Demand Divisible

1. What is the difference between the demand for a divisible good and the demand for a discrete good? Which of the following are discrete transportation commodities and which are divisible?

   a. The work-trip mode of travel.
   b. The number of airline trips to the east coast.
   c. The number of automobiles that a household owns.
   d. Passenger-miles flown.
   e. A vacation traveller's decision to rent a car.
   f. The number of miles driven in a rental car.
   g. The choice of vehicle to own.

2. Suppose that an individual consumes transportation (T) and all other goods (G). Assume that the price of G is p_g, the price of transportation is p_t, and Y is income.

   a. If this consumer spends all of her income on transportation, how much could she buy? How much G could she buy if all of her income were spent on G? How would you answer this question if her income per period were $250, p_g = $1, and p_t = $3.00?
   b. Depict the consumer's equilibrium consumption of G and T and identify the equilibrium condition.
   c. With the use of indifference curves and budget lines, demonstrate that an increase in the price of transportation will reduce the household's consumption of transportation. Can we predict what will happen to a consumer's level of economic welfare?
   d. Suppose that transportation is an inferior good. Graphically demonstrate the effect on G and T from an increase in per period incomes.

3.
   a. Suppose that Bob enjoys both railroad trips and automobile scenic trips. If Bob's indifference curves for railroad and auto trips are convex to the origin, what does this say about Bob's preferences for each type of trip? Graphically depict Bob's equilibrium.
   b. Alternatively, suppose that Bob's indifference curves are concave to the origin. What does this say about Bob's equilibrium consumption for railroad and automobile trips?

4. According to demand theory, the market demand curve for transportation is downward-sloping.

   a. In deriving the market demand curve for transportation, what assumptions are we making?
   b. You are a transportation economist for Amtrak and you are asked to estimate the price elasticity of demand for Amtrak services.

Describe in some detail what steps you would follow to obtain the price elasticity of demand.

c. Suppose that your analysis found that the price elasticity of demand for Amtrak services was –0.78. What impact would a 10% increase in price have upon the quantity of Amtrak services demanded? Do you know whether Amtrak revenues would rise or fall?

5. The following table gives nominal average passenger airline and intercity bus fares between 1980 and 1990. The last column gives the consumer price index for the same period:

Year	Airline Fare	Intercity Bus Fare	CPI (1990 = 100)
1980	84.55	10.57	75
1981	95.42	10.3	81.7
1982	92.08	10.9	84.6
1983	92.17	10.66	85.7
1984	97.1	11.09	87.4
1985	92.53	11.02	87.9
1986	84.99	12.35	85.8
1987	88.95	12.28	87.6
1988	96.67	17.15	89.9
1989	103.65	18.62	94.9
1990	107.86	20.18	100

a. What is the difference between nominal prices and real (constant) prices?

b. Set up another table that uses the information in the above table to calculate real air carrier and intercity bus fares in 1990 dollars. Comment on the differences between the nominal and real series.

c. Between 1980 and 1990, what has happened to the relative price of air fares: that is, the real price of air fares relative to the real price of intercity bus?

d. Assuming no change in income, use indifference curves and budget lines to identify the expected effect of the change in the relative price of air travel between 1980 and 1990 on airline and intercity bus consumption demands.

6. The following table gives real per capita income and per capita automobile passenger-miles between 1980 and 1989:

Year	Real Per Capita Income (1982-4 = 100)	Passenger-Miles Per Capita
1980	9,722	8,832
1981	9,769	8,771
1982	9,725	8,860

1983	9,930	8,916
1984	10,419	8,934
1985	10,625	9,006
1986	10,905	9,103
1987	10,946	9,285
1988	11,368	9,589
1989	11,531	9,639

a. Holding all else constant, use budget lines and indifference curves to depict the effect that an increase in Real Per Capita Income will have upon Passenger-Miles Per Capita travelled between 1980 and 1989. Theoretically, would you expect passenger-miles travelled to be a normal good?

