KEELE UNIVERSITY

MID-TERM TEST, 2007

Thursday 22nd NOVEMBER, 12.05-12.55

BA BUSINESS ECONOMICS
BA FINANCE AND ECONOMICS
BA MANAGEMENT SCIENCE

ECO 20015

MANAGERIAL ECONOMICS II

Candidates should attempt Question 1 and ONE other. Each question is worth 50 marks.

For time allocation purposes, 10 marks corresponds to five minutes.

When presenting numerical results, please give a complete step-by-step presentation of your derivations. All mathematical derivations should be accompanied by brief explanatory remarks and interpretations.

ECO 20015: MANAGERIAL ECONOMICS II

Candidates should attempt Question 1 and ONE other. Each question is worth 50 marks.

1. Briefly outline and explain the relevance of **four** of the following: [**50 marks**]

    (*a*) Elastic and inelastic demand

    (*b*) Double marginalisation

    (*c*) Second-degree price discrimination

    (*d*) The difference between economic and accounting profit

    (*e*) Complementors

    (*f*) The waterbed effect

2. Suppose that in a perfectly competitive industry, every firm has a total cost function $TC(x) = (90/49) + 2x + (x^2/10)$. Demand is given by $D(p) = 10(5 - p)$.

    (*a*) Derive the supply function for an individual firm. [**15 marks**]

    (*b*) If the industry consists of four identical firms, with no possibility of entry or exit, calculate the industry equilibrium. What is the equilibrium price, and quantity produced by each firm. [**15 marks**]

    (*c*) Calculate the profit of each firm in the industry. Will there be entry or exit into the industry in the long-run? [**10 marks**]

    (*d*) Is the long-run supply curve flat? [**10 marks**]

3. An ice-cream seller in a seaside town sells to locals and tourists. The demand for tourists is given by $D_T(p) = 120(5 - p)$ provided $p \leq 5$ where p is the price. The demand from locals is $D_L(p) = 180(3 - p)$ provided $p \leq 3$. The seller has a constant marginal cost of 0.5.

    (*a*) If the seller can set different prices for tourists and locals what prices would maximise profits? What quantities would be sold and what profits would be earned from each group? [**20 marks**]

(*b*) If the seller was forced to set the same price for locals and tourists, what price would be set to maximise profits? Remember that in this case total demand is

$$D(p) = \begin{cases} 120(5 - p) & \text{for } 3 < p \leq 5 \\ 120(5 - p) + 180(3 - p) & \text{for } 0 \leq p \leq 3. \end{cases}$$

How much would each group buy and what would be the seller's profits? [**20 marks**]

(*c*) Explain who gains and who loses from price discrimination. [**10 marks**]

4. A firm that produces a single output can sell its product for price $p = 100 - (x/100)$ for each unit it produces, where x is its level of output. Its total cost function is $TC(x) = 1200 + 20x + (x^2/300)$.

(*a*) Calculate the marginal revenue and marginal cost. [**15 marks**]

(*b*) Calculate the profit maximising level of output, the price and profit. Explain why you have found a maximum. [**20 marks**]

(*c*) Another firm that produces a single product has marginal revenue and marginal costs functions drawn in Figure 1. Carefully explain where you think profit is maximised for this firm. Carefully state any assumptions you make about total cost at zero output. [**15 marks**]
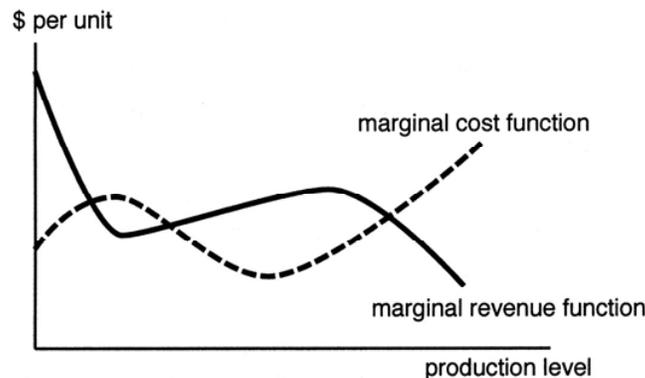

Figure 1: Marginal Revenue and Marginal Cost for Question 4c

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ECO 20015: MANAGERIAL ECONOMICS II

