

Final Exam
December 15, 2008

Rules for this Exam

Please read the following rules carefully before starting this exam:

- 1. You MUST complete problems 1 and 2, which together are worth a total of 60 points.**
- 2. Problems 3, 4, and 5 are each worth 20 points. You MUST choose EXACTLY 2 of these problems.**
- 3. To be clear, you need answer 4 out of 5 problems on this exam, which must include problems 1 and 2.**
4. This exam has a total of 100 points.
5. You have 3 hours to complete this exam.
6. You are allowed to use your notes from class, as well as any other notes or textbooks.
7. A calculator will be required to complete this exam.
8. Laptops, mobile phones, and PDA's are not allowed.
9. Please show all your work for maximum partial credit.

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1. Revenue Forecasting and Private Transportation Contracts

This problem is worth 35 points, and is required

The Mayor of New York City wants to replace the elevated Gowanus Expressway in Brooklyn with a tunnel so as to enable the development of prime Brooklyn waterfront property. He is interested in using the private sector to finance, construct, and operate this project, which will require tolling of the new facility. For the sake of this problem, let us assume:

- The average toll will be \$4.50, and does not increase over time
- There is no inflation
- All parties use a discount rate of 10%
- Traffic on the Expressway is the same for every day of the year
- All years have 365 days
- The annual traffic on the first year of operation of the new facility is uncertain, but every year thereafter will be the same as the first

Let us also assume that there are two bidders for this project who have, through their own analysis, worked out the following financial packages:

	Cost to Build (Present Value)	Operation and Maintenance Costs + Expected Profits (Present Value)
Firm A	\$650 Million	\$160 Million
Firm B	\$700 Million	\$70 Million

You are advising the mayor on this project, and have commissioned a traffic forecast for use by the various private players, which has the following results:

Scenario	Daily Traffic
Worst Case	43,000 vehicles/day
Expected	47,000 vehicles/day
Best Case	51,000 vehicles/day

It may be of use in this problem to recall that, for some $|c| < 1.0$,

$$\sum_{i=1}^{\infty} c^i = \frac{c}{1-c}$$

The following table may also be of use:

n	1	2	4	8	10	15	20	25	30	40	50	75	99
$\sum_{i=1}^n .91^i$	0.91	1.74	3.17	5.33	6.14	7.61	8.51	9.08	9.43	9.78	9.91	9.99	10.0

Part I Traditional Contract

Under the traditional contract structure, the winning bidder would build the new facility and then maintain and operate it while collecting all toll revenues for 99 years. At the end of 99 years of operations, ownership transfers over to the City. For this kind of contract, the bidders only reveal to the City their Cost to Build the facility.

Please answer the following questions:

- a) For **both firms**, calculate the **minimum daily volume of traffic** required to meet their financial goals for the project.
- b) As part of the bidding process, all bidders had to define the bonds they would sell to finance the construction of the facility. Given the forecasts that were published, if you were a banker on this deal, **which bidder's bonds** would you insist **have a higher interest rate**? Why?
- c) Is this type of arrangement better characterized as *privatization or PPP*? Why?

Part II New Type of Contract

Consider using a new kind of contract, the “Flexible Term Present-Value-of-Revenue” (FTPRV) contract, in which:

- i. Each bidder specifies the *present value* of total revenue they would like to earn from the project (i.e. the Cost to Build + Operations/Maintenance/Profit)
- ii. The contract goes to the lowest bidder
- iii. The firm that is awarded the contract builds and then maintains and operates the facility until they have collected revenues (measured in *present value at the year of the contract*) equal to their bid.

Since the traditional contract structure is to build the facility and then collect all revenues for 99 years, one supposed benefit of the FTPRV contract is that it is impossible for the private firm to collect any more revenue than they have specified in their bid.

Please answer the following questions:

- d) Under this setup, **which bidder** would have won the bid to build and then operate the new Skyway?
- e) For the **best and worst case** scenarios, approximately **when (if ever) will the contract end**?
- f) Again for the best and for the worst case scenarios: if the contract does end, approximately **how much revenue will the City of New York have gained** (in year-of-collection dollars) by using this new kind of contract **as compared to the traditional 99 year contract**?

