the average transit time in transit of a given shipment by Private Carriage, measured in days.

TIME_RAIL is the average transit time of a given shipment by Rail Freight, measured in days.

REL_PC is the reliability of transit time by Private Carriage, measured in standard deviations of transit time, in days.

REL_RAIL is the reliability of transit time by Rail Freight, measured in standard deviations of transit time, in days.

DIST_SIDING is the distance, in miles, of the shippers' operations from a rail siding.

Answer the following questions:

- a. What are the effects implied by the model of the following variables on an lumber company's shipping decisions:
 - i. Shipment Size (3 points)
 - ii. Distance from a Siding (3 points)

- b. What is the value (in dollars) of one day of transit time implied by the model? What about a day of potential variability in transit time? Does the difference between these two values make sense? Explain. (8 points)

- c. Table 2.2 contains data on the model's independent variables for one lumber shipment. From the data in Table 2.2 and the estimation results in Table 2.1, calculate the probability that the shipment will be made by each of the two alternatives. (9 points)

Table 2.2: Data on the model's independent variables for one example lumber shipment

Variable	Observed value for the individual
SIZE	120,000 pounds
VALUE	\$0.50 per pound
COST_PC	\$4,200
COST_RAIL	\$3,000
TIME_PC	2.5 days
TIME_RAIL	4 days
REL_PC	1 day
REL_RAIL	2 days
DIST_SIDING	2 miles

- d. The consultants generated a sample of 1,000 lumber shipments that they believed was representative of the entire lumber shipping market in the Pacific Northwest. For each shipment in that sample, there were data on each of the two currently available alternatives (similar to the information shown in Table 2.2). How would you use these data to estimate the proportion of all shipments in the Pacific Northwest that are made by Private Carriage? (4 points)
- e. After the trucking service is introduced, a new model for mode choice has to be specified and estimated with three alternatives (Private Carriage, Rail Freight, Truck Freight). How would you structure such a new model? Please explain your thinking. (*Hint: Think of the similarities among some of the three alternatives. Your answer can be in the form of a sketch.*) (7 points)

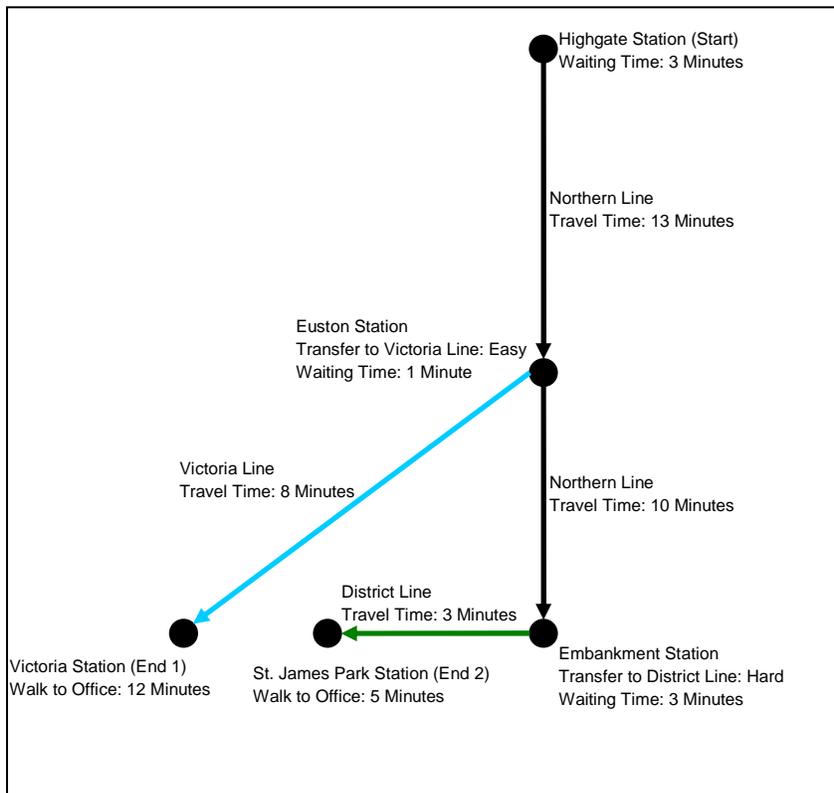
Question 2 (36 points)

Path Choice Models and Investment on the London Underground

Mike (the TA) took the London Underground to commute to work during his summer internship in London. From where he lived right near Highgate Station to where he worked downtown there were two possible ways he could go:

1. via Euston Station to Victoria Station
2. via Embankment Station to St. James Park Station

Both paths involve a transfer and have similar end-to-end travel times, but he had a hard time deciding which was best. The schematic diagram of these paths with network attributes is shown in the figure below.



