

## Exam Energy and Economics (0C930)

Date: **March 10, 2005**

Time: 3 hours

Teacher: W.J.H. van Groenendaal

The number of points per exercise is indicated.

You can answer either in English or Dutch.

**This is an open-book exam.**

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### Exercise 1 (5points each)

- Imagine a figure containing the demand and supply curves for gasoline. What happens to the demand curve for gasoline if the price of automobiles were to increase substantially?
- If the price of gasoline were to increase substantially, what would happen to the demand curve for public transportation?
- Suppose there are 200 identical firms in the rag industry, and each firm is willing to supply 50 rags at any price. What will the market supply curve look like?
- From the 1980s till now the relative price of a college education has increased greatly. During the same time period, enrollment has also increased. What does this evidence suggest with respect to the demand curve?

### Exercise 2 (5points each)

- Which of the following cost curves suggests the presence of a natural monopoly?  
 $TC = 100 + 5Q^2$   
 $TC = 500 + 5Q$   
 $TC = Q$
- A monopoly sets a price of €25 per unit for an item that has a marginal cost of €10. Assuming profit maximization, what is the implicit demand elasticity?
- Patents are a kind of monopoly and allow recovering the large research and development costs that some products require. What would happen to the consumer surplus without a patent? (Think in terms of size.)
- Bob is the only carpet installer in a small isolated town. The demand for carpet installation from residential consumers is  $p = 10 - Q$  and from business consumers  $p = 15 - Q$ , where  $Q$  is measured in  $m^2$ . If the marginal cost of installing carpet is €1 per  $m^2$ , how much will Bob charge each of the customer types?

**Exercise 3** (5 points each)

- a) What is the deadweight loss generated by perfect price discriminating monopoly?
- b) Given that they all operate in a free market, which of the following sellers is most able to perfectly discriminate: the post office, a grocery supermarket, a clothing store, or a college or university?
- c) For a profit maximizing monopoly  $AC > MC > 0$ ,  $AC$  decreases with  $Q$  and  $MC$  increases with  $Q$ . The demand curve is given by  $p = 150 - 0.25Q$ . The regulator sets the price at the point where  $demand = AC$ . Will there be deadweight loss? Will the monopolist be happy with this policy? (Explain.)
- d) Why do energy distribution companies also act as cable companies or try to sell other services simultaneously?

**Exercise 4** (20 points each)

- a) In Slovenia the electricity market has been liberalized and privatized. Several members of parliament worry about the protection of the end consumers. For this reason they have drafted a law to protect households. The law states that price increases of electricity annually should not exceed the general inflation level. Their argument is that the goal of the privatization and liberalization exercise was reasonable energy prices and their law makes sure that this is the case. What do you think will be the effect of this law on electricity production?
- b) Some time ago there was an electricity crisis in California. Demand in August 2000 was 7% higher in 2000 than it was in 1999. Explain under what market conditions (shapes of the demand and supply curve) this increase in demand of 7% can cause large price increases. If you like you can illustrate your explanation with a figure.

**Exercise 5** (10 points each)

- a) What is the main difference between retail competition and mandatory (or wholesale) pool?
- b) What are the main disadvantages of transaction-based approaches to transmission pricing?
- c) Both the Rate of Return regulation and the Revenue Cap regulation allow the company to make a healthy profit. In what respect do they differ?

**Exercise 6** (10 points each)

- a) Newbery argues that the best short-run method of supporting electricity liberalization is to rapidly increase transmission capacity offered at efficient prices. For the Netherlands many

would like to keep the import export capacity limited. Consider electricity producers, consumers, and the government. Who would be in favor and who not, and why?

- b) What is meant by the energy efficiency gap?
- c) What does the banking of green certificates mean and why does Monthorst think it is important?

**Exercise 7** (10points each)

- a) What do Vine et al. mean by commercialization of the electricity sector?
- b) Why do commercialized utilities have no incentive to go beyond the meter with end-user energy-efficiency programs?
- c) What is the likely net-effect of introducing wholesale competition on the incentives for end-users to adopt energy-efficiency measures?

## Answers for the exam Energy and Economics of March 2005

### Exercise 1

- Shift leftward.
- Shift rightward.
- A vertical line where  $Q = 10,000$
- The demand curve has shifted rightward.

### Exercise 2

- $TC = 500 + 5Q$
- 1.67
- The surplus would be zero. If a company cannot recover its research and development costs, the product would not be invented.
- Since Bob is a monopolist  $MR = 10 - 2Q$  and  $MC = 1$ . With  $MR = MC$ ,  $Q_{residential} = 4.5$  and  $Q_{business} = 7$ . The respective prices then become  $P_{residential} = 5.5$  and  $P_{business} = 8$ .

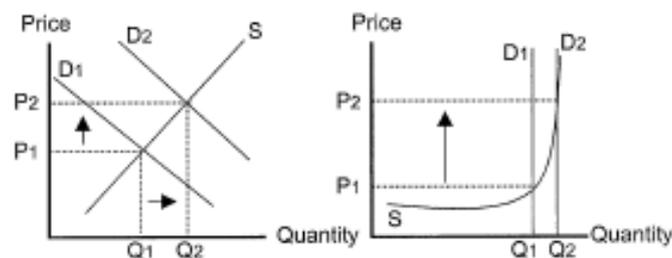
### Exercise 3

- Zero.
- A college or university.
- Yes, because the equilibrium is not at  $p = MC$ . No, the monopolist would prefer  $MR = MC$ , which is to the left of the equilibrium set by the regulator.
- Through this bundling the company tries to make it more difficult for consumers to switch to another supplier.

### Exercise 4

- Effect will depend on difference between (a) average increase in production costs and (b) general inflation level. If (a) < (b) no effect, if (a) > (b) it will reduce incentive to invest. This situation resembles the California crisis. When cost increases are less than the general inflation level, there is no problem. However, when cost increases exceed the general inflation level, the profitability of energy companies will be squeezed and finally companies cannot invest in the system anymore or even will go bankrupt.
- The demand curve is steep (inflexibility in demand) and so is the supply curve; so large price increases occur despite the relatively small increase in demand. Also see figure below.

When demand is inelastic and supply constrained, prices go through the roof



Source: EEnergy Informer, Oct 2000

Normal demand and supply and demand and supply for the Californian situation.

**Exercise 5** (10 points each)

- a) What is the main difference between retail competition and mandatory pool (or wholesale competition)?  
In a mandatory pool generators compete, whereas in retail competition there is a larger degree of market opening, including opening the retail market for competition (see Ocana, p. 10).
- b) What are the main disadvantages of transaction-based approaches to transmission pricing?  
Prices neither reflect costs nor serve congestion efficiently. They may have anti-competitive effects also (Ocana p 24).
- c) Both the Rate of Return regulation and the Revenue Cap regulation allow the company to make a healthy profit. In what respect do they differ?  
Rate of Return regulation has no incentive to reduce costs whereas Revenue Cap regulation does.

**Exercise 6** (10 points each)

- a) Electricity producers not because it increases competition and dilutes market power.  
Electricity consumers yes, because it increases supply.  
The government yes, because it reduces the need for government market intervention.
- b) What is meant by the energy efficiency gap?  
According to some authors there are low-cost profitable energy efficient technologies that are not applied, whereas they should be according to profit maximization. This is called the energy efficiency gap.
- c) What is meant by the banking of green certificates and why does Monthorst think it is important?  
Banking of green certificates means that certificates issued this year are valid eternally (that is till actual usage).  
If green certificates are valid only in the year they are issued, in case of excess supply (“buyers” market) buyers might defer purchase till the end of the year, putting a downward pressure on the price. In case of a sellers market producers might hold back certificates to force higher prices. Through banking the possibility to exercise this market power is mitigated.

**Exercise 7** (10 points each)

- a) The introduction of commercial objectives into the management and operation of a state-owned (public) utility. It becomes a business entity subject to the same tax laws, prices and accounting rules as other private companies.
- b) Because a kWh saved is lost revenue.
- c) The likely net-effect of introducing wholesale competition on the incentives for end-users to adopt energy-efficiency measures is negative. Wholesale competition creates wholesale price signals based on short-term costs. If only these costs are passed through to the end users there is a weaker incentive to invest in energy savings because (a) this leads to more price variation and under uncertainty consumers are less willing to invest in energy efficiency, and (b) short-term energy costs are expected to be lower than past cost of energy generation so there is less incentive.

## Exam Energy and Economics (0C930)

Date: **March 21, 2006**

Time: 3 hours

Teacher: W.J.H. van Groenendaal

The number of points per exercise is indicated.

You can answer either in English or Dutch.

**This is an open-book exam. You are allowed to use a PC.**

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### Exercise 1 (10 points each)

For the relationship between price and supply we have established the curve

$P_s = 0.40 + 0.05Q$  and for demand the curve  $P_d = 1.60 - 0.1Q$ , where  $Q$  is in million units per day. Suppose that the government imposes an excise tax of €0.60 per unit sold.

- What will the impact of this tax be on the supply and the demand curve?
- At the new equilibrium, how many units will be consumed?
- What is the total tax revenue for the government?
- How much do buyers pay per unit?
- How much after tax revenue do sellers receive per unit?
- Calculate the amount of tax burden per unit borne by the buyers and by the sellers

### Exercise 2 (10 points each)

- A rent control law limits the price of apartments. What is the likely effect of such a law in the short run? What in the long run? Be sure to discuss the quality and quantity of apartments available for rent.
- Show that an increase in a specific sales tax  $\tau$  reduces quantity by less and tax revenue more, the less elastic the demand curve.  
(Hint: the quantity demanded depends on its price, which in turn depends on the specific tax,  $Q(p(\tau))$ , and tax revenue is  $R = pQ(p(\tau))$ .)
- In harmonizing its patent laws, the European Community outlawed exportation of certain chemicals used in 85% of U.S. generic drugs. This prohibition may delay the entry of generics onto the U.S. market by two to three years, a circumstance favoring U.S. patent holders, who already have enough chemicals to produce their own generics. What is the likely effect of this law on drug prices in the United States?  
(Translation of “generic drug” is “merkloos geneesmiddel”.)

**Exercise 3** (10 points each)

- a) Define consumer surplus and producer surplus.
- b) What is the effect of a profit tax on a monopoly? Assume the government takes  $\gamma$  fraction of the before tax economic profit,  $\pi$ , and the monopoly maximizes after-tax profit.
- c) Explain why the Lerner Index  $\frac{p - MC}{p}$  can be used to indicate a company's market power.

