Department of Economics Spring 2004
University of California Woroch/Lopez/Tovar

***Economics 121*: MIDTERM EXAM ANSWERS**

GENERAL INSTRUCTIONS: Write your name on the front cover of your blue book. The exam has 3 parts and is worth a total of 100 points. Point assignments are given in the instructions for each part. You are encouraged to check your calculations on scratch paper but be certain to put all of your answers in the bluebooks.

I. TRUE or FALSE or UNCERTAIN and EXPLAIN: Choose 3 of the following 4 statements, decide whether each is true or false or uncertain, and then explain the reasoning behind your answer in a few sentences. *Supply any assumptions you may think necessary to draw your conclusion*. Each question is worth 7 points for a total of 21 points.

1. If the costs of producing two goods, 1 and 2, individually and jointly, are given by the cost functions:

$C(q_1, 0) = 75{,}000 + (1/2)\, q_1^2$
$C(0, q_2) = 100{,}000 + (1/2)\, q_2^2$
$C(q_1, q_2) = 125{,}000 + (1/2)\,(q_1 + q_2)^2$

then the average incremental cost of good 2 is given by: $AIC_2 = \frac{25{,}000}{q_2} + \frac{q_2}{2}$.

FALSE. $IC = C(q_1, q_2) - C(q_1, 0) = 125{,}000 + (1/2)\,(q_1 + q_2)^2 - [75{,}000 + (1/2)q_1^2]$
$= 50{,}000 + (1/2)(q_1^2 + 2q_1q_2 + q_2^2 - q_1^2) = 50{,}000 + (1/2)(q_2^2 + 2q_1q_2)$
$AIC = (50{,}000/q_2) + (q_2/2) + q_1$

2. Too many firms will enter an industry if after entry the firms behave as Cournot oligopolists.

UNCERTAIN. First, consider an industry with constant marginal cost and falling average costs (i.e., positive fixed cost). With such a cost structure, it would be most efficient to have just one firm producing all the production and pricing at marginal cost (or at average cost if there was no way to make up the losses caused by marginal cost pricing). Assuming identical firms in an undifferentiated product market, firms continue to enter until profits are zero as we saw in problem #4 of PS1. The inefficiency occurs because each firm incurs a fixed cost in order to gain its (equal) share of Cournot profits.

Second, if the firms offer differentiated products, then there could be too few firms that enter even when they compete as Cournot described. The reason it that a firm is unable to derive a positive profit even when its entry generates a net increase in total welfare, i.e., the increment in consumer surplus is greater than the firm's loss. This could occur even in the natural monopoly situation described above; it would take the form of an average cost curve everywhere above the demand curve and yet total welfare positive. The same could hold in oligopoly situations because then the firms have less opportunity to generate revenue due to competition. The source of the problem is firms' inability to extract the full consumer surplus in the form of profits. Linear/uniform pricing is often the culprit. Nonlinear and discriminatory pricing could help in this case to make entry profitable.

3. In the below normal form game, both firm 1 and firm 2 have a dominated strategy, but neither firm has a dominant strategy:

TRUE. Firm 1 has no dominant strategy. However strategy C1 is dominated by strategy B1, as 0 > -1, 3 > 1 and 5 > 4. Firm 2 also has no dominant strategy. However strategy C2 is dominated by both A2 (1 > -1, 2 > 1, 5 > 4) and B2 (0 > -1, 3 > 1, 5 > 4) strategies. Incidentally the game has two pure-strategy Nash Equilibria: (A1, A2) and (B1, B2)

		Firm 2		
		A2	**B2**	**C2**
Firm 1	**A1**	1 1	0 2	-1 5
	B1	2 0	3 3	1 5
	C1	5 -1	5 1	4 4

4. *The Bertrand Paradox will arise for a duopoly on the Hotelling line as transportation costs go to zero.*

UNCERTAIN. - Recall that price in the model is P + tx. If t = 0, then each consumer will only pay the price regardless of its position on the Hotelling line.

- If t=0, we can assume that consumers view the products as perfect substitutes. In this case, the price will converge to the marginal cost.
- However, if marginal costs differ across firms, then firms will compete on price. If we assume two firms with different costs, say $MC_1 > MC_2$. Then, when the firms compete on price, firm 2 will be able to price just below MC_1

II. <u>MULTI-PART QUESTIONS</u>: For each of the following two questions, answer <u>all parts</u>. Point assignment for each subpart is given in [square brackets]. They are worth <u>55</u> points.