The London Underground has estimated a multinomial logit model for Path Choice across its entire network with the coefficients shown in Table 3.1:

Table 3.1: Path Choice model specification and estimation results

	$\beta_{\text{Travel_Time}}$	$\beta_{\text{Wait_Time}}$	$\beta_{\text{Walk_Time}}$	$\beta_{\text{Hard_Transfers}}$	$\beta_{\text{Easy_Transfers}}$
Coefficient Estimate	-0.17	-0.32	-0.37	-1.42	-0.66

(all times in this model are specified in minutes)

This model handles transfers by labeling all transfers as either 'hard' or 'easy' depending on the complexity, walking distance, and stairs involved. Waiting time for transfers is included in the Wait_Time variable. Assume that the London Underground uses a Value of Time (VOT) of \$20 per hour of in-vehicle Travel Time and that Mike and 99 other people make this same trip every day.

- a. Make a table of the values for both paths of the variables needed to apply the path choice logit model. (5 points)
- b. Calculate the total daily generalized cost (i.e. disutility) in dollars of the transfers these 100 passengers have to make on their morning commutes to work. (10 points)
- c. The London Underground is considering reconstructing the Embankment Station to make it an 'easy' transfer between the Northern and District lines. For those passengers currently traveling via Embankment, calculate the reduction in total daily generalized cost in dollars from this improvement. Assume that for each of the 100 passengers the random utility values (i.e. epsilons) for each path would not change as a result of such an investment. (6 points)
- d. Still considering only these 100 commuters and these two paths, what does the answer from part (c) fail to account for in terms of the reductions in generalized cost (to passengers) of such an investment? (4 points)
- e. An analyst at the Underground asserted that the model does not account for the different types of 'waiting times'. She said: "A minute waiting for the initial boarding of a trip not cause as much disutility as a minute waiting for a transfer." Suggest an alternative specification that would account for such differences. (You can write the specification either as a utility function or in a tabular form similar to the one in Table 3.1.) (6 points)
- f. Are there any improvements that can be made to the model in terms of modeling how people experience the disutility of different transfer points? (5 points)

Question 3 (30 points)

A Cobb-Douglas Cost Function for US Trunk and Local Service Airlines

To examine the total operating costs of US trunk and local service airlines, a simple Cobb-Douglas cost function was estimated. In this model, total cost (CT)—the dependent variable—is a function of passenger and cargo output (Y), the route network (P), input prices (W), control variables to reflect airline characteristics (Z), time-specific factors (T), and firm-specific shifts (F).

Data used to estimate the model included annual costs reported by all US trunk and local service airlines from 1970 through 1981, with a total of 15 airlines and 208 observations. The following function was estimated:

$$\ln(CT) = \alpha_0 + \sum_T \alpha_T + \sum_F \alpha_F + \alpha_Y \ln(Y) + \alpha_P \ln(P) + \sum_i \beta_i \ln(W_i) + \sum_i \phi_i \ln(Z_i)$$

The estimation results for this regression are shown in Table 3.1.

Table 3.1: Estimation results for Cobb-Douglas cost function

Regressor	Estimated coefficient	Standard error
Revenue Vehicle-Miles(Y)	+0.792	0.034
Number of points served (P)	+0.123	0.031
Stage length (Z_1)	-0.152	0.054
Load factor (Z_2)	-0.293	0.070
Labor price (W_1)	+0.356	0.002
Fuel price (W_2)	+0.187	0.001
Capital-materials price (W_3)	+0.501	0.002

Answer the following questions:

- In a given month, fuel prices have jumped as much as 5%. In terms of percent changes, how would this affect the airlines' total cost? (7 points)
- Based on your answer to (a), how can we interpret the reported coefficient estimates in general? (*Hint: a few words at most*) (4 points)
- Compute the returns to scale for the airlines studied. (7 points)
- Compute the returns to density for the airlines studied. (7 points)
- What would be the advantages of using a more complicated Translog function instead of the simple Cobb-Douglas form specified above? (5 points)

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1.201J / 11.545J / ESD.210J Transportation Systems Analysis: Demand and Economics
Fall 2008

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