b. Based upon the data in the table, the following regression model was estimated:

$$\text{Auto Passenger-Miles Per Capita} = 4\ 653,8 +$$
$$(7,89)$$
$$+\ 0,4231\ \text{Real Per Capita Income}$$
$$(7,54)$$

where the numbers in parenthesis are the t-statistics. The two-tail critical t-value for a model with eight degrees of freedom and a significance level of 0.01 is 3.35.

    i. Are the regression results consistent with your theoretical expectations?

    ii. What quantitative effect will a $1,000 increase in income have upon Automobile Passenger-Miles Per Capita?

    iii. The table below provides the sample means of the independent and dependent variables:

Variable	Sample Mean
Automobile Passenger-Miles Per Capita	10,494
Real Per Capita Income	9,094

Use this data to determine the effect that a 5% increase in Real Per Capita Income will have upon the demand for passenger-miles travelled.

c. According to the empirical model estimated above, only Real Per Capita Income affects the demand for passenger-miles. Yet demand theory tells us that the price of travel is also an important determinant of automobile travel. If, as economic theory predicts, increases in the price of travel reduce the quantity of miles demanded, would you expect the estimated coefficient of income to be biased (that is, not equal its expected value) if the price of auto travel were not included in the equation? Consider two cases:

i. there is no correlation between price and income over time;

ii. because price and income both increase over time, they are positively correlated.

In each of these cases, can you predict the direction of the bias; that is, do you think the exclusion of price would increase or decrease the estimated coefficient of income?

d. What other variables might be relevant determinants of the demand for automobile passenger travel?

7. Suppose that you have a sample of identical travellers – that is, consumers whose incomes are identical, prices of travel and all other goods that are identical, and preferences for travel and all other goods that are identical. Why do the observed travel demands of consumers generally differ from that predicted by economic theory? Does this imply that our economic theory is not very useful? Explain your answer.

8. Evaluate the following statement: "When transportation markets are functioning well, the opportunity cost of transportation will primarily reflect monetary costs. To the extent that time costs are present, they will be small."

9. Recall table 3.2, which reported the estimation results of an empirical model of the average daily consumption of gasoline per month in Carolina during the period 1970–1975.

    a. Two significant by-products of automobile use are air pollution and traffic congestion. In order to reduce the extent of each, suppose that the federal government raises the gasoline tax by $.25. From table 3.2, what effect will this have on gasoline consumption in California? Use budget lines and indifference curves to demonstrate the effect of the tax on consumer welfare.

    b. Wanting to increase the price of gasoline *but not reduce economic welfare*, suppose that, in addition to the $0.25 cent tax on gasoline, the government also provides consumers with an income tax rebate amounting to $16.7 billion dollars.

        i. According to the empirical model, what would be the effect of the gasoline tax and income tax policies?

        ii. According to economic theory, would the gasoline tax rise combined with the welfare-offsetting income tax rebate produce any reduction in the demand for gasoline?

        iii. Given your analysis in parts (i) and (ii), is it possible to implement a policy that is consistent with the goals of environmentalists and yet not reduce the economic welfare of consumers?

10. Public transportation is oftentimes argued to be an inferior good.

    a. Identify why this might be so.

    b. Is public transportation an inferior good at all levels of income? If so, why; and if not, why not?

11. Consistent with the results reported in tables 3.2 and 3.4, various studies indicate that the price elasticity of demand for automobile usage lies above –0.5 (that is, below 0.5 in absolute value). What does this say about the potential success of policies designed to reduce urban congestion by monetary disincentives?