2. Benefit Cost Analysis and Project Programming

This problem is worth 25 points, and is required

The governor of Massachusetts is considering a program of transportation upgrades. There is an investment project for Boston's regional transit system and an investment project for Boston's Logan Airport. A number of alternatives have been developed for each project, and the present value of costs and benefits have been estimated for each alternative, as shown in the following tables:

Transit Alternatives

Alternative	Cost (\$ Billion)	Benefit (\$ Billion)
T0*	0.00	0.00
T1	3.00	3.75
T2	6.00	8.50
T3	9.00	12.00
T4	12.00	13.50

Airport Alternatives

Alternative	Cost (\$ Billion)	Benefit (\$ Billion)
A0*	0.00	0.00
A1	3.00	4.50
A2	6.00	7.75
A3	9.00	10.00
A4	12.00	11.00

*T0 and A0 are the "do-nothing" alternatives for Transit and for the Airport, respectively.

For parts a, b, and c consider only the costs and benefits that have been converted to dollar terms.

- a) Which, if any, of these alternatives are simply **not justified**?
- b) Using incremental cost-benefit analysis, which is the **best Transit alternative** and the **best Airport alternative**? Explain briefly how you arrived at this answer.
- c) Again using incremental cost-benefit analysis, and now considering all possible investments together as one **integrated program**, pick the **best Transit** alternative and **best Airport** alternative under the following **total budget constraints**. Explain briefly how you arrived at these answers.
 - i. \$5 Billion budget
 - ii. \$10 Billion budget
 - iii. \$15 Billion budget
 - iv. \$20 Billion budget
- d) For either the Transit or Airport project, discuss **one cost and one benefit** that you think would be not **fully captured in the analysis of benefits and costs** in the table. That is, a benefit and a cost that are not accurately reduced to dollar terms.

3. Elasticities, Gas Taxes, and Fuel Economy

This problem is worth 20 points (remember: choose 2 problems from 3, 4, and 5)

In November, Professor Sperling of UC Davis suggested in an Op-Ed in the NY Times that we should tax gasoline so that it is never less than \$3.50/gallon. He said that this strategy would:

- Raise revenue to invest in infrastructure
- Incentivize the auto companies to manufacture more fuel-efficient vehicles

For the sake of this problem, let us use the following terminology:

- V = Vehicle Miles Traveled (VMT), measured in miles (mi)
- E = Fuel Economy, measured in miles per gallon (mpg or mi/gal)
- G = Total gasoline consumed, measured in gallons (gal)
- P = price of gasoline, measured in dollars per gallon (\$/gal)

Let us also assume that, today:

- Annual Vehicle Miles Traveled in the US is 3 Trillion miles. ($V = 3 \times 10^{12}$)
- The fuel economy of automobiles is 30 miles per gallon (mpg). ($E = 30$)
- The 'real' price of gasoline is \$2 per gallon, and does not change. ($P = \$2/\text{gal}$)
- The only cost of operating an automobile is the cost of gasoline.

a) We have learned in this course that there are a number of different kinds of direct and indirect taxes. **What kind of tax** is this gas tax (you should be more specific than direct/indirect)? Why?

b) One study has estimated that the elasticity of demand for VMT with respect to the price of driving a mile is constant at -0.25. Using this elasticity:

- Estimate the **percent change in annual Vehicle Miles Traveled** if gasoline were taxed so that the price paid by consumers were \$3.50 per gallon.
- Estimate the **total annual tax revenue** that would be collected under this tax.

c) Not wanting to be accused of hampering economic development, the government plans to increase standards for fuel economy so that drivers can drive the same amount as they do now at the same total price (to drivers) of gasoline. Assuming the same elasticity as in part (b):

- Estimate the **fuel economy that cars must have** so that the total annual VMT will be the same under this new tax as it is today.
- Estimate the **total annual tax revenue** that would be collected under this tax with this new level of fuel economy.