**Exercise 4** (10 points each)

- a) In the Netherlands the employees of the electricity companies that produce, transmit, and sell electricity oppose the government's plans to unbundle the production and sales activities from the transmission activities. What is/are the main argument(s) against this proposal from the employees' point of view?
- b) Give the main argument(s) why the government wants to unbundle these activities?
- c) What is the name of this type of separation?
- d) The companies argue that the Dutch electricity industry without transmission is too small to survive as independent companies and that Dutch electricity production, and possibly sales, will become part of one big foreign company, resulting in a monopoly. What might be the result of this development?
- e) Suppose the Dutch government implements its current plans and the situation under c) occurs. What is needed to prevent such a company from exercising monopoly power?

**Exercise 5** (10 points each)

- a) What is counter-trade used for in pricing networks?
- b) Why could a state owned monopolistic electricity company cross-subsidize one group of customers by charging another group more?
- c) Name the three main causes for California's electricity crisis in 2000.

**Exercise 6** (10 points each)

- a) What is according to Newberry the best method to support short-run market liberalization?
- b) What are according to Krause the two main principles to regulate a natural monopoly?
- c) Which four methods to price network operations does Kopsakangas-Savolainen analyse?  
What are the main conclusions with respect to the four methods compared to the current situation?

**Exercise 7** (10points each)

- a) McKibbin and Wilcoxon argue that the EU trading system for allowances has some major drawbacks. What do they propose and why do they think this is an improvement?
- b) Why is the EU trading system in combination with JI and CDM insufficient to promote the use of renewable energy sources for electricity?
- c) What are the main disadvantages of auctioning permits instead of grandfathering?

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## Answers for the exam Energy and Economics of March 2005

### Exercise 1

- The supply curve shifts up by €0.60.
- The new equilibrium features a price of €1.20 per unit and a quantity of 4 million units per day.
- A tax of €0.60 per unit levied on 4 million units per day yields revenue of €2.4 million per day.
- The buyers pay €1.20 per unit.
- Before tax sellers receive €1.20, after tax €0.60.
- Before tax, buyers paid €0.80 per unit, now they pay €1.20 per unit, so they are worse off by €0.40; and sellers are €0.20 per unit worse off.

### Exercise 2

- A binding rent control law results in excess demand in the short run and transfers wealth from landlords to renters by reducing rent paid. In the long run, the supply curve of apartments shifts to the left and quality falls as landlords convert apartments to other uses, allow other units to deteriorate, and build fewer new units than they would have without the law. As a consequence, the excess demand may be greater in the long run than in the short run.
- The tax causes revenue to change by  $\frac{dR}{d\tau} = \left( Q + p \frac{dQ}{dp} \right) \frac{dp}{d\tau} = (1 + \varepsilon) Q \frac{dp}{d\tau}$ . The closer  $\varepsilon$  is to zero, the larger the tax revenue effect.
- The law delays entry by new firms. The patent holder has decided that it does not pay to sell both its name-brand and its own generic (otherwise it would do so). Thus the law delays the introduction of generics for several years. When entry occurs, the price of generics will fall below the price of the name brand.  
The price of the name-brand drug may rise or fall. It will rise if the customers are loyal and suspect the generic drug is sub-standard.

### Exercise 3

- Define consumer surplus and producer surplus.  
CS is defined as the difference between the reservation price of the buyer (the maximum the buyers are willing and able to pay for each unit) and the market price.  
PS is the difference between the market price and the reservation price of the seller (the minimum the seller will accept for each unit).
- What is the effect of a profit tax on a monopoly? Assume the government takes  $\gamma$  fraction of the before tax economic profit,  $\pi$ , and the monopoly maximizes after-tax profit. The government takes a percentage of before-tax profit. The quantity that maximizes the monopoly's before-tax profit also maximizes its after tax profit. The before tax profit is  $\pi_B = R(Q) - C(Q)$  and the after tax profit  $\pi_A = (1 - \gamma)[R(Q) - C(Q)]$ . For both the first order condition is  $R'(Q) = C'(Q)$ .
- Explain why the Lerner Index  $\frac{p - MC}{p}$  can be used to indicate a company's market power. This index is between 0 and 1, and 0 when  $MC = P$  (full competition) and increases the more a

company can set its price and charge more than the MC.

**Exercise 4** (10 points each)

- a) In the Netherlands the employees of the electricity companies that produce, transmit, and sell electricity oppose the government's plans to unbundle the production and sales activities from the transmission activities. What are the main arguments against this proposal from the employees' point of view?

*Indication:* They are afraid that many of them will lose their job because much of the work that is currently done domestically will be done abroad.

- b) Give the main argument(s) why the government wants to unbundle these activities?

*Indication:* The government wants (i) to make sure there are equal conditions for electricity sellers and producers, and (ii) exercise some control on a vital infrastructure, the transmission and distribution system.

- c) What is the name of this type of separation?

Divestiture of ownership separation.

- d) The companies argue that the Dutch electricity industry without transmission is too small to survive as independent companies and that Dutch electricity production, and possibly sales, will become part of one big foreign company, resulting in a monopoly. What might be the result of this development?

*Indication:* If most or all of the Dutch electricity production capacity and sales become part of a large foreign company, a vital product for the Dutch economy is owned by foreigners, which will make it difficult for the Dutch government to regulate. As a result the company might abuse its market power and charge too much. As a result the Dutch consumer will be worse off.

- e) Suppose the Dutch government implements its current plans and the situation under c) occurs. What is needed to prevent such a company from exercising monopoly power?

*Indication:* At least a European regulation and a European watchdog.

**Exercise 5** (10 points each)

- a) What is counter-trade used for in pricing networks?

Counter-trade uses a parallel generation market to deal with congestion.

- b) In case a state owned electricity company cross-subsidizes one group of customers by charging another group more, what is the most important characteristic of the subsidizing group compared to the subsidized group?

Because it is a monopoly the subsidizing group cannot buy its electricity elsewhere.

- c) Name the three main causes for California's electricity crisis in 2000.

- High energy prices due to serious supply and demand imbalance in both generation and transmission capacity which had been festering for years;
- Unusual price volatility due to the absence of incentives to hedge the risks and offer fixed prices; and

- Lack of appropriate incentives for demand to respond to variable prices.

**Exercise 6** (10 points each)

- a) What is according to Newberry the best method to support short-run market liberalization?

The best short-run method of supporting electricity liberalization is to rapidly increase transmission capacity offered at efficient prices. This would increase the number of generators competing against each other, dilute market power, and reduce the need for regulatory intervention.

- b) What are according to Krause the two main principles to regulate a natural monopoly?  
Cost of service and price-cap regulation.

- c) Which four methods to price network operations does Kopsakangas-Savolainen analyse?  
What are the main conclusions with respect to the four methods compared to the current situation?

By changing the pricing network operations it is possible to considerably improve social welfare. The first best optimum prices, Ramsey prices and optimal two-part prices improve welfare, whereas moving to the FDC prices decreases welfare as measured by the consumer and producer surpluses.

**Exercise 7** (10points each)

- a) McKibbin and Wilcoxon argue that the EU trading system for allowances has some major drawbacks. What do they propose and why do they think this is an improvement?

They propose a hybrid system that combines the Cap and Trade system and the an annual flexible amount of permits that effectively mimics a tax system that according to these authors is more effective due to the uncertainty in the marginal cost curve, which is steep, and under a Cap and Trade system can easily lead to large cost increases. With the flexible permits system that increase will be limited.

- b) Why is the EU trading system in combination with JI and CDM insufficient to promote the use of renewable energy sources for electricity?

Because the cost increase is still insufficient to make most renewable resources profitable under market conditions.

- c) What is/are the main disadvantage(s) of auctioning permits instead of grandfathering?

The costs for the producer will be much higher and the tax cost issue will be more important in the debate than the environmental issue.

## Exam Energy and Economics (0C930)

Date: **January 19, 2007**

Time: 3 hours

Teacher: W.J.H. van Groenendaal

The number of points per exercise is indicated.

You can answer either in English or Dutch.

**This is an open-book exam.**

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### Exercise 1 (5 points each)

Consider the market for apartments for students in a small university town (say) Eindhoven. There are two sorts of apartments, apartments adjacent to the university and apartments far away. Many students prefer the apartments close to the university. The monthly rent for apartments is the same.

- a) Define the concept of reservation price.
- b) What is its relationship with the demand curve?

An outcome is Pareto efficient if nobody can improve his situation without somebody else being worse off. Are the following situations Pareto efficient yes or no (**explain**)

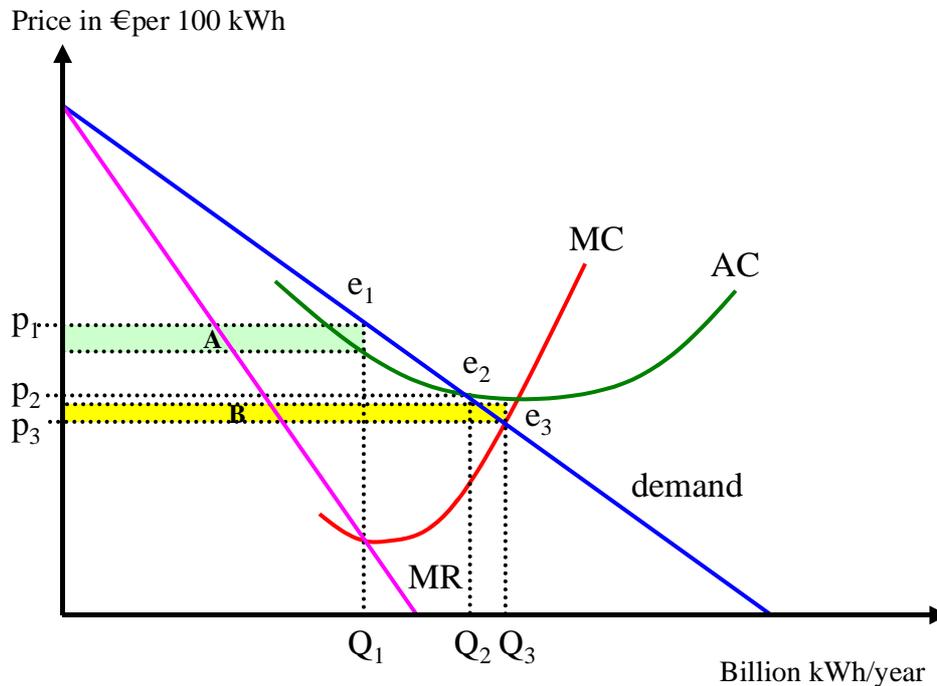
- c) Assume the renter assigns the apartments to the students randomly. As a result some students who really want to live close to the university get an apartment far away, and others who do not care that much get an apartment close by.
- d) Assume the renter is a perfect price discriminating monopolist (so prices can vary) and does not assign apartments randomly.
- e) Assume there is rent control by the government and the apartments are assigned randomly.

