Quiz #3 - EconS330
Due on Monday, September 23rd at 11.10am.

Name__________________________

Instructions. You are allowed to work in groups but I expect each student to hand in his/her own solution.

1. Oil is an example of a depletable resource. Assume that the demand for oil in period 1 is \( p_1 = 10 - 0.5q_1 \) and in period 2 it changes to \( p_2 = 6 - 0.5q_2 \). However, the marginal cost in both periods is constant and equal to $3. [Please round your results to 2 decimal places]

(a) Identify the dynamic efficient allocation when the total stock is 20 gallon barrels and the interest rate is 10%. (25 points)

(b) Identify the efficient price and marginal user cost (MUC) in both periods. (25 points)

(c) Identify the static efficient allocation and compare it to the dynamic efficient allocation (part (a)). Discuss your results considering that the demand function is different in both periods. (25 points)

(d) Depict the dynamic efficient allocation in each period and identify the net benefits. (25 points)

Solution

Part (a)

First identify the three equations that represent present (Period 1), future (period 2) and total stock. Note that \( MUC = p - MC \), where \( MUC \) denotes marginal user cost, \( p \) is the price and \( MC \) represents the marginal cost.

\[
MUC_1 = 10 - 0.5q_1 - 3 \quad (1)
\]

\[
MUC_2 = \frac{6 - 0.5q_2 - 3}{1.1} \quad (2)
\]

\[
q_1 + q_2 = 20 \quad (3)
\]

Using the condition \( MUC_1 = MUC_2 \), we have that

\[
10 - 0.5q_1 - 3 = \frac{6 - 0.5q_2 - 3}{1.1}
\]

Multiplying the equality by 1.1

\[
11 - 0.55q_1 - 3.3 = 6 - 0.5q_2 - 3
\]

\[
4.7 = 0.55q_1 - 0.5q_2
\]

Hence, solving for \( q_1 \) we obtain equation A

\[
q_1 = \frac{4.7 + 0.5q_2}{0.55} \quad (A)
\]

Plugging (A) into (3) we obtain,

\[
\frac{4.7 + 0.5q_2}{0.55} + q_2 = 20
\]

Multiplying the equality by 0.55 we have that

\[
4.7 + 0.5q_2 + 0.55q_2 = 11
\]

and solving for \( q_2 \)

\[
1.05q_2 = 6.3
\]

\[
q_2 = \frac{6.3}{1.05} = 6
\]

given that the total stock is \( q_1 + q_2 = 20 \) then \( q_1 = 14 \).
Part (b)
The price in period 1 is $p_1 = 10 - 0.5 \times 14 = 3$ and in period 2 $p_2 = 6 - 0.5 \times 6 = 3$. Hence, the marginal user cost is the same in both periods and it is equal to zero ($MUC = p - MC = 3 - 3 = 0$).

Part (c)
The static efficient criterion argues that an optimal allocation is obtained when $P = MC$. Hence, in period 1

\[10 - 0.5q_1 = 3\]
\[q_1 = \frac{7}{0.5} = 14\]

and in period 2

\[6 - 0.5q_2 = 3\]
\[q_1 = \frac{3}{0.5} = 6\]

Therefore, in this particular case the efficient and the dynamic criterion provide the same solution. This is due to the fact that the demand function is different in each period. Specifically, in period 2 the demand for oil is lower which compensates the consumption in period 1. A decrease in the demand for oil can be explained by a change in the preferences of future generations.

Part (d)