12. Hilton (1980) reports the following empirical demand model that Amtrak, the nation's passenger rail service, used in forecasting service changes. The model is based upon a sample of 71 observations of annual ridership changes on 39 routes served between 1974–5 and 1975–6:

$$R\% = -0{,}38 + 1{,}109F\% + 0{,}319E + 0{,}073T\% + 4{,}963P\% - 18{,}325ED \qquad R^2 = 0{,}978,$$
$$\quad\;\;\;(51{,}2) \qquad\quad (4{,}58) \qquad (1{,}80) \qquad\quad (2{,}10) \qquad\quad (-5{,}73)$$

where $R\%$ is the annual percentage change in ridership on a route; $F\%$ is the annual percentage change in frequency [(train mile days)/(route miles)]*365 on a route; E is the absolute change in the percentage of train days having new equipment; $T\%$ is the annual percentage change of Amtrak on-time performance on a route; $P\%$ is the annual percentage change of population in states along the routes; and ED is a dummy variable that equals one for recovery from energy shortage and zero otherwise.

    a. Interpret the results and discuss whether they are consistent with your expectations.
    b. When Amtrak was first formed, its proponents forecasted a demand for service that fell far short of that realized. Part of the reason for this was Amtrak's inability to attract bus passengers, due to a generally lower service frequency. Are the results in the table consistent with this?
    c. Since its inception, Amtrak has dropped a variety of luxury services. Is this behaviour consistent with the above empirical model? (Hint: assume that newer equipment is also more luxurious.)
    d. Graphically identify the effect that an energy shortage has on ridership.
    e. Although the model explains over 97% of the variation in ridership changes, why might the coefficient estimates be biased? (Hint: what important economic variable is missing from the empirical model?)

13. Consider the following observations: (1) between 1978 and 1988 real per capita income increased by 25%; (2) during the same time span there was a decrease in the average number of hours spent working; (3) there was an increase in the number of single households and households with unrelated members. Why might you expect each of these factors to increase the demand for air travel?

14.

   a. In 1991, public transportation received $9.79 billion dollars in operating subsidies from federal, state and local government. Use budget lines and indifference curves to identify the economic welfare and public transit consumption effect of the subsidy.

   b. The price elasticity of transit demand has been estimated in the range of –0.2 to –0.4. Suppose that the transit authority seeks to increase demand through a 10% reduction in fares. What impact will this have on transit demand, and what impact do you think it would have on the operating subsidies?

15. One would expect that the demand for automobile ownership in metropolitan areas would be influenced by population density. Holding all else constant, the denser the area, the more public transit will be provided. Also, the denser the area, the more traffic congestion will be present.

   a. Assuming that the public transit fare remains constant, explain why an increased supply of public transit in denser areas would reduce the opportunity cost of public transit.

   b. Assuming no change in the per-mile monetary cost of automobile travel, explain why increased congestion will increase the opportunity cost of automobile travel.

   c. Based upon 65 large US central cities in 1970, Kain (1983) assumed that the demand for automobiles depended upon median household income and population density. He obtained the following linear regression results:

   $$\text{Autos per Household} = 0.224 + 0.069 \text{ (Median Income)} -$$
   $$\qquad\qquad\qquad\qquad\quad (6{,}1) \qquad\quad (6{,}1)$$

   $$- 0{,}013 \text{ (Population Density)} \qquad\qquad R^2 = 0{,}77,$$
   $$\quad (-13{,}9)$$

   where Median Income is in thousands of dollars and Population is in thousands of persons per square mile. t-statistics are in parenthesis.

      i. Are these results consistent with expectations?

      ii. What effect will a $1,000 increase in median family income have upon automobile ownership? From these results, what difference in automobile ownership would you expect to see between a household earning $50,000 per year and one earning $20,000 per year?

      iii. Assume that Median Income is $25,000. According to Kain's model, how many automobiles will a typical household own if it resides in a low-density area characterized by 50 persons per square mile? Compare this with a high-density city that has 100 persons per square mile.

iv. Throughout the 20th century, we saw population movements away from rural areas and into urban areas. At the same time, household median income rose steadily. Using Kain's empirical model, what can you say about the net effect of these changes on automobile ownership? From the above results, which has the greater effect – a $1,000 increase in median income or a 1,000-person increase in population density?