### Exercise 2 (10 points each)

- a) Suppose a monopolist is facing a linear demand curve  $p(y) = a - by$ . If the government imposes a quantity tax of €6 per unit output, how much does the price rise?  
(Hint: Calculate the MR-curve and remember  $MR(y) = MC + \text{tax}$  in the optimum.)
- b) Suppose that the supply curve is vertical. What is the deadweight loss of a tax in this market?
- c) Western Europe imports a substantial part of its natural gas from Russia. Suppose Russia is willing to supply as much gas as Western Europe wants at a constant price (say)  $p_{rg}$  per  $\text{m}^3$ . What will happen to the price of Western European gas if a tax  $t$  was placed on the imported gas?

**Exercise 3** (10 points each)

For a natural monopoly a regulator has drawn the following picture



- Which situation is covered by  $e_1$ ? (Explain!)
- Which by  $e_2$ ? (Explain!)
- The regulator sets the price at  $p_3$ . Comment on this decision.

**Exercise 4** (10 points each)

- What are the distinctive features of electricity that strongly influence price formation?
- Why is cost of service regulation replaced by performance-based regulation according to Woo et al.?
- What will be the effect of market reform (liberalization) on prices in case of excess capacity? (Explain.)

**Exercise 5** (10 points each)

- When the Dutch UMTS franchises were auctioned off, the bidders were not allowed to contact each other during the bidding process. Why do you think this was?
- Suppose the Dutch government would organize an auction for a gas distribution system it owns. What is, from an economic efficiency point of view, a drawback of franchise bidding?
- Why is it important electricity traders can hedge?
- What is a major disadvantage of the contract path methodology?

**Exercise 6** (10 points each)

- a) What are competitive electricity markets good at and what not according to Vine et al.?
- b) What is the possible effect of wholesale competition on energy efficiency measures by end-users?
- c) Why is metering considered a separate business in deregulated gas or electricity distribution?
- d) What is the difference between privatization and liberalization?

**Exercise 7** (10points each)

- a) What are according to Kopsakangas-Savolainen two fundamental problems of a social planner when deciding on a welfare maximizing two-part tariff?
- b) What do Ramsey pricing, two-part tariffs, and fully-distributed costs imply for welfare measured by consumer and producer surplus?
- c) Why do McKibbin and Wicoxen think a tax would be more efficient than a permit system for controlling greenhouse gas emissions? What is the main disadvantage of a tax?
- d) The CDM in the Kyoto Protocol helps developing countries through collaboration with developed countries to invest in cleaner and more efficient energy production and thus reducing emissions considerably. Why is this not necessarily a good idea?

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## Solutions of the exam Energy and Economics (0C930) of January 2007

### Exercise 1 (5 points each)

Consider the market for apartments in a small university town (say) Eindhoven. There are two sorts of apartments for students, apartments adjacent to the university and apartments far away. Many students prefer the apartments close to the university. The monthly rent for all apartments is the same.

a) Define the concept of reservation price.

The maximum amount a person would be willing to pay for a unit of output.

b) What is its relationship with the demand curve?

The demand curve is a plot of the reservation prices.

An outcome is Pareto efficient if nobody can improve his situation without somebody else being worse off. Are the following situations Pareto efficient yes or no (**explain**)

c) Assume the renter assigns the apartments to the students randomly. As a result some students who really want to live close to the university get an apartment far away, and others who do not care that much get an apartment close by.

This situation is not Pareto efficient. If students were allowed to sublet apartments to each other, students with higher reservation prices would be willing to compensate others for a move from the far away apartments to the apartments close to the university, and both groups would be better off. In the end the students with the highest reservation prices would live close by.

d) Assume the renter is a perfect price discriminating monopolist and does not assign apartments randomly.

This solution is Pareto efficient since the monopolist will assign apartments to the students with the highest reservation prices.

e) Assume there is rent control by the government and the apartments are assigned randomly. In general this is not Pareto optimal, since there will most likely be one or more students living close by who are willing to move if compensated by students who value them more highly and living far away.

**Exercise 2** (10 points each)

Suppose a monopolist is facing a linear demand curve  $p(y) = a - by$ .

- a) If the government imposes a quantity tax of €6 per unit output, how much does the price rise? (Hint: Calculate the MR-curve and remember  $MR(y) = MC + \text{tax}$  in the optimum.)

The revenue function is  $r(y) = p(y)y = ay - by^2$  and the marginal revenue function is

$MR(y) = a - 2by$ . With  $MR(y) = MC + t$  we get  $a - 2by = c + t$  and  $y = \frac{a - c - t}{2b}$ . With

$\frac{\partial(y)}{\partial t} = -\frac{1}{2b}$  it is easy to see that  $\frac{dp(y)}{dt} = -b \times -\frac{1}{2b} = \frac{1}{2}$ . So for a linear demand curve the price rises by half the change in cost, in this case €3.

- b) Suppose that the supply curve is vertical. What is the deadweight loss of a tax in this market?

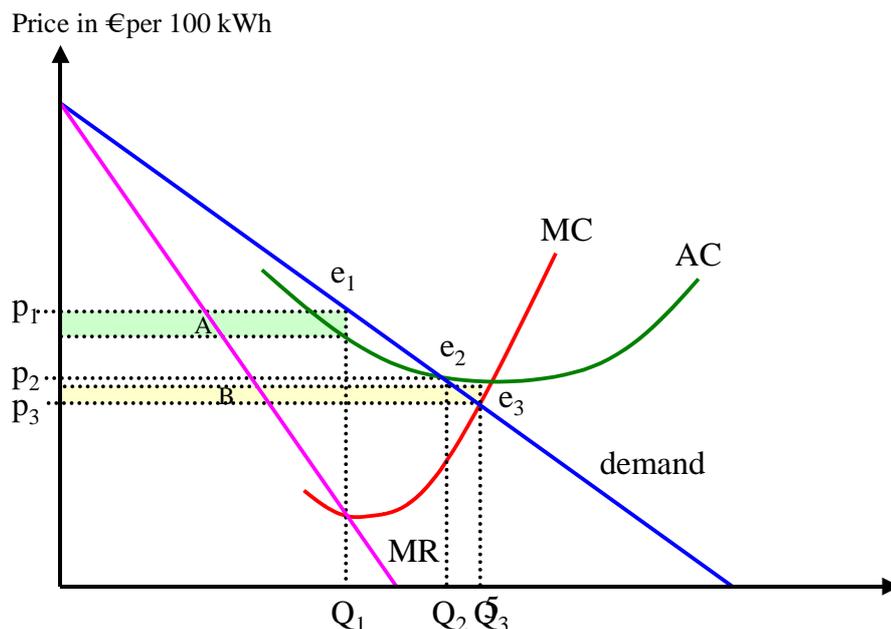
Zero. The same amount is supplied before and after the tax, so there is no deadweight loss. The suppliers are paying the entire amount of the tax.

- c) Western Europe imports a substantial part of its natural gas from Russia. Suppose Russia is willing to supply as much gas as Western Europe wants at a constant price (say)  $p_{rg}$  per  $m^3$ . What will happen to the price of Western European gas if a tax  $t$  was placed on the imported gas?

The supply curve for Russian gas is flat at  $p_{rg}$ . Thus the price to consumers must rise by  $t$  to  $p_{rg} + t$ . Since imported and European gas are perfect substitutes as far as the consumers are concerned, the European producers will sell their gas at  $p_{rg} + t$  as well and get a windfall gain of  $t$  per  $m^3$ .

**Exercise 3** (10 points each)

For a natural monopoly a regulator has drawn the following picture



a) Which situation is covered by  $e_1$ ? (Explain!)

The conventional monopoly equilibrium here  $MR = MC$ . The profit is square A.

b) Which by  $e_2$ ? (Explain!)

At this point the price is equal to the average cost so it is the break-even point.

c) The regulator sets the price at  $p_3$ . Comment on this decision.

At  $p_3$  the monopoly will run at a loss and only if it gets compensated an amount equal to square B it will be able to operate in the long run.

#### **Exercise 4** (10 points each)

a) What are the distinctive features of electricity that strongly influence price formation?

These distinctive features are:

- Electricity cannot be easily stored, supply must be instantaneously matched to demand,
- Transmission constraints require active systems balancing, and
- Demand is highly inelastic in the short run over which daily price variations occur (where the peak price may be many times as high as the trough).

Electricity is therefore managed by system operators with direct control over at least some plant, creating important differences with other commodity markets, even gas.

b) Why is cost of service regulation replaced by performance-based regulation?

To induce a regulated firm to effect such gains as cost efficiency, customer choices and service improvement.

c) What will be the effect of market reform (liberalization) on prices in case of excess capacity? (Explain!)

Prices will most likely go down because of marginal cost pricing instead of cost of service pricing.

#### **Exercise 5** (10 points each)

a) When the Dutch UMTS franchises were auctioned off, the bidders were not allowed to contact each other during the bidding process. Why do you think this was?

To avoid collusion among bidders.

b) Suppose the Dutch government would organize an auction for a gas distribution system it owns. What is, from an economic efficiency point of view, a drawback of franchise bidding?

The price will most likely exceed the franchise owner's marginal cost.

c) Why is it important electricity traders can hedge?

Hedging allows them to reduce the risks of price volatility.

d) What is a major disadvantage of the contract path methodology?

The method is likely to provide the wrong economic signals since the contract path is fictitious and not dependent on the real network situation. The real path may differ in terms of distance and affected lines. Transaction cost may strongly vary and therefore cause cost as well as network inefficiencies.

**Exercise 6** (10 points each)

a) What are competitive electricity markets good at and what not according to Vine et al.?

We know that competitive markets are good at:

- Allocating similar resources;
- Efficient short-term transactions; and
- Incremental improvements in resource allocation.

We also know that competitive markets are not good at:

- Explicit tradeoffs between the present and the future;
- Valuing externalities;
- Equity issues;
- Information barriers; and
- Non-transparent benefits.

b) What is the possible effect of wholesale competition on energy efficiency measures by end-users?

(Vine et al., 6.4) The net effect of introducing wholesale competition is likely to be negative on end-user incentives to adopt energy-efficiency measures. Wholesale competition creates wholesale price signals based on short-term costs. If only short-term generation costs are passed through to end users, end users will have a weaker incentive to invest in energy-efficiency measures: short-term energy costs are expected to be lower than past costs of generation energy and capacity. Moreover, short-term energy costs are expected to be more variable, making savings from energy efficiency more uncertain.

c) Why is metering considered a separate business in deregulated gas or electricity distribution?

If consumers can choose from many companies, a separate metering company is the best way to organize this. It is a separate activity in the supply of electricity or gas.

d) What is the difference between privatization and liberalization?

