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Final Exam ISyE 4301

Please read the following: This is a closed-note exam. In addition, only calculators that *do not* have the capability to send or receive data may be used (e.g., phones are not allowed). By signing the following, you are agreeing to these terms and acknowledging that all of the work on this exam is your own.

_____(*Signature*)

1. (*10 points*) STH hospital currently uses two types of surgical gloves (G1 and G2) for their healthcare workers. The annual demand for each is normally distributed. For G1 the mean is 5,000 pairs with a variance of 3,000; for G2 the mean is 8,000 pairs with a variance of 5,000. Each pair of gloves costs $3 (regardless of type), the cost to place an order is $100, and STH uses an annual holding cost of 20% of the value. Demand between G1 and G2 is positively correlated, with a correlation coefficient equal to 0.3. STH uses an (R,Q) system where Q is determined by the EOQ and a service level of 93% is used. The replenishment leadtime is 5 weeks for each glove type. Answer the following:
   a. Determine the cycle, safety, and pipeline stock.
   b. STH decides that is will standardize by using G1 to meet all demand for gloves. Determine the cycle, safety, and pipeline stock in this case.

2. (*10 points*) Sarah's utility is based on two things: skydiving (S) and listening to lectures by Dr. Hackman (L), and has the form:

$$U(S, L) = 200(S^{0.4}L^{0.7})$$

An hour of skydiving costs $60 and an hour of Dr. Hackman's lectures costs $50, and she has a budget of $1000. Answer the following:
   a. Determine the marginal rate of substitution of S for L. Explain in words what the value means.
   b. Derive Sarah's demand for L.

3. (*10 pints*) Tech3D is a printing facility that serves as a contract manufacturer for three types of customers: government (G), medical (M), and aerospace (A). Over the next month, they have the capacity to print 100 parts. The cost to print any part is roughly equal. Demand from each customer type for the next month is Normally distributed: $N(\mu=25, \sigma=8)$ for G; $N(30, 5)$ for M, and $N(10, 3)$ for A. Tech3D is able to charge different prices depending on the customer: $100/part for G, $80/part for M, and $200/part for A. Determine how they should best use their capacity across the three customer types. Is this a strict partition of the capacity? Why or why not?

4. (*10 points*) Tech3D has been asked by a medical device company (Hackpak) to make a specialized vaccine packaged product for them. Tech3D will need to make a rather large unique investment in order to do this. Hackpack will charge $1000 per vaccine kit, and it is estimated that at that price the monthly market demand is: 5,000 with probability of 0.3, 10,000 with probability of 0.5, and 15,000 with probability of 0.2. Tech3D has also determined that over the long run, their production cost per kit is $600. In order to be worthwhile for their investors, they determine that they will need to charge Hackpak $800 per kit. Hackpak places orders each month, but because the vaccine kit has a short shelf life they cannot inventory it for future periods. Unsold vaccine kits at the end of the month have no salvage value. The cost of a kit to Hackpak is the price that they pay Tech3D plus $50 for handling and packaging. Answer the following:
   a. Under the current arrange, determine the expected profit for both Hackpak and Tech3D.
   b. Develop a buyback contract (if possible) that would make both Hackpak and Tech3D better off.

5. (*10 points*) Stevesbees is a new startup firm that makes honey-based cosmetics. They will sell their product through specialty stores, and they need to hire a distributor. The distributor will manage the inventory and shipping and has regularly used two carriers (C1 and C2) to ship for them. The carriers have varying levels of on-time delivery (probabilities shown in the table below). Steevesbees wants to contract with the distributor and for the distributor to choose carrier C1. They will pay the distributor monthly. However, they cannot directly control which carrier the distributor uses. They are in regular contact with the specialty stores, however, and can get feedback on the service level actually provided.   The cost to the distributor to handle the demand for Stevesbees is $60,000 if they use C1 and $50,000 if they use C2.   Further, they won't take the job unless they receive at least $80,000 from Stevesbees. Develop a contract for Stevesbees to offer. Show the formulation and explain each part. Next, solve for the contract (it is simple enough in this case to do by hand).

