Study Questions to Accompany International Energy Markets

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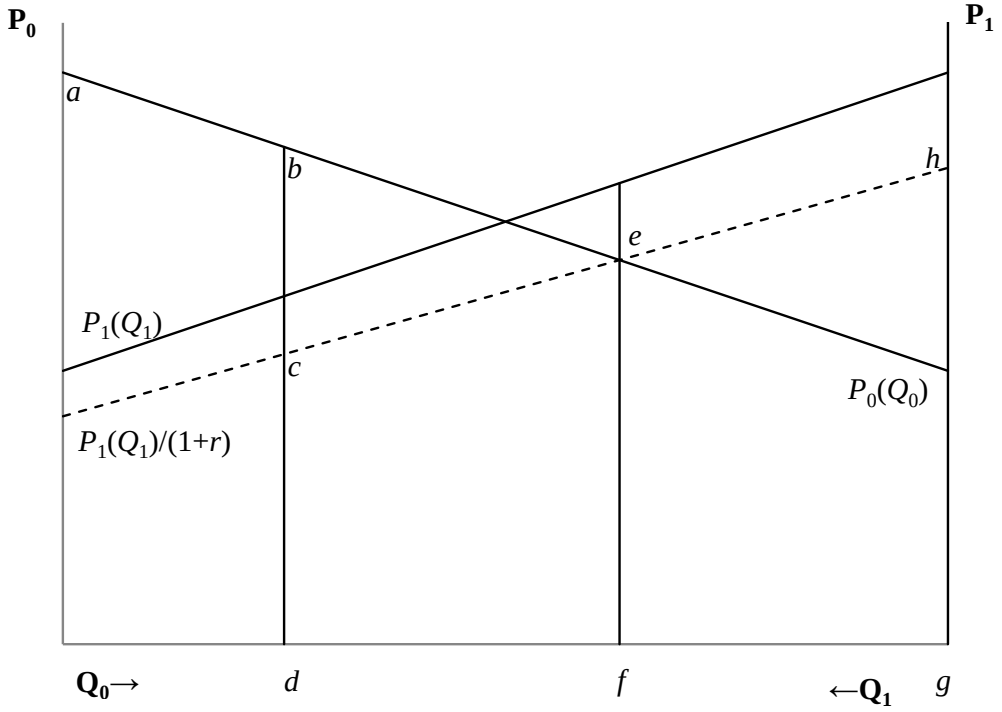
Chapte14. Allocating Fossil Fuel Production over Time and Oil Leasing

14.1 Pick a country not discussed in class or text and graph its oil R/P from BP statistics. Reserves and production can also be found in the Oil and Gas Journal, Worldwide Production Issue in Mid December.

14.2 Use a graph to show that if the allocation were between f and g in Figure 14.6 below, instead of at d, you would have lower social welfare than at the competitive optimum.



14.3 What are Q_o, Q_1, P_o, P_1, NPV of π and NPV of consumer surplus for a competitive model 2, if the interest rate is 20% with income growth that raises demand in the second period as follows:

$Q_o = 100 - 2.5P_o$.

$Q_1 = 105 - 2.5P_o$.

14.4 Let's investigate what happens when we add costs to the model.

14.4a Suppose $P_0 - MC_0 < \frac{P_1 - MC_1}{(1+r)}$. Discuss market forces that might move the market towards the optimization condition. $P_o - MC_o = \frac{P_1 - MC_1}{1+r}$

14.4b What are Q_o, Q_1, P_o, P_1, NPV of π and NPV of consumer surplus the model in 14.3 with MC_0=20, interest rate of 20% and demand in the two periods of

$Q_o = 100 - 2.5P_o$.

$Q_1 = 105 - 2.5P_o$.

14.5 In the model in 14.4, make marginal cost a function of production (Model 5b – cost a function of production) instead of a constant as in 4a (constant marginal costs) or

$MC_o = 20+ 0.2Q_o$,

$MC_1 = 10 + 0.2Q_1$.

Costs are lower in the future period because of technical progress. Show the optimum for this problem in a diagram and mathematically solve for Q_o, Q_1, P_o, P_1, PV of producer surplus and PV consumer surplus of social welfare.

14.6 Although technology reduces costs, depletion raises them. We can represent depletion by making costs in the above model a function of cumulative production in model 5c or

$MC_o = 20 + 0.2Q_o$,

$MC_1 = 20 + 0.2Q_o$.