1. *Alpha, Inc. has a store located at $x_A = 0$ (Store A) on a Hotelling line of length 1 with 100 consumers evenly distributed along it (i.e., N = 100). Each consumer derives value from the good of V = 80 and incurs transportation cost per unit distance equal to t = 50. There are no marginal costs (c = 0) but each store incurs a positive fixed cost (F > 0). Note: it may be helpful to draw this market.*

a) ***[6]*** *Verify that the demand realized by Alpha at Store A is: $D(P_A) = 160 – 2P_A$ when $30 \# P_A \# 80$, and $D(P_A) = 100$ when $P_A < 30$.*

The marginal consumer will be located where

$$U(A) = V – P_A – t|x^m – x^*| = 0.$$
$$80 – P_A – 50x^m = 0$$
$$x^m = (80 – P_A)/50$$

This gives the proportion of consumers that will purchase.

Thus, the demand the firm faces will be:

$$D(P_A) = x^m N = ((80 – P_A)/50)*100$$
$$= 2(80 – P_A) = 160 – 2P_A$$

Note, that if prices fall enough, the whole market will be served. The consumer located at x = 1 will buy if:

$$80 – P – 50(1) \geq 0$$
$$P \leq 30$$

Thus, demand is D(P) = 160 – 2P for $30 \leq P \leq 80$ and D(P) = 100 (full market) for $P \leq 30$.

b) ***[6]*** *Given the demand in part (a), find Alpha's profit-maximizing price and the quantity sold.*

Inverse demand is given by

$P_A = 80 - \frac{1}{2}Q$
$MR = 80 - Q = MC = 0$
$Q = 80$ (which implies that the marginal consumer is located at 0.8)
$P_A^* = 40$ (by plugging Q^M into the inverse demand).

c) ***[6]*** *Alpha is now considering opening a second store (Store B) located at $x_B = 1$. Find Alpha's profit-maximizing price when it charges the <u>same price</u> at both stores: $P_A = P_B = P$.*

From part A, absent a second store, the firm would choose a price such that more than 50% of the market is served. Now consider what would happen if both stores charged a price of P = 40. The marginal consumer would be located at $x^M = 0.5$ (see figure 1). All the consumers to the left of 0.5 would patronize firm A, while all those to the right would patronize firm B. Total profits would be $\pi = 40*100 = \$4{,}000$.

Now, the marginal consumer will have some positive excess utility, since the total cost (price plus transportation costs) are still less than the value ($P + tx^M = 40 + 25 = 65 < 80 = V$). If the store raises the price at both stores, the marginal consumer will remain at 0.5. Thus, Alpha Inc. can raise its price without loosing any demand.

The marginal consumer ($x^m = 0.5$) has zero excess utility.

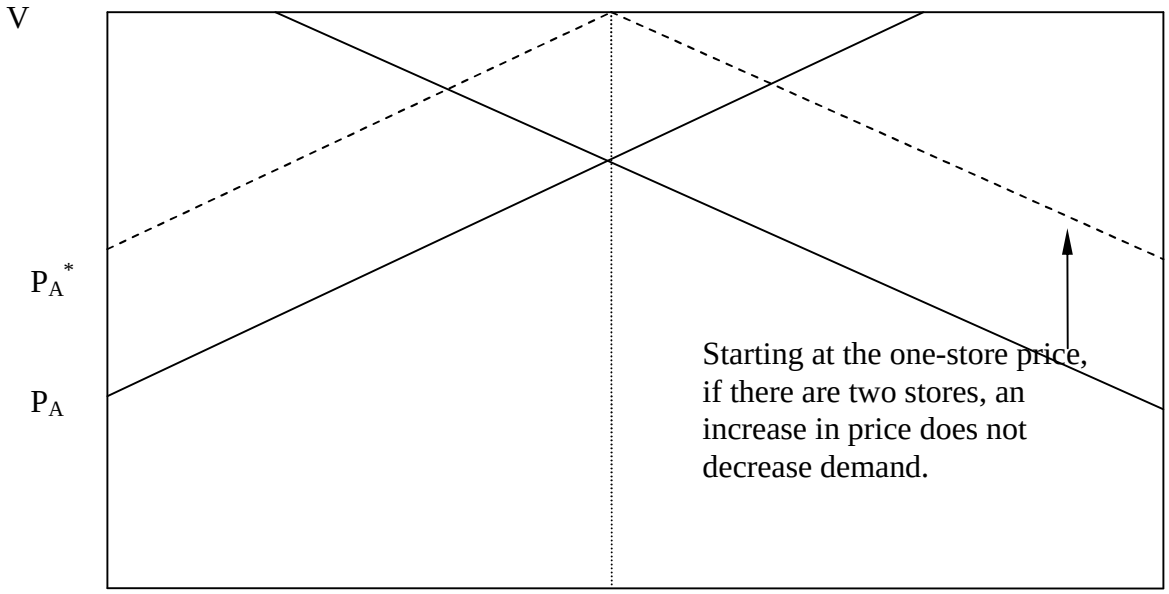
$$U^m(A) = V - P - t(0.5) = 80 - P - 50(0.5) = 0$$
$$55 - P = 0$$
$$P = 55$$