Privatization means the transfer of ownership (or responsibility) from the government sector to the private/business sector.

Liberalization usually refers to less government regulations and restrictions in the economy in exchange for greater participation of private entities.

**Exercise 7** (10points each)

a) What are according to Kopsakangas-Savolainen two fundamental problems of a social planner when deciding on a welfare maximizing two-part tariff?

- Choosing the tariff such that it enables the firm to break even, and
  - The tariff structure should be such that the consumer is willing to participate in the market.
- b) What do Ramsey pricing, two-part tariffs, and fully-distributed costs imply for welfare measured by consumer and producer surplus?

By changing the pricing of network operations it is possible to considerably improve social welfare. The first best optimum prices, Ramsey prices and optimal two-part prices improve welfare, whereas moving to the FDC prices decreases welfare as measured by the consumer and producer surpluses. The producer surplus decreases in all the alternatives except with the optimal two-part tariff. The increase in the consumer surplus compensates for this decrease in the case of marginal cost pricing and Ramsey pricing. Welfare improves most and equally in the case of marginal cost pricing and the optimal two-part tariff system.

- c) Why do McKibbin and Wicoxen think a tax would be more efficient than a permit system for controlling greenhouse gas emissions? What is the main disadvantage of a tax?

A tax is more efficient because of the flat marginal benefits, rising marginal costs, and high levels of uncertainty. However, there is a political liability, a tax would induce large transfers of income from firms to the government.

- d) The CDM in the Kyoto Protocol helps developing countries through collaboration with developed countries to invest in cleaner and more efficient energy production and thus reducing emissions considerably. Why is this not necessarily a good idea?

If the export of permits is considerable, a developing country could see its exchange rate appreciate becoming more expensive, causing its other export industries decline. The CDM money also has to be invested in improved energy technology, which may be not what the country needs for its long-term development.

## Exam Energy and Economics (0C930)

Date: **March 23, 2007**

Time: 09:00-12:00 (3 hours)

Teacher: W.J.H. van Groenendaal

The number of points per exercise is indicated.

You can answer either in English or Dutch.

**This is an open-book exam.**

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### Exercise 1 (10 points each)

- What problems face a regulatory agency attempting to force a monopolist to charge perfectly competitive price?
- If the demand curve facing a monopolist has a constant elasticity of 2, then how many times larger will the monopolist's price be compared to his marginal cost?
- The government wants to subsidize the marginal costs of the monopolist under b). What level of subsidy should the government choose if it wants the monopolist to produce socially optimal?

### Exercise 2 (5 points each)

Let the inverse demand functions a monopoly faces in two different countries, (say) EU and CH, be  $p_{EU} = 2,500 - 0.75Q_{EU}$  and  $p_{CH} = 3,500 - Q_{CH}$ . The company has constant marginal and average cost,  $m$ , in both countries and trade between customers from EU and CH is not possible.

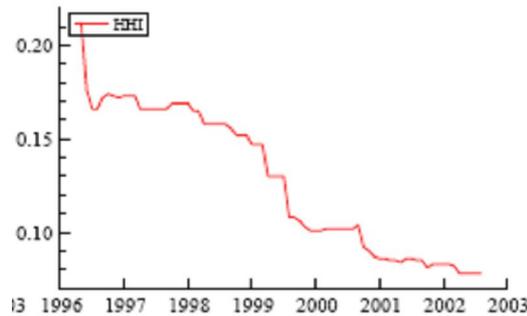
- Show how the firm's optimal quantity sold in each country is a function of  $m$ .
- What are the quantities sold in each country when  $m = €500$ ?
- What are the profits in the two countries?
- What are the deadweight losses in each country?

### Exercise 3 (10 points each)

- What is the main argument for the efficiency of franchise bidding and why is the bidding repeated after some time?
- What is cross-subsidization and what arguments are there for the claim that price cap regulation reduces cross-subsidization?
- What are the conditions necessary for a monopolist to be able to practice price discrimination?
- Give an example of price discrimination in the electricity market.

**Exercise 4** (10 points each)

- Prices are the main tool for network regulation. Name at least three of the main objectives of regulation.
- Why are market prices of many resources not equal to their value?
- What are Pigouvian taxes and why are they sometimes called sin taxes?
- Below a figure showing the decline in the HHI (normalized to [0,1]) for electricity supply in the United Kingdom. What does this figure tell you?



**Exercise 5** (10 points each)

- What is meant by the energy efficiency gap?
- What causes this according to technologists?
- What causes this according to economists?

**Exercise 6** (10 points each)

- What is meant by the rolled-in transmission cost paradigm? What is its main drawback?
- What is the effect of short run marginal cost pricing in case of no transmission constraints? How can this be resolved?
- What type of bidding suites the offering of a public service franchise (f.e. a electricity distribution network) best and why?

**Exercise 7** (10points each)

- Why do McKibbin and Wilcoxon propose to introduce long-term tradable emission permits and short-term permits that are good only for one year?
- What are the main benefits of this policy?
- What is the main disadvantage of auctioning off emission permits at the start of an emission-trading scheme?

-- END --

## Solutions of the exam Energy and Economics (0C930) of March 2007

### Exercise 1 (10 points each)

- a) What problems face a regulatory agency attempting to force a monopolist to charge perfectly competitive price?

A number of problems arise, including: determining the true marginal costs for the firm, making sure all customers will be served, and ensuring the monopolist will not make a loss at the new price and output level.

- b) If the demand curve facing a monopolist has a constant elasticity of 2, then how many times larger will the monopolist's price be compared to his marginal cost?

Remember  $MR = p = \left( \frac{1}{1 + \frac{1}{\varepsilon}} \right) MC$  for a monopoly and with increasing prices demand

will go down. The price will be  $\left( \frac{1}{1 + \frac{1}{-2}} \right) = 2$  times the marginal cost.

- c) The government wants to subsidize the marginal costs of the monopolist under b). What level of subsidy should the government choose if it wants the monopolist to produce socially optimal?

A subsidy of 50%, so the marginal cost facing the monopolist are half of the actual marginal cost. This will ensure that the price equals marginal cost at the monopolist's choice of output.

### Exercise 2 (5 points each) (based on 12.17 Perloff)

Let the inverse demand functions a monopoly faces in two different countries, (say) EU and CH, be  $p_{EU} = 2,500 - 0.75Q_{EU}$  and  $p_{CH} = 3,500 - Q_{CH}$ . The company has constant marginal and average cost,  $m$ , in both countries and trade between customers from EU and CH is not possible.

- a) Show how the firm's optimal quantity sold in each country is a function of  $m$ .

The revenue functions are  $R_{EU} = p_{EU} Q_{EU} = 2,500Q_{EU} - 0.75Q_{EU}^2$  and

$R_{CH} = p_{CH} Q_{CH} = 3,500Q_{CH} - Q_{CH}^2$ . So  $MR_{EU} = 2,500 - 1.5Q_{EU}$  and  $MR_{CH} = 3,500 - 2Q_{CH}$ .

With  $MR_j = m; j = EU, CH$  we get  $Q_{EU} = 1,667 - 0,667m$  and  $Q_{CH} = 1,750 - 0.5m$ .

- b) What are the quantities sold in each country when  $m = €500$ ?

$Q_{EU} = 1,333$  and  $Q_{CH} = 1,500$ .

- c) What are the profits in the two countries?

$\pi_{EU} = (p_{EU} - m)1,333 = (1,500 - 500)1,333 = 1,333,000$

$\pi_{CH} = (2,000 - 500)1,500 = 2,250,000$

d) What are the deadweight losses in each country?

$$DWL_{EU} = 0.5(1,500 - 500)1,333 = 666,6667$$

$$DWL_{CH} = 0.5(2,000 - 500)1,500 = 1,125,000$$

**Exercise 3** (10 points each)

a) What is the main argument for the efficiency of franchise bidding and why is the bidding repeated after some time?

If there is sufficient competition the bidding will (i) result in the lowest tariff and (ii) the government does not have to organize a regulation. Because of changes in the environment, for example technological progress and or input prices, the contract needs to be renegotiated regularly or other companies can bid for the franchise also after some time (normally five years or more). The current franchise holder has the advantage that he has capital in place.

b) What is cross-subsidization and what arguments are there for the claim that price cap regulation reduces cross-subsidization?

Cross-subsidization means that one group of consumers is paying more for the good or service than their cost share and another group pays less than its cost. Often occurs between companies (that pay more) and households (that pay less) in the electricity sector in developing countries.

Because in PCR correct cost accounting is most profitable.

c) What are the conditions necessary for a monopolist to be able to practice price discrimination? The monopolist must (i) have knowledge of the demand curve for its product by different classes of customers or in different markets, (ii) these demand curves must have different elasticities, and (iii) the two or more markets must be separable.

d) Give an example of price discrimination in the electricity market.

The different prices for large and small customers (trade is prevented through metering), and two- or multi-part tariffs that are used.

**Exercise 4** (10 points each)

a) Prices are the main tool for network regulation. Name at least three of the main objectives of regulation.

Financial sufficiency; recovering (sunk) cost, long-term efficiency; incentives for investments, short-term efficiency; efficient management of congestion, competitive neutrality; no discrimination among users; and promoting simplicity and transparency

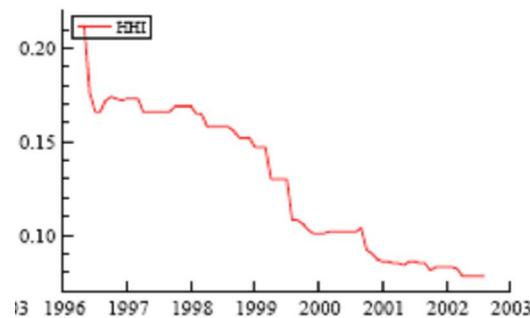
b) Why are market prices of many resources not equal to their value?

Because for many natural resources markets do not exist; for example, long distance ecological effects (China's coal and US air quality) or long-term temporal effects (markets between generations).

c) What are Pigouvian taxes and why are they sometimes called sin taxes?

A Pigouvian tax is a tax levied to correct the negative externalities of a market activity. For instance, levied on producers who pollute the environment to encourage them to reduce pollution, and to provide revenue, which may be used to counteract the negative effects of the pollution. Certain Pigouvian taxes are sometimes referred to as sin taxes (taxes on alcohol and cigarettes.)

d) Below a figure showing the decline in the HHI (normalized to [0,1]) for electricity supply in the United Kingdom. What does this figure tell you?



A HHI of 0.18 or more indicates a lack in competition at the supply side till about mid 1998. The index dropping below 0.065 indicates supply has become competitive, although this has to be interpreted with care.