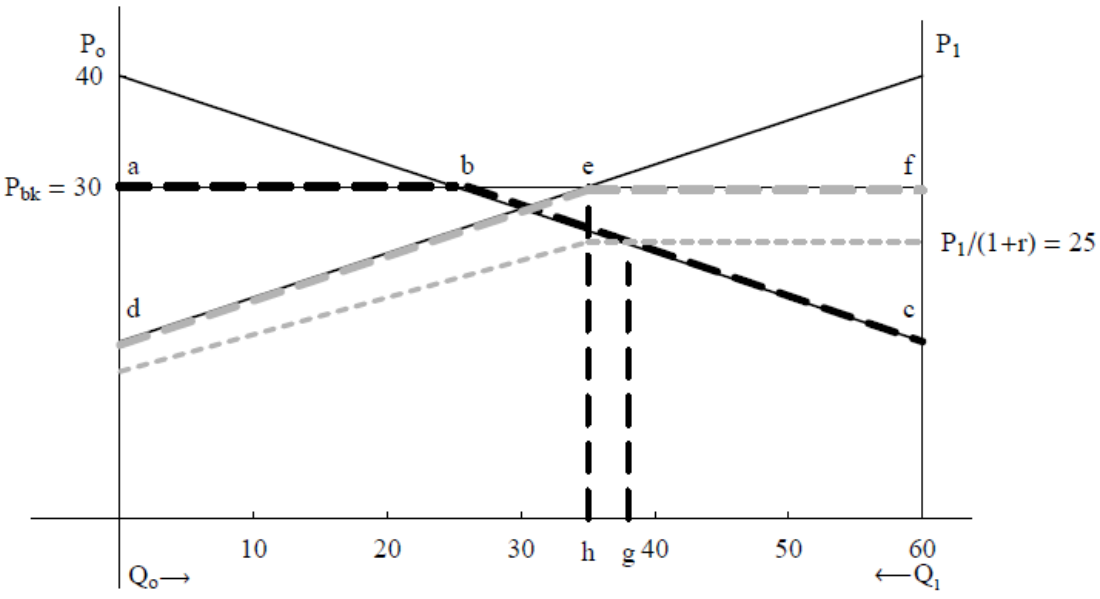
14.6a Explain why MC_1 is a function of Q_o when costs are a function of cumulative production.

14.6b Show the optimum for this problem in a diagram.

14.6c Mathematically solve for Q_o, Q_1, P_o, P_1, PV of π, and PV of social welfare.

14.6d How could we change the marginal cost function to represent economies of scale but with no depletion effect?

14.7 Suppose the backstop price were $27 in the above two period example and represented in the figure below.



14.7a What would price in the future be?

14.7b What would current price be?

14.7c. What is Q_o and Q_1?

14.7d. How much of the backstop is consumed in the future period?

14.8 Now assume that technical progress has increased reserves to 500 and there is no backstop product and no demand growth. Demand is Q=150-2.5P+1Y with Y=100.

14.8a Complete the following table to determine how long the reserves will last.

	P	Q	R
Pn	100	0.000	500
Pn-1	83.33	41.667	458.33
Pn-2			
Pn-3			
Pn-4			
Pn-5			
Pn-6			
Pn-7			
Pn-8			

14.8b Why does income growth make the problem considerably more difficult?

14.8c Now complete the table for the same model if MC is constant at 20. Do reserves last a shorter or long period when costs are included in the model?

14.9 What are Q_o, Q_1, P_o, P_1, NPV of π and NPV of consumer surplus for a monopolist in model 2 if the interest rate is 20% with income growth that raises demand in the second period as follows:

$Q_o = 100 - 2.5P_o$.

$Q_1 = 105 - 2.5P_o$.

14.10 Assume a monopolist producer faces the demand P = 200 –2Q (in model 1, no cost, no income growth) with reserves of 200.

14.10a Fill in the following table to determine the price and quantity trajectories and how long the reserves last.

Monopoly

	MR	Q	P=	R
Pn	200	100	200.000	200
Pn-1	166.67	8.3333	183.333	191.67
Pn-2				
Pn-3				
Pn-4				
Pn-5				
Pn-6				
Pn-7				
Pn-8				

14.10b Fill in the following table if the model in **14.10b** is competitive. What happens to the price and quantity trajectories and how long the reserves last.?

Competitive model

	P	Q	R
Pn	200	0.000	200
Pn-1			
Pn-2			
Pn-3			
Pn-4			
Pn-5			
Pn-6			
Pn-7			
Pn-8			

14.11 Adding taxes may change the production profile in a dynamic model. Go back to the model in 14.4. MC_0=20, interest rate of 20% and demand in the two periods of

$Q_o = 100 - 2.5P_o$.

$Q_1 = 105 - 2.5P_o$.

14.11a What happens if you add a unit tax of 1 on the resource?

14.11b What if instead an ad valorem tax on price of 8% was passed in the above model? Would it change the production profile?

14.11c Suppose instead a 50% rent tax is imposed in the above model.

14.11d Suppose the company is able to inflate accounting costs to $22 for tax purposeS. How would this distort the production profile from the optimal profile?

14.12 One way of allocating government owned reserves to companies is through competitive bonus bidding. Go back to the model in **14.4.** MC_0=20, interest rate of 20% and demand in the two periods of $Q_o = 100 - 2.5P_o$ and $Q_1 = 105 - 2.5P_o$.

14.12a What would you expect competitive bonus bidding to yield in revenue?

14.14b If the government gave the bid to the company that promised the most production in the current period, what would you expect the price and production profile to look like?

14.15 According to technical reports, an oil field in the Middle East has an initial production of 1,500,000 barrels of oil per year. The reservoir engineers have determined that oil production will probably follows an exponential pattern. Oil production in year "t", *q(t)*, is approximately determined by the following function:

$q(t) = q(0)e^{-rt}$ where *q(0)* in the initial oil production, and *r* is the annual rate of extraction which is equal to 4%. Calculate the amount of reserves in this field.

14.16 Suppose you have found a new field in Gunnison, Colorado. Its decline rate is alpha = 0.15, the discount rate is 0.09, the field cost $1.5 billion to find and develop, and reserves are 200 million barrels.

14.16a What is the levelized cost per barrel?

14.16b Because there are no outlets in Gunnison, you'll have to transport all of the product through a pipeline for 30 years at a cost of 70 million dollars. Assume you will be able t keep the pipeline full (30 million barrels per yeaar0 because other fields will be developed to fill in the pipeline. What are the levelized cost per barrel of oil?