4. Pricing a Port Facility

This problem is worth 20 points (remember: choose 2 problems from 3, 4, and 5)

In this question we will determine the optimal prices for a port facility under a number of different objectives. In analyzing the facility, we will use the following variables:

- P = price of processing one Twent-Foot Equivalent Unit (TEU) through this port, measured in dollars (\$)
- Q = daily demand for port facility, measured in TEU
- C = daily cost for the port facility, measured in dollars (\$)
- t = average processing time for each TEU, measured in minutes (min)
- T = total processing time, measured in minutes (min)
- V = value of time (VOT) for one TEU, as perceived by the customers of the port, measured in dollars per hour (\$/hr)

The demand, costs, and behavior of the port facility are characterized by the following relationships:

$$Q = 4,000 - 20P$$

$$C = 50,000 + 15Q + 1.5T$$

$$t = 10 + .005Q$$

a) Consider the perspective of the port operator, and **find the profit-maximizing price** for this port facility.

b) Next consider the perspective of a regulatory agency, **find the price that maximizes social welfare** for each of the three following values for V . Do this by developing an **equation for social welfare**, *not* by setting $P = \text{Marginal Cost}$.

- $V = 0$
- $V = 60$
- $V = 180$

5. Demand for Bus Services in a Developing City

This problem is worth 20 points (remember: choose 2 problems from 3, 4, and 5)

You are a transport consultant working for the mayor of a growing city in a developing country. The bus network in this city currently looks something like the map shown in Fig. 1 below. The Mayor is going to invest in a central East-to-West exclusive busway and in strategic station facilities as shown in Fig. 2 and Fig. 3 below.

The mayor is unsure whether to regulate bus services after making the investment. He is considering two alternatives, A1 and A2, shown in Fig. 2 and Fig. 3 below. The key *regulatory* difference between these two alternatives is that in A1 the busway and stations will be *available only to operators under contract by the city* to operate certain routes. In A2, the busway and stations are *available to any bus operator* that chooses to participate in the market.