#### Exercise 5 (10 points each)

a) What is meant by the energy efficiency gap?

The fact that the most energy-efficient technologies available that seem to have a positive financial contribution when used, are actually not used.

b) What causes this according to technologists?  
Technologists think it is due to market failure.

c) What causes this according to economists?  
The partial analysis conducted by technologists does not take into account several other issues. These are market related issues (organizational inertia, time needed to incorporate designs into the supply chain, etc.), public policies (existence of split incentives) and individual consumer issues (effect of transaction costs on consumer decision-making, tendency overemphasize initial appliance cost at the expense of future benefits, lack of importance of the relatively small savings achieved through energy-efficient investments, and the role of uncertainty regarding future benefits from efficiency investments).

#### Exercise 6 (10 points each)

a) What is meant by the rolled-in transmission cost paradigm? What is its main drawback?  
In the rolled-in transmission cost paradigm all cost are summed up (rolled-in) into a single number. All cost are included and cost types are not distinguished. The sum of cost is allocated to various system users.

It is economically inefficient since it ignores transmission resources scarcity.

b) What is the effect of short run marginal cost pricing and no transmission constraints? How can this be resolved?

The effect is zero revenue for the transmission. It can be resolved by a complementary charge.

c) What type of bidding suites the offering of a public service franchise (f.e. a electricity distribution network) best and why?

Reversed English Auction. When sufficient bidders are interested, this will result in a relative low price for the service.

### **Exercise 7 (10points each)**

a) Why do McKibbin and Wilcoxon propose to introduce long-term tradable emission permits and short-term permits that are good only for one year?

To reduce the adverse effects of uncertainty about the (steep) marginal cost curve of abatement and the flat marginal benefit curve of mitigation.

b) What are the main benefits of this policy?

- The plan combines the key advantages of tax and permit policies by allowing trade and placing a limit on the marginal cost of abatement.
- It avoids many of the distributional issues of an emission tax and transfers that take place are within the private sector.
- The policy has built-in incentives for monitoring and enforcement. The government because it receives revenue from selling annual permits and firms because cheating by one would put the others at a disadvantage and the value of permits held.
- It provides information about the true marginal abatement cost curve.
- The policy is flexible and decentralized (national rather than international).
- The policy is very transparent.

c) What is the main disadvantage of auctioning off emission permits at the start of an emission-trading scheme?

The large sums of money companies would have to pay and the possible effect this would have on their financial position.

## Exam Energy and Economics (0C930)

**Date:** 07-01-2009

**Time:** 3 hours (14:00-17:00)

**Teacher:** W.J.H. van Groenendaal

The number of points per exercise is indicated.

You can answer either in English or Dutch.

**This is an open-book exam.**

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### Exercise 1 (10 points each)

- What is the relationship between total revenue (TR) and elasticity if price declines? Why?
- Should firms that make losses close down at once? Explain your answer?
- Is it possible for a monopolist to produce on the inelastic section of the demand curve? Explain your answer?
- Suppose the DeBeers company exercises monopoly power in the distribution of diamonds. This year, the company earns economic profits and maximizes profit. What does this imply for the price of diamonds per carat compared to marginal cost and average cost?

### Exercise 2 (10 points each)

- When would a regulator have to choose one of  $P = MC$  for a natural monopoly and when  $P = AC$ ? Why?
- Suppose Sun Air has a monopoly on the route between Schiphol and Paella. During the winter (November-April) the monthly demand curve is  $P = a_1 - bQ$ . During the summer (May-October), the monthly demand curve is given by  $P = a_2 - bQ$ , where  $a_2 > a_1$ . Assuming the marginal cost function is independent of the quantity  $Q$  of passengers served; will Sun Air charge a higher price in the summer or the winter?
- A monopolist sells in two different markets. In market A  $\varepsilon_D = 2$  and in market B  $\varepsilon_D = 4$ . Its marginal cost is €42. What price can it charge assuming it can price discriminate?

### Exercise 3 (10 points each)

- What are opposing points of view could one have with respect to the California energy crisis?
- Were the changes in the Californian wholesale and retail electricity market the result of supply shift, demand shift, or both? And what was the impact of those shifts?
- What problems can arise when retail prices for electricity are held below their natural market level? Do these regulated market prices insure that electricity is put to its best uses? Why or why not?

**Exercise 4** (10 points each)

- a) What are the two main conditions necessary for price discrimination to work?
- b) Explain in economic terms why restaurants use children's menus?

**Exercise 5** (10 points each)

- a) What can be the result of tackling a market failure for a technological improvement, but not the result of tackling a market barrier?
- b) Empirical studies show that the actual financial benefit of an energy conservation investment is often substantially below a typical engineering estimate. What does this imply for energy efficiency studies?

**Exercise 6** (10 points each)

- a) Why is third-party access so important for competitive electricity and gas distribution networks?
- b) The government of country Y privatizes its transmission company. To induce efficiency the company is allowed to keep a fraction of the profits obtained from efficiency improvements. However, this fraction decreases with the amount of profits obtained. What is the name for this type of regulation?
- c) Most governments require a universal service obligation. However, electricity sellers are not allowed to charge high level market clearing prices in case of severe scarcity. What does this mean for new entrants?
- d) For many decades electricity generation showed increasing economies of scale. This has recently changed and smaller efficient power stations are feasible. What could be the consequence of this technological trend?

**Exercise 7** (10points each)

- a) In the latest agreement on ETS the EU is considering the auctioning of permits instead of grandfathering. With some exceptions the electricity sector is under the agreement, but a number of energy intensive industries not? What reason may the EU have for this?
- b) What critical distinction can be made in the benefits people derive from environmental protection. What do they mean?
- c) Many opponents of green quota for electricity argue that it will increase the consumer price. Is this correct? (Explain.)
- d) What is by far the most important attribute of climate change as a policy problem?

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## Solutions of the exam Energy and Economics (0C930) of January 2007

### Exercise 1 (10 points each)

a) What is the relationship between total revenue (TR) and elasticity if price declines? Why?

If TR rises as P falls  $\varepsilon_D > 1$ , because for TR to rise the percentage increase in quantity must exceed the percentage decline in price. This is by definition  $\varepsilon_D$ .

If TR remains unchanged  $\varepsilon_D = 1$ , because the percentage change in increase in quantity must be equal to the decrease in price.

If TR falls  $\varepsilon_D < 1$ , because for TR to fall the increase in quantity must be less than the percentage fall in price.

b) Should firms that make losses close down at once? Explain your answer?

No, only if the price is below the average variable cost.

c) Is it possible for a monopolist to produce on the inelastic section of the demand curve? Explain your answer?

Yes, but it would not maximize profit.

d) Suppose the DeBeers company exercises monopoly power in the distribution of diamonds. This year, the company earns economic profits and maximizes profit. What does this imply for the price of diamonds per carat compared to marginal cost and average cost?

If it's got monopoly power it will exploit that power to make abnormal profit. Price will exceed the marginal cost and the average cost for abnormal profit to be made.

### Exercise 2 (10 points each)

a) When would a regulator have to choose one of  $P = MC$  for a natural monopoly and when  $P = AC$ ? Why?

At  $P = MC$ , the misallocation of resources is eliminated. If the monopolist still makes a profit, this can be taxed away imposing a flat or lump-sum tax. However,  $P$  may be smaller than  $AC$ , so the monopolist would incur a loss and not supply the service in the long run without a subsidy. This, together with the difficulties in estimating  $MC$ , usually leads the regulator to set  $P = AC$ .

- b) Suppose Sun Air has a monopoly on the route between Schiphol and Paella. During the low season (November-April) the monthly demand curve is  $P = a_1 - bQ$ . During the high season (May-October), the monthly demand curve is given by  $P = a_2 - bQ$ , where  $a_2 > a_1$ . Assuming the marginal cost function is independent of the quantity  $Q$  of passengers served; will Sun Air charge a higher price in the summer or the winter?

Sun air will produce where  $MR = MC$  and for Sun air  $MC = c$ .

In the low season this implies  $Q = \frac{a_1 - c}{2b}$  and the price will be  $P_{LS} = a_1 - b\left(\frac{a_1 - c}{2b}\right) = \frac{a_1 + c}{2}$ .

For the high season this results in  $P_{HS} = \frac{a_2 + c}{2}$ . With  $a_2 > a_1$  the price charged during the high season will be greater.

- c) A monopolist sells in two different markets. In market A  $\varepsilon_D = 2$  and in market B  $\varepsilon_D = 4$ . Its marginal cost is €42. What price can it charge assuming it can price discriminate?

With  $MR = P\left(1 - \frac{1}{\varepsilon_D}\right)$  and  $MR = MC$  to maximize profits. This results in  $P_A = €84$  and  $P_B = €56$ .

### Exercise 3 (10 points each)

- a) What are opposing points of view could one have with respect to the California energy crisis?

The basic disagreement is whether the California energy crisis is the result of a (over) regulated energy market (i.e. what some would call “government failure”) or the result of de-regulation (so-called “market failure”).

- b) Were the changes in the Californian wholesale and retail electricity market the result of supply shift, demand shift, or both? And what was the impact of those shifts?
- The capacity problem was the result of a long term increase in demand - presumably as the population of California grew. (In graphic terms, we're talking about a shift to the right.)
  - The more recent phenomenon has been a change in the cost of generating electricity - the rising price of natural gas and a change in production cost is a supply shifter. (Graph shift to the left.) The wholesale market experienced this shift, as power generators compensated for higher resource costs.
  - Also important is the fact that new generating plants weren't being built. The government-imposed restrictions, many of them environmental, raise the cost of new electricity generating plants to the level that businesses are unwilling to take the risk.
  - In the retail market utility companies, facing a higher price for electricity, reacted as the law of demand tells us buyers always react to higher prices—they were unwilling to purchase more electricity to sell on the California retail market.
  - This, in turn, means that the supply in the California retail market wasn't responding to the ever-growing demand. Even worse, the fixed prices of kilowatt hour meant that the quantity supplied was less than the quantity demanded, hence the shortages.
- c) What problems can arise when retail prices for electricity are held below their natural market level? Do these regulated market prices insure that electricity is put to its best uses? Why or why not?

One of the problems that arises when retail prices are held below their natural market level is that buyers who value the product more than someone else have no way to express their higher value. Consumers who want to light Christmas displays are competing directly with, for example, a hospital needing electricity to power lifesaving machines. In a market with freely moving prices, the electricity is allocated by price to the uses that people value most. When fixed prices are in place the allocation process cannot distinguish between users. While markets do not assure that electricity will always be used wisely, (some people may decide to pay the higher bills for their Christmas lights), they do assume that it will move toward the most highly valued uses.

