Economics 121: MIDTERM SUGGESTED ANSWERS

<u>GENERAL INSTRUCTIONS</u>: Write <u>your name</u> and <u>your TA's name</u> on the front cover of each of TWO BLUE BOOKS. The exam has 3 parts. Put Parts I and II.1 in one blue book, and Parts II.2 and III in the second. Point assignments are given in the instructions for each part. The exam is worth 100 points. You may check your calculation on scratch paper but be certain to <u>put all of your answers in the bluebooks</u>.

- I. <u>TRUE or FALSE or UNCERTAIN and EXPLAIN</u>: Choose 4 of the following 5 statements, and decide whether each is true or false or uncertain, and then explain the reasoning behind your answer in a few sentences; if appropriate, provide a diagram. Each question is worth 8 points for a total of 32 points.
- 1. If the costs of producing two goods, 1 and 2, individually and jointly, are given by the cost functions: $C(q_1, 0) = 125 + q_1^2$ $C(0, q_2) = 200 + q_2^2$

$$C(q_1, q_2) = 250 + q_1^2 + q_2^2 + q_1q_2$$

then there are economies of <u>scope</u> between the two products for all levels of production. **FALSE:** Economies of scope exist when the cost of producing the two goods jointly is cheaper than producing them separately:

 $\begin{array}{rl} C(q_1, q_2) & < C(q_1, 0) + C(0, q_2) \\ 250 + {q_1}^2 + {q_2}^2 + q_1 q_2 & < (125 + {q_1}^2) + (200 + {q_2}^2) \\ q_1 q_2 & < 250 \text{-} 325 \\ q_1 q_2 & < 75 \end{array}$

Which signifies that economies of scope only exist for when $q_1q_2 < 75$.

The Lerner Index increases as the number of symmetric Cournot oligopolists increases.
 FALSE: The Lerner index, the measure of price markups falls as additional firms enter a Cournot oligopoly. In the symmetric Cournot oligopoly, the relationship is between the markup L = (P-c)/P and the market share of an individual firm, s_i. As that market share falls, so does the markup. (You are not

required to remember the exact formula, but the Cournot Oligopoly markup formula is $(P-c)/P = s_i/\eta$). Intuitively, as the number of firms increases, the residual demand faced by any one firm shifts back, increasing competitive pressure and ultimately driving prices towards marginal costs.

3. In the normal form game at the rights, if 2 < X < 3 and 3 < Y < 4, then (B1, B2) is a Nash equilibrium and it is also Pareto Optimal.
FALSE: It is true that (B1,B2) is the only (pure strategy) Nash Equilibrium of the game. To get full credit, you would need to show this, either by solving the game and/or explaining why it is a Nash Equilibrium. (B1,B2) is a NE because:

Firm 2										
		A2			<i>B2</i>		<i>C2</i>			
	<i>A1</i>		2		0		-1			
Ι		1/2		2		7				
rm	B1		1		Y		3			
Fi		-3		X		5				
	<i>C1</i>		4		5		-2			
		3		1		3				

- Given firm 1 plays B1, firm 2 will choose B2 (since A2 yields it a payoff of 1, C2 yields 3 and B2 yields greater than 3.

- Given firm 2 plays B2, firm 1 will choose B1 (since A1 yields it a payoff of 2 and C1 yields a payoff of only 1 while B2 yields more than 2.

However (C1,A2) Pareto Dominates (B1,B2), as both Firms would be better off with (C1,A2) as (3 > X & 4 > Y). Note that this has nothing to either firms strategy (since given firm 1 plays C1, firm 2 would rather play B2). It only asks if, compared to (B1,B2), can we move to (C1,A2) making someone better off without making anyone else worse off. Thus, it not Pareto Optimal.

4. In Stackelberg duopoly where both firms have constant marginal cost, in equilibrium, the firm with a lower marginal cost will produce a greater amount than the high cost firm.

UNCERTAIN: Consider the two effect separately, the first mover advantage in the Stackelberg and the cost advantage. In the Stackelberg duopoly when cost are the same, the leader will produce more in equilibrium. Now consider a Cournot duopoly where one firm has lower marginal costs. We know the lower cost firm will produce more.

Given it could be the case that the Stackelberg leader could have the higher costs, the two effects will be offset. If the cost differences are small, we would expect the first mover advantage to dominate, while large enough costs difference (where the follower has much lower marginal costs), we expect the cost effect to dominate.

5. The pattern of "brand proliferation" in the Competitive Strategy Game (i.e., how per-firm sales are affected by the number of sellers in each product market) is better described by Hotelling's model of product differentiation than by the model of monopolistic competition.