Carrier	95% on time	75% on time
C1	0.8	0.2
C2	0.4	0.6

6. (*10 points*) Five distribution centers are participating in a benchmarking study. There are three inputs i_1, i_2, and i_3 and two outputs o_1 and o_2. The data is shown in the table below. Answer the following:

   a. Suppose input i_2 is non-discretionary, write the DEA formulation (but do not solve) for the technical efficiency of firm 1.

   b. Suppose now that all three inputs are discretionary and that the unit cost for input 1 is \$30, for input 2 is \$45, and for input 3 is \$60. Write the formulation for the linear program where the iso-cost curve is tangent to the production frontier for firm 2.

   c. Suppose for part b, the technical efficiency of firm 2 is 0.859, and that from the formulation in part b that: $i_1^* = 12$, $i_2^* = 22$, and $i_3^* = 8$. Determine the allocative efficiency of firm 2. Explain the difference between the allocative and technical efficiency, and where firm 2 should focus their efforts on improvement.

Firm	i_1	i_2	i_3	o_1	o_2
1	12	22	8	15	24
2	17	26	9	15	22
3	14	21	10	15	25
4	13	29	7	15	18
5	18	18	8	15	23

7. (*10 points*) Evets Inc. orders product each month from a single (unique) supplier. Roughly 80% of the time the supplier delivers exactly what is needed, and 20% of the time it delivers nothing. When the supplier makes a delivery, Evets earns $100,000 for the month; otherwise it earns $0 for the month. Answer the following:

  a. Determine the expected monthly earnings for Evets Inc.
  b. Suppose Evets Inc. is risk averse (utility equals square root of earnings). Further, suppose that the supplier could guarantee that Evets Inc. will make its expected earnings each month. How much would Evets Inc. be willing to pay for the guarantee?
  c. Suppose that we don't know the form of Evets Inc. risk aversion. However, we know that the probability (p) for which they are indifferent between $80,000 with certainty and $100,000 with probability 0.91 and $0 with probability of 0.09. What would your answer to b be in this case?

8. (10 points) The BL Bike Company uses two main inputs X and Y. Output (Q) is defined by the Cobb Douglass production function: $Q = 300X^\alpha Y^{1-\alpha}$. The cost to BL is $400 per unit of X and $500 per unit of Y. Answer the following:
   a. What is the value of α for which the production function exhibits constant returns to scale? Please be clear if there is more than one value, or if one doesn't exist.
   b. Suppose α=0.6 and that BL wants to make 30 bikes. Determine the average cost per bike.
   c. Suppose α=0.6. Explain in words how you would determine the marginal cost at Q=30 bikes (please do not solve for this value). Further explain why this value may differ from the marginal cost at Q=20 bikes.

9. (10 points) A linear regression model is run with demand for product A (Q_A) as the response. The independent variables are price of A (P_A), price of another product B (P_B), discretionary income (I), and trend (T). The model is given by: $Q_A = \alpha + \beta_1 P_A + \beta_2 P_B + \beta_3 I + \beta_4 T + \epsilon$. The results are shown in the following table (note: average quantity demanded of A is 2300, average unit price of A is $133, and average unit price of B is $120. Further, adjusted R^2=0.893):

Parameter	Value	*p*-value
α	110	0.17
β_1	-13.83	0.03
β_2	24.92	0.01
β_3	58.62	0.08
β_4	21.88	0.03

Answer the following:

a. Estimate the own price elasticity of demand. Is the good elastic or inelastic?

b. Estimate the cross price elasticity for product B. Is this good a compliment or substitute? Why?

c. Explain why there could be endogeneity in this model.

d. Suppose a 2-stage least squares model will be used to address the endogeneity. Give two examples of instrumental variables that could be used. What are important properties to consider in the choice of an instrumental variable?

e. Pick one of the instrumental variables in d, and explain in words how it would be used in a 2-stage least squares approach.

10. (*10 points*) Home Depot and Lowes are each considering locating a new store in either Newnan or Palmetto Georgia. The monthly revenue (demand) in Newnan is estimated to be $300,000 and in Palmetto to be $160,000. If they both locate in the same city, they split the revenue equally. Assume the costs of operating the store are the same for Home Deport and Lowes. If they both locate in Newnan, the costs are $40,000 per month (each). If they both locate in Palmetto, the costs are $30,000 per month (each). If only one store locates in Newnan, the costs are $70,000 per month. If only one store locates in Palmetto, the costs are $40,000 per month. Assume the goal for both Home Depot and Lowes is to maximize their profit from this choice.

   a. If both stores choose their location at the same time what would be the resulting equilibria (if any)? Also, is there a Pareto improving outcome?
   b. Suppose Lowes moves first followed by Home Depot. What will be the equilibrium (if any)?
   c. Suppose we relax the assumption that the companies want maximize the profit from this one choice. Give an intuitive explanation of why might the equilibrium from part b. (if one were found) might change?