For P = 55, profits are \$5,500.

- Slightly more formally, consider prices such that the whole market is served. Demand will be

$D(P) = 100$ for $P < 55$
$= 320 - 4P$ for $P > 55$ (twice the demand form part a).

For $P < 55$, the inverse demand is $P = 80 - \frac{1}{4}Q$, $MR = 80 - \frac{1}{2}Q = MC = 0 \rightarrow Q^* = 160$. First, note that this would give P = 40, which we know earns the store less profits. Also note that this is out of the range for our demand, thus P = 55 must be the profit maximizing point.



d) ***[6]*** *Suppose that the government forces Alpha to divest Store B to a second, independent firm, Beta, Ltd. Compared to the two-store monopoly, what will be the direction of the effect of this divestiture on store prices, and on total welfare? Note: no derivations are expected, just give your intuition.*

PRICES: FALL.

Suppose store B kept its price at 55. Can the best response to firm A also be to set $P_A = 55$? We know that, unconstrained, firm A would set a price of $P_A = 40$ (from part b). Thus, with one store, starting at 55, decreasing prices increases demand and increases profits overall. With two competing stores, decreasing price will also increase demand, but by a lesser amount. Firms will have an incentive to undercut each other in (vain) hopes of increasing demand. The new equilibrium price will be $P_A = P_B = 50$. Note that in equilibrium, neither firm accomplishes increasing its demand.

More formally, consider the marginal consumer in part c, located at $x^M = 0.5$. Each firm will have an incentive to undercut the other firm by a little in order to gain market share. Suppose that store B keeps its price at 55. Then, the marginal consumer for firm A (given $P_B = 55$) will be by

$$\begin{aligned} 80 - P_A - 50x^M &= 80 - P_B - 50(1-x^M) \\ 80 - P_A - 50x^M &= 80 - 55 - 50 + 50x^M \qquad \text{(for } P_B = 55\text{)} \\ 80 - P_A - 50x^M &= -25 + 50x^M \\ 105 - P_A &= 100x^M \\ x^M &= (105 - P_A)/100 \end{aligned}$$

Profits for firm A will be

$$\begin{aligned} &= (100\, x^M)\, P_A \\ &= (105 - P_A)P_A \end{aligned}$$

$= 105P_A - P_A^2$

$dPr/dP = 105 - 2P_A = 0$

$P_A = 105/2 = 52.5$

Here, we can see that the best response to $P_B = 55$ is for A to price lower to 52.5. In the end, prices must fall.

TOTAL WELFARE: UNCHANGED.

Clearly, consumer surplus will go up and combined profits will go down. Total welfare, however, does not changes since the price decrease is just a net-zero transfer from the firms to consumers (in both cases, total welfare will be 67.5.).