**Exercise 4** (10 points each)

- a) What are the two main conditions necessary for price discrimination to work?

Essentially there are two main conditions required for discriminatory pricing

*Differences in price elasticity of demand between markets:* There must be a different price elasticity of demand from each group of consumers. The firm is then able to charge a higher price to the group with a more price inelastic demand and a relatively lower price to the group with a more elastic demand. By adopting such a strategy, the firm can increase its total revenue and profits (i.e. achieve a higher level of producer surplus). To profit maximise, the firm will seek to set marginal revenue = to marginal cost in each separate (segmented) market.

*Barriers to prevent consumers switching from one supplier to another:* The firm must be able to prevent “market seepage” or “consumer switching” – defined as a process whereby consumers who have purchased a good or service at a lower price are able to re-sell it to those consumers who would have normally paid the expensive price. This can be done in a number of ways, – and is probably easier to achieve with the provision of a unique service such as a haircut rather than with the exchange of tangible goods. Seepage might be prevented by selling a product to consumers at unique and different points in time – for example with the use of time specific airline tickets that cannot be resold under any circumstances.

- b) Explain in economic terms why restaurants use children’s menus?

Economists doubt that restaurant owners have a special love for children; they suspect that the owners find offering children's menus to be profitable. It can be profitable if adults who come to restaurants with children are, on the average, more sensitive to prices on menus than adults who come to restaurants without children. Children often do not appreciate restaurant food and service, and often waste a large part of their food. Parents know this and do not want to pay a lot for their child's meal. If restaurants treat children like adults, the restaurants may lose customers as families switch to eating at home or fast-food restaurants. The restaurants price discriminate.

**Exercise 5** (10 points each)

- a) What can be the result of tackling a market failure for a technological improvement, but not the result of tackling a market barrier?

In some cases, it is possible to simultaneously increase energy efficiency and economic efficiency. This will be the case if market failures impede the most efficient allocation of society’s energy, capital, and knowledge resources in ways that also reduce energy efficiency. These are examples of what economists and others refer to as “win-win” or “no regrets” measures. Unlike market failures, however, market barriers cannot be lowered in a win-win fashion.

- b) Empirical studies show that the actual financial benefit of an energy conservation investment is often substantially below a typical engineering estimate. What does this imply for energy efficiency studies?

An important implication of this perspective is that comparisons of an engineering ideal for a particular energy use with average practice for existing technology are inherently misleading, because the former does not incorporate all the real-world factors influencing energy technology decision making. The overall economic costs of switching to more energy efficient technology constitute what can be thought of as a market barrier to their use in that individual consumers and producers will not have incentives to use more costly technologies unless policy measures (such as technology standards or carbon taxes) compel or induce behavioral changes.

**Exercise 6** (10 points each)

- a) Why is third-party access so important for competitive electricity and gas distribution networks?

Without it no competition.

- b) The government of country Y privatizes its transmission company. To induce efficiency the company is allowed to keep a fraction of the profits obtained from efficiency improvements. However, this fraction decreases with the amount of profits obtained. What is the name for this type of regulation?

Sliding scale regulation.

- c) Most governments require a universal service obligation. However, electricity sellers are not allowed to charge high level market clearing prices in case of severe scarcity. What does this mean for new entrants?

New entrants will decrease the expected returns in periods of scarcity. Their response will be to delay entry and under-invest relative to the efficient level of capacity, raising average prices.

- d) For many decades electricity generation showed increasing economies of scale. This has recently changed and smaller efficient power stations are feasible. What could be the consequence of this technological trend?

A trend towards distributed generation and because of the smaller scale of production the possibility for more competition by an increase in the number of market players, reducing the market power of each player. (Krause, p 3)

**Exercise 7** (10points each)

- a) In the latest agreement on ETS the EU is considering the auctioning of permits instead of grandfathering. With some exceptions the electricity sector is under the agreement, but a number of energy intensive industries not? What reason may the EU have for this?

Leakage.

- b) What critical distinction can be made in the benefits people derive from environmental protection. What do they mean?

A critical distinction is between use value and non-use value. The direct benefits people receive through protection of their health or through use of a natural resource is the use value. However, people also derive passive or non-use value from environmental quality, particularly in the ecological domain. For example, an individual may value a change in an environmental good because she wants to preserve the good for her heirs (bequest value). Still other people may envision no current or future use by themselves or their heirs, but still wish to protect the good because they believe it should be protected or because they derive satisfaction from simply knowing it exists (existence value).

- c) Many opponents of green quota for electricity argue that it will increase the consumer price. Is this correct? (Explain.)

The discussion of increasing the green quota shows that the effect on the consumer price is not unambiguously an increase. There is the possibility of lowering as well as increasing the consumer price. There is a cost saved by lowering the power price, and an additional cost following the use of renewable energy technologies instead of thermal energy technologies. It is ambiguous as to whether the additional cost is larger than the saved cost. Therefore, the consumer costs can either increase or decrease, as a result of introducing a green quota.

- d) What is by far the most important attribute of climate change as a policy problem?

Uncertainty, from climatology to economics the uncertainties are widespread, large in magnitude and very difficult to resolve.

-END-

## Exam Energy and Economics (0C930)

Date: 12-03-2009

Time: 3 hours

Teacher: W.J.H. van Groenendaal

The number of points per exercise is indicated.

You can answer either in English or Dutch.

**This is an open-book exam. You are allowed to use a laptop.**

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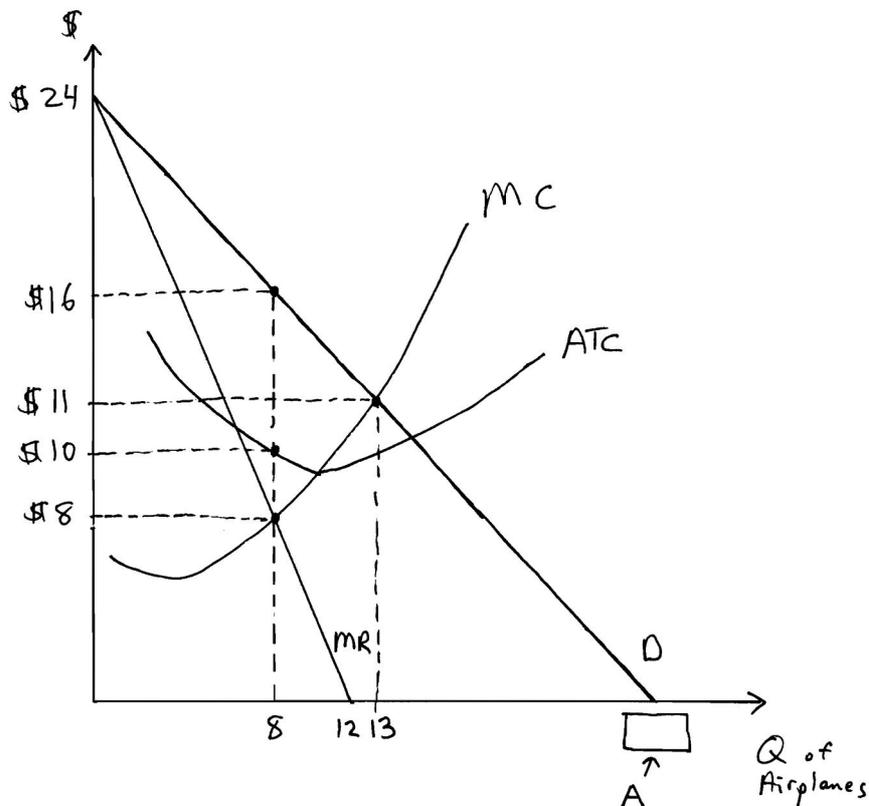
### Exercise 1 (10 points each)

What will happen to the demand curve for air transport between Amsterdam and Stockholm as a result of

- An increase in income of 20% in both, The Netherlands and Sweden? (Explain.)
- A reduction in the boat fare of 50%? (Explain.)
- A decrease in the price of an airline ticket of 20%? (Explain.)

### Exercise 2 (10 points each)

*Consider the Monopoly producer of airplanes depicted below.*



The monopoly in the figure pays its CEO a salary of 10% of the total revenues of the firm.

Suppose that the monopoly initially is run by a CEO (Selfless Sally) who is concerned with the profits of the monopoly and not with her own personal salary. Thus, she has the monopoly produce the profit-maximizing quantity and charge the profit maximizing price. After retiring she was replaced by a modern and greedier CEO (Greedy Gary) who cares more about his personal paycheck than the profits of the firm. Therefore, he has the monopoly charge the price and produce the quantity that maximize the total revenue of the firm.

- a) How many airplanes did the monopoly produce under Selfless Sally?
- b) How many do they produce under Greedy Gary?
- c) What is the Lerner index of this monopolist under profit maximization and no price discrimination?

**Exercise 3** (10 points each)

- a) In what respect does franchise bidding on a public utility franchise, such as bus rides or electricity, differ from traditional bidding?
- b) When does a company have market power?
- c) What defines a natural monopoly?
- d) Can a firm be a natural monopoly if it has a U-shaped average cost curve? Why or why not?

**Exercise 4** (15 points each)

All-Furniture, a Swedish household furniture retailer, produces a total of about 12,000 products, and sells them in a total of 140 stores in twenty-nine countries. Product designs are unique to All-Furniture, thus the goods are differentiated. Yet, All-Furniture has a number of similarly-sized competitors producing more or less close substitutes, and so it seems reasonable to classify the products examined here as differentiated products sold in an imperfect competition environment. The following table shows All-Furniture retail prices for 3 types of mirrors in different European countries. Alg is a two-pack of a very simple square mirror tile, Guldros is a fairly simple round mirror with beveled glass, and Krabb is a wavy mirror tile. While Alg and Guldros have no distinctive features and similar products are available in competing stores, Krabb is quite distinct.

Table: Final Retail Selling Prices 1998 (in €)

	Alg	Guldros	Krabb
Austria	24	113	48
Belgium	22	111	28
Denmark	13	119	34
Finland	15	107	21
France	21	100	33
Germany	22	97	51
Italy	23	79	44
Netherlands	20	101	20
Norway	12	82	27
Spain	32	112	34
Sweden	15	94	24
Switzerland	19	67	27
United Kingdom	25	115	30

Note that the products ordered in these countries are identical in terms of both design and country of origin, and that the final retail selling prices listed above are the local currency catalogue prices, converted into a common currency (in €).

We see that prices for a given type of mirror vary substantially across countries: for instance, prices for the Alg mirror run from the equivalent of 12 € in Norway to 24 € in Austria and 25 € in the UK. Conceptually, the final retail selling price of a product may be decomposed into the import price of the product, the local distribution cost (including differences in VAT rates across countries), and the profit mark-up.