FALSE: Profiles of product markets in the CSG clearly show that as additional firms enter the market the sales of each firm in the market falls, holding the common price constant. This is the same as monopolistic competition in which a representative consumer treats all brands in the market symmetrically, so that a new entrant will get the same sales share as an existing product when the price is the same for all brands. In contrast, entry into a Hotelling oligopoly will impact sales only of those brands that are neighbor. As long as prices are held fixed, and products are not repositioned, sales of brands not adjacent to new entrant are unaffected sales. This is a property of horizontal, spatial product differentiation.

II. <u>MULTI-PART QUESTIONS</u>: Answer <u>all parts</u> of the following two multipart questions. The point assignment for each subpart is given in [square brackets].

- 1. Firms 1 and 2 each produce a single homogeneous product in quantities q_1 and q_2 , respectively. Demand for this product is given by the (inverse) demand curve: $P(q_1, q_2) = 180 - q_1 - q_2$. Both firms face zero marginal costs and any fixed costs are entirely sunk
 - a) [4] Show that firms 1's best response curve will be: $r_1(q_2) = 90 \frac{1}{2}q_2$. Maximize firm 1's profits for a given q_2 :

π	=	$P(q_1, q_2) \ge q_1 - 900$	
	=	$(180-q_1-q_2)q_1-900\\$	
	=	$180q_1 - {q_1}^2 - q_2q_1 - 900$)
$d\pi/dq_1$	=	$180 - 2q_1 - q_2 =$	= 0
$2q_1$	=	$180 - q_2$	

$$r_1(q_2) = q_1^* = 90 - \frac{1}{2}q_2$$

b) [3] Draw the best response curves for both firms with q_1 on the x-axis and q_2 on the y-axis. (below)

IMPORTANT: You need to label each of the best response curves.

c) [5] Solve for the Cournot equilibrium, and indicate this point on your graph.

 $r_2(q_1) = 90 - \frac{1}{2}q_1$ q_2 = $90 - \frac{1}{2}(90 - \frac{1}{2}q_2)$ by substituting $q_1 = 60 - \frac{1}{2}q_2$ = $90 - 45 + \frac{1}{4}q_2$ = $(1 - \frac{1}{4})q_2$ (90 - 45)= $(90-45)/(1-\frac{1}{4})$ q_2 = 45/(3/4) q_2 =60 _

NOTE: There were some people who simply set $r_2(q_1) = r_1(q_2)$, by setting

 $90 - \frac{1}{2}q_1 = 90 - \frac{1}{2}q_2$

Incidentally, this gives you the correct answer if you then plug $q_2 = 90 - \frac{1}{2}q_1$ on the right-hand-side. But this only works when costs are the same and equilibrium quantities will be the same. Graphically, if you would like to find the intersection between r_1 and r_2 , you need to rearrange one of the equations. r_2 : $q_2 = 90 - \frac{1}{2}q_1$ and rearrange r_1 so that q2 is on the left-hand-side: $q_2 = 180 - 2q_1$ (think finding the intersection between two lines, you need to solve both for y before setting them equal to each other).

d) [3] Show that the equilibrium price is $P^* = (1/3) (180 + c_1 + c_2)$.

e) [4] Suppose firm 2's marginal cost rises to $c_2 = 20$, while firm 1's marginal cost remains zero. Draw on your graph what happens to firm 2's best response curve, firm 1's best response curve and the equilibrium quantities. Explain your answer: No calculations are necessary. (Below)

- Firm 1: First note that firm 2's marginal cost does not affect how firm 1 will respond. That is, firm1's BR only tells us how firm 1 will respond to firm 2'

- Firm 2's best response shifts inward. For any given quantity that firm 1 produces, firm 2 is a weaker competitor and its best response therefore will be to produce less.

- The new equilibrium will have Firm 1 producing more, firm 2 producing less and the total quantity going down.

f) [4] Suppose, instead, that marginal costs of both firms rise to \$20. Without any additional calculations, give your reasoning why the increase in the equilibrium price will be more or less than that in part (e)?

- Many read the question as: does the price increase from part e? Since the total quantity will go down again, the price must increase from part e. This can be seen from the equation in part d.

- The question was mean to be: will the price <u>increase</u> here (when firm 1 mc increases by \$20) be more or less than the <u>increase</u> in price from part e.

