Information Economics, Fall 2013
Midterm Exam

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Rules

1. The instructor chooses to change the exams from in-class to take-home because (1) he wants to have more lecture time to interact with you and (2) he believes that people care about honors, especially students in National Taiwan University.
2. This is a take-home exam. You may check your notes, course videos, reference books, papers, and everything you may find on Internet. For group problems, you may discuss with and ONLY with your teammates. For individual problems, you CANNOT discuss with anyone. Whenever discussion is disallowed, revealing problems to others is also prohibited. If one is caught to disobey the above rule, she/he will definitely FAIL this course with no exception.
3. If you cannot understand any problem, let the instructor know through e-mails. You may want to do it as soon as possible, because the instructor will not be able to stay in front of a computer for the whole weekend. The instructor will try his best to answer any question, but he does not promise to answer all the questions, especially late questions.
4. According to your choice, the deadline of this exam is either at ***11:59pm on November 9, 2013*** or ***11:59pm on November 10, 2013***. Late submissions will NEVER be accepted even if it is just one second late.
5. Before the due time, you need to send ***a single PDF file*** to the instructor's e-mail box (lckung@ntu.edu.tw). If you do not type your answers, make sure that your hand writing is understandable and then scan or take photos for your answers.
6. Each student should send the instructor an e-mail containing a single PDF file for her/his individual work. Each team should send the instructor a single e-mail containing a single PDF file for their group work.
7. For the team with only two students, the team's grades for group problems will be $\min\{x+10, 50\}$, where x is their original grades.
8. Try your best to make your answers precise, concise, and complete. This is an exam!

References

Hsiao, L., Y.-J. Chen. 2013. Benefiting from the economic recession? a supply chain perspective. *Operations Research Letters* **41**(1) 61–66.

McGuire, T. W., R. Staelin. 1983. An industry equilibrium analysis of downstream vertical integration. *Marketing Science* **2**(1) 115–130.

Pasternack, B. 1985. Optimal pricing and return policies for perishable commodities. *Marketing Science* **4**(2) 166–176.

Sundararajan, A. 2004. Nonlinear pricing of information goods. *Management Science* **50**(12) 1660–1673.

Taylor, T., W. Xiao. 2009. Incentives for retailer forecasting: rebates vs. returns. *Management Science* **55**(10) 1654–1669.

1 Individual problems

1. (10 points) Complete the following calculations. You need to have enough steps to show that you really know how to do the calculations.

   (a) (2 points) $\int_0^t xe^{-2x}dx$.

   (b) (2 points) $\frac{d}{dt}\int_t^{t^2} x^4e^{-2x}dx$.

   (c) (3 points) $\max_{q\geq 0} \frac{a}{q} + bq$.

   (d) (3 points) $\min_{q\geq 0} \frac{a}{q} + bq$.

2. (10 points; 5 points each) In Pasternack (1985), it is shown that full returns with partial credits can be coordinating. In this problem, we will work on the following numerical examples under the setting of Pasternack (1985). Suppose the random demand is uniform between 0 and 50, unit retail price is 20, unit production cost is 5, and there is no salvage value and shortage cost. Both the manufacturer and retailer are expected profit maximizer.

   (a) Find the manufacturer's optimal wholesale (i.e., no return) contract.

   (b) Find a full return contract that makes the manufacturer earn exactly three times more than the retailer (i.e., $\pi_M = 3\pi_R$ if π_M and π_R are the manufacturer's and retailer's expected profit, respectively) or show that there is none.

3. (10 points) In McGuire and Staelin (1983), we have shown that, from the manufacturers' perspective, pure decentralization may outperform pure integration when the price competition is intense. This is based on the assumption that $q_i = 1-p_i+\theta p_{3-i}$ for $i = 1, 2$. where q_i is the demand volume of product i, p_i is the retail price of product i, and $\theta \in (0, 1)$ measures how intense the competition is. Now consider another model, in which the two products are identical and thus all consumers (whose size is normalized to 1) buys the cheaper product. If the two prices are identical, however, $\frac{1}{2}$ buys product 1 and $\frac{1}{2}$ buys product 2. Under this alternative setting, determine the equilibrium industry structure (pure integration, pure decentralization, mixture, or multiple equilibria) and the players' equilibrium profits. Does your answer fit the prediction of McGuire and Staelin (1983)?