- a) Based on the information given in the table, do you think that the price differences we observe can be fully explained by differences in transportation and local distribution cost? Why or why not?
- b) Assume All-Furniture price discriminates, which form of price discrimination do they apply?

**Exercise 5** (10 points each)

- a) Name and briefly describe the two approaches that mark the extremes of regulating a natural monopoly.
- b) What are the main transmission pricing paradigms; and what is/are the most important difference(s)?
- c) How do we call it when a price is set equal to the estimated cost of providing the same service by other companies?

**Exercise 6** (10 points each)

- a) How can California's electricity market problems be fixed?
- b) What is the likely effect of introducing wholesale competition on energy-efficiency measures?
- c) Name important conditions for successfully liberalizing gas and electricity markets.

**Exercise 7** (10 points each)

- a) What is the main difference between "Joint implementation" and the "Clean Development Mechanism"?
- b) What distinction in cost does Lund make and why is this important?
- c) Many opponents of an emission quota for electricity argue that it will increase the consumer price. Is this correct? (Explain.)
- d) Why is it important that to analyze the distribution price of local distribution companies?

-- END --

## Solutions of the exam Energy and Economics (0C930) of January 2007

### Exercise 1 (10 points each)

- a) More disposable income means more travel; demand curve up and to the right.
- b) Alternative transport cheaper, so more people will use it. Demand for air transport down; demand curve down and to the left.
- c) Lower price for the ticket results in more people using air transport. Result is movement down the existing demand curve.

### Exercise 2 (10 points each)

- a) How many airplanes did the monopoly produce under Selfless Sally?  
8
- b) How many do they produce under Greedy Garry?  
12
- c) What is the Lerner index of this monopolist under profit maximization and no price discrimination?  
 $\frac{1}{2}$ .

### Exercise 3 (10 points each)

- a) Bidding is on the fee for the utility. In every bid round the fee is reduced. In traditional bidding the product goes to the highest bidder.
- b) Market power is the ability to of a firm to charge a price above marginal cost and earn a positive profit.
- c) Situation in which one firm can produce the total output of the market at lower cost than several firms could.
- d) Yes. The demand curve could cut the average cost curve in its downward-sloping section. Consequently the average cost is strictly downward sloping in the relevant region.

**Exercise 4** (10 points each)

- a) Based on the information given in the table, do you think that the price differences we observe can be fully explained by differences in transportation and local distribution cost? Why or why not?

The price differences observed cannot be explained by differences in transportation and distribution costs alone. If this was the case, then we should observe a consistent pricing pattern across countries, i.e. all types of mirrors should be uniformly more expensive in some countries than in others. For instance, mirror Alg is much more expensive in Austria than in Denmark (24 vs. 13 €): if this price difference is due to transportation/distribution costs alone, then why is mirror Guldros actually cheaper (!) in Austria than in Denmark (113 vs. 119 €)? This suggests that price differences also reflect differences in mark-ups across countries. This evidence supports the following presumptions: (i) in some countries All-Furniture can raise the price above marginal cost (for certain types of products), i.e. All-Furniture has market power.

- b) Assume All-Furniture price discriminates, which form of price discrimination do they apply?

All-Furniture seems to practice multimarket (or "third-degree") price discrimination: If markets are segregated (e.g. by high transportation costs) so that arbitrage across markets cannot take place, then a monopolist can charge higher prices in countries where there is more demand for its product. For All-Furniture products, it is relatively unlikely that consumer arbitrage takes place on a substantial scale. Price differences could however be exploited by competing retailers to influence their competitive position.

**Exercise 5** (10 points each)

- a) Name and briefly describe the two approaches that mark the extremes of regulating a natural monopoly.

Cost of service regulation in which suppliers cover their costs including a specific rate of return, and price cap regulation that cap supplier's prices according to a specified formula that takes account of inflation and technical progress. (Krause p 7.)

- b) What are the main transmission pricing paradigms; and what is/are the most important difference(s)?

Rolled in pricing and incremental pricing. The main difference is that in rolled-in-pricing the embedded or overall cost are taken into account and in incremental pricing only the new resp. the additional cost are taken into account. (Krause Sections 3 and 4.)

- c) Yardstick and benchmark pricing. (Oscana.)

### **Exercise 6** (10 points each)

a) How can California's electricity market problems be fixed?

According to Sioshansi there are three fundamental solutions to California's electricity market problems:

- Increase supply by building additional generation and transmission capacity;
- encourage long term, fixed-price contracts outside the PX; and
- make demand responsive to high prices.

b) What is the likely effect of introducing wholesale competition on energy-efficiency measures?

The net effect of introducing wholesale competition is likely to be negative on end-user incentives to adopt energy-efficiency measures. Wholesale competition creates wholesale price signals based on short-term costs. If only short-term generation costs are passed through to end users, end users will have a weaker incentive to invest in energy-efficiency measures: short-term energy costs are expected to be lower than past costs of generation energy and capacity. Moreover, short-term energy costs are expected to be more variable, making savings from energy efficiency more uncertain.

c) Name conditions for successfully liberalizing gas and electricity markets (Newbery).

- Potential suppliers must have access to the transmission system in order to reach customers.
- There should be adequate and secure supply.
- There should be appropriate regulation of the markets of these liberalized utilities.

### **Exercise 7** (10points each)

e) What is the main difference between “Joint implementation” and the “Clean Development Mechanism”?

Joint implementation allows one Annex B country to do a emission reduction project in another Annex B country in exchange for emission credits, whereas CDM is designed to extend participation to non-annex B countries. Under CDM an Annex B country can receive emission credits for projects undertaken in non-Annex B country. The project must be certified by an independent agent.

f) What distinction in cost does Lund make and why is this important?

One of the main findings of the paper is that the ETS influences the industry sectors quite differently. The indirect expenses from electricity price increases to energy-intensive industries may be considerable and comparable to the direct emission reduction costs. In the Kyoto period, the total cost impacts remain below 2% of the production value for most industries within the ETS. The exception is the very electricity intensive industry sectors where the cost increase may even jeopardize profitability if all electricity is purchased from the open market.

- g) Many opponents of an emission quota for electricity argue that it will increase the consumer price. Is this correct? (Explain.)

An emission quota implies an introduction of an additional cost to all the thermal producers, when purchasing emission permits. All thermal producers face an additional cost which shifts the thermal supply curve upwards. In this case, the price shows an unambiguous increase since the marginal power supplier has a higher cost than that without regulation. (Jensen and Skytte.)

- h) Why is it important that to analyze the distribution price of local distribution companies?

Because this price component is as large as the wholesale price and can significantly disturb total efficiency. They show that better pricing rules will increase welfare. (Kopsakangas and Savolainen)

-END-

## Exercises Market and Monopoly

### Exercise 1

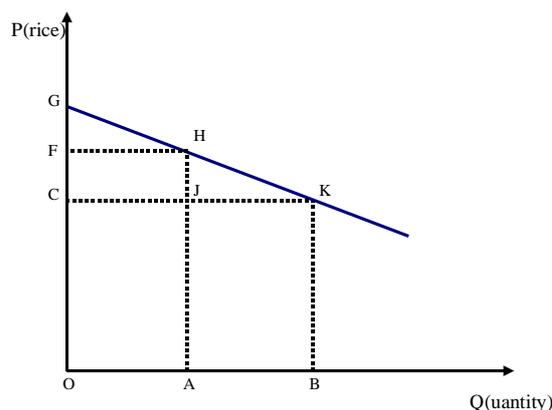
- Define equilibrium in terms of what buyers and sellers want.
- Suppose the total cost function for a firm is  $TC = 20 + (0.2 * q^2)$  and the price  $P = 10$ . What will the firm's profits be?
- Suppose a market encompasses buyers of smaller as well as larger quantities. When does it make sense for a monopoly to engage in quantity discrimination?

#### Answers

- Neither buyers nor sellers want to change their behavior.
- $MC = 0.4Q$ . With  $MC = MR = P$  we get  $Q = 25$ . Then  $TC = 145$  and  $TR = 250$ , so profits are 105.
- When the buyers of smaller quantities of the good are less price sensitive than the buyers of larger quantities.

### Exercise 2

The following figure contains the demand curve a monopolist is facing.



- What prices should the monopolist charge without price discrimination if its best level of output (given by the point where  $MR = MC$ ) is  $OB$ ? What would the total revenue be? How much is the consumers' surplus?
- Suppose the monopolist sold  $OA$  units at price  $OF$  and in order to induce consumers to buy  $AB$  additional units, it lowered its price to  $OC$  only on  $AB$  units. How much would the total revenue be now? How much of the consumers' surplus remains? If the monopolist were already making profits without price discrimination, why would the profits now be higher?
- Could the monopolist completely take away all the consumers' surplus?

#### Answers

- The highest price the monopolist can charge without price discrimination to sell  $OB$  units is  $OC$ . The total revenue would then be equal to the area of the rectangle  $OCKB$ . Consumers' surplus is  $CGK$ .

- b) Total revenue is OFHA for OA units plus AJKB for AB units. Price discrimination has increased total revenue by CFHJ, by which consumers' surplus has declined. Consumers' surplus is now only FGHJ plus HKJ. Profit is higher because total cost has not changed.
- c) The monopolist can take away all the consumers' surplus only if all OB units can be sold as whole for OGKB. In the real world this is very rare.

### Exercise 3

- a) Define market power.
- b) Define natural monopoly.

#### *Answers*

- a) Market power is the ability to of a firm to charge a price above marginal cost and earn a positive profit.
- b) Situation in which one firm can produce the total output of the market at lower cost than several firms could.

### Exercise 4

Read the following excerpt from the New York Times of October 27, 2000.

For 10 years, British officials consistently misled the public by deliberately playing down the possibility that mad-cow disease could be transmitted to humans, an official report said today . . . The 4,000-page report, published after a three-year investigation . . . severely criticized the "culture of secrecy" that characterized the government's response to a crisis that has wreaked havoc with Britain's once-proud beef industry, forced the slaughter of almost four million cows and led to the deaths so far of 77 Britons. . . "My own personal belief would be that we are more likely looking in the region of a few hundred to several thousand more" victims, Prof. Peter Smith, acting head of the government's advisory committee on the disease, said on television this morning. "But it must be said that we can't rule out tens of thousands."

[It was] "a consuming fear of provoking an irrational public scare" . . . that caused a government veterinary pathologist to label "confidential" his first memo on mad-cow disease in 1986; that led John Gummer, then the agriculture minister, to make a show of publicly feeding a hamburger to his 4-year-old daughter, Cordelia, in 1990; and that led Britain's chief medical officer in 1996 to declare, "I myself will continue to eat beef as part of a varied and balanced diet." . . .At the same time, government policy was marred by bureaucratic bungling, a lack of coordination between departments and the fact that the Ministry of Agriculture, Fisheries and Food had two somewhat contradictory missions: to protect consumers and to support the beef industry.