2. *Firms 1 and 2 each produce a single product, also called 1 and 2, which have the following (inverse) demand curves:*

$$P_1(q_1, q_2) = 120 - q_1 - bq_2$$
$$P_2(q_2, q_1) = 120 - q_2 - bq_1$$

where 0 # b < 2. Each firm faces zero marginal costs and has fixed costs of F = 900.

a) ***[4]*** *Explain how you would use information about the value of demand parameter b to decide whether the two products were in the same economic market.*

Consider what happens as b goes to 0: each firm's demand gets closer to P = 120 – q. In this case, we would consider each to be in a separate market, since the output/price in one market has no affect on the other market. As b increases, the cross-elasticity between the two markets also increase (in absolute terms). A change in the output/price in one market has a greater affect the greater b, making them closer substitutes.

b) ***[5]*** *Write down the profit for firm 1 and then verify that firm 1's best response curve to firm 2's quantity is: $r_1(q_2) = 60 - \frac{1}{2} bq_2$. Be certain to show each step of your derivation.*

Firm 1's profit is given by:

$\pi_1 = (P - c)q_1 - F$

$= (120 - q_1 - bq_2 - 0)q_1 - F$

$= 120\, q_1 - q_1^2 - bq_2\, q_1 - F$

$d\pi_1 = 120 - 2q_1 - bq_2 = 0$

$r_1(q_2) = 60 - \frac{1}{2}bq_2$

c) ***[7]*** *Solve for the Cournot-Nash equilibrium quantities for an arbitrary value of b.*

Plug firm 1's best response into firm 2's best response (which will be symmetric):

$q_2 = r_2(q_1) = 60 - \frac{1}{2}bq_1$

$= 60 - \frac{1}{2}b(60 - \frac{1}{2}bq_2)$

$q_2 = 60 - 30b + \frac{1}{4} b^2 q_2$

$(1 - 1/4\, b^2)q_2 = (60 - 30b)$

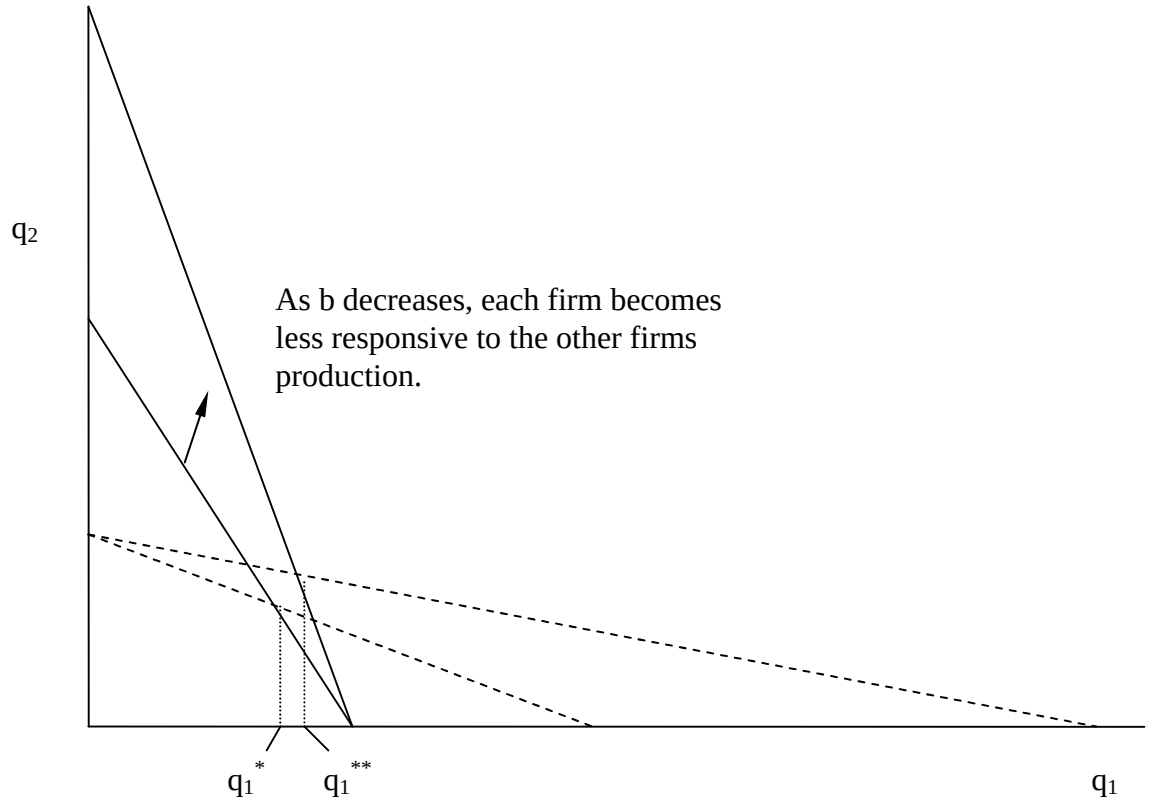
$q_2 = (60 - 30b) / (1 - \frac{1}{4} b^2)$