MID-TERM TEST SOLUTIONS

1. (a) Demand is *elastic* if it responds strongly to a change in price. It is *inelastic* if demand is unresponsive to a change in price. Elasticity is measured as a the percentage change in demand for a small percentage change in price. Thus if $D(p)$ is the demand function the elasticity is measured as

$$\eta = -\frac{dD(p)}{dp}\frac{p}{D(p)}.$$

Letting $x = D(p)$ this formula can be written as $\eta = -(dx/dp)(p/x)$. Demand is said to be unit elastic if $\eta = 1$, demand is said to be elastic if $\eta > 1$ (i.e. demand changes more than proportionately to a change in price) and demand is inelastic if $\eta < 1$ (i.e. demand changes less than proportionately to a change in price). A firm with market power will set marginal revenue equal to marginal cost. Since marginal revenue is $MR(x) = x(dp(x)/dx) + p(x)$ where $p(x)$ is the inverse demand we have that the mark-up rule that

$$\frac{p - MC}{p} = \frac{1}{\eta}.$$

Hence, given a positive marginal cost, the left-hand-side of the above equation is less than one and thus $\eta > 1$. Thus a profit-maximising firm will always choose a price-quantity combination where demand is elastic. Furthermore, where a firm can price discriminate, a firm will prefer to charge a higher price to a customer with a lower elasticity of demand and a lower price to a customer with a higher elastic demand so as to maximise profits.

(a) *Double marginalisation* arises when there is a distribution channel of say wholesaler and retailer each of which has some monopoly power. For the wholesaler to make a profit it sets the price it charges to the retailer above its marginal cost. This is the first *marginalisation*. The price the wholesaler charges the retailer, is in turn the retailer's marginal cost. If the retailer is to make a profit it sets its price to final consumers above its marginal cost.

This leads to a double marginalisation of the marginal cost to the wholesaler. At each stage output is restricted below the efficient quantity so the distribution chain leads to higher prices and lower quantities than direct sales. The problem can be reduced if the wholesaler sets a fixed fee as well as a unit price as this means the unit price charged to the retailer can be set equal to the wholesaler's marginal cost.

(b) *Second degree price discrimination* is an indirect form of price discrimination. In second degree price discrimination each customer is offered a *non-linear* price schedule. Discounts for bulk purchases or lower prices for the first few items bought are examples of second degree price discrimination. Other forms include a fixed charge for access and then a per unit fee as is commonly used in the telecommunications industry or entry to theme parks and so on. Second degree price discrimination can be contrasted with third degree price discrimination where different groups of customers are offered different prices. Like first degree or perfect price discrimination, second degree price discrimination allows firms to extract some surplus from customers.

(c) *Economic profit* is total revenue less total costs. Included in costs are all charges for capital, land, labour and so on. If the firm borrows to finance capital purchases then the interest charged is the appropriate cost. If the firm raises funds through equity, then an appropriate *risk-adjusted* rate is appropriate. However, the firm's accounts will not include a charge for equity as accounting profit measures what is left over for equity holders after all other claimants have been paid. Therefore accounting profit is typically greater than economic profit. Economic profit provides an incentive for new firms to enter the market. Accounting profit is the reward for equity holders.

(d) *Complementors* was a term used by Brandenburger and Nalebuff as a contrast to a competitor. A complementor is a firm in the same or related industry that provides complementary goods or services. That is goods or services that enhance the value of another firm's products. A good example would be Intel who provide chips that increase the efficacy of operating systems such

as Microsoft Windows. Complementarity is often considered as a sixth force to be added to Porter's five forces in industry analysis.

(e) The *waterbed effect* is a term used in the supermarket industry in the UK. A waterbed effect occurs if the as a consequence of the strong bargaining position of the large supermarkets relative to producers, the prices charged by producers to the smaller retailers rises and if this in turn leads the smaller grocery suppliers to charge higher prices leading to decreased competition for the larger supermarkets. The effect is like lying on a waterbed, the lower prices for the large supermarkets force up the prices for the smaller retailers. The recent competition commission report finds very little evidence of a waterbed effect, in part because of the existence of large distribution firms who supply to the smaller retailers.

2. (a) For an individual competitive firm the price it faces is fixed and does not vary with its own output. Thus total revenue is simply price times quantity. Therefore marginal revenue = price and the profit maximising output is determined the equation of price and marginal cost. Given the total cost function $TC(x) = (90/49) + 2x + (x^2/10)$, the marginal cost function is

$$MC(x) := \frac{dTC(x)}{dx} = 2 + \frac{x}{5}.$$

Equating this to price we have that at the profit maximising solution $p = 2 + (x/5)$. Since output cannot be negative, the quantity optimally produced at any given price is

$$x = \begin{cases} 5(p-2) & \text{for } p \geq 2 \\ 0 & \text{for } p < 2. \end{cases}$$

(b) With four identical firms in the industry, total supply of the industry is $4 \times (5(p-2)) = 20(p-2)$ for $p \geq 2$ and zero otherwise. Equating this to demand determines the equilibrium price. Thus we solve

$$20(p-2) = 10(5-p)$$

which gives $20p - 40 = 50 - 10p$ or rewriting $30p = 90$. Hence the equilibrium price is $p = 3$. The quantity produced by each firm at this price is $x = 5(3 - 2) = 5$.

(c) The firm's profit is

$$\pi = px - TC(x) = 3(5) - \frac{90}{49} - 2(5) - \frac{5^2}{10} = 5 - \frac{90}{49} - \frac{5}{2} = \frac{65}{98} \approx 0.663.$$

With positive economic profit there will be entry into the industry.