4. (10 points; 5 points each) Taylor and Xiao (2009) compare returns contracts and rebates contracts. It is argued that rebates contracts encourage demand forecasting while returns contracts discourage forecasting. Now, consider revenue sharing contracts. By agreeing on a contract (q, ϕ, t), the manufacturer sells q units to the retailer in exchange of a lump sup transfer t and the retailer gives $100\phi\%$ of the total sales revenue to the manufacturer.

   (a) Formulate the manufacturer's and retailer's expected profit under a revenue sharing contract. Assume the random demand is $D \sim f, F$, the retailer does not forecast, the unit production cost is c, and the unit retail price is p.

   (b) Does a revenue sharing contract encourage or discourage the retailer to forecast? Provide economic reasoning without any mathematical derivations.

5. (10 points; 5 points each) In Sundararajan (2004), information goods instead of physical goods are studied. While information goods are special due to the near-zero marginal production cost, their are also other properties that distinct information goods from physical goods.

   (a) Write down at least one special property of information goods (something that is especially common/significant on information goods but is not so typical for physical goods). Use words only; do not use any mathematical notations.

   (b) For the special property you write down in Part (a), briefly explain how a game-theoretic model can be built to address it. Writing down the complete mathematical model is definitely the best; if not possible, partial credits will also be given to explanations in words.

2 Group problems

1. (20 points) The continuous-type procurement problem we discussed in class is as follows. A buyer wants to purchase a product from a supplier, whose unit production cost θ is privately observed by the supplier. The cost $\theta \in [\underline{\theta}, \bar{\theta}]$ follows a pdf f and a cdf F, where f and F is assumed to satisfy the increasing failure rate assumption that $\frac{f(\theta)}{1-F(\theta)}$ is increasing in θ. Under a procurement contract (q, t), the supplier sells the buyer q units of the product in exchange of a lump sum transfer t. In this case, the buyer's utility is $v(q) - t$ and the supplier's utility is $t - \theta q$, where $v(\cdot)$ is a strictly increasing and strictly concave function. Both the buyer and supplier act to maximize their expected utility. In this game, first the buyer designs a menu of contracts, then the supplier selects one contract or rejects the menu. If the supplier rejects the menu, both players earns zero utility. Otherwise, the contract is executed.

   (a) (10 points) Formulate the buyer's contract design problem. and then find the buyer's optimal menu.

   Note. You may take the fact that local IC plus monotonicity is equivalent to global IC as given. You do not need to prove it.

   (b) (5 points) Verify monotonicity, efficiency at top, and no rent at bottom.

   (c) (5 points) Suppose when the supplier rejects the menu, he can earn $u_0 > 0$ as his reservation utility. Therefore, the supplier will accept a contract only if accepting the contract results in a utility no lower than u_0. Reformulate and resolve the buyer's contract design problem and find the buyer's optimal menu. How does u_0 affect the optimal menu?

2. (30 points) Hsiao and Chen (2013) study a product line design problem on a supply chain. Unlike the product line design problem we discussed in class, they model the problem with two groups of consumers (instead of a continuum) and two firms (instead of one). This problem is based on their work.

   (a) (10 points) Read the paper and write a summary of it WITHOUT any mathematical notations. You should state the research question, describe the conceptual model (with words only), demonstrate their main findings, and explain the underlying reason for the phenomena they observe. If you are able to capture their main ideas, you may answer this question satisfactorily without going through the derivations.

   (b) (5 points) While they focus on an indirect channel, the direct channel case (in which the two firms integrate) has been solved without showing the details. You may find the solution to the direct channel in Appendix A. In this problem, your task is to verify the answer. In particular, you need to determine the players (as a principal-agent relationship), identify the principal, formulate her contract design problem under information asymmetry, solve it, and verify that the optimal solution you obtain is the same as theirs.

   (c) (10 points) It is typically said that "integration enhances efficiency". In the environment studied in this paper, first find the indicators of efficiency and then prove or disprove that integration enhances efficiency. More precisely, you need to compare the values of the efficiency indicators under decentralization (the indirect channel) and integration (the direct channel). Show that integration "always" enhances efficiency or "sometimes" integration makes things worse. In the latter case, explicitly show when it happens.

   (d) (5 points) In this paper, it is shown that $\beta \leq \frac{3}{4}$ is necessary for recession to benefit the whole indirect channel. If you think that makes sense, give economic intuitions for this fact. Otherwise, provide reasons why you do not agree with it.