- The pass-through rate tell us that the increases will be the same. As can be seen from part (d), the pass-through rate for any one Cournot duopolist is 1/3 (e.g. increasing the price by \$1 increases the equilibrium price by 0.33). Thus, in part e, when firm 2's marginal cost increase by \$20, the price will increase by \$6.33. When firm 1's marginal costs increase, the price will increase by an additional



- 2. There are 1,000 customers uniformly distributed along the 10 miles of Center Street. Chong's Chow is the monopoly provider of Chinese takeout located at mile 5 (the exact middle of the street). Each consumer derives a value of \$50 from Chinese takeout and buys at most 1 dinner a month. The transport costs are \$2 per mile (round trip). Chong's marginal cost of supplying a dinner is \$10. There are no fixed costs at this location.
 - a) [3] Show that if Chong's were to serve the entire market, it would set P = \$40. For Chong's to serve the entire market, it would want to set a price so that people located at mile zero and mile 10 are just indifferent to buying the product. So in particular for the consumer located at mile zero we equate:

$$V = EP = p + t(5-0)$$

$$50 = p + 2(5-0)$$

$$p = $40$$

[3] What are Chong's monthly profits at this price?

$$\pi = (P - MC)Q - FC$$

$$= (40 - 10)1,000 - 0$$

$$= 30,000$$

A space for lease has opened at the far end of the street at mile 0 for a rent of \$500 per month. Chong's can not move its original store to a new location, but can open a second restaurant. The new restaurant will have the same marginal production cost as the original restaurant (c = \$10). The two locations can set different prices $P_{original}$ and P_{new} for meals.

b)

c) [5] Give a formula for the marginal consumer (z) who is just indifferent between buying from the new restaurant (mile 0) and the original restaurant (mile 5).

The marginal consumer will lie in the interval from 0 to 5 (unless the new store sets a price so low that it serves the entire market, in which case there is no marginal consumer. However, this price is lower than the price for the original store to serve the entire market, and thus can be ignored)

We find the marginal consumer by setting the effective price from buying from the two different stores equal for consumer z. That is

EPoriginal	$= EP_{new}$?
$P_{\text{original}} + 2(5-z)$	$= P_{new} + 2(z - 0)$
Z	$= [P_{original} + 10 - P_{new}]/4$

d) [7] Suppose that Chong fixes the price of the original store (located at mile 5) at P = \$40 so that the entire market is served. Find the profit maximizing price for the new store.
Since Chong's owns both stores, Chong's cares about overall profits, and thus must set the price at the new store taking into account how it will cannibalize consumers from the original store.

We know that everyone to the right of the original store (those located past mile 5) is being served by the original store, because we are fixing the price at that store at \$40.

So the original stores serves 10-z miles of the street, and the new store serves z miles of the street, which given there are 100 people per mile implies: $Q_{\text{original}} = (10-z)*100$ and $Q_{\text{new}} = z*100$

We can then write the total weekly profits for Chong's as:

π

 $= \pi_{\text{original}} + \pi_{\text{new}}$ $= (P - c)Q_{\text{original}} + (P_{\text{new}} - c_{\text{new}})Q_{\text{new}} - FC_{\text{new}}$ $= (P_{\text{original}} - c_{\text{original}}) (10-z)100 + (P_{\text{new}} - c_{\text{new}}) z100 - FC_{\text{new}}$ $= [(P_{\text{new}} - c_{\text{new}}) - (P_{\text{original}} - c_{\text{original}})]z100 + (P_{\text{original}} - c_{\text{original}})(10)100$ $- FC_{\text{new}}$

Because we are fixing P_{original} , when maximizing we need only worry about terms involving P_{new} , which means we can ignore the terms in the equation above, which do not depend on P_{new} .

So Chong's problem can be boiled down to:

$$\begin{split} \text{Max}(\text{P}_{\text{new}}) &= [(\text{P}_{\text{new}} - \text{c}_{\text{new}}) - (\text{P}_{\text{original}} - \text{c}_{\text{original}})]100z \\ &= [(\text{P}_{\text{new}} - 10) - (40 - 10)]100[40 + 10 - \text{P}_{\text{new}}]/4 \\ &= (\text{P}_{\text{new}} - 40)(50 - \text{P}_{\text{new}})25 \end{split}$$
 So the FOC is: $(50 - \text{P}_{\text{new}})25 - 25(\text{P}_{\text{new}} - 40) = 0 \\ 90 &= 2 \text{ P}_{\text{new}} \end{aligned}$ $\begin{aligned} \text{P}_{\text{new}} &= 45 \\ \text{we can see that } z = 5/4 \end{split}$

e) [3] Suppose Chong's allowed the original store (at mile 5) to choose any price (not necessarily such that the entire market were served). Without doing any calculations, would you expect the prices at each store to increase, decrease or stay the same compared to part d? Explain your intuition.

In general we would expect the prices at both stores to rise somewhat. The intuition is that by raising the price at the original store, Chong's eliminates some of the cannibalization problem between the two stores and allows the new store to charge a higher price serving more customers. Of course by raising the price above \$40 at the original store, Chong's will lose some of it's customers on the far side of town (those near mile 10). Whether that tradeoff is worth it to Chong's will depend on transportation costs and V - it may turn out to be that Chong's is still better off charging \$40 at the original store and serving the whole market (in which case the answer to part d would still hold). It will never be in Chong's interest to lower the prices at the two stores.