Note that b = 1 is the usual form of the Cournot game, where $q_2 = 30/(3/4) = 40$.

d) ***[5]*** *As b decreases from 1 down to ½, what happens to equilibrium quantities of the individual firms and to the industry output? Give your economic intuition that explains this result.*

- Intuitively, as b becomes smaller, the two markets become more independent, thus we would expect each firm to look more like a monopolist, increasing output and prices.
- From part c) for b = ½, $q_A^* = q_B^* = 48$.
- Best response curves. As b goes from 1 to ½, the best response curve goes from $q_2 = 60 - \frac{1}{2}q_1$, to $q_2 = 60 - \frac{1}{4}q_1$. That is, each firm becomes less responsive to the other firm's

output. Thus Nash equilibrium has each firm producing more.
- Graphically, the best-response curves rotate out and we can see that quantities produced increases.



e) ***[6]*** *Now suppose that firm 1 chooses its quantity first, and firm 2 follows with its quantity taking firm 1's output as given. For b = 1, find firm 1's output level such that firm 2 can at best break even. Compute the associated "limit price."*
Firm 1 will want to produce a quantity such that firm 2 cannot make positive profits. To begin, Firm 1 knows that for any quantity q_1, firm to will produce on its best response curve. Firm 2's profits will be:

$$\begin{aligned}\pi_2 &= (P_2 - c)q_2 - F \\ &= (120 - q_2 - bq_1)q_2 - 900 \\ &= (120 - (60 - \tfrac{1}{2}bq_1) - bq_1)\,(60 - \tfrac{1}{2}bq_1) - 900 \\ &= (120 - (60 - \tfrac{1}{2}q_1) - q_1)\,(60 - \tfrac{1}{2}q_1) - 900 \quad \text{for } b = 1\end{aligned}$$

Firm 1 can then choose the limit quantity q_1^L such that

$$\begin{aligned}(120 - (60 - \tfrac{1}{2}q_1) - q_1)\,(60 - \tfrac{1}{2}q_1) - 900 &= 0 \\ (60 - \tfrac{1}{2}q_1)^2 &= 900 \\ (60 - \tfrac{1}{2}q_1) &= 30 \\ q_1^L &= 60\end{aligned}$$

The associated limit price will be

$$P_1 = 120 - q_1^L = 60$$

f) ***[4] W****ithout making any further calculations, explain why you would expect this limit price to rise or fall if b was to fall from 1 down to ½.*
As b falls from 1 down to ½, the two goods become more independent (the substitutability goes down). That is, firm 2's demand will depend less on the output of firm 1. Given this, it must be

more difficult for firm 1 to implement a successful limit output/price strategy. The limit output must increase and the price in market 1 will decrease.
To confirm this intuition, find the limit output as a function of b (this is not needed in order to get full credit):

$$\begin{aligned} \pi_2 &= (120 - q_2 - bq_1)q_2 - 900 \\ &= (120 - (60 - \tfrac{1}{2}bq_1) - bq_1)\,(60 - \tfrac{1}{2}bq_1) - 900 \\ &= (60 - \tfrac{1}{2}bq_1)^2 - 900 = 0 \\ q_1^{\,L} &= 60/b \end{aligned}$$

Thus, as b falls, the limit output increases and the price will fall.

III. INDUSTRY STUDIES: Answer each of the following two questions about the industry studies. Note that you choose just one of two industries in the second question.