(d) If the same technology is freely available to all firms including potential entrants and the prices of inputs are fixed independently of the size of the industry then the long-run supply curve for the industry will be flat as any economic profits at the given output price will attract new entrants that will operate with exactly the same cost function and hence all firms will produce at the minimum efficient scale.

3. (a) Each market can be treated separately. With a constant marginal cost of $1/2$, the profits from tourists are

$$\pi_T(p) = \left(p - \frac{1}{2}\right) 120(5 - p) = 660p - 120p^2 - 300.$$

Differentiating w.r.t. p we have

$$\frac{d\pi_T(p)}{dp} = 660 - 240p.$$

Noting that the second derivative is negative, we are assured of a maximum when $660 - 240p = 0$ or $p = 11/4 = 2.75$. Thus the firm should charge £2.75 to tourists. Likewise the profits from locals is

$$\pi_L(p) = \left(p - \frac{1}{2}\right) 180(3 - p) = 630p - 180p^2 - 270.$$

Differentiating w.r.t. p we have

$$\frac{d\pi_L(p)}{dp} = 630 - 360p.$$

Noting that the second derivative is negative, we are assured of a maximum when $630 - 360p = 0$ or $p = 7/4 = 1.75$. Thus the firm should charge £1.75 to locals. The profits from tourists is

$$\pi_T(2.75) = 660(2.75) - 120(2.75)^2 - 300 = 607.5.$$

The profits from locals is

$$\pi_L(1.75) = 630(1.75) - 180(1.75)^2 - 270 = 281.25.$$

Total profit is $607.5 + 281.25 = 888.75$.

(b) Since the price optimally charged to tourists is less than £3, the relevant portion of the demand curve is where both locals and tourists buy. Thus the profit of the firm is

$$\pi(p) = \left(p - \frac{1}{2}\right)(120(5 - p) + 180(3 - p)) = 1290p - 300p^2 - 300.$$

Differentiating w.r.t. p we have

$$\frac{d\pi(p)}{dp} = 1290 - 600p.$$

Noting that the second derivative is negative, we are assured of a maximum when $1290 - 600p = 0$ or $p = 43/20 = 2.15$. Thus the price charged to both groups should be £2.15. At this price total profits are

$$\pi(2.15) = 1290(2.15) - 300(2.15)^2 - 300 = \frac{3267}{4} = 816.75.$$

(c) The firm gains from price discrimination. So to do locals who pay a lower price. Tourists are worse off. Of course if tourists have an opportunity to move to the next seaside where there's no price discrimination, they may do that, but this is something outside the assumptions of the example.

4. (a) As the firm faces a downward sloping demand curve, total revenue is

$$TR(x) = \left(100 - \frac{x}{100}\right)x = 100x - \frac{x^2}{100}.$$

Hence marginal revenue is

$$MR(x) := \frac{dTR(x)}{dx} = 100 - \frac{x}{50}.$$

With the total cost function as given, the marginal cost function is

$$MC(x) := \frac{dTC(x)}{dx} = 20 + \frac{x}{150}.$$

(b) The profit maximum is found by equating marginal revenue and marginal cost. Thus we solve

$$100 - \frac{x}{50} = 20 + \frac{x}{150}$$

or $80 = 4x/150$. This gives $x = 3,000$. Hence the price is $p = 100 - (3000/100) = 70$ and profits are

$$\pi(3000) = 3000(70) - 1200 - 20(3000) - (3000^2/300)$$
$$= 50(3000) - 1200 - 30000 = 150000 - 31200 = 118800.$$

We know this is a maximum because the marginal revenue is decreasing in x and marginal cost is increasing in x. Thus for $x < 3000$ we have $MR(x) > MC(x)$. Thus a small increase in x will generate greater extra revenue than the extra cost and therefore increase profits. Likewise for $x > 3000$ we have $MR(x) < MC(x)$. Thus a small increase in x will generate greater extra cost than the extra revenue and therefore decrease profits. However, reducing x by a small amount will save more in costs than the extra revenue lost and therefore will be profitable.

(c) As seen in part (b) if we have a profit maximum then the marginal revenue curve must cut the marginal cost curve from above. Thus we can rule out the middle intersection as a point of profit maximisation. At that intersection profits will be increased by increasing x and by decreasing x. As drawn profits are maximised at the intersection with the largest output. This is because total revenue and total cost are measured as the areas under the appropriate marginal curves. Thus the change in profit is measured by the area between the two curves. In increasing output from the first intersection to the second, profits are reduced. However, in

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increasing output to the third intersection, the extra profits generated more than offset the initial losses. Thus there is a global maximum at the third intersection. The effect of a fixed cost is simply to reduce overall profit but doesn't affect turning points in the profit function. It is however, possible that the fixed cost is so large that profits become negative even at the maximum. If the fixed costs can be avoided by producing nothing, then it will, in that case, be better to produce nothing and have zero rather than negative profits.