- a) What was the effect of mad-cow disease on the demand curve for British beef? Draw a supply and demand graph and indicate the effect on the equilibrium.
- b) What was the effect of mad-cow disease on the supply curve for British beef? Draw a supply and demand graph and indicate the effect on the equilibrium.

- c) Combining your answers to the previous two questions, can you predict with certainty what happened to the equilibrium price for British beef? What about the equilibrium quantity?
- d) The British government put together quite a PR campaign in their effect to avoid an irrational public scare". Would such a public scare have pleased or displeased the following groups?
  - i. Diehard beefeaters
  - ii. Die-hard chicken eaters
  - iii. Beef suppliers
  - iv. Chicken suppliers

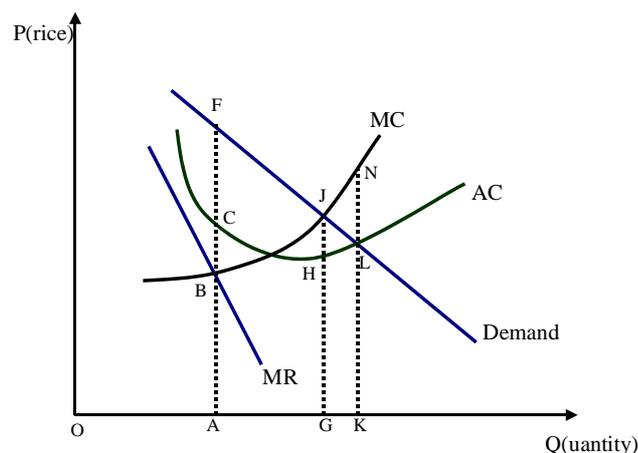
*Answers*

- a) Demand decreases. Equilibrium price down, quantity down.
- b) Supply decreases. Equilibrium price up, quantity down.
- c) Equilibrium quantity fell. The effect on equilibrium price is unclear, since the demand shift and the supply shift move in opposite directions.
- d) A public scare would decrease demand for beef and increase demand for chicken. The equilibrium price and quantity of beef would therefore fall, and the equilibrium price and quantity of chicken would rise. These changes would benefit beefeaters and chicken suppliers and hurt chicken eaters and beef suppliers.

**Exercise 5**

With reference to the figure below:

- a) Determine the output, price (P), and profit for the unregulated monopolist.
- b) What happens if the government sets the price P equal to AC?
- c) What happens if the government sets the price P equal to MC?
- d) For utilities it is much more difficult to estimate MC compared to AC. What will happen under c) if the government wrongly assumes MC is larger than AC?



*Answers*

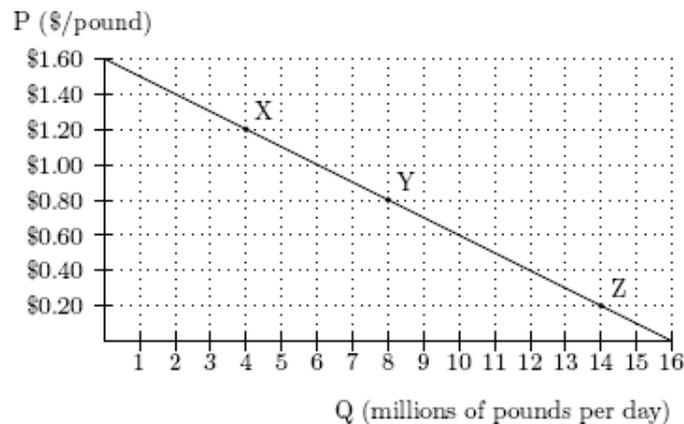
- a) The unregulated monopolist would produce OA (at which  $MR = MC$ ), sell at  $P = AF$ , receive a profit of  $FC$  per unit, and  $OA$  times  $FC$  in total.

- b) If the government set  $P = AC$ , the monopolist would produce  $OK$ , sell at  $P = KL$  ( $= AC$ ), and break-even (no profit). However,  $P$  is smaller than  $MC$  and resources are misallocated (too much of the product is produced).
- c) If the government set  $P = MC$ , the monopolist would produce  $OG$ , sell at  $P = GJ$  ( $= MC$ ), and obtain a profit per unit of  $JH$ , or a total profit of  $OG$  times  $JH$ .
- d) This means that  $AC$  is smaller than  $MC$ . With  $P = MC$ , the utility will lose money and cannot continue to supply in the long run without a subsidy.

**Exercise 6**

In the figure below, the supply curve is such that point  $Y$  is the equilibrium.  $Y$  is the equilibrium during normal years;  $X$  during “bad” years (when frost damages the orange crop), and  $Z$  is the equilibrium during “good” years (when the orange crop thrives).

The orange growers’ profit is total revenue minus total costs. If total costs are the same in all years, do the growers have higher profits in “bad” years or “good” years? Can you explain what's going on here?



*Answer*

Growers make higher profits during “bad” years: their revenue is higher and their costs are assumed to be identical. This is basically a Prisoner's Dilemma situation for the growers: they would all be better off if they could restrict supply during “good” years, but the individual incentives lead them to flood the market and get low prices and low profits.

**Exercise 7** (10 points for A, 10 points for B, and 10 points for C)

Read the following excerpt from the New York Times of October 5, 2000.

The energy proposals that Mr. Bush, the Republican presidential candidate, brought out last week including opening part of the Arctic National Wildlife Refuge to exploration and incentives to promote coal and nuclear power could test the willingness of Americans to rebalance environmental and energy priorities in the face of higher prices. For his part, Vice President Al Gore, the Democratic presidential candidate, favors investments in mass transit and incentives to encourage the use of more fuel-efficient vehicles and alternative energy sources.

- A** The “energy crisis” was a big topic in the presidential race. (It might be interesting to investigate how the real price of gasoline has changed over the last 30 or so years.) For each item ( a to d), indicate the likely impact on the supply and demand for oil. Then indicate the effect on the equilibrium price and quantity. It might help to use a graph. Please note that, in addition to being refined to make gasoline for cars, oil is also used to heat homes and to produce electricity; coal and nuclear power are also used to produce electricity.
- Opening part of the Arctic National Wildlife Refuge to oil exploration.
  - Government incentives to promote coal and nuclear power.
  - Government investments in mass transit.
  - Government incentives to encourage the use of solar-powered vehicles.

**B**

- Is the statement that Bush’s proposals all address the supply side of the problem correct?
- Is the statement that Gore’s proposals all address the demand side of the problem correct?

**C** Let's look a little more closely at one of now-President Bush's energy proposals: opening up the Arctic National Wildlife Refuge (ANWR) to oil drilling. When you answered the previous question, you probably assumed that that oil would become available immediately, i.e., that oil companies could immediately begin extracting and selling that oil. (I wanted you to assume that, so do not go back and rethink your answer above!) It turns out that life is more complicated than that: it takes time to build pipelines and to drill oil wells into pristine Arctic wilderness, so any oil that comes from ANWR will not reach the market for something like 5 years. This fact became a source of contention during the presidential campaign, with Al Gore arguing that opening ANWR would have no effect on current gasoline prices because of this 5-year time lag, and George W. Bush arguing . . .well, I don't remember what his argument was, but it probably had something to do with fuzzy math and how when people take actions there have to be consequences.

Unlike the majority of the American public, you now understand how supply and demand works, and you should be able to assess the validity of Al's argument. You should try to do this on your own; otherwise (or once you try it on your own), the questions below can serve to guide and/or confirm your thinking.

- Think ahead five years into the future (to 2006), when that oil from ANWR will finally reach the market. Indicate the effect this will have on the market for oil five years from now. (You should draw a supply and demand graph.)
- What is the effect on the market price for oil in 2006? Will it be higher, lower, or the same?
- Next: Come back to the year 2001. We need to figure out the impact of that future price change on the market for oil today. So: imagine that you own a bunch of oil. You're trying to decide whether to invest in the bank (by extracting and selling the oil and putting the money in the bank) or to “invest in the oil” (by leaving the oil in the ground until, say, 2006). Does your answer to the previous question make investing in oil look more attractive or less attractive?
- Next: As a result, are you likely to sell more oil this year or less oil?
- Finally, think about what this means in terms of your individual supply curve, and remember that all the oil companies are thinking just like you. So: use a supply

and demand graph to determine the effect on oil prices today of opening up ANWR for oil drilling. Does today's price go up, down, or stay the same?

*Answers*

**A**

- a) Supply increases. Equilibrium price down, quantity up.
- b) Demand decreases. Equilibrium price down, quantity down.
- c) Demand decreases. Equilibrium price down, quantity down.
- d) Demand decreases. Equilibrium price down, quantity down.

**B**

- a) No. Promoting substitutes to oil (e.g., coal and nuclear power) is a demand-side strategy.
- b) Yes.

**C**

- a) Supply increases. Equilibrium price down, quantity up.
- b) Lower.
- c) Less attractive.
- d) More oil.
- e) Supply increases. Equilibrium price down, quantity up.

### **Exercise 8**

- a) Which of the following cost curves suggests the presence of a natural monopoly?  
 $TC = 100 + 5Q^2$   
 $TC = 500 + 5Q$   
 $TC = Q$
- b) A monopoly sets a price of €25 per unit for an item that has a marginal cost of €10. Assuming profit maximization, what is the implicit demand elasticity?
- c) Patents are a kind of monopoly and allow recovering the large research and development costs that some products require. What would happen to the consumer surplus without a patent? (Think in terms of size.)
- d) Bob is the only carpet installer in a small isolated town. The demand for carpet installation from residential consumers is  $p = 10 - Q$  and from business consumers  $p = 15 - Q$ , where  $Q$  is measured in  $m^2$ . If the marginal cost of installing carpet is €1 per  $m^2$ , how much will Bob charge each of the customer types?

*Answers*

- a)  $TC = 500 + 5Q$
- b) With  $MR = P\left(1 - \frac{1}{|\varepsilon|}\right) = MC$  it follows that the implicit demand elasticity is  $-1.67$ .
- c) The surplus would be zero. If a company cannot recover its research and development costs, the product would not be invented.

- d) Since Bob is a monopolist and with  $TR = QP$  it follows that  $MR = 10 - 2Q$  for residential customers and  $MR = 15 - 2Q$  for business customers;  $MC = 1$ . With  $MR = MC$ ,  $Q_{residential} = 4.5$  and  $Q_{business} = 7$ . The respective prices then become  $P_{residential} = 5.5$  and  $P_{business} = 8$ .