1. *For the U.S. beer industry, answer each of the following two questions:*
   a) ***[6]*** *Describe the major changes that took place in industry concentration over the course of the second half of the 20th century.*

The U.S. beer industry showed a consistent increase in concentration over that period. In the late 1940's, there were more than four hundred firms operating a total of 465 plants, and the C2 concentration index was a mere 8.8 percent. In contrast, in 1996 five firms operate 31 breweries, and the C2 in 1996 was 67.2 percent. In the late 1940's Stroh-Schlitz was the industry leader with 5.5 percent of market share. Today, Anheuser-Busch and Miller account for roughly two thirds of the market. During these years, imports have made forays into the U.S. market but never amounted to significant market share: by 1960, imported beer and super-premiums accounted for 1 percent of total sales, rising to 8 percent by 1996. Microbreweries have been a more recent phenomenon, but they have garnered an even smaller of the market.

   b) ***[6]*** *Explain the pattern of scale economies over this same period and its role in the changes in concentration that occurred.*

Technological change has lead to significant increases in scale economies at the plant level of the time period. The minimum efficient scale of a brewery currently is about 4.5 million barrels per year, up from less than a half million just after the World War II. Multi-plant economies of scale are currently realized at three to four plants per brewer whereas a single plant was the norm fifty years ago. Besides economizing on transportation cost by distributing a homogeneous product from geographically disperse breweries, multi-plant production benefited from cost advantages that derive from national advertising. In particular, the effective cost of network television advertising is significantly lower than alternative advertising media whether that is local or regional advertising or even national spot TV ads.

Scale economies was not the only factor leading to rising concentration in this industry. There were many mergers over the years, but much of that took the form of acquisition of "failing firms." The net result was not much contribution to increased concentration compared to internal expansion. Furthermore, antitrust policy discouraged many of the larger proposed mergers in the beer industry.

2. *For either the auto or breakfast cereal industry, but not both, describe one significant entry threat to this U.S. industry during the second half of the 20th century. In your answer, address each of the following:*

a) ***[6]*** *Describe the source of the threat and explain why it was a significant threat to incumbent suppliers.*

AUTOMOBILES: Perhaps the most significant entry threat in recent years was the Japanese imports that began in the 1960s and 1970s. These were reliable, small, fuel efficient vehicles which were effective in stealing sales from the big three U.S. auto makers which had large, gas guzzlers with a record for poor quality. (An entry threat still on the horizon is the alternative fuel vehicle whether it is a gas-electric hybrid, or powered by hydrogen or fuel cells.) Japanese auto makers also had significant cost advantages relative to Detroit. In particular labor costs were significantly lower in Japan compared to the rates paid under United Auto Workers contracts. Over time, Japanese (and European) auto makers began to locate assembly in the U.S. thereby eliminating transportation costs and import restrictions in exchange for higher labor costs.

BREAKFAST CEREALS: Health cereals challenged the major U.S. ready to eat breakfast cereal makers beginning in the late 1960s. These cereals were made by small, new entrants into the cereal industry, and most but not all of them being domestic. Private label cereals (or "store brands") represented another competitive entry threat. The most prominent supplier of these products which sat side-by-side on store shelves with major brands was Ralston. These products offered a substitute that was close in product attributes and quality, but was branded usually by the grocer, e.g., Safeway Select corn flakes. They typically were sold at discount from the national brand even if produced by the same plant.

b) ***[6]*** *Give the impact it had on the industry structure, if any, and <u>one</u> major response by the incumbents.*

AUTOMOBILES: Detroit responded at first by seeking a variety of limitations on the Japanese imports, succeeding in persuading Washington in some cases or eliciting "voluntary" restraints from Japan. (With time, Detroit built smaller, more fuel efficient cars, and with much more time, improved the quality record. In fact, a few days ago Consumer Reports gave U.S. vehicles a better rating that European cars in their annual auto issue, though still short of Japanese car makers. A story on this will be posted to the course website.) Detroit also engaged in significant price cutting to meeting this competition with the rebate offers and low/zero financing being the two most prominent means.

BREAKFAST CEREALS: In response to health cereals, the major cereal makers responded principally by fashioning their own versions. Some entrants were acquired by the majors. Very few of any health brands have survived until today with non-negligible market share, with the exception being Quaker 100% Natural. They also responded by fortifying their existing brands with vitamins and minerals line to deflect the health challenge. In response to private label, almost all of the majors refused to supply retailers with product with the exception of Ralston. In the case of Kellogg, it created a brand (Crispix) to attack Ralston's core brands (Chex), apparently attempting to punish it for facilitating private label products.