Fig 1: Unregulated Network, no Investment

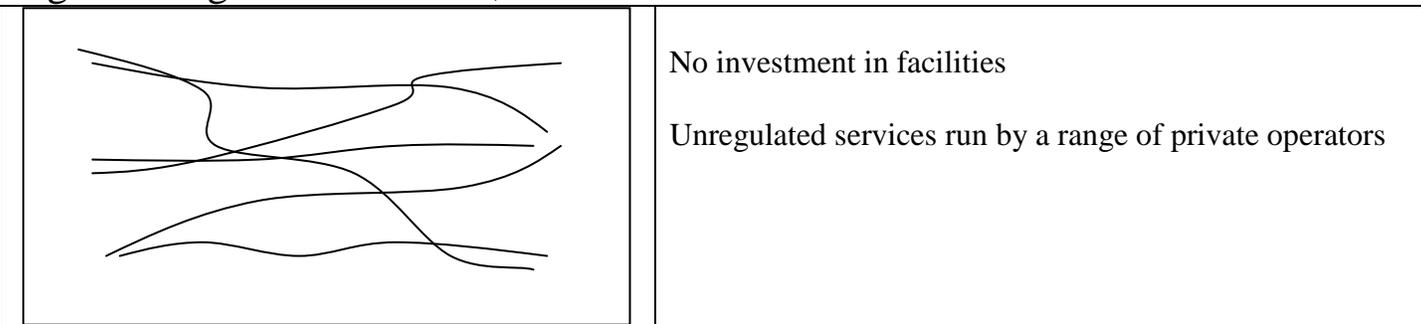


Fig 2: A1: Investment, Closed System, Regulated Trunk & Feeder Services

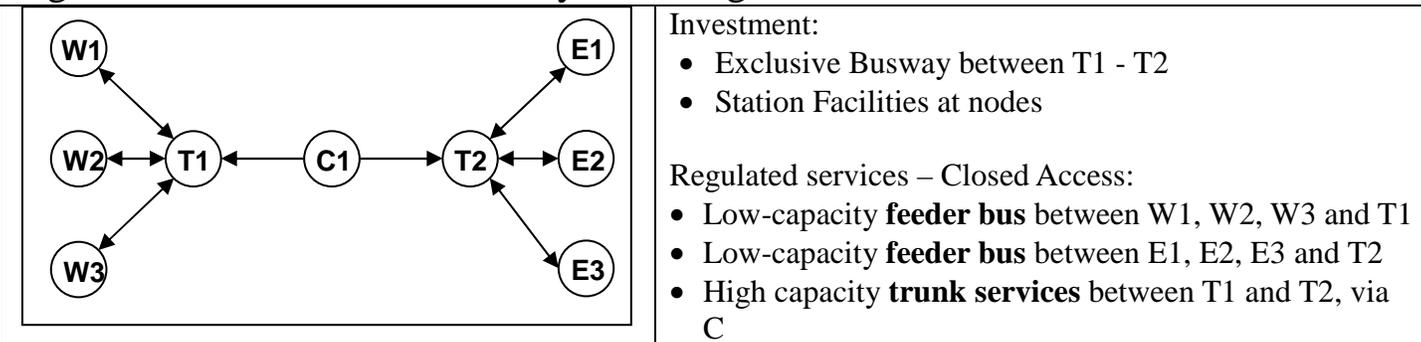
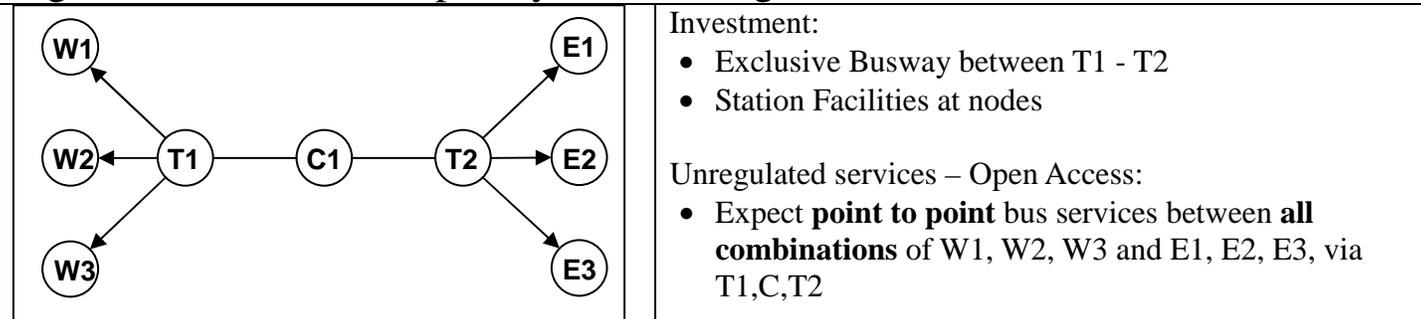


Fig 3: A2: Investment, Open System, no Regulation of Services



The Mayor has hired you because of your expertise in modeling the demand for transportation services. Before the Mayor makes the investment, you will conduct a survey and develop a logit model to understand the way residents of this city choose between the using the Bus and using other modes.

a) Before thinking about demand models, it is useful to think about what kind of service is likely to be provided in both alternatives. Under both A1 and A2, the Mayor hopes to make use of competition in the private sector to keep costs low. **What kind of competition** would we expect to see in A1? What about in A2? (This question should be answered in at most two sentences).

b) How would the two types of **competition** you answered in part (a) likely **affect the actual service** that is delivered to passengers?

c) A1 and A2 represent very different ways to run a bus network. In terms of the factors that affect passenger demand for buses, **what are the three most important ways in which A1 and A2 will differ?** This can include factors that result from differences in the regulatory structure or in the network structure. Please be as specific as possible, and feel free to include your answers from part (b).

d) Please specify the **utility function you will use for the Bus mode** (don't worry about other modes). You will use this model for forecasting demand for A1 and A2, so it is important that this utility function **includes the factors you listed** in part (c).

e) Please list the **expected sign** (positive or negative) for each of the coefficients in your Bus utility function in part (d).

f) After you do your survey and estimate your logit model, you have coefficients for each of the factors in (c). For each of those three factors please indicate **which alternative** (A1 or A2) would be more likely to have **higher demand if the coefficient is large in magnitude?**

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

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