NTNU

Department of Industrial Economics and Technology Management

Examination paper for TIØ4285 Production and Network Economics

Academic contact during examination: Peter Schütz

Phone: +47 98086185

Examination date: 21 May 2019

Examination time (from-to): 9:00 – 13:00

Permitted examination support material: Code A – All printed and hand-written support material is allowed. All calculators are allowed.

Other information:

Language: English

Number of pages (front page excluded): 4

Number of pages enclosed: 0

Informasjon om trykking av eksamensoppgave
Originalen er:

1-sidig ☐ **2-sidig** ☐

sort/hvit ☐ **farger** ☐

skal ha flervalgskjema ☐

Checked by:

_____

Date Signature

Students will find the examination results in Studentweb. Please contact the department if you have questions about your results. The Examinations Office will not be able to answer this.

Exercise 1 (25 %)

Jürgen is selling football jerseys over the internet. He is currently preparing his order for the upcoming season and needs help with the task of determining how many to order from his supplier, Mauricio. He assumes that demand for his jerseys will be uniformly distributed between 33,000 and 158,000. Before the end of the season, the jerseys sell for 125 each, but once the season is over, he can only get 50 for each of them as the fans then eagerly wait for the following season's jerseys.

Jürgen also tells you that he has to pay 80 for each jersey to Mauricio. In addition, he has to pay 25 in shipping for each jersey sold online. Any unsold jersey will be put in Jürgen's (physical) discount store at the end of the season, where customers eventually pick it up at the reduced price. The discount store incurs fixed costs of 125,000.

a) Express Jürgen's expected profit as a function of the order quantity and demand. Explain your profit function.
b) How many jerseys should Jürgen order from Mauricio? What will be his expected profits?
c) Jürgen considers to close down the discount store and also sell the jerseys at reduced prices over the internet. Can Jürgen increase his expected profits by only selling over the internet?
d) How would Jürgen's order quantity change, if he were risk-averse?

Mauricio's cost of producing and selling a jersey is actually just 60. He sees an opportunity to increase profits and after having been impressed by the work you did for Jürgen, he asks for your assistance.

e) Design an optimal Buy-Back contract that is acceptable to both Jürgen and Mauricio. What are the expected profits?
f) Which of the two agreements (the original or the Buy-Back contract) would Mauricio prefer, if he were risk-averse?

Exercise 2 (25 %)

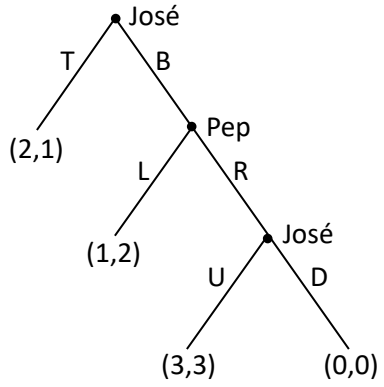
José and Pep are playing a series of games. As usual, they are trying to win, i.e. maximize their payoff. For the remainder of this exercise, the first number in a pair of payoffs denotes José's payoff, while the second number denotes Pep's payoff.

1. In their first game, both have 3 strategies to choose from:

		Pep		
		L	C	M
José	T	4, 2	3, 0	1, 1
	M	1, 2	2, 4	0, 3
	B	1, 1	4, 2	2, 4

   a) Find the set of pure strategy Nash equilibria.
   b) Find the set of mixed strategy Nash equilibria.

2. Their second game is given in extensive form below. The name next to the node indicates which of the two players moves.



   c) Apply backward induction.
   d) Write the game in strategic form.
   e) Find all pure strategy Nash equilibria. Which ones are sub-game perfect?
   f) Is there a pure Nash equilibrium which Pareto-dominates the other pure Nash equilibria?

3. Arsène joins José and Pep for a third game and each of the three needs to decide whether he should start participate or not. The rules for the third game are the following: a player that does not play has a payoff of 0. A player that chooses to play has to pay a cost of 62 up front in order to participate, and will receive a payoff equal to $\frac{150}{n}$, where n is the number of players that choose to participate.

   g) Find the set of pure strategy Nash equilibria.
   h) Find the symmetric mixed strategy Nash equilibrium, where all three player join the game with the same probability.

Exercise 3 (10 %)

Thomas sells footballs. The demand for footballs is given as 7,300 boxes per year (365 days). It costs Thomas 40 per order of footballs, and it costs 2.34 per box per year to keep the balls in stock. Once Thomas has placed an order for footballs, it takes 4 days to receive the order from the wholesaler.

a) What is the cost-minimizing order quantity?
b) How high are the minimum total annual costs (order plus inventory holding costs)?
c) At which inventory level does Thomas have to place the next order, i.e. what is the reorder point?

Exercise 4 (20 %)

Ernesto owns a company that produces football shoes. The company consists of 2 divisions: an upstream division that prepares and cuts the leather, and a downstream division that manufactures and sells the shoes. Demand for Ernesto's football shoes is given as

$$p_S = 1{,}700 - 0.35q_S,$$

where q_S is the number of pairs of shoes sold and p_S is the price for each pair of shoes.

The cost function for preparing and cutting the leather in the upstream division is

$$C_L = 0.65q_L^2 + 150q_L + 75{,}000,$$

where q_L is the quantity of leather prepared and cut in m^2. The downstream division needs $1m^2$ of leather per pair of shoes. Excluding leather, the cost function for manufacturing a pair of football shoes is

$$C_S = 200q_S.$$

a) What is the optimal transfer price for leather? How many pairs of shoes does Ernesto produce?
b) Suppose that there is a competitive market for prepared and cut leather where leather can be bought and sold for $p_L = 800$ per m^2.
How much leather should Ernesto's company prepare and cut? How much leather does the downstream division use to produce shoes and what is the optimal transfer price?
c) Assume now that the leather that the upstream division of Ernesto's company produces is unique and of extremely high quality. The division can therefore act both as a supplier to the downstream division and as a monopoly supplier to an outside market. Demand in the outside market for Ernesto's leather is given as $p_L^{out} = 1{,}380 - 0.125q_L^{out}$, where q_L^{out} is the number of m^2 sold in the outside market and p_L^{out} is the price per m^2 in the outside market.
What is the optimal transfer price paid by the downstream division? At what price, if any, should leather be sold in the outside market?

Exercise 5 (20 %)

In this exercise, you are given three different discussion questions. Answer each question short and concise. If you think the questions are imprecise or vague, state necessary assumptions and, in each case, discuss the relevant aspects of the imprecise formulation(s).

a) Consider a game with a finite number of players and a finite number of actions. Will there always be a pure strategy Nash equilibrium?

b) We are given two nodes, 1 and 2, connected by a pipeline. Production is located at node 1. Demand at node 2. Demand is given by an inverse demand curve, $p(q) = a - bq$. The pipeline has a capacity limit. Compare the following situations: we have located at node 1 either (A) a monopoly supplier or (B) many perfectly competitive suppliers.
Assume that marginal production cost are constant and the same in both situations (A) and (B), and that in both situations, (A) and (B), the pipeline capacity restricts the supply. In which of the two situations, (A) or (B), is the shadow price on the pipeline capacity the highest?

c) If the value of an item that is auctioned off is not known with certainty, the bidders can be exposed to what is known as "Winner's Curse", i.e. the winner has to pay more than the true value of the item. Is the probability of being exposed to the Winner's Curse greater in an English auction or in a first-price, sealed bid auction? Explain.