III. <u>INDUSTRY STUDIES</u>: Answer each of the following two questions. Notice that you have some choice in each question. Be brief: a complete answer is possible in <u>less than one blue book page</u> for each part. Point assignments are given in [square brackets].

1. [12] Choose either the BEER or the AUTO industry.

a) Describe the change in concentration in the U.S. industry over the second half of the 20th century.

BEER: Over this period, there was significant and steady increase in concentration. At mid century, the two largest brewers had less than 10% of the sales whereas today the two largest (Anheuser-Busch and Miller) have more than $2/3^{rd}$ of the U.S. beer industry. In this time frame, imports and microbrews have appeared but their market share has never grown more than single-digit percentage. Many older brewers have exited or sold off to other major brewers adding to concentration.

AUTO: Over this period, there has been a steady decrease in the market share of the big three U.S. auto makers and a reduction in the overall reduction in concentration in the U.S. industry. The big three has seen their market share drop from 85% to 60%. Most market share has shifted to Japanese auto makers who, at mid century, effectively had zero market share. The European makers have gained as well but by an amount small in comparison. Stabilization in market share of U.S. makers can be traced to their success in the categories of minivans, small truck and SUVs, compensating for significant losses in passenger cars.

b) Briefly describe two key sources for the observed trend besides changes in economies of scale.
BEER: Besides scale economies, the industry has moved toward multiplant production. Multiple plants reduce transportation cost by distributing from geographically disperse breweries. It also takes advantage of savings in the form of national advertising which was not possible if distribution was localized.
Standardized recipes, processes, and equipment enable multiple plants while maintaining uniform quality.
AUTO: The biggest source of reduced concentration is the success of imports, and the failure of U.S. auto makers. The latter were committed to large, fuel inefficient cars which suffered a cost disadvantage after the oil crisis and rising gas prices in the 1970s. Imports also benefited from lower labor costs and production techniques that resulted in higher quality cars. Trade policy has contributed to the trend in concentration, both up and down. Voluntary import restrictions held back an even faster increase in Japanese imports in the 1970s.

- 2. [12] Choose either the AUTO or the BREAKFAST CEREAL industry.
 - *a) Give an example of vertical product differentiation in the industry, and an example of horizontal product differentiation.*

Keep in mind the definitions for vertical and horizontal product differentiation. Two products are vertically differentiated when all consumers would prefer one over the other if they were priced the same. This would

occur if one consisted of more of all of the attributes that consumers agreed were desirable. Two products are horizontally differentiated if some consumers would prefer one product, while others preferred the other when they are priced at the same level.

AUTO: (i) vertical: a model of a car that scores higher on each and every attribute that consumers agree are desirable, such as acceleration, gas mileage, safety, style, comfort and so on. We might argue that a used version of a model is vertically differentiated from a brand new version. (ii) horizontal: two "categories" of automobiles—such as, coupe and minivan—would be horizontally differentiated because families overwhelming would prefer minivans while singles would prefer a coupe, when they cost the same. Similar cars that have different relative amounts of desirable characteristics would also split the vote: two passenger cars in which one is fast but less safe (Acura) while another is safe but not very fast (Volvo). **CEREAL**: (i) vertical: this can be complicated by the difficulty of choosing characteristics that consumers would unanimously agree are desirable; one possibility might be "freshness." Consider two identical cereal but with one being "fortified." Assuming this has no effect on other characteristics such as taste, then everyone would prefer the fortified version. (ii) horizontal: along many dimensions consumers will differ in their ideal amount of a characteristic, e.g., sweetness and calories. This may even apply to hard-to-quantify characteristics such as "crunchiness."

b) Describe how product differentiation in the industry might have the effect of erecting barriers to new entrants into the U.S. market.

AUTO: A wide range of products with small differences between models could leave a market niche that cannot generate enough sales for an entrant to spread its fixed, entry costs. An alternative would be to enter with multiple models but this will raise entry costs. In addition, a pattern of continuous model changes makes it relatively more difficult for a smaller firm to cover fixed costs of style changes (e.g., new design, new stamping machines, retrofit assembly line, advertising launch).

CEREAL: Similarly a proliferation of cereal brands that do not differ much in their characteristics makes it more difficult for an entrant who enters with a single brand, or small number of brands. Also, evidence shows that incumbent major cereal makers often responded to a new type of cereal by marketing a similar product. The case of health cereals offers a good example. Also notice how Kelloggs came out with Crispix in response to Ralston's Chex, though